Chapter 11
Sustainable Non Traditional Manufacturing Processes:
A Case with Electrochemical Machining (ECM)

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ABSTRACT

Sustainable operations strategy, an important field of research for engineering optimization, is posing an increasing challenge to operations managers. Sustainable operations can become a key to competitive advantage. Consequently, there is a need for research for the complex interfaces between the dimensions of sustainable operations strategy. The companies need to accommodate environmental demands, emphasized by media and government, along with social aspect in day to day operations for formulating strategies. Non-traditional manufacturing processes involves mechanical, thermal, electrical or chemical energy or combinations of these energies but do not use a sharp cutting tools as required for traditional manufacturing processes. In this chapter a non-traditional machining process namely Electro chemical Machining (ECM) has been considered. Material Removal Rate (MRR) and Surface Roughness (SR) has been optimized using Taguchi, Grey Relation, Artificial Neural Network, Fuzzy Logic and Genetic Algorithm to achieve the best.

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1. INTRODUCTION

Sustainability is a recent increasingly global issue to all business led organizations; management strategies and practices towards sustainability have been established to cater to a growing interest to business environment. Impacts on sustainability are strongly influenced by shop floor decisions in the supply chain; it is vital that the functions of operations management embrace the requirements of sustainability management. This has implications for decision making in associated with all aspects of operations management in the supply chain. Scope of any given 'operation' is, thus, expanded considerably with the nature of operations management perspective. Generally accepted definition of sustainability is considered in the line of development as *'…development that meets the needs of the present without compromising the ability of future generations to meet their own needs'* (Brundtland Commission, 1987).

In economic perspective, every human action or societal undertaking is purely depending on basic objective of profit maximization or loss minimization. This requires the trade-off between increase in net profit and decrease in available energy (Fan & Tengyan, 2012). As per their view, notion of sustainability arises from the need to balance between increase in economic benefit and decrease in energy. Sustainability engineering can be regarded as an engineering discipline to craft frameworks or establish paradigms for attaining sustainability in any human or social perspective; an emerging discipline of engineering. Obviously, sustainability assessment constitutes the initial phase of sustainability engineering (Fan & Tengyan, 2012).

Sustainability in long term requires that artifacts, materials, systems and processes be designed to maximize reuse and utility (Tsahalis et al., 2012). Sustainability optimization task is basically an attempt to integrate mutually as well as conflicting goals like minimize negative impact and maximize quality, minimize cost and maximize profit, etc. Apart from this, holistic view of sustainability must cover entire life of a product from material procurement, design, production, distribution to its end-of-life. Introduction of sustainability issues, therefore, complicates the problem of process optimization more by adding more objectives to meet.

As per the latest report of 'FoFdation: Foundation for the Sustainable Factory of the Future', manufacturing sustainability optimization is by its definition a Multi-Objective Optimization problem. It integrates sustainability methods, goals, targets, indexes, indicators and product properties that need to be optimized, by adjusting a large number of product / process / tool parameters, thus leading to a large number of alternative solutions. In order to optimize the performance of manufacturing process, a more complex model is required. This enhanced process and sustainability model should be able to calculate the production performance on sustainability, as well as, production performance regarding time, cost, quality or any other indicator of interest (Tsahalis et al., 2012). A general sustainability optimization for the entire life cycle of the product is not the same as the sustainability optimization of a machine tool stage, although they are related to each other.

Sustainability in optimization involves many metrics / indicators and constitutes a structure of multiple-objective optimization problem. Even if overall indices are used; objectives are contradicting. The basic methodology is described in the following steps (Tsahalis, Moussas, & Tsahalis, 2012):

- Index and Indicator goals: will provide objective functions for the optimization problem. The optimization tool will try to reduce the overall target-indicator distance based on the adopted sustainability methodology.