3 PROCESS PLANNING FOR GROUP TECHNOLOGY

3.1 Essentials of Process Planning

Process planning is the decision making as to the production process through which raw materials are converted into products planned by product design, with a series of operations. This planning is interrelated with product design and layout planning. Information on technical specifications of products established by a product-design function is an important input to process planning. Layout planning requires information on the sequence of operations to manufacture each part or product, which is derived from process planning.

In general, process planning includes the following decision problems [1]:

1. **Process design (or work design).** This is a macroscopic decision making which determines an overall process route for converting raw materials into products. This includes flow-line analysis (analysis of work flow) and selection of work stations for each operation included in the work flow determined. A work flow for a product is usually determined with a process chart that indicates the sequence of operations composing multi-stage manufacturing. Then an appropriate
combination of work stations for performing operations included in the work flow determined is selected from among several technologically possible combinations of production facilities available and operative human power.

2. **Operation design (or job design).** This is a microscopic decision making as to the implementation of production. Specifically speaking, this design decides the content of each operation in the work flow determined by process design and the method of performing the operations.

### 3.2 Basic Models of Process Planning

A work route for completing a product consists of multiple operations (stages) such as turning, planing, drilling, finishing, and others, each of which usually has several alternatives in terms of what type of machine is to be used. Furthermore, several operations can be performed by using a single machine, such as a machining center, that can perform a sequence of multiple operations by automatically changing cutting tools. In general, there are several alternative process routes for converting a piece of raw material into a piece of product. From a process planning viewpoint, it is necessary to select the one best process route (work flow) from among those alternatives under a certain criterion such as minimum time, minimum cost, maximum productivity, and maximum profit. This decision is called "optimum process planning," or "optimum routing analysis."

Consider a process planning problem that requires four stages of operations—turning, planing, drilling, and finishing—to complete a product. There are two, three, three, and two alternatives, respectively, for these four operations. In addition, a machining center can be employed to perform both planing and drilling operations. These alternative routings excluding technologically impossible ones can be represented in the form of a network, for example, as shown in figure 3.1 [2]. In figure 3.1 arrows indicate operations with definite work contents and production times (or costs). The present problem is to select the one best work route from among 9 possible alternative process patterns.

Clearly this problem is among a class of combinatorial problems. Since the number of alternative process routes to be searched is limited, it is possible to select the best one by complete enumeration, calculating total times (or costs) for all possible process routes and then selecting a route with the least time (or cost). This complete enumeration procedure is not an appropriate method for large-scale process planning which includes a large number of