CHAPTER 1

INTRODUCTION

1.1 EMERGENCE OF THE NEED

The Research work “Design and Development of a Web-Enabled Knowledge Base System for Selection of Appropriate Non-Traditional Machining Processes” focuses on selecting an appropriate Non-Traditional Machining Process (NTMP) from among host of currently practiced Non-Traditional Machining Processes (NTMPs) to suit the given machining problem.

Over the last few decades there has been a large increase in the number of NTMPs. Although NTMPs are categorized according to the type of energy used, the mechanism of material removal and the source of energy requirements, they vary widely with their vastly different capabilities and specifications for a wide range of applications (Pandey et al 1988). Today over 30 different NTMPs are successfully implemented (El Hofy 2005 and Jain 2002).

Effective utilization of the capabilities of the NTMPs needs careful selection of the suitable process for the application. The lack of versatility of NTMPs, uncertainties regarding the capabilities of the NTMPs, and different cost elements of operating NTMPs make the comparison and selection of NTMPs a challenging task. Only an experienced design engineer can make the correct selection of an appropriate NTMP easily. However, an increasing shortage of experienced design engineers in the field of NTMPs makes the
selection of the appropriate NTMPs a critical problem. More specialized and less experienced engineers are being involved in the design and manufacturing process now a days. Therefore, there is a growing need for computer software in making selection decisions on suitable appropriate NTMPs (Rajurkar 1992).

These NTMPs generally are characterized by a number of attributes. The important process capability attributes which have industrial relevance are: surface finish, material removal rate, tolerance, surface damage, corner radii, taper, hole diameter, depth to diameter ratio (for cylindrical holes), depth to width ratio (for blind cavities), and width of cut (Neelesh et al 2001).

1.2 CURRENT SCENARIO OF NON-TRADITIONAL MACHINING PROCESSES

Today’s manufacturing industry is facing challenges from advanced materials, making it difficult to machine them (tough super alloys, ceramics, and composites), stringent design requirements (high precision, complex shapes, and high surface quality), and machining costs. Advanced materials play an increasingly important role in modern manufacturing industries, especially, in aircraft, automobile, tool, and die-making industries. The greatly improved thermal, chemical, and mechanical properties of the material (such as improved strength, heat resistance, wear resistance, and corrosion resistance), while having yielded enormous economic benefits to manufacturing industries through improved product performance and product design, are making traditional machining processes unable to machine them or unable to machine them economically. This is because traditional machining is most often based on removing metal using tools harder than the work pieces. For example, Polycrystalline Diamond (PCD), which is almost as hard as natural diamond, cannot be effectively machined by traditional
machining process. One of the most commonly used conventional technique is diamond grinding. In order to remove the material from a PCD blank, the diamond layer of the grinding wheel must be renewed by truing or dressing operations resulting in rapid wear of the wheel, because the G-ratio (ratio of the work piece volume removal rate to grinding wheel volume wear rate) is 0.005 to 0.02. Thus the grinding wheel wear rate is 50 to 200 times higher than the work piece removal rate. Hence, classical grinding is suitable to a limited extent for production of PCD profile tools. The high costs associated with machining ceramics and composites, and damage generated during machining is major impediments in implementing these materials. For example, the cost of machining structural ceramics (such as silicon nitride) often exceeds 50% of the total production costs in the engine manufacturing industry. In some cases, current machining methods cannot be used and hence improved techniques or modifications of existing methods are needed.

In addition to the advanced material, stringent design requirements also pose major problems in the manufacturing industry. More and more complex shapes (such as an aerofoil section of a turbine blade, complex cavities in dies and molds, non-circular, small and curved holes), low rigidity structure, micro mechanical components with tight tolerances, and fine surface quality are often needed. Traditional machining is often ineffective while machining these parts (Kalpakjian 1997).

To meet these challenges new processes need to be developed. The technological improvement of machining processes can be achieved by combining different physical or chemical actions on the materials being treated. In particular, a mechanical action which is used in conventional material removal process can be combined with respective interactions applied in NTMPs such as Electrical Discharge Machining (EDM), Electrochemical Machining (ECM), and Laser Beam Machining (LBM). The
reasons for developing these processes are to make use of the combined or mutually enhanced advantages, and to avoid or reduce some adverse effects the constituent processes produce when they are individually applied. Although some NTMPs have shown to be very effective in machining new and advanced materials and manufacturing of machine parts and tools, the research effort on process innovation and process selection of NTMPs has been inadequate (Rajurkar et al 1992). More importantly, adequate theory and methodology in the selection of NTMPs are needed, to make selection of appropriate manufacturing strategy.