EXAMINING REMANUFACTURING IN SUPPLY CHAIN AND OPERATIONS MANAGEMENT
ABOUT THIS REPORT

Research shows that remanufacturing is growing in maturity in many industries and organizations, and skilled professionals are essential to that development. APICS conducted a survey of supply chain and operations management practitioners in response to a growing interest in remanufacturing and requests for more in-depth research. In 2013, APICS invited approximately 18,000 practitioners to participate in the survey.

APICS Research Reports are based on practitioner surveys that explore trending topics in supply chain and operations management. They include survey results, analysis, tips, and best practices to keep you and your organization informed of insights and innovations in supply chain and operations management.

This report was developed by the APICS Foundation, the research arm of APICS. The APICS Foundation advances supply chain and operations management and innovation through research, publications, education and talent development. Organizations and academic programs gain access to the information they need to contribute to the success of supply chains and meet enterprise goals through the foundation’s exceptional network and resources.
EXAMINING REMANUFACTURING IN SUPPLY CHAIN AND OPERATIONS MANAGEMENT

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SUPPLY CHAIN REMANUFACTURING

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Gold-Medal Reverse Logistics 46
Achieve a winning supply chain program
An excerpt from the APICS magazine article written by Dave Turbide, CFPIM, CIRM, CSCP, CMfgE
A company’s introduction to reverse logistics typically is based on the return of reusable shipping containers or pallets, product returns handling, or recycling or reprocessing of production scrap and offal materials.
Remanufacturing:
The APICS Dictionary, 14th edition, defines remanufacturing as an industrial process in which worn-out products are restored to like-new condition. In contrast, a repaired product normally retains its identity, and only those parts that have failed or are badly worn are replaced or serviced.
EXECUTIVE SUMMARY
Remanufactured goods are an opportunity in price-sensitive markets and the growing field of emerging economies. Technology is making designed-for-remanufacturing product development easier and more cost effective than in the past. Many expect these trends to continue in the long-term. Organizations are increasingly seeking greater value from supply chains. Investments already made for reverse supply chain capability, such as recycling or regulatory compliance, mean remanufacturing has even more opportunity to leverage existing supply chain partnerships and infrastructures.

Global Acceptance
In the past, remanufacturing was typically limited to supporting business-to-consumer (B2C) warranty, customer returns, and business to business (B2B) return of capital-intensive “core” products (such as engines and industrial goods) to long-term service, within a domestic or regional marketplace. While these applications remain, new reasons for entering the remanufacturing market are growing. Remanufacturing and reverse supply chains are essential for:

- New market development
- Customer service
- Value-chain development
- Sustainability
- Research and development.

Career Development for Supply Chain Professionals
Becoming experienced and skilled in remanufacturing helps make the careers of supply chain and operations management professionals more versatile.

Remanufacturing requires new skills in forecasting, planning, inventory management, and many other supply chain practices. With these skills, a professional can better identify potential for opportunity and innovation in traditional forward supply chains and reverse supply chains.
**KEY FINDINGS**
Remanufacturing adds complexity to supply chains. A reverse supply chain, where the customer becomes the supplier, presents complexities not found in traditional supply chains. Approximately 59 percent of survey respondents stated that reverse supply chains add complexity to their organizations. However, practitioners expect growing demand for remanufactured goods, so understanding and training for remanufacturing is becoming a necessity.

**Improving Visibility and Integration**
Organizations may not be gaining all the value they can from their remanufacturing operations because of low visibility compared to the rest of the organization.

>35%
More than 35 percent of respondents stated that remanufacturing is a key method of complying with sustainability policies, goals, and requirements.

14%
Only 14 percent of survey respondents stated that remanufacturing was part of their R&D process.

≈48%
Approximately 48 percent of respondents stated that remanufacturing was somewhere between less than moderately visible and not visible at all.

Remanufacturing directly serves the growth of the reverse supply chain, sustainability and value-chain, and research and development. In addition, it serves more traditional functions including warranty, maintenance repair, and overhaul (MRO), and customer request. Combined, remanufacturing increasingly supports high-priority goals, competitive practices, and critical customer service functions.
**Challenges in Forecasting and Opportunities with IT**

It’s difficult to forecast the condition of many used products returning to the remanufacturing process. More than 32 percent of respondents reported that their information technology (IT) systems were poor at forecasting anticipated demand. This is not surprising. Relying on the customer as your supplier often means enduring greater variability in supply quantity and quality. This makes forecasting more difficult compared to forecasting supply from traditional new suppliers. Remanufacturing operations must address continually varying component conditions. Others reported issues with enterprise resources planning (ERP) systems support.

*Technology is creating many options in designed-for remanufacturing,* and many other designed-for attributes, such as designed-for six sigma or designed-for assembly. Product design in component materials, assembly options, and product tracking are improving. Past challenges related to inefficient core parts, or difficult to remanufacture parts, are addressed in the design phase and create new value chain opportunity.

**IT Solution Assessments**

Respondents were asked to rate remanufacturing-related IT solutions used by their organizations.

<table>
<thead>
<tr>
<th></th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Excellent</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anticipated demand forecasting</td>
<td>32%</td>
<td>27%</td>
<td>28%</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>Incoming or outgoing product core credits and charges</td>
<td>15%</td>
<td>26%</td>
<td>34%</td>
<td>16%</td>
<td>9%</td>
</tr>
<tr>
<td>Multiple product or component versions</td>
<td>17%</td>
<td>27%</td>
<td>35%</td>
<td>13%</td>
<td>8%</td>
</tr>
<tr>
<td>Inventory</td>
<td>14%</td>
<td>26%</td>
<td>35%</td>
<td>20%</td>
<td>5%</td>
</tr>
<tr>
<td>Data integration with other departments and systems</td>
<td>22%</td>
<td>26%</td>
<td>37%</td>
<td>9%</td>
<td>6%</td>
</tr>
</tbody>
</table>
Advancing Remanufacturing Skills

Remanufacturing skills are generally transferable to traditional “forward” supply chain and operations management practices.

- Staff and professionals can cross-train and transfer between forward supply chain and or remanufacturing.
- Survey results show that specific remanufacturing skills such as sales and operations planning (S&OP), inventory management, scheduling, and planning are highly transferable to new product manufacturing.
- More than 50 percent of survey respondents agreed that most supply chain and operations management professionals need familiarity with the topic of remanufacturing.
- The improvement of legal and trade recognition of remanufactured goods, designed-for-remanufacturing technologies, trends of sustainability, and value-chain will help remanufacturing uncover new opportunities for supply chain professionals.
- Practitioners expect growing demand for remanufactured goods.
- Meeting increasing demand for remanufactured goods requires strategic-level consideration of both new and remanufactured product production.

Skill Set Transferability

Respondents were asked to assess the transferability of the following remanufacturing skills to new product manufacturing.

<table>
<thead>
<tr>
<th>Skill</th>
<th>1 Not at all</th>
<th>2 Very</th>
<th>3 Very</th>
<th>4 Very</th>
<th>5 Moderate</th>
<th>6 Very</th>
<th>7 Very</th>
<th>8 Very</th>
<th>9 Very</th>
<th>10 Very</th>
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<tr>
<td>Planning</td>
<td>3%</td>
<td>5%</td>
<td>2%</td>
<td>5%</td>
<td>16%</td>
<td>4%</td>
<td>14%</td>
<td>17%</td>
<td>12%</td>
<td>22%</td>
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<td>Procurement</td>
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<td>2%</td>
<td>4%</td>
<td>5%</td>
<td>14%</td>
<td>5%</td>
<td>13%</td>
<td>17%</td>
<td>14%</td>
<td>24%</td>
</tr>
<tr>
<td>Scheduling</td>
<td>2%</td>
<td>4%</td>
<td>7%</td>
<td>3%</td>
<td>10%</td>
<td>8%</td>
<td>13%</td>
<td>22%</td>
<td>11%</td>
<td>20%</td>
</tr>
<tr>
<td>Production</td>
<td>2%</td>
<td>2%</td>
<td>5%</td>
<td>6%</td>
<td>14%</td>
<td>11%</td>
<td>11%</td>
<td>19%</td>
<td>11%</td>
<td>19%</td>
</tr>
<tr>
<td>Customer service</td>
<td>2%</td>
<td>4%</td>
<td>4%</td>
<td>2%</td>
<td>10%</td>
<td>7%</td>
<td>11%</td>
<td>18%</td>
<td>14%</td>
<td>28%</td>
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<tr>
<td>S&amp;OP</td>
<td>5%</td>
<td>8%</td>
<td>3%</td>
<td>4%</td>
<td>12%</td>
<td>6%</td>
<td>11%</td>
<td>16%</td>
<td>16%</td>
<td>19%</td>
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<tr>
<td>Inventory</td>
<td>2%</td>
<td>6%</td>
<td>4%</td>
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<td>13%</td>
<td>6%</td>
<td>8%</td>
<td>17%</td>
<td>14%</td>
<td>24%</td>
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Questions for Discussion
Use these questions to help assess the role played by remanufacturing in your organization:

How would you answer the survey questions for your organization?
Comparing your results with those of our respondents may be useful in assessing the strengths and weaknesses of your organization’s current remanufacturing operation.

Is your organization considering the addition of a remanufacturing operation?
Consider using these survey responses as guidelines to maximize benefits and reduce shortcomings while planning.

Remanufacturing vs Refurbishing
Only 32 percent of respondents stated that most or all of their management could distinguish between remanufacturing (meaning restore to as good-as-new condition) and refurbishing (meaning restore to a serviceable condition).
RESPONDENT PROFILE
The majority of respondents surveyed had professional experience in remanufacturing and about a fifth had worked a decade or more in the area.

≈35%  
Approximately 35 percent of respondents indicated that their organizations’ production facilities currently use remanufactured equipment.

>25%  
More than 25 percent of respondents indicated that most or all of their competitors offer remanufactured products similar to those produced by their organizations.

>50%  
More than half of the respondents surveyed have spent more than 12 years in supply chain or operations management positions.

≈33%  
Approximately a third of the respondents were from the manufacturing industry, followed by the healthcare and pharmaceutical, telecommunications, food and beverage, and automotive industries.

Remanufacturing Experience
Respondents were asked whether or not they have professional remanufacturing experience in supply chain or operations management.

<table>
<thead>
<tr>
<th>Response</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Yes</td>
<td>56%</td>
</tr>
<tr>
<td>No</td>
<td>40%</td>
</tr>
<tr>
<td>I Don’t Know</td>
<td>4%</td>
</tr>
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Necessity of Remanufacturing Knowledge
Respondents were asked to indicate their level of agreement with the following statement: “Most supply chain and operations management professionals need at least some familiarity with the topic of remanufacturing.”

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<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Strongly Agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1%</td>
<td>8%</td>
<td>23%</td>
<td></td>
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<td>2%</td>
<td>21%</td>
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<td>4</td>
<td>1%</td>
<td>12%</td>
<td>23%</td>
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Extent of Remanufacturing Experience
Respondents were asked to indicate the amount of experience they have with producing remanufactured products.

- **14%** Less than 1 year
- **20%** 1 to 3 years
- **17%** 5 to 8 years
- **19%** 3 to 5 years
- **20%** 8 to 12 years
- **23%** More than 12 years
Customer-to-Supplier Transition
Respondents were asked to identify the reason(s) a customer might eventually become a supplier to their remanufacturing operations.

54% Remanufacturing is our process for taking in customer returns, and providing warranty replacement products to the customer.

39% Customers demand or expect the option of remanufactured products. Remanufacturing is a competitive requirement to serve our market.

35% Remanufacturing is a key method of complying with sustainability policies, goals, and requirements.

23% A high-cost product eventually requires more maintenance or repair than a customer’s own maintenance-repair-overhaul (MRO) process can handle. These customers prefer to sell back their old product and purchase an identical remanufactured product.

22% Specific price-sensitive markets see value in remanufactured items; while these markets cannot be easily reached by your customer, they can be reached by your organization.

13% Remanufacturing is part of my organization’s research and development (R&D) process. We remanufacture products in order to gather information on actual customer usage and wear patterns.
**Visibility**
Respondents were asked to assess the level of remanufacturing visibility in their organizations.

<table>
<thead>
<tr>
<th>1 Very Visible</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Moderately Visible</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10 Not at All Visible</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
<td>8%</td>
<td>10%</td>
<td>20%</td>
<td>21%</td>
<td>12%</td>
<td>23%</td>
</tr>
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</table>

**Remanufacturing Versus Refurbishing**
Respondents were asked if their organizations’ management is generally able to distinguish between the terms “remanufacturing” (restoring to ‘as good as new condition’) and “refurbishing” (restoring to ‘a serviceable condition’).

- **41%** Some could, some could not
- **6%** I don’t know
- **21%** No
- **32%** Yes

**Sustainability Policy Inclusion**
Respondents were asked whether or not remanufacturing is considered to be a formal component of their organizations’ sustainability policies.

- **41%** Yes
- **11%** Not sure
- **18%** Not yet, we are working on it
- **30%** No
Organizational Benefits
Respondents were asked to select the way(s) in which remanufacturing benefits their organizations.

- Customer satisfaction: 66%
- Enhances product and organization value chain: 47%
- Reduced production costs in relation to new manufacturing: 46%
- Sustainability: 44%
- Further develops business unit or supply chain strategy: 38%
- New market development: 33%

Organizational Challenges
Respondents were asked to select the challenge(s) posed by remanufacturing to their organizations.

- Additional complexity of reverse supply chains: 59%
- Internal management and resource competition with new production: 39%
- Potential to cannibalize new product sales: 34%
- Fewer customers accepting remanufactured products: 31%
- Limited sales and distribution channels: 29%
Competition
Respondents were asked to indicate how many of their competitors offer remanufactured products similar to those produced by their organizations.

- 28% I don’t know
- 22% A few
- 18% Some
- 20% Most
- 6% None
- 6% All

Long-term Forecasting
Respondents were asked which statement best reflects long-term forecasts of customer demand for remanufactured products in their respective markets.

- 28% Demand will grow at moderate rates as existing customers continue to see value in remanufactured products.
- 24% Demand forecasts are too difficult to develop at this time.
- 20% Demand will grow at substantial rates as increasing numbers of new customers will find greater value, lower cost, or additional flexibility in remanufactured goods.
- 15% Demand for remanufactured goods will fall as customers seek to buy new products and new designs due to high rates of technological change.
Customer or Market-based Perceptions
Respondents were asked to select the customer or market-based perception(s) of remanufacturing they have encountered.

- **71%** Even if the quality is the same, remanufactured goods have lower resale value than newly manufactured goods.
- **37%** Remanufacturing is a fancy term used to resell used products.
- **24%** No manufacturer really wants remanufactured products to succeed because they hurt new product sales.
- **22%** Remanufactured products have poor warranty or after-sales service.
- **19%** Since remanufactured goods are lacking in national and global standards, product quality and performance are too variable to trust.

Remanufactured Equipment in Production Facilities
Respondents were asked whether or not their organizations currently use remanufactured equipment in their production facilities.

- **43%** No
- **34%** Yes
- **23%** I Don’t Know
Advantages
Respondents were asked to select the advantage(s) they associate with remanufacturing, based on their experiences.

- **Sustainability**: 68%
- **Potential for new markets and price points**: 57%
- **Value-chain enhancement**: 53%
- **Greater customer loyalty**: 30%

Drawbacks
Respondents were asked to select the drawback(s) they associate with remanufacturing, based on their experiences.

- **Additional complexity of reverse supply chains**: 57%
- **Fewer customers trust remanufactured products**: 56%
- **Potential to cannibalize new product sales**: 40%
- **Internal management and resource competition with new production**: 36%
DISCOVERING REMANUFACTURING OPPORTUNITY IN YOUR SUPPLY CHAIN

An examination of remanufacturing as an area of growing opportunity for supply chain and operations management professionals and organizations.
DESIGNED FOR REMANUFACTURING

Traditional supply chains are taking more notice of remanufacturing. New products that are designed for remanufacturing are becoming more common as buyers, sellers, and a variety of supply chain and operations management trends create demand for new choices and value.

APICS research has analyzed the data presented in the first part of this report to provide insights that will help you:

- Discover an overview of remanufacturing practices and issues for supply chain and operations management professionals.
- Understand how remanufacturing is evolving on a global scale.
- Use knowledge of remanufacturing to advance best practices at your organization.

Remanufacturing serves a broad array of strategic interests, helps open new markets, and creates additional value. Yet remanufacturing still lacks visibility in many areas. Remanufacturing complexities and challenges are not well understood outside of the remanufacturing industry. This report seeks to increase knowledge and provide information about the topic as it specifically relates to supply chain and operations management professions.

Relationships in Remanufacturing

Remanufacturing is integral to many aspects of production and manufacturing, including operations management, the reverse supply chain, and the value chain.

The Reverse Supply Chain

Reverse supply chains typically include all activities, organizations, and information that facilitate the flow of used products from the customer back to the producer. This is the reverse of the usual flow of products from producer to consumer. Reasons for operating a reverse supply chain may come from environmental or disposal regulation, product recall requirements, or the desire to achieve additional value or profit. Remanufacturing is a specific example of reverse supply chain activity. Remanufacturing returns a customer’s used product to as good-as-new condition. However, not all reverse supply chain activity returns used products to a good-as-new condition. For example, reverse supply chains may operate to stockpile, recondition, or recycle used products.

Remanufacturing: A History

Modern remanufacturing dates back to World War II, when automobile part rebuilding began to transition away from repair shop benches and moved toward becoming its own remanufacturing industrial process. Today, remanufacturing is no longer an industrial or professional niche. According to a report by the Office of the United States Trade Representative, "remanufacturing accounts for 90 percent of the market for certain replacement auto parts in the United States. Overall it is responsible for creating roughly 680,000 jobs."
Remanufacturing and Operations Management
Achieving profitably in remanufacturing, in part, relies on operations management. Remanufacturing operations seek to maximize flow and yield, despite constant variation. Below is an outline of typical operational steps:

Qualification: After acquisition, a product undergoes an initial examination to confirm it is suitable for remanufacturing. The product, or the core of the product, must be free from unusual wear, damage, or missing components that would otherwise disqualify it. This step may also capture precise data about the condition or state of the product in order to document, plan, or refine future remanufacturing production schedules and component inventory levels.

Disassembly: Disassembly seeks to balance speed and productivity while preserving as much product or component value as possible. Where possible, disassembly reverses original new product assembly steps. In other cases, where a product was not designed for remanufacturing, disassembly may create damage. (While this damage will be restored in later steps, it can be costly to the remanufacturing business.) The depth of disassembly is governed by determining what is needed to ensure the remanufactured product meets new product specifications and capabilities.

Component inspection and decontamination: This step evaluates and identifies components for further processing. This step may discard some components while retaining others. Retained modules and components typically undergo recovery cleaning or decontamination to remove the by products of use, wear, or aging.

Component restoration or replacement: Components discarded in the previous step are replaced from remanufacturing component inventories. Remaining components are restored to like-new condition. This step, as with the previous step, may require special skill in order to consistently recognize and perform necessary work needed to reach a like-new condition. Given all the variation possible, these tasks may require substantial experience, training, or qualification.

Reassembly: In a postponement model, final reassembly may await a specific customer order. In a remanufacturing inventory-pool model, final reassembly proceeds when inventory levels call for additional remanufactured stock. An inventory pool ensures that a remanufactured product immediately ships upon receipt of a used product. Reassembly may also involve steps where remanufactured goods are required by law to be labeled, documented, or tracked.

Remanufacturing often serves business-to-consumer (B2C) models where returns and warranty claims create supply and demand for remanufactured products. Other common business models are business-to-business (B2B), end-of-life maintenance and trade-in service.
Testing and quality assurance: Products undergo quality assessment to ensure each objectively meets the standards of newly manufactured products. This may involve testing every product to satisfy regulatory or marketing claims. This step may also document specific quality assurance data as required by the customers, regulators, or industry practice.

Value Chain: Swapping Traditional Buyer and Supplier Roles
Remanufacturing relies on a supply chain of original product buyers to become suppliers to a remanufacturing process. This reversal creates and preserves value for three parties:

- **OWNER**
  The owner of a worn product sees value when a remanufacturer offers an acquisition price higher than the product’s scrap value.

- **REMANUFACTURER**
  The remanufacturer sees value in acquiring a worn product at a price that does not include much of the energy, labor, material and design expense originally expended to create the product when new.

- **FUTURE BUYER**
  The future buyer of the remanufactured product sees value in acquiring a product as good as new but at a lower price than new production. The remanufacturing marketplace helps to establish competitive, ongoing value to all parties.

Eventually, a remanufactured product will be refurbished, recycled, or scrapped when remanufacturing is no longer profitable. This may occur even if a remanufactured unit remains physically capable of serving its purpose in its market. Part of the reason for this is the difficulty of global trade for many remanufactured products.

In many nations, remanufacturing is active in the areas of:
- Transportation equipment
- Computer or telecommunications devices
- Medical devices
- Audio or visual instruments
- Commercial and industrial equipment (particularly in agriculture, mining, construction, printing-copying, utilities, heating and air conditioning, baking, vending, and musical instruments).
However, current trends are changing because remanufacturing is well suited to products, industries, and market trade where products have

- Durable, long life spans
- High cost or complexity when new, which helps create value for remanufacturing
- Market and regulatory recognition or approval of remanufactured products
- Predictable wear or usage patterns
- Standardized designs even over multiple product versions or generations.

### B2C Remanufacturing

Most business-to-consumer business models routinely see the customer becoming a product supplier due to product returns and warranty claims. Even goods free of functional defects may hold “subjective defects” (the product was returned because the customer didn’t want it versus it was returned for actual defects). Remanufacturing seeks to conserve and recover value from returned products.

Consumer products designed for remanufacturing need to balance cost, quality, durability, and volume. For example, higher quality and durability tend to increase new product price and reduce new product demand and production volume. However, this outcome may increase demand and volume for remanufactured products. Ultimately, the combination of cost, quality, durability, and volume must result in predictable supply to the remanufacturing operation.

This may be challenging because not every customer will purchase remanufactured goods. Remanufactured products may not create a green or sustainable perception to the customer due to lack of awareness of remanufacturing. Customer demand may come from a subset of consumers who value equivalent capability at a lower price than new products.

### B2B Remanufacturing

While subjective defects may be less common in the business-to-business arena, warranty service, balancing cost, quality, durability, and sales volume remain important. Repurchase agreements may exist in sales contracts, which set specific dates or fixed hours of use before a product becomes available to remanufacturing.

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**Remanufactured Product**

The Remanufacturing Institute classifies a product as remanufactured if

- Its primary components come from a used product (sometimes called a core).
- The used product is dismantled to the extent necessary to determine the condition of its components. The used product’s components are thoroughly cleaned and made free of rust and corrosion.
- All missing, defective, broken or substantially worn parts are either restored to sound, functionally good condition, or they are replaced with new, remanufactured, or sound, functionally good used parts.
- To put the product in sound working condition, tasks such as machining, rewinding, refinishing or other operations are performed as necessary.
- The product is reassembled and a determination is made that it will operate like a similar new product.
In addition, a company may influence remanufacturing supply and demand based on:

- Repurchase or exchange promotions
- Special financing or financial risk sharing
- Differing levels of customer support.

End-to-end supply chain strategy and/or goals may also influence specific customer relationships, particularly those who seek product suppliers that provide sustainable reuse capability.

**Trends Driving Remanufacturing**

Outside traditional remanufacturing domains, swapping the roles of buyer and supplier to create value is unfamiliar. Buyers and markets operate in terms of resale value or salvage value rather than remanufacturing value; this view is changing due to the following trends that increasingly support remanufacturing:

- Maximizing value in each area of supply chain and operations management
- Improving risk management practices through reverse supply chain capability
- Growing legal and regulatory clarifications and support, economically and through sustainable and responsible legislation
- Increasing demand for greater value and choice from customers and markets
- Advancing sustainability and responsible business practices
- Developing product value stewardship across the triple bottom line of people, planet, and profit through the reuse of resources
- Finding more value from every supply chain function—particularly where remanufacturing offers greater value than refurbishment and/or recycling.

Businesses will see remanufacturing opportunities, particularly where:

- Industries recognize product value not just for product materials but for their inherent design, intellectual property, or regulatory approved status
- Markets accept and trust the “as-good-as-new” concept
- Good customer service and support ensure remanufactured products become solutions, not just price-sensitive commodity items.

**TREND: Closed Loop Supply Chains**

Closed-loop supply chains work by taking back products from customers and recovering added value by reusing the entire product, or some of its modules, components, and parts. Remanufacturing supply chain management establishes a closed loop not only by physical reacquisition of products, but also by managing the risk, opportunity, and value of the customer as an eventual supplier. The tactics of managing supply and demand, inventory management, and channel and logistics functions vary substantially from traditional forward supply chains. Closed-loop supply chains help develop greater capability to advance value-chains, sustainability, and innovative procurement practices.
MANAGING CHALLENGES
Remanufacturing introduces a number of challenges to the environment, including the additional complexity of reverse supply chains; balancing customer-as-supplier; reputation management; and regulatory issues.

Complexity in Supply and Demand

**CHALLENGES**

- As with new production, profitable supply chain and operations management depends on effective forecasting, careful inventory management, and consistent rebalancing of supply and demand. However, remanufacturing introduces variations in both supply and demand that are unfamiliar to new production.

- Remanufacturing in supply chains is often challenged by suppliers that do not deliver consistent quality or supply. Products entering the remanufacturing supply flow may be in poor condition and unsuitable for remanufacturing. In addition, the supply of returned products may decline if other buyers compete for the same supply.

- Demand for remanufactured products decreases if new product prices fall close to remanufactured pricing. This is where remanufacturing must remain as effective in reducing costs and increasing productivity as new production.

**RECOMMENDATIONS**

- Sales and marketing should work to effectively position the value of both new and remanufactured products to all customers.

- Because profitably in remanufacturing relies on operations management, operations should seek opportunities to maximize flow and yield, despite constant variation.
Complexity in Supply and Demand

CHALLENGES

- Supply and demand forecasting based on historical averages produces routine high-level results. However, day-to-day variation can be substantial, particularly in terms of supply.

- As the new product buyer plays the roles of buyer and supplier over time, the buyer must see reliable and predictable value in serving both roles. For example, changing from buyer to supplier may happen when anticipated ownership, repair, and maintenance costs are easy to determine.

RECOMMENDATIONS

- Where possible, a remanufacturing business model should seek to create predictable supply and demand by remaining sensitive to the buyer, and the needs which remanufacturing serves.

- A remanufacturer can help provide guidance to new product life span and life cycle costs in order to help maximize the new product owner return on investment that supports remanufacturing. A new product buyer gains the benefit of an outline for ownership expense and potential repurchase future payment for selling the product to the remanufacturer.

- Setting clear expectations with new product buyers can help establish supply and demand forecasting based on actual customer use and need.

- Maintain alignment with new production and marketing to help create early new and remanufactured product awareness, and updated forecasts and plans. Every sale to a new product customer becomes a potential future supplier. New product sales forces may provide insight into demand from other buyers who cannot afford new product pricing.

Additional supply and demand factors may include:

- Financial and tax requirements such as accelerated depreciation

- Strategic plans and goals of the organization change

- Products once owned and operated by the organization disappear because of outsourcing or business refocusing efforts.

- New product trade-in pricing and promotion.
Reputation and Perception
Organizations can help manage public perception, branding, and marketing of "used" products by making available certified remanufactured units that meet new product standards. These products enhance the reputation of the manufacturer by creating instant choice in the market for good-as-new products, in contrast to used products of unknown quality from unknown sellers. Remanufactured units frequently offer new warranty and service options, which creates greater flexibility for the buyer in terms of ownership risk reduction.

If the original manufacturer engages in remanufacturing, the market may expect the manufacturer to provide warranty or after-sales service comparable to newly produced products. As an original manufacturer begins remanufacturing in a new market, buyers begin to see remanufactured goods as legitimate alternatives to new production. This may stimulate remanufacturing supply chain businesses.

Positioning
The new product manufacturer’s marketing and branding will need to position and differentiate both its competitors, as well as its own remanufactured products. The original manufacturer can stress the advantages of greater research and development, design, pricing, service, and support for both new and remanufactured products. Marketing may create incentives to create a customer relationship that includes both new and remanufactured purchases. For example, the manufacturer may ensure that all components, whether new or remanufactured, are guaranteed to be genuine and manufacturer approved for the highest quality at the best price.

Sales and marketing may need to overcome perceptions about quality, durability, or reliability of remanufactured products. Doubts may exist about the manufacturer’s actual commitment to customer service for remanufactured goods. There may also be the perception that a customer relationship based on remanufactured goods is of lower priority compared to new product customers. Messaging that emphasizes standards and trust for remanufactured products being equal to that of new products, as well as offering greater value, may be important to both markets.
New Product Sales
Internal management or supply chain channel partners may hold concerns about remanufacturing and new product cannibalism, loss of focus, or uncertainty in brand reputation. Supply chain partners may have specific local or market knowledge that can help or hinder the introduction of remanufactured goods. Their formal and informal acceptance, or lack of acceptance, can influence both supply and demand. Early communication, relationship building, and opportunity to share in value help overcome these concerns. Marketing research, staff training, and coordinated strategy support this effort.

Regulatory Environment
Remanufacturing is a relatively recent phenomenon in many nations. Maturity is developing, but laws permitting trade and resale in other markets may not be clear. Laws may view remanufacturing as a threat to new product manufacturing and employment. Current regulation and taxation may fail to distinguish between remanufacturing and repair or refurbishment. Establishing a remanufacturing operation may introduce additional penalties or capital restrictions when compared to new production. This may entail:

- Taxable valuation of remanufactured goods, including depreciation rates, scrap value, value or added taxation rates
- Intellectual property and antitrust matters
- Sustainable regulation
- Industry protection and incentives.

Many nations do not recognize remanufacturing as an industry. Therefore, few national-level statistics are available, making competitive analysis and market development studies difficult.

Lack of Recognition
Some nations forbid labeling remanufactured goods as new goods but also do not recognize remanufactured goods—this may reduce the perceived value for remanufactured products, even if they are as good as new and available at a lower price. Some nations ban the import or export of “second-hand” goods, whose definition may encompass remanufactured goods. Alternatively, the trade of remanufactured goods may be tolerated only due to uncertainty in interpretation of regulatory requirements in some cases.
Despite these challenges, awareness, visibility, and recognition are improving:

- Sustainability regulations that promote the **reduce, reuse, and recycle** model increasingly recognize remanufacturing as a business standard supporting sustainable practices.
- Free trade accords can improve business opportunity by eliminating tariffs, quotas, or permits in trade of all kinds, including remanufactured goods.
- Remanufacturing offers re-skilling and business development opportunity. This attracts entrepreneurs who can identify value and profit potential.
- International trade-level talks in recent years have begun to cover remanufacturing.

As with other supply chain planning, substantial due diligence should accompany any consideration of establishing formal remanufacturing activity or trade with other nations.

**OPPORTUNITIES AND BENEFITS**

Remanufacturing brings a broad spectrum of potential to organizations, particularly those that produce both new and remanufactured products. These examples demonstrate core elements of value and strategy that remanufacturing is uniquely able to provide:

**Big Data**

As used products return and enter the remanufacturing process, a remanufacturer can gather data about the unit’s actual use and performance. This information combined with information about the original buyer and buyer expectations, creates objective data to improve new product development, marketing, and customer relationships. In addition, this information may help reduce warranty claims in future products, improve return forecasts, or lower new market development costs. Marketing may gain a wealth of objective data in operations, finance, and sustainability cost savings. As this information flows to the market and customer community, the remanufacturer and new product manufacturer can demonstrate widespread innovation, responsiveness, and thought leadership in business practices. This may serve general reputation and public relations in areas outside the remanufactured products market. Sophisticated data capture and knowledge management systems may be necessary to leverage all of the data. (For more information on big data, access the [APICS Big Data Folio](#)).
Demand Management
With design knowledge, and knowledge of new designs and their advantages, the manufacturer of both new and remanufactured products can anticipate and forecast when the original purchaser will want to sell units back for remanufacturing. This information assists new product forecasting and new product launches. New product launches may also trigger future remanufactured product launches. This helps plan a coordinated long-term product life cycle that maximizes return on investment in new product design.

Sales and Marketing
Remanufacturing creates opportunities for relationships, new markets, and greater price-point flexibility. In rapidly developing new markets, a remanufactured unit can establish an early brand and customer relationship. Over time, that relationship can grow into loyal brand preference and additional purchases as economic development occurs in the market. This can help build demand for new manufacturing and access to adjacent new markets not yet served by the organization.

Risk Management
Remanufacturing serves the practice of risk management in many ways:

Reducing economic risk
An organization can attract and engage wider audiences for its products and brands. These audiences become loyal customers to the brand and over time become interested in new and remanufactured products.

Direct product safety and performance evaluation
Remanufacturing allows an organization direct access to patterns reflected by customers. Evaluating the performance of a product’s safety and features is no longer theoretical. Research and development can improve future products based on real-world customer use.

Product family life cycle
Development of new products is usually expensive and risky. A new product may have a limited life cycle in the marketplace to recover its development and marketing costs. Remanufacturing helps create a long-term opportunity, lengthening the traditional new product life cycle and creating opportunity for ongoing revenue. With anticipated revenue from remanufacturing, an organization faces fewer financial risks than from relying on new product sales alone.
Access to essential, but expensive or scarce parts
Products that contain scarce or expensive components, difficult to manufacture parts, or highly regulated elements often face procurement uncertainty. For example, a rare metal alloy essential for production may only have a few suppliers or an unstable global market price. Remanufacturing allows a past customer to become the supplier of these scarce components, which reduces procurement risk.

Rapid ability to recover from defects
If a new product family ships with hidden defects, remanufacturing capability offers a ready channel to take back and repair these products, shielding both the customer and the company from full loss and liability that such defects might have caused.

Recommendations: Aligning New Manufacturing and Remanufacturing
Remanufacturing seeks to increase an organization’s market share and increase its reputation for choice and quality. However, remanufacturing risks reducing new manufacturing supply and demand. Remanufactured goods may cannibalize new manufacturing demand. Depending on how remanufacturing is implemented, remanufacturing may compete for capital, skill, and overall management. This risks creating silos of separate manufacturing and remanufacturing business units. In addition, distribution and sales channels may be threatened.

Remanufacturing relies on the success of new manufacturing for products to remanufacture. New manufacturing relies on remanufacturing to create new markets and price points, and the fulfillment of strategic goals, such as increasing value-chain and sustainability performance.

Ideally, value begins with research and development and product design, which serve both new and remanufacturing needs. This creates the concept of a shared product value stewardship business model. In terms of value, sustainability, and strategy, products continually retain and offer value to all supply chain participants.
To satisfy the downstream sales channel, a business model might include one or more of the following:

- Products remanufactured by the company will be sold exclusively through the organization’s existing authorized parts and distribution network.
- The company offers its channel partners a variety of innovative product trade-in incentives, ensuring that the large majority of its parts are returned by its suppliers to the remanufacturing operation. This creates value for new manufacturing by increasing trade-in demand for new products, as well as providing remanufacturing supply.

To ensure optimal risk-reward balancing among distribution and channel partners, the business model might include:

- An inventory repurchase agreement for unsold remanufactured parts
- A credit or deposit for returned used parts to ensure partners return used parts for remanufacture
- Targeted marketing depending on the region, market, or opportunity.

To overcome potential conflicts, supply chains and planned product life cycles should follow a business strategy that leverages and aligns the benefits of new production and remanufacturing.

**CONCLUSION**

Supply chain and operations management practitioners are central to the success of remanufacturing. Their positions connect the tactics, strategies and stakeholders necessary for remanufacturing to function successfully. It’s important for organizations to envision a future where remanufacturing is a standard process for every manufacturing organization.

- No longer a niche: remanufacturing has become mainstream supply chain practice
- New opportunities: remanufacturing is trade legal technology
- Benefits for strategic execution: value chain, sustainability, new markets
- Demand is expected to grow: potential competitive advantages
PERSPECTIVES
FROM APICS MAGAZINE

APICS magazine is an award-winning publication featuring innovative ideas and real-world strategies for inventory, materials, production, and supply chain management; planning and scheduling; purchasing; logistics; warehousing; transportation and logistics; and more. Visit apics.org/magazine to view current and archived issues and to learn more about the magazine.
REVERSE LOGISTICS AT ROLLS-ROYCE

Remanufacturing for a more sustainable supply chain

From the APICS Interview with:

Peter H. Clonts, CPIM  
Master Scheduler  
Rolls-Royce Global Repair Services: Americas

James W. (Jim) Tilton, CPIM  
Logistics Manager  
Rolls-Royce Global Repair Services: Americas

Rolls-Royce has an extensive jet engine remanufacturing operation. This article provides an organizational perspective on making a used product as good as new—the definition of remanufacturing.
Editor’s note: Peter H. Clonts, CPIM, and James W. (Jim) Tilton, CPIM, recently presented the educational session “The Supply Chain in Reverse—Component Remanufacturing at Rolls-Royce” at APICS 2013 in Orlando, Florida, USA. Here, APICS magazine managing editor Elizabeth Rennie speaks with them to learn more about their company’s reverse logistics and sustainability practices.

Rennie: Logistics professionals have dedicated a great deal of time to squeezing margins, managing rising transportation costs, and mitigating risk and shifting demand patterns. Now, they also are responsible for helping to create more sustainable supply networks. With this growing focus on sustainability, what are the new important roles of today’s logistics professionals?

Clonts: I can’t really say there are new roles, per se, but the same old roles are having to shift or expand focus. The logistics manager, master scheduler, material requirements planner, warehouse manager, forecaster, and planner all have to take what they’ve learned in the traditional forward supply chain and prepare for the added levels of complexity inherent in sustainability and remanufacturing efforts.

As we’ve learned from the APICS operations management body of knowledge, operations are operations are operations—until they’re not. In other words, we all take the body of knowledge and apply it to our specific industry, company, customer base, business model, [enterprise resources planning] system, products, and people. Logistics professionals guard the same gates they always have, but what is behind those gates is changing.

Recycling and remanufacture—to me, they are just the next step in the evolution of business; and, therefore, the evolution of the logistics professional. So, the short answer is, roles aren’t changing, just the focus. Today, we are focusing on product return from the customer base; engineering and production capability for medium-to-small-volume repairs, as well as runners and repeaters; product usage data and traceability; the science of varying yield rates management; intimate knowledge of forecasting, with particular ability to recognize that historical consumption of new parts becomes your leading indicator for the core raw material availability; and commodity recycling.

Tilton: Sustainability can be defined as the capacity to endure, so another important role or skill required of today’s logistics professionals would be the ability and aptitude to recognize, deal with, and withstand the increasingly complex and evolving demands that are put upon today’s supply chain to not erode its performance and affect customer satisfaction levels. Years ago, to
become more competitive, manufacturers invested in higher-technology equipment—replacing multiple single-capability machines with fewer multi-capability and computer-guided machines. This required fewer high-skilled workers and [less] outsourcing. Then, we started to cut costs by cutting inventory. We started squeezing our suppliers for more and more cost reductions. Now, for about the last decade or so, our attention has been turned to supply chain and logistics costs to find the hidden savings to be realized in competitiveness and profitability.

To meet the challenges of today and tomorrow, logistics professionals must keep looking forward to stay ahead of the game. Challenge the status quo. Be proactive. (To learn about Tilton’s specific strategies for success, read the October 2013 APICS Extra by Rennie.)

Rennie: Typical responsibilities for today’s logistics professionals also include regulatory compliance and environmental concerns. Do both of these sustainable supply chain forces affect your specific roles at Rolls-Royce?

Clonts: Absolutely. Every decision we make must consider the impacts to all of the appropriate governing bodies. It’s in our DNA... The most visible body is the [Federal Aviation Administration] here in the United States. There is also [the European Aviation Safety Agency], not to mention the governmental requirements for supplying engines to the military.

Tilton: Additionally, Rolls-Royce is International Environmental Management System Standard ISO 14001-certified... And we have a global recycle/revert program whereby our scrap metals are reintroduced into the raw materials supply chain for both Rolls-Royce and our supply base.

Clonts: The other thing I’ll add is that being so highly regulated can put constraints on what suppliers, recyclers, and [third-party logistics providers] we can use—which is a good thing. Often, they have to meet the same requirements we do, so it simplifies the search.

Rennie: What are the major goals of Rolls-Royce’s remanufacturing practices? Please give our readers a brief explanation of what the process entails.

Tilton: In Indianapolis, the remanufacturing part of our business is managed by Global Repair Services: Americas (GRSA). GRSA is made up of repair engineering; program management; aftermarket supply chain; scheduling; logistics; quality; and, of course, finance. The reason and mission of GRSA is to reduce the cost
per flight hour of [aircraft engines], develop and oversee component repair suppliers, create additional revenue opportunities for Rolls-Royce, offer customers a one-stop shop for repaired serviceable components, and provide a mechanism to turn technology into revenue.

Clonts: We also strive to reduce engine overhaul turn times by having a pool of repaired inventory available and reduce our carbon footprint through reuse and repair parts, as much as possible, and recycling those parts that cannot be repaired or reused by reverting to original billet form. From my perspective as master scheduler, the planning aspect is much more complex than the standard forward supply chain. While we have to understand overall demand, we additionally have to understand the constantly moving target of the expected split between new and repaired components. In one sense, it can be viewed simply as balancing a requirement between two different suppliers. However, when the rate at which your core items—raw material input into your remanufacturing supply chain—become available, the condition of that core, which historical configuration of that core arrives, and which repair scenarios can be applied all vary greatly. Suddenly, it can feel like you’re trying to hit a moving target at 300 yards with a Wiffle Ball while blindfolded.

Rennie: What are some other noteworthy challenges Rolls-Royce has faced along the way to building an effective remanufacturing program?

Tilton: I think one of the challenges has been to keep pace with the growth of this program. GRSA started out as an idea to provide support for a set of programs limited to one business unit. As the business significance became evident, it was being applied across other business sectors. Oftentimes, multiple business sectors can end up doing the exact same thing, but using totally different approaches. Standardization becomes paramount; mass customization is rarely ever cost effective. Another big issue in a remanufacturing program and the reverse logistics that support it is relationship management. The relationship requires a bit of “role swapping,” if you will. In a program such as this, the customer becomes the supplier, and vice versa. The customer now supplies you with their core returns. This is where the ability to think and act collaboratively comes in full steam. The more complex and diversified the organizations involved are, the more challenging the relationship becomes to manage.

The same people aren’t always the ones controlling what comes in and goes out. Program coordination can be challenging without a solid understanding of the bigger picture.
Clonts: We also had to determine the best way to get used parts and components returned in a timely manner from the overhaul shops and aircraft operators. Eventually, we had to offer an incentive—a core credit—to encourage more timely part returns. Otherwise, some facilities would wait until they were overwhelmed with parts lying around and ship us months-worth of inventory. Those kinds of surges really interrupt continuous material flow.

Another issue we faced was knowing which parts to keep as core and which ones to revert directly. In the early days, we kept absolutely everything and ran out of storage space to the point of needing to make decisions on what we keep and what we revert directly. Eventually, we began setting maximum inventory levels on some of the cores that didn’t have an active repair.

Rennie: In your APICS 2013 presentation, you said that remanufactured products sometimes can surpass their original design specifications in terms of durability, life span, and performance thanks to the design and component improvement that occurred while the product was in service. Can you share more on this point?

Tilton: Sure. Here are a couple of examples: On a component exposed to extreme thermal conditions, a repair development allowed the part to better resist the rubbing wear created by the thermal expansion. This performance improvement doubled the life span of the part. On another component exposed to constant burning, the repair addition of a special coating extended the life of the part so that it no longer causes the teardown of the assembly. In both of these cases, the repair technology was so successful that it was incorporated into the [original equipment] design.

Rennie: Also in your presentation, you shared with attendees that “success starts at the front end of your returns management system.” Why do you believe this is true? Can you share some of the key front-end enablers and requirements for your remanufacturing and returns management systems?

Tilton: One thing about being associated with any processes involving warehouse storage space is that people will seek you out to “find a place to put their stuff,” as the late, great George Carlin used to say. A warehouse is not a place to just put your stuff; those places are called storage units. A warehouse is a storage and issuance facility. It is not unlike an efficient filing system. Items are received into predetermined locations and valuations. This facilitates proper and timely stockkeeping activities, reporting, issuances, et cetera.
Rennie: How does remanufacturing relate to risk management? Can an effective reverse flow help mitigate some potential hazards?

Tilton: Absolutely. Having a pool of parts on hand and knowing their status allows us to have an additional material supply other than the standard raw, work in process, finished goods. This “pool exchange program” enables Rolls-Royce to keep a set of serviceable parts on hand to be exchanged for incoming core to be repaired. You now have a supply of goods that can be reviewed for possible mitigation of a gap in the original equipment manufacturer supply side. It gives customers an alternative to other higher-priced, longer-lead-time options.

Clonts: In fact, this was part of the impetus of developing repairs in the first place. Early in the life cycle of the engine program, the market demand for [a particular] engine grew much, much faster than originally anticipated. That created a strain on our supply chain and manufacturing ability, leaving very limited capacity to support the aftermarket engine repair and overhaul. So, what could we do? To stand up and get all of the appropriate approvals for a new manufacturer would have taken far too much time. To paraphrase Princess Leia, “Repair development, you’re our only hope.” And like any good Jedi, they delivered victory against the supply constraints. Those early days haven’t been the only instances of mitigating supply risk. In fact, part of our current planning for repair includes determining what the sustainable repair rate can be. What can both the repair suppliers and [original equipment manufacturing] suppliers rely on as a predictable balance of demand? As I stated earlier, it’s a constantly moving target, but one that is critical to the business in order to meet our customer satisfaction requirements and inventory budget constraints.

Rennie: What specific benefits does Rolls-Royce enjoy as a result of its remanufacturing initiatives?

Tilton: Customer-facing business units are able to achieve 95 percent on-time parts delivery. Additionally, inventory that is managed to optimum levels in our pool exchange program provides reduced administration needs for expedited or one-off repairs, reduced supplier repair cost, optimized inventory levels through part exchange, better visibility, better management of potential supply chain shortages, more scrap kept out of landfills, reduced raw material costs, and cost-saving incentives for suppliers ... In short, predictable parts delivery to the shops means that our customer business units and our engine build shops are able to achieve higher customer satisfaction levels.
Clonts: The benefits Jim speaks of are now coveted in other parts of the business. We developed and grew this remanufacturing/pool exchange model in Indianapolis. It has been recognized as a best practice in Rolls-Royce globally. We are currently adopting this mind-set and methodology for use worldwide, specifically in the [United Kingdom] and Germany. And, like any other process, we’re always driving improvement in and waste out—always keeping our people, partners, and planet at the forefront of it all.
THE ROAD TO ZERO IMPACT

Green efforts go hand in hand with continuous improvement and cost reduction

By Ron Crabtree, CIRM, CSCP, MLSSBB
This article demonstrates the implementation of zero-landfill as a step towards supply chain reversal, and supports remanufacturing.

Organizations have discovered new and innovative ways to reduce the environmental impacts of their operations. For example, forward-thinking firms engage lean six sigma principles to find cost-effective solutions to meet environmental mandates and reduce waste in all aspects of the business.

One success story of embracing both lean and green can be found in the US automotive industry. In the mid-1990s, I was head of materials management and continuous improvement programs at an automotive parts supplier. We manufactured interior trim used in headliners and insulation for the Big Three US automakers. The process of forming finished parts out of resonated fiberglass, foam, and textiles generated a large amount of extra trimming. Each production cell was equipped with its own trash receptacle. If production was running well, these were emptied into a large compactor around 16 times per shift, a process that required lifting up and shaking out the containers.

It took a team of four forklifts working continuously to keep up with the volume. Lifting the trash receptacles overhead was dangerous work—sometimes they would even fall off the forklifts while drivers banged at them to dislodge the contents. In addition, the compactor would jam two or three times a day, as the nature of the trimmings made it difficult to compact them tightly. Each 40-cubic yard container usually went to the landfill with only about 20 cubic yards of material in it.

To begin to tackle the problem, I led a lean kaizen event. First, we obtained a baseline of the current process in order to understand the true and total costs. A team was formed to brainstorm measures that could either reduce the effort required to handle trimmings or the need for them in the first place. One innovation was to use smaller baling compactors at each production cell. This made it easier for operators to place trimmings in a more convenient location instead of high above in a large hopper. This was an improvement in terms of both ergonomics and safety.

The balers also enabled us to achieve maximum compaction. In fact, the forklifts simply drove the bales into an open container and stacked them neatly—any need for a monster-sized compactor was eliminated completely. Not only were forklift trips per shift reduced from 16 to 4 (or fewer), but we also realized a four-to-one improvement in the density of compressed trimmings. This reduced the landfill costs by about 75 percent.
The only investment required to achieve these benefits was the capital for eight small compactors, which paid for themselves in nine months. And, because these costs were amortized over five years, the factory enjoyed a bottom-line improvement of more than $250,000 per year associated with labor, forklift operations, and landfill use while improving safety dramatically. On top of that, environmental impact in the form of landfill volumes was greatly reduced in just a few weeks. In this case, becoming lean and green paid for itself handsomely.

**Looking to Improve**

Of course, the automobile manufacturing landscape has changed significantly since those days. Let’s take a look at some of the work that General Motors and one of its suppliers are doing to accomplish the goal of landfill-free plant status.

MPS Group is an industrial and facilities services provider headquartered in Detroit. Owner Charlie Williams and president and CEO Ed Schwartz both know the importance of forming strong supply chain relationships to reach green sustainability objectives. For manufacturers attempting zero-landfill status, it is imperative to partner with a supplier that carries a core competency in total waste management. Such companies have the expertise to bring solutions to waste issues and understand the finances and how to bring together the business case.

It’s easy for manufacturers to overlook the many fine details involved in reducing the level of trash in operations and achieve zero-landfill status. For MPS Group, getting to this point required being proactive in preventing trash from being produced in the first place, collaborating with packaging to reduce materials. Additionally, every item is examined for its potential for reuse, and any remaining waste is recycled or transported to an energy-from-waste facility where materials are burned or otherwise converted to generate heat, steam, or electricity instead of buried. However, it usually costs more to send to an energy-from-waste facility than a landfill—likely a result of the longer transportation distances—which becomes a further incentive to minimize waste.
For manufacturers attempting zero-landfill status, it is imperative to partner with a supplier that carries a core competency in total waste management.

MPS Group currently manages more than 13 zero-landfill sites, most of which are operated by General Motors, but the company still looks for ways to improve. Even at locations that have reached zero-landfill status, further waste reductions are sought. The next goal at many sites is to go zero-impact, which includes eliminating landfills, non-recycled waste, and air and water emissions.

The ongoing environmental challenge for organizations of all types is to innovate continuously and adopt the credo of “good enough is never enough.” My hope is that these two short success stories will in some way help you and your organization take on the challenge of becoming both lean and green.

Ron Crabtree, CIRM, CSCP, MLSSBB, is president of MetaOps and coauthor of four books on operational excellence. He also writes an online magazine; runs an online radio show; and teaches, presents, and consults. He may be contacted at rcrabtree@metaops.com.
GOLD-MEDAL REVERSE LOGISTICS

Achieve a winning supply chain program

By Dave Turbide, CFPIM, CIRM, CSCP, CMfgE

Building up capability in reverse logistics may start with packaging, move on to product design, and then move to more specialized supply chain functions. Recovery of value, whether from scrap or deliberate product design, is a core feature of remanufacturing. As organizations increase reverse logistics maturity, remanufacturing may be a good way to leverage that capability.
A company’s introduction to reverse logistics typically is based on the return of reusable shipping containers or pallets, product returns handling, or recycling or reprocessing of production scrap and offal materials. These indeed are the best places to start for company leaders not currently involved in such practices.

Reusable packaging is not always practical, but packaging and shipping materials should be a key part of reverse logistics. Smaller packages are less costly to produce and ship; meaning, customers appreciate them, too. For example, a lot of household cleaners now come in concentrated refill form, and industrial products often can be shipped inside recyclable or reusable containers.

Most commonly, product returns are handled through package shipping services and include return for repairs or, perhaps, for credit. The green approach—and something that is required in many industries—is to encourage consumers to return end of life products for recycling. In order to take advantage of the numerous benefits of capturing the value of scrap and offal materials, you may want to offer incentives or returns at no cost to the customer.

For instance, some printer cartridge manufacturers include postage-paid envelopes at purchase, and some stores give a credit for returned cartridges.

This gets old products off the market and—if there is additional life possible through refurbishment—revenue in your hands. Another great place to look for savings is in design. When new products are designed or existing products updated, every effort should be made to make use of parts rather than specify a new part to be acquired, stored, and managed. Modular design is a big cost saver, as is late customization.

Beyond those practices, designers and engineers should keep an item’s eventual end of life and disposal in mind to maximize reuse and recycling potential. One step beyond that is to design for logistics (making products easy and economical to pack, handle, and ship); design for reverse logistics (employing reusable or salvageable packaging, materials, and components); and design for sustainability (specifying renewable materials).

There are suppliers that specialize in the reverse logistics arena. In fact, there even is a Reverse Logistics Association—a collection of third-party service providers focusing on such services as repair, customer service, parts management, end-of-life manufacturing, returns processing, order fulfillment, and more.

Reverse logistics, which is defined by the APICS Dictionary as “a complete supply chain dedicated to the reverse flow of products and materials for the purpose of returns, repair, remanufacture, and/or recycling.”
**Worldwide Attention**

Consider the case of Teck Resources, a Canadian metal supplier that provided the gold, silver, and copper used in the medals for the Vancouver Olympics. For the first time in Olympic history, the medals at the games contained recovered electronic waste. According to the *Los Angeles Times*, the recovered gold, silver, and copper used in the medals originated from 6.8 metric tons of circuit boards collected and processed by Teck Resources.

*For the first time in Olympic history, the medals at the games contained recovered electronic waste.*

The article also says that responsible processing of electronic waste “has become an increasingly important issue.” Indeed, conscientious reverse logistics is more than a trend or a fad. It is a new business requirement that happens to make sense economically as well as ecologically.

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GLOSSARY

**Closed-loop manufacturing**
Closed-loop manufacturing is a system in which a product is created using renewable energy, with no pollutant output and no waste—the materials used in production are recycled and reused, not discarded. Products are built for durability and reuse, and producers are responsible for the entire product lifecycle, including the post-consumer phase. The concept is rooted in circular concepts of product design and production.

**Corporate social responsibility**
Corporate social responsibility means using fair and beneficial business practices regarding labor and the community or region where a firm conducts its business. It is about providing a safe work environment, giving back to a community by contributing to health care and education, and avoiding the exploitation of labor and resources of an area.

**Demanufacturing**
Demanufacturing, or disassembly, is often used for products that will be recycled or remanufactured. However, remanufacturing may use processes that seek to preserve design and intellectual property rather than recycled scrap value. For example, scrap vehicles may undergo demanufacturing to ensure that recyclable materials such as metals or plastics are not mixed, rather than restoring the vehicle or a component to as good-as-new condition.

**Inventory pooling**
The act of holding inventory in a single location instead of multiple locations.

**Product life cycle management (PLM)**
The process of facilitating the development, use, and support of products that customers want and need. PLM helps professionals envision the creation and preservation of product information, both to the customer and along the reverse-logistics portion of the supply chain.
Recycle
1) The reintroduction of partially processed product or carrier solvents from one operation or task into a previous operation.

2) A recirculation process.

Rebuilding
The term rebuilding was used prior to the term remanufacturing. “Rebuilt,” may in some circumstances, refer to a product that underwent a process similar to remanufacturing but not necessarily to achieve good-as-new condition. Rebuilding may also refer to work performed on a single unit, such as a “bench rebuilt” unit, and many not define a manufacturing-style process production and operations management.

Remanufacturing
1) An industrial process in which worn-out products are restored to like-new condition. In contrast, a repaired product normally retains its identity, and only those parts that have failed or are badly worn are replaced or serviced.

2) The manufacturing environment where worn-out products are restored to like new condition.

Reuse
To use again in a new or different way than originally intended for a product, or to use again after a product undergoes reclaiming or reprocessing work. Remanufactured products normally return to their originally intended purpose.

Reverse logistics
A complete supply chain dedicated to the reverse flow of products and materials for the purpose of returns, repair, remanufacture, and/or recycling.

Reverse supply chain
The planning and controlling of the processes of moving goods from the point of consumption back to the point of origin for repair, reclamation, recycling, or disposal. See: reverse logistics.
Value chain
The functions within a company that add value to the goods or services that the organization sells to customers and for which it receives payment.

Value stream mapping
A lean production tool to visually understand the flow of materials from supplier to customer that includes the current process and flow as well as the value-added and non-value-added time of all the process steps. Used to lead to reduction of waste, decrease flow time, and make the process flow more efficient and effective.
ADDITIONAL RESOURCES
These organizations and publications provide resources and detailed information about the topic.

The Remanufacturing Institute
www.reman.org

Centre for Remanufacturing and Reuse UK
www.remanufacturing.org.uk

National Key Laboratory for Remanufacturing China
www.chinaremanufacture.net/kfjj/kfjj.htm

Remanufacturing Industries Council
remancouncil.org/

Journal of Remanufacturing
www.journalofremanufacturing.com

ReMaTecNews.com
www.rematecnews.com

Center for Remanufacturing - Rochester Institute of Technology
www.rit.edu/gis/remanufacturing/

www.usitc.gov/publications/332/pub4356.pdf
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