6.3 LAYOUT PROCEDURES

A number of different procedures have been developed to aid the facilities planner in developing layout alternatives. These procedures can be classified into two main categories: construction type and improvement type. *Construction* layout methods basically involve developing a new layout "from scratch." *Improvement* procedures, on the other hand, generate layout alternatives by seeking improvements in an existing layout.

Although a number of papers in the facility layout literature focus on the development of construction-type procedures, most layout work still involves some form of improving the layout of an existing facility. As Immer [29, p. 32] observed as early as the 1950s,

> Much of [the] work will consist of making minor changes in [an] existing layout, locating new machines, revising a section of the plant, and making occasional studies for material handling. The plans for a complete new production line or a new factory may make the headlines, but except for a war or a new expansion, the average layout [planner] will very seldom have to consider such a problem.

While Immer's observation still holds today for the most part, some changes to the layout are no longer "minor" changes (due to the far-reaching impact lean manufacturing has had in the manufacturing sector), and there are new plants being built around the globe, as manufacturing spreads from traditional bases such as the United States to other regions of the world.

We begin our discussion of layout procedures by discussing some of the original approaches to the layout problem. The concepts in these approaches continue to serve as the foundation of many of the methodologies proposed today.

6.3.1 Apple's Plant Layout Procedure

Apple [2] proposed the following detailed sequence of steps in producing a plant layout.

1. Procure the basic data.
2. Analyze the basic data.
3. Design the productive process.
4. Plan the material flow pattern.
5. Consider the general material handling plan.
6. Calculate equipment requirements.
7. Plan individual workstations.
8. Select specific material handling equipment.
9. Coordinate groups of related operations.
10. Design activity interrelationships.
11. Determine storage requirements.
12. Plan service and auxiliary activities.
13. Determine space requirements.
14. Allocate activities to total space.
15. Consider building ty[pes]...

16. Construct master layout.
17. Evaluate, adjust, and check the layout with the appropriate persons.
18. Obtain approvals.
19. Install the layout.
20. Follow up on implementation of the layout.

Apple noted that these steps are not necessarily performed in the sequence given. As he put it,

> Since no two layout design projects are the same, neither are the procedures for designing them. And, there will always be a considerable amount of jumping around among the steps, before it is possible to complete an earlier one under consideration. Likewise, there will be some backtracking going back to a step already done—to re-check or possibly re-do a portion, because of a development not foreseen [2, p. 14].

6.3.2 Reed's Plant Layout Procedure

Reed [53] recommended the following "systematic plan of attack" as required steps in "planning for and preparing the layout."

1. Analyze the product or products to be produced.
2. Determine the process required to manufacture the product.
3. Prepare layout planning charts.
4. Determine workstations.
5. Analyze storage area requirements.
6. Establish minimum aisle widths.
7. Establish office requirements.
8. Consider personnel facilities and services.
9. Survey plant services.
10. Provide for future expansion.

Reed calls the layout planning chart "the most important single phase of the entire layout process" [53, p. 10]. It incorporates the following:

1. Flow process, including operations, transportation, storage, and inspections
2. Standard times for each operation
3. Machine selection and balance
4. Manpower selection and balance
5. Material handling requirements

An example of a layout planning chart is given in Figure 6.2. Such charts can be viewed as the predecessors of value stream maps used in lean manufacturing today [54].

6.3.3 Muther's Systematic Layout Planning (SLP) Procedure

Muther [49] developed a layout procedure he named systematic layout planning, or SLP. The framework for SLP is given in Figure 6.3. It uses as its foundation the activity relationship chart described in Chapter 3 and illustrated in Figure 6.4.

LAYOUT PLANNING CHART

PART NO. 1 | PART NAME PLASTIC CONTACT PAD | PCS/ASSY 1 | PCS REQ/HR 70.4 | SHEET 1 OF 1

ASSY NO. — | ASSY NAME — | ASSY/PRODUCT 2 | PRODUCTION HRS/DAY 6.0 | PREPARED BY J.G.D. | DATE 1-4-60

MATERIAL PLASTIC | SIZE 11/2" OD × 3/8" ID (from 4' × 8' × 1/4" SHEETS) | PCS/DAY 422 | LOT SIZE 1 | APPROVED BY | DATE

ST NO.	F M S I	DESCRIPTION	OPER NO.	DEPT NO.	TIME PER PIECE	MACHINE OR EQUIPMENT	MACHINES REQD			OPER PER MACH	TOTAL MANPOWER				HANDLING REQUIREMENTS				REMARKS
							MACH FRAC	COMB WITH	MACH REQD		CREQ FRAC	MAN FRAC	COMB WITH	MEN REQD	HOW MOVED	CONT TYPE	LOAD SIZE	DIST MOVED	
1		FROM MATERIALS STORAGE													FORK LIFT	PALLET	4 SHEETS	100'	
2		ON PALLET BY SAW		2															
3		TO SAW TABLE																	
4		SAW INTO STRIPS 2 1/2" × 8'	10	2	.02	TABLE SAW	.028	9 – 10 16 – 10	1	2	.028	.056	9 – 10 16 – 10	2					
5		TO RACK BY SAW											1 – 20 14 – 30						
6		IN RACK		2									17 – 20 3 – 20						
7		TO HEATER											6 – 30 13 – 20						
8		IN RACK BY HEATER		2									14 – 20						
9		FEED INTO HEATER																	
10		HEAT	10	2	.04	HEATER	.055	9 – 20 16 – 20	1	1	.055	.055	6 – 20 6 – 10	1					
													3 – 10 2 – 10						
													9 – 20 16 – 20						
													13 – 10 14 – 10						
													17 – 10						
11		FEED TO PUNCH PRESS																	
12		PUNCH TO SHAPE	10	2	.04	PUNCH PRESS	.055	4 – 10 4 – 20	1	1	.055	.055	4 – 10 4 – 20	1					
13		TP BIN BY PUNCH PRESS						9 – 30 16 – 30					9 – 30 16 – 30						
14		IN BIN		2				19A – 10 19B – 10					19A – 10 19B – 10						
15		TO PARTS STORAGE											19A – 20 5A – 10		4 WHEEL HAND TRUCK	TOTE BOX	400 PER BOX	150'	
16		IN PARTS STORAGE		5															
17		TO ASSEMBLY													4 WHEEL HAND TRUCK	TOTE BOX	400 PER BOX	60'	
18		IN BIN IN ASSEMBLY		6															
19		TO TABLE																	

Figure 6.2 Layout planning chart.

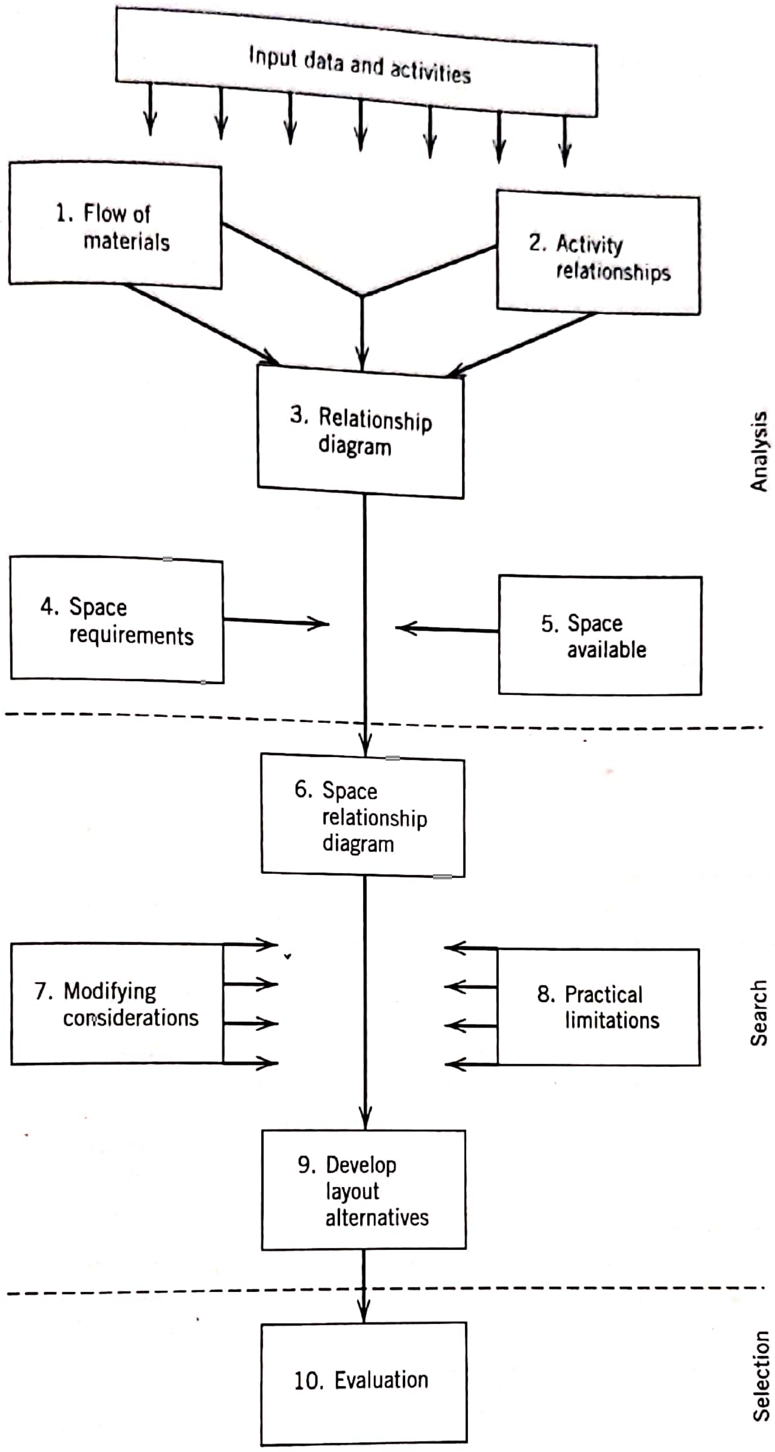

Figure 6.3 Systematic layout planning (SLP) procedure.

Based on the input data and an understanding of the roles and relationships between activities, a material flow analysis (from-to chart) and an activity relationship analysis (activity relationship chart) are performed. From the analyses performed, a relationship diagram is developed (Figure 6.5).

The relationship diagram positions activities spatially. Proximities are typically used to reflect the relationship between pairs of activities. Although the relationship diagram is normally two-dimensional, there have been instances in which three-dimensional diagrams have been developed when multistory buildings, mezzanines, and/or overhead space were being considered.

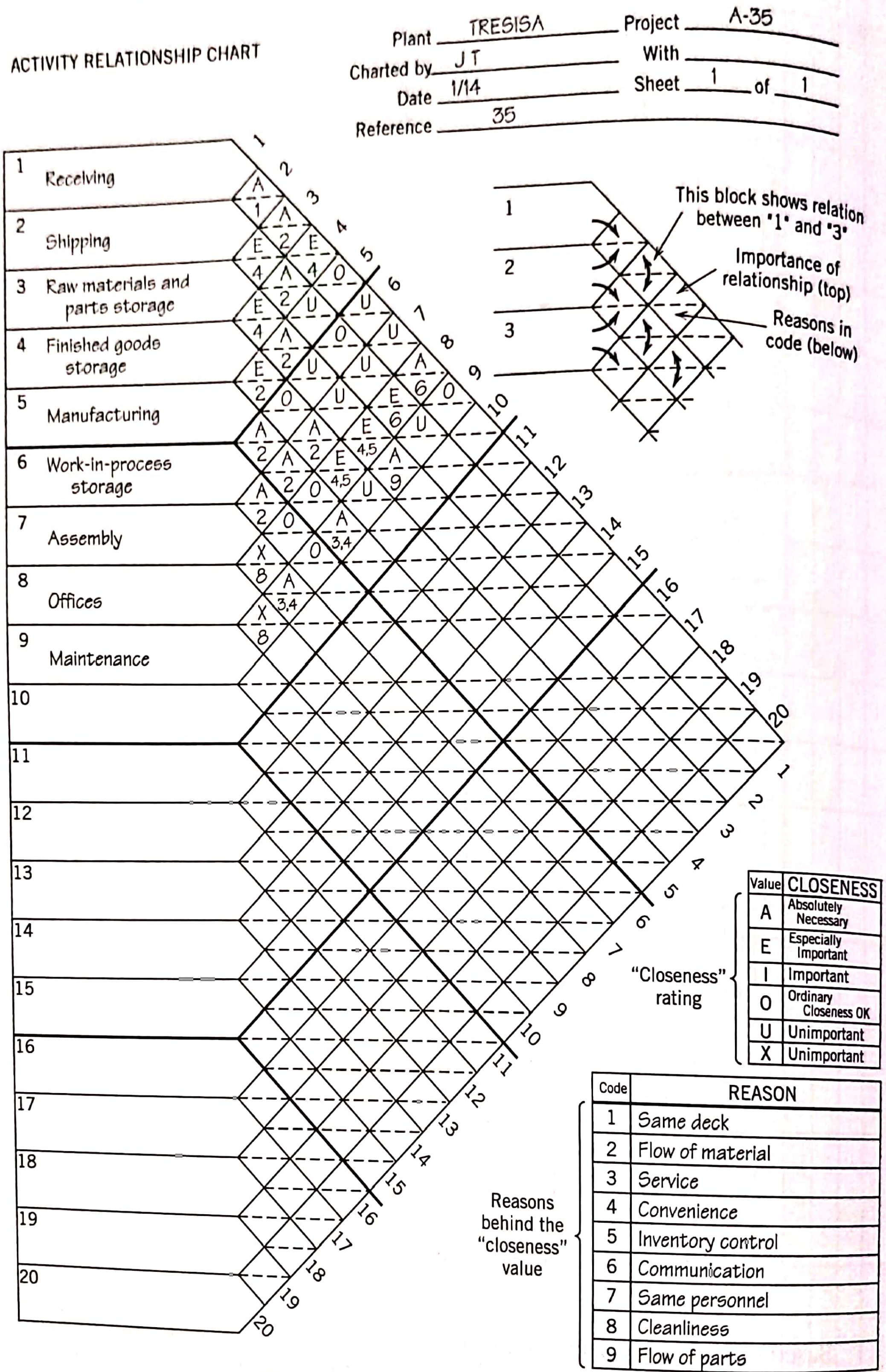

Figure 6.4 Activity relationship chart.

The next two steps involve the determination of the amount of space to be assigned to each activity. From Chapter 3, departmental service and area requirement sheets would be completed for each planning department. Once the space assignments have been made, space templates are developed for each planning department, and the space is "hung on the relationship diagram" to obtain the space relationship diagram (Figure 6.6).

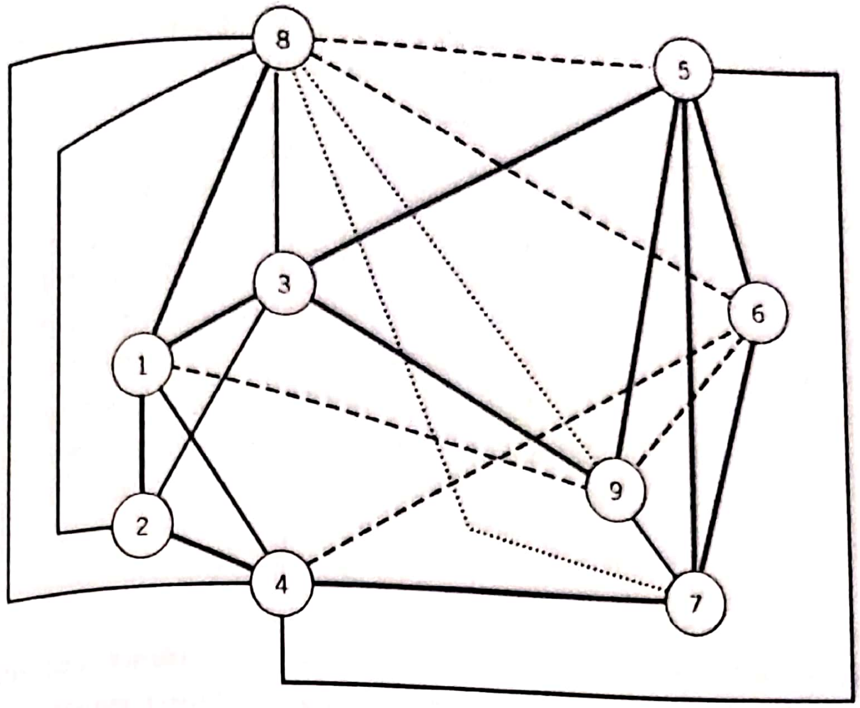

Figure 6.5 Relationship diagram.

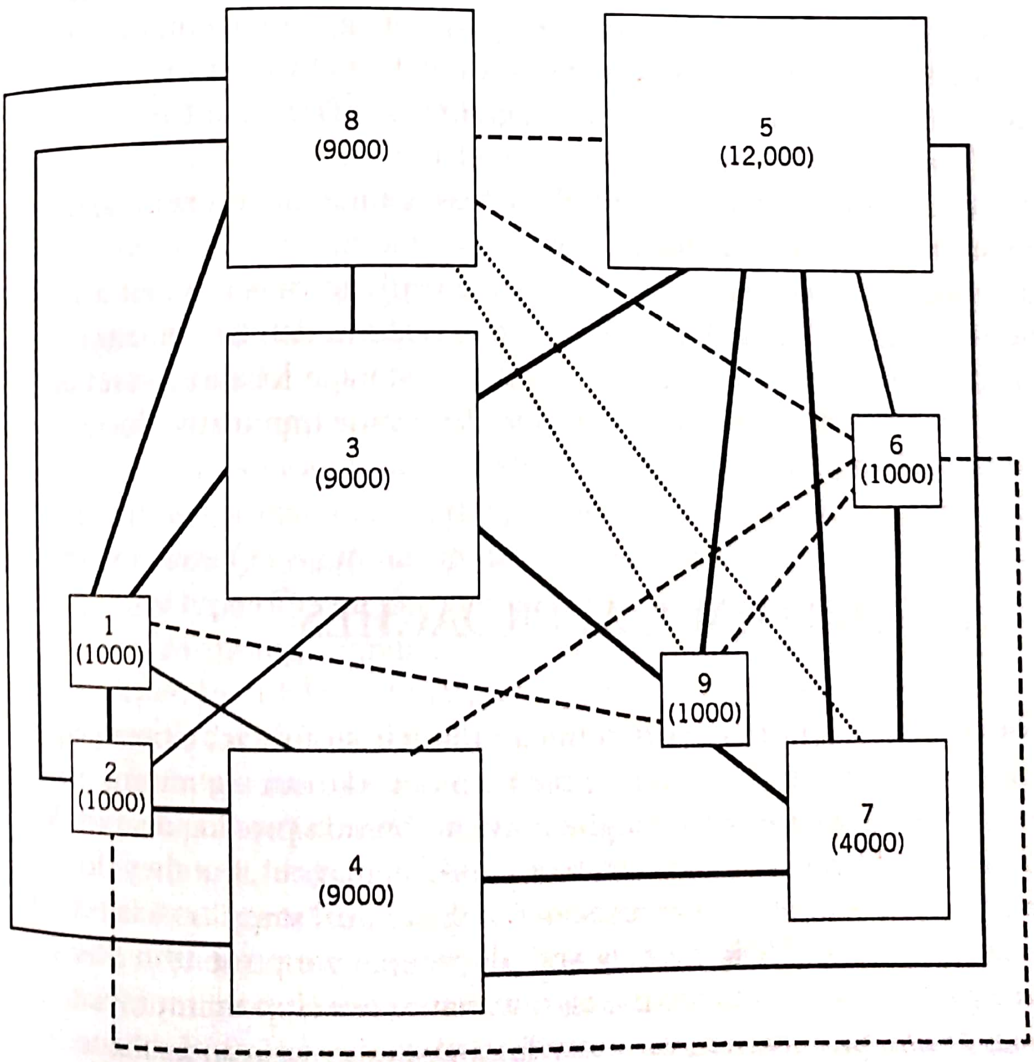

Figure 6.6 Space relationship diagram.

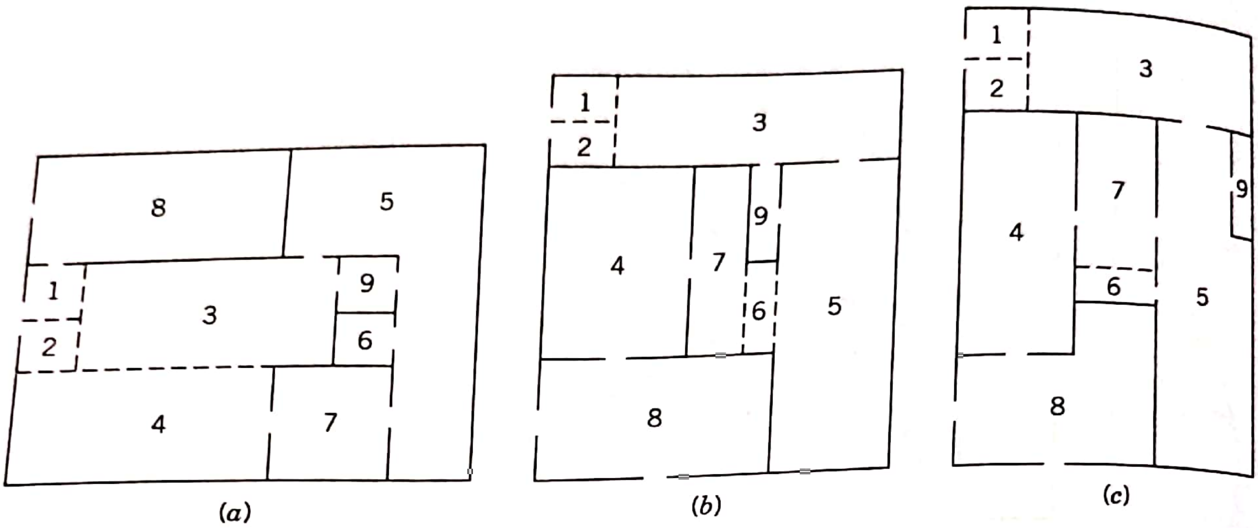

Figure 6.7 Alternative block layouts.

Based on modifying considerations and practical limitations, a number of layout alternatives are developed (Figure 6.7) and evaluated. The preferred alternative is then identified and recommended.

While the process involved in performing SLP is relatively straightforward, it does not necessarily follow that difficulties do not arise in its application. We addressed in Chapter 3 such issues as the *a priori* assignment of activity relationships and the use of proximity as a criterion for measuring the degree of satisfaction of activity relationships. In addition to those concerns, it should be noted that alternative relationship diagrams can often be developed, with apparent equivalent satisfaction of activity relationships. Likewise, the shapes of the individual space templates used in constructing the space relationship diagram can influence the generation of alternatives. Finally, the conversion of a space relationship diagram into several feasible layout alternatives is not a mechanical process: intuition, judgment, and experience are important ingredients in the process.

The SLP procedure can be used sequentially to develop first a block layout and then a detailed layout for each planning department. In the latter application, relationships between machines, workstations, storage locations, and entrances to and exits from the department are used to determine the relative location of activities within each department.