Chapter 11
Micro and Nanotechnology Maturity and Performance Assessment

Nazrul Islam
Cardiff University, UK

ABSTRACT

This chapter aims to provide a new readiness matrix called 'innovative manufacturing readiness levels (IMRLs)' to evaluate and assess the areas of micro and nanotechnology maturity including their performance. The study employs a case study approach through which the practicability and applicability of the IMRLs conceptual matrix were verified and confirmed. A case study with laser-based manufacturing technologies explores the stages of micro and nano technologies (MNTs)' maturity, including the key issues and performances that contributed to the development of a new assessment tool. Concerning intense global R&D competition in MNTs, this study exhibits a forward-looking approach in assessing MNTs maturity and performance. A generic conclusion is reached by which product designers and technology managers position themselves and take into account risk reduction exercises related to MNTs. The novelty of the research could be that organizations, which develop and use MNTs, have an opportunity in applying such a specific assessment matrix to quantify the technology readiness of unreleased MNTs.

INTRODUCTION

Nanotechnologies have been attaining wide recognition in recent years and are expected to bring significant changes to a wide range of technologies due to having novel and improved properties in their materials in relation to the nanometre scale. Because of their potential applications, nanotechnologies are considered as one of the emergent fields having the potential for important social and economic impacts in the future. A turning point in science and technology policy in relation to nanotechnology has been the launch of the National nanotechnology Initiatives (NNI) in the United States in 2000. Since then, developed countries and many developing countries have launched initiatives or have prioritised research in nanotechnology. Nanotechnology as it appears today is not

DOI: 10.4018/978-1-61692-006-7.ch011

a single technology but a constellation of diverse and unfocused technological fields. Research into technologies based on nano scale structures is nothing new. What has led to a nanotechnological breakthrough is the development and application of new sophisticated instruments that have been applied to observe and manipulate processes at the nano scale level. The so-called breakthroughs were mainly made with the development of the STM (scanning tunneling microscope) and the AFM (atomic force microscope) in the mid 1980s by IBM for the semiconductor industry. Since then a range of other tools and advancements have appeared in how to measure and interpret at the nano scale (Royal Society 2004).

At the present time, manufacturing industries see the benefits of micro and nano technologies (MNTs) for industrial production, since R&D activities in the emergent technologies have been strengthened worldwide, and it is thought their potential is likely to be pervasive in wider applications. Micro and nanomanufacturing technologies are increasingly employed in a huge variety of consumer products and industrial components (Rooks, 2004) incorporating machine tools and processes. In addition, the demand for nano-products and components has been increasing rapidly with versatile applications in electronics, optics, medicine, biotechnology, automotive and communications industries (Alting et al, 2003). Researchers in academia and industry worldwide are striving to get involved in the development of innovative (micro and nano) manufacturing technologies to meet the demand of miniaturized products (Islam, 2009). The mission for micro and nanotechnology-based companies, both small and large, is to adopt or implement the technology successfully. However, to achieve this, companies face challenges rooted in technological and process uncertainties and risks which demand new managerial approaches. With the fast moving pace of emerging MNTs and their disruptive nature, coping with their maturity and performance measures has become the foremost issue for manufacturing design engineers as well as technology managers. Therefore, it is crucial for successful tracking and controlling of an innovative manufacturing technologies life cycle.

The importance of technology readiness and capability has been recognized as an important driver for the successful deployment of technological as well as manufacturing systems. To implement the technologies successfully, companies face challenges rooted in technological and process uncertainties which demand new and improved managerial approaches. In addition, in the management of micro and nano technologies' life cycles, challenges still remain in its practice and implementation which demand novel or improved approaches. The main objective of this chapter is to build and use a new readiness matrix called 'innovative manufacturing readiness levels (IMRLs)' to evaluate and assess technology maturity, including the performances of the emergent MNTs. It also has the practical purpose of supporting the companies related to micro and nanotechnologies to develop their capabilities in technology management. For assessing the maturity of generic technology and manufacturing systems several concepts and scales currently exist. For example, technology readiness levels originally developed in the 1980s by the National Aeronautics and Space Administration and further adopted in the 1990s by the United States Air Force, and manufacturing readiness levels as defined by the Department of Defense in 2005. These existing concepts have limitations, specifically in embracing MNTs maturity. Therefore, a comprehensive understanding in the implementation of MNTs has provided the basis on which an improved matrix can be developed.

Since micro and nanotechnologies have been regarded as a major driver of future global economic development, small and medium-sized companies and industry increasingly seek more effective ways to manage MNTs. This chapter explores how MNTs are managed throughout their lifecycle in a more explicit way than has so far been accomplished by this research. The

Related Content