Chapter XXV

An Integrated Approach for the Planning and Control of Flexible Retro-Production Systems

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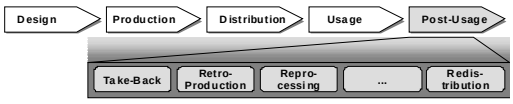
INTRODUCTION

While in the past only the product phases of development, production, distribution as well as use and service were considered, today, more complete consideration up to the end of a product life is common. Along with the demand for an environmentally-friendly handling of important resources, recycling of worn-out products, for example, in the automotive sector, electrical and electronic equipment, or industrial goods, will gain crucial importance in the near future. In addition, comprehensive environmentally-related legal demands force the industry to take recycling of products into consideration (BMU, 1999; EU, 1999; Griese, 1997; Seliger et al., 1997; Thierry et al., 1995). Additionally this includes several processes (Figure 1) of the post-usage phase, such as:

- systematic take-back of used products to specific facilities,
- definition of adequate recycling strategies,
- dismantling of products,
- reprocessing of components,
- mechanical treatment,
- reuse of components and utilization of materials as well as
- redistribution of the recycled goods into production and secondary raw material market.

Figure 1: Enlargement of the Products Life Cycle



The focus of this chapter is set to the key process *dismantling*, so-called retro-pro-

duction, in order to close the loop of components, parts or materials in the production. Dismantling of worn-out products is a difficult process for different reasons. On the one hand, dismantling enables the separation of components suitable for reuse, to regain pure materials, as well as the isolation of harmful substances. In addition, the process retro-production also receives a higher importance because aspects like maintenance and service of products, whereby disassembly activities are also performed. In the automotive industry, for example, old generators and starters as well as compressors of trucks are repaired, checked and resold. On the other hand, dismantling is time-intensive and costly because of the large share of manual work. This is caused by the great heterogeneity of the products arising at the recycling facilities: the product spectrum is multifarious in functionality, design and years of construction as well as manufacturers that makes automation difficult (Lund, 1996; Seliger et al., 1999; Wiendahl et al., 1998).

Therefore, it is necessary to enlarge the possible application fields of common environmental information systems. Suitable instruments have to be developed to plan and to control dismantling processes and to integrate these processes into suitable retro-production systems. Methods known from the production planning are enlarged and integrated into this approach.

A brief overview about the actual status of dismantling and important requirements on appropriate instruments are given next. In the following parts, the approach is outlined, whereas the specific parts and the underlying methods are described in more detail.

OVERVIEW OF THE STATUS OF RETRO-PRODUCTION SYSTEMS

The actual situation in the recycling field is mainly featured by workmanship. Apart of the great variety of variants and the complex product structures, their emergence and distribution in a recycling facility are subjected to strong stochastic fluctuations. Aggravating for dismantling is the fact that the outdated products of today are generally not designed to be disassembled (Hesselbach et al. 1998a; 1999a).

At the recycling facilities, the optimal recycling strategy of the products has to be determined. For products to be dismantled, the related expenditure has to be estimated and the corresponding processes have to be planned. In practice, products are dismantled in several work steps into a certain amount of fractions resulting in a diverging material flow. It is difficult to automate the individual dismantling operations due to these reasons mentioned above. Therefore, existing organizational structures in recycling facilities are based mainly on manual disassembly at individual working places. The differences between the actual retro-production in practice and the highly industrialized production become quite clear. Rationalizing potentials, by an optimized use of existing equipment or job sharing and the herewith resulting exploitation of learning effects, will not be fully exhausted.

Studies performed at recycling facilities showed positive results when reducing the variety of dismantling operations and unifying the corresponding processes (Figure 2). In this case, a group of similar monitors (Nokia 41BJ251) were dismantled by the same operator at one place and the corresponding processes were analyzed.