



# **Core Acquisitions Planning in the Automotive Parts Remanufacturing Industry**



by

Toyin Clotley  
Department of Supply Chain and  
Information Systems  
College of Business  
Iowa State University  
3258 Gerdin Business Building  
Ames, Iowa 50011  
515-294-8198  
tclotley@iastate.edu

W. C. Benton  
Department of Management Sciences  
Fisher College of Business  
The Ohio State University  
2100 Neil Ave.  
Columbus, Ohio 43210  
614-292-8868  
benton.1@osu.edu

## **Executive Summary**

### **ABSTRACT**

An important problem faced by a remanufacturer is ensuring a sufficient supply of cores to support remanufacturing operations. The sourcing of cores to be remanufactured is a complex set of activities that requires careful coordination to avoid the uncontrolled accumulation of core inventory, or shortages leading to unacceptable levels of customer service. We report on current practice in the automotive industry via an extensive survey of North American automotive parts remanufacturers. The key results of the survey indicate that sourcing arrangements are mostly arms-length, core forecasts are mostly short-term and mainly based on management opinion with frequent forecast modifications, and few remanufacturers use optimization or statistical techniques to determine batch sizes, routings, and safety stock and lead times for remanufacturing. These findings represent lost opportunities for remanufacturers to better manage their supply of cores. We describe the managerial needs and the research opportunities that exist as a result of the findings of this study.

### **1. RESEARCH MOTIVATION AND OBJECTIVE**

Remanufacturing is the process by which products are recovered, processed and sold as like-new products in the same or separate markets. Due to increasing legislation and the realization that being 'green' can be profitable, an increasing number of companies have been implementing comprehensive programs in order to reap the potential benefits of remanufacturing. In the U.S, laws mandating companies to be responsible for take-back of products are becoming prevalent at the state level. As an example, the Remanufacturing Institute ([www.reman.org](http://www.reman.org)) reports that as at May, 2010, twenty-one states in the US had passed laws requiring OEM's to be responsible for taking back and reusing and/or disposing electronic products at end-of-life. However, few guidelines are available to the practicing manager to aid in planning, controlling and managing remanufacturing operations.

In order to assure a sufficient quantity of cores, remanufacturers often use multiple sources for their supply of cores. The primary, and usually the cheapest, source of cores is product returns from the customer due to end-of-life or end-of-use. A secondary source is cores acquired from third parties (e.g. brokers, salvage operators and salvage

auctioneers). Acquiring cores for remanufacturing operations is difficult because of the uncertainty in the quantity and quality of cores from the primary and secondary sources.

The purpose of this study is to identify the management practices that remanufacturers use to source cores for production planning and control. To the best of our knowledge, this study is the first to address the issue of management practices in the core acquisition process.

## **2. THE SURVEY AND RESPONDENTS**

A survey instrument was developed based on previously tested and validated instruments, whenever possible. Several items were modified to suit the remanufacturing environments considered in this research. A pre-test survey was used to refine the questions and to validate the sample viability in meeting the objective of the research. A decision was made to select respondents within the automotive parts remanufacturing industry. The automotive parts industry was chosen mainly because results from remanufacturing in the automotive parts industry are generalizable. Automotive parts were the first products suited to large scale remanufacturing in the U.S. and therefore remanufacturing of automotive parts occurred since the early 1900's ([www.reman.rit.edu](http://www.reman.rit.edu)). The Automotive Parts Remanufacturers Association (APRA) has been in existence since 1941 and is the oldest remanufacturing association in the U.S. APRA currently boasts a membership of over 1000 members worldwide and represents a stable industry in which a diversity of products are remanufactured ([www.apra.com](http://www.apra.com)). This stability and diversity made results, from a sampling frame consisting of APRA members, generalizable to a variety of businesses. With the cooperation of members from APRA, the survey was conducted in late 2009 and consisted of 29 questionnaire items. The survey was administered via an online link sent to 300 members of APRA in North America. Of these, 10 of the contacts responded that they were no longer in the business of remanufacturing, yielding an effective sample size of 290. A total of 101 surveys were returned, yielding an approximate response rate of 35% which is considered exceptional for this kind of research. Of the 101 surveys that were returned, ten had excessive missing data and were removed from the study, resulting in 91 usable responses. Some of the questionnaire items were not relevant to all of the respondents, so these items had less than 91 responses. Table 1 shows a summary of the survey respondents.

Table 1: Profile of respondents

<b>Firm's primary activity</b>		<b>Firm's secondary activity</b>	
Remanufacturing	69%	Service and repair	51%
Service and repair	7%	New product manufacture (OEM)	34%
New product manufacture (OEM)	11%	Selling new products made by others	74%
Selling new products made by others	10%	Other (Describe)	12%
Other	3%	<b>Total Responses:</b>	<b>91</b>
<b>Total Responses:</b>	<b>91</b>	<b>Approximate revenue</b>	
<b>Principal products remanufactured</b>		0 to 299 thousand	19%
Air conditioning systems	5%	300 to 999 thousand	16%
Electrical systems	41%	1-2.99 million	23%
Brake systems	19%	3-10 million	16%
Clutch systems	15%	More than 10 million	26%
Transmission systems	19%	<b>Total Responses:</b>	<b>88</b>
Electronic control modules	10%	<b>Approximate unit sales</b>	
Engines	9%	0 to 9 thousand	42%
Other (Describe)	33%	10 to 29 thousand	28%
<b>Total Responses:</b>	<b>91</b>	30 to 50 thousand	3%
<b>Number of employees used for remanufacturing</b>		More than 50 thousand	27%
fewer than 100	79%	<b>Total Responses:</b>	<b>78</b>
100-249	10%	<b>Remanufactured products as a proportion of total sales</b>	
250-499	6%	0-19%	10%
500-999	5%	20-39%	13%
1,000 or more	0%	40-59%	13%
<b>Total Responses:</b>	<b>80</b>	60-79%	32%
<b>Years of operation</b>		80-99%	29%
0-3 years	3%	100%	3%
4-10 years	7%	<b>Total Responses:</b>	<b>78</b>
11-30 years	41%		
Over 30 years	49%		
<b>Total Responses:</b>	<b>91</b>		

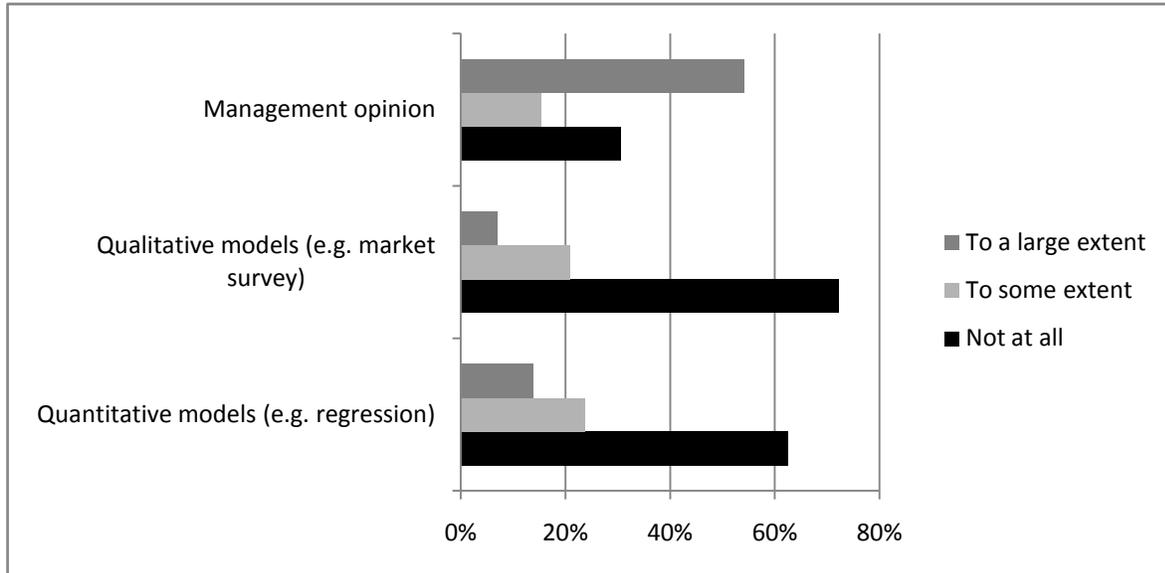
Table 1 shows that the sample represents a variety of remanufacturing operations in the automotive parts industry. Remanufacturing is the primary activity of 69% of the respondents. All but two of the respondents indicated having a secondary activity in addition to remanufacturing. The remanufacturing operations of the respondents are mostly small-to-medium in size in terms of number of employees (fewer than 100), approximate annual unit sales (less than 50,000 units) and approximate revenue (less than 3 million).

### 3. THE RESEARCH RESULTS AND DISCUSSIONS

The respondents indicated that cores mostly represented up to 19% of the cost of a remanufactured product. This 19% figure was also the approximate percentage costs that respondents attributed to factory overhead. A few respondents (approximately 8%) indicated that cores represented up to 59% of the cost of their remanufactured product. The primary source of cores for remanufacturing was trade-in returns from the customer (60-79% of all cores).

Some key conclusions arising from the study are that sourcing arrangements with suppliers of cores are mostly arms-length. This has implications for the successful management of the supply chain for cores. Forecasts of cores are mostly short-term and mainly based on management opinion. Figure 1 shows that the majority of respondents (58%) agreed to using management opinion, to a large extent, to forecast cores. Frequent modifications of these forecasts indicate a lack of confidence in the accuracy of the forecasts.

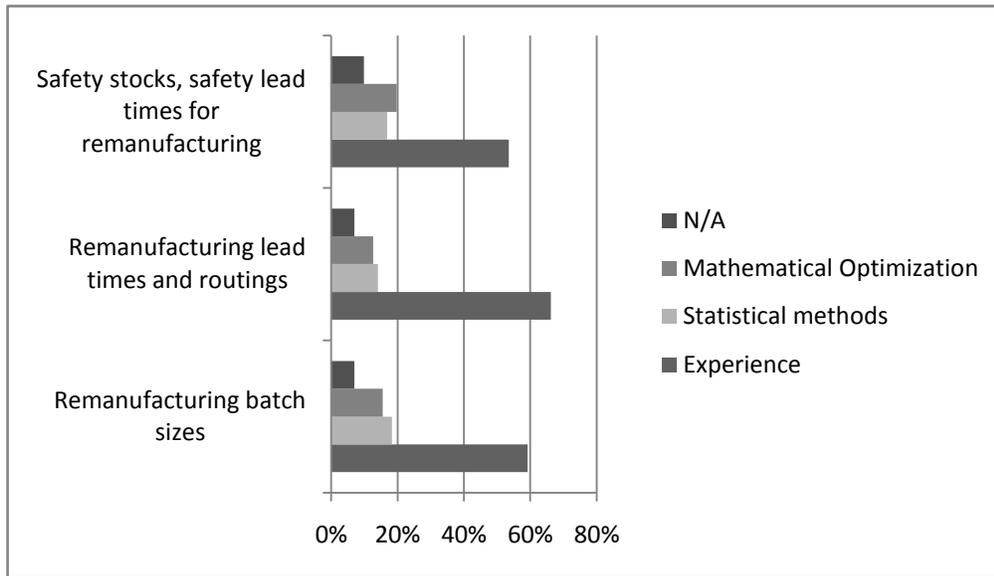
Figure 1: Methods used for forecasting cores



Almost all the respondents (98%) indicated that less than 20% of cores are immediately rejected as unusable. 78% of the respondents indicated that the salvage value of a core is at most 30% of the value of the core; therefore significant value can be lost via the quality rejection of a core. Such a low rejection rate suggests that currently the main supply issue faced by remanufacturers in industries such as automotive parts remanufacturing is one of *quantity* as opposed to the *quality* of cores.

Figure 2 below shows that the majority of respondents relied solely on experience for determining the remanufacturing production data shown. Alternative techniques such as optimization or statistical methods could be used for determining batch sizes, routings, and safety stock and lead times for remanufacturing. The use of such techniques represents an opportunity for remanufacturers to better manage their supply of cores.

Figure 2: Methods for determining production data



#### 4. MANAGERIAL IMPLICATIONS

This research provides market information in the form of the management practices used by remanufacturers and is thus a source of such information for remanufacturers. This survey therefore addresses a need by practitioners for market information used to source cores.

##### 4.1 *Uncertainty in the supply of cores*

Responses concerning the uncertainty in the supply of cores, from suppliers were equally split. This split in responses may be explained by the arms-length relationship that the majority of respondents have with their suppliers. Such relationships would suggest that the remanufacturer is not heavily dependent on its supplier and therefore will perceive that sufficient quantity of cores could be obtained from elsewhere. This could indicate that the remanufacturers may not be sufficiently aware of their dependence on core suppliers (e.g. brokers and salvage operators) even though they can represent up to 40% of their supply of cores. This lack of awareness means that remanufacturers are vulnerable to the risk of core shortages from third party suppliers of cores. The risk of a supply shortage can be mitigated via activities such as selecting reliable suppliers, buying from alternative suppliers to guarantee uninterrupted supply and collaborative communication between buyer and suppliers (Krause et al. 1998; Tang 2006).

##### 4.2 *Forecasting cores*

Forecasts of product returns by the automotive parts remanufacturers were mostly short-term and mainly based on management opinion. Frequent modifications of these forecasts indicated a lack of confidence in the accuracy of the forecasts. The application of more accurate forecasting methods could help managers to resolve this lack of confidence. Such forecasting methods are currently being developed by the authors of this study, in collaboration with other researchers.

##### 4.3 *Production planning activities*

Apart from inventory planning, the majority of respondents did their activity planning and control manually. The use of non-manual systems for planning and control activities represents an opportunity for the remanufacturers to better manage the supply of cores. Also, the majority of remanufacturers relied solely on experience to determine batch

sizes, shop floor routings, safety stocks and safety lead times. The use of statistical or mathematical optimization techniques represent an opportunity for remanufacturers to better manage their production planning and control processes for remanufacturing.

## 5. CONCLUSION

The results of the study provided key insights into the acquisition of cores and production planning for remanufacturing. First, the sourcing arrangements are mostly arms-length and this has implications for the successful management of the supply of cores from third-party suppliers. Arms-length type sourcing relationships represent a lost opportunity for remanufacturers to better manage the supply of their cores. Second, forecasts are mostly short-term and mainly based on management opinion. Frequent modifications of these forecasts indicate a lack of confidence in the accuracy of the forecasts. The application of more accurate forecasting methods could help to resolve this lack of confidence. More accurate forecasting methods for cores is the focus of ongoing research by the authors of this study. Third, only a few remanufacturers used optimization or statistical techniques to determine batch sizes, routings, and safety stock and lead times for remanufacturing. The uses of such techniques represent an opportunity for remanufacturers to better manage their supply of cores.

## REFERENCE

- Krause, D.R, Handfield, R.B and Scannell, T.V. (1998) "An empirical investigation of supplier development: reactive and strategic processes" *Journal of Operations Management*, 17 (1), p39-58
- Tang, Christopher S. (2006), "Perspectives in Supply Chain Risk Management" *International Journal of Production Economics*, 103 (10), 451-88.
- Vollmann, T. E., Berry, W. L. and Whybark, D. C., Jacobs, F.R. (2005), *Manufacturing Planning and Control for Supply Chain Management*, Irwin/McGraw-Hill, New York

**Acknowledgement:** The authors would like to acknowledge the support of all participants in this research.