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THE CURRENT PERCEPTION OF REMANUFACTURING AS AN INDUSTRIAL ACTIVITY

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Abstract: *In order to avoid costly retrieving of equipment on their end of life, the designers should state the procedures of recovery – remanufacturing – recycling, before specifying their structural characteristics. The strategies of recovering the used equipment may include a combination of remanufacturing, recycling and disposal procedures.*

Taking into account effectively the recycling capacity of equipment even since the design stage, enhances both the industrial ecology by rational use of natural resources and energy and the reducing of waste.

The remanufacturing of the technological equipment may be increased significantly by their projecting and design towards remanufacturing, looking for the principles of durable development.
Key words: *Remanufacturing, Recycling, Wear-out Life, Technological Cycle*

1. INTRODUCTION

In order to enhance the remanufacturing activity, a series of requirements are imposed for the technological equipment that are to be remanufactured, thus requirements have to be respected since the product conception and design.

In his work, „*The Remanufacturing Industry. Hidden Giant*" (1996), professor Robert T. Lund of the Boston University presents the main characteristics needed for a product to undergo the remanufacturing process.

► Those components of the technological equipment that have not physical characteristics of being grounded or dissipated.

► There is a technology needed to reduce the product to its original shape, condition and functioning.

► The original technologic equipment had been carried out according to plans, norms and standards and it has interchangeable parts.

2. THE BASICS OF THE DEVELOPMENT OF THE REMANUFACTURING AND RECYCLING TECHNOLOGIES

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** – the term from the product purchasing until the date when the equipment would not respect the original functions.
- **projecting cycle –** the term between two successive generations of equipment, or the frequency with which the designers' team re-designs the equipment or designs a new one that makes the original to become outdated.
- **technologic cycle** – the term in which the equipment will be on the top of the technology, before the new technologies would make the original product to become morally outdated.
- **replacement period** – the term until the customer changes the equipment with a higher performance one
- th**e causes of the outdating of the equipment** – the reasons for which a product is not anymore able to fulfill the functions it had been designed for. The equipment is **worn out physically** when its main parts, which carry out its basic functions, fail. The product is **worn out morally** when the users consider its functions are not the best on the market because of the technological innovations.
- **the operational complexity –** it refers to the relation between the modules and the operations they carry out. A high operational complexity product has the highest degree dependable modules that carry out a variety of operations, as well as a low operational complexity product has modules which carry out the operations independently
- **the overall dimensions of the technological equipment** – give information about the quantity of used raw material
- **the hazardous materials contained within the structure of the technological equipment –** the hazardous materials are to be removed before commencing the remanufacturing-recycling process

- **the cleanliness of the equipment** – during the operation process the equipment accumulate some quantities of dirt that consume time and labor for the remanufacturing process.
- **the number of material sorts** – of which the parts of the core of the equipment are made
- **the number of modules** – the number of sub-assembles that are physically detachable and are able to preserve their functions.

During the preliminary stage of the projecting of the technological equipment the designers are due to take into account the following aspects, too:

- the interest and the orientation of the organization for an "ecological projecting", which tends to eliminate as much as possible the negative influences on the environment (respecting the condition imposed by the ISO 14000) [1];
- the parts and subassemblies of the highest recycling values – parts or materials that, through remanufacturing or recycling, bring in maximum profit.
- the motivation for dismantling – the dismantling cost should not overwhelm the income obtained through the remanufacturing or the recycling of the part or subassembly.
- the responsibilities for the costs of the parts dismantling, collecting and transportation
- the trading opportunities (purchasing) – the compensation policy for returning of the equipment
- the beneficiary of the recycling – the organizations which receive the parts for recycling and obtain profit by this activity.

Two of the main characteristics, as the wear-out life and the technological cycle, are critical for determining the recovery procedure of the used equipment. As presented in the table 1, there is a relationship between the reuse and the remanufacturing of the parts, when the technologic cycle is short, notwithstanding their wear-out life.

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

Recovery strategies may be stated, starting with the information within the table 1, after the completion of the life cycle, for different goods. In the figure 1, having on the horizontal axis the **wear-out life** and on the vertical axis the **technological cycle**, the locations for some products are set in this coordinate system. The arrow in the figure shows where are opportunities for recovering the product in maximum efficiency conditions.

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.

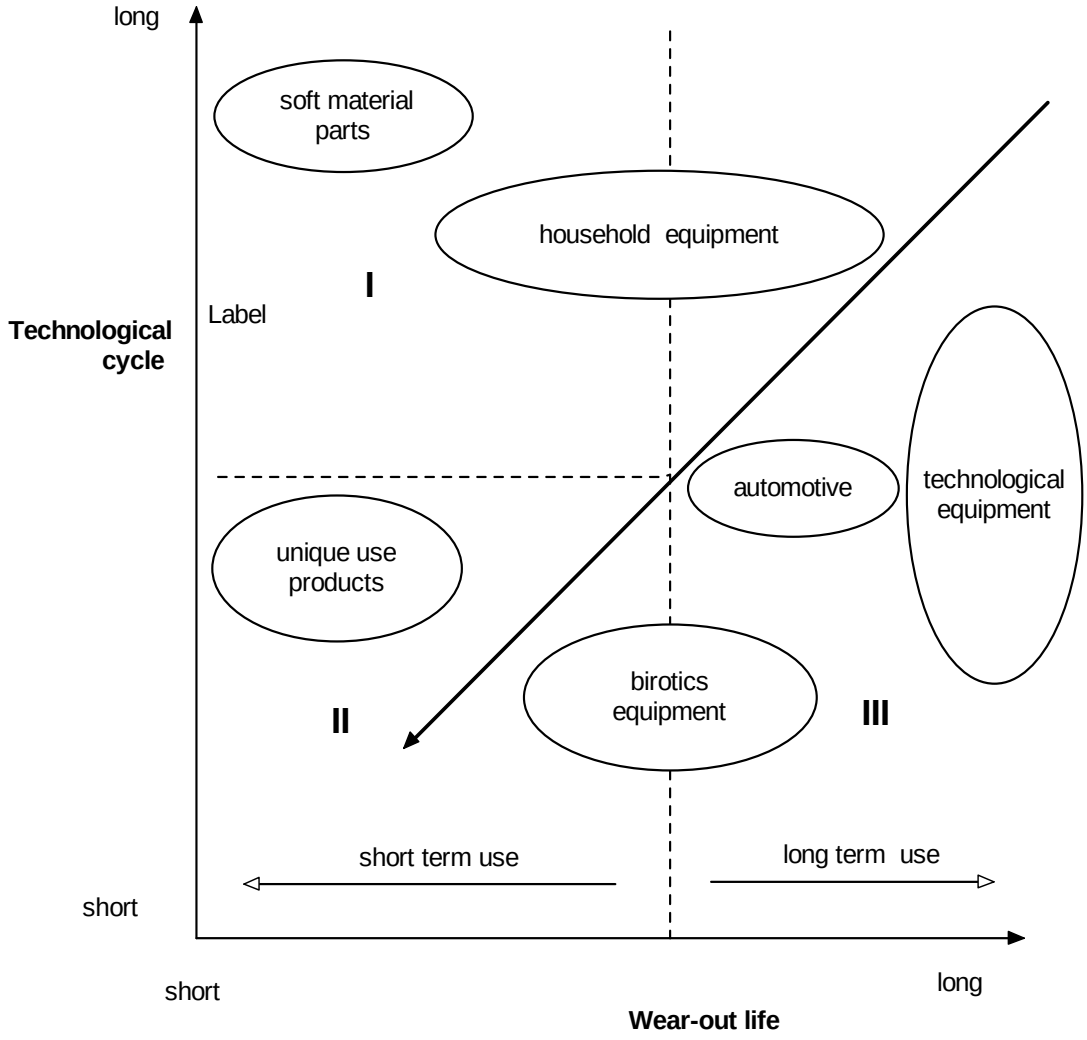

Fig. 1. *Recovery strategies of the value of the used goods – adapted [3]*

The table 1 shows the guidelines for increasing the technology of the remanufacturing and recycling technology, starting from the figure no.1.

The designers may propose the parts severing to increase the materials recycling degree, in case of the 1st type products, characterized by long technological cycles and short wear periods.

The short wear period and short technologic cycle of the 2nd type products, support the designers to enhance the opportunities of recycling and remanufacturing of the products, by using the modular parts and standardized pieces, for all products families.

The development of more efficient cleaning technologies reduces the remanufacturing costs for the 2nd type products. The products of long term wear and short-term cycle have to be modulated since the projecting stage. The nondestructive dismantling techniques may be an ideal research area for the development of the remanufacturing technologies of the 3rd type products.

Table 2. Guidelines for the projecting and the developing of the remanufacturing and recycling technologies - adapted [3]

The Product Type	**Suggestions for the Products Designers**	**Suggestions for the Designers of the Remanufacturing and Recycling Technologies**
Type I	Feasible solutions which are to permit the parts separation according to each case	Projecting separation technologies according to the physical characteristics of materials that cannot be sorted out.
Type II	- Parts modulation - Feasible solutions of easy assembling/ taking apart	Projecting efficient technologies of cleaning the products in order to reduce their manufacturing costs.
Type III	Adopting technical solutions that are to permit adding some accessories to the basic product to increase the wear duration and value.	Nondestructive technical solutions for the accessories dismantling
Type IV	Feasible solutions that are to facilitate the technological equipment maintenance and modernization, in order to increase the operation life.	Nondestructive technical solutions for the technological equipment maintenance and modernization.

The designers have the opportunity to expand the products end of life by facilitating their maintenance and simplifying their modernization possibilities, for the 4th type of products.

The recovery of a part of the remaining value of the physically and/or morally worn out technological equipment should be addressed in two ways, in the current stage of recognizing the remanufacturing industry.

- recovering by remanufacturing the existent technological equipment –during operation or preserved – and that had not been originally designed to be remanufactured.
- addressing the remanufacturing of the technical equipment since the projecting stage.

3. CONCLUSIONS

Generally, in case of the technological equipment, the core elements (frames, cases, stakes, diaphragms, etc.) that are the object of the remanufacturing, are processed accurately during the manufacturing stage, for a reliable operation and with shape and dimension changes within the prescribed parameters.

The durability and reliability of these parts lead to a relatively simple remanufacturing, concretized by relatively simple operations like: guides plating or touching finishes, replacing the classic lead screw axles by ball screw axles, replacing the bearings, replacing and/or reconditioning the worn out bearings

The problems that appear in case of these equipment remanufacturing are due to their long lifetime on one hand, and to the technological progress on the other hand, that bring significant changes within the command, control and measuring systems, but also in the area of materials and action systems. Thus it is imposed that by remanufacturing the equipment to be fitted with operational command systems (CNC), improving their technical characteristics to the level of the new similar equipment.

4. REFERENCES

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