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Waste to Resource Process Chain Strategies for Global Manufacturers

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Abstract

In order for suppliers to stay competitive in the global market, innovative and resource efficient process chains need to be a part of their manufacturing strategies. In this study the effect of different waste to resource process chain strategies were evaluated. The objective was to transform the material waste from a cutting process into a resource. The metal chips were collected and the effect of lubrication and briquette forming strategies on value were investigated. The effects on cost and quality were evaluated and the influence on factory planning assessed. The value of the briquette increased with a reduction in lubricant during the cutting process and by compacting the metal chips.

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Keywords: Waste; Resource; Recycling; Aluminium; Process Chains; Sustainability; Manufacturing

1. Introduction and Background

In 1966, Boulding [1] described the current state of the economy as a transition between the so called 'cowboy economy' of the late 19th century and the 'spaceman economy' of the future, which we will reach by the latter end of the 21st century. In the 19th century, the economy was driven by exploitative tendencies, where resources were readily available for the taking. Consumption and production in this type of economy was seen as a positive thing and success was measured by the amount of throughput in the system. This mindset largely prevails even today in most parts of the world. In contrast, the 'spaceman economy' is used by Boulding to explain a system which is aimed at minimising throughput. The resources already in the system needs to be reused and maintained in the current system. These terms are closely linked with modern buzzwords such as sustainability. Environmental and economic incentives are forcing manufacturers to think with this mindset and reconsider the process they use to manufacture goods. One environmental concern is the sheer volume of earth that needs to be removed to produce small quantities of metals. Table 1 shows the metal content in ore for the various metals [2]. Not only is the demand for metal growing, but metal ore is degrading in quality as well. The quality of copper ore has fallen from about 10% in the 19th century to 0.47% in 2014 [2,3].

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Table 1: Metal Content of Ores [2]

Metal	Metal Content (%)
Aluminium	19
Chromium	10
Copper	0.4
Gold	0.0005
Iron	52
Lead	6.5
Manganese	33
Nickel	0.7
Platinum	0.0005
Uranium	0.002
Zinc	3.2

Waste to resource processes allow manufacturers to close the manufacturing cycle. The general, simplified product life cycle is seen in Figure 1 [4]. The goal of this waste to resource research is to achieve as close as possible to 100% efficiency in this cycle, thereby reusing as much metal as possible that is available in the current system. This can be achieved by minimising as much residues as possible. In this paper, a case study is done at Hansens Engineering. The facility produces aluminium parts for use in the automotive industry. Machining of these parts create a considerable amount of scrap, because of the high volumes they produce, the in-house recycling process of which is analysed.

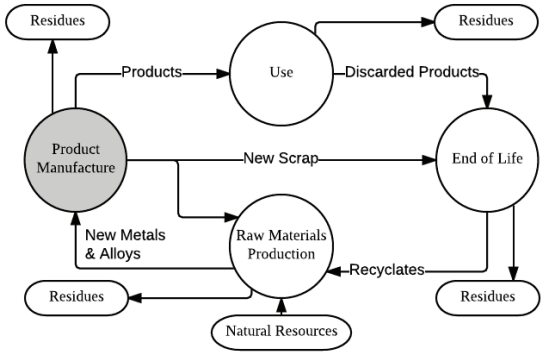

Figure 1: Simplified Metal Material Flow. Adapted from [4]

The process analysed is thus that of the 'Product Manufacture' circle in Figure 1. Out of this process flows products, new scrap and residues. In this paper, as is done by the engineers at Hansens, this new scrap is seen as a product on its own and not a waste product. Residues arise from this operation, which is everything that is not recycled and directly disposed of. These are minimised by implementing manufacturing strategies such as minimum quantity lubrication (MQL) and an automatic briquetting system, ensuring a greater amount of swarf (new scrap) can be recovered at a greater economic value. This is a prime example of a waste to resource process, where swarf is used to produce a product, simultaneously with the production of the machined component. Primarily, financial resources are compared, with discussions on the implications on environmental and human resources.

2. Waste to Resource Strategies

Lubrication and swarf processing systems are assessed as waste to resource strategies. MQL is a lubrication technique which implements very small amounts of lubrication fluid. This results in a near dry manufacturing environment. Hansens Engineering provides the ideal scenario to assess the implications of different waste to resource strategies, because they have implemented the MQL and briquetting systems in their manufacturing processes, but still have older, conventional flood lubrication installed in older processes. Swarf is also sold in briquette and loose form, which is another strategy which can be assessed. This creates a platform where in-house recycling for different scenarios can