Optimal Selection of PERT for large complex and distributed projects

Mr. K Koteswara Rao [†] *, Mr. T.V.Madhusudhana Rao* [††] *, Mr. P.Veerabhadra Rao* [†††] *, Dr GSVP Raju®*
Mr.M Sumender Roy [††††] *Mr.SSS.Sarath* [†††††]
[†] *Sr.Asst. Professor, GMRIT, Rajam, Srikakulam 532127 India*
[††] *HOD Dept of IT, TPIST, Bobbili, Vizanagaram, AP, Indaia*
[†††] *Software programmer, GVPCOE, Visakhapatnam 530041 India*
[††††] *Associate Professor, GIET, Rajahmundry, AP, India*
®Associate Professor,CSE Dept,Andhra University, AP, India
[†††††] *4/4 B.Tech, GVPCOE, Visakhapatnam 530003 India*

Summary

The project management is the discipline of defining and achieving the targets while optimizing the use of resources over the course duration of a project. Project managers are always in tension to keep the budget and schedule, to provide accurate forecast of efforts and the other parameters. Project manager is responsible to see the project can be completed in stipulated time and does not suffer from cost, time overruns. Project development can be controlled by the tools and techniques used to manage the development effort. Large scale software development necessitates an automated process for tracking the progress of the software project.

This paper explains about a technique for tracking the progress of the software project being built. The methodology was developed based on extracting information for crashing a project through best criteria. The project manager periodically documents the team status reports. The technique was implemented in the form of a prototype tool. The prototype tool is also briefly described from the project development standpoint. The template object would facilitate configuration of any project and generates an optimal PERT specifications by applying fuzzy logic and also reconfigure dynamically based on accepted changes. A prototype of this object-oriented template has a potential to propose optimality of large complex, multilayered and distributed projects. The team status reports contain relevant information about the project and its status in terms of its progress in the development cycle. This template takes the input in terms of total cost, manpower and function points for crashing a project. A technique for selecting an optimal PERT chart was developed by using fuzzy logic

Chapter 1

Manuscript received June 5, 2008.
Manuscript revised June 20, 2008.

Introduction

The main work of a software project manager is to see that the project taken up is going to be completed in the stipulated time. For this the project manager needs to be able to monitor the resources, able to generate reports on the performance of the employees. The project manager is responsible to the company to see that the project does not suffer time overrun or cost overrun or both.

In complex, interrelated business activities, the manager or the administrator constantly looks forward to those techniques or methods which help him in planning, scheduling, and controlling such activities. The concepts of network planning and critical path analysis have greatly assists him. The network approach to action planning is a major advance in management science. It is a technique through which large projects are broken down to individual jobs or events and arranged in a logical network. These individual jobs are given time estimates for their execution, and the network helps in identifying those jobs or events which control the completion of the project.

We have made an attempt of developing a fuzzy expert system. The fuzzy expert system is used to select an optimal PERT chart on the basis of the constraints like cost, manpower, total minimum cost, etc.

Project Control

There are three fundamental sets of management metrics: technical progress, financial status, and staffing progress. By examining these perspectives, management can generally assess whether a project is on budget and on schedule. Financial status is very well understood; it always has been. Most mangers know their resource expenditure in terms of costs and schedule. The problem is to assess how much technical progress has been made. Conventional projects whose intermediate products were all the number of documents relied on subjective assessments of technical progress or measured the number of documents completed. While these documents did reflect progress in expending effort, they were not very indicative of useful work being accomplished.

The progress towards project goals and the quality of software products must be measurable throughout the software development cycle. Metric values provide an important perspective for managing the process. Metrics trend provide another.

The management indicators recommended here include standard financial status based on an earned value system, objective technical progress metrics tailored to the primary measurement criteria for each major team of the organization, and staffing metrics that provide insight into team dynamics. The management indicators are:

1. Work and Progress
2. Budgeted Cost and Expenditure
3. Staffing and Team Dynamics

Review Techniques

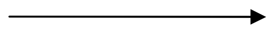
Network Analysis refers to a number of techniques for the planning and control of complex projects. The basis of network planning is the representation of sequential relationships between activities by means of a network of lines and circles. The idea is to link the various activities in such a way that the overall time spent on the project is minimum. The optimum linking of various stages is called *critical path.*

The two most frequently used forms of network planning are program evaluation and review technique (PERT) and critical path method (CPM). PERT or CPM has helped management is drastically reducing the project execution time.

Program Evaluation and Review Technique (PERT)

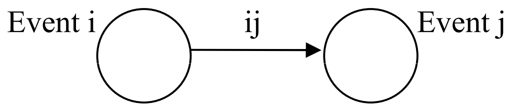
Program Evaluation and Review Technique is a tool to evaluate a given program and review the progress made in it from time to time. A program is also called a project. A project is defined as a set of activities with a specific goal occupying a specific period of time. PERT is concerned with estimating the time for different stages in such a program or a project and find out what the critical path is, that is, which consumes the maximum resources. The basic terminology used in the PERT are:

Activity is a task or job of work, which takes time and resources. An activity is represented by an arrow like this:



The head of the arrow indicates where the task ends and the tail where the task begins. The arrow points from left to right but is not drawn to scale

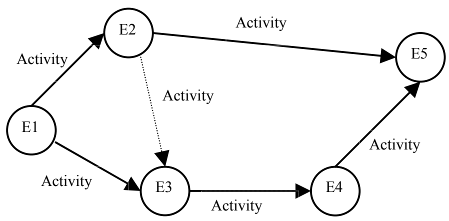
Event is a point in time and indicates the start or finish/end of an activity or activities, for example, building wall completed, etc. An event is represented in a network by a circle or node as follows:



The event which an arrow comes out is called the predecessor event and it is denoted by event i. The event into which the arrow gets in it is called the successor event. It is denoted by event j. The arrow connecting these two events is called activity ij.

PERT planning involves the following steps:
Step1: Identify Activities and Milestones
Step2: Determine Activity Sequence
Step3: Construct the Network Diagram
Step4: Estimate Activity Times
Step5: Determine the Critical Path
Step6: Update as Project Progresses

PERT diagrams usually include a horizontal time line marked off in appropriate units, such as days or weeks. The following figure shows how the events are connected by activities.



The e1,e2,e3,e4,e5 represents the event1, event2, event3, event 4, event5 respectively and the links between the events represents the activities. The dotted line represents a dummy activity. The above is a simple example of a PERT chart.

Critical Path Method (CPM)

The Critical Path Method (CPM) was developed as a network model for project management. CPM is a deterministic method that uses a fixed time estimate for each activity. While CPM is easy to understand and use, it does not consider the time variations that can have a great impact on the completion time of a complex project. Critical Path Method assumes that the time required to complete an activity can be predicted fairly accurately, and thus, the costs involved can be quantified once the critical path has been identified. Since time is an important factor, CPM involves a trade-off between costs and time. It involves determining an optimum duration for the project, that is, a minimum duration which involves the lowest overall costs.

A PERT type of network differs from CPM type of network in three ways:

- A CPM network is built on the basis of jobs or activities instead of events.
- CPM does not take into account the uncertainties involved in the estimation of time for the execution of a job or an activity.
- In CPM, times are related to costs.

Weeks are a commonly used unit of time for activity completion, but any consistent unit of time can be used. A distinguishing feature of PERT is its ability to deal with uncertainty in activity completion times. For each activity, the model usually includes three time estimates:

1. Optimistic time
2. Most likely time
3. Pessimistic time

PERT assumes a beta probability distribution for the time estimates. For a beta distribution, the expected time for each activity can be approximated using the following weighted average:

Expected time = (Optimistic + 4 * Most likely + Pessimistic) / 6

This expected time may be displayed on the network diagram. To calculate the variance for each activity completion time, if three standard deviation times were selected for the optimistic and pessimistic times, then there are six standard deviations between them, so the variance is given by:

[(Pessimistic – Optimistic) / 6]^2

The Critical path is determined by adding the times of the activities in each sequence and obtains the longest path in the project. The critical path determines the total calendar time required for the project

Process Control Management

The process control management can be done by altering the resources over the activities belonging to the critical path. If the critical path is not immediately obvious, it may be helpful to determine the following four quantities for each activity:

- ES – Earliest Start time
- EF – Earliest Finish time
- LS – Latest Start time
- LF - Latest Finish time

These times are calculated using the expected time for the relevant activities. The earliest start and finish times of each activity are determined by working forward through the network and determining the earliest time at which an activity can start and finish considering its predecessor activities. The latest start and finish times are the latest times that an activity can start and finish without delaying the project. LS and LF are found by working backward through the network. The difference in the latest and earliest finish of each activity is that activity's slack. The critical path then is the path through the network in which none of the activities have slack.

Since the critical path determines the completion date of the project, the project can be accelerated by adding the resources required to decrease the time for the activities in the critical path. Such a shortening of the project sometimes is referred to as project crashing. By following the method of project crashing, the project control management can be achieved.

Why PERT based control chosen

PERT based control has been chosen because PERT has the potential to reduce both the time and cost required to complete a project. Here there is a probability of completion of a project before a specified date. Here there is an ease to know the activity start and completion times. As the project unfolds, the estimated times can be replaced with actual times. In cases where there are delays, additional resources may be needed to stay on schedule and the PERT chart may be modified to reflect the new situation. The flow of the processes or stages in a project can be controlled and can be understood by using PERT. There is a clear outline of the project completion time and the cost can be estimated. In present day world, most of the software project managers go for the PERT based control of the project which thus proved to be a best way in all the aspects.

Control Under Uncertainty

Software management may have a presence of states of uncertainty wherein decision making may be difficult. During these situations there is a need for an expert system to make decision on time. The controlling in these situations can be made by using expert systems. Thus the soft computing techniques are used which are based on Artificial Intelligence. The soft computing techniques which can be used are as discussed in the further sections.

Chapter 2

Soft Computing Techniques

Soft computing refers to a collection of new computational techniques in AI, machine learning, computer science and may applied in engineering areas where one tries to study, model and analyze very complex phenomena with low cost and complete solution. The Soft Computing Techniques are

1. FUZZY LOGIC

2. NEURAL NET WORKS

3. GENETIC ALGORITHMS

FUZZY LOGIC: This part is entirely deals with fuzzy logic. FL is a logic used to represent the Fuzzy sets to respective logical values of any hedge. A Fuzzy set a can be defined by its membership Ma (x).

To represent FL are use a list of pairs each pair represents value and Fuzzy membership..

Ex: a = { (x1, M_a (x1)... (x_n, M_a (x_m)}

Ex: representing the heights of 3 members, Joseph, John, James by using Fuzzy logic. A concept such as height which can have values from a range of Fuzzy values including “tall”, “medium”, “short”.

Joseph is of 7 feet, John is of 4 feet, James is of 5.10 feet.

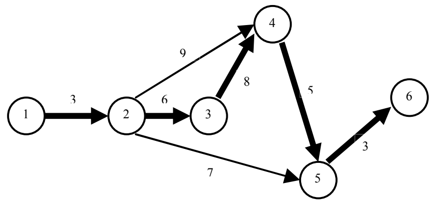
The definition of height of James falls under category of “Tall” for some and “Medium” for some people. By using Fuzzy James can be put in the list of “tall” people by giving rate of “tall” So the Fuzzy values can be defined as {1,0,,0.5} for Joseph, John, James.

Why we chosen fuzzy logic

1. Be cause of rule base operation any reasonable number of inputs can be processed and numerous outputs can be generated.
2. FL is a inherently robust and don’t require precise.
3. FL can control non linear systems that would be difficult are impossible to model mathematical.
4. FL can give accurate result.
5. Since FL control processes user defined rules governing the target control system. It may be modified easily to improve performance.

Need for Project Compression or Expansion

The management may decide to reduce the project time for, broadly, two reasons. One such reason may be to complete the project before a certain target date. The second reason could be to reduce the overall cost itself. This is possible if the indirect cost per day is greater than some of the cost slopes. Let us take an example of a project:



The indirect costs, let us say, work out to $160 per day. The normal duration for the project is found to be 25 days. Note that this is obtained from the critical path and not by summing up the normal durations for all the activities. It is better to draw whenever possible a time-scaled version of the project instead of the conventional network as shown above. The overall normal distribution is 25 days and the total direct cost $ 7560. According to the crash time, the critical path still appears as 1-2-3-

4-5-6, and the crash duration is 15 days. Hence, the project may take anywhere from 15 days to 25 days depending on the money the management is prepared to spend. If the management decides to complete the project in 15 days, then, the direct cost appears to be $ 9330. So speeding up i.e., compressing the project is required at times which can be done by using the activities in critical path during the reduction in the project duration time.

Methodologies for selection of optimal PERT chart

In project control, there are several occasions, wherein a project needs to be compressed to meet the amended deadlines or costs. Owing to possible existence of parallel paths to critical paths, we can generate more than one PERT by compressing the activities on critical path. In such an event, selection of optimum PERT chart amongst available options becomes critical. Usually organizations depend on the experience of the project manager to bail them out of the situation. Depending on the priorities, resources, policies and past practices make a final selection. This based on project managers behavior pattern, intuition and experience. For example, in this project the optimality is decided based on the three factors (i) *cost*: by crashing the cost (ii) *manpower*: by crashing the manpower (iii) *function points:* by reducing the function points. In this way, for different projects, depending on the experience of the project manager, the different criteria are considered for selecting the best PERT chart.

Benefits of PERT

PERT is useful because it provides the following information:

1. Expected project completion time.
2. Probability of completion before a specified date.
3. The critical path activities that directly impact the completion time.
4. The activities that have slack time and that can lend resources to critical path activities.
5. Activity start and end dates

Limitations

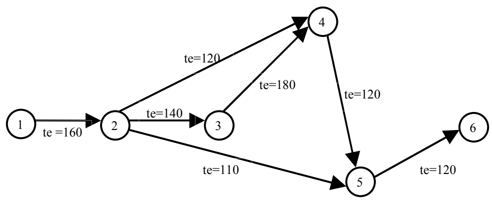
The following are some of PERT's weaknesses:

1. The activity time estimates are somewhat subjective and depend on judgment. In cases where there is little experience in performing an activity, the numbers may be only a guess. In other cases, if the person or group performing the activity estimates the time there may be bias in the estimate.
2. Even if the activity times are well-estimated, PERT assumes a beta distribution for these time estimates, but the actual distribution may be different.
3. Even if the beta distribution assumption holds, PERT assumes that the probability distribution of the project completion time is the same as that of the critical path. Because other paths can become the critical path if their associated activities are delayed, PERT consistently underestimates the expected project completion time.

Let us consider a simple example of a PERT wherein the average estimated times are given for each activity and the crash cost crash time are given in a tabular form. The PERT can be drawn by using the data from the table. The table is as shown below:

Activities	Average time or expected time (te)
1-2	160
2-3	140
3-4	180
2-4	120
4-5	120
2-5	110
5-6	120

From the details shown above in the table, the PERT can be drawn by following the steps. The figure shown below is PERT drawn from the details in the table.



From the table given, the *earliest expected time* (T_E) can be calculated for each event. Starting from the initial event 1, the values for successive events can be evaluated easily from the network. These T_E's are shown close to the events. A rule to do this for any event can be formulated as follows:

T_E (successor event) = T_E (predecessor event) + te (activity).

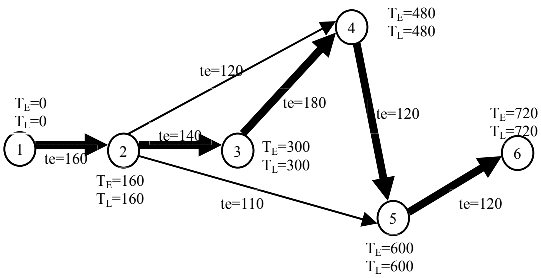
Thus the earliest expected time can be calculated by using above formula.
Another time estimate is to be discussed regarding the event. The latest time by which by which an event must occur to keep the project on schedule is known as the *latest allowable occurrence time*, and is denoted by T_L. To calculate this time, the formula used is:

T_L (predecessor) = T_L (successor) – te (activity).

The slack can be calculated at each event by the formula:

Slack = $T_L - T_E$.

The "critical path" connects those events, for which the earliest and latest times are the same, i.e., these events have zero slack time. The activities connecting these nodes are called critical activities. After calculating all these, the critical path can be obtained. The critical path can be represented by a thick line in a PERT diagram. The PERT can be as shown below:



The PERT can be optimized by some optimization techniques. The optimization is discussed in the next section in detail.

Chapter 3
Issues in comparing PERT charts

This section deals with the methods of issues for comparing PERT charts. In project control, there are several occasions, where in a project needs to be compressed to meet the deadlines or costs. Owing to possible existence of parallel paths to critical paths, we can generate more than one PERT by compressing the activities on critical path. In such an event, selection of optimum PERT chart amongst available options becomes critical. In our project we considered the issues like cost, manpower and function points. The project crashing is done on the basis of these issues. The PERT is crashed considering all the three constraints and from these three PERTs the optimal is selected by applying the fuzzy expert system which is discussed in further section in detail. The detailed description for how the crashing is done on the basis of cost, manpower and function points is discussed below.

Cost Crashing

Cost crashing is one of the issues in comparing PERT chart. The management may decide to reduce the project time for some reasons. One such reason may be to complete the project before a certain target date. At this situation, the management when is least bothered for increase in cost, then we can go with the cost crashing. As the delivery date is reduced by some days, the cost relatively increases with reduction in delivery date. One main point is to be considered that the events which are in the critical path are only to be crashed. Let us consider the example to explain the cost crashing in a project. The table below gives the details of crash time and crash cost for each activity.

Activity	Time		Cost		Cost Slope	Slope priority
	Normal	Crash	Normal	crash		
1-2	160	155	36000	40000	800	I
2-3	140	130	144400	162000	1800	II
3-4	180	175	40000	60000	4000	IV
4-5	120	115	160000	177000	3400	III
5-6	120	115	48000	76000	5600	V

The cost slope is calculated by the formula:

Cost slope = (crash cost – normal cost)/ (normal time – crash time).

By considering the cost slope, the activity with the least slope is given the first priority to crash. By considering the cost overhead per day which is the cost slope, the priority for the activity which is to be crashed, the optimal activity is selected for the crisp input for the fuzzy logic. The corresponding manpower and Function points of the activity are taken for the crisp input for the fuzzy controller. The fuzzy set could be as - {Crash cost, Normal manpower, Normal Function points} of the respective activity selected.

Man power Crashing

The manpower is the number of men required for the project to complete by the time at a skill factor and at a productivity rate.

Crashing manpower means increasing the manpower with respect to the days and by considering the effort applied. The total effort of the manpower can be calculated for any given inputs like the productivity parameter (P), skill factor (B), LOC (P), date of delivery (T) with the formula:

$$E= (L*B^{0.333}/P)^3 * (1/T)^4 .$$

The manpower can be obtained from the effort by dividing effort with the time (T). In this way we can get the total manpower required to complete the project within time. When the Project manager had opted for manpower crashing, first the manpower is crashed using above formula and the respective cost of the activity and function points are taken as the other set of crisp inputs. The first and the foremost thing to be considered while crashing with manpower is that when considering a project, the manpower cannot be crashed more than the 70% of its actual manpower. Since a project cannot be completed in a day by appointing large number of manpower. Finally, the set may be of the form {normal cost, crashed manpower, normal function points}. The table of crashed manpower for the above example is as shown below.

These values are given as the input for the fuzzy controller and these are converted to respective weights. Thus the output will be with respect to the crashed manpower, normal cost and normal function points in the form of PCQ.

Activity	Time		Manpower	
	Normal	Crash	Normal	Crash
1-2	160	155	40	43
2-3	140	130	35	45
3-4	180	175	42	47
4-5	120	115	45	50
5-6	120	115	50	55

Function Points Crashing

The function point crashing is said to be the reducing of the no. of function points used in the code. As the number of function points reduces, the manpower, days, cost get reduced. The function points can be calculated by using the same formula as shown in the manpower. Since manpower can be calculated by using either LOC or function points, the effort can be calculated with the same formula as above.

$$E= (L*B^{0.333}/P)^3 * (1/T)^4 .$$

Thus the function points can be reduced. For reducing of function points, in a project, we depend on the vitality and priority of an activity. The project manager if opted for the crashing of function points, then the crisp set obtained can be of the form: {normal cost, normal manpower, crashed function points}. The table for the function points for the fig1 is as shown below:

Activity	Function points	Vitality	Priority
1-2	20	3	1
2-3	40	1	3
3-4	22	2	2
4-5	23	2	1
5-6	30	3	1

Unlike the cost in cost crashing, manpower in manpower is crashing, the function points crashing means reducing the function points with the time basis rather than increasing them. Since, the issue function point is directly proportional to the time, the function points are reduced if the project delivery date is reduced. Thus the above values are given as the input for the fuzzy controller and these are converted to respective weights. Thus the output will be with respect to the crashed function points, normal cost and normal manpower in the form of PCQ.

Algorithm

The algorithm developed builds a relationship for the crashed PERT and fuzzy logic to be applied to these PERTs.

Step1: Start.

Step2: Enter the details of PERT chart. Now crash the PERT with cost, manpower and function points.

Step3: 3a: PERT1 is obtained with cost crashing.
3b: PERT2 is obtained with manpower crashing.
3c: PERT3 is obtained with function point crashing.

Step4: Obtain the values and apply fuzzy logic to it.

Step5: The best PERT is obtained as output and its specifications i.e., the corresponding manpower, cost, function points are displayed representing the optimal values.

Step6: End.

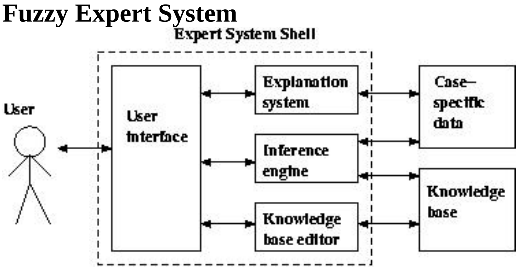
The sets of data may be of the form:

PERT1	PERT2	PERT3
Crashed cost	normal cost	normal cost
Normal MP	crashed MP	normal MP
Normal FP	normal FP	crashed FP

The above is a matrix representation of the fuzzy sets showing the three sets of observations for a given PERT. The different sets for each PERT can be got from each column of the matrix shown above.

Chapter 4

Fuzzy Expert System



Fuzzy logic is a form of logic that applies to fuzzy variables. Fuzzy logic is non-monotonic, in the sense that if a new fuzzy fact is added to a database, this fact may contradict conclusions that were previously derived from the database.

The concept of Fuzzy Logic (FL) was conceived by Lotfi Zadeh, a professor at the University of California at Berkley, and presented not as a control methodology, but as a way of processing data by allowing partial set membership rather than crisp set membership or non-membership. We here discuss the application of fuzzy logic to obtain the optimized PERT chart. In fuzzy logic, the fuzzy set, membership functions etc., are used and the optimized PERT specification is obtained. The inference we use in our fuzzy logic is said to be the **Mamdani Inference.**

Expert systems are meant to solve real problems which normally would require specialized human expert. (Doctor or Mineralogist) Building an expert system requires extracting knowledge from expert (human).

Knowledge Engineer: - Knowledge Engineer can extract knowledge and can build expert system knowledge database.

Rule and Expert System: Expert system is based on IF - THEN rule work. Rule based systems can be 1. Goal driven using back ward chaining, 2. Data driven using forward chaining. Expert system can use both.

The user interacts with the system through UI which may use menus, Natural language or other style of information. Inference engine used to reason with expert knowledge and data specific of problem. Case specific data includes both data provided by the user and partial conclusions, explanation system which allows the program to explain its reasoning to the user. Knowledge database editor helps their expert or knowledge engineer.

Steps in Fuzzy Expert System

1. Obtain information from one or more experts
2. Define the Fuzzy sets
3. Defining the Fuzzy rules.

Directed steps to use Fuzzy Expert System

1. Relate the observations to the Fuzzy sets
2. Evaluate case for all Fuzzy rules
3. Combine information from the rules.
4. Deffuzify the results.

Defining Fuzzy Set

Having obtained the suitable information from the experts, the fuzzy set is defined.

- TMC- Total minimum cost.
- MP- Man Power.
- FP- Function points.

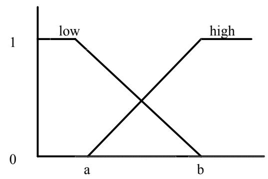
As well as defining the linguistic variables, there is need to give each one a range of possible values. Linguistic variables of TMC, MP, FP are high (h), low (l). To represent the fuzzy membership functions, the notation used is W_{AB} where A is the variable (tmc, mp, fp) and B is the variable (h, l). For example, Wtmcl represents the function of total minimum cost low.

Membership Functions: The membership functions we use here give the weights for each of the fuzzy sets. The representation of weights may be of the form Wab –where 'a' gives the fuzzy set and 'b' gives the linguistic variable of the fuzzy set.

The membership functions for the total minimum cost (TMC):

TMC High:

Wth(x) = 0, x<a
= (x-a)/ (b-a), a<=x<b
= 1, x>=b



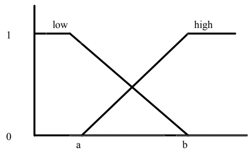
TMC low:

Wtl(x) = 1, x<a
= (b-x)/ (b-a), a<=x<b
= 0, x>=b

The membership function for the manpower (MP) are:

MP Low:

Wml(x) = 0,x>=b
= (b-x)/a, a<=x<b
= 1, x<a



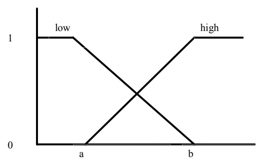
MPhigh:

Wmh(x) = 0, x<a
= (x-a)/b , a<=x<b
= 1, x>=b

The membership functions for the Function Points (FP) are:

FP low:

Wfl(x) = 0, x<a
= (x-a)/b , a<=x<b
= 1, x>=b



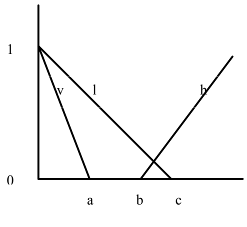
FP high:

Wfh(x) = 0, x<a
= (x-a)/b , a<=x<b
= 1, x>=b

We need to define one more fuzzy set, which is the set used to describe the output of the system. It is Pert Chart Quotient (PCQ).
Linguistic variable for PCQ: very low (v), low (l), high (h).
The membership functions for PCQ are:

PCQ verylow:

Wpv(x) = (a-x)/a , x<=a
= 0, x>a



PCQ low:

Wpl(x) = (c-x)/c , x<=c
= 0 , x>c

PCQ high:

Wph(x) = 0 , x<=b
= (x-b)/(max -b) ,x>b

<u>Defining fuzzy rules</u>:

The second step in creating a fuzzy expert system is to define a set of fuzzy rules. These rules, unlike those used by traditional expert systems, are expressed in vague English terms and do not define cut-off or thresholds, but rather use subjective terms such as “high” and “low”. This map more naturally to the way an expert would express his or her knowledge and makes the process of converting that knowledge into rules far simpler and less prone to error. Our rules are defined as follows:

<u>Rule1</u>: If TMC is high
AND MP is high
OR FP is low
THEN PCQ is high

<u>Rule2</u>: If TMC is high
AND MP is low
OR FP is high
THEN PCQ is low

<u>Rule3</u>: If TMC is high
AND MP is high
AND FP is high
OR PCQ is high

We now relate the observations to the fuzzy sets. We will examine three sets of data, for the three PERTs. The obtained related values are defuzzified by using defuzzication.

Defuzzication: We now need to Defuzzify the outputs to obtain a crisp PCQ to get the required result. The crisp values are obtained by calculating the Centroid for the PCQ using the formula-

Centroid (c) = (∑Wp(x)*x)/(∑Wp(x)).

Chapter 5

Problem solution & Methodology

Module 1: *Validation and criteria.* In this module, a login page is provided wherein the project manager has to first login with a username and a password. The valid person is authorized to enter into the main module. These login details must be unique i.e., the login and password must be unique. The details are maintained in the database.

Module 2: *PERT Generation.* Once the project manager is recognized, a form is offered in which the details of the PERT are to be entered consigning of number of events, activities between the events and their estimated times where these details are stored in a database. Here each PERT is assigned a unique identification number. As soon as the details are entered, they are stored in a database in MS Access and these details are retrieved when required by the other modules.

Module 3: *Crashing.* As the PERT has to be crashed, a dialog box appears requesting for the details of which PERT to be crashed and how many days to be crashed. As the details are entered, buttons are available for viewing the PERT. This button provides a facility to have a glance at the PERT either before or after the crashing. There are also buttons facilitating a query of the type of crash to be done over the PERT. Each of these buttons provide support to carry out the corresponding crashing required. All the values after crashing are maintained in corresponding databases.

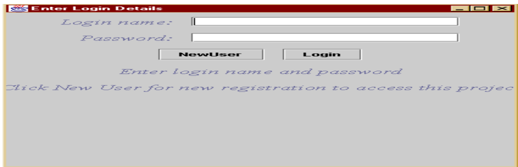
Module 4: *Optimal PERT selection.* From the previous module we obtain the corresponding values of each of the crashed PERT. By applying the fuzzy functions internally, the values are converted to corresponding fuzzy values. These values are related to the rules, and the obtained values are defuzzified by applying the related process. Thus the PCQ is obtained of each of these PERTs and now the specifications of the best PERT selected are displayed in a window which are said to be the optimal ones.

Chapter 6

Results:

Login:

This is the login page for the new user and the existing users. We can access the template by clicking the new user. The login name, passwords are to be given as input to enter into the main menu.

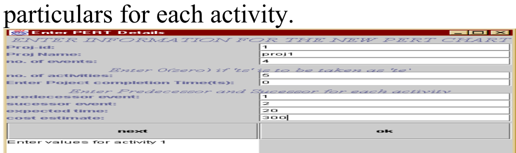


Start:

This window shows the title of the project. On clicking "new PERT generation" button, we enter the PERT details of the pert which is to be generated.

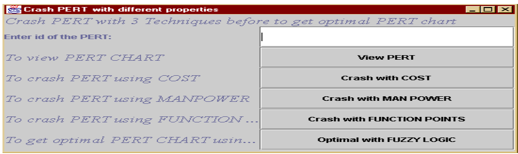
New chart:

We can enter the PERT details through this window. The details to be entered are project id, project name, number of events, number of activates, estimated time. While entering the details of each activity and each event, the above fields are inactivated. This window asks for particulars for each activity.



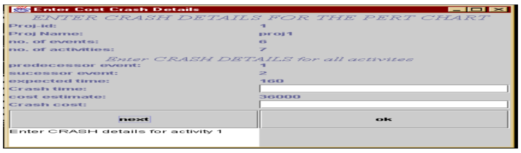
Crash:

We can crash the selected PERT using the buttons over the window. Here there are buttons for cost crash, man power crash, function point crash and another button for applying fuzzy logic to the crashed pert. The window is as shown below.



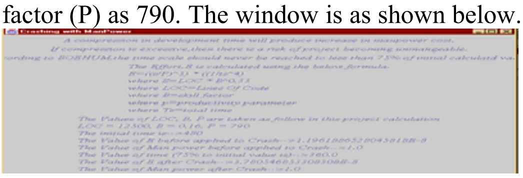
Cost crash:

This window asks for the cost crashing details. The window is as shown below:



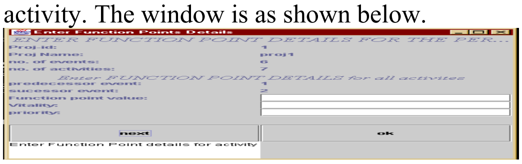
Man Power:

Manpower is calculated in this window. We can view the man power which is calculated and the procedure for calculation can also be viewed. The LOC is considered as 12500, the skill factor (B) as 0.16 and the productivity factor (P) as 790. The window is as shown below.



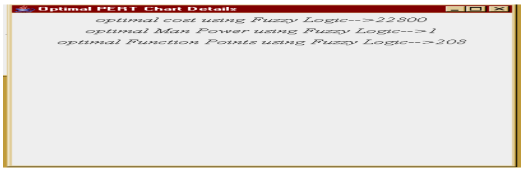
Function Points

Function points can be entered through this window. Here the window asks for the vitality, priority and the function points for each activity. The window is as shown below.



Output:

The output window displays the specifications of the best PERT which is to be selected. The output will be as follows:



Conclusion

The main goal of this project is to get an optimal PERT chart using fuzzy logic. The issues considered while selecting a PERT as Total minimum cost taken for a project to complete, manpower required to complete the project, function points required to complete it. All the three constraints are crashed on time basis. The constraints are crashed by considering the crashed time only. Now the optimal PERT is to be selected using fuzzy logic. We developed a fuzzy expert system which is used to select an optimal PERT chart. Optimality is described here within the rules of fuzzy logic. The soft computing techniques are used to develop the Software management tools. Thus we made an attempt to develop a tool to select an optimal PERT of a project.This prototype can be used as a tool by the project managers to select an optimal PERT chart in a project. The PERT can be crashed not only by considering the issues like cost, manpower and function points, but also with the issues like the vitality, quality, delivery date etc., basing on the interest of the project manager and also the choice of the customer. Hereby we conclude that the object-oriented template built by us can be used as a software tool to select an optimal PERT chart.

Chapter 7
Bibliography:

[1]. Henrik Legind Larsen – An Approach to Flexible Information Access Systems using Soft Computing - 32nd Hawaii International Conference of System Sciences, 1999.

[2]. Magnr Jorgensen, Molokken Ostvold "Reasons for Software Effort Estimation Error: Impact of Respondent Role, Information Collection Approach, and Data Analysis Method " ,IEEE Transactions on Software Engineering Vol. 30, No. 12; December2004, pp. 993-1007

[3]. Pankaj Jalote ," An Integrated Approach to Soft ware Engineering" 2nd Edition , Narosa Publishing House,2004,Chapter-4 (Planning a Software Project),Pg no. 166-170. ISBN – 81-7319-271-5.

[4]. "PERT and CPM " – L.S.Srinath

[5]. "Software Project Management" – Walker Royce

[6]. "Software Engineering" – Pressman

[7]. "Artificial Intelligence Illumination" – Ben Coppins

Mr.K.Koteswara Rao received the B.Tech dregree in CSE from Acharya Nagarjuna University in 2004. He received M.Tech dregree in CSE from Jawaharlal Nehru Technological University in 2006. From 2006 onwards working as Assistant Professor in the Dept. of CSE in Gayatri Vidya Parishad College of Engineering, Visakhapatnam. His research interest includes Software Engineering, Object Oriented Systems Development, Project Management, Data Mining.

Mr.P Veerabhadra Rao received the B.Tech dregree in CSE from Berhampur University in 2006. He is presently pursing M.Tech dregree in CSE from Jawaharlal Nehru Technological University in QIP Scheme. From 2006 onwards working as Software programmer in the Dept. of CSE in Gayatri Vidya Parishad College of Engineering,

Visakhapatnam. His research interest includes Software Engineering, Data Mining and Computer Networks.

Dr.G. Samuel Vara Prasada Raju received the M.Tech dregree in CSE from Andhra University in 1993. He received PhD dregree from Andhra University in 1996. From 1994 to 2003 worked as Asst. Professor in the Dept. of CS&SE in Andhra University College of Engineering. From 2003 onwards worked as Associate Professor and Director of the CS&SE Department for School of Distance Education of Andhra University College of Engineering His research interest includes e-commerce, Network Security, Cryptography and Data Mining.