5. Product Recovery Systems

5.1 Strategic Aspects of Product Recovery Management

This section deals with product recovery management and its relevance for manufacturers of durable products. Product recovery management deals with the management of all used and discarded products, components, and materials for which a producing company is legally, contractually, or otherwise responsible (see, e.g., Thierry [127]). The aim of product recovery management is to regain as much of the economical (and ecological) value of the used or discarded items as is reasonably possible, therefore reducing waste disposal to a minimum.

Literature provides several definitions for the recovery of products. Like Fleischmann et al. [36] and Gungor and Gupta [45], for the purpose of this study, the recovery process is categorized into material recovery (recycling) and product recovery (remanufacturing). Recycling recovers the material content of a old product. Remanufacturing preserves the product's identity and returns the product to a desired level of quality. The operations for both recovery options may be disassembly and sorting. In the case of remanufacturing, there is also the assembly of the new products, under certain circumstances, there may also be refurbishing operations necessary.

There are several incentives for companies to take back used products. On the one hand, there are legislative rules, e.g. legislative action encompasses disposal bans for specific product, or recovery quotas. For instance, in Germany, on 7th October 1996, the commercial and industrial waste avoidance and management act (KrW-/AbfG) came into force. It puts the polluter principle into action, and the emphasis is on the product responsibility of the manufacturers and distributors. In addition, the Federal Government has defined several ordinances where the product responsibility for certain products is specified. For instance, recovery goals for sales packaging materials are mandatory between 60 % and 75 % (see packaging ordinance of 1991). The battery ordinance of 1998 obliges customers to return all old device batteries to collecting points or retailers, respectively. The traders have to point out the obligation to return discarded batteries to customers, i.e. consumers must

1 Gungor and Gupta [45] provide a current overview of the literature in the field of environmentally conscious manufacturing and product recovery.
be supplied with adequate information about this obligation. The electronic scrap ordinance of 1996 sets similar goals for electronic goods, analogously the used car ordinance for all components and materials of cars, e.g., steel, metals, tires,... The European Community has set a law that by the year 2002 no more than 15\% of an automotive product can be disposed of, and in the year 2015 this percentage must be reduced to 5\% (see, e.g., Nasr [96]). In Frosch [39] the development of environmental regulations in the USA is described. On the other hand, even if legislation is less stringent, environmentally conscious customers increasingly force manufacturers to take back their products after use. By designing and marketing environmentally friendly products, manufacturers may gain advantage in the marketing platform against their competitors (see also Gungor and Gupta [45]). Moreover, the customer pressure is also triggered by increasing product disposal costs. In recent years, these costs have risen significantly as landfill and incineration capacity is being depleted (see, e.g., Thierry [127]). Manufacturers are therefore more and more responsible for the entire life cycle of their products. Considerable efforts are made more recently to re-integrate used items into "traditional" industrial production processes. In the traditional approach, most products were designed with respect to minimizing materials, assembly and distribution costs, disregarding repair, reuse and disposal costs. These aspects were also not taken into account by most consumers. Minimizing purchasing costs sells products, not optimizing life-cycle performance including maintenance, reuse and disposal issues. As already emphasized, nowadays, both customers and government authorities demand that companies reduce or even avoid waste disposal. Moreover, in addition to enhanced environmental constraints and a "green" image there are also economic drivers for recovering used products (see, e.g., Thierry [127]). On the one hand, a "green" image has also become an important marketing element. By offering "green" products, companies may attract environmentally conscious customers, leading to higher sales. Moreover, producing environmentally friendly products reduces future liabilities, insurance and tax rates, and customers' disposal costs. On the other hand, the reuse of products may lead to savings in material, manufacturing and disposal costs. A first opportunity is to upgrade some parts of the returned old items instead of purchasing all the components to assemble a new product. The product can then be sold as a new one. Furthermore, it may be possible to remanufacture some of the disassembled parts of the returned items and to use these components as spare parts for the original product. Examples from practice include reusable packaging, electronic scrap recycling, or car part remanufacturing. The management of the material flow concerned with the recovery of returned products, which is opposite to the usual supply chain flow, is considered in the recently emerged field of "reverse logistics" (see, e.g., Fleischmann et al. [36]).