

A METHODOLOGY FOR PARSIMONIOUSLY STRUCTURING A SET OF
ACTIVITIES

by

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(ABSTRACT)

In project or program planning, a Gantt or PERT chart is usually employed as a graphical representation of schedule for activities. Planners utilize this chart in performing analyses such as the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). Very little effort, however, has been devoted to the formulation of activity networks, which is the initial step before aforementioned analyses. This research addresses this problem by developing a systematic methodology to aid in the identification and rapid structuring of a system of activities.

The theoretical foundation of the methodology is based on Interpretive Structural Modeling (ISM). It consists of seven basic steps: (1) identifying the activities in the set; (2) identifying the set of relation statements; (3) identifying the initial input; (4) establishing a transitive inference mechanism based upon previous responses; (5) generating a logical combination of relationships based on previous responses; (6) storing the relationship for each pair of activities in a relation matrix; and (7) outputting the relationships in the form of a simplified Gantt chart.

The merits of applying this methodology include (1) efficiency in activity structuring and (2) avoidance of illogical and inconsistent sequential relationship specifications. A

"Business Appreciation" example is used in illustrating the application of this methodology. It reveals that 85% of a total of 120 possible sequential activity relationships can be deduced without asking for information from the user. In general, over 57% of the sequential relationships can be inferred without input by the user.

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1. INTRODUCTION

Activity scheduling is one of the most important tools for determining how resources should be integrated in project or program planning.¹ The schedule is usually displayed in the form of a Gantt or PERT chart. Gantt (or bar) charts are most commonly used for exhibiting program progress or defining specific work tasks required to accomplish an objective (see Fig. 1). They detail the duration and scheduled dates for start and finish. They give little information, however, on the interdependencies of the activities.² On the other hand, a PERT chart conveys these interdependencies through the construction of networks³ (see Fig. 2). Still, the relative times for start and finish are not as clear when compared with the Gantt chart.⁴

¹ So, Frank S.; Stollman, Israel; Beal, Frank and Arnold, David S. *The Practice of Local Government Planning*. International City Management Association, Washington, D.C., 1979, pp. 62-63.

² Kerzner, Harold. *Project Management - A Systems Approach to Planning, Scheduling, and Controlling*, Second Edition. Van Nostrand Reinhold Company, New York, 1984, p. 641.

³ Kerzner, p. 604.

⁴ "SuperProject Plus, 10 Minute Guide," *SuperProject Plus*, First Edition, January 1986. Computer Associates International, Inc., California, 1986, p. 20.

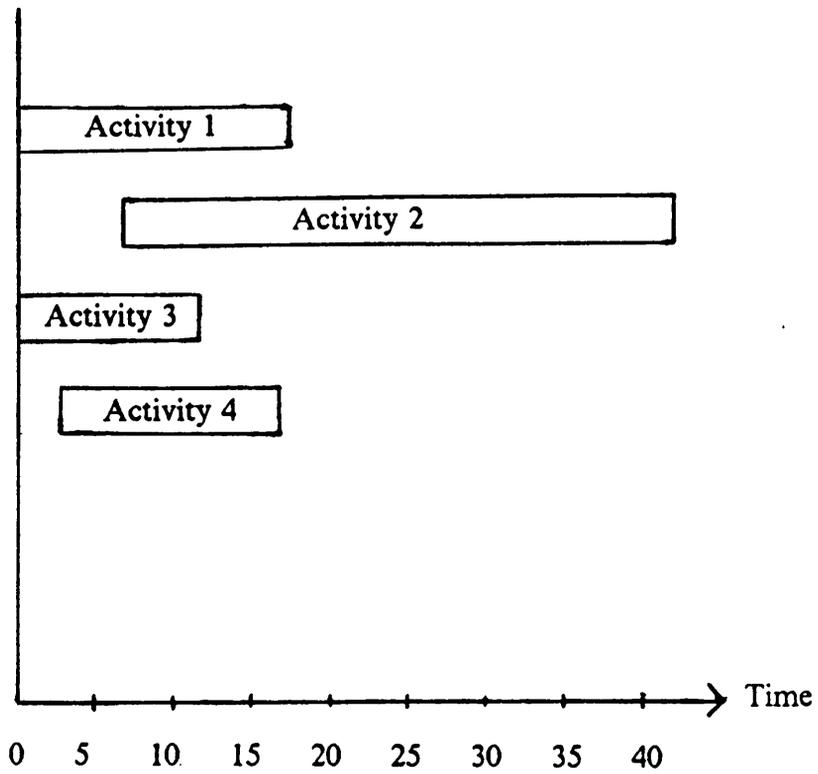
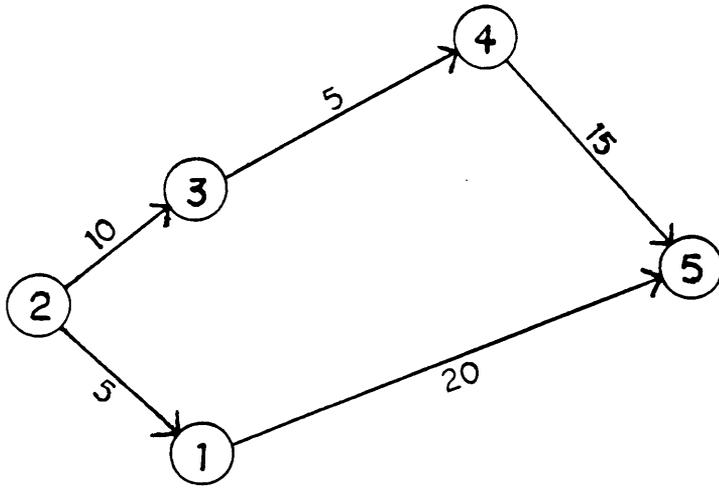


Figure 1. Schematic of a Gantt Chart



Legend:

② Event

→ Activity

10 Duration of Activity

Figure 2. Schematic of a PERT Chart

A Gantt or PERT chart is a model of the progress of a project or program. Prior to the formulation of either, one has to work out the system of connections of activities intuitively. All-too-often the large number of activities involved and the large number of interactions among these activities create a high degree of complexity for such an undertaking.

An objective in activity scheduling is that of transforming unclear, poorly articulated perceptions of elements into visible, well-defined structures useful for future purposes. This process requires an understanding of the structure associated with complex systems. It thus seems desirable that some methodology be developed which would assist in identifying structure within a system, and doing so in a quick and efficient manner. The methodology also should help avoid mistakes and oversights, yet be flexible enough to allow for modification of inputs.

1.1 Purpose and Objective of this Study

The purpose of this research is to develop a systematic methodology to aid in the identification and rapid structuring of a system of activities undertaken in a problem solving effort. The scope of the relationships considered is restricted to the relative sequencing of the activities, rather than a more detailed timing. In other words, the concern is for whether activity *A* starts before *B*, rather than whether *A* starts, say, 8 months before *B*.

The user's task is to identify the sequential⁵ relationship between each pair of "*consecutively numbered*" activities in a system. The sequential relationships for the re-

⁵ Following in order of time, without reflecting the interrelationships between activities.

maintaining pairs of activities are to be deduced based on logical reasoning. In the case that deduction is impossible, logical reasoning is to be employed to eliminate some possibilities about the sequential relationship between the activity pair. Upon the complete determination of these relationships, a simplified⁶ Gantt chart will be output to depict the situation. The intent of the entire process then is to transform unclear, poorly articulated systems of activities into well-defined and logically related ones and present them pictorially.

The objectives of this study thus can be summarized as:

1. to develop a methodology that will facilitate rapid user identification of the sequential relationships between activities undertaken in a planning endeavour.
2. to generate a simplified Gantt chart which portrays the sequential relationships graphically.

1.2 Rationale

Activity schedules are invaluable for projecting time-phased resource utilization requirements as well as providing a basis for visually checking performance. The ability to perceive the sequential relationships among activities in order to facilitate the allocation of available resources is imperative in today's world of scarce resources.

When a large system of activities is involved, as in multi-disciplinary projects or programs, it is commonplace that considerable time and effort is spent in specifying the connections between the various activities. Mistakes and inconsistencies also are com-

⁶ One that outlines the sequential relationships among activities without detailing the duration and scheduled dates for start and finish for any activity.

monplace. It is relatively easy to overlook necessary connections and/or to make some which later turn out to be inappropriate.

The methodology proposed here helps overcome the first problem in that in many instances the relationships need not be input by the user but can be deduced using logical reasoning. Mistakes and inconsistencies also can be avoided if previously - specified connections are used to structure the remaining ones.

It is important to note that a particular emphasis in this research is on "*activities*" as represented by "ideas." These we assume are generated in a preplanning, strategic planning or prototype problem solving stage which eventually leads to more detailed planning. The emphasis in the former stages, however, is in visualizing the ideas and seeing how they might be employed in an approximate sequential fashion over time. To illustrate, if we were just starting to think about a certain local transportation problem, we might come up with the ideas:

- {1} use a bus-on-rail system
- {2} have citizens design their own participation mechanism.

The latter idea would have to start before the former, and probably would continue past it. At this point in the process, however, it is too early to try to assign times to these ideas. This, then, is the reason for the focus in this paper on the *temporal sequence* of activities rather than on *timing*.

The methodology proposed here can be adopted rather simply, however, to gather and utilize timing information. This would lead to more specific Gantt charts and even to PERT chart development.

1.3 Procedure

To accomplish the above objective, we first will review the relevant literature, then set out the methodology and associated theory in detail. Lastly, a computer program will be written to implement the methodology developed. The entire process will be done in the context of an example activity set dealing with the development of a human services information and referral system for a region. The following chapter will focus on a large scale application where "activities" are ideas for the Town of Blacksburg to show appreciation to businesses for their help in making the Town what it is. The last chapter will highlight the results, conclusions, and future research directions based on the theories and applications.

2. REVIEW OF THE LITERATURE

Four integrated project management techniques have come into prominence since World War II. Among them, the Gantt chart has long been employed in industry. Next to it is the "line of balance," which was introduced in 1941.⁷ As the complexity and scale of projects increased, successful management required careful planning, scheduling, and coordination of numerous interrelated activities. The Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) came into existence in the late 1950s⁸ to help in these endeavours.

Descriptions and illustrations of the use of the Gantt chart, CPM, and PERT in project management are readily available. A few of the appropriate references include:-

- A Systems View of Development - Methodology of Systems Engineering and Management, by Donald Drew and Charng-Horng Hsieh⁹

⁷ Kerzner, p. 601.

⁸ Hillier, Frederick S. and Lieberman, Gerald J. *Introduction to Operations Research*, Fourth Edition. Holden-Day, Inc., Oakland, California, 1986, p. 310.

⁹ Drew, Donald R. and Hsieh Charng-Horng. *A Systems View of Development - Methodology of Systems Engineering and Management*. Cheng Yang Publishing Company, Taipei, Rep. of China, 1984.

- Analytic Techniques in Urban and Regional Planning, by John Dickey & Thomas Watt¹⁰
- Introduction to Operations Research, by Frederick Hillier and Gerald Lieberman¹¹
- Project Management - A Systems Approach to Planning, Scheduling, and Controlling, by Harold Kerzner¹²

These references all focus on the analysis of a system of activities in planning and project management based on the assumption that the user has already structured the activities. The initial step of formulating the system of activities has been emphasized by only a few researchers. Among them, the technique of interpretive structural modeling (ISM) is advocated.

The term interpretive structural modeling is used here to refer to the systematic application of some elementary notions of graph theory in such a way that theoretical, conceptual, and computational leverage is exploited to efficiently construct a directed graph,¹³ or network representation, of the complex pattern of a contextual relationship among a set of elements.^{14 15}

¹⁰ Dickey, John W. and Watts, Thomas M. *Analytic Techniques in Urban and Regional Planning - With Applications in Public Administration and Affairs*. McGraw Hill Book Company, New York, 1978.

¹¹ Hillier.

¹² Kerzner.

¹³ An irreflexive relation; Sage, Andrew P. *Methodology for Large Scale Systems*. McGraw Hill Book Company, New York, 1977, p. 95.

¹⁴ Sage, Andrew P. *Systems Engineering: Methodology & Applications*. The Institute of Electrical and Electronics Engineers, Inc., New York, 1977, p. 70.

¹⁵ Mathematical foundations of ISM can be found in Harary, F.; Norman, R. Z.; and Cartwright, D. *Structural Models: An Introduction to the Theory of Directed Graphs*. Wiley, New York, 1965; as cited in Sage, Systems Engineering, p. 77.

The philosophical basis for the development of the ISM approach can be found in Warfield, J. N., "An Assault on Complexity," *Battelle Monogr.* 3, Battelle Memorial Inst., Columbus, Ohio, April 1973; as cited in Sage, Systems Engineering p. 77.

Conceptual and analytical details of the ISM process can be found in Warfield, J. N., "Structuring Complex Systems," *Battelle Monogr.* 4, Battelle Memorial Inst., Columbus, Ohio, April 1974; as cited in Sage, Systems Engineering, p. 77.

The noteworthy contribution of the ISM procedure is that it operates without prior knowledge of the structure. The process is initiated by specifying an element set and a transitive relational statement. An "embedding" operation is then performed. The user is requested to respond to a query like "is place a closer than place b from a specified reference point? ". In this example *closer than* represents the transitive relational statement which operates on the elements *a* and *b* of the same set. A computer is employed to keep track of the responses supplied by the user to provide implicit transitive inferences based upon previous responses, and to generate an efficient ordering of subsequent queries.

ISM is intended for use when it is desired to utilize systematic and logical thinking to approach a complex issue. The objective is to expedite the process of creating a directed graph, or network which can be converted to a structural model, and then inspected and revised to capture the user's best perceptions of the situation.¹⁶

As mentioned by Sage,¹⁷ the interpretive structural modeling process transforms unclear, poorly articulated mental models of systems into visible, well-defined models useful for many purposes.

Despite the existence of such an efficient modeling procedure, the present state of the art in formulating the system of activities in a planning effort relies on a complete knowledge of the sequential relationships for each and every pair of activities. In cases involving large-scale plans or projects, particularly those with an innovative and/or multi-disciplinary nature, the problem of structuring sequential relationships becomes manifest.

¹⁶ Sage, p. 72.

¹⁷ *Methodology for Large Scale Systems*. McGraw Hill Book Company, New York, 1977, p. 92.

A number of commercial software packages have been developed. An example is SuperProject Plus.¹⁸ Project management using PERT and Gantt charts has been included. Whenever a user creates a PERT chart, its counterpart -- a Gantt chart -- will be created automatically. In formulating the sequential relationships, the user inputs the duration and the scheduled start date for each activity. This is possible as far as the user can completely define these temporal relationships.

There appears to be an absence of software that utilizes the interpretive structural modeling technique in formulating the sequential relationships among activities in the fields of planning and project management. Research efforts geared towards the use of ISM in these areas thus would certainly benefit planners in visualizing the complex interrelationships among activities in large-scale or innovative endeavours.

¹⁸ *SuperProject Plus*, First Edition, January 1986. Computer Associates International, Inc., California, 1986.

3. THEORY AND METHODOLOGY

3.1 Theory

3.1.1 *Mathematical Concepts*

An understanding of two key mathematical concepts is important before delving into the theoretical background of interpretive structural modeling as applied to scheduling of activities. A "relation" is an ordered pairing of the elements from one set with the elements of another. A binary relation is a particular one in which the first and the second sets are the same set.¹⁹ An example of a binary relation involving the set of integers would be a comparison of the magnitudes of the integers, depending on which one was greater than another.

There are three important properties associated with a binary relation, namely: reflexivity, symmetry and transitivity.²⁰ Not every binary relation possesses all these properties, and in ISM only transitivity is relevant. A relation, R , is transitive if when

¹⁹ West, Beverly H.; Griesbach, Ellen N.; Taylor, Jerry D. and Taylor, Louise T. *The Prentice-Hall Encyclopedia of Mathematics*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982, p. 452.

²⁰ West, pp. 453-455.

aRb is true and bRc is true, then aRc is also true. Again we can consider the example of integers. Let a , b and c be any three elements in the set of integers and the binary relation be *greater than*. If a is *greater than* b and b is *greater than* c , then the statement " a is *greater than* c " is an obviously true conclusion.

3.1.2 Concepts of the Modified ISM as Applied to Activity Scheduling

Conventionally, ISM is initiated by specifying an activity set and a transitive relational statement. The user is requested to respond to a query with regard to the presence or absence of the relation between selected pairs of activities. A computer is employed to record the responses supplied by the user (which are explicit entries to the relation matrix²¹), to provide implicit transitive inferences based upon previous responses, and to generate queries for pairs of activities for which no transitive inference can be made with regard to the relation statement.

In structuring the sequential relationships of activities in a project, the user may have more than a single relation statement to select (illustrated later). Moreover, not all the relations may be "*uniquely*" transitive. This complexity, however, has not hampered the application of ISM.

The logical reasoning behind a "*modified*" ISM is based on transitivity. Transitivity includes *unique transitivity* and *multiple transitivity*. *Unique transitivity* means a definite inference can be made on the sequential relationship of two activities. *Multiple transitivity* means that a sole inference about the sequential relationship of two activities can-

²¹ A table in which the relationship for each and every pair of activities is recorded. The row and column indices are the activity identifications while an entry in the matrix represents the case possibility of an activity having the column index with respect to (w.r.t.) that having the row index. For instance: [1,2] in the relation matrix indicates the case possibility of activity {2} w.r.t. activity {1}.

not be made, but a reduced subset can. In the case of "multiple" transitivity, the computer can be used to generate allowable logical combinations of relationships, based on previous responses, for pairs of activities for which no sole inference is possible (i.e., unique transitivity is inapplicable).

An example of unique transitivity is (for the terminology, see Section 3.2.2):

Activity {1} starts and ends before activity {2} starts.

Activity {2} starts and ends before activity {3} starts.

Therefore, "activity {1} starts and ends before activity {3} starts" is a unique inference. Their sequential relationships are shown in Fig. 3.

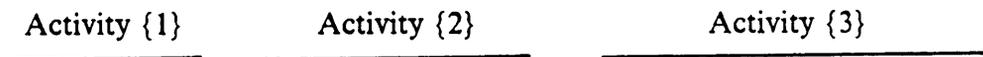


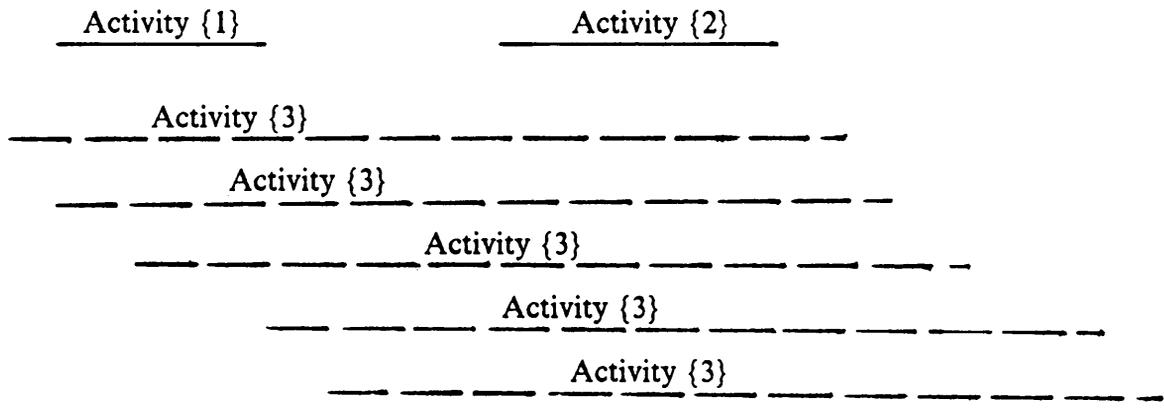
Figure 3. An Example of Unique Transitivity: Schematic Layout of the Sequential Relationships of Activities.

As an example of multiple transitivity:

Activity {1} starts and ends before activity {2} starts.

Activity {2} starts during activity {3} and ends before activity {3} ends.

There are five possibilities for the sequential relationship of activity {3} with respect to (w.r.t.) activity {1} and therefore no sole inference is possible. These five possible cases are shown in Fig. 4.



Legend :-
 ----- Possible Case for Activity {3}

Figure 4. An Example of Multiple Transitivity: Schematic Layout of the Sequential Relationships of Activities.

3.2 Methodology

The modified ISM methodology proposed here consists of the following seven basic steps:

1. identify the activities in the set
2. identify the set of relation statements
3. identify the initial input
4. establish a transitive inference mechanism based upon previous responses
5. generate a logical combination of relationships based on previous responses to guide the user in formulating subsequent sequential relationships for the other pairs of activities
6. store the relationship for each pair of activities in a relation matrix
7. output the relationships in the form of a simplified Gantt chart

The entire process of the methodology is diagrammed in Fig. 5.

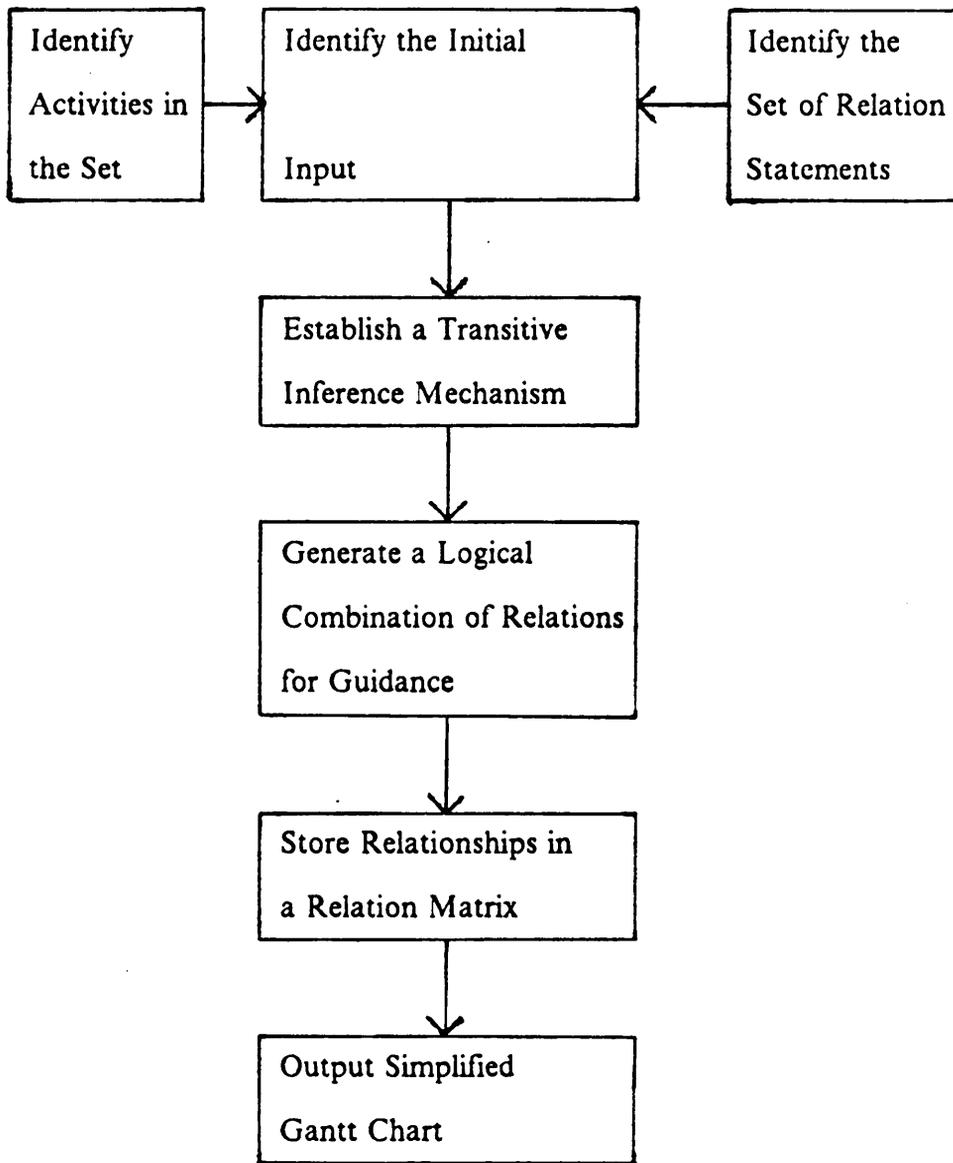


Figure 5. Flow Chart of Modified ISM Methodology

All steps are generic to the task of activity scheduling. A computer program has been written to implement the methodology. In the man-machine environment, activities in the project have to be numbered consecutively, starting from 1. The sequential relationship between a pair of activities is referenced to the lower-numbered one.

In subsequent discussions in this section, an example will be used to illustrate the application of the theory and the methodology in structuring the sequential relationships among activities in a program. As a demonstration, a program for setting up a social services information and referral (I & R) system in a region will be employed.

3.2.1 Identify the Activities in the Set

Nine activities have been considered as pertinent to the setting up of an information and referral system in a region. They include:

- {1} develop an application for data collection funds from the state welfare agency.
- {2} apply for data collection funds.
- {3} undertake data collection and the prototype experiment.
- {4} develop a study report, operating manuals, etc..
- {5} use available funds to design an I & R system and the prototype experiment.
- {6} purchase equipment and material needed for a full-scale I & R system.
- {7} develop an application for personnel funds from the federal health agency.
- {8} apply for personnel funds.
- {9} hire personnel.

3.2.2 Identify the set of relation statements

Let us start by exploring the sequential relationship between activities {1} and {2}. Their relative start and finish times first are specified. There are five possibilities for which activity {2} can start relative to activity {1} (see top row of Table 1). Activity {2} can start before activity {1} starts (designated by b {1} s); at the same time that (or "when") activity {1} starts (designated by w {1} s); and so on. Now, in conjunction with each of these situations, there are various possibilities for when activity {2} can end relative to activity {1}. As shown in Table 1, five cases can result when {2} starts before {1} starts; three cases when {2} starts either when {1} starts or during {1}, and exactly one when {2} starts either when {1} ends or after {1} ends. Consequentially, there are thirteen possible sequential relationships for activity {2} with respect to (w.r.t.) activity {1}. These are summarized in Table 1 and diagrammed in Fig. 6.

Each of these 13 cases is numbered and is an element in the set of relation statements. Referring to the example, the activity "apply for data collection funds" (activity 2) can start only when "develop an application for data collection funds from the state welfare agency" (activity 1) ends; which corresponds to a case code of 12. In the relation matrix in Table 2, the entry of the number 12 in cell [1,2] reflects the case code for activity {2} w.r.t. activity {1}.

Table 1. Possible Sequential Relationships Between Two Activities {1} and {2}

	{2} Starts				
	b{1}s	w{1}s	d{1}	w{1}e	a{1}e
{2} Ends	(1) b{1}s				
	(2) w{1}s				
	(3) d{1}	(4) d{1}	(5) d{1}		
	(6) w{1}e	(7) w{1}e	(8) w{1}e		
	(9) a{1}e	(10) a{1}e	(11) a{1}e	(12) a{1}e	(13) a{1}e

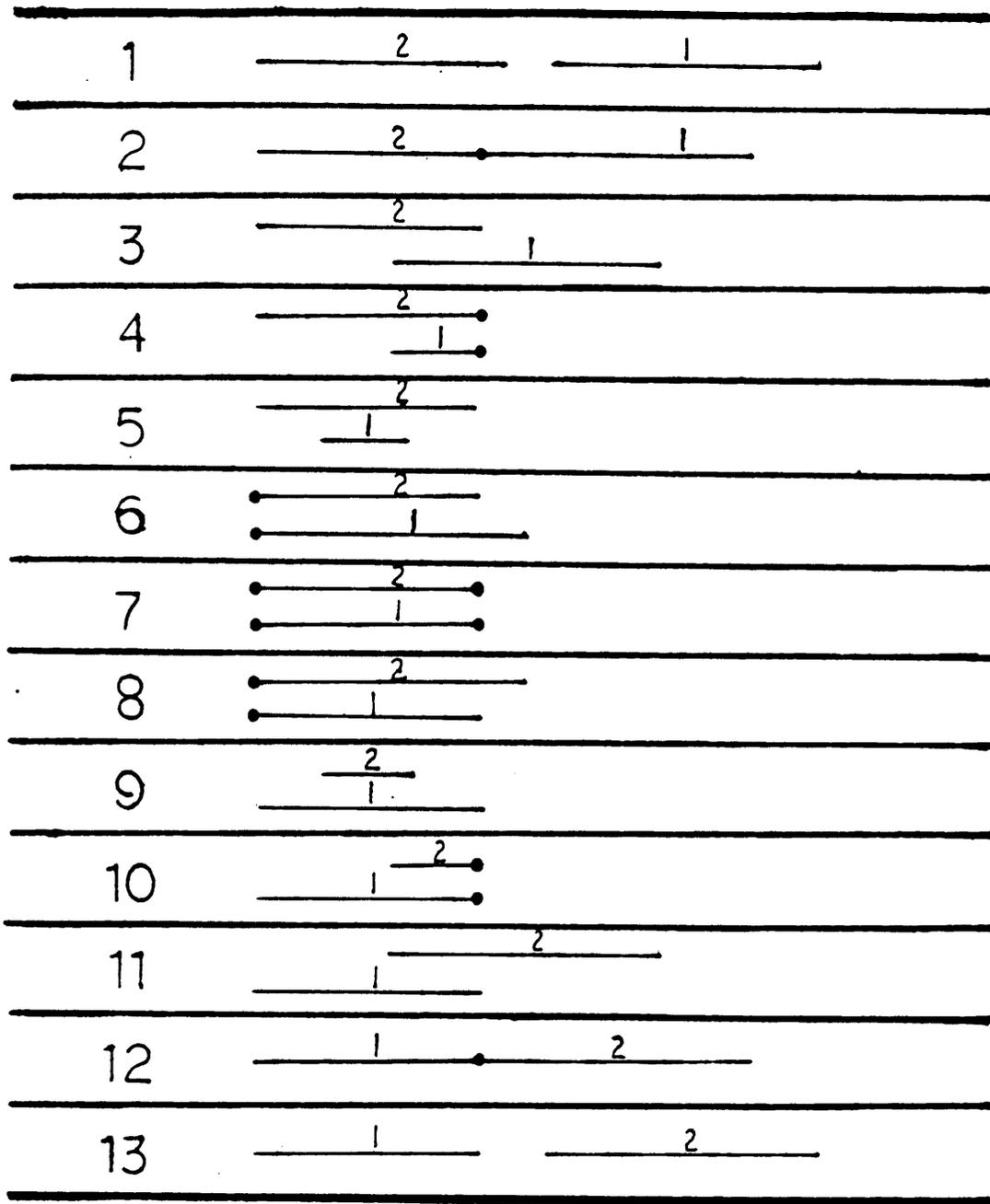
Note:

b{1}s = before activity {1} starts
w{1}s = when activity {1} starts
d{1} = during activity {1} (in the middle)
w{1}e = when activity {1} ends
a{1}e = after activity {1} ends

(1) = case code for the 13 case possibilities

For a graphical representation of the 13 case possibilities, see Fig. 6.

case code



Time ----->

Figure 6. Schematic of Thirteen Possible Sequential Relationships Between Two Activities

Table 2. Relation Matrix for the Example of Setting up an I & R System

Activity	1	2	3	4	5	6	7	8	9
1		12	13	13	11	13	9	13	13
2			12	13	3	13	1	11	13
3				12	1	11	1	3	13
4					1	3	1	1	10
5						13	9	13	13
6							1	3	11
7								13	13
8									13
9									

Note: Numbers in the table represent the case codes for the 13 possible relationships. A blank indicates that the relationship is symmetrical.

In the context of the modified ISM, transitivity encompasses unique transitivity and multiple transitivity. Unique transitivity means a definite inference can be made on the sequential relationship between two activities. For instance, the activity "apply for personnel funds" {8} w.r.t. "develop an application for personnel funds from the federal health agency" {7} is case 13 since the latter must start and end before the former event starts. Moreover, "hire personnel" {9} w.r.t. "apply for personnel funds" {8} also is case 13. Applying transitive inference, "hire personnel" {9} w.r.t. "develop an application for personnel funds from the federal health agency" {7} should also be case 13. This case number thus is recorded in entry [7,9] in the relation matrix. In the case of multiple transitivity, a sole inference about the sequential relationship of a pair of activities cannot be made from the knowledge of the sequential relationships of two previous pairs of activities. In this situation, however, a number of possible sequential relationships (i.e., usually less than 13 total case relationships) can be identified based on the sequential relationship for previous pairs of activities. These limited possible cases serve as guidance for the user to structure and input the sequential relationships for subsequent pairs of activities. A concrete illustration will be given in Section 3.2.5.

3.2.3 Identify the Initial Input

The next step in the process is to request of the user the initial sequential relationships for consecutively numbered activities. In the example, the necessary sequential relationships to be input by the user thus are:

{2} w.r.t. {1}

{3} w.r.t. {2}

{4} w.r.t. {3}

{5} w.r.t. {4}

{6} w.r.t. {5}

{7} w.r.t. {6}

{8} w.r.t. {7}

{9} w.r.t. {8}

These correspond to entries with an 'x', in Table 3, which are the elements on the first off-diagonal in the relation matrix (i.e. entries [1,2]; [2,3]; [3,4]; [4,5]; [5,6]; [6,7]; [7,8]; [8,9]). Many of the entries for the remaining cells in the relation matrix can be deduced; if not, the user is requested to input their relationships directly. Table 3 gives a pictorial summary.

Table 3. Relationship Between Any Two Activities in the System

Activity	1	2	3	4	5	6	7	8	9
1	▶	x	⊕	⊕	⊕	⊕	⊕	⊕	⊕
2	▶	▶	x	△	△	△	△	△	△
3	▶	▶	▶	x	△	△	△	△	△
4	▶	▶	▶	▶	x	△	△	△	△
5	▶	▶	▶	▶	▶	x	△	△	△
6	▶	▶	▶	▶	▶	▶	x	△	△
7	▶	▶	▶	▶	▶	▶	▶	x	△
8	▶	▶	▶	▶	▶	▶	▶	▶	x
9	▶	▶	▶	▶	▶	▶	▶	▶	▶

Note:

- ▶ no input is required due to symmetry
- x initial input of relationship between two consecutively numbered activities
- ⊕ relationship might be deduced or else input by user
- △ relationship might be deduced in whole or part, or else input by user

3.2.4 Establish a Transitive Inference Mechanism

Utilizing transitive inference, we can sometimes deduce the sequential relationship between the subsequent pair of activities from the defined relationships of the two previous pairs of activities. This process is initialized with the pairs (1,2) and (2,3). An attempt is made to infer the relationship of the pair (1,3), based on the fact that relationships for the first two pairs are initial input in the process. Whether the relationship of (1,3) is deducible or not, it has to be defined before the user can proceed to the next entry, [1,4]. The same principle is applied here, where the known relationships of (1,3) and (3,4) are utilized to try to infer the relationship for the pair (1,4). As an example of the process, let us look at "apply for personnel funds" (activity 8) w.r.t. "develop an application for data collection funds from the state welfare agency" (activity 1). This is case 13 since {1} starts and ends before {8} starts. Now "hire personnel" (activity 9) w.r.t. "apply for personnel funds" (activity 8) also is case 13 since {8} starts and ends before {9}. Based on the transitive property of these cases, "hire personnel" (activity 9) w.r.t. "develop an application for data collection funds from the state welfare agency" (activity 1) is inferred to be case 13, and is entered in the [1,9] position in the relation matrix in Table 2.

Table 4 has been set up to facilitate the structuring of relationships among activities with any combination of the 13 case possibilities for two known pairs of activities. Each row represents a case possibility for {2} w.r.t. {1}, while a column is for {3} w.r.t. {2}. An entry in the table represents the resultant relationship inferred for the pair (1,3). A zero entry signifies inference is impossible, so the user has to input the sequential relationship directly.

Table 4. Inferred Case Codes for Relationships Between Two Activities

{3}w.r.t.{2}	1	2	3	4	5	6	7	8	9	10	11	12	13
{2}w.r.t.{1}	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	1	1	1	0	1	1	0	1	1	0	0	0
2	1	1	1	2	0	1	2	0	1	2	0	0	0
3	1	1	0	3	0	0	3	0	0	0	0	0	0
4	1	1	0	4	5	0	4	5	0	0	0	12	13
5	1	1	0	5	5	0	5	5	0	0	0	13	13
6	1	2	3	3	0	6	6	0	9	9	0	0	0
7	1	2	3	4	5	6	7	8	9	10	11	12	13
8	1	2	0	5	5	0	8	8	0	0	0	13	13
9	0	0	0	0	0	9	9	0	9	9	0	0	0
10	0	0	0	0	0	9	10	11	9	10	11	12	13
11	0	0	0	0	0	0	11	11	0	0	0	13	13
12	0	0	0	0	0	12	12	12	13	13	13	13	13
13	0	0	0	0	0	13	13	13	13	13	13	13	13

Note: Numbers in the table represent the case codes for the 13 possible relationships. A zero indicates that a deduction is impossible and user input of the sequential relationship between activities {1} and {3} is required

Table 5 has been constructed to enhance the utility of the transitive inference technique, with the intent of deducing the relationship of (2,4) when relationships for the previous pairs (1,2) and (1,4) are known. For instance, "undertake data collection and the prototype experiment" (activity 3) starts when "apply for data collection funds" (activity 2) ends (i.e., case 12); and "use available funds to design an I & R system and the prototype experiment" (activity 5) starts before "apply for data collection funds" (activity 2) and ends during it (i.e., case 3). It is obvious that "use available funds to design an I & R system and the prototype experiment" (activity 5) can only start and finish before "undertake data collection and the prototype experiment" (activity 3); leading to case 1. Symbolically, the relation for (2,3) is case 12 (see row 12 of Table 5) and that for (2,5) is case 3 (see column 3 of Table 5). From these, the relation (3,5) is inferred to be case 1 (see entry [12,3] of Table 5). However, the relationship of (3,5) cannot be inferred through Table 4; based on the known relationships (3,4) and (4,5). Thus Table 5 can be used to supplement Table 4. To infer subsequent relationships of activities w.r.t. the first one, only Table 4 can be utilized, as insufficient information is available to make use of Table 5.

In summary, the initial input to the process is the sequential relationship for each pair of consecutively numbered activities. The relationships of these activities w.r.t. the others, except the first one, might be inferred via Tables 4 and 5; while that w.r.t. the first one might only be inferred via Table 4. The logic behind this process has been diagrammed in Fig. 7.²²

²² In order to utilize Table 5, the sequential relationships of two pairs of activities should already be known and these pairs should be higher on the relation matrix than the pair whose relationship is to be inferred.

Table 5. Inferred Case Codes for Relationships Between Two Activities(Supplemental)

{3}w.r.t.{1}	1	2	3	4	5	6	7	8	9	10	11	12	13
{2}w.r.t.{1}													
1	0	0	0	0	0	13	13	13	13	13	13	13	13
2	0	0	0	0	0	12	12	12	13	13	13	13	13
3	0	0	0	0	0	0	11	11	0	0	0	13	13
4	0	0	0	0	0	9	10	11	9	10	11	12	13
5	0	0	0	0	0	9	9	0	9	9	0	0	0
6	1	2	0	5	5	0	8	8	0	0	0	13	13
7	1	2	3	4	5	6	7	8	9	10	11	12	13
8	1	2	3	3	0	6	6	0	9	9	0	0	0
9	1	1	0	5	5	0	5	5	0	0	0	13	13
10	1	1	0	4	5	0	4	5	0	0	0	12	13
11	1	1	0	3	0	3	3	0	0	0	0	0	0
12	1	1	1	2	0	1	2	0	1	2	0	0	0
13	1	1	1	1	0	1	1	0	1	1	0	0	0

Note: Numbers in the table represent the case codes for the 13 possible relationships. A zero indicates that a deduction is impossible and user input of the sequential relationship between activities {2} and {3} is required

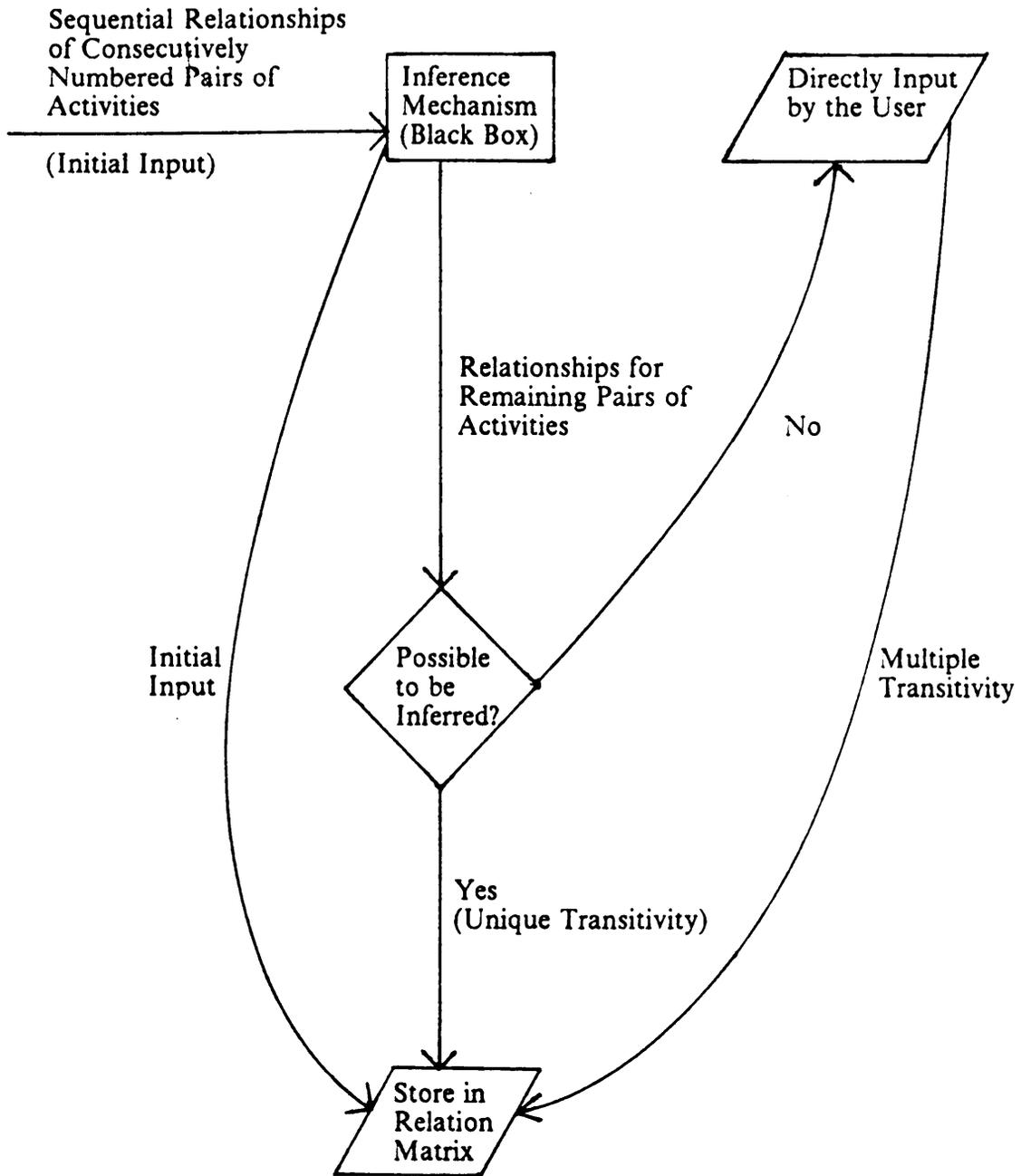
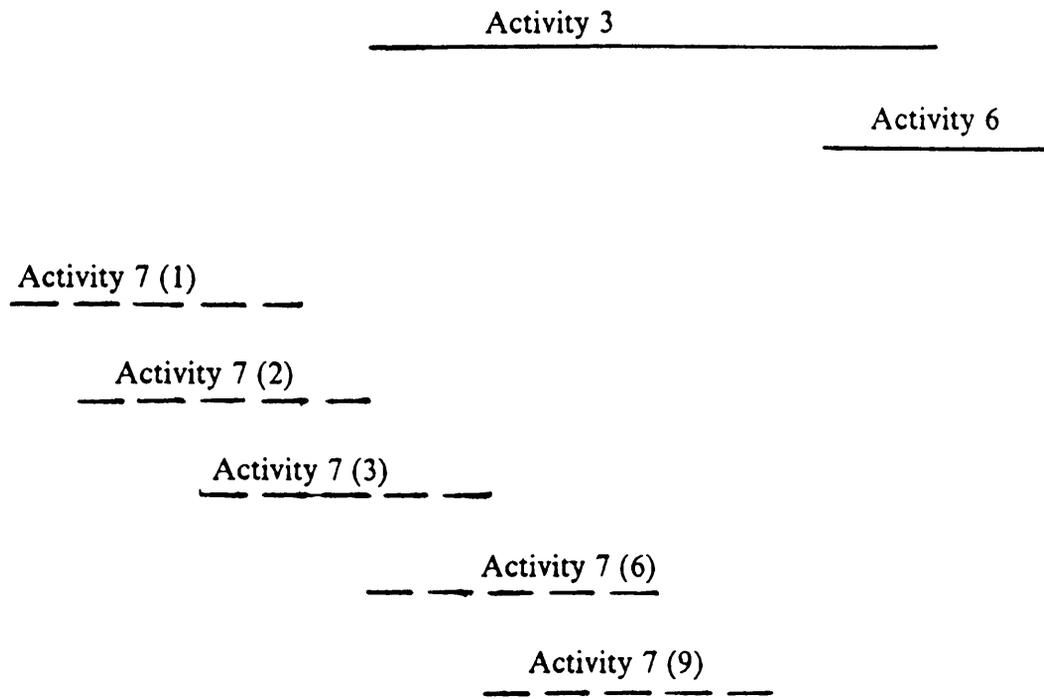


Figure 7. Flow Chart for Input of Sequential Relationships

3.2.5 Applying "Multiple Transitivity" to Generate a Logical Combination of Relationships

A count of the number of zero entries in Table 4 reveals 72 cases, out of a total of 169, in which inference fails. To further relieve some of the burden on the user in formulating the sequential relationships among activities in these 72 cases, we call upon certain logical combination of relationships as a guide, via the process of "multiple transitivity." For instance, "purchase equipment and material needed for a full-scale I & R system" (activity 6) w.r.t. "undertake data collection and the prototype experiment" (activity 3) is case 11 whereas "develop an application for personnel funds from the federal health agency" (activity 7) w.r.t. "purchase equipment and material needed for a full-scale I & R system" (activity 6) is case 1. Out of the 13 total case relationships for (3,7)(see Fig. 8), only a limited number are possible; namely the five: 1, 2, 3, 6 and 9, based on the fact that "develop application for personnel funds from the federal health agency" (activity 7) can start before or at the same time as "undertake data collection and the prototype experiment" (activity 3) starts, or even during it. However, the latest time for activity 7 to finish is during activity 3 (i.e., {7} can finish b{3}s, w{3}s, and d{3}).

Providing the user with a logically limited subset of relation statements for the pair of activities being studied can help considerably in the efficient focusing of the original unclear image and the erection of a well-defined one. Presented with the five alternatives for {7} w.r.t. {3}, the user might decide that {7} will start and end before {3} starts. This would be case 1.



Legend :-
 ——— Possible Case for Activity 7
 (1) Possible Case Code

Figure 8. Possible Relationships for (3,7) Deduced via Multiple Transitivity

3.2.6 Store the Relationship for Each Pair of Activities in a Relation Matrix

The overall methodology is employed beginning with the pair (1,3) and proceeds across the other elements on the first row. It then continues with the elements on the second row and so on, until a complete and clear description of the sequential relationships among all activities has been established. As each relationship is established, it is then entered into the relation matrix.

3.2.7 Output Relationships in the Form of a Simplified Gantt Chart

In the final stage of the methodology the verbal description of the sequential relationships among activities is transformed into a graphical representation. The output of the relation matrix is in the form of a simplified Gantt chart, shown in Fig. 9. There is no need to have any input in terms of specific start date and duration for any activity concerned, as the purpose of this Gantt chart is simply to echo the rough mental image of the user. Nevertheless, the chart depicts the sequential relationships among all the activities and is a product of the transformation from an unclear, poorly articulated mental model into a visible, well-defined model useful for further discussion and for analyses such as CPM and PERT.

Activity No.	Activity Description	Sequence of Activities
1	develop application for data collection funds from state welfare agency	_____
2	apply for data collection funds	_____
3	undertake data collection and prototype experiment	_____
4	develop study report, operating manuals, etc.	_____
5	use available funds to design I & R system and prototype experiment	_____
6	purchase equipment and material needed for full-scale I & R system	_____
7	develop application for personnel funds from federal health agency	_____
8	apply for personnel funds	_____
9	hire personnel	_____

Figure 9. Simplified Gantt Chart for the Example of Setting up an I&R System.

3. THEORY AND METHODOLOGY

4. APPLICATION OF THE METHODOLOGY

This expanded example goes through the entire process of the methodology. It involves the packaging of a set of ideas generated from The Idea Machine (TIM).²³ By way of background, businesses in Blacksburg help provide a desirable environment for the Town's citizens. The Town has an annual affair to show its appreciation to business. However, the Director of Economic Development would like to make a change in format for that occasion this year. The objective of the idea generation effort with TIM was "to show the Town of Blacksburg's appreciation for business" in an innovative fashion.

4.1 Identify the Activities in the set

Listed below is the set of sixteen ideas generated via TIM. Under each is a shortened description used as input in our methodology.

²³ Dickey, John W. and David Golay, "Generating Alternative Financing Models for Urban Transportation: An Application of The Idea Machine," in *Managing Urban Transportation as a Business*, edited by Eric Bers and Chris Hendrickson, American Society of Civil Engineers, New York, 1987.

1. Establish a "Brain Trust" (perhaps called the "Blacksburg Business Brain Trust")
(establish Brain Trust).
2. Have the Brain Trust help create an economic development program
(establish trust development program).
3. Develop and announce a program that fits in with the new job of the Director of
Economic Development
(establish program for economic development).
4. Have the Brain Trust help identify a symbol
(create trust development symbol).
5. Have the Brain Trust help identify a slogan
(create trust development slogan).
6. Employ the Town's general operating fund to sponsor the program
(use general fund).
7. Request that the businesses themselves participate in financing the program
(request business funding).
8. Utilize the Town's own TV station in making a video tape
(use town TV station).
9. Get old pictures and videos. Compare with current situation
(show old/new business video).

10. Bring in a prominent personality (sex symbol?)
(invite personality visit).
11. Develop a symbol of a vision of the future of business in the Town
(create symbol of future).
12. Thank businesspeople for the opportunity they have helped give us to have employment and income and still live in a relatively tranquil place, close to nature
(show thanks for nice place).
13. Introduce the slogan and the symbol
(create slogan for future).
14. Transform the video tape to 16mm movie format in order to display to a large audience
(transfer to 16 mm).
15. Display the video tape at any time upon request at the Town Municipal Building
(view at Municipal Building).
16. Present the video tape to prospective businesses
(show prospective businesses).

4.2 Identify the Set of Relation Statements

The thirteen possible relation statements shown in Table 1 are generic to any idea/activity scheduling problem. They thus are used for this example application as well. A sample of some of the possibilities for idea 2 w.r.t. idea 1 are presented below:

"establish trust development program (Idea 2)" starts before "establish Brain Trust (Idea 1)" starts and ends before the latter starts -- case (1);

"establish trust development program (Idea 2)" starts before "establish Brain Trust (Idea 1)" starts and ends when the latter starts -- case (2);

"establish trust development program (Idea 2)" starts during "establish Brain Trust (Idea 1)", and ends after the latter ends -- case (11);

"establish trust development program (Idea 2)" starts after "establish Brain Trust (Idea 1)" ends, and ends after the latter ends -- case (13);

The user has selected case 11 from above.

4.3 Identify the Initial Input

The user was requested to input the relationship of the second idea w.r.t. the first idea; 3rd idea w.r.t. 2nd idea; ...; 16th idea w.r.t. 15th idea. Table 6 shows the entries in the relation matrix at the end of this stage.

Table 6. Relationship Matrix for the Example to Show the Town of Blacksburg's Appreciation for Business (Initial Input)

Idea No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		11														
2			11													
3				11												
4					7											
5						7										
6							7									
7								12								
8									7							
9										7						
10											9					
11												7				
12													11			
13														7		
14															8	
15																7
16																

Note: Numbers in the table represent the case codes for the 13 possible relationships. A blank indicates that the relationship has neither been input nor deduced at this stage.

4.4 Establish a Transitive Inference Mechanism based upon Previous Responses

Tables 4 and 5 were employed after the relationships for all pairs of consecutively numbered ideas had been entered. These two tables were used to infer the sequential relationships of all other pairs of ideas, starting with the pair (1,3). In this instance, unique inference failed, as the relation of (1,2) was 11 (see Table 4, row 11) and the relation (2,3) also was 11 (see Table 4, column 11). This resulted in an entry of zero (see Table 4, entry [11,11]). Before proceeding to the pair (1,4) in the relation matrix, the user was requested to input the sequential relationship for (1,3) directly (see Section 4.5 below).

There were three pairs of relationships which could not be inferred from the use of Tables 4 and 5. They were (1,3), (2,4) and (8,13). Relationships for the pairs (9,13) and (10,13) could not be inferred through Table 4 but were deducible with the supplement of Table 5.

4.5 Applying "Multiple Transitivity" to generate a Logical Combination of Relationships

Upon failure to deduce uniquely the relationship for (1,3), the user was requested to select a possible case from the set containing relationships 11, 12, and 13. A list of these 3 cases are:

"establish program for economic development (Idea 3)" starts during "establish Brain Trust (Idea 1)", and ends after the latter ends -- case (11);

"establish program for economic development (Idea 3)" starts when "establish Brain Trust (Idea 1)" ends, and ends after the latter ends -- case (12);

"establish program for economic development (Idea 3)" starts after "establish Brain Trust (Idea 1)" ends, and ends after the latter ends -- case (13).

The user selected case 13. Similarly, for the relationship between (2,4), the user was requested to choose one from a set containing: 11, 12 and 13. Again, the input was 13. For the pair (8,13), the user was provided with a set of relationships with cases 9, 10, and 11. The selection was 10.

4.6 Store the Relationship for Each Pair of Activities in a Relation Matrix

When each element in the relation matrix was obtained, it was immediately stored to facilitate inference and generation of the logical combinations of relationships for guidance. The resultant overall relation matrix is presented in Table 7.

4.7 Output the Relationship in the Form of a Simplified Gantt Chart

The sequential structure of the whole set of ideas was output via a simplified Gantt chart (see Fig. 10).

Table 7. Relationship Matrix for the Example to Show the Town of Blacksburg's Appreciation for Business

Idea No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		11	13	13	13	13	13	13	13	13	13	13	13	13	13	13
2			11	13	13	13	13	13	13	13	13	13	13	13	13	13
3				11	11	11	11	13	13	13	13	13	13	13	13	13
4					7	7	7	12	12	12	13	13	13	13	13	13
5						7	7	12	12	12	13	13	13	13	13	13
6							7	12	12	12	13	13	13	13	13	13
7								12	12	12	13	13	13	13	13	13
8									7	7	9	9	10	10	11	11
9										7	9	9	10	10	11	11
10											9	9	10	10	11	11
11												7	11	11	11	11
12													11	11	11	11
13														7	8	8
14															8	8
15																7
16																

Note: Numbers in the table represent the case codes for the 13 possible relationships. A blank indicates that the relationship is symmetrical. Circled items are those involving multiple transitivity.

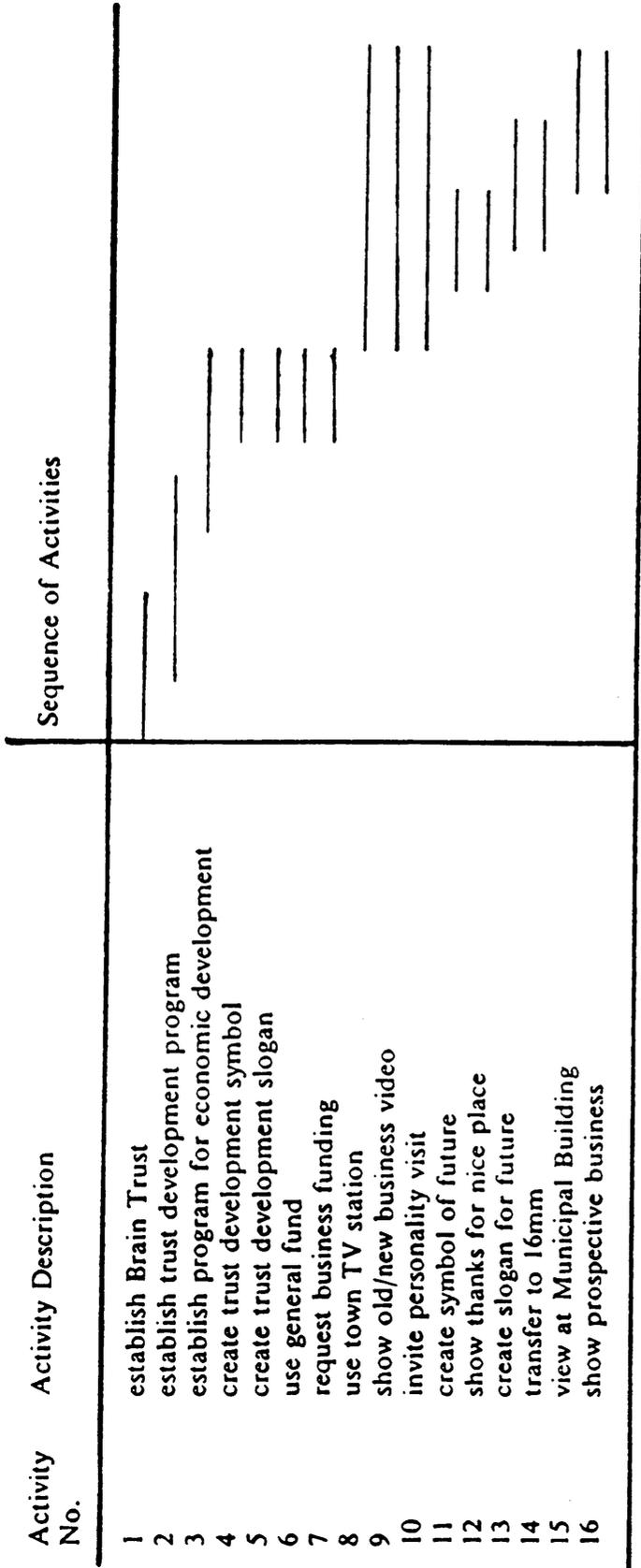


Figure 10. Simplified Gantt Chart for the "Business Appreciation" Example

4. APPLICATION OF THE METHODOLOGY

4.8 Provisions for Modifying Input

Other features have been included in the computer program to facilitate its use in modifying the set of ideas. These features are :

- add new idea(s)
- modify relationship(s) among ideas
- modify descriptions of idea(s)
- delete idea(s)

A detailed description and demonstration of their uses is found in Appendix B.

5. FINDINGS, CONCLUSIONS, FUTURE RESEARCH

In the preceding application there was a need for initial input of 15 sequential relationships for all pairs of consecutively numbered ideas (see Table 6), as well as for three other pairs of ideas to produce a complete knowledge of the sequential relationships among ideas. The total thus was 18. Without applying this methodology, the user would have had to formulate $16 \cdot 15 / 2 = 120$ relationships among the sixteen ideas. We thus were able to be extremely parsimonious, reducing the number of questions requested of the user by $(120 - 18) / 120 = 0.85$, or 85%. We also avoided many possible illogical and inconsistent relation specifications, while still maintaining the capability to modify later the answers to the questions.

While the above comparison is just for one case, there is other evidence to highlight the efficiency of this methodology in formulating sequential relationships among activities or ideas. By counting the number of zeros in Table 4, we find there are 72 cases, out of a total of 169, where inference fails. In other words, in 97 cases out of 169, or

57%, inference will succeed. Table 5 also can contribute to the efficiency of the inference mechanism by supplementing Table 4. The burden of structuring sequential relationships among activities or ideas is thus anticipated to be relieved considerably, with additional gains in consistency and exhaustiveness.

This research was triggered by a literature review which indicated that very little research effort had been devoted to the area of formulating sequential relationships among activities in a project. In an era of large-scale and multi-disciplinary project involvements, activity scheduling becomes a challenging task. A systematic methodology which transforms unclear mental images of the set of activities into a visible and well-defined model would certainly assist the planner in strategic planning, project planning and management. Moreover, the concept of activity scheduling can be extended to the structuring of innovative ideas.

In the methodology described in this paper, a systematic approach has been to model the sequential relationships among activities. The relative occurrence of activities is assumed to be subject solely to constraints imposed by other activities (i.e., the interactions). In reality, the objective of optimizing resource commitments may further influence sequential relationships. In a more severe case, scheduling might be subject to resource constraints. The problems inherent in many existing scheduling techniques which do not consider limited or scarce resources have been documented in Davis,²⁴ and Davis and Patterson.²⁵ On the other hand, the incorporation of resource constraints in

²⁴ Davis, Edward W., "Project Scheduling Under Resource Constraints - Historical Review and Categorization of Procedures," *AIEE Transactions*, Vol. 5, No. 4, December 1973.

²⁵ Davis, Edward W. and Patterson, James H., "A Comparison of Heuristic and Optimum Solutions in Resource - Constrained Project Scheduling," *Management Science*, Vol. 21, No. 8, April 1975, pp. 944-955.

formulating the sequential relationships of activities certainly would complicate the development of a systematic and comprehensive methodology.

The current computer program has the provision for constructing a detailed Gantt chart when the formulation process has been completed. As mentioned in Chapter 1, a Gantt chart does not portray the interdependencies of activities in the system. A possible extension of the program would be to incorporate the construction of a PERT chart as a supplement. This, as mentioned in the beginning, could be done with relatively little effort. It would require asking the user about the timing (and possible variations therein) of activities as well as their sequencing.

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Appendix A. An Example of a Computer Run

1 Start a New Network

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 1
Do you want to change your choice? Enter "y" for yes and "n" for no: n

Enter the title for this idea structuring case. This at most is 40 characters: the "Business Appreciation" Example
Do you want to modify the title you just entered?

Enter "y" for yes and "n" for no: n

Enter number of ideas, excluding dummy ideas, in the network which must be greater than 2 and NOT greater than 100: 16

Do you want to change the number you just entered? Enter "y" for yes and "n" for no: n

Idea description at most is 50 characters

Enter description for idea 1: establish Brain Trust

Do you want to modify the description you just entered?

Enter "y" for yes and "n" for no: n

Enter description for idea 2: establish trust development program

Do you want to modify the description you just entered?

Enter "y" for yes and "n" for no: n

Enter description for idea 3: establish program for economic development

Do you want to modify the description you just entered?

Enter "y" for yes and "n" for no: n

Enter description for idea 4: create trust development symbol

Do you want to modify the description you just entered?

Enter "y" for yes and "n" for no: n

Enter description for idea 5: create trust development slogan

Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 6: use general fund
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 7: request business funding
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 8: use town TV station
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 9: show old/new business video
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 10: invite personality visit
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 11: create symbol of future
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 12: show thanks for nice place
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 13: create slogan for future
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 14: transfer to 16 mm
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 15: view at Municipal Building
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 16: show prospective businesses
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n

If there is no preceding idea, enter "none"
If there are more than one, list the identifications in
ascending order and separate each with only a comma
Enter the idea identification(s) which precedes idea 1: none
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea identification(s) which precedes idea 2: 1
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea identification(s) which precedes idea 3: 2
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea identification(s) which precedes idea 4: 1
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea identification(s) which precedes idea 5: 1
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea identification(s) which precedes idea 6: 3
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea identification(s) which precedes idea 7: 3
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea identification(s) which precedes idea 8: none
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea identification(s) which precedes idea 9: 4,5,6,7
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n

Enter the idea identification(s) which precedes idea 10: 9
 Do you want to modify the list you just entered?
 Enter "y" for yes and "n" for no: n
 Enter the idea identification(s) which precedes idea 11: 4,9
 Do you want to modify the list you just entered?
 Enter "y" for yes and "n" for no: n
 Enter the idea identification(s) which precedes idea 12: 9
 Do you want to modify the list you just entered?
 Enter "y" for yes and "n" for no: n
 Enter the idea identification(s) which precedes idea 13: 5,9
 Do you want to modify the list you just entered?
 Enter "y" for yes and "n" for no: n
 Enter the idea identification(s) which precedes idea 14: 9
 Do you want to modify the list you just entered?
 Enter "y" for yes and "n" for no: n
 Enter the idea identification(s) which precedes idea 15: 9
 Do you want to modify the list you just entered?
 Enter "y" for yes and "n" for no: n
 Enter the idea identification(s) which precedes idea 16: 9
 Do you want to modify the list you just entered?
 Enter "y" for yes and "n" for no: n

Is there any dummy idea involved in the network? Enter "y"
 for yes and "n" for no: n
 Do you want to change the character you just entered? Enter
 "y" for yes and "n" for no: n

Do you want to save your input? Enter "y" or "n": y
 Do you want to change your choice? Enter "y" or "n": n
 Enter file name which is of DOS file type: test1a.dat
 Do you want to continue with the input of the relation
 array? Enter "y" or "n": y
 Do you want to change your choice? Enter "y" or "n": n
 Number the ideas from 1 to the maximum number in the network
 consecutively in its physical order as far as possible
 Abbreviation of the relationship:-

bis = before idea 1 starts
 wis = when idea 1 starts
 di = during idea 1
 wie = when idea 1 ends
 ale = after idea 1 ends

There are 13 cases describing the relationship with regard to
 start and finish between two ideas
 Choose the case that represents the relationship between the
 first and the second idea by entering the corresponding number
 A list of 13 cases are:-

Idea 2 starts : bis and Idea 2 ends : bis -- case (1)
 Idea 2 starts : bis and Idea 2 ends : wis -- case (2)
 Idea 2 starts : bis and Idea 2 ends : di -- case (3)
 Idea 2 starts : bis and Idea 2 ends : wie -- case (4)
 Idea 2 starts : bis and Idea 2 ends : ale -- case (5)
 Idea 2 starts : wis and Idea 2 ends : di -- case (6)
 Idea 2 starts : wis and Idea 2 ends : wie -- case (7)
 Idea 2 starts : wis and Idea 2 ends : ale -- case (8)
 Idea 2 starts : di and Idea 2 ends : di -- case (9)
 Idea 2 starts : di and Idea 2 ends : wie -- case (10)
 Idea 2 starts : di and Idea 2 ends : ale -- case (11)
 Idea 2 starts : wie and Idea 2 ends : ale -- case (12)
 Idea 2 starts : ale and Idea 2 ends : ale -- case (13)

Choose the relationship between "establish Brain Trust (1)" and "establish
 trust development program (2)" by entering the corresponding case number: 11
 Do you want to change the number you just entered? Enter "y"
 for yes and "n" for no: n

A list of 13 cases are:-

Idea 3 starts : b2s and Idea 3 ends : b2s -- case (1)
Idea 3 starts : b2s and Idea 3 ends : w2s -- case (2)
Idea 3 starts : b2s and Idea 3 ends : d2 -- case (3)
Idea 3 starts : b2s and Idea 3 ends : w2e -- case (4)
Idea 3 starts : b2s and Idea 3 ends : a2e -- case (5)
Idea 3 starts : w2s and Idea 3 ends : d2 -- case (6)
Idea 3 starts : w2s and Idea 3 ends : w2e -- case (7)
Idea 3 starts : w2s and Idea 3 ends : a2e -- case (8)
Idea 3 starts : d2 and Idea 3 ends : d2 -- case (9)
Idea 3 starts : d2 and Idea 3 ends : w2e -- case (10)
Idea 3 starts : d2 and Idea 3 ends : a2e -- case (11)
Idea 3 starts : w2e and Idea 3 ends : a2e -- case (12)
Idea 3 starts : a2e and Idea 3 ends : a2e -- case (13)

Choose the relationship between "establish trust development program (2)" and "establish program for economic development (3)" by entering the corresponding case number: 11

Do you want to change the number you just entered? Enter "y" for yes and "n" for no: n

A list of 13 cases are:-

Idea 4 starts : b3s and Idea 4 ends : b3s -- case (1)
Idea 4 starts : b3s and Idea 4 ends : w3s -- case (2)
Idea 4 starts : b3s and Idea 4 ends : d3 -- case (3)
Idea 4 starts : b3s and Idea 4 ends : w3e -- case (4)
Idea 4 starts : b3s and Idea 4 ends : a3e -- case (5)
Idea 4 starts : w3s and Idea 4 ends : d3 -- case (6)
Idea 4 starts : w3s and Idea 4 ends : w3e -- case (7)
Idea 4 starts : w3s and Idea 4 ends : a3e -- case (8)
Idea 4 starts : d3 and Idea 4 ends : d3 -- case (9)
Idea 4 starts : d3 and Idea 4 ends : w3e -- case (10)
Idea 4 starts : d3 and Idea 4 ends : a3e -- case (11)
Idea 4 starts : w3e and Idea 4 ends : a3e -- case (12)
Idea 4 starts : a3e and Idea 4 ends : a3e -- case (13)

Choose the relationship between "establish program for economic development (3)" and "create trust development symbol (4)" by entering the corresponding case number: 11

Do you want to change the number you just entered? Enter "y" for yes and "n" for no: n

A list of 13 cases are:-

Idea 5 starts : b4s and Idea 5 ends : b4s -- case (1)
Idea 5 starts : b4s and Idea 5 ends : w4s -- case (2)
Idea 5 starts : b4s and Idea 5 ends : d4 -- case (3)
Idea 5 starts : b4s and Idea 5 ends : w4e -- case (4)
Idea 5 starts : b4s and Idea 5 ends : a4e -- case (5)
Idea 5 starts : w4s and Idea 5 ends : d4 -- case (6)
Idea 5 starts : w4s and Idea 5 ends : w4e -- case (7)
Idea 5 starts : w4s and Idea 5 ends : a4e -- case (8)
Idea 5 starts : d4 and Idea 5 ends : d4 -- case (9)
Idea 5 starts : d4 and Idea 5 ends : w4e -- case (10)
Idea 5 starts : d4 and Idea 5 ends : a4e -- case (11)
Idea 5 starts : w4e and Idea 5 ends : a4e -- case (12)
Idea 5 starts : a4e and Idea 5 ends : a4e -- case (13)

Choose the relationship between "create trust development symbol (4)" and "create trust development slogan (5)" by entering the corresponding case number: 7

Do you want to change the number you just entered? Enter "y" for yes and "n" for no: n

A list of 13 cases are:-

Idea 6 starts : b5s and Idea 6 ends : b5s -- case (1)
Idea 6 starts : b5s and Idea 6 ends : w5s -- case (2)
Idea 6 starts : b5s and Idea 6 ends : d5 -- case (3)
Idea 6 starts : b5s and Idea 6 ends : w5e -- case (4)
Idea 6 starts : b5s and Idea 6 ends : a5e -- case (5)
Idea 6 starts : w5s and Idea 6 ends : d5 -- case (6)
Idea 6 starts : w5s and Idea 6 ends : w5e -- case (7)
Idea 6 starts : w5s and Idea 6 ends : a5e -- case (8)
Idea 6 starts : d5 and Idea 6 ends : d5 -- case (9)
Idea 6 starts : d5 and Idea 6 ends : w5e -- case (10)
Idea 6 starts : d5 and Idea 6 ends : a5e -- case (11)
Idea 6 starts : w5e and Idea 6 ends : a5e -- case (12)
Idea 6 starts : a5e and Idea 6 ends : a5e -- case (13)

Choose the relationship between "create trust development slogan (5)" and "use general fund (6)" by entering the corresponding case number: 7
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

A list of 13 cases are:-

Idea 7 starts : b6s and Idea 7 ends : b6s -- case (1)
Idea 7 starts : b6s and Idea 7 ends : w6s -- case (2)
Idea 7 starts : b6s and Idea 7 ends : d6 -- case (3)
Idea 7 starts : b6s and Idea 7 ends : w6e -- case (4)
Idea 7 starts : b6s and Idea 7 ends : a6e -- case (5)
Idea 7 starts : w6s and Idea 7 ends : d6 -- case (6)
Idea 7 starts : w6s and Idea 7 ends : w6e -- case (7)
Idea 7 starts : w6s and Idea 7 ends : a6e -- case (8)
Idea 7 starts : d6 and Idea 7 ends : d6 -- case (9)
Idea 7 starts : d6 and Idea 7 ends : w6e -- case (10)
Idea 7 starts : d6 and Idea 7 ends : a6e -- case (11)
Idea 7 starts : w6e and Idea 7 ends : a6e -- case (12)
Idea 7 starts : a6e and Idea 7 ends : a6e -- case (13)

Choose the relationship between "use general fund (6)" and "request business funding (7)" by entering the corresponding case number: 7
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

A list of 13 cases are:-

Idea 8 starts : b7s and Idea 8 ends : b7s -- case (1)
Idea 8 starts : b7s and Idea 8 ends : w7s -- case (2)
Idea 8 starts : b7s and Idea 8 ends : d7 -- case (3)
Idea 8 starts : b7s and Idea 8 ends : w7e -- case (4)
Idea 8 starts : b7s and Idea 8 ends : a7e -- case (5)
Idea 8 starts : w7s and Idea 8 ends : d7 -- case (6)
Idea 8 starts : w7s and Idea 8 ends : w7e -- case (7)
Idea 8 starts : w7s and Idea 8 ends : a7e -- case (8)
Idea 8 starts : d7 and Idea 8 ends : d7 -- case (9)
Idea 8 starts : d7 and Idea 8 ends : w7e -- case (10)
Idea 8 starts : d7 and Idea 8 ends : a7e -- case (11)
Idea 8 starts : w7e and Idea 8 ends : a7e -- case (12)
Idea 8 starts : a7e and Idea 8 ends : a7e -- case (13)

Choose the relationship between "request business funding (7)" and "use town TV station (8)" by entering the corresponding case number: 12
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

A list of 13 cases are:-

Idea 9 starts : b8s and Idea 9 ends : b8s -- case (1)
Idea 9 starts : b8s and Idea 9 ends : w8s -- case (2)

Idea 9 starts : b8s and Idea 9 ends : d8 -- case (3)
 Idea 9 starts : b8s and Idea 9 ends : w8e -- case (4)
 Idea 9 starts : b8s and Idea 9 ends : a8e -- case (5)
 Idea 9 starts : w8s and Idea 9 ends : d8 -- case (6)
 Idea 9 starts : w8s and Idea 9 ends : w8e -- case (7)
 Idea 9 starts : w8s and Idea 9 ends : a8e -- case (8)
 Idea 9 starts : d8 and Idea 9 ends : d8 -- case (9)
 Idea 9 starts : d8 and Idea 9 ends : w8e -- case (10)
 Idea 9 starts : d8 and Idea 9 ends : a8e -- case (11)
 Idea 9 starts : w8e and Idea 9 ends : a8e -- case (12)
 Idea 9 starts : a8e and Idea 9 ends : a8e -- case (13)

Choose the relationship between "use town TV station (8)" and "show old/new business video (9)" by entering the corresponding case number: 7
 Do you want to change the number you just entered? Enter "y"
 for yes and "n" for no: n

A list of 13 cases are:-

Idea 10 starts : b9s and Idea 10 ends : b9s -- case (1)
 Idea 10 starts : b9s and Idea 10 ends : w9s -- case (2)
 Idea 10 starts : b9s and Idea 10 ends : d9 -- case (3)
 Idea 10 starts : b9s and Idea 10 ends : w9e -- case (4)
 Idea 10 starts : b9s and Idea 10 ends : a9e -- case (5)
 Idea 10 starts : w9s and Idea 10 ends : d9 -- case (6)
 Idea 10 starts : w9s and Idea 10 ends : w9e -- case (7)
 Idea 10 starts : w9s and Idea 10 ends : a9e -- case (8)
 Idea 10 starts : d9 and Idea 10 ends : d9 -- case (9)
 Idea 10 starts : d9 and Idea 10 ends : w9e -- case (10)
 Idea 10 starts : d9 and Idea 10 ends : a9e -- case (11)
 Idea 10 starts : w9e and Idea 10 ends : a9e -- case (12)
 Idea 10 starts : a9e and Idea 10 ends : a9e -- case (13)

Choose the relationship between "show old/new business video (9)" and "invite personality visit (10)" by entering the corresponding case number: 7
 Do you want to change the number you just entered? Enter "y"
 for yes and "n" for no: n

A list of 13 cases are:-

Idea 11 starts : b10s and Idea 11 ends : b10s -- case (1)
 Idea 11 starts : b10s and Idea 11 ends : w10s -- case (2)
 Idea 11 starts : b10s and Idea 11 ends : d10 -- case (3)
 Idea 11 starts : b10s and Idea 11 ends : w10e -- case (4)
 Idea 11 starts : b10s and Idea 11 ends : a10e -- case (5)
 Idea 11 starts : w10s and Idea 11 ends : d10 -- case (6)
 Idea 11 starts : w10s and Idea 11 ends : w10e -- case (7)
 Idea 11 starts : w10s and Idea 11 ends : a10e -- case (8)
 Idea 11 starts : d10 and Idea 11 ends : d10 -- case (9)
 Idea 11 starts : d10 and Idea 11 ends : w10e -- case (10)
 Idea 11 starts : d10 and Idea 11 ends : a10e -- case (11)
 Idea 11 starts : w10e and Idea 11 ends : a10e -- case (12)
 Idea 11 starts : a10e and Idea 11 ends : a10e -- case (13)

Choose the relationship between "invite personality visit (10)" and "create symbol of future (11)" by entering the corresponding case number: 9
 Do you want to change the number you just entered? Enter "y"
 for yes and "n" for no: n

A list of 13 cases are:-

Idea 12 starts : b11s and Idea 12 ends : b11s -- case (1)
 Idea 12 starts : b11s and Idea 12 ends : w11s -- case (2)
 Idea 12 starts : b11s and Idea 12 ends : d11 -- case (3)
 Idea 12 starts : b11s and Idea 12 ends : w11e -- case (4)
 Idea 12 starts : b11s and Idea 12 ends : a11e -- case (5)

Idea 12 starts : w11s and Idea 12 ends : d11 -- case (6)
Idea 12 starts : w11s and Idea 12 ends : w11e -- case (7)
Idea 12 starts : w11s and Idea 12 ends : a11e -- case (8)
Idea 12 starts : d11 and Idea 12 ends : d11 -- case (9)
Idea 12 starts : d11 and Idea 12 ends : w11e -- case (10)
Idea 12 starts : d11 and Idea 12 ends : a11e -- case (11)
Idea 12 starts : w11e and Idea 12 ends : a11e -- case (12)
Idea 12 starts : a11e and Idea 12 ends : a11e -- case (13)

Choose the relationship between "create symbol of future (11)" and "show thanks for nice place (12)" by entering the corresponding case number: 7
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

A list of 13 cases are:-

Idea 13 starts : b12s and Idea 13 ends : b12s -- case (1)
Idea 13 starts : b12s and Idea 13 ends : w12s -- case (2)
Idea 13 starts : b12s and Idea 13 ends : d12 -- case (3)
Idea 13 starts : b12s and Idea 13 ends : w12e -- case (4)
Idea 13 starts : b12s and Idea 13 ends : a12e -- case (5)
Idea 13 starts : w12s and Idea 13 ends : d12 -- case (6)
Idea 13 starts : w12s and Idea 13 ends : w12e -- case (7)
Idea 13 starts : w12s and Idea 13 ends : a12e -- case (8)
Idea 13 starts : d12 and Idea 13 ends : d12 -- case (9)
Idea 13 starts : d12 and Idea 13 ends : w12e -- case (10)
Idea 13 starts : d12 and Idea 13 ends : a12e -- case (11)
Idea 13 starts : w12e and Idea 13 ends : a12e -- case (12)
Idea 13 starts : a12e and Idea 13 ends : a12e -- case (13)

Choose the relationship between "show thanks for nice place (12)" and "create slogan for future (13)" by entering the corresponding case number: 11
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

A list of 13 cases are:-

Idea 14 starts : b13s and Idea 14 ends : b13s -- case (1)
Idea 14 starts : b13s and Idea 14 ends : w13s -- case (2)
Idea 14 starts : b13s and Idea 14 ends : d13 -- case (3)
Idea 14 starts : b13s and Idea 14 ends : w13e -- case (4)
Idea 14 starts : b13s and Idea 14 ends : a13e -- case (5)
Idea 14 starts : w13s and Idea 14 ends : d13 -- case (6)
Idea 14 starts : w13s and Idea 14 ends : w13e -- case (7)
Idea 14 starts : w13s and Idea 14 ends : a13e -- case (8)
Idea 14 starts : d13 and Idea 14 ends : d13 -- case (9)
Idea 14 starts : d13 and Idea 14 ends : w13e -- case (10)
Idea 14 starts : d13 and Idea 14 ends : a13e -- case (11)
Idea 14 starts : w13e and Idea 14 ends : a13e -- case (12)
Idea 14 starts : a13e and Idea 14 ends : a13e -- case (13)

Choose the relationship between "create slogan for future (13)" and "transfer to 16 mm (14)" by entering the corresponding case number: 7
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

A list of 13 cases are:-

Idea 15 starts : b14s and Idea 15 ends : b14s -- case (1)
Idea 15 starts : b14s and Idea 15 ends : w14s -- case (2)
Idea 15 starts : b14s and Idea 15 ends : d14 -- case (3)
Idea 15 starts : b14s and Idea 15 ends : w14e -- case (4)
Idea 15 starts : b14s and Idea 15 ends : a14e -- case (5)
Idea 15 starts : w14s and Idea 15 ends : d14 -- case (6)
Idea 15 starts : w14s and Idea 15 ends : w14e -- case (7)
Idea 15 starts : w14s and Idea 15 ends : a14e -- case (8)

Idea 15 starts : d14 and Idea 15 ends : d14 -- case (9)
Idea 15 starts : d14 and Idea 15 ends : w14e -- case (10)
Idea 15 starts : d14 and Idea 15 ends : a14e -- case (11)
Idea 15 starts : w14e and Idea 15 ends : a14e -- case (12)
Idea 15 starts : a14e and Idea 15 ends : a14e -- case (13)

Choose the relationship between "transfer to 16 mm (14)" and "view at Municipal Building (15)" by entering the corresponding case number: 8
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

A list of 13 cases are:-

Idea 16 starts : b15s and Idea 16 ends : b15s -- case (1)
Idea 16 starts : b15s and Idea 16 ends : w15s -- case (2)
Idea 16 starts : b15s and Idea 16 ends : d15 -- case (3)
Idea 16 starts : b15s and Idea 16 ends : w15e -- case (4)
Idea 16 starts : b15s and Idea 16 ends : a15e -- case (5)
Idea 16 starts : w15s and Idea 16 ends : d15 -- case (6)
Idea 16 starts : w15s and Idea 16 ends : w15e -- case (7)
Idea 16 starts : w15s and Idea 16 ends : a15e -- case (8)
Idea 16 starts : d15 and Idea 16 ends : d15 -- case (9)
Idea 16 starts : d15 and Idea 16 ends : w15e -- case (10)
Idea 16 starts : d15 and Idea 16 ends : a15e -- case (11)
Idea 16 starts : w15e and Idea 16 ends : a15e -- case (12)
Idea 16 starts : a15e and Idea 16 ends : a15e -- case (13)

Choose the relationship between "view at Municipal Building (15)" and "show prospective businesses (16)" by entering the corresponding case number: 7
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

There are 3 cases which are relevant in describing the relationship with regard to start and finish between two ideas
Choose the case that represents the relationship between "establish Brain Trust (1)" and "establish program for economic development (3)" by entering the corresponding number

A list of 3 cases are:-

Idea 3 starts : d1 and Idea 3 ends : a1e -- case (11)
Idea 3 starts : w1e and Idea 3 ends : a1e -- case (12)
Idea 3 starts : a1e and Idea 3 ends : a1e -- case (13)

Choose the relationship between "establish Brain Trust (1)" and "establish program for economic development (3)" by entering the corresponding case number: 13

Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

There are 3 cases which are relevant in describing the relationship with regard to start and finish between two ideas
Choose the case that represents the relationship between "establish trust development program (2)" and "create trust development symbol (4)" by entering the corresponding number

A list of 3 cases are:-

Idea 4 starts : d2 and Idea 4 ends : a2e -- case (11)
Idea 4 starts : w2e and Idea 4 ends : a2e -- case (12)
Idea 4 starts : a2e and Idea 4 ends : a2e -- case (13)

Choose the relationship between "establish trust development program (2)" and "create trust development symbol (4)" by entering the corresponding case number: 13

Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

There are 3 cases which are relevant in describing the

relationship with regard to start and finish between two ideas
Choose the case that represents the relationship between "use town TV station
(8)" and "create slogan for future (13)" by entering the corresponding
number

A list of 3 cases are:-

Idea 13 starts : d8 and Idea 13 ends : d8 -- case (9)
Idea 13 starts : d8 and Idea 13 ends : w8e -- case (10)
Idea 13 starts : d8 and Idea 13 ends : a8e -- case (11)

Choose the relationship between "use town TV station (8)" and "create slogan
for future (13)" by entering the corresponding case number: 10

Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

Do you want to save your input? Enter "y" or "n": y
Do you want to change your choice? Enter "y" or "n": n

12 Output Idea Relation Array and Gantt Chart after Structuring

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 12
Do you want to change your choice? Enter "y" for yes and "n" for no: n

Relation Matrix For the "Business Appreciation" Example

Idea No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	11	13	13	13	13	13	13	13	13	13	13	13	13	13	13
2	0	0	11	13	13	13	13	13	13	13	13	13	13	13	13	13
3	0	0	0	11	11	11	11	13	13	13	13	13	13	13	13	13
4	0	0	0	0	7	7	7	12	12	12	13	13	13	13	13	13
5	0	0	0	0	0	7	7	12	12	12	13	13	13	13	13	13
6	0	0	0	0	0	0	7	12	12	12	13	13	13	13	13	13
7	0	0	0	0	0	0	0	12	12	12	13	13	13	13	13	13
8	0	0	0	0	0	0	0	0	7	7	9	9	10	10	11	11
9	0	0	0	0	0	0	0	0	0	7	9	9	10	10	11	11
10	0	0	0	0	0	0	0	0	0	0	9	9	10	10	11	11
11	0	0	0	0	0	0	0	0	0	0	0	7	11	11	11	11
12	0	0	0	0	0	0	0	0	0	0	0	0	11	11	11	11
13	0	0	0	0	0	0	0	0	0	0	0	0	0	7	8	8
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Enter the unit of time which at most is 12 characters: Weeks
 Do you want to change the word you just entered? Enter "y"
 for yes and "n" for no: n

12 show thanks for nice place

[REDACTED]

13 create slogan for future

[REDACTED]

14 transfer to 16 mm

[REDACTED]

15 view at Municipal Building

[REDACTED]

16 show prospective businesses

[REDACTED]

13 Output a Summary of Sequence and Duration of Ideas

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 13
Do you want to change your choice? Enter "y" for yes and "n" for no: n

A SUMMARY OF SEQUENCE AND DURATION OF IDEAS

Idea No.	Preceding Ideas	Number of Dummy Preceding Ideas	Duration
1	none	0	2
2	1	0	3
3	2	0	3
4	1	0	2
5	1	0	2
6	3	0	2
7	3	0	2
8	none	0	6
9	4, 5, 6, 7	0	6
10	9	0	6
11	4, 9	0	2
12	9	0	2
13	5, 9	0	4
14	9	0	4
15	9	0	5
16	9	0	5

Appendix B. Examples of Modifying Input

2 Retrieve an Existing Network

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 2
Do you want to change your choice? Enter "y" for yes and "n" for no: n

Enter file name which is of DOS file type: test1a.dat
Do you want to display the title of idea structuring case?
Enter "y" or "n": n

Existing file contains: number of ideas, their description
and a list of their preceding ideas
Do you want to display them? Enter "y" or "n": n

Existing file contains: number of ideas, idea description
a list of preceding ideas and array of relationships
Do you want to display the array of relationships? Enter "y" or "n": n

3 List All Ideas in the Network

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 3
Do you want to change your choice? Enter "y" for yes and "n" for no: n

THIS IS A LIST OF IDEAS IN THE NETWORK WITH A LIST OF
ITS PRECEDING IDEA AND THE NUMBER OF DUMMY PRECEDING
IDEAS

Idea 1 -- establish Brain Trust
A list of its preceding ideas is none

Idea 2 -- establish trust development program
A list of its preceding ideas is 1

Idea 3 -- establish program for economic development
A list of its preceding ideas is 2

Idea 4 -- create trust development symbol

A list of its preceding ideas is 1

Idea 5 -- create trust development slogan
A list of its preceding ideas is 1

Idea 6 -- use general fund
A list of its preceding ideas is 3

Idea 7 -- request business funding
A list of its preceding ideas is 3

Idea 8 -- use town TV station
A list of its preceding ideas is none

Idea 9 -- show old/new business video
A list of its preceding ideas is 4,5,6,7

Idea 10 -- invite personality visit
A list of its preceding ideas is 9

Idea 11 -- create symbol of future
A list of its preceding ideas is 4,9

Idea 12 -- show thanks for nice place
A list of its preceding ideas is 9

Idea 13 -- create slogan for future
A list of its preceding ideas is 5,9

Idea 14 -- transfer to 16 mm
A list of its preceding ideas is 9

Idea 15 -- view at Municipal Building
A list of its preceding ideas is 9

Idea 16 -- show prospective businesses
A list of its preceding ideas is 9

8 Delete Idea(s)

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 8
Do you want to change your choice? Enter "y" for yes and "n" for no: n

Enter the number of ideas to be deleted: 3
Do you want to change the number you just entered? Enter
"y" for yes and "n" for no: n
Enter the identification for the ideas to be deleted,
which can be in any order, one at a time and then press return: 16 14 15
Do you want to change any of the identification you
just entered? Enter "y" for yes and "n" for no: n
Do you want to save your input? Enter "y" or "n": n
Do you want to change your choice? Enter "y" or "n": n

Relation Matrix For the "Business Appreciation" Example

Idea No.	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	11	13	13	13	13	13	13	13	13	13	13	13
2	0	0	11	13	13	13	13	13	13	13	13	13	13
3	0	0	0	11	11	11	11	13	13	13	13	13	13
4	0	0	0	0	7	7	7	12	12	12	13	13	13
5	0	0	0	0	0	7	7	12	12	12	13	13	13
6	0	0	0	0	0	0	7	12	12	12	13	13	13
7	0	0	0	0	0	0	0	12	12	12	13	13	13
8	0	0	0	0	0	0	0	0	7	7	9	9	10
9	0	0	0	0	0	0	0	0	0	7	9	9	10
10	0	0	0	0	0	0	0	0	0	0	9	9	10
11	0	0	0	0	0	0	0	0	0	0	0	7	11
12	0	0	0	0	0	0	0	0	0	0	0	0	11
13	0	0	0	0	0	0	0	0	0	0	0	0	0

14 Save Input Data

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 14
Do you want to change your choice? Enter "y" for yes and "n" for no: n

Enter file name which is of DOS file type: test1c.dat

5 Add New Idea(s)

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
 - 2 RETRIEVE AN EXISTING NETWORK
 - 3 LIST ALL IDEAS IN THE NETWORK
 - 4 CONTINUE INPUT RELATION ARRAY
 - 5 ADD NEW IDEA(S)
 - 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
 - 7 MODIFY DESCRIPTION OF IDEA(S)
 - 8 DELETE IDEA(S)
 - 9 MODIFY THE LIST OF PRECEDING IDEA(S)
 - 10 MODIFY THE NUMBER OF DUMMY PRECEDING IDEAS
 - 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
 - 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
 - 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
 - 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 5
Do you want to change your choice? Enter "y" for yes and "n" for no: n

There are 13 ideas, excluding dummy ideas,
in the network. The resulting
number of ideas in the network should NOT be greater than 100
Enter the number of ideas, excluding dummy ideas, to be added: 3
Do you want to change the number you just entered? Enter
"y" for yes and "n" for no: n

Idea description at most is 50 characters
Enter description for idea 14: transfer to 16 mm
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 15: view at Municipal Building
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n
Enter description for idea 16: show prospective businesses
Do you want to modify the description you just entered?
Enter "y" for yes and "n" for no: n

If there is no preceding idea, enter "none"
If there are more than one, list the identifications in
ascending order and separate each with only a comma
Enter the idea identification(s) which precedes idea 14: 9
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea identification(s) which precedes idea 15: 9
Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea identification(s) which precedes idea 16: 9

Do you want to modify the list you just entered?
Enter "y" for yes and "n" for no: n

Is there any dummy idea involved added in the network? Enter
"y" for yes and "n" for no: n
Do you want to change the character you just entered? Enter
"y" for yes and "n" for no: n

Abbreviation of the relationship:-

b1s = before idea 1 starts
w1s = when idea 1 starts
d1 = during idea 1
w1e = when idea 1 ends
a1e = after idea 1 ends

A list of 13 cases are:-

Idea 14 starts : b13s and Idea 14 ends : b13s -- case (1)
Idea 14 starts : b13s and Idea 14 ends : w13s -- case (2)
Idea 14 starts : b13s and Idea 14 ends : d13 -- case (3)
Idea 14 starts : b13s and Idea 14 ends : w13e -- case (4)
Idea 14 starts : b13s and Idea 14 ends : a13e -- case (5)
Idea 14 starts : w13s and Idea 14 ends : d13 -- case (6)
Idea 14 starts : w13s and Idea 14 ends : w13e -- case (7)
Idea 14 starts : w13s and Idea 14 ends : a13e -- case (8)
Idea 14 starts : d13 and Idea 14 ends : d13 -- case (9)
Idea 14 starts : d13 and Idea 14 ends : w13e -- case (10)
Idea 14 starts : d13 and Idea 14 ends : a13e -- case (11)
Idea 14 starts : w13e and Idea 14 ends : a13e -- case (12)
Idea 14 starts : a13e and Idea 14 ends : a13e -- case (13)

Choose the relationship between "create slogan for future (13)" and
"transfer to 16 mm (14)" by entering the corresponding case number: 7
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

A list of 13 cases are:-

Idea 15 starts : b14s and Idea 15 ends : b14s -- case (1)
Idea 15 starts : b14s and Idea 15 ends : w14s -- case (2)
Idea 15 starts : b14s and Idea 15 ends : d14 -- case (3)
Idea 15 starts : b14s and Idea 15 ends : w14e -- case (4)
Idea 15 starts : b14s and Idea 15 ends : a14e -- case (5)
Idea 15 starts : w14s and Idea 15 ends : d14 -- case (6)
Idea 15 starts : w14s and Idea 15 ends : w14e -- case (7)
Idea 15 starts : w14s and Idea 15 ends : a14e -- case (8)
Idea 15 starts : d14 and Idea 15 ends : d14 -- case (9)
Idea 15 starts : d14 and Idea 15 ends : w14e -- case (10)
Idea 15 starts : d14 and Idea 15 ends : a14e -- case (11)
Idea 15 starts : w14e and Idea 15 ends : a14e -- case (12)
Idea 15 starts : a14e and Idea 15 ends : a14e -- case (13)

Choose the relationship between "transfer to 16 mm (14)" and "view at
Municipal Building (15)" by entering the corresponding case number: 8
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

A list of 13 cases are:-

Idea 16 starts : b15s and Idea 16 ends : b15s -- case (1)
Idea 16 starts : b15s and Idea 16 ends : w15s -- case (2)
Idea 16 starts : b15s and Idea 16 ends : d15 -- case (3)
Idea 16 starts : b15s and Idea 16 ends : w15e -- case (4)
Idea 16 starts : b15s and Idea 16 ends : a15e -- case (5)
Idea 16 starts : w15s and Idea 16 ends : d15 -- case (6)
Idea 16 starts : w15s and Idea 16 ends : w15e -- case (7)
Idea 16 starts : w15s and Idea 16 ends : a15e -- case (8)
Idea 16 starts : d15 and Idea 16 ends : d15 -- case (9)

Idea 16 starts : d15 and Idea 16 ends : w15e -- case (10)
Idea 16 starts : d15 and Idea 16 ends : a15e -- case (11)
Idea 16 starts : w15e and Idea 16 ends : a15e -- case (12)
Idea 16 starts : a15e and Idea 16 ends : a15e -- case (13)

Choose the relationship between "view at Municipal Building (15)" and "show prospective businesses (16)" by entering the corresponding case number: 7
Do you want to change the number you just entered? Enter "y" for yes and "n" for no: n

Do you want to save your input? Enter "y" or "n": y
Do you want to change your choice? Enter "y" or "n": n
Enter file name which is of DOS file type: testid.dat

Relation Matrix For the "Business Appreciation" Example

Idea No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	11	13	13	13	13	13	13	13	13	13	13	13	13	13	13
2	0	0	11	13	13	13	13	13	13	13	13	13	13	13	13	13
3	0	0	0	11	11	11	11	13	13	13	13	13	13	13	13	13
4	0	0	0	0	7	7	7	12	12	12	13	13	13	13	13	13
5	0	0	0	0	0	7	7	12	12	12	13	13	13	13	13	13
6	0	0	0	0	0	0	7	12	12	12	13	13	13	13	13	13
7	0	0	0	0	0	0	0	12	12	12	13	13	13	13	13	13
8	0	0	0	0	0	0	0	0	7	7	9	9	10	10	11	11
9	0	0	0	0	0	0	0	0	0	7	9	9	10	10	11	11
10	0	0	0	0	0	0	0	0	0	0	9	9	10	10	11	11
11	0	0	0	0	0	0	0	0	0	0	0	7	11	11	11	11
12	0	0	0	0	0	0	0	0	0	0	0	0	11	11	11	11
13	0	0	0	0	0	0	0	0	0	0	0	0	0	7	8	8
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

6 Modify Relationship(s) Among Ideas

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK

- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 6
 Do you want to change your choice? Enter "y" for yes and "n" for no: n

Enter the number of ideas to be modified: 2
 Do you want to change the number you just entered? Enter
 "y" for yes and "n" for no: n
 Enter the identification of the idea to be modified one at a time: 3
 Do you want to change the number you just entered?
 Enter "y" for yes and "n" for no: n
 Enter the idea to be affected when 3 is
 modified one at a time: 2
 Do you want to change the number you just entered?
 Enter "y" for yes and "n" for no: n
 A list of 13 cases are:-

Idea 3 starts : b2s and Idea 3 ends : b2s -- case (1)
 Idea 3 starts : b2s and Idea 3 ends : w2s -- case (2)
 Idea 3 starts : b2s and Idea 3 ends : d2 -- case (3)
 Idea 3 starts : b2s and Idea 3 ends : w2e -- case (4)
 Idea 3 starts : b2s and Idea 3 ends : a2e -- case (5)
 Idea 3 starts : w2s and Idea 3 ends : d2 -- case (6)
 Idea 3 starts : w2s and Idea 3 ends : w2e -- case (7)
 Idea 3 starts : w2s and Idea 3 ends : a2e -- case (8)
 Idea 3 starts : d2 and Idea 3 ends : d2 -- case (9)
 Idea 3 starts : d2 and Idea 3 ends : w2e -- case (10)
 Idea 3 starts : d2 and Idea 3 ends : a2e -- case (11)
 Idea 3 starts : w2e and Idea 3 ends : a2e -- case (12)
 Idea 3 starts : a2e and Idea 3 ends : a2e -- case (13)

Choose the relationship between "establish trust development program (2)"
 and "establish program for economic development (3)" by entering the
 corresponding case number: 1
 Do you want to change the number you just entered? Enter "y"
 for yes and "n" for no: n

If all the relationships affected by a modification
 of 3 have been updated, enter "y" for yes
 and "n" for no: y

Do you want to change your choice? Enter "y" for
yes and "n" for no: n
Enter the identification of the idea to be modified one at a time: 16
Do you want to change the number you just entered?
Enter "y" for yes and "n" for no: n
Enter the idea to be affected when 16 is
modified one at a time: 15
Do you want to change the number you just entered?
Enter "y" for yes and "n" for no: n

A list of 13 cases are:-

Idea 16 starts : b15s and Idea 16 ends : b15s -- case (1)
Idea 16 starts : b15s and Idea 16 ends : w15s -- case (2)
Idea 16 starts : b15s and Idea 16 ends : d15 -- case (3)
Idea 16 starts : b15s and Idea 16 ends : w15e -- case (4)
Idea 16 starts : b15s and Idea 16 ends : a15e -- case (5)
Idea 16 starts : w15s and Idea 16 ends : d15 -- case (6)
Idea 16 starts : w15s and Idea 16 ends : w15e -- case (7)
Idea 16 starts : w15s and Idea 16 ends : a15e -- case (8)
Idea 16 starts : d15 and Idea 16 ends : d15 -- case (9)
Idea 16 starts : d15 and Idea 16 ends : w15e -- case (10)
Idea 16 starts : d15 and Idea 16 ends : a15e -- case (11)
Idea 16 starts : w15e and Idea 16 ends : a15e -- case (12)
Idea 16 starts : a15e and Idea 16 ends : a15e -- case (13)

Choose the relationship between "view at Municipal Building (15)" and "show
prospective businesses (16)" by entering the corresponding case number: 11
Do you want to change the number you just entered? Enter "y"
for yes and "n" for no: n

If all the relationships affected by a modification
of 16 have been updated, enter "y" for yes
and "n" for no: y
Do you want to change your choice? Enter "y" for
yes and "n" for no: n
Do you want to save your input? Enter "y" or "n": y
Do you want to change your choice? Enter "y" or "n": n
Enter file name which is of DOS file type: testie.dat

Relation Matrix For the "Business Appreciation" Example

Idea No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	11	13	13	13	13	13	13	13	13	13	13	13	13	13	13
2	0	0	1	13	13	13	13	13	13	13	13	13	13	13	13	13
3	0	0	0	11	11	11	11	13	13	13	13	13	13	13	13	13
4	0	0	0	0	7	7	7	12	12	12	13	13	13	13	13	13
5	0	0	0	0	0	7	7	12	12	12	13	13	13	13	13	13
6	0	0	0	0	0	0	7	12	12	12	13	13	13	13	13	13
7	0	0	0	0	0	0	0	12	12	12	13	13	13	13	13	13
8	0	0	0	0	0	0	0	0	7	7	9	9	10	10	11	11
9	0	0	0	0	0	0	0	0	0	7	9	9	10	10	11	11
10	0	0	0	0	0	0	0	0	0	0	9	9	10	10	11	11
11	0	0	0	0	0	0	0	0	0	0	0	7	11	11	11	11
12	0	0	0	0	0	0	0	0	0	0	0	0	11	11	11	11
13	0	0	0	0	0	0	0	0	0	0	0	0	0	7	8	8
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

7 Modify Description of Idea(s)

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
 - 2 RETRIEVE AN EXISTING NETWORK
 - 3 LIST ALL IDEAS IN THE NETWORK
 - 4 CONTINUE INPUT RELATION ARRAY
 - 5 ADD NEW IDEA(S)
 - 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
 - 7 MODIFY DESCRIPTION OF IDEA(S)
 - 8 DELETE IDEA(S)
 - 9 MODIFY THE LIST OF PRECEDING IDEA(S)
 - 10 MODIFY THE NUMBER OF DUMMY PRECEDING IDEAS
 - 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
 - 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
 - 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
 - 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 7
Do you want to change your choice? Enter "y" for yes and "n" for no: n

Enter the number of ideas to be modified: 2
Do you want to change the number you just entered? Enter
"y" for yes and "n" for no: n
Idea description is at most 50 characters
Enter the identification of the idea to be modified one at a time: 14
Idea 14 -- transfer to 16 mm
Is this the idea you want to modify? Enter "y" or "n": y
Enter the modified idea description: transfer to 16 mm movie
Do you want to modify the description you just entered? Enter "y" or "n": n
Enter the identification of the idea to be modified one at a time: 16
Idea 16 -- show prospective businesses
Is this the idea you want to modify? Enter "y" or "n": y
Enter the modified idea description: show to potential businessmenn
Do you want to modify the description you just entered? Enter "y" or "n": y
Enter the modified idea description: show to potential businessmen
Do you want to modify the description you just entered? Enter "y" or "n": n
Do you want to save your input? Enter "y" or "n": y
Do you want to change your choice? Enter "y" or "n": n
Enter file name which is of DOS file type: testif.dat

9 Modify the List of Preceding Idea(s)

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 9
Do you want to change your choice? Enter "y" for yes and "n" for no: n

Enter the number of ideas for which the preceding idea(s)
are to be modified: 2
Do you want to change the number you just entered? Enter
"y" for yes and "n" for no: n
If there is no preceding idea, enter "none"
If there are more than one, list the identifications in
ascending order and separate each with only a comma
Enter the identification of the idea of which the preceding
idea(s) is to be modified, one at a time: 14
Idea 14 -- transfer to 16 mm movie
A list of its preceding ideas is 9
Is this the idea you want to modify? Enter "y" or "n": y
Enter the modified list of preceding idea(s): 5,9
Do you want to modify the list you just entered? Enter
"y" or "n": n
Enter the identification of the idea of which the preceding
idea(s) is to be modified, one at a time: 16
Idea 16 -- show to potential businessmen
A list of its preceding ideas is 9
Is this the idea you want to modify? Enter "y" or "n": y
Enter the modified list of preceding idea(s): 5,9
Do you want to modify the list you just entered? Enter
"y" or "n": n
Do you want to save your input? Enter "y" or "n": y
Do you want to change your choice? Enter "y" or "n": n
Enter file name which is of DOS file type: testif.dat

10 Modify the Number of Dummy Preceding Ideas

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 10
Do you want to change your choice? Enter "y" for yes and "n" for no: n

Enter the number of ideas for which the number of dummy preceding idea(s) are to be modified: 1

Do you want to change the number you just entered? Enter "y" for yes and "n" for no: n

Enter the identification of the idea of which the number of dummy preceding idea(s) is to be modified, one at a time: 7

Idea 7 -- request business funding
Number of its dummy preceding ideas is 0

Is this the idea you want to modify? Enter "y" or "n": n

Enter the identification of the idea of which the number of dummy preceding idea(s) is to be modified, one at a time: 7

Idea 7 -- request business funding
Number of its dummy preceding ideas is 0

Is this the idea you want to modify? Enter "y" or "n": y

Enter the modified number of dummy preceding idea(s): 2

Do you want to modify the number you just entered? Enter "y" or "n": n

Do you want to save your input? Enter "y" or "n": y

Do you want to change your choice? Enter "y" or "n": n

Enter file name which is of DOS file type: testif.dat

3 List All Ideas in the Network

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 3
Do you want to change your choice? Enter "y" for yes and "n" for no: n

THIS IS A LIST OF IDEAS IN THE NETWORK WITH A LIST OF
ITS PRECEEDING IDEA AND THE NUMBER OF DUMMY PRECEEDING
IDEAS

Idea 1 -- establish Brain Trust
A list of its preceeding ideas is none

Idea 2 -- establish trust development program
A list of its preceeding ideas is 1

Idea 3 -- establish program for economic development
A list of its preceeding ideas is 2

Idea 4 -- create trust development symbol
A list of its preceeding ideas is 1

Idea 5 -- create trust development slogan
A list of its preceeding ideas is 1

Idea 6 -- use general fund
A list of its preceeding ideas is 3

Idea 7 -- request business funding
A list of its preceeding ideas is 3
Number of its dummy preceeding ideas is 2

Idea 8 -- use town TV station
A list of its preceding ideas is none

Idea 9 -- show old/new business video
A list of its preceding ideas is 4,5,6,7

Idea 10 -- invite personality visit
A list of its preceding ideas is 9

Idea 11 -- create symbol of future
A list of its preceding ideas is 4,9

Idea 12 -- show thanks for nice place
A list of its preceding ideas is 9

Idea 13 -- create slogan for future
A list of its preceding ideas is 5,9

Idea 14 -- transfer to 16 mm movie
A list of its preceding ideas is 5,9

Idea 15 -- view at Municipal Building
A list of its preceding ideas is 9

Idea 16 -- show to potential businessmen
A list of its preceding ideas is 5,9

13 Output a Summary of Sequence and Duration of Ideas

IDEA STRUCTURING MENU

- 1 START A NEW NETWORK
- 2 RETRIEVE AN EXISTING NETWORK
- 3 LIST ALL IDEAS IN THE NETWORK
- 4 CONTINUE INPUT RELATION ARRAY
- 5 ADD NEW IDEA(S)
- 6 MODIFY RELATIONSHIP(S) AMONG IDEAS
- 7 MODIFY DESCRIPTION OF IDEA(S)
- 8 DELETE IDEA(S)
- 9 MODIFY THE LIST OF PRECEEDING IDEA(S)
- 10 MODIFY THE NUMBER OF DUMMY PRECEEDING IDEAS
- 11 PRINT GANTT CHART ONLY WHEN IDEAS ARE ALREADY STRUCTURED
- 12 OUTPUT IDEA RELATION ARRAY AND GANTT CHART AFTER STRUCTURING
- 13 OUTPUT A SUMMARY OF SEQUENCE AND DURATION OF IDEAS
- 14 SAVE INPUT DATA
- 9999 EXIT PROGRAM

Choose an option by entering the corresponding number: 13
Do you want to change your choice? Enter "y" for yes and "n" for no: n

A SUMMARY OF SEQUENCE AND DURATION OF IDEAS

Idea No.	Preceding Ideas	Number of Dummy Preceding Ideas	Duration
1	none	0	2
2	1	0	3
3	2	0	3
4	1	0	2
5	1	0	2
6	3	0	2
7	3	2	2
8	none	0	6
9	4, 5, 6, 7	0	6
10	9	0	6
11	4, 9	0	2
12	9	0	2
13	5, 9	0	4
14	5, 9	0	4
15	9	0	5
16	5, 9	0	5

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the scanned document**