Annals of the Academy of Romanian Scientists
Series on **Engineering Sciences**
ISSN 2066-8570 Volume **3**, Number **1**/**2011**

RECYCLING AND REMANUFACTURING -TWO FORMS OF RECOVERY OF END LIFE PRODUCTS

Ionuţ Daniel COZMUŢA[1],
Cristian Vasile PETRIC[2]

Rezumat. *În mediul economic se constată că se confundă refabricarea cu recondiţionarea sau chiar cu repararea unui echipament tehnologic. Din experienţa practicienilor rezultă că refabricarea, recondiţionarea şi repararea necesită un conţinut de muncă diferită iar calitatea produselor rezultate este diferită. Problemele care apar în cazul refabricării utilajelor, se datorează duratei de viaţă destul de lungi pe de o parte şi avansul tehnologic, pe de altă parte, care aduce modificări semnificative în sistemele de comandă, control şi măsurare, dar şi în domeniul materialelor şi al sistemelor de acţionare. Ciclul de viaţă tradiţional al produselor este unul secvenţial care se dezvoltă liniar de la faza de materie primă şi până la scoaterea din uz evacuarea acestuia.*

Abstract. *In the economic environment is found that we are always mixing up rebuilding, remanufacturing and the repair of technological equipment. Experience shows that remanufacturing, refurbishing and repair requires a different work content and offers different quality results. The problems that arise in the remanufacturing process of these machines occur because of the long life period on one hand and technological advance, on the other hand, bringing significant changes in command, control and measurement systems, but also in materials and driving systems. The traditional life circle of the products is sequential that develops linear from raw material to elimination. The product recovery and recycling changes his linear evolution into a cyclic one the embraces a specific recycling degree of the product.*

Keywords: remanufacturing, recycling, products life circle, technological cycle.

1. The products life circle

The products life circle refers to the medium life time of a product making an analogy with Biology (the products are born, they develop, reach maturity and then get old); his sales depend on the time period his in.

The traditional life circle of the products is sequential that develops linear from raw material to elimination. The product recovery and recycling changes his linear evolution into a cyclic one the embraces a specific recycling degree of the product.

[1]PhD Student, Eng.: Faculty of Engineering, North University of Baia Mare, Maramureş, România, e-mail: daniel.cozmuta@gmail.com.
[2]Student: Faculty of Engineering, North University of Baia Mare, Maramureş, România, e-mail: ptriccristian@yahoo.com.

To avoid costly removal of equipment reached the end of operation, designers must establish procedures for recovery - remanufacturing, recycling, before specifying their structural attributes. Recycling is the easiest strategy to avoid the use of new materials but requiring an external source of energy to transform waste into new resources.

2. Remanufacturing, Recycling

2.1. Remanufacturing

Remanufacturing is considered the most important form of recycling. The essential difference between the two processes that occurs is that remanufacturing maintains a certain measure of value added to raw materials while recycling breaks it, bringing the product to the raw material value. Through remanufacturing we can for see two or more life times for technological equipment, with different functional cycles.

In „*The remanufacturing Industry. Hidden Giant*" (1996), Professor Robert T. Lund, from the Boston University, presents the necessary requirements for a product to be remade:

► in the remanufacturing process we can use those technological equipment components that don't have the dissipate and grinding property

► there is technology to return the product to form, original condition and operation;

► the original technological equipment was made in conformity with an execution documentation, a norm and has Interchangeable components

For the outset of some strategies of equipment recovering, the designers have to take into account the following main characteristics of the technological equipment, in order to do the remanufacturing:

- Wear-out life;
- Design cycle ;
- Technological cycle;
- Replacement period;
- The causes of the outdating of the equipment;
- The operational complexity;
- The overall dimensions of the technological equipment;

- The hazardous materials contained within the structure of the technological equipment;
- The cleanliness of the equipment;
- The number of material sorts;
- The number of modules.

2.1. Recycling

Recycling can be defined as the process by which waste materials are collected, sorted, processed and returned to the economy as raw materials.

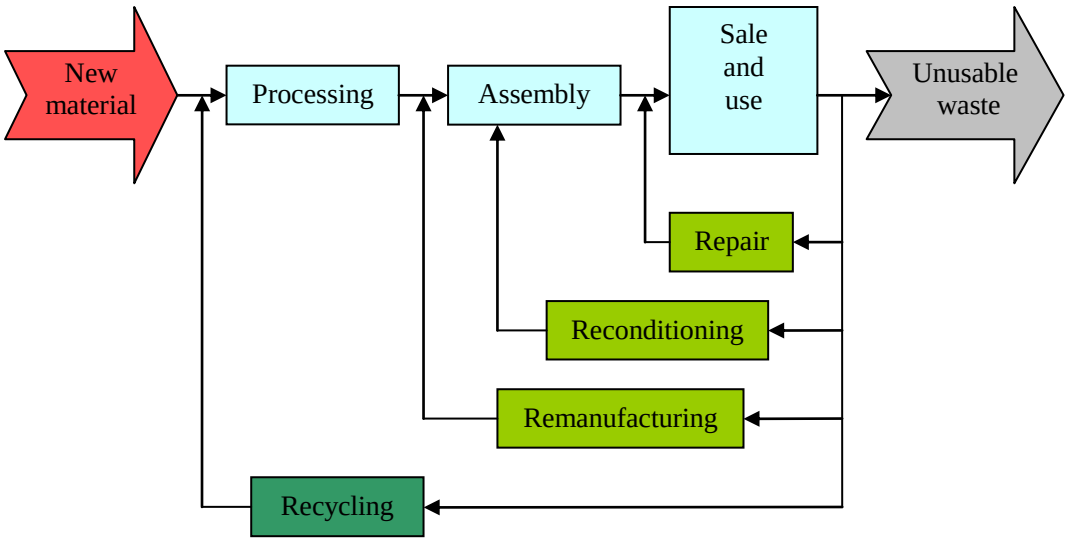

Fig. 1. The sustainable approach mode – adapted [3].

Recycling can be defined as the process by which waste materials are collected, sorted, processed and returned to the economy as raw materials.

An important aspect is to evaluate the recycling.

A uniform calculation is required in conjunction with European legislation.

To define the recycling PRV has defined these five categories of recycling:

1) Recyclable- clearly defined infrastructure and technology.; the component is completely recyclable and the infrastructure clearly defined and functional;
2) Potentially recyclable- invalid infrastructure, undefined or unorganized collection network;

3) Potential recyclable, but requires the development of processes or materials. The technology was not yet sold;
4) Potential energy recovery- Technology / capacity to produce energy with economic value;
5) Unknown recycling potential and unknown recycling technology.

The fundamental issues related to recycling are:

- Identify recyclable materials;
- Identify the opportunities for the reuse and recycling;
- Identification of markets for recovered materials.

The recovery strategies for the used machines may include a combination of processes of remanufacturing, recycling and dismissal.

For recycling, the following three stages are usually considered:

- Separation of materials;
- Sorting;
- Reprocessing.

Table 1. The influence of the wear-out life and of the technological cycle on the recovery procedure – adapted [3]

Wear-out life	*Technological Cycle*	*Recovery procedure*
Short	Long	Recycling
Short	Short	Reuse
Long	Short	Remanufacturing
Long	Long	Recycling

The position of the products shown in the figure bellow may suggest important information about the basis guidelines, for the designers of remanufacturing and recycling as well as for the designers of new equipment.

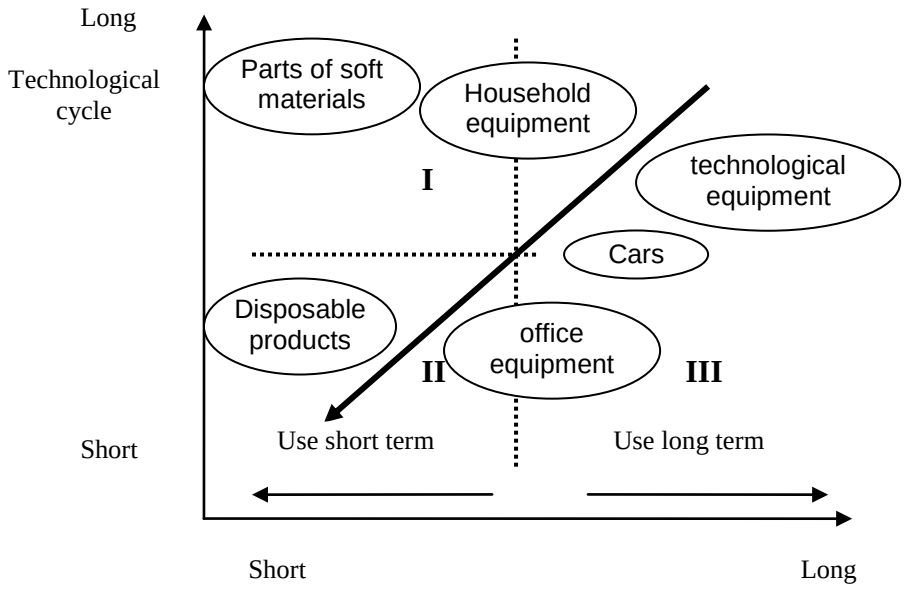

Fig. 2. Strategies recovery of the amount of waste products [3].

In Table 2 we have presented the guidelines to improve technology for remanufacturing and recycling process starting from the dates in Figure 2.

Table 2. Guidelines for designing and developing technologies for remanufacturing and recycling

Product category	*Suggestions for products designers*	*Suggestions for designers of remanufacturing and recycling technologies*
Type I	Constructive solutions to enable the appropriate separation of the components for recycling	Design separation technologies based on physical properties of materials that can not be sorted
Type II	-Component modularization - Constructive Solutions assembly / disassembly easy	Designing efficient cleaning technologies for reducing the cost of reworking products
Type III	Adoption of technical solutions to enable the addition of accessories to the basic product, which extend wear life and its value	Technical solutions for removing accessories non-destructive.
Type IV	Constructive solutions to facilitate maintenance and modernization of technological equipment in order to prolong service life.	Technical solutions for maintenance and upgrading equipment destructive technology.

Conclusions:

1. It was found that remanufacturing, using the largest amount of work and most qualified develops the highest quality, followed by refurbishment and repair.

2. Remanufacturing technology equipment can be significantly enhanced by the design concept and the redesign direction, considering the principles of sustainable development.

3. Advanced Recycling of materials contributes significantly to the implementation of enhanced environmental management, which allows the environment and economy to coexist harmoniously.

4. Remanufacturing occurs in case the product does not comply and can be altered to get to the product stage.

5. Recycling must become a permanent activity, including all phases from product conception to its removal from service, benefiting from feedback on results achieved throughout the chain of processes involved.

R E F E R E N C E S

[1] D. Daraba, R*emanufacturing - industrial activity unknown*, (In: Scientific Bulletin of "Management Technology, North University of Baia Mare, 2005, second year, number one, pp. 73-78).

[2] D. Daraba, *Studies and Researches Regarding the Remanufacturing of the Technological*, (Thesis PhD, The North University of Baia Mare, 2008).

[3] D. Daraba, *Current perception of remanufacturing as industrial activity*, (International Multidisciplinary Conference, Baia Mare, 2007).

[4] V.D. Guide, *Remanufacturing Production Planning and Control: U.S. Industry Best Practices and Research issues* (Second International Working Paper on Re-use, Eindhoven, 1999).

[5] W. Hanser and R. T. Lund, *Remanufacturing* (Technology Review, 2003).

[6] R.T. Lund, *The remanufacturing Industry - Hidden Giant* (Boston University, 1996).