CRITICAL PATH ANALYSIS IN PROJECT MANAGEMENT: AN APPLICATION

A THESIS
SUBMITTED TO THE DEPARTMENT OF MANAGEMENT
AND THE INSTITUTE OF MANAGEMENT SCIENCES
OF BILKENT UNIVERSITY
IN PARTIAL FULLFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF BUSINESS ADMINISTRATION

BY
BÜLENT NEHA KARAGÖZ

February, 1989

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February, 1989

I certify that I have read this thesis and in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Business Administration.

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ABSTRACT

CRITICAL PATH ANALYSIS

IN

PROJECT MANAGEMENT:

AN APPLICATION

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Critical Path Analysis (CPA) in project management has found extensive applications in the last three decades, mainly because it enables the completion of project in the shortest possible time and increases the efficiency. The purpose of this thesis is to explain CPA by means of an application on a construction project, using HTPM software.

Key Words: Project Management, Critical Path Analysis, PERT, HTPM

ÖZET

PROJE YÖNETIMINDE

KRITIK YÖRÜNGE ANALIZI:

BIR UYGULAMA

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Tez Yöneticisi: Y.Doc.Dr.Erdal Erel

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Proje yönetiminde kritik yörünge analizi, projeyi en kisa zamanda bitirmeyi saglamasi ve verimliligi arttirmasi yuzunden son otuz yildir hizla yaygınlasmaktadir. Bu tezin amacı, kritik yörünge analizinin bir insaat projesi üzerinde, HTPM yazilimi kullanılarak, uygulamali olarak açiklanmasıdir.

Anahtar Kelimeler: Proje Yönetimi, Kritik Yörünge Analizi, PERT, HTPM

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CHAPTER ONE : INTRODUCTION

1.1. Overview

A project can be defined as an undertaking having a definite goal and consisting of a number of individual elements that must be completed in some sequence to achieve the goal. Project management occurs when management gives emphasis and special attention to the conduct of those activities to achieve a specified goal.

Project management has several stages. These are: project selection, proposal evaluation, project organization, project planning and control, and project termination and evaluation. Each stage individually has a wide field of applications. Among them, planning and control have become the center of attention. They are also the subject of this thesis. In this thesis, critical path analysis (CPA) is discussed with respect to its application to planning and control. CPA can be defined as the characterization of a project as a network of interrelated events which must be accomplished in a particular sequence in order to achieve a desired objective by a certain date, utilizing a given level of resources [2, p 1].

The purpose of this thesis is to show the practical aspects of CPA, rather than its theoretical side. An actual case in the construction industry is taken as an application and the project is managed referring to basic rules of CPA. A computer software called Harvard Total Project Manager (HTPM) is used in computations.

1.2. Background of the problem

In any project management environment the most important fields are planning and control. Planning is the process of analyzing a project in order to break it down into its elements and to identify the order of operations. It consumes time, money, people, and materials. Control is used to avoid large deviations from the plan. CPA is a means of control of the plans.

The importance of critical path analysis comes from the following facts. In many cases, scheduling and budget controls play the major role. Generally, several groups

in the project do their planning and scheduling. These independent efforts may cause lack of coordination in further stages of the project. Also the estimates of the total requirements are based on past experience, which may be misleading because people may oversimplify the data. The reason is that human beings may not be capable of dealing with all the factors that comprise a problem at one time. Consequently, some undesirable effects may arise. Some important aspects of the operation, which should be dealt with at the outset, are ignored or unrecognized; or uncoordinated interpretations and improvisations, and double countation becomes common. When a change in the schedule becomes necessary, corrective action has tended to be made to all of the jobs, since the complexity of the situation has not permitted rapid economical analysis to single out the particular jobs affected by a change. The managememt can be affected by the facts such as losing control and does not know whether or not its objectives are being met.

By the help of adequate tools and techniques the above situations can be avoided. Most of the traditional scheduling techniques are based on the Gantt or bar chart which has been in common use for many years. Although it is still a valuable tool for scheduling small projects, its use is limited and very constrained to the scheduling of large scale operations. In particular, bar charts fail to delineate the complex interactions and precedence relationships which exist among the project events.

In order to deal with planning and control side of project management several techniques have been developed. Known by several acronyms such as CPM (Critical Path method), DCPM (decision CPM), PDM (Precedence Diagramming Method), PERT (Project Evaluation and Review Technique), GERT (Graphical Evaluation and Review Technique), etc., these techniques share a number of common elements. The most common element is the use of a network or flow diagram as a model of the project's technological precedence relationships. The network represents all the activity paths or chains of events that must be accomplished before achieving the project's objective. The most time-wise restrictive of these activity paths is the "critical path" which permits management to focus its atten tion on pacing the activities of the operation. For this reason the term critical path analysis is given to this fami-

ly of techniques. Anologically, all the techniques share some common concepts, but researchers in this field tend to diversify rather than unify. For that reason, there are numerous methods available in the literature, many of them gathered under the original techniques of PERT and CPM [2, p 5]. These two major techniques differ among themselves by the project types that they use. "Development" projects use non-repetitive tasks and they have probabilistic time estimates for activity durations. "Non-development" projects, on the other hand, use repetitive tasks with deterministic time estimates. From these, PERT deals with the former and CPM with the latter.

1.3. Problem definition

In order to finish the project in the shortest possible time, a sound planning is required with efficient means of controlling. A work breakdown structure is essential in planning to result a network of events so that,CPA can be applied to find the critical path of events which directly affect the project completion time. Considering the application, construction industry is a good example for deterministic time estimates. Events in the project are repetitive and depend on past experience. Thus, construction industry is considered as a non-development project. In construction-type projects the critical element is time; not only because of the restrictions due to contracts but also rapidly increasing cost of materials in the inflationary environment.

Aks Insaat Ltd. Sti., a recently established construction firm has made a contract with another construction firm, Koray AS., which is responsible for construction of seven buildings in Istanbul. Aks' responsibility is the rough work of the buildings, and since it is a subproject, it has tight restrictions on time. The problem can be defined as searching for the events that directly affect the project completion time and concentrating on them, that is, employing CPA to project management.

1.4. Definition of terms

Before dealing with more conceptual subjects, it is appropriate to explain some terms concerning the CPA.

The term **network** (arrow diagram) is used to show all of the project's events and activities in a logical manner, as Archibald and Villoria [1, pp 437-438] define it, " A flowplan of all the activities and events that must be accomplished to reach the project objectives, graphically depicting the planned sequences in which they are to be accomplished and their interdependencies and interrelationships."

Work Breakdown Structure (WBS), as its name implies, states the breakdown of the end item of the project into subgroups of milestones and events, to the lowest practical level [1, p 440]. It can be thought of as an inverted tree, with the root (the project goal) at the top, the branches below, and the leaves at the lowest level.

Events (nodes) refer to start or end of an operation in the project. They are the main elements of the work breakdown structure. They do not require any time allocations. Major events in the project are called as milestones.

Activities (jobs) are the means of accomplishing events, and can be referred as sub-events. They are the actual means of consuming time and resources.

The time estimates of the activities are called **durations** and are usually taken in working days. To determine the durations, several methods can be applied depending on the project type. For non-development projects, such as projects for process and construction industries, activities are well known and past experience provides a basis for reliable and accurate time estimates; these are referred as deterministic time estimates.The other form is the probabilistic time estimates, which are used for development projects. Since many of the activities in a development project have rarely been carried out before, an uncertainty exists, and this is overcome by the "three estimates technique". In this technique planner gives three estimates of durations. An optimistic time estimate for the shortest possible time, a pessimistic time estimate for the longest possible completion time, and finally a most likely time estimate for normal conditions. Then, these estimates are combined to compute the expected duration, which approximates the means of three values in estimates [1, pp 76-90].

To apply this technique, it is necessary to assume that activity durations are distributed according to a unimodal Beta disribution. Expected durations [t(e)] can be calculated by the following formula [6, pp 89-127];

$$t(e)=\frac{a+4m+b}{6}$$

where,

a - optimistic estimate

b - pessimistic estimate

m - most likely value

After defining the problem and related terms, it is appropriate to state the purpose of the thesis in condensed form.

1.5. Purpose of the thesis

This thesis deals with the planning and control side of project management, focusing on critical path analysis. The purpose is to show the practical aspects of CPA on an actual project.

1.6. Outline of the thesis

In the next chapter, a literature review concerning CPA is presented. A short summary of different models of CPA is presented and implementations from these models are reviewed. These are: (1) implementations from PERT, such as PERT/COST, PERT/LOB, MOST, BPERT, VERT, and GERT; (2) implementations from CPM, such as PDM, Heuristic techniques, CPM/MRP, interactive CPM, and DCPM. Chapter three explains the application of CPA. An overview of the project is given and the applied procedure is discussed. The chapter continues with a description of the project, planning of the activities with time estimates and lead times. Then, the procedure of applying the network to the computer is given. Finally, project is updated to comment on the scheduling activities.

In chapter four, a summary of the study is presented. Also, relevant conclusions and recommendations are stated.

CHAPTER TWO : LITERATURE REVIEW

2.1. Overview

In this chapter the applications of CPA, starting from the early days to present, is discussed. Resulting from the strict regulations on project control on Polaris Missile Program, project network models came into action three decades ago. Then, it became very popular and used in many fields, especially in the construction industry.

At the same time when US Navy's regulations were in use, DuPont of USA developed a similar method to improve the scheduling techniques for such projects as shutdown of a plant for maintenance and building pilot model plants [2, p 15].

Those two simultaneous studies resulted in the original models of CPA, and they are referred to as PERT and CPM, respectively. Actually, they were very close to each other in theory except for the time estimates of the events. PERT was using probabilistic time estimates whereas CPM was using deterministic time estimates.

The similarity between the two methods could not be perceived well in the early days because of the different notations used in these two independently developed models. Table 1 shows the PERT and CPM notations [5, p 28]. In recent years, the two methods are usually referred to as PERT-type systems with the same notations. Therefore, there is a tendency to merge those two systems. The HTPM software also refers to CPA using PERT-type system and names it in the program as PERT, though the model is exactly the same with CPM as well.

In the next two sections the evaluations of these two methods are discussed separately. Figure 1 depicts these evaluations, which is stated by Wiest as "Gene-Splicing models of PERT and CPM" [10The separation process of the new techniques and their origins are based on the acronyms because they do not involve the unique features of PERT and CPM (i.e., probabilistic vs deterministic time estimates), rather they are the improvements in CPA; so they could be connected to either PERT or CPM.

Table 1 : PERT vs CPM Notations

PERT	CPM
Network	Arrow diagram
Event	Node
Activity	Job
Activity expected time	Duration
Slack (primary)	Total float
Slack (secondary)	Free float
T_H	Earliest start
T_L	Latest start

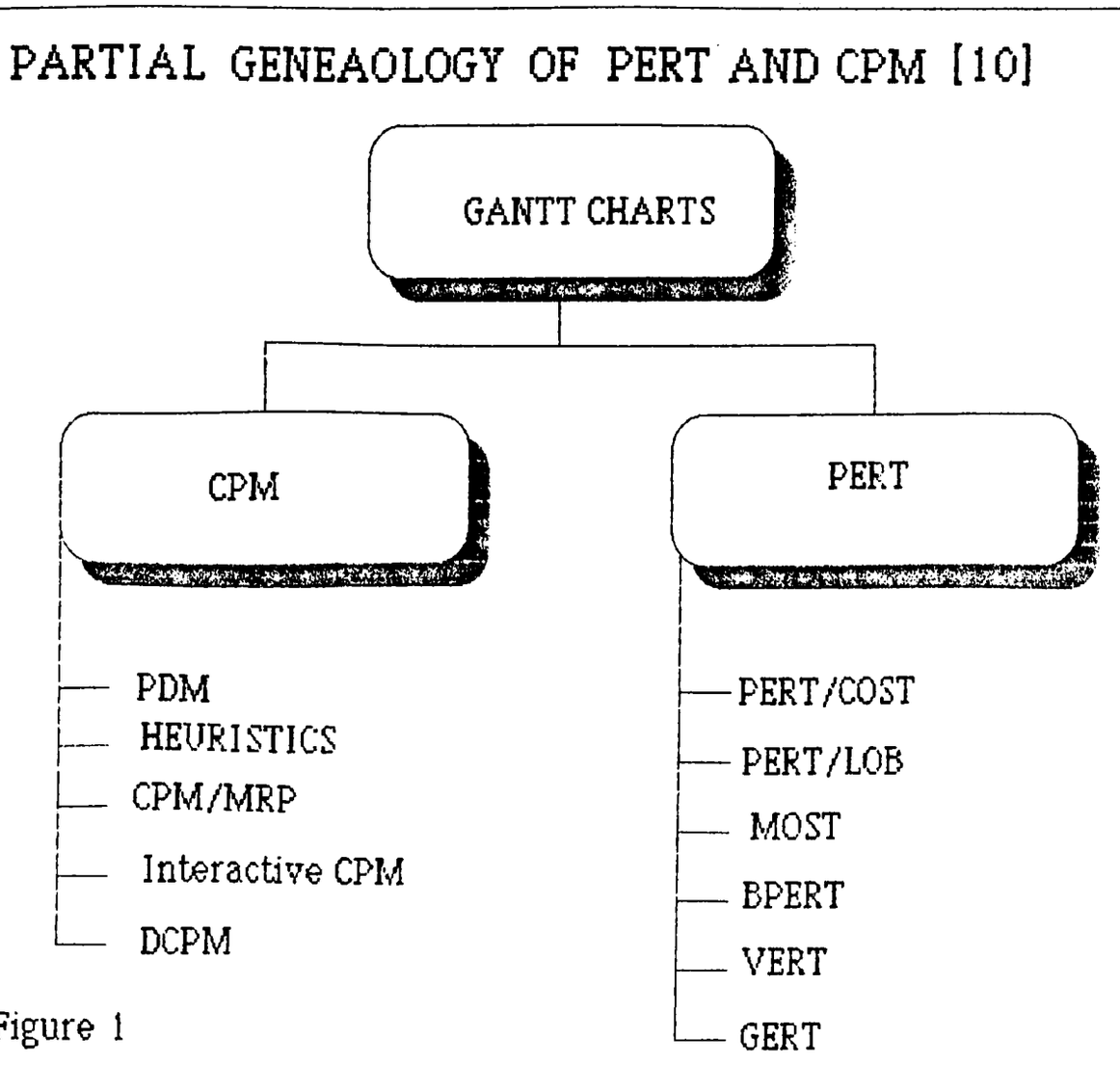


Figure 1

2.2. Implementations from PERT

The first criticisms concerning PERT were stating that the technique does not consider cost accounting. PERT was only dealing with scheduling, but CPM, on the other hand, was dealing with both scheduling and cost accounting. In order to overcome this disadvantage, **PERT/COST** was introduced. Here, costs are assigned to specific activities in the work breakdown structure rather than assigning costs on a departmental bases. This is useful in identifying the past and projected costs of the project and the sources of the excess costs. Unfortunately, this method could not be used excessively, because it was hard for the firms to change their cost accounting systems; the ones who employed the method did not change the old procedures, so double countation of cost accounting became the problem. For that reason, this method faced criticisms in its early days of introduction [5, pp 89-127], and today it is hardly used.

MOST (Management Operations System Technique) is a simpler form of PERT in which bar charts are used to identify the project network. Its capabilities are similar to PERT/COST but due to its dependance on bar charts it can only be used for small scale projects [10].

The three time estimates of PERT was rather difficult to implement. To overcome this, Bayesian statistics [3, p 64] was used to estimate the times. **BPERT** (Bayesian PERT) is the name given to the method suggesting that Bayesian point estimates can be formulated for beta-distributed activity duration estimates; which results a reduction in the time misestimation. The problem with this method is the increased complexity for the project managers. If a project manager has difficulty in estimating three times for the events, it would be much harder for him to use Bayesian statistics.

PERT/LOB joins the Line of Balance (LOB) technique with PERT to ease the operations in development of a new product and its production period. It includes repetitive activities and its difference from PERT is that it can use multiple contact points, and it has one-time estimates [10].

So far, the models listed were interested with the uncertainty of the duration times, the two recently developed models, called **GERT** and **VERT**, deal also with the uncertainty in the network as well. They depend on the fact that events might be failed or there might be counter flows in the network (i.e., network should require to turn back to start). For that reason they use probabilistic nodes, which allow for the possibility that existing activities may commence when one or more entering activities are completed. These two models, especially GERT, are the most widely used procedures for development-type projects, and there is a lot of research concentrating on these techniques. The main applications are used while managing of a large number of research projects to show where it is worth investing money; also a form of it has been applied successfully to the assessment of the reliability of complex systems [7].

2.3. Implementations from CPM

The basic CPM and PERT models employ activity-on-arrow diagrams. In a new model called **PDM** (Precedence Diagramming Method) activities are represented by nodes, and arrows are used to denote the precedence relationships (i.e., the activities -not the events- are placed within a circle or square, and the dependencies between activities are shown by lines or arrows) such as "finish-to-finish", "start-to-start", "finish to start", and "start to finish". To give an example, "finish-to-start" relationship is showed as FS=n, which states that a new job cannot start unless n days are passed from the last finished event. These relationships cause the model to look sophisticated, but it decreases the total number of the activities in a network 20-30 percent, primarily due to the elimination of dummy constraints; its applications had increased recently by the introduction of powerful computers and softwares [1, pp 441-446]. HTPM uses a similar type of PDM in which dependencies between activities are simplified by removing relationships of "finish-to-finish", finish-to-start", etc., and a single set of dependency is used.

Heuristic techniques are used in finding feasible solutions for those problems that are not necessarily globally optimal, but usually are better than those that can

be found by simple rounding [4, pp 420-421]. They came into the picture due to the need of a program for scheduling activities under both precedence and limited resource constraints. Today, they are sold as commercially available computer packages, and since they are dealing with "more" realistic problems than PERT and CPM, they are well accepted [10].

In limited resource projects **optimizing models** are used with the CPM and PERT (such as LP, IP, DP), and it has found considerable applications. But in real life, projects are too large and complex, so a mathematical model cannot be always constructed. Thus, use of optimizing models are limited in that sense.

Interactive models of CPM are the kind of trial-and-error procedures; they depend on the computers' capabilities and speed, and require the managers to sit in front of a terminal and try the different possibilities for project planning.

DCPM, Decision CPM, is the GERT version of the CPM, but it is more powerful than GERT. Its power comes from the fact that in a project there are a number of alternative methods for completing at least some of the jobs. Wiest [10, p 85] defines them in the following manner: "These are usually sorted through and the "best" ones included in the final network which can then be used for scheduling purposes. DCPM attempts to combine those processes by including in the network not only jobs which must be performed but also subsets of alternative jobs with their durations and precedence relationships, each subset headed by a decision node"

Another recent use of CPM is in the manufacturing industry and it is called **CPM/MRP**. Materials requirements planning is based on a product structure tree and this may well be considered as a network, so CPM's features can be used with the relationships concerning resource requirements, acqusition lead times, and inventory records [8, pp 540-590].

2.4. Use of computers

Today handiwork in CPA is almost eliminated. All the applications listed above use some kind of computer software in computations. Computer has the advantages of

being fast, accurate, it is capable of supplying tabular outputs, and gives ease of updating the project.

Computer software are only tools, they are not substitutes for judgment. They are recommended:

1- for large projects which cannot be broken into smaller subprojects.

2- where there is a need for frequent reports.

3- where frequent updating is expected.

4- where least-cost sacheduling (for CPM) is required.

Today, computer software of project management are grouped into two categories. They are referred as, "low-end" and "high-end" software [9], according to the selling prices. Low-end packages are sold under $600, examples are: HTPM, Time Line, Microsoft Project, Micro planner, etc. High-end packages cost between $600 to $8,000, Primavera Project Planner, Open Plan, Promise are the examples.

The most significant difference between the two types is the size of the project each can handle. Low-end programs can handle up to 1,000 activities, whereas high-end programs can handle up to 62,000 activities. Low-end programs can handle relatively small projects, but since they are small, they can be placed in the RAM of the computer; and this increases the speed of calculations. High-end programs, on the other hand, use disk accesses which decrease the speed of calculation considerably.

HTPM is one of the simple-to-use software which has highly developed graphic capabilities. Refer to Appendix A5 for details on HTPM software.

CHAPTER THREE : APPLICATION

3.1. Overview of the project

The procedure of application involves the following steps:

· Determining the project events

· Stating the relationships

· Forming the project network

· Applying the project network to the HTPM

· Finding the critical path

· Getting outputs such as PERT chart, Gant chart, etc.

· Updating the project

· Commending on the scheduling (whether it is beyond or ahead of the schedule)

· Giving recommendations regarding the specific project management.

3.2. Description of the project

The original project consists of construction of seven buildings, each being a single dwelling. Every building is similar to one another in architectural style, and each building has two floors, except for the seventh building which has three floors.

The location is in Istanbul, and the project is called "Sabanci Koru Sitesi". Koray AS. has the responsibility of the project in which Aks Insaat Ltd. Sti. has a sub-contract for rough work of the buildings. Aks' responsibility is to build concrete structures of the buildings. Certain off-site improvements such as landscaping will be done by Koray. The starting date of the sub-project is 3rd of September, 1988. It does not

have a predetermined due date, but Koray As. wants it to be completed as soon as possible, preferably before May, 1989.

3.3. Planning

The first step in planning is defining the events and activities. In this project works are broken down into smaller units, based on the activities required to build a floor of the buildings. There are four main activities in constructing a floor, these are:

1- building reinforcement structure, molding, and applying concrete

2- waiting for concrete to gain strength

3- removing molds

4- building side walls.

In addition to these activities, there are additional ones for the foundation and roof of the building.

The start and finish of the buildings are taken to be events, and since they are the major events they are referred as milestones. The reason for taking the buildings as milestones is that the activities required for buildings are listed serially and their start and finish are dependent on each other. Also building walls are done in the latter stages of the construction, which as a whole makes it impractical to divide events into much smaller works.

In total, project is broken down into 157 tasks and milestones. These are listed in the task and milestone list of Appendix A1 with their codes, durations, and descriptions; which are sorted according to their planned start dates.

The relationships of the activities concerning an event are taken in the following logical sequence:

1- a foundation should be built

2· construction of floors should be done regarding the first three necessary activities listed above

3· side walls should be built, can be done two at a time

4· at the end, a roof should be built.

The project is started with the construction of the first building, then second building started, and this is planned to continue with the following order of, third, fifth, fourth, seventh, and sixth buildings. Here, this rank is determined from the past experiences of the project manager, and numbering of the buildings are done according to the locations on the site.

3.4. Time estimates

Time estimates are also based on the past experience of the project manager. Integer numbers are used in stating the durations, the reason is that it is not possible to be sufficiently accurate so as to estimate the time with fractions. Also finishing of an activity causes the beginning of another. This immediate following could only be done by working on a daily basis because a new activity requires a new allocation of resources which lags the actual finish.

The longest duration is for building reinforcement structure, molding, and applying concrete; which takes 14 working days. Mold removing requires 2 days, and building walls requires 7 days.

Since time estimates are given with working days, a specific calendar is needed for this project. A new calendar consisting of 7 working days in a week between 8am to 5pm is built; there are holidays in the first day of the year and in the national holidays, which are legally required; as a policy over-time is not used.

3.5. Lead times

Lead time activities are the ones which consume time but do not consume any

resources. They are not operational, rather they state the relationships between two "real" activities.

In this project there are two types of "lead time" activities; first type includes the dummy activities which state the amount of time required to start an event; these are referred with codes of hundereds. For example, activity called 200 states that five working days are required for second building to start after activity 102; similarly, activity 700 states that 20 working days are required after activity 401 for the seventh building to start.

Second type of "lead time" activities are so called "strength" activities in the task and milestone list of Appendix A1. These are related with the concrete curing time, and obviously do not consume any resources. Actually they do consume resources in an indirect manner. While concrete is applied to the mold, it is supported underneath by timbers. These timbers are removed after 14 days have passed, and used in other activities. Then, 12 days are spent for concrete to gain strength so that it will be strong enough to restrain forces due to new floors built on it.

To increase efficiency and decrease the project time, these activities are eliminated in the construction of sixth and seventh buildings. Since at the end of the project only these two buildings are built, there will be extra available timbers to support molds, so they are not removed after concrete is applied, rather they stay there for 14 days as a means of support to concrete.

3.6. Applying the project to the HTPM

There are several possible ways to enter a project into the HTPM, namely; a WBS can be drawn, which is automatically converted to PERT chart, or milestones and activities can be written in a scheduled order, which again converted to PERT chart, finally PERT chart can directly be drawn. In this application the last possibility is chosen because network was highly structured and relatively complicated, so, to avoid complications PERT chart was drawn directly.

While creating a project network, HTPM automatically states the milestones of start and finish of the projects. The first step is to insert the milestones of 101 and 101END (start and finish of first building) between start and finish of the project; then activities are inserted between 101 and 101END; it continues until all milestones and activities are represented in the PERT chart. Critical path is calculated by HTPM, which comes out to follow the activities of the first building, then switching to the seventh building (see Appendix A4).

3.7. Updating of the project

Project is updated referring to the percent completion of an activity. Updating was done on January 31st, 1989, by getting information from Aks.

Since Aks is not familiar with the project scheduling, it was not possible to obtain actual start and finish date of the activities, the only available information is the current situation of the buildings on January 31st,1989. On that day, concrete was applied to the main roof of the first building, the same operation would be done to building three six days later, molds of the main roof were being constructed for building two, reinforcement structure was bulding at roof for the fourth building. For the fifth building, reinforcement structure was being built at the basement. Foundation activities were finished in building six, and finally for building seven, building of reinforcement structure was continuing for the basement. Table 2 summarizes the current activities on the updating date.

Since the actual start and finish dates of the activities are not known, it is not easy to use the Gantt chart because HTPM does not convert the percent completions to the Gantt chart (see Appendix A3), it requires the actual dates to place the activities on the chart.

TABLE 2: Progressing Activities on 31st January, 1989

	BUILDINGS						
	1	2	3	4	5	6	7
ACTIVITY	116	216	314	413	504	603	704
% COMP.	80	20	80	80	30	100	20

Though Gantt chart could not help much, it is still possible to reach some conclusions regarding the scheduling. It is done by comparing the latest finish dates of the activities (given in the tasks and milestones list of Appendix A2) with the current date of January 31st, 1989, and percent completion is investigated.

With the above procedure applied, eleven activities turned out to be beyond the schedule; these are listed in Table 3.

As it is seen, three activities, namely; 116, 117, and 118 are on the critical path (slack=0), and they are already late, also 117 and 118 are not started yet. Ii is a big problem to have three activities of the critical path to be beyond the schedule, so, more resources (if available) should be allocated to the activities on the critical path. Also, other activities, which are not on the critical path, are beyond the schedule as well. They do not affect the project completion time critically, but considering their slacks (most of them have 71 working days of slack), they should have already been completed.

TABLE 3: Activities Beyond The Schedule

Activity	Latestfinish	%Complete	Slack
504	15-Dec-1988	30	71 WD
505	27-Dec-1988	0	71 WD
506	29-Dec-1988	0	71 WD
507	12-Jan-1989	0	71 WD
508	24-Jan-1989	0	71 WD
509	26-Jan-1989	0	71 WD
116	12-Jan-1989	80	0 WD
216	19-Jan-1989	20	2 WD
117	24-Jan-1989	0	0 WD
217	31-Jan-1989	0	2 WD
118	29-Jan-1989	0	0 WD

CHAPTER FOUR : SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

4.1. Summary

The purpose of this thesis is to show the practical aspects of the critical path analysis on an actual project in construction industry. Here, the idea is to deal with real situations, rather than dealing with the theoretical aspects.

The problem of application is about a construction project. Aks Insaat Ltd. Sti. signed a contract of constructing concrete structure of seven buildings in Istanbul. They are faced with tight restrictions on time, and to finish the project in the shortest possible time, they decided to use critical path analysis.

CPA is given as a means of solution to the problem because, it characterizes the project in the form of a network of inter- related events that are to be accomplished in a given time, order, and level of resources.

The first step in application is to determine the project activities. There came out to be 157 activities and milestones presented in the project network; when it is applied to the computer, the critical path came out to follow the activities of the first and the seventh buildings (PERT chart is presented in the Appendix A4).

The final step is updating of the project; it is done on 31st of January, 1989. According to the information gathered, the project seemed to be beyond the schedule; totally eleven activities are beyond the schedule, from which three of them are on the critical path.

4.2. Conclusions and recommendations

The results taken from the updated project show that, tight controls on project activities are necessary. This requires a new descipline of procedure selection and application.

The current situation is that, project manager seems to work with traditional techniques, though he said he is willing to apply CPA. While updating the project it became obvious that the use of CPA is just for seeing the activities of a project in a network, that is, they want to clearly define the relationships between the activities. They observe the critical path as a result of the latest finishing events. The elements of the critical path as the means of completing the project on time is ignored. So, they do not really understand the use of CPA clearly.

Referring to the results taken from the updating of the project, the above conclusions are improved. They do not follow the critical path, actually they do not follow any path, rather, they organize the activities according to the best suited allocation of resources. This conclusion is driven from the fact that the foundations of sixth and seventh buildings are not followed by the rest of the activities concerning these buildings (as it is seen in the PERT chart of Appendix A4). The foundations are chosen to be completed earlier because, it would be more efficient to do them with the other buildings' foundations. It sounds reasonable as long as the PERT chart is constructed in that fashion. But due to the resource restraints, such as limited number of timbers, the PERT chart is constructed in a hierarchical order (i.e., when the molds of the first building is removed, timbers are used to built the molds of the second building etc.); but this hierarchical order does not fit with the traditional techniques, which require tight and continuous control and recording of the events.

As a result, it would be recommendable for the project manager to review the allocations to the activities, and concentrate on the activities of the critical path. It would be much more efficient and profitable to apply CPA correctly, and it may be considered as a distinctive advantage in the environment where traditional techniques dominate.

APPENDICES

APPENDIX A1

TASK & MILESTONE LIST 1

Task & Milestone List
31-Jan-1989

Selected by:	Range:
Project name	AKS1
Sorted by:	Ascending/Descending:
Planned start	A

Task name	Description	Planned duration	Planned start	Planned finish	% Complete
Start	Start of the project		3-Sep-1988	3-Sep-1988	
101	1st building starts		3-Sep-1988	3-Sep-1988	
102	1st bld. ,reinforcement erection at mat foundation	4.00 Dys W	3-Sep-1988	6-Sep-1988	100
200	Waiting for 2th building to start	5.00 Dys W	3-Sep-1988	7-Sep-1988	100
300	Waiting for 3th building to start	10.00 Dys W	3-Sep-1988	12-Sep-1988	100
103	1st building foundation concrete	1.00 Dys W	7-Sep-1988	7-Sep-1988	100
201	2nd building starts		7-Sep-1988	7-Sep-1988	
500	Waiting for 5th building to start	8.00 Dys W	8-Sep-1988	15-Sep-1988	100
202	2nd bld. ,reinforcement erection at mat foundation	4.00 Dys W	8-Sep-1988	11-Sep-1988	100
104	1st bld. ,basement floor,reinforecement,concrete	14.00 Dys W	8-Sep-1988	21-Sep-1988	100
400	Waiting for 4th building to start	10.00 Dys W	8-Sep-1988	17-Sep-1988	100
203	2nd building, foundation concrete	1.00 Dys W	12-Sep-1988	12-Sep-1988	100
301	3rd building starts		12-Sep-1988	12-Sep-1988	
302	3rd bld., reinforcement erection at mat foundation	4.00 Dys W	13-Sep-1988	16-Sep-1988	100
204	2nd bld. ,basement floor, reinforcement, concrete	14.00 Dys W	13-Sep-1988	26-Sep-1988	100
501	5th building starts		15-Sep-1988	15-Sep-1988	
502	5th bld.,reinforcement erection at mat foundation	4.00 Dys W	16-Sep-1988	19-Sep-1988	100
303	3rd building, foundation concrete	1.00 Dys W	17-Sep-1988	17-Sep-1988	100
401	4th building starts		17-Sep-1988	17-Sep-1988	
700	Waiting for the 7th building to start	20.00 Dys W	18-Sep-1988	7-Oct-1988	100
402	4th bld., reinforcement erection at mat foundation	4.00 Dys W	18-Sep-1988	21-Sep-1988	100
600	Waiting for the 7th building	95.00 Dys W	18-Sep-1988	22-Dec-1988	100

Task name	Description	Planned duration	Planned start	Planned finish	% Complete
	to start				
304	3rd bld. ,basement floor, reinforcement, concrete	14.00 Dys W	18-Sep-1988	1-Oct-1988	100
503	5th bld. ,foundation concrete	1.00 Dys W	20-Sep-1988	20-Sep-1988	100
504	5th bld. ,basement floor, reinforcement, concrete	14.00 Dys W	21-Sep-1988	4-Oct-1988	30
403	4th bld. ,foundation concrete	1.00 Dys W	22-Sep-1988	22-Sep-1988	100
105	1st bld. ,strength	12.00 Dys W	22-Sep-1988	3-Oct-1988	100
404	4th bld. ,basement floor, reinforcement, concrete	14.00 Dys W	23-Sep-1988	6-Oct-1988	100
205	2nd bld. ,strength	12.00 Dys W	27-Sep-1988	8-Oct-1988	100
305	3rd bld. ,strength	12.00 Dys W	2-Oct-1988	13-Oct-1988	100
106	1st bld. ,basement, mold removing	2.00 Dys W	4-Oct-1988	5-Oct-1988	100
505	5th bld. ,strength	12.00 Dys W	5-Oct-1988	16-Oct-1988	0
107	1st bld. ,1st floor, reinforcement, concrete	14.00 Dys W	6-Oct-1988	19-Oct-1988	100
405	4th bld. ,strength	12.00 Dys W	7-Oct-1988	18-Oct-1988	100
701	7th building starts		7-Oct-1988	7-Oct-1988	
702	7th bld., reinforcement erection at mat foundation	4.00 Dys W	8-Oct-1988	11-Oct-1988	100
206	2nd bld. ,basement, mold removing	2.00 Dys W	9-Oct-1988	10-Oct-1988	100
207	2nd bld. ,1st floor, reinforcement, concrete	14.00 Dys W	11-Oct-1988	24-Oct-1988	100
703	7th bld. ,foundation concrete	1.00 Dys W	12-Oct-1988	12-Oct-1988	100
306	3rd bld. ,basement, mold removing	2.00 Dys W	14-Oct-1988	15-Oct-1988	100
307	3rd bld. ,1st floor, reinforcement, concrete	14.00 Dys W	16-Oct-1988	30-Oct-1988	100
506	5th bld. ,basement, mold removing	2.00 Dys W	17-Oct-1988	18-Oct-1988	0
507	5th bld. ,1st floor, reinforcement, concrete	14.00 Dys W	19-Oct-1988	2-Nov-1988	0
406	4th bld. ,basement, mold removing	2.00 Dys W	19-Oct-1988	20-Oct-1988	100
108	1st bld. ,strength	12.00 Dys W	20-Oct-1988	1-Nov-1988	100
407	4th bld. ,1st floor,	14.00 Dys W	21-Oct-1988	4-Nov-1988	100

Task name	Description	Planned duration	Planned start	Planned finish	% Complete
	reinforcement, concrete				
208	2nd bld. ,strength	12.00 Dys W	25-Oct-1988	6-Nov-1988	100
308	3rd bld. ,strength	12.00 Dys W	31-Oct-1988	11-Nov-1988	100
109	1st bld. ,1st floor, mold removing	2.00 Dys W	2-Nov-1988	3-Nov-1988	100
508	5th bld. ,strength	12.00 Dys W	3-Nov-1988	14-Nov-1988	0
110	1st bld. ,2nd floor, reinforcement, concrete	14.00 Dys W	4-Nov-1988	17-Nov-1988	100
408	4th bld. ,strength	12.00 Dys W	5-Nov-1988	16-Nov-1988	100
209	2nd bld. ,1st floor, mold removing	2.00 Dys W	7-Nov-1988	8-Nov-1988	100
210	2nd bld. ,2nd floor, reinforcement, concrete	14.00 Dys W	9-Nov-1988	22-Nov-1988	100
309	3rd bld. ,1st floor, mold removing	2.00 Dys W	12-Nov-1988	13-Nov-1988	100
310	3rd bld. ,2nd floor, reinforcement, concrete	14.00 Dys W	14-Nov-1988	27-Nov-1988	100
509	5th bld. ,1st floor, mold removing	2.00 Dys W	15-Nov-1988	16-Nov-1988	0
510	5th bld. ,2nd floor, reinforcement, concrete	14.00 Dys W	17-Nov-1988	30-Nov-1988	0
409	4th bld. ,1st floor, mold removing	2.00 Dys W	17-Nov-1988	18-Nov-1988	100
111	1st bld. ,strength	12.00 Dys W	18-Nov-1988	29-Nov-1988	100
410	4th bld. ,2nd floor, reinforcement, concrete	14.00 Dys W	19-Nov-1988	2-Dec-1988	100
211	2nd bld. ,strength	12.00 Dys W	23-Nov-1988	4-Dec-1988	100
311	3rd bld. ,strength	12.00 Dys W	28-Nov-1988	9-Dec-1988	100
112	1st bld. ,2nd floor, mold removing	2.00 Dys W	30-Nov-1988	1-Dec-1988	100
511	5th bld. ,strength	12.00 Dys W	1-Dec-1988	12-Dec-1988	0
120	1st building, basement walls	7.00 Dys W	2-Dec-1988	8-Dec-1988	100
122	1st building, 1st floor walls	7.00 Dys W	2-Dec-1988	8-Dec-1988	100
113	1st bld. ,roof, reinforcement, concrete	14.00 Dys W	2-Dec-1988	15-Dec-1988	100
411	4th bld. ,strength	12.00 Dys W	3-Dec-1988	14-Dec-1988	100
212	2nd bld. ,2nd floor, removing molds	2.00 Dys W	5-Dec-1988	6-Dec-1988	100

Task name	Description	Planned duration	Planned start	Planned finish	% Complete
222	2nd building, 1st floor walls	7.00 Dys W	7-Dec-1988	13-Dec-1988	100
220	2nd building, basement walls	7.00 Dys W	7-Dec-1988	13-Dec-1988	100
213	2nd bld. ,roof, reinforcement, concrete	14.00 Dys W	7-Dec-1988	20-Dec-1988	100
121	1st building, entrance floor walls	7.00 Dys W	9-Dec-1988	15-Dec-1988	100
312	3rd bld. ,2nd floor, mold removing	2.00 Dys W	10-Dec-1988	11-Dec-1988	100
320	3rd building, basement walls	7.00 Dys W	12-Dec-1988	18-Dec-1988	100
322	3rd building, 1st floor walls	7.00 Dys W	12-Dec-1988	18-Dec-1988	100
313	3rd bld. ,roof, reinforcement, concrete	14.00 Dys W	12-Dec-1988	25-Dec-1988	100
512	5th bld. ,2nd floor, mold removing	2.00 Dys W	13-Dec-1988	14-Dec-1988	0
221	2nd building, entrance floor walls	7.00 Dys W	14-Dec-1988	20-Dec-1988	100
513	5th bld. ,roof, reinforcement, concrete	14.00 Dys W	15-Dec-1988	28-Dec-1988	0
412	4th bld. ,2nd floor, mold removing	2.00 Dys W	15-Dec-1988	16-Dec-1988	100
522	5th building, 1st floor walls	7.00 Dys W	15-Dec-1988	21-Dec-1988	0
520	5th building, basement walls	7.00 Dys W	15-Dec-1988	21-Dec-1988	0
114	1st bld. ,strength	12.00 Dys W	16-Dec-1988	27-Dec-1988	100
422	4th building, 1st floor walls	7.00 Dys W	17-Dec-1988	23-Dec-1988	100
413	4th bld. ,roof, reinforcement, concrete	14.00 Dys W	17-Dec-1988	30-Dec-1988	80
420	4th building, basement walls	7.00 Dys W	17-Dec-1988	23-Dec-1988	0
321	3rd building, entarence floor walls	7.00 Dys W	19-Dec-1988	25-Dec-1988	100
214	2nd bld. ,strength	12.00 Dys W	21-Dec-1988	1-Jan-1989	100
521	5th building, entarence floor walls	7.00 Dys W	22-Dec-1988	28-Dec-1988	0
601	6th building starts		22-Dec-1988	22-Dec-1988	
602	6th bld., reinforcement erection at mat foundation	4.00 Dys W	23-Dec-1988	26-Dec-1988	100
421	4th building, entarence floor walls	7.00 Dys W	24-Dec-1988	30-Dec-1988	0
314	3rd bld. ,strength	12.00 Dys W	26-Dec-1988	6-Jan-1989	80
603	6th bld. ,foundation concrete	1.00 Dys W	27-Dec-1988	27-Dec-1988	100

Task name	Description	Planned duration	Planned start	Planned finish	% Complete
115	1st bld. ,roof, mold removing	2.00 Dys W	28-Dec-1988	29-Dec-1988	100
514	5th bld., strength	12.00 Dys W	29-Dec-1988	9-Jan-1989	0
123	1st building, 2nd floor walls	7.00 Dys W	30-Dec-1988	5-Jan-1989	80
116	1st bld., main roof, reinforcement, concrete	14.00 Dys W	30-Dec-1988	12-Jan-1989	80
414	4th bld., strength	12.00 Dys W	31-Dec-1988	11-Jan-1989	0
215	2nd bld., roof, mold removing	2.00 Dys W	2-Jan-1989	3-Jan-1989	100
216	2nd bld., main roof, reinforcement, concrete	14.00 Dys W	4-Jan-1989	17-Jan-1989	20
223	2nd building, 2nd floor walls	7.00 Dys W	4-Jan-1989	10-Jan-1989	20
315	3rd bld., roof, mold removing	2.00 Dys W	7-Jan-1989	8-Jan-1989	0
316	3rd bld., main roof, reinforcement, concrete	14.00 Dys W	9-Jan-1989	22-Jan-1989	0
323	3rd building, 2nd floor walls	7.00 Dys W	9-Jan-1989	15-Jan-1989	0
515	5th bld., roof, mold removing	2.00 Dys W	10-Jan-1989	11-Jan-1989	0
523	5th building, 2nd floor walls	7.00 Dys W	12-Jan-1989	18-Jan-1989	0
415	4th bld., roof, mold removing	2.00 Dys W	12-Jan-1989	13-Jan-1989	0
516	5th bld., main roof, reinforcement, concrete	14.00 Dys W	12-Jan-1989	25-Jan-1989	0
117	1st bld., strength	12.00 Dys W	13-Jan-1989	24-Jan-1989	0
416	4th bld., main roof, reinforcement, concrete	14.00 Dys W	14-Jan-1989	27-Jan-1989	0
423	4th building, 2nd floor walls	7.00 Dys W	14-Jan-1989	20-Jan-1989	0
217	2nd bld., strength	12.00 Dys W	18-Jan-1989	29-Jan-1989	0
317	3rd bld., strength	12.00 Dys W	23-Jan-1989	3-Feb-1989	0
118	1st bld., main roof, mold removing	2.00 Dys W	25-Jan-1989	26-Jan-1989	0
517	5th bld., strength	12.00 Dys W	26-Jan-1989	6-Feb-1989	0
124	1st building, roof walls	7.00 Dys W	27-Jan-1989	2-Feb-1989	0
704	7th bld., basement floor, reinforcement, concrete	14.00 Dys W	27-Jan-1989	9-Feb-1989	20
417	4th bld., strength	12.00 Dys W	28-Jan-1989	8-Feb-1989	0
218	2nd bld., main roof, mold removing	2.00 Dys W	30-Jan-1989	31-Jan-1989	0
604	6th bld., basement floor, reinforcement, concrete	14.00 Dys W	1-Feb-1989	14-Feb-1989	0
224	2nd building, roof walls	7.00 Dys W	1-Feb-1989	7-Feb-1989	0
101 END	1st building ends		2-Feb-1989	2-Feb-1989	
318	3rd bld., main roof, mold removing	2.00 Dys W	4-Feb-1989	5-Feb-1989	0
324	3rd building, roof walls	7.00 Dys W	6-Feb-1989	12-Feb-1989	0
518	5th bld., main roof, mold	2.00 Dys W	7-Feb-1989	8-Feb-1989	0

Task name	Description	Planned duration	Planned start	Planned finish	% Complete
	removing				
201 END	2nd building ends		7-Feb-1989	7-Feb-1989	
524	5th building, roof walls	7.00 Dys W	9-Feb-1989	15-Feb-1989	0
418	4th bld., main roof, mold removing	2.00 Dys W	9-Feb-1989	10-Feb-1989	0
707	7th bld., 1st floor, reinforcement, concrete	14.00 Dys W	10-Feb-1989	23-Feb-1989	0
424	4th building, roof walls	7.00 Dys W	11-Feb-1989	17-Feb-1989	0
301 END	3rd building ends		12-Feb-1989	12-Feb-1989	
607	6th bld., 1st floor, reinforcement, concrete	14.00 Dys W	15-Feb-1989	28-Feb-1989	0
501 END	5th building ends		15-Feb-1989	15-Feb-1989	
401 END	4th building ends		17-Feb-1989	17-Feb-1989	
710	7th bld., 2nd floor, reinforcement, concrete	14.00 Dys W	24-Feb-1989	9-Mar-1989	0
610	6th bld., 2nd floor, reinforcement, concrete	14.00 Dys W	1-Mar-1989	14-Mar-1989	0
713	7th bld., 3rd floor, reinforcement, concrete	14.00 Dys W	10-Mar-1989	23-Mar-1989	0
613	6th bld., roof, reinforcement, concrete	14.00 Dys W	15-Mar-1989	28-Mar-1989	0
720	7th building, basement walls	7.00 Dys W	24-Mar-1989	30-Mar-1989	0
716	7th bld., roof, reinforcement, concrete	14.00 Dys W	24-Mar-1989	6-Apr-1989	0
616	6th bld., main roof, reinforcement, concrete	14.00 Dys W	29-Mar-1989	11-Apr-1989	0
721	7th building, entarence floor walls	7.00 Dys W	31-Mar-1989	6-Apr-1989	0
717	7th bld., main roof, reinforcement, concrete	14.00 Dys W	7-Apr-1989	20-Apr-1989	0
722	7th building, 1st floor walls	7.00 Dys W	7-Apr-1989	13-Apr-1989	0
620	6th building, basement walls	7.00 Dys W	12-Apr-1989	18-Apr-1989	0
624	6th building, roof walls	7.00 Dys W	12-Apr-1989	18-Apr-1989	0
622	6th building, 1st floor walls	7.00 Dys W	12-Apr-1989	18-Apr-1989	0
723	7th building, 2nd floor walls	7.00 Dys W	14-Apr-1989	20-Apr-1989	0
623	6th building, 2nd floor walls	7.00 Dys W	19-Apr-1989	25-Apr-1989	0
621	6th building, entarence floor walls	7.00 Dys W	19-Apr-1989	25-Apr-1989	0
724	7th building, 3rd floor walls	7.00 Dys W	21-Apr-1989	27-Apr-1989	0

Task name	Description	Planned duration	Planned start	Planned finish	% Complete
725	7th building, roof walls	7.00 Dys W	21-Apr-1989	27-Apr-1989	0
601 END	6th building ends		25-Apr-1989	25-Apr-1989	
701 END	7th building ends		27-Apr-1989	27-Apr-1989	
End	Project ends		27-Apr-1989	27-Apr-1989	

APPENDIX A2

TASK & MILESTONE LIST 2

Task & Milestone List
31-Jan-1989

Selected by:	Range:
Project name	AKS1
Sorted by:	Ascending/Descending:
Planned start	A

Task name	Earliest start	Earliest finish	Latest start	Latest finish	% Complete	Slack
Start	3-Sep-1988	3-Sep-1988	3-Sep-1988	3-Sep-1988		0.00 Dys W
101	3-Sep-1988	3-Sep-1988	3-Sep-1988	3-Sep-1988		0.00 Dys W
102	3-Sep-1988	6-Sep-1988	3-Sep-1988	6-Sep-1988	100	0.00 Dys W
200	3-Sep-1988	7-Sep-1988	5-Sep-1988	9-Sep-1988	100	2.00 Dys W
300	3-Sep-1988	12-Sep-1988	17-Nov-1988	26-Nov-1988	100	74.00 Dys W
103	7-Sep-1988	7-Sep-1988	7-Sep-1988	7-Sep-1988	100	0.00 Dys W
201	7-Sep-1988	7-Sep-1988	10-Sep-1988	10-Sep-1988		2.00 Dys W
500	8-Sep-1988	15-Sep-1988	19-Nov-1988	26-Nov-1988	100	71.00 Dys W
202	8-Sep-1988	11-Sep-1988	10-Sep-1988	13-Sep-1988	100	2.00 Dys W
104	8-Sep-1988	21-Sep-1988	8-Sep-1988	21-Sep-1988	100	0.00 Dys W
400	8-Sep-1988	17-Sep-1988	17-Nov-1988	26-Nov-1988	100	69.00 Dys W
203	12-Sep-1988	12-Sep-1988	14-Sep-1988	14-Sep-1988	100	2.00 Dys W
301	12-Sep-1988	12-Sep-1988	27-Nov-1988	27-Nov-1988		74.00 Dys W
302	13-Sep-1988	16-Sep-1988	27-Nov-1988	30-Nov-1988	100	74.00 Dys W
204	13-Sep-1988	26-Sep-1988	15-Sep-1988	28-Sep-1988	100	2.00 Dys W
501	15-Sep-1988	15-Sep-1988	27-Nov-1988	27-Nov-1988		71.00 Dys W
502	16-Sep-1988	19-Sep-1988	27-Nov-1988	30-Nov-1988	100	71.00 Dys W
303	17-Sep-1988	17-Sep-1988	1-Dec-1988	1-Dec-1988	100	74.00 Dys W
401	17-Sep-1988	17-Sep-1988	27-Nov-1988	27-Nov-1988		69.00 Dys W
700	18-Sep-1988	7-Oct-1988	3-Apr-1989	22-Apr-1989	100	196.00 Dys W
402	18-Sep-1988	21-Sep-1988	27-Nov-1988	30-Nov-1988	100	69.00 Dys W
600	18-Sep-1988	22-Dec-1988	18-Jan-1989	22-Apr-1989	100	121.00 Dys W
304	18-Sep-1988	1-Oct-1988	2-Dec-1988	15-Dec-1988	100	74.00 Dys W
503	20-Sep-1988	20-Sep-1988	1-Dec-1988	1-Dec-1988	100	71.00 Dys W
504	21-Sep-1988	4-Oct-1988	2-Dec-1988	15-Dec-1988	30	71.00 Dys W
403	22-Sep-1988	22-Sep-1988	1-Dec-1988	1-Dec-1988	100	69.00 Dys W
105	22-Sep-1988	3-Oct-1988	22-Sep-1988	3-Oct-1988	100	0.00 Dys W
404	23-Sep-1988	6-Oct-1988	2-Dec-1988	15-Dec-1988	100	69.00 Dys W
205	27-Sep-1988	8-Oct-1988	29-Sep-1988	10-Oct-1988	100	2.00 Dys W
305	2-Oct-1988	13-Oct-1988	16-Dec-1988	27-Dec-1988	100	74.00 Dys W
106	4-Oct-1988	5-Oct-1988	4-Oct-1988	5-Oct-1988	100	0.00 Dys W
505	5-Oct-1988	16-Oct-1988	16-Dec-1988	27-Dec-1988	0	71.00 Dys W
107	6-Oct-1988	19-Oct-1988	6-Oct-1988	19-Oct-1988	100	0.00 Dys W
405	7-Oct-1988	18-Oct-1988	16-Dec-1988	27-Dec-1988	100	69.00 Dys W
701	7-Oct-1988	7-Oct-1988	23-Apr-1989	23-Apr-1989		196.00 Dys W
702	8-Oct-1988	11-Oct-1988	23-Apr-1989	26-Apr-1989	100	196.00 Dys W
206	9-Oct-1988	10-Oct-1988	11-Oct-1988	12-Oct-1988	100	2.00 Dys W
207	11-Oct-1988	24-Oct-1988	13-Oct-1988	26-Oct-1988	100	2.00 Dys W
703	12-Oct-1988	12-Oct-1988	27-Apr-1989	27-Apr-1989	100	196.00 Dys W
306	14-Oct-1988	15-Oct-1988	28-Dec-1988	29-Dec-1988	100	74.00 Dys W
307	16-Oct-1988	30-Oct-1988	30-Dec-1988	12-Jan-1989	100	74.00 Dys W
506	17-Oct-1988	18-Oct-1988	28-Dec-1988	29-Dec-1988	0	71.00 Dys W
507	19-Oct-1988	2-Nov-1988	30-Dec-1988	12-Jan-1989	0	71.00 Dys W
406	19-Oct-1988	20-Oct-1988	28-Dec-1988	29-Dec-1988	100	69.00 Dys W
108	20-Oct-1988	1-Nov-1988	20-Oct-1988	1-Nov-1988	100	0.00 Dys W
407	21-Oct-1988	4-Nov-1988	30-Dec-1988	12-Jan-1989	100	69.00 Dys W
208	25-Oct-1988	6-Nov-1988	27-Oct-1988	8-Nov-1988	100	2.00 Dys W
308	31-Oct-1988	11-Nov-1988	13-Jan-1989	24-Jan-1989	100	74.00 Dys W
109	2-Nov-1988	3-Nov-1988	2-Nov-1988	3-Nov-1988	100	0.00 Dys W
508	3-Nov-1988	14-Nov-1988	13-Jan-1989	24-Jan-1989	0	71.00 Dys W
110	4-Nov-1988	17-Nov-1988	4-Nov-1988	17-Nov-1988	100	0.00 Dys W
408	5-Nov-1988	16-Nov-1988	13-Jan-1989	24-Jan-1989	100	69.00 Dys W

Task name	Earliest start	Earliest finish	Latest start	Latest finish	% Complete	Slack
209	7-Nov-1988	8-Nov-1988	9-Nov-1988	10-Nov-1988	100	2.00 Dys W
210	9-Nov-1988	22-Nov-1988	11-Nov-1988	24-Nov-1988	100	2.00 Dys W
309	12-Nov-1988	13-Nov-1988	25-Jan-1989	26-Jan-1989	100	74.00 Dys W
310	14-Nov-1988	27-Nov-1988	27-Jan-1989	9-Feb-1989	100	74.00 Dys W
509	15-Nov-1988	16-Nov-1988	25-Jan-1989	26-Jan-1989	0	71.00 Dys W
510	17-Nov-1988	30-Nov-1988	27-Jan-1989	9-Feb-1989	0	71.00 Dys W
409	17-Nov-1988	18-Nov-1988	25-Jan-1989	26-Jan-1989	100	69.00 Dys W
111	18-Nov-1988	29-Nov-1988	18-Nov-1988	29-Nov-1988	100	0.00 Dys W
410	19-Nov-1988	2-Dec-1988	27-Jan-1989	9-Feb-1989	100	69.00 Dys W
211	23-Nov-1988	4-Dec-1988	25-Nov-1988	6-Dec-1988	100	2.00 Dys W
311	28-Nov-1988	9-Dec-1988	10-Feb-1989	21-Feb-1989	100	74.00 Dys W
112	30-Nov-1988	1-Dec-1988	30-Nov-1988	1-Dec-1988	100	0.00 Dys W
511	1-Dec-1988	12-Dec-1988	10-Feb-1989	21-Feb-1989	0	71.00 Dys W
120	2-Dec-1988	8-Dec-1988	14-Apr-1989	20-Apr-1989	100	133.00 Dys W
122	2-Dec-1988	8-Dec-1988	21-Apr-1989	27-Apr-1989	100	140.00 Dys W
113	2-Dec-1988	15-Dec-1988	2-Dec-1988	15-Dec-1988	100	0.00 Dys W
411	3-Dec-1988	14-Dec-1988	10-Feb-1989	21-Feb-1989	100	69.00 Dys W
212	5-Dec-1988	6-Dec-1988	7-Dec-1988	8-Dec-1988	100	2.00 Dys W
222	7-Dec-1988	13-Dec-1988	21-Apr-1989	27-Apr-1989	100	135.00 Dys W
220	7-Dec-1988	13-Dec-1988	14-Apr-1989	20-Apr-1989	100	128.00 Dys W
213	7-Dec-1988	20-Dec-1988	9-Dec-1988	22-Dec-1988	100	2.00 Dys W
121	9-Dec-1988	15-Dec-1988	21-Apr-1989	27-Apr-1989	100	133.00 Dys W
312	10-Dec-1988	11-Dec-1988	22-Feb-1989	23-Feb-1989	100	74.00 Dys W
320	12-Dec-1988	18-Dec-1988	14-Apr-1989	20-Apr-1989	100	123.00 Dys W
322	12-Dec-1988	18-Dec-1988	21-Apr-1989	27-Apr-1989	100	130.00 Dys W
313	12-Dec-1988	25-Dec-1988	24-Feb-1989	9-Mar-1989	100	74.00 Dys W
512	13-Dec-1988	14-Dec-1988	22-Feb-1989	23-Feb-1989	0	71.00 Dys W
221	14-Dec-1988	20-Dec-1988	21-Apr-1989	27-Apr-1989	100	128.00 Dys W
513	15-Dec-1988	28-Dec-1988	24-Feb-1989	9-Mar-1989	0	71.00 Dys W
412	15-Dec-1988	16-Dec-1988	22-Feb-1989	23-Feb-1989	100	69.00 Dys W
522	15-Dec-1988	21-Dec-1988	21-Apr-1989	27-Apr-1989	0	127.00 Dys W
520	15-Dec-1988	21-Dec-1988	14-Apr-1989	20-Apr-1989	0	120.00 Dys W
114	16-Dec-1988	27-Dec-1988	16-Dec-1988	27-Dec-1988	100	0.00 Dys W
422	17-Dec-1988	23-Dec-1988	21-Apr-1989	27-Apr-1989	100	125.00 Dys W
413	17-Dec-1988	30-Dec-1988	24-Feb-1989	9-Mar-1989	80	69.00 Dys W
420	17-Dec-1988	23-Dec-1988	14-Apr-1989	20-Apr-1989	0	118.00 Dys W
321	19-Dec-1988	25-Dec-1988	21-Apr-1989	27-Apr-1989	100	123.00 Dys W
214	21-Dec-1988	1-Jan-1989	23-Dec-1988	3-Jan-1989	100	2.00 Dys W
521	22-Dec-1988	28-Dec-1988	21-Apr-1989	27-Apr-1989	0	120.00 Dys W
601	22-Dec-1988	22-Dec-1988	23-Apr-1989	23-Apr-1989		121.00 Dys W
602	23-Dec-1988	26-Dec-1988	23-Apr-1989	26-Apr-1989	100	121.00 Dys W
421	24-Dec-1988	30-Dec-1988	21-Apr-1989	27-Apr-1989	0	118.00 Dys W
314	26-Dec-1988	6-Jan-1989	10-Mar-1989	21-Mar-1989	80	74.00 Dys W
603	27-Dec-1988	27-Dec-1988	27-Apr-1989	27-Apr-1989	100	121.00 Dys W
115	28-Dec-1988	29-Dec-1988	28-Dec-1988	29-Dec-1988	100	0.00 Dys W
514	29-Dec-1988	9-Jan-1989	10-Mar-1989	21-Mar-1989	0	71.00 Dys W
123	30-Dec-1988	5-Jan-1989	21-Apr-1989	27-Apr-1989	80	112.00 Dys W
116	30-Dec-1988	12-Jan-1989	30-Dec-1988	12-Jan-1989	80	0.00 Dys W
414	31-Dec-1988	11-Jan-1989	10-Mar-1989	21-Mar-1989	0	69.00 Dys W
215	2-Jan-1989	3-Jan-1989	4-Jan-1989	5-Jan-1989	100	2.00 Dys W
216	4-Jan-1989	17-Jan-1989	6-Jan-1989	19-Jan-1989	20	2.00 Dys W
223	4-Jan-1989	10-Jan-1989	21-Apr-1989	27-Apr-1989	20	107.00 Dys W

Task name	Earliest start	Earliest finish	Latest start	Latest finish	% Complete	Slack
315	7-Jan-1989	8-Jan-1989	22-Mar-1989	23-Mar-1989	0	74.00 Dys W
316	9-Jan-1989	22-Jan-1989	24-Mar-1989	6-Apr-1989	0	74.00 Dys W
323	9-Jan-1989	15-Jan-1989	21-Apr-1989	27-Apr-1989	0	102.00 Dys W
515	10-Jan-1989	11-Jan-1989	22-Mar-1989	23-Mar-1989	0	71.00 Dys W
523	12-Jan-1989	18-Jan-1989	21-Apr-1989	27-Apr-1989	0	99.00 Dys W
415	12-Jan-1989	13-Jan-1989	22-Mar-1989	23-Mar-1989	0	69.00 Dys W
516	12-Jan-1989	25-Jan-1989	24-Mar-1989	6-Apr-1989	0	71.00 Dys W
117	13-Jan-1989	24-Jan-1989	13-Jan-1989	24-Jan-1989	0	0.00 Dys W
416	14-Jan-1989	27-Jan-1989	24-Mar-1989	6-Apr-1989	0	69.00 Dys W
423	14-Jan-1989	20-Jan-1989	21-Apr-1989	27-Apr-1989	0	97.00 Dys W
217	18-Jan-1989	29-Jan-1989	20-Jan-1989	31-Jan-1989	0	2.00 Dys W
317	23-Jan-1989	3-Feb-1989	7-Apr-1989	18-Apr-1989	0	74.00 Dys W
118	25-Jan-1989	26-Jan-1989	25-Jan-1989	26-Jan-1989	0	0.00 Dys W
517	26-Jan-1989	6-Feb-1989	7-Apr-1989	18-Apr-1989	0	71.00 Dys W
124	27-Jan-1989	2-Feb-1989	21-Apr-1989	27-Apr-1989	0	84.00 Dys W
704	27-Jan-1989	9-Feb-1989	27-Jan-1989	9-Feb-1989	20	0.00 Dys W
417	28-Jan-1989	8-Feb-1989	7-Apr-1989	18-Apr-1989	0	69.00 Dys W
218	30-Jan-1989	31-Jan-1989	1-Feb-1989	2-Feb-1989	0	2.00 Dys W
604	1-Feb-1989	14-Feb-1989	3-Feb-1989	16-Feb-1989	0	2.00 Dys W
224	1-Feb-1989	7-Feb-1989	21-Apr-1989	27-Apr-1989	0	79.00 Dys W
101 END	2-Feb-1989	2-Feb-1989	27-Apr-1989	27-Apr-1989		84.00 Dys W
318	4-Feb-1989	5-Feb-1989	19-Apr-1989	20-Apr-1989	0	74.00 Dys W
324	6-Feb-1989	12-Feb-1989	21-Apr-1989	27-Apr-1989	0	74.00 Dys W
518	7-Feb-1989	8-Feb-1989	19-Apr-1989	20-Apr-1989	0	71.00 Dys W
201 END	7-Feb-1989	7-Feb-1989	27-Apr-1989	27-Apr-1989		79.00 Dys W
524	9-Feb-1989	15-Feb-1989	21-Apr-1989	27-Apr-1989	0	71.00 Dys W
418	9-Feb-1989	10-Feb-1989	19-Apr-1989	20-Apr-1989	0	69.00 Dys W
707	10-Feb-1989	23-Feb-1989	10-Feb-1989	23-Feb-1989	0	0.00 Dys W
424	11-Feb-1989	17-Feb-1989	21-Apr-1989	27-Apr-1989	0	69.00 Dys W
301 END	12-Feb-1989	12-Feb-1989	27-Apr-1989	27-Apr-1989		74.00 Dys W
607	15-Feb-1989	28-Feb-1989	17-Feb-1989	2-Mar-1989	0	2.00 Dys W
501 END	15-Feb-1989	15-Feb-1989	27-Apr-1989	27-Apr-1989		71.00 Dys W
401 END	17-Feb-1989	17-Feb-1989	27-Apr-1989	27-Apr-1989		69.00 Dys W
710	24-Feb-1989	9-Mar-1989	24-Feb-1989	9-Mar-1989	0	0.00 Dys W
610	1-Mar-1989	14-Mar-1989	3-Mar-1989	16-Mar-1989	0	2.00 Dys W
713	10-Mar-1989	23-Mar-1989	10-Mar-1989	23-Mar-1989	0	0.00 Dys W
613	15-Mar-1989	28-Mar-1989	17-Mar-1989	30-Mar-1989	0	2.00 Dys W
720	24-Mar-1989	30-Mar-1989	14-Apr-1989	20-Apr-1989	0	21.00 Dys W
716	24-Mar-1989	6-Apr-1989	24-Mar-1989	6-Apr-1989	0	0.00 Dys W
616	29-Mar-1989	11-Apr-1989	31-Mar-1989	13-Apr-1989	0	2.00 Dys W
721	31-Mar-1989	6-Apr-1989	21-Apr-1989	27-Apr-1989	0	21.00 Dys W
717	7-Apr-1989	20-Apr-1989	7-Apr-1989	20-Apr-1989	0	0.00 Dys W
722	7-Apr-1989	13-Apr-1989	14-Apr-1989	20-Apr-1989	0	7.00 Dys W
620	12-Apr-1989	18-Apr-1989	14-Apr-1989	20-Apr-1989	0	2.00 Dys W
624	12-Apr-1989	18-Apr-1989	21-Apr-1989	27-Apr-1989	0	9.00 Dys W
622	12-Apr-1989	18-Apr-1989	14-Apr-1989	20-Apr-1989	0	2.00 Dys W
723	14-Apr-1989	20-Apr-1989	21-Apr-1989	27-Apr-1989	0	7.00 Dys W
623	19-Apr-1989	25-Apr-1989	21-Apr-1989	27-Apr-1989	0	2.00 Dys W
621	19-Apr-1989	25-Apr-1989	21-Apr-1989	27-Apr-1989	0	2.00 Dys W
724	21-Apr-1989	27-Apr-1989	21-Apr-1989	27-Apr-1989	0	0.00 Dys W
725	21-Apr-1989	27-Apr-1989	21-Apr-1989	27-Apr-1989	0	0.00 Dys W
601 END	25-Apr-1989	25-Apr-1989	27-Apr-1989	27-Apr-1989		2.00 Dys W

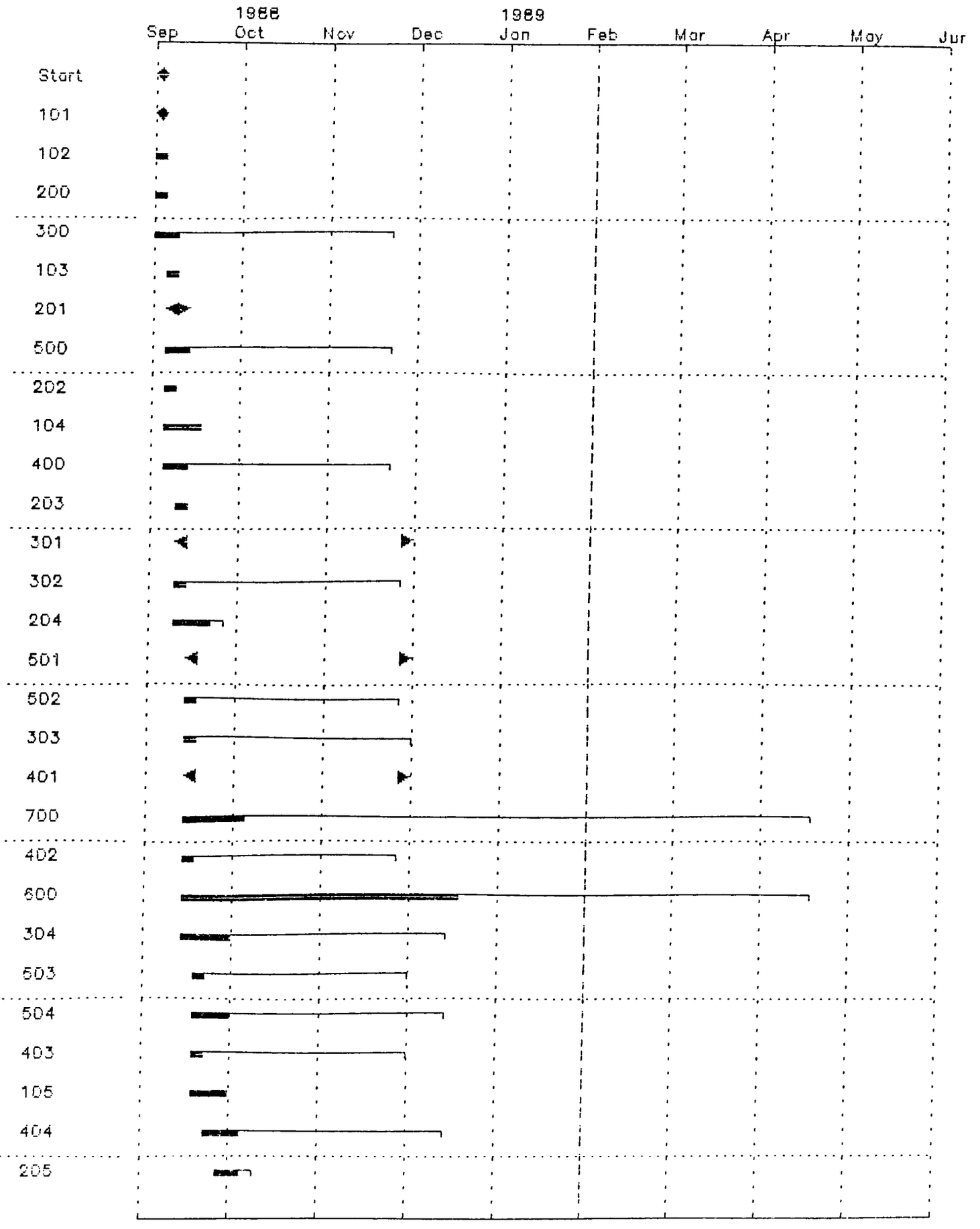
Task name	Earliest start	Earliest finish	Latest start	Latest finish	% Complete	Slack
701 END	27-Apr-1989	27-Apr-1989	27-Apr-1989	27-Apr-1989		0.00 Dys W
End	27-Apr-1989	27-Apr-1989	27-Apr-1989	27-Apr-1989		0.00 Dys W

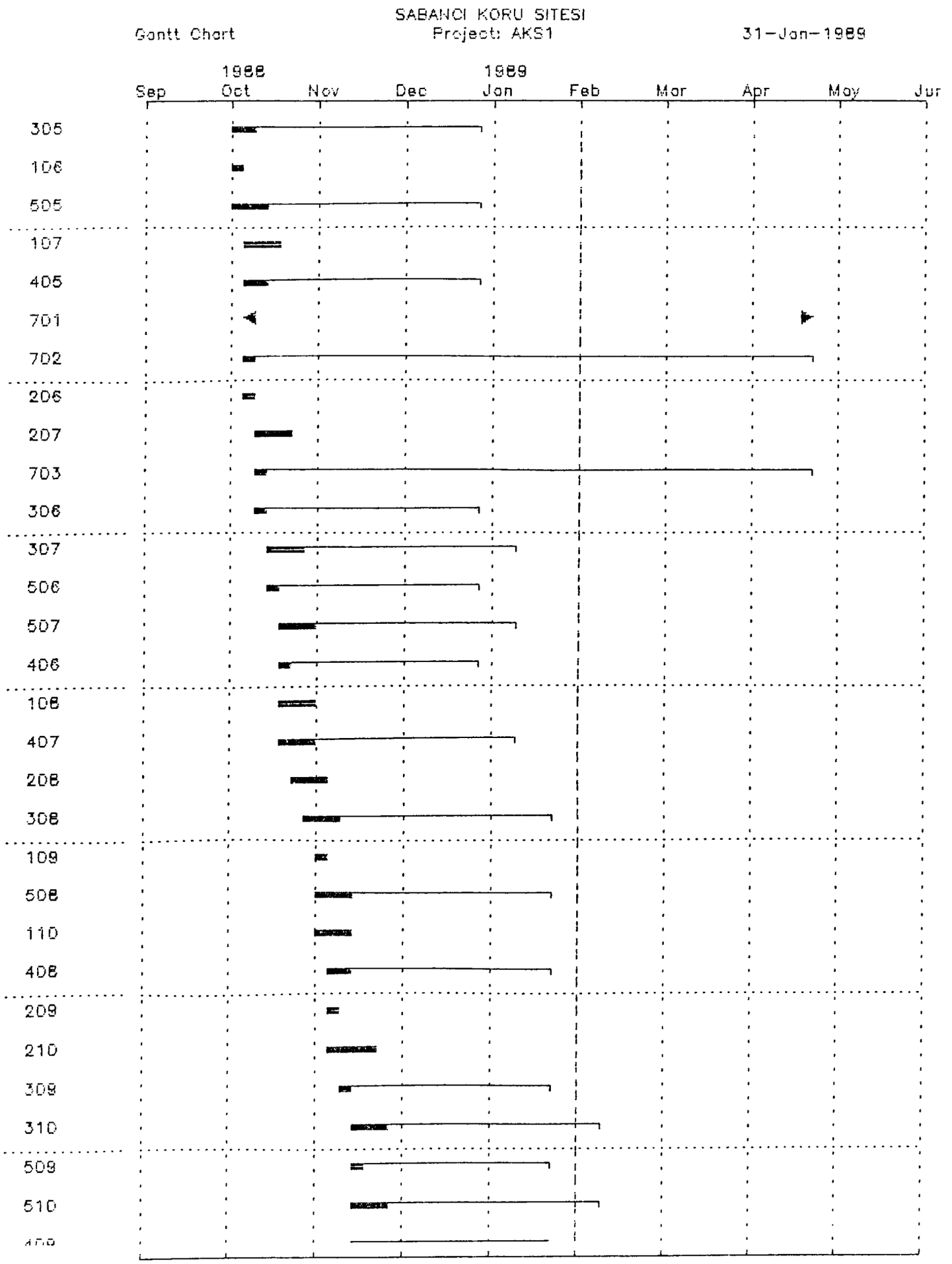
APPENDIX A3

GANTT CHART

SABANCI KORU SITESI

Gantt Chart — Project: AKS1 — 31-Jan-1989




SABANCI KORU SITESI
Gantt Chart
Project: AKS1
31-Jan-1989
1988
1989
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
305
106
505
107
405
701
702
206
207
703
306
307
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108
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308
109
508
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408
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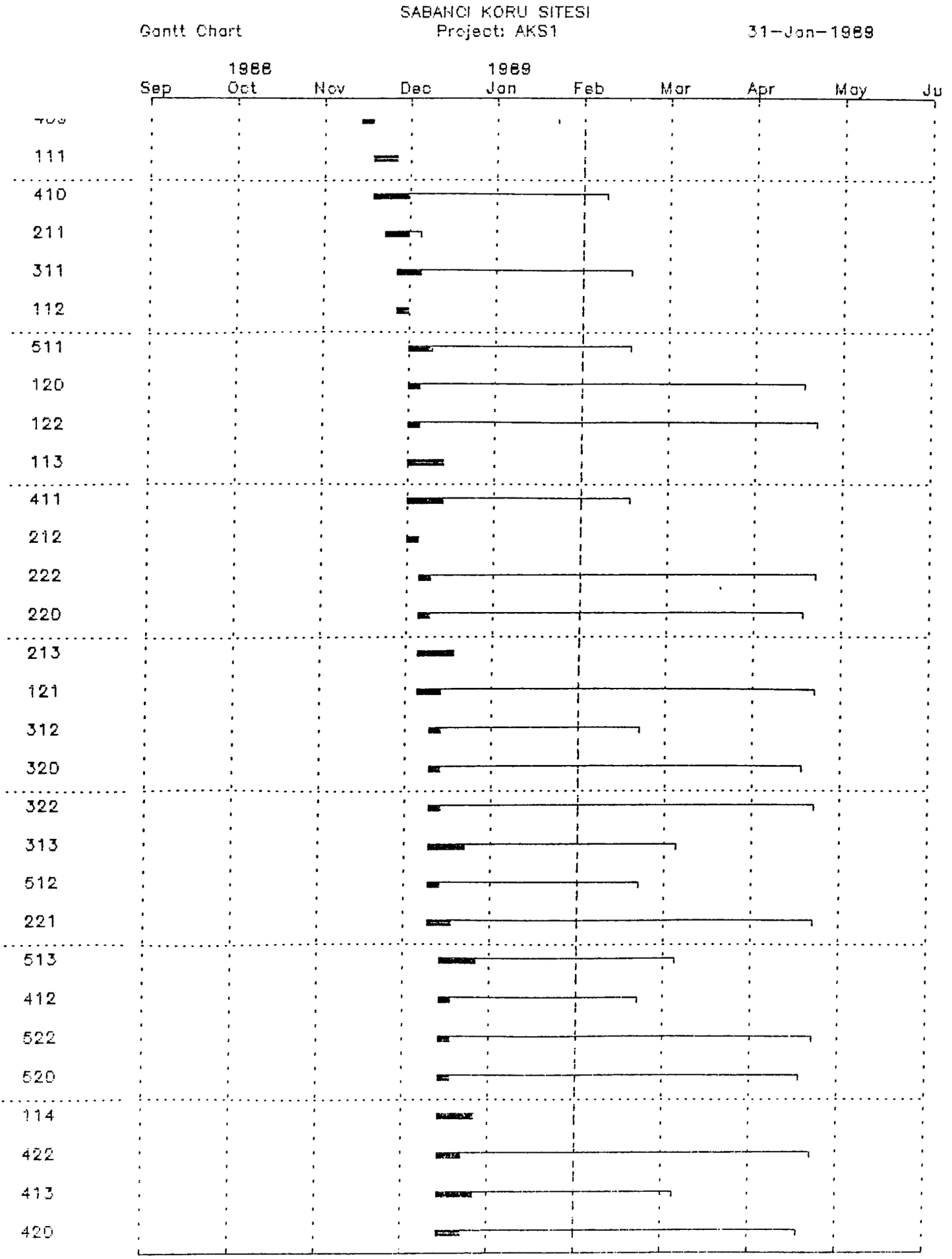
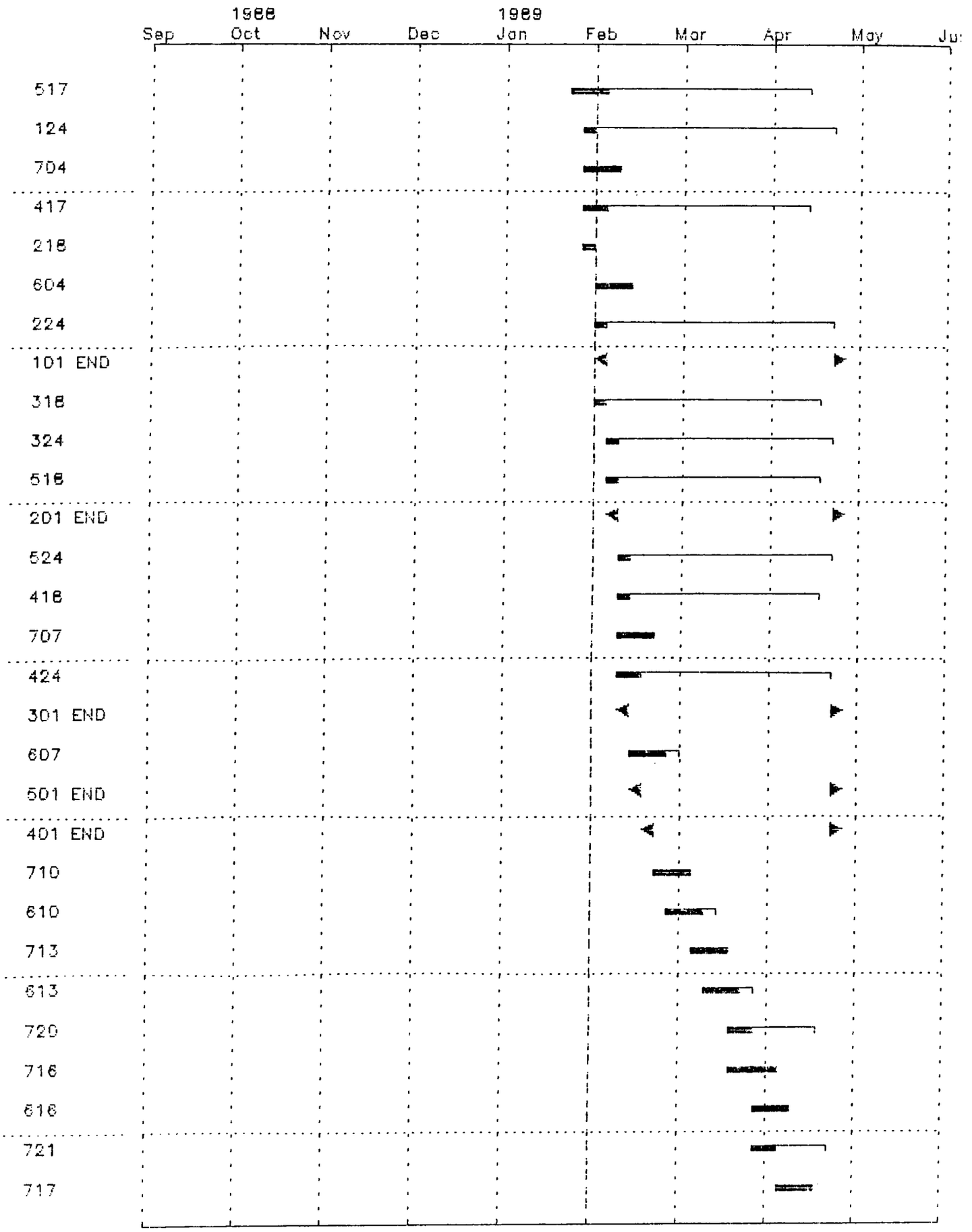
210
309
310
509
510


SABANCI KORU SITESI
Gantt Chart
Project: AKS1
31-Jan-1989
1988
1989
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Ju
111
410
211
311
112
511
120
122
113
411
212
222
220
213
121
312
320
322
313
512
221
513
412
522
520
114
422
413
420

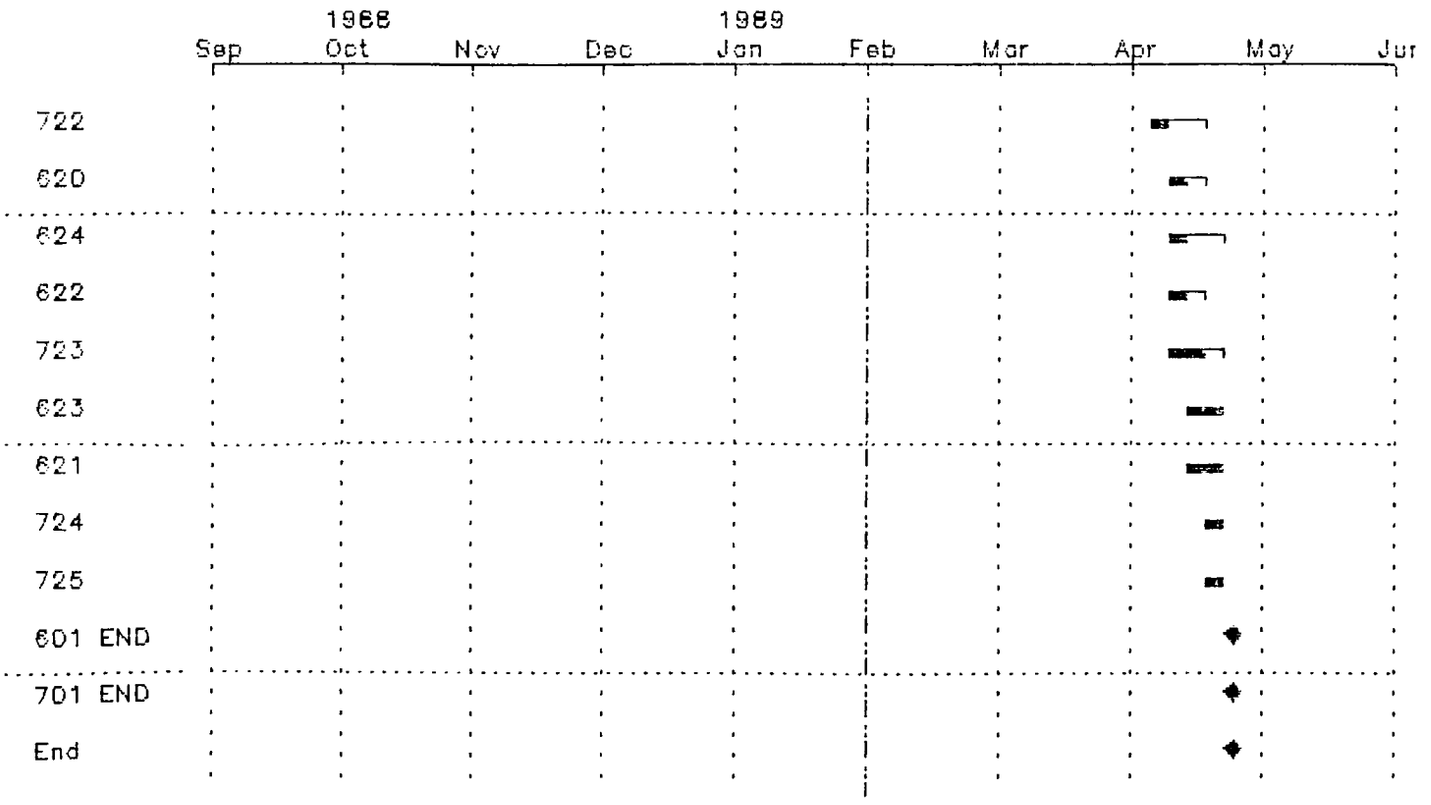
SABANCI KORU SITESI

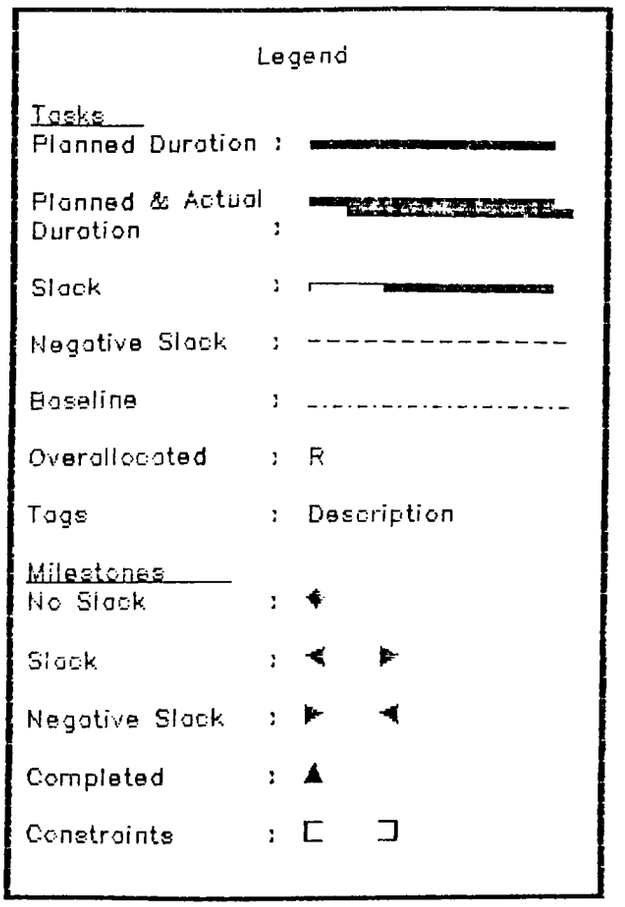
Gantt Chart — Project: AKS1 — 31-Jan-1989



SABANCI KORU SITESI

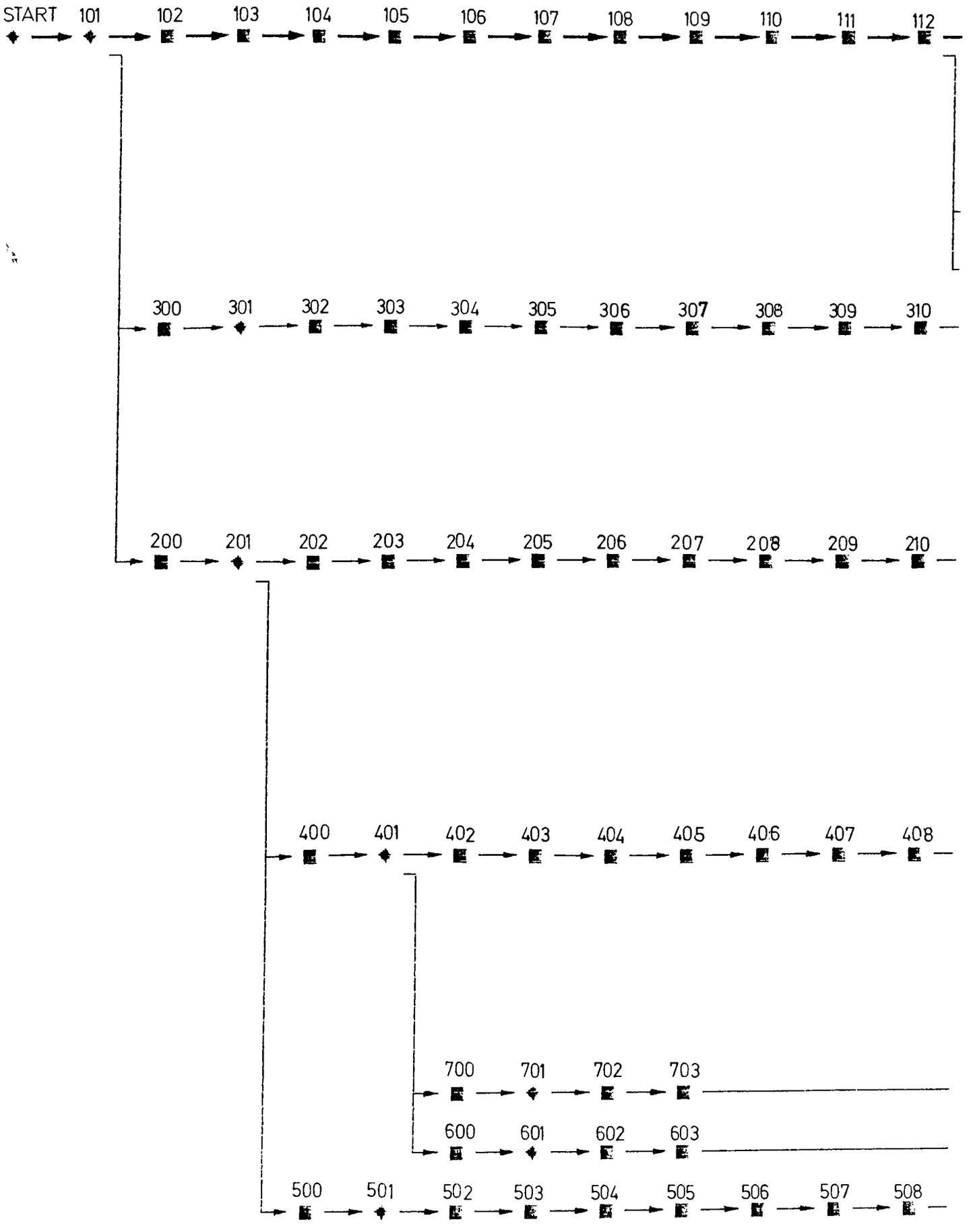
Gantt Chart — Project: AKS1 — 31-Jan-1989




Legend
Tasks
Planned Duration :
Planned & Actual Duration :
Slack :
Negative Slack :
Baseline :
Overallocated : R
Tags : Description
Milestones
No Slack :
Slack :
Negative Slack :
Completed :
Constraints :

APPENDIX A4

PERT CHART


START
101
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112
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306
307
308
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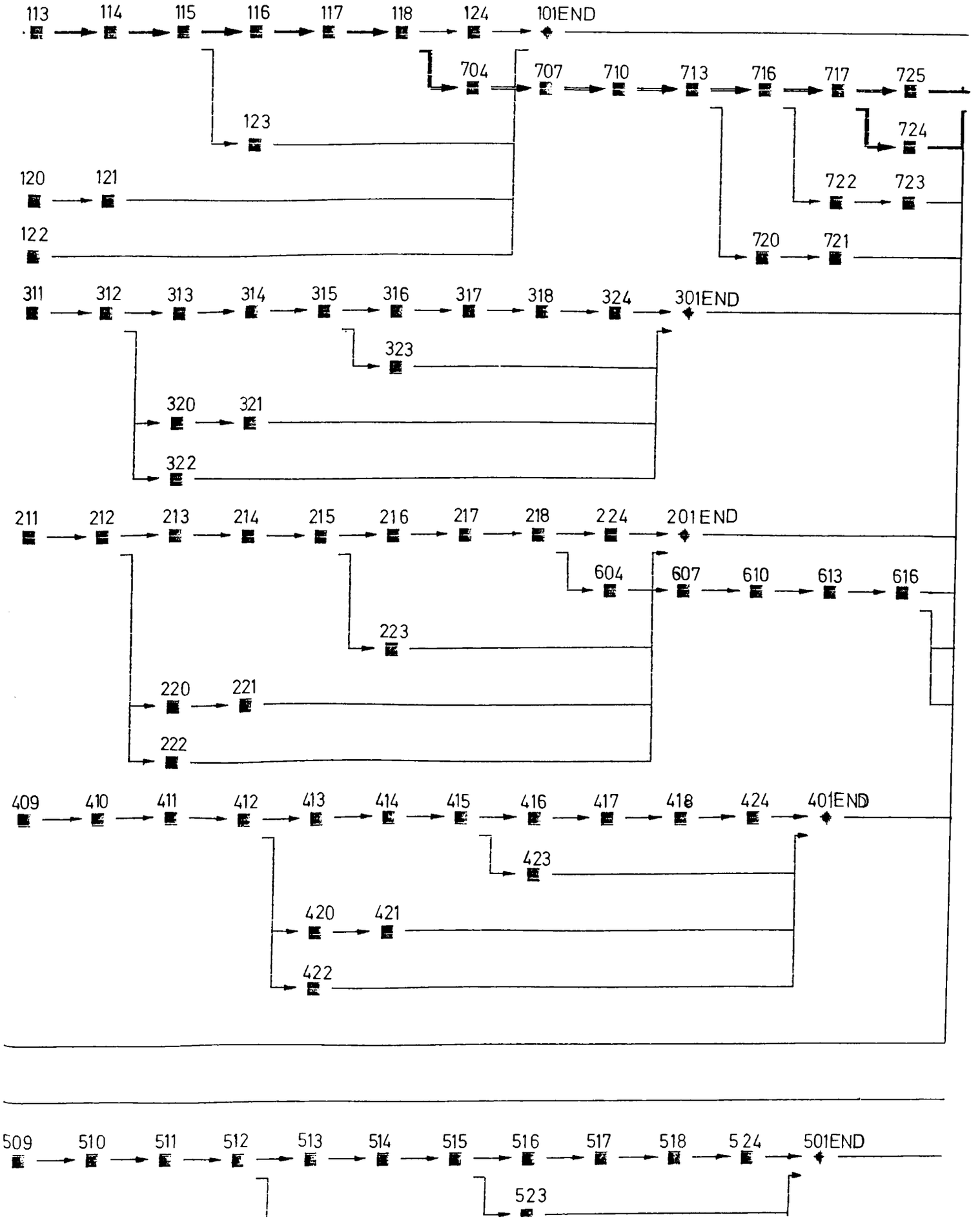
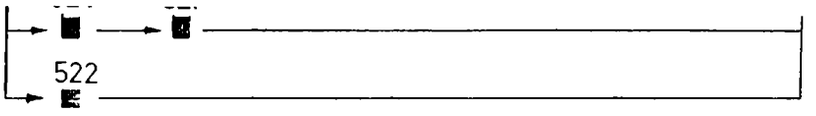
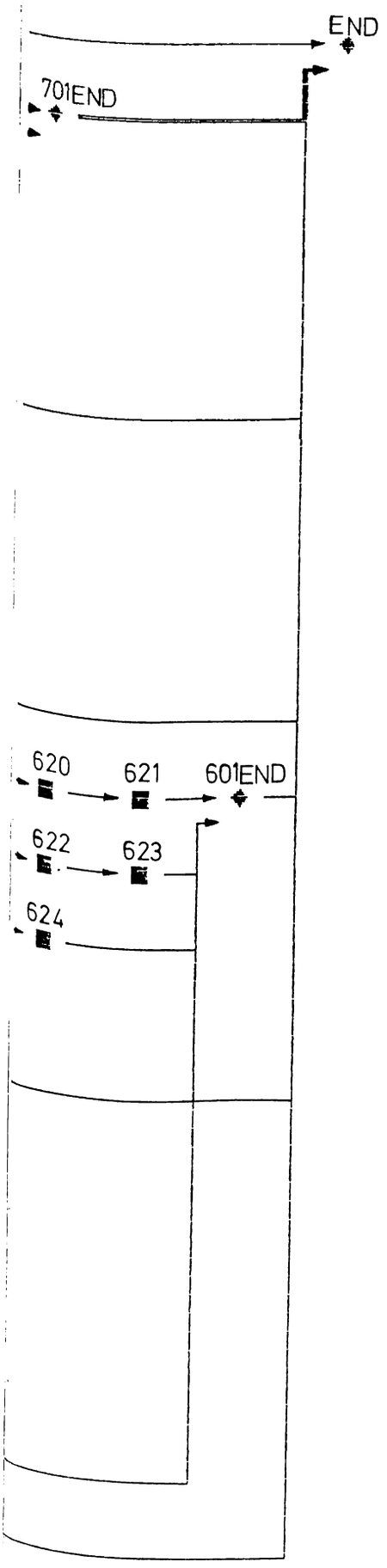
SABANCI KORU SITESI
Chart Project: AKS1 31-Jan-1989





BULENT REHA KARAGOZ



Legend

Task :

Milestone :

Critical Path :

Slack Path :

APPENDIX A5

HTPM Software

HTPM starts with the main menu, where it lists all the major features. Main menu contains eight choices, namely:

1. Create a project
2. Edit a project
3. Create a calendar
4. Edit a calendar
5. Get/Save/Remove
6. Resources
7. Reports
8. Setup

The first step in starting a project is to make a calendar. While creating the calendar, the following informations are given

1. Number of years for calendar to run
2. Time at which the workday starts
3. Working days ina week
4. Company holidays

There are several ways of starting the planning of a project. The most basic one is discussed in the tutorial, which is to start planning with a work breakdown structure. It is a common method for dividing a project into its major components, and then dividing the components into tasks.

The work breakdown structure divides the project into its main parts. It can be thought of as inverted tree, with the root (the project goal) at the top, the branches below, and the leaves at the lowest level.

HTPM converts the WBS into a PERT chart. The PERT chart shows tasks and milestones as bars and rectangles linked in a network. A double line between tasks on the chart represents the critical path. Normally, HTPM draws a critical path on the project network when slack is zero (i.e., when the time between planned start and late start is zero), actually, using the project form the minimum slack can be selected to a larger amount, then HTPM draws a critical path line through any part in the project with less slack than the minimum seted.

HTPM offers several graphic reports, namely:

- Gannt chart
- PERT chart
- PERT zoom
- PERT time relative
- Work breakdown graph
- Cost graph, cumulative
- Cost graph, per time unit
- Cost graph, earned value

· Resource allocations

· Resource loading

PERT zoom is the condensed form of the PERT chart, in which project network is represented by figures of tasks and milestones. PERT time relative has no difference from other PERT charts, but it draws the chart so that activities occuring on the same day represented in the same column.

The Gannt chart is a bar chart that measures times scheduled for tasks against a timescale. It shows tasks and milestone slack, planned vs. actual dates. Project can be editted while working in the Gannt chart.

HTPM also provides text reports concerning tasks, milestones, costs, resources,allocations, etc. There are numereous combinations of available report formats, user is responsible to create his own format.

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VITA

Bulent Reha Karagoz, son of Aysel and Burhan Karagoz, was born in 1965. Graduated from T.E.D. Ankara College, he continued his education in Middle East Technical University, in the field of Mechanical Engineering, and took his BSc degree in 1987. In 1989 he graduated from Bilkent University, and earn MBA degree.