

Maximizing Automotive Parts Reuse, Remanufacturing, and Recycling Through Effective End-of-Life Vehicle Management: A Different Perspective on What Needs to be Done

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ABSTRACT

Life-cycle assessments (LCAs) conducted, to date, of the end-of-life phase of vehicles rely significantly on assumed values and extrapolations within models. The end phase of vehicles, however, has become all the more important as a consequence of increasing regulatory requirements on materials recovery, tightening disposal restrictions, and the rapid introduction of new materials and electronics, all potentially impacting a vehicle's efficacy for achieving greater levels of sustainability. This article presents and discusses selected research results of a comprehensive gate-to-gate life-cycle-inventory (LCI) of end-of-life vehicle (ELV) dismantling and shredding processes, constructed through a comprehensive and detailed case study, and argues that managing and implementing creative dismantling practices can improve significantly the recovery of both reusable and recyclable materials from end-of-life vehicles.

Although the amount of parts and materials recovered and directed for reuse, remanufacturing or recycling may be as much as 11.6% by weight of the ELVs entering a dismantling process [1], greater rates of reuse and/or recycling may be achieved by the strategic management of the ELVs entering the dismantling process according to age. Late model, high-salvage ELVs (HSELVS) of an optimum age range (e.g., 5-9 years) could be targeted for maximum recovery of parts for reuse and remanufacture. Older low-salvage ELVs (LSELVS) would be targeted principally for materials recovery and recycling. This paper discusses the challenges anticipated with the development of an ELV management system promoting maximum parts reuse/remanufacturing and materials recycling.

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INTRODUCTION

The end-of-life phase has been the least studied aspect of the vehicle life cycle and to date, there has not been a detailed life-cycle assessment (LCA) completed for North American dismantling and shredding processes using site-specific data. LCAs conducted to date rely significantly on assumed values and extrapolations within models. While previously overshadowed by the production and use phases for vehicles, the end phase of vehicles has become increasingly important. Increasing regulatory requirements on materials recovery, tightening disposal restrictions, and the rapid introduction of new materials and electronics all potentially impact a vehicle's efficacy for achieving greater levels of sustainability. A comprehensive gate-to-gate life-cycle-inventory (LCI) of end-of-life vehicle (ELV) dismantling and shredding processes was constructed through a comprehensive and detailed case

study and included review of ELV management practices at 7 dismantling facilities and one shredding facility [1]. The construction of the LCI has permitted the evaluation of the rates that parts and materials are recovered and processed from ELVs, via dismantling and shredding, on a mass basis (e.g., kilograms per tonne ELVs processed). Selected results from this LCI research are presented, herein, and argue that managing and implementing creative dismantling practices can improve significantly the recovery of both reusable and recyclable materials from end-of-life vehicles.

END-OF-LIFE VEHICLE CHARACTERISTICS

In North America, vehicles that have reached the end of their useful life or that have been damaged significantly in accidents are typically brought to and then processed by automotive dismantlers. Within the dismantling industry, these end-of-life

vehicles (ELVs) are generally grouped into two categories, described in this research as “high-salvage” ELVs (HSELVs) and “low salvage” ELVs (LSELVs). HSELVs are mainly “late-model” vehicles, retired as a consequence of limited damage by collision or impact, and are processed for fluids and hazardous materials recovery, and maximum parts recovery. In contrast, LSELVs will principally be represented by “early-model”, old-age vehicles, retired as a result of poor mechanical and/or physical condition or as a consequence of age and/or damage (by collision, impact, fire, or flood). LSELVs may also be late-model vehicles that are so severely damaged by collision or impact that there are little or no recoverable parts for reuse. Like HSELVs, LSELVs will be processed for fluids and hazardous materials recovery, but minimum parts recovery.

In the baseline LCI case study, this research assessed the LSELVs and HSELVs received and processed by a dismantler over one operating year (2005), or approximately 17,000 vehicles. ELV count data provided by the dismantler (by vehicle make, model, and model year) was used, in combination with representative curb weights, to estimate the masses of LSELVs and HSELVs processed annually. Approximately 6.5 tonnes of LSELVs were processed for every tonne of HSELVs, or one HSELV processed for every 7-8 LSELVs processed. This proportion will vary from dismantler to dismantler, with some dismantlers processing only HSELVs and others processing principally LSELVs. However, based on the commonality of industry practices and approaches within the dismantling industry, this quantity approximates a baseline value of the proportion of HSELVs to LSELVs retired and processed annually within the U.S. and Canada. Future research can confirm the proportions of vehicles in North America that are processed annually as HSELVs versus LSELVs.

Table 1 summarizes the characteristics of the case study HSELVs and LSELVs processed in 2005. The HSELVs and LSELVs averaged 7 and 15 years in age, respectively.

Table 1. Characteristics of the HSELVs and LSELVs processed in 2005

Vehicles Represented By ELVs Processed in 2005		HSELVs	LSELVs
	Number of Makes	37	49
	Number of Models	213	240
	Range of Model Years	1986-2005	1963-2004
	Mean Model Year	1998	1990
	Average Age	7-year old ELVs	15-year old ELVs
	Average Vehicle Curb Weight	1522 kg	1343 kg

VEHICLE END-OF-LIFE PARTS/MATERIALS RECOVERY

To assess the mass-based quantities of parts that are dismantled and sold for reuse, remanufacturing, and “pre-shredder” recycling per tonne of ELVs entering the dismantling

process, the researchers used dismantler-supplied part sales data and representative parts weights. As much as 11.6% weight of the ELVs entering the dismantling process were recovered and directed for reuse, remanufacturing or recycling (including recovered fluids). Almost half of the recovered ELV parts and materials were parts recovered from both HSELV and LSELVs and directed for reuse: 4.9% by weight and 0.8% by weight of the ELVs (i.e. HSELV and LSELVs) respectively. The reusable LSELV parts were parts recovered from vehicles from a “UPIC” or “U-Pull-It” self-service facility. After removal of fluids, batteries, catalytic converters, and tires, LSELVs are placed into a yard where customers may come and pull the parts themselves, using their own tools, and buy them at reduced prices.

Dismantlers processing only HSELVs are expected to achieve greater parts and/or materials recoveries for reuse, remanufacture and “pre-shredder” recycling per tonne ELVs processed. For facilities that principally process LSELV, parts and materials recoveries for reuse, remanufacture and “pre-shredder” recycling will likely be less than what was found in this case study. Instead, more materials will be directed for shredding and metals recovery. For example, in the baseline LCI case study HSELV parts, materials and fluids recovered for reuse, remanufacture and “pre-shredder” recycling averaged 432 kg per tonne (43.2% weight) of HSELVs processed versus 68 kg of LSELV parts, materials and fluids recovered per tonne (or 6.8% weight) of LSELVs processed.

Figures 1, 2, and 3, respectively, illustrate the HSELV counts, the HSELV reusable part counts, and HSELV deleted part counts aggregated and plotted by vehicle model year as derived from this research. “Deleted” parts arise as a consequence of dismantlers routinely cleaning-up their sellable parts inventories. HSELV parts will be purged from inventory because they are old, overstocked, or damaged.

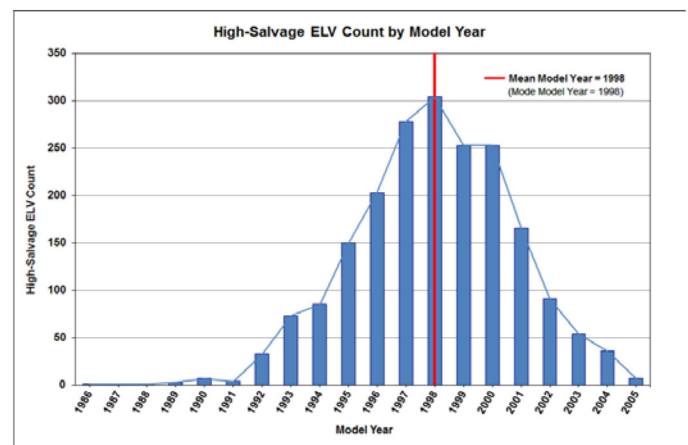


Figure 1. HSELV counts (for HSELVs processed in 2005) aggregated and plotted by vehicle model year.

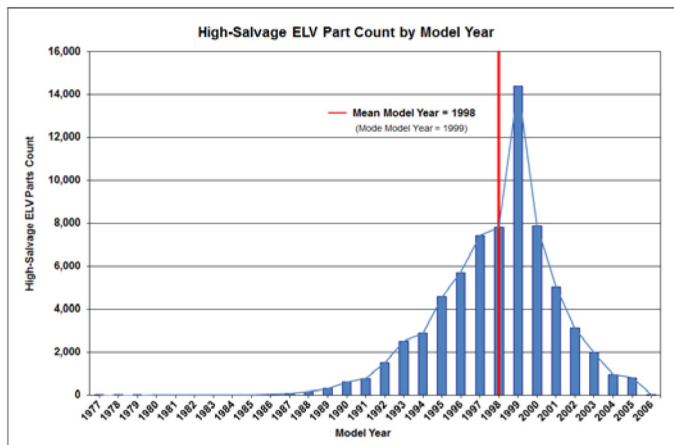


Figure 2. HSELV part counts, for all parts sold for direct reuse in 2005, aggregated and plotted by vehicle model year.

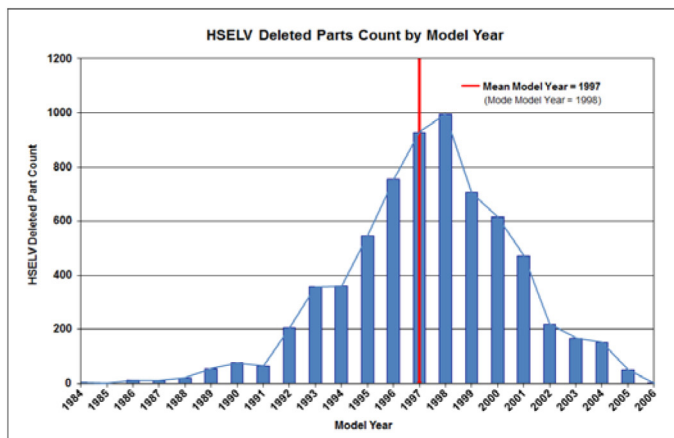


Figure 3. HSELV deleted part counts aggregated and plotted by vehicle model year.

Some of these parts may be directed for remanufacturing, but predominantly these “scrapped out” parts are sent for shredding, with or independently of the ELV hulks sent for shredding and metals recovery. In some respects, these graphs represent “supply and demand” curves for higher value automotive parts.

The HSELV counts in Figure 1 represent the supply of vehicles available to dismantlers for recovery of parts for reuse, as well as for remanufacturing and post-shredder recycling. The greatest proportion of these vehicles average approximately 7 years in age, as indicated by an average vehicle model year of 1998 (based on vehicles processed in 2005).

The HSELV part counts in Figure 2 represent the demand for parts sold for reuse, with the greatest proportion of parts being sold for vehicles averaging 7 years in age as indicated by an average vehicle model year of 1998 (based on vehicles processed in 2005). Reusable part sales drop significantly for vehicles slightly older and younger than this potentially “optimum” vehicle age.

The HSELV parts deleted from inventory demonstrate similar trends. As illustrated in Figure 3, the greatest proportion of HSELV parts that were deleted from inventory, and directed for shredding with ELV hulks, were for vehicles averaging 8 years old as indicated by the mean vehicle model year of 1997 (for vehicles processed in 2005). The deleted parts, consisting of 98 different part types, represent approximately 3% by weight (30 kg per tonne) of the HSELVs processed, but only 0.4% by weight (4 kg per tonne) of all the ELVs processed [1]. Based on this case study, parts-demand and parts-supply correspond to within a year time frame. After the 8-year mark, the demand for used parts dwindles rapidly

Might there then be incentives, opportunities or justification to consider redirecting these parts for post-dismantling/pre-shredder recycling instead of shredding them with ELV hulks? These parts may represent potential “missed opportunities” for enhanced materials recovery and recycling. Even though the percentage is small this percentage can be significant on a mass-flow basis. For example, in this scenario 0.4% by weight of the ELVs processed represented approximately 90 tonnes annually. This opportunity should be evaluated as part of follow-up research.

Interestingly, these trends may suggest an optimum dismantling scheme, using “planned” or anticipated vehicle obsolescence: ELVs of an “optimum” average age range of between, for example, 5 and 9 years are targeted as HSELVs so that parts recovery and sales may be maximized for direct reuse and remanufacturing. Older vehicles would be targeted as LSELVs and principally directed for materials recovery and recycling. The potential benefits of such an ELV management scheme would be the:

1. Maximization of parts/materials reuse, and remanufacturing for reuse, which is in the 4-R's hierarchy preferred over parts/materials recycling or energy recovery;
2. Conservation of resources and energy required to produce these parts from virgin materials;
3. Maximization of the economic returns to the dismantling and automotive parts remanufacturing industries; and
4. Reduction in air emissions by decreasing the number of older, less fuel-efficient vehicles on the road.

OPPORTUNITIES FOR INCREASED PARTS REUSE/REMANUFACTURING

The feasibility of “managing” vehicle obsolescence to maximize parts reuse/remanufacturing would depend on: suitability, supply and demand of the part types for reuse or remanufacturing, end markets, infrastructure, customer attitudes, and economics. The greatest potential for increased parts reuse is most likely in remanufacturable parts.

Remanufactured products typically cost 30 to 40 percent less