4 Flexible Fixture Systems

4.1 Introduction

In Chapter 1 the relationship between fixtures and manufacturing system flexibility was explained. Flexibility in manufacturing systems was discussed in terms of flexibility in scheduling (short-term flexibility), and flexibility in re-configuring the system to accept a not previously manufactured workpiece (reconfigurability or long term flexibility). Manufacturing systems must have both long and short-term flexibility, in order to satisfy both company demands for a high rate of return on investment and market pressures for a short lead-time for production of new products with changed characteristics.

Current FMS demonstrate excellent short-term flexibility but this is achieved by using special purpose dedicated fixtures designed for a single operation on a single workpiece. Such fixtures cannot be used for other workpieces. They are built using mostly non-standard fixture elements and are generally not reusable or reconfigurable. The lead-time to design and manufacture dedicated fixtures is very long. These fixtures increase the cost of production and fixture storage, especially if the parts are in small batches and of large variety. Dedicated fixtures are more appropriate for relatively large production runs requiring high accuracy. This reliance on dedicated fixtures means the FMS have poor reconfigurability.

Fixtures employed in the FMS environment must be readily adaptable. Fixtures must be able to accommodate part families which vary in size and shape and provide quick loading/unloading of the workpiece. Since in FMS the parts are manufactured in batches, the changeover of tools, fixtures and accessories is frequent and the production system must be changed in a very short period of time to keep up with the schedule. To accomplish this, fixtures must be easily modifiable, reconfigurable, disassemblable, attachable and detachable to and from a pallet or machine tool table.

A new class of fixtures called flexible fixtures is emerging to satisfy the flexibility requirements of modern manufacturing. The main categories of flexible fixture systems are summarised in Figure 4.6 and will be discussed and evaluated later in this chapter. Previous reviews of flexible fixtures have been published by Thompson [1], and [2].
4.2 Evaluation of Fixture Systems

Fixture systems, like any other component of a manufacturing system, should be evaluated on the basis of cost, fitness for purpose and in the present context long and short-term flexibility. Dedicated fixtures will first be assessed on the basis of these criteria and compared with flexible systems in general. In later sections the same evaluation criteria will be applied to specific flexible fixture systems where information is available.

4.2.1 Capital Cost

Capital costs include the following:

- **Design costs**

  Design costs for dedicated fixtures are high. The designer has an almost infinite range of possible design choices. Given such freedom a designer can arrive at optimum design solutions but the time involved is long and hence expensive. Flexible fixtures, on the other hand, must follow a prescribed, limited set of design solutions. Satisfactory, though not necessarily optimal solutions can be designed quickly and comparatively cheaply.

- **Fabrication costs**

  Fabrication costs include the cost of materials, bought in components, machining, heat treating, finishing, and assembly. All these costs are expensive for dedicated fixtures because they are produced in a toolmaking environment that does not afford the economies of scale that flexible fixtures produced for a larger market can claim. Assembly is particularly expensive for dedicated fixtures because components must be fitted to achieve design tolerances.

- **Commissioning costs**

  Commissioning costs are the costs involved in trying out a new fixture, inspecting it to ensure it meets design specifications and making any adjustments found to be necessary. Because of their inherent unique design, these costs are high for dedicated fixtures. Commissioning costs for flexible fixtures are much lower in comparison because they follow a common design philosophy and hence have a more predictable performance.