Types of Processes

Low-volume manufacturing processes are limited in the viable options for both assembly and testing. The driving factor for the application of a particular type of testing is most often cost-related. The options open include manual test processes, semiautomated test processes, and automated test processes. Because of the limited number of units produced in most low-volume processes, setup costs for many options simply cannot be justified as they constitute an added expense to each unit produced. In a few situations where quality or performance are paramount, the issue of cost may be diminished or ignored, and the number of options open in selecting process steps increases. A process is most often considered low volume by virtue of the number of units processes. A low-volume process is one where the rate at which units are produced is low, even though the process may be used for years to produce thousands of units. Manual assembly and testing processes are used by the majority of low-volume manufacturers because of cost constraints. The cost of full manual test processes quickly rises with any appreciable volume.

Manual processes are more time-consuming than those using automation and labor costs are a prime contributor to the expense of manual process steps. As the amount of automation used by a process step is increased, the amount of human labor per step is decreased and the costs per unit decrease
while the overhead costs in terms of process development and setup charges increase. Figure 7-1 illustrates the relationships between the amount of automation and both the cost per step (recurring) and the setup cost (nonrecurring). The cost per step includes equipment and labor costs and any expendable material or utility costs. In most cases, the setup costs are entirely nonrecurring and may be amortized over the process volume. Higher volumes allow the nonrecurring cost per unit to be reduced. Figure 7-2 is a graph showing the effect of increasing the number of units produced upon the total cost of manufacture. This graph is simplified, and is not intended to show the additional beneficial effects of volume purchasing discounts or the economy of scale in inventory and asset utilization. Even without these effects, the cost per unit decreases somewhat as volume increases.

**Choosing the Correct Process**

**Manual Testing**

The lowest-volume processes are totally manual. The instruments and tools used in the testing stations are operated by people. Units are connected to the test instruments by people, and the test instruments are controlled and

![Figure 7-1. Relationships between the Amount of Automation, and Recurring and Nonrecurring Costs.](image)