Automotive Products Recovery Activities in China: Background and Development

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Background

By the end of the year 2007, the volume of in-use vehicles was 43 million in China. The volume of production and import was increasing rapidly (see also, Figure 1, 2, 3). Due to their life time, by the end of the year 2006, it could be estimated that about 3.0~6.0 million should have reached end of life but the data of year 2006 shown us that only 0.38 million in total were dismantled in China. It was about 1% of the in-use volume of year 2006 (Table 1). The rapid development in China leads to the estimation that in the year 2010 the volume of in use vehicles will be 55 millions and the end of life vehicle will be 4.8 millions. The facts are showing the promising future of ELV recycling industry in China.

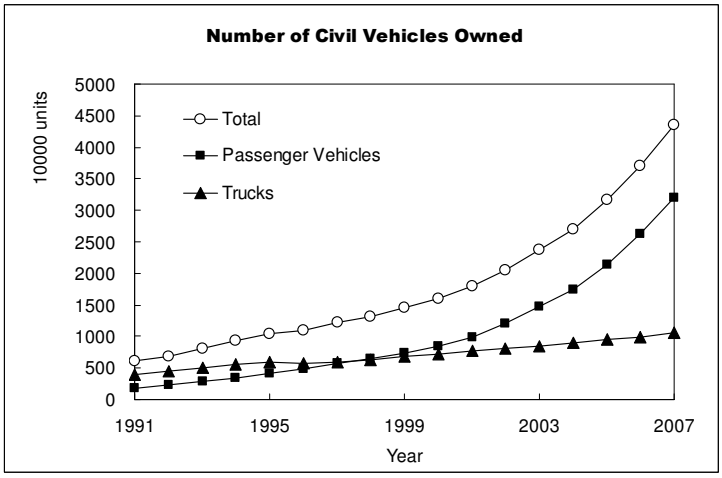

Figure 1 Volume of In-use Vehicle in China (1991~2007)

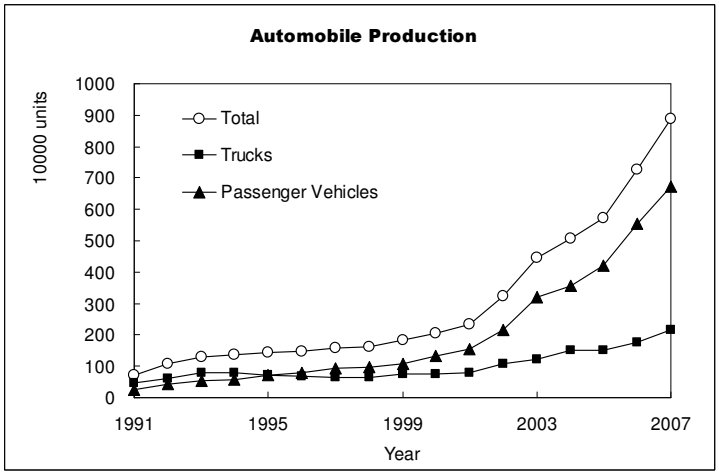

Figure 2 Volume of Auto Production in China (1991~2007)

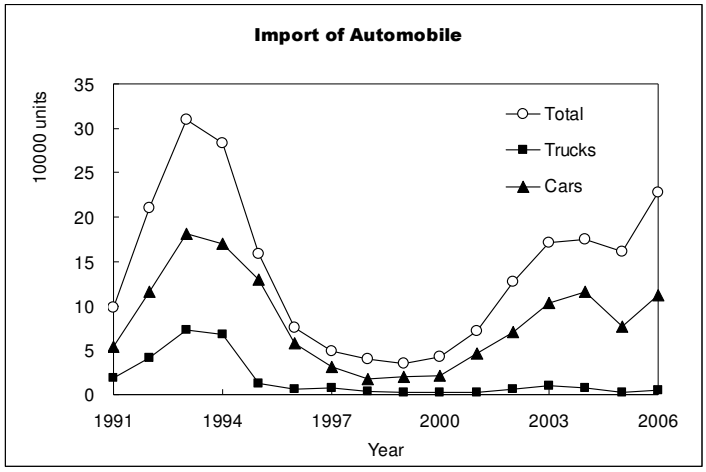

Figure 3 Volume of Auto Import in China (1991~2006)

Consideration and Response Measures towards EU "ELV Directive"

The implementation of ELV Directive (2000/53/EC, Directive of the European Parliament and of the Council of 18 September 2000 on end-life-vehicles) has deeply and broadly influence on Chinese auto industry. It is obviously considering following conceptions for Chinese auto industry: EPR (Extend Producer Responsibility), recovery in whole life cycle, sustainable manufacturing and sustainable consumption as well as getting inspiration for ELV recycling development in China:

1) Both recycling of ELV and effective supervision of government should be emphases.

2) Dismantling operation mode in China must be consistent with China's national conditions.

- China has abundant labor resources; large-scale automatic recycling equipment is not suitable for China's national conditions, today;
- Dismantling operation mode in China should be: "mechanization tools + manual dismantling".

3) An emerging model of ELV recycling industry development in China is featured as:

- Used parts remanufacturing is the opportunity of development for Chinese ELV recycling industry; a transition of business model for Chinese ELV recycling industry, from scrap steel sales to remanufacturing;
- But, it is a real challenge, because establishing a nation-wide distributed automotive parts remanufacturing and reverse logistics system only relying on dismantling enterprises is not realistic;
- Technically, remanufacturing tools and equipments should be of: good accuracy, low cost,

high efficiency, various application and manual operation. It leaves enough space for remanufacturing technology providers.

4) Remanufacturing in China is far beyond business. It is changing Chinese people's rigid ideas about manufacturing industry:

- It meets requirements of constructing a resource-saving and environment-friendly society; and requirement of sustainable development of manufacturing industry, for example, EPR.
- Remanufacturing is the best way to recycling because remanufacturing preserves added value of products to the greatest extend.

5) Responsibility of auto product manufacturers is concretely defined as:

- Promote design for dismantling (DfD) and design for recycling (DfR) in product design phase; promote use of materials maring/coding system;
- Continuously improve the recoverability of products; promote the use of environmentally-friendly materials; ban the hazardous substances;
- Product recoverability and use of restricted substances should abide by the policies and regulations;
- Provide true, accurate and reliable report of product recoverability and restricted substances use for approval institute;
- Components and raw material suppliers should bear the corresponding responsibility as well

The establishing legislation and specification system on ELV could be regarding as response actions of China towards EU ELV directives, from national law to specifications.

- National Law
  - "People's Republic of China Solid Waste Pollution Prevention Law"
  - "People's Republic of China Circular Economy Law", draft for review
- National Technical Policies
  - "Automobile Industry Development Policy" released in May 2004
  - "Automobile Trade Policy" released in August 2005
  - "Technical Policy of Automotive Products Recovery" released in Feb. 2006
  - "Pilot Scheme of Auto Parts Remanufacturing Management" released in March 2008
  - "Management Regulation of ELV Take-back", draft for review
  - "Management Regulation for Recoverability and Banned/Restricted Substances of Automotive Products", draft for review
- Technical Specifications
  - GB/T 19515-2004 "Calculation Method of Recyclability & Recoverability for Motor vehicle"

- HJ 348-2007 “Environmental Protection Technical Specification for ELV Dismantling”
- QC/T 797-2008 “Material Marking for Automotive Plastics, Rubbers & Elastomers”

ELV Take-Back and Treatment

There are about 356 qualified ELV dismantlers approved by the state administrative department, and, more than 800 take-back stations distributed throughout the municipal cities all over China, employing up to 16,000 people, dismantling capacity of 1.2 million vehicles per year. It provides more than 200 million tons of scrap steel, 50,000 tons of non-ferrous metals and large amount of waste rubbers and plastics each year. Practice shows that the ELV dismantler administrative qualification system and the control of enterprises number are fit for China's current national conditions, and it is conducive not only to the supervision and administration of government, but also conducive to ELV dismantlers to improve economic efficiency and technology innovation promotion. For more information about China ELV treatment, see also Literatures (Chen 2005, 2006). But, there are still some key issues for China ELV recovery industry facing:

1) The existing policy, administration and technical specifications system can not fit for the development of ELV recovery industry.

2) Manual dismantling process, improper disposal of hazardous substances, short of environmental protection measures, that is common in ELV dismantler.

- Mainly for the scrap metals, it is common to use oxygen torch cutting process in shelterless dismantling yard.
- It is insufficient in specialized tools and equipments, such as waste liquid collecting, ELV dismantling, material sorting, and shredding facilities.
- The hazardous substances, such as lead, cadmium, mercury, hexavalent chromium and other heavy metals, if not in the form of metal parts, usually are improper treated as common waste, and easily causing heavy metal pollution.
- It is short of environmental protection measures, such as the separate collection and treatment facilities for waste liquids, oil and water separation facilities and ground seepage control measures, resulting in severe secondary pollution.

3) The reuse and remanufacturing of used parts are not popular.

4) The extend producer responsibility of OEM is not clear and there are less communication between auto manufacturers, dismantlers and other stakeholders.

Innovation in Parts Remanufacturing

Key issues for used auto parts remanufacturing include theories and technologies for clean processing of remanufacturing core, residual life evaluating, dimension and precision inspecting of core, dimension and

precision restoring of core, disassembly, reassembly and running-in of remanufacturing products, quality control system of remanufacturing products. Innovations in parts remanufacturing in China aim at providing technical support and exploring development model for automotive products remanufacturing industry.

1) Magnetic Memory NDT Based Residual Fatigue Life Evaluation

Fatigue is the most common failure mode for mechanical parts. Residual fatigue life is a key indicator for evaluation of remanufacturability of used parts. Residual fatigue life is hard to acquire by means of statistics because the service history of parts is no clear.

Magnetic memory is a physics phenomenon: the ferromagnetic materials which are located in geomagnetic field and under the action of service loads will behave with the decreasing of magnetic conductivity and the increasing of leakage magnetic flux in the concentration areas of residual stress and deformation.

The research group in Shanghai Jiao Tong University takes crankshaft as research objective, to establish magnetic memory residual fatigue life evaluation method with following features: establishing the magnetic memory quantitative characterization mode of the material's fatigue damage; establishing the mapping between parameter of magnetic memory characterization and fatigue life; establishing the practical residual fatigue evaluation method based on used crankshaft.

The investigation based on 48MnV steel shows that metal magnetic memory non destructive testing technique can be used to characterize, evaluate the fatigue damage of ferromagnetic material. Further theory study also indicates, on the dangerous cross-section, the D-value of the maximum and the minimum tangential component of the leakage magnetic field of testing surface can be used to be the magnetic memory quantitative characterization parameter.

2) Flow plating: automatic operation and mass production of brush plating

Partial surface damage is another common failure mode for mechanical parts. Surface engineering, such as electroplating, thermo spraying, those common repairing methods are developed especially for bearing houses, crank shafts and other expensive parts. Because of low efficiency, labor-intensive and coating-instable, the traditional manual brush plating is not suitable for automation and mass production requirements. Therefore, the research group in Shanghai Jiao Tong University proposes a so-called flow plating technology. It is characterized by anodic without a cotton pack to store plating fluid; plating anodes and the work piece maintaining a certain space; plating fluid circularly pumped to flow to plating work area. Through a series of researches, brush-plating anode material has been chosen, flow plating interface has been designed, through optimizing parameters of orthogonal test-plating process, industrial applications have been processing.

Constitution of Management System for Recoverability and Banned/Restricted Substances of Automotive Products

The establishing of management system

for recoverability and banned/restricted substances of automotive products would be including at least following items:

- Management for Recoverability and Banned/Restricted Substances of Automotive Products
  - Estimated in year 2009, it will begin the register of recoverability and restricted substances use in new auto product (the initial review and product certification);
  - Estimated in year 2010, all new auto product sold in China should abide by the policy provided quotes in recoverability and restricted substances, and as a new product announcement on the mandatory requirements;
  - The recoverability of automotive products is calculated according to related regulation or specification such as GB/T 19515-2004/ISO 22628:2002;
  - Banned/restricted substances include Lead (Pb), mercury (Hg), cadmium (Cd), hexavalent chromium [Cr (VI)], polybrominated biphenyls (PBB) and multi-bromo ether (PBDE).
- Exemption List for Banned/Restricted Substances of Automotive Products
  - Reference to the EU ELV directive annex Ⅱ, an increase of PBB and PBDE in addition to the four heavy metals;
  - Comprehensive considering the alternative technologies and products supply capacity of suppliers, and, the time and cost required for complete replacement of restricted substances as well.
- Related Specifications
  - Method for Auto Materials Marking/Coding
  - Method for Hazardous Materials Marking/Coding
  - Method for Automotive Products Hazardous Materials Identification
  - Proven Technology List for Vehicle Materials Recyclability Calculation
- Operational/Supporting System
  - Approval and Management System for Recoverability and Banned/Restricted Substances of Automotive Products
  - Automobile Materials Data Management System
    - National Development and Reform Commission (NDRC) agreed that vehicle manufacturers have the right to choose International Material Data System (IMDS) or China Automotive Material Data System (CAMDS), coupled with internal data systems for type approving.
    - CAMDS scheduled officially running in March 2009. All auto enterprises should provide material data to meet the requirements of materials data management. The system will review and manage the data provided by enterprises. For lower

the cost, local brand OEMs choose to participate in the preparation of CAMDS.

- IMDS is another choice for local brand OEMs. Local OEM contact EDS frequently for IMDS orientation due to their export business drive.It seems obviously influenced by their international partners; key joint ventures are ready to kick off their IMDS project in 2008. Suppliers are more aggressive than OEM in IMDS due to their export business drive. EDS has offered IMDS training sessions in Beijing, Shanghai and IMDS helpdesk will be located in Wu Han.

Non Governmental Organization for ELV Recovery

In year 2007, the first ELV recovery non-governmental organization of China, the Shanghai Automotive Product Recycling Technical Committee, which is affiliated to Shanghai Society of Automobile Engineers (SSAE) has been constituted. The members are mostly engineers and technicians from Shanghai Automobile Industry Co. (SAIC) and other related industries, such as, suppliers, dismantlers, remanufacturers and research institutes. Up to now, the committee has successfully organized the "Shanghai International Workshop for Asian Eco-Auto Forum" with its Korean and Japanese partners.

In year 2008, the "Management Regulation for Recoverability and Banned/Restricted Substances of Automotive Products" will be expected to be released. And, in order to help Chinese auto industry committing its responsibility for sustainable products manufacturing in coming future under this new regulation, a national-wide automotive product recycling technical committee will be constituted, which is affiliated to China Society of Automobile Engineers (CSAE) in this year. The technical committee should be a platform for governmental administrative departments, industries, research institutes and universities to communicate and collaborate on scopes of automotive product reuse, remanufacturing, recycling and recovery. And, it should also be an international platform for understanding and communication on auto product recycling. In this organization, there would be an international steering committee to fulfill the function of international communication and collaboration, to disseminate the idea of sustainability in manufacturing and consumption in China. The main functions of this international steering committee are described as following:

- Exchanges and collaboration in science and technology on the scopes of auto product recycling and recovery
- Promoting auto industrial policy for product recovery in China
- Advocating automobile sustainable consumption in Chinese communities

Co-initiation of Asian EcoAuto

Forum(AEAF) & International Conference

As the first Asian regional non-governmental Auto Forum, the initiation of Asian EcoAuto Forum(AEAF) will improve the sustainable development of Asian automotive industry because of the reason:

- China, Japan, Korea belong to East Asia, broader political and cultural exchanges, higher mutual economic dependence;
- In the coming decade, the automobile production and sales of East Asia region will account for half of the world's.

The objective of the AEAF will be: Control the consumption of resources and relieve the burden on the environment, bear international responsibility. And it main tasks:

- Exchanges and Cooperation in Science and Technology

  Through the establishment of information exchange and consultation mechanism, coordinate the Sino-Korea-Japan trilateral exchanges and cooperation in science and technology on the sustainability of auto industry.
- Promote Sustainable Auto Industrial Policy

  Through the promotion of tripartite government, research institutions and community groups visits, exchanges and cooperation, actively promote sustainable auto industrial policy under the 21st century new environment system in China, Korea and Japan.
- Advocate Sustainable Auto Consumption

  Through the establishment of tripartite research and cooperation mechanism for automotive product life cycle recycling technology, Research and publish automotive products sustainability index, advocate automobile sustainable consumption in the region.
- Deal with Green Trade Barriers

  Through the establishment of related measures, coordinate the Asian auto industry to jointly deal with the EU and other green trade barriers.

And the 1st international conference of Eco-Auto Forum will be held on er of 2008, Soul, Korea.

Figure 4 Sep. 17th 2007, Shanghai AEAF international Workshop
Announcement of Co-initiation of AEAF

ies in the future

olicies and Regulations

- Automotive products recoverability calculation, approval and management;
- Automotive materials proven recycling technology database;
- Material information collection and banned / restricted substance management in

parts supply chain system;
  - Automotive products dismantling information (vehicle dismantling manual) providing, managing and sharing;
  - Parts and components remanufacturing and circulation management;
  - Automotive products hazardous and dangerous substances disposal management;
  - Automotive products and their packaging take-back system.

- Technical Specifications and Standards
  - Automotive products recoverability calculation related technical specifications and standards;
  - Exemption list for banned/restricted substances and automotive materials declaration related technical specifications and standards;
  - Automotive products hazardous materials identification related technical specifications and standards;
  - Plastic / rubber parts marking and coding related technical specifications and standards;
  - Vehicle material recyclability proven technology related technical specifications and standards;
  - Automotive products dismantling information and publication related technical specifications and standards;
  - Scrapped automobiles and the release of information related to dismantling the technical norms and standards ;
  - Parts and components remanufacturing related technical specifications and standards.

- Technology Innovation

  Research and development of the necessary technology processes and facilities, including:
  - Process and equipment for sustainable ELV recycling with the main targets of clean dismantling;
  - Process and equipment for non-metal materials identification and sorting systems;
  - Techniques and theory for clean processing of remanufacturing core;
  - Techniques and theory for residual life evaluating of remanufacturing core;
  - Techniques and theory for dimension and precision restoring of remanufacturing core.

Literature

[Chen 2006] *Sustainable Recycling of Automotive Products in China. Technology and Regulation, Ming Chen, Jiao Tong University, JOM, August 2006*

[Chen 2005] *End-of-Life Vehicle Recycling in China: Now and the Future, Ming Chen, Jiao Tong University, JOM, October 2005*

Table 1 China End-of Life Vehicle in 2006

	Number of End-of Life Vehicles in 2006 (A)				Number of Civil Vehicles Owned in 2006 (B)				A/B			
	Total	Passenger Vehicles	Trucks	Others	Total	Passenger Vehicles	Trucks	Others	Total	Passenger Vehicles	Trucks	Others
Total	380560	224561	147646	8353	36973531	26195686	9862992	914853	1.0%	0.9%	1.5%	0.9%
Beijing	16234	10764	4188	1282	2391234	2175551	176946	38737	0.7%	0.5%	2.4%	3.3%
Tianjin	5684	3420	1754	510	792195	648211	128240	15744	0.7%	0.5%	1.4%	3.2%
Hebei	15751	5145	10021	585	2293397	1495221	703926	94250	0.7%	0.3%	1.4%	0.6%
Shanxi	2589	1426	1073	90	1215470	832787	362904	19779	0.2%	0.2%	0.3%	0.5%
Inner Mongolia	1065	812	226	27	837858	513375	284285	40198	0.1%	0.2%	0.1%	0.1%
Liaoning	12895	8723	3926	246	1592211	1073364	473050	45797	0.8%	0.8%	0.8%	0.5%
Jilin	16011	7576	8378	57	722532	534203	176207	12122	2.2%	1.4%	4.8%	0.5%
Heilongjiang	8925	7301	1547	77	940011	658417	258011	23583	0.9%	1.1%	0.6%	0.3%
Shanghai	91640	77466	14174	N/A	1070375	870571	199804	12166	8.6%	8.9%	7.1%	N/A
Jiangsu	13148	6758	5851	539	2408044	1907262	448951	51831	0.5%	0.4%	1.3%	1.0%
Zhejiang	17620	7963	8846	811	2483581	1844670	597414	41497	0.7%	0.4%	1.5%	2.0%
Anhui	4958	3431	1375	152	946136	535193	364504	46439	0.5%	0.6%	0.4%	0.3%
Fujian	6288	3435	2539	314	895654	601426	272312	21916	0.7%	0.6%	0.9%	1.4%
Jiangxi	2932	1668	1151	113	580690	344593	219637	16460	0.5%	0.5%	0.5%	0.7%
Shandong	13545	6246	6773	526	2992294	2135760	764353	92181	0.5%	0.3%	0.9%	0.6%
Henan	8080	4299	3654	127	1833833	1212850	518814	102169	0.4%	0.4%	0.7%	0.1%
Hubei	10255	6786	3137	332	987423	653895	309641	23887	1.0%	1.0%	1.0%	1.4%
Hunan	6390	3014	3345	31	917566	607332	294576	15658	0.7%	0.5%	1.1%	0.2%
Guangdong	24973	12933	11324	716	4289452	3024873	1188797	75782	0.6%	0.4%	1.0%	0.9%

Guangxi	8246	3388	4518	340	661432	455164	187589	18679	1.2%	0.7%	2.4%	1.8%
Hainan	301	233	57	11	192307	125627	58584	8096	0.2%	0.2%	0.1%	0.1%
Chongqing	8055	4114	3711	230	560665	322109	226079	12477	1.4%	1.3%	1.6%	1.8%
Sichuan	19102	11973	6806	323	1572253	1151394	403327	17532	1.2%	1.0%	1.7%	1.8%
Guizhou	9311	4158	5062	91	493626	321990	166758	4878	1.9%	1.3%	3.0%	1.9%
Yunnan	9013	6598	2324	91	1147231	744604	393799	8828	0.8%	0.9%	0.6%	1.0%
Tibet	3921	1228	2670	23	98187	56321	41856	10	4.0%	2.2%	6.4%	230.0%
Shaanxi	34757	8498	25808	451	756950	561251	177630	18069	4.6%	1.5%	14.5%	2.5%
Gansu	3401	2087	1259	55	372565	227096	135994	9475	0.9%	0.9%	0.9%	0.6%
Qinghai	2203	1365	820	18	133416	81833	48278	3305	1.7%	1.7%	1.7%	0.5%
Ningxia	2460	1386	1032	42	168597	95063	66276	7258	1.5%	1.5%	1.6%	0.6%
Xinjiang	807	367	297	143	626346	383680	214450	28216	0.1%	0.1%	0.1%	0.5%