SATISFYING BOTH DEADLINES AND RESOURCE CONSTRAINTS

Vikash Raikwar[1]; Sanjay Tiwari[2]
[1,2]*Department of Civil Engineering*
MITS Gwalior-474005
vikii009@gmail.com , sanjaymits2@gmail.com

Abstract: The Project deadline for resource limits and constrained resource scheduling (CRS) have become mainstream in commercial scheduling software, time-cost trade-off (TCT) And the cycles of crashing for lowest-cost critical activities and resolves any resource over allocation within each TCT cycle. Both deadlines and resource constraints does not work in a commercial software.so these project provides a set of feasible project durations that do not violate resource limits. The proposed method has been programmed as an add-in tool to Microsoft Project software for both deadlines.

This paper introduces a simple computer application that would allow its users to identify all the paths of a network schedule. To analyze all the paths of a project's schedule, from the beginning of the crashing process. In MS Project application developed via Microsoft Visual Studio, utilizing C++ programming language for the crashing tools and resource allocation. The programming of the application allows it to be used in various operating platforms such as Windows and Linux.

Keywords: Resource scheduling (CRS), Time-cost trade-Off (TCT) Cycle, Crashing for lowest-cost critical activities, Computer application

I. INTRODUCTION

The objectives of project management network techniques is widely used. It is commonly known as PERT (Programmed Evaluation and Review Technique), CPM (Critical Path Method).PERT is used in Research type of projects. The network techniques of PERT and CPM were concurrently developed in 1957. In the beginning, CPM was used for planning and scheduling of constructional projects. It was also used for scheduling the maintenance shutdown. The construction industry in general and the petro-chemical industry in particular were the major areas of CPM applications.

PERT was developed by US Navy for scheduling the research and development work for the Polaris Fleet Ballistic Missiles Programmed whose activities were subject to a considerable degree of uncertainty. Initially, this technique was named as "Programmed Evaluation and Review Technique" after 1958, this technique was used by Russian Scientists for the utilization and management of their huge ammunition. But after 1960, this technique came up as a revolutionary technique for the purpose of decision-making. Critical path method and program evaluation and review technique (CPM/PERT) without resource allocation are totally inadequate for control of major projects. Resource allocation has been a major concern of research and actual application development since the advent of the CPM/PERT network scheduling techniques. Many algorithms have been developed including theoretical optimization and heuristic rules since early 1960. The theoretical approaches generate too many combinations and are, therefore, quite expensive to use. The heuristic approaches provide a reasonable solution to the "too expensive" problem. How- ever, none of these algorithms has the capability to resolve the impacts of a variety of external forces, such as weather conditions and resource availability that are unavoidable in any real-life project.

II. INTRODUCTION TO CRS:

a) Resource Allocation:-

It is used to assign the available resources in an economic way. It is part of resource management. In project management, resource allocation is the scheduling of activities and the resources required by those activities while taking into consideration both the resource availability and the project time. In strategic planning, resource allocation is a plan for using available resources, for example human resources, especially in the near term, to achieve goals for the future. It is the process of allocating resources among the various projects or business units.

There are two contingency mechanisms. There is a priority ranking of items excluded from the plan, showing which items to fund if more resources should become available; and there is a priority ranking of some items included in the plan, showing which items should be sacrificed if total funding must be reduced.

The problem of resource allocation can be thought of as :

(a) Estimation of the resource requirement of a project during its various stages of completion (Resource -loading)

(b) Estimation of the minimum delay in the project duration when resource availability is constrained.

(c) When project is required to be completed in a fixed time span, the estimation of most efficient allocation of available resources.

b) Resource Leveling:-

The main objective is to smooth resources requirements by shifting slack jobs beyond periods of peak requirements. Some of the methods essentially replicate what a human scheduler would do if he had enough time; others make use of unusual devices or procedures designed especially for the computer. They of course depend for their success on the speed and capabilities of electronic computers.

The basic feature of resources leveling is the rescheduling activities within the limits of available slake to achieve better distribution of resource usage. The slack available in each activity is determined from the basic scheduling operations without consideration of resource requirements or availabilities. Then during the rescheduling or "juggling" of activities to smooth resources, project duration is not allowed to increase.

c) Algorithms:-

Resource allocation may be decided by using computer programs applied to a specific domain to automatically and dynamically distribute resources to applicants. It may be considered as a specialized case of automatic scheduling.

This is especially common in electronic devices dedicated to routing and communication. For example, channel allocation in wireless communication may be decided by a base transceiver station using an appropriate algorithm.

One class of resource allocation algorithms is the auction class, whereby applicants bid for the best resource(s) according to their balance of "money".

III. EXAMPLE FOR RESOURCE ALLOCATION:-

Activity	Duration (days)	Laborer's required
A	2	2L
B	4	2C,2L

C	4	4C
D	3	2L
E	4	6C
F	7	2L
G	2	4C
H	5	4C,2L
J	2	2C
K	5	2C
L	2	2L
M	3	4L
N	2	4L

IV. INTRODUCTION OF TCT:-

Time-Cost trade off analysis is a formal means of analysing when and where to buy time on a project. It is effective tool for analysing schedules. It can be equally effective during initial project scheduling and during the rescheduling that always seems to be required at some point during a project. However, the nature of critical path schedules and the amount of data necessary

The activity slack for each node may be easily calculated:-

Activity Slack = SLACK = LS - ES = LF – EF In any network, there will be activities with zero slack. Any delay to these activities will produce a delay in the completion of the project as a whole. We call these tasks critical activities, and a path through the network made up of critical activities is called a critical path.

There will always be at least one critical path, and there may be more than one. All critical paths have the same length. Not surprisingly, critical paths are the longest paths through the network and the length of a critical path is equal to the duration of the Project.

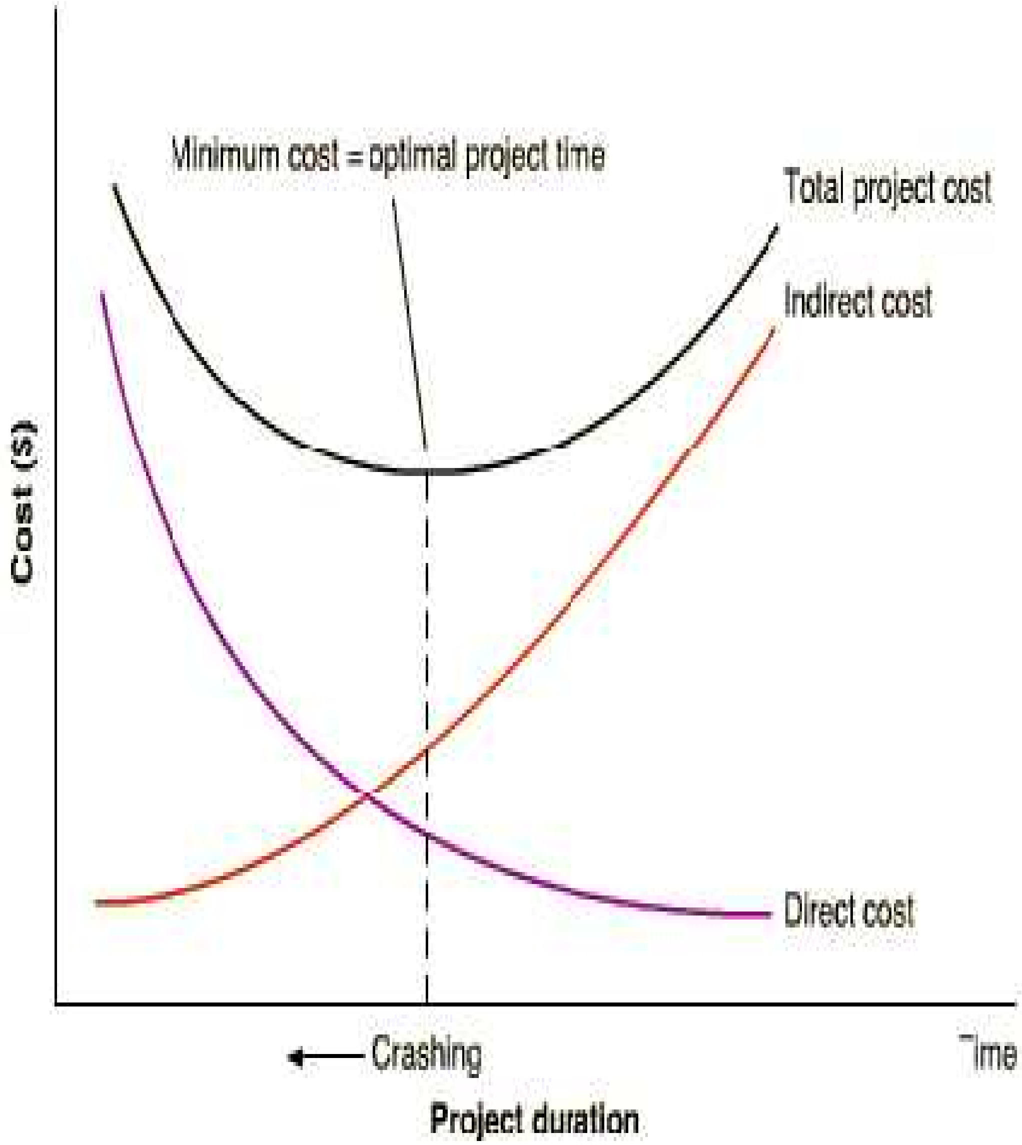
The time-cost trade off problems may also be of interest in the limited resource case. In such case a time-cost trade off analysis is carried out followed by a resource allocation procedure. If necessary time-cost trade off problems are sometimes described as resource allocation problems. because of implicit relationship between cost and resources but it is, important to note that the tradeoff problems and the resource allocation. Problems are two separate cases and the resource allocation is to consider it under resource constraints and to determine the minimum project duration which can be achieved solution techniques for such cases have been proposed using linear and integer programming, dynamic programming, implicit enumeration bounded enumeration and heuristic programs.

V. CRASHING

Crashing is the process of fine-tuning of project schedule to short end delivery time. It is a possible solution when stakeholders ask for a faster delivery while not willing to reduce the scope of work. So, how does crashing work? Simple Reduce the time to complete the tasks in the critical path. Note that crashing works only on tasks in the critical path because reducing time on non-critical tasks will not affect the project delivery time. Do not waste time in crashing non-critical path tasks instead, of crash on tasks in the critical path to get immediate results.

VI. DIRECT AND INDIRECT COSTS

Project crashing costs and indirect costs have an inverse relationship; crashing costs are highest when the project is shortened, whereas indirect costs Increase as the project duration increases. So, the best project time is at the minimum point on the total cost curve as below:



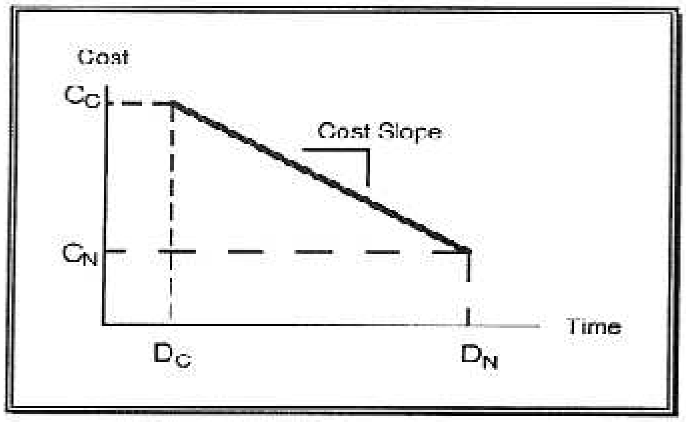


Figure 1: Traditional approximation of activity time-cost relationships

D_N – Normal Duration
C_N = Normal Cost
D_C – Crash Duration (minimum possible duration)
C_C – Crash Cost (cost to achieve minimum possible duration)
Cos: Slope = $\Delta C/\Delta D$ – $(C_C - C_N) / (D_C - D_N)$

This data-intensive approach is impractical for most real world problems. One objection is simply the amount of data required. There is seldom enough time to develop even one estimate adequately, let alone a second for a different set of constraints. Even when such information is made available, the time-cost relationships are estimated. That is, the path between the normal and crash limits is often assumed to be linear, as shown in figure 1. A related objection then arises concerning what is meant by some point along this line between the end- points. If actual cumulative resource falls under the LS (late start) curve, the project is either behind schedule or the resource requirements were overestimated, if on the other hand they exceed the ES (early start) curve, the project is either ahead of schedule of the resource requirements were under estimated.

VII. PRINCIPLE OF OPERATION

Project creates budgets based on assignment work and resource rates. As resources are assigned to tasks and assignment work estimated, the program calculates the cost, equal to the work times the rate, which rolls up to the task level and then to any summary tasks and finally to the project level. Resource definitions (people, equipment and materials) can be shared between projects using a shared resource pool. Each resource can have its own calendar, which defines what days and shifts a resource is available. Resource rates are used to calculate resource assignment costs which are rolled up and summarized at the resource level. Each resource can be assigned to multiple tasks in multiple plans and each task can be assigned multiple resources, and the application schedules task work based on the resource availability as defined in the resource calendars. All resources can be defined in label without limit. Therefore it cannot determine how many finished products can be produced with a given amount of raw materials. This makes MS Project unsuitable for solving problems of available materials constrained production. Additional software is necessary to manage a complex facility that produces physical goods. The application creates critical path schedules, and critical chain and event chain methodology third-party add-ons also are available. Schedules can be resource leveled, and chains are visualized in a Gantt chart. Additionally, MS Project can recognize different classes of users. These different classes of users can have differing access levels to projects, views, and other data. Custom objects such as calendars, views, tables, filters, and fields are stored in an enterprise global which is shared by all users

VIII. LITERATURE REVIEW

Tarek Hegazy, M.ASCE; and Wail Menesi, S.M.ASCE [2012] developed a Heuristic Method While heuristic methods for constrained resource scheduling (CRS) have become mainstream in commercial scheduling software, time-cost trade-off (TCT) heuristic to help meet deadline, let alone any procedure to resolve both deadline and resource constraints. they, introduces a practical heuristic method to meet both deadline and resource limits.

Daniel Castro-Lacouture, A.M.ASCE; Gursel A. Suer; Julian Gonzalez-Joaqui; and J. K. Yatesmanual [2009] critical path method scheduling calculations, Primavera Project Management software _P5_, and mathematicalmodels using the Optimization Programming Language software. Fuzzy mathematical models that allow the multiobjective optimizationof project schedules considering constraints such as time, cost, and unexpected materials shortages were used to verify commonlyused methodologies for finding the minimum completion time for projects

Márcio Botelho da Fonseca Lima, Dr. Universidade Federal da Paraíba (UFPB) Luiz Bueno da Silva, Dr.Universidade Federal da Paraíba (UFPB) Renata Jorge Vieira estranda em Engenharia de Producao [2006] presents the brute force method, improved for the use of the MS Project. Second, it develops the models for determining the earliest crash completion time and for determining a least costly crash schedule, for the same home-building project used in the brute force method. Third, it Establishes costs laws, which allow inferring that the cost of a project does not depend only on the production rate but depending also on the time were the first unit of production will be available, on the global volume of production and on the project completion time.

‘B. Gokhan Celik PhD, LEED-AP’ Roger Williams University Bristol, Rhode Island and Providence Plantations ‘S. Gokce Celik’ Havelsan Hava Electronic Sanayi ve Ticaret A.S. Ankara, Turkey ‘Gilbert C**.** Brunnhoeffer, III PhD, P.E’**.** Roger Williams University Bristol, Rhode Island and Providence Plantations The calculation of the minimum duration of a schedule (crashing the schedule), and identifying various milestones (durations) along the way, requires identifying the best order for reducing durations of the individual tasks. In April 2010 by Brunnhoeffer & Celik at the Associated Schools of Construction Annual Conference in Boston, MA. It is the goal of this paper to introduce Schedule Path Explorer Beta version1.0 (SPE Beta v.1) as an initial step toward developing a crashing software program to be used mainly by instructors and students but also by professionals to improve the understanding of how to crash a schedule. The SPE that is a response to the issue of automatically identifying all the paths on a given network problem. Identifying the activities on each of the paths makes it possible for students to build spreadsheets and track the changes in critical or noncritical status, as the duration of certain activities are reduced based on their associated costs.

IX. BY USING MS PROJECT TOOLS TO SOLVE A NETWORK

a) PLANNING TOOLS AND TECHNIQUES:

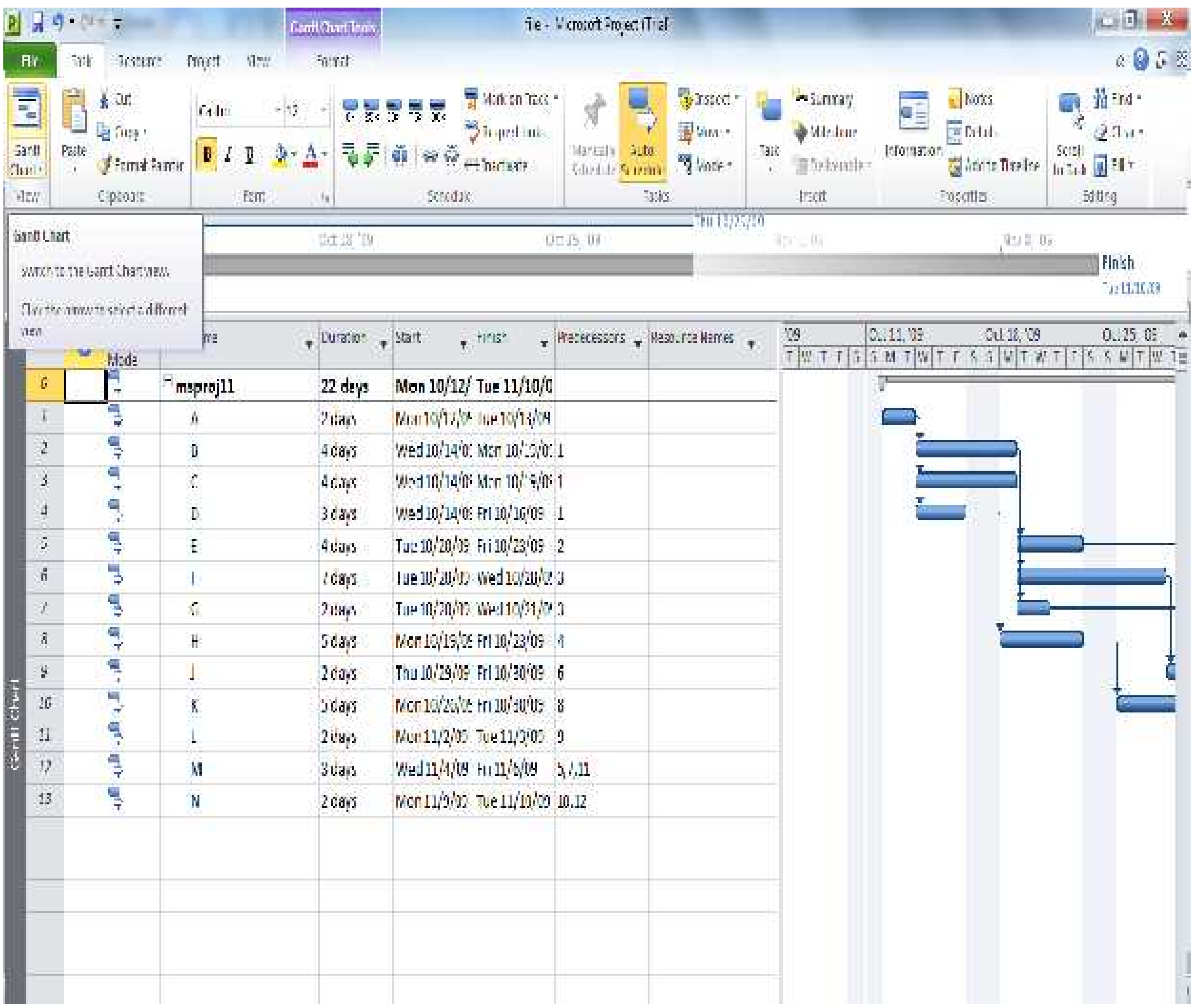
Building on the previous sessions participants now the information generated during the creation of the WBS & estimating to produce the project schedule. After this session participants will be able to construct a practical and effective schedule enabling a positive start on the project. Amongst the topics covered are:

- Networks & Gantt-charts
- Critical Path Analysis
- Resource Histograms and resource smoothing
- Milestones and deliverables.

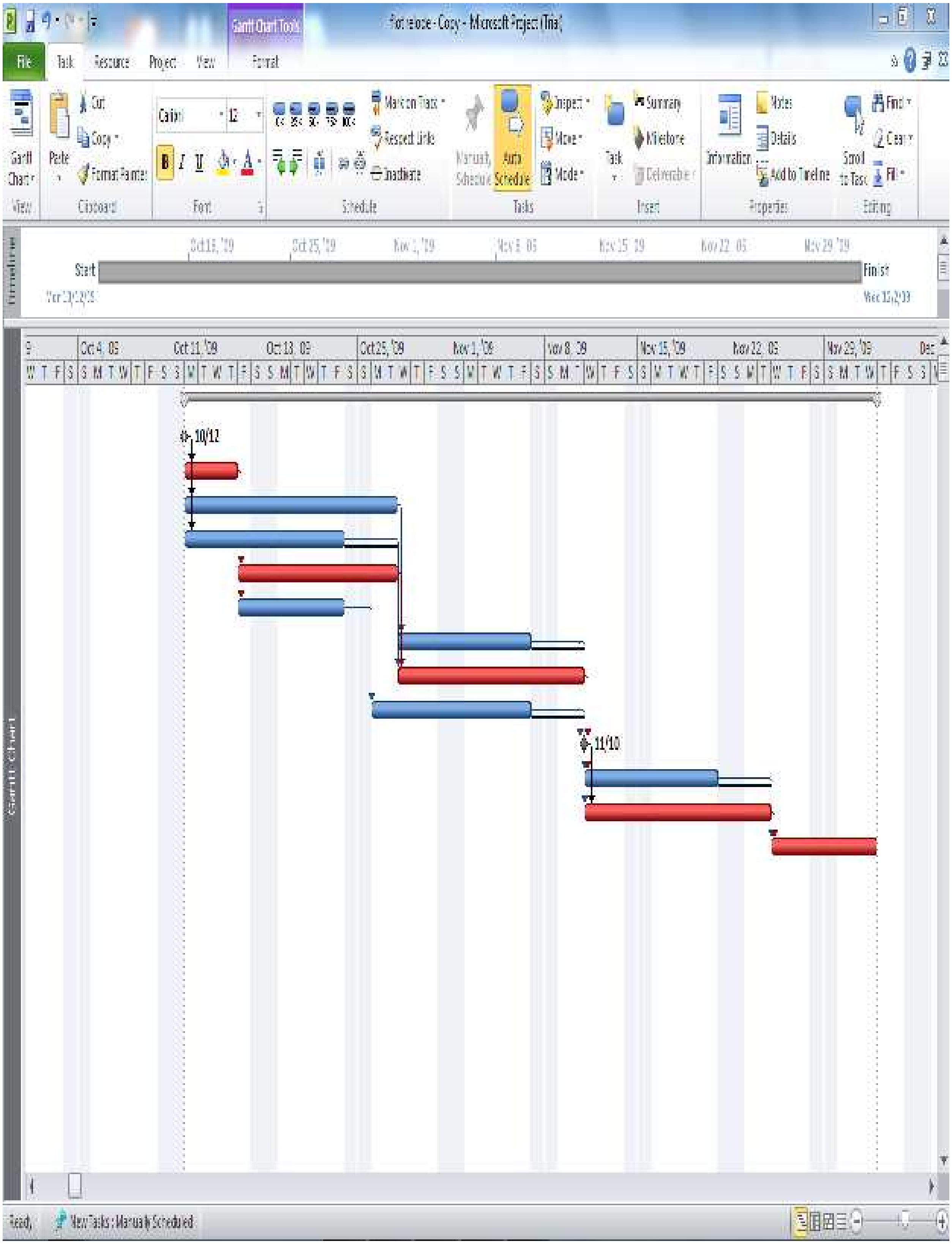
b) APPLYING LOGIC TO MS PROJECT:

This session enables the participants to create a constrained network, view the critical path in the software and level the project to resolve any resource issues.

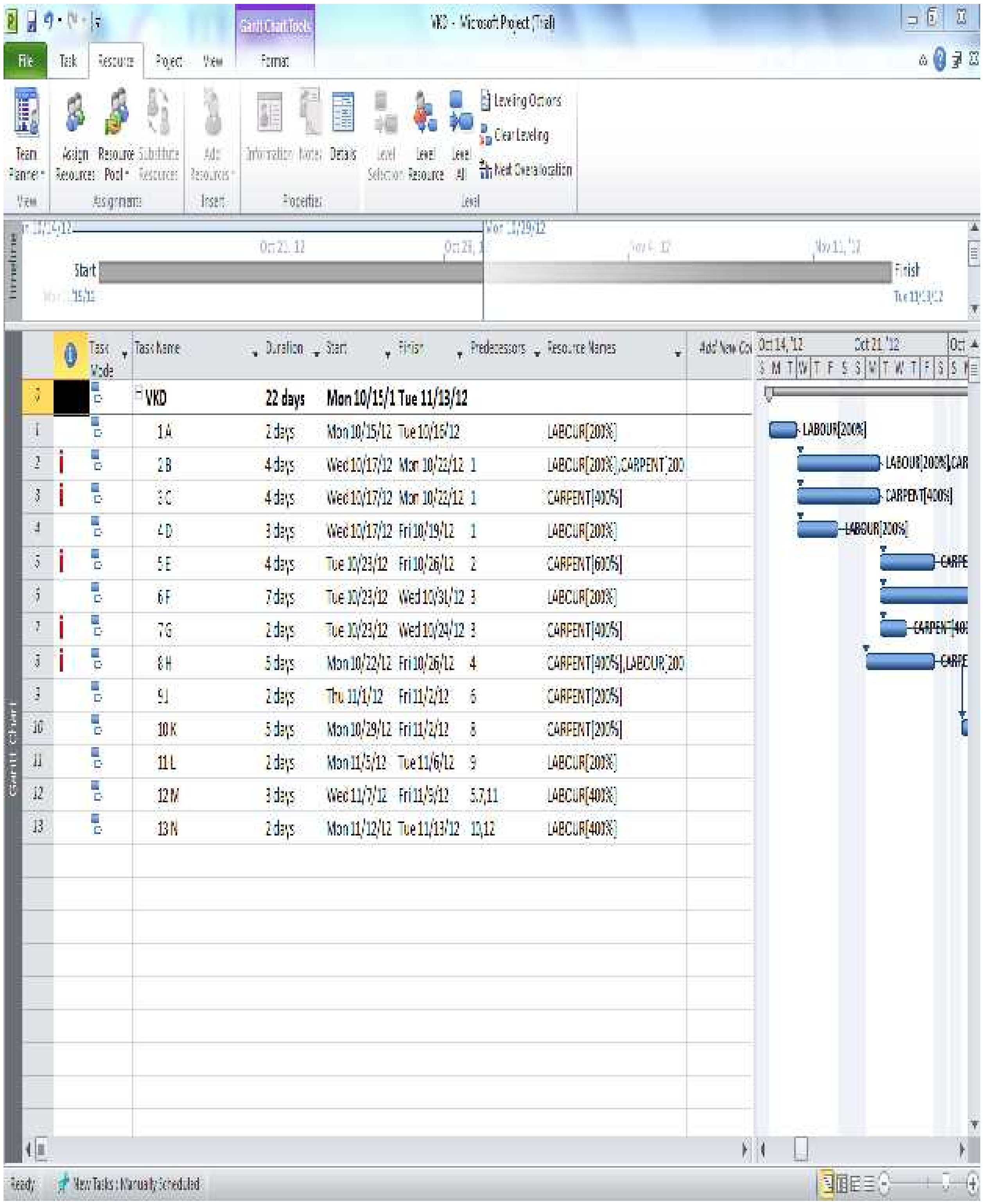
Networks & Gantt Charts:

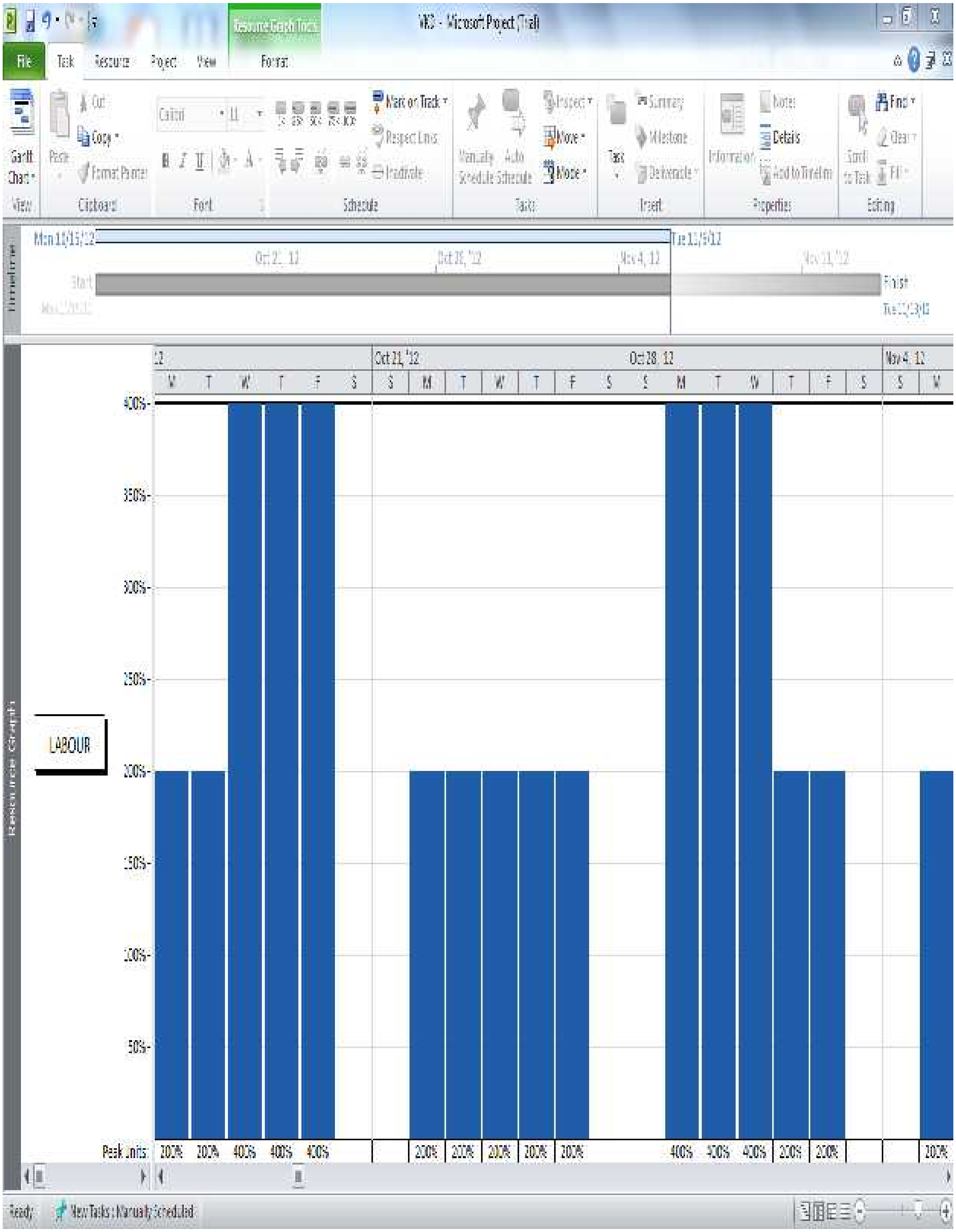


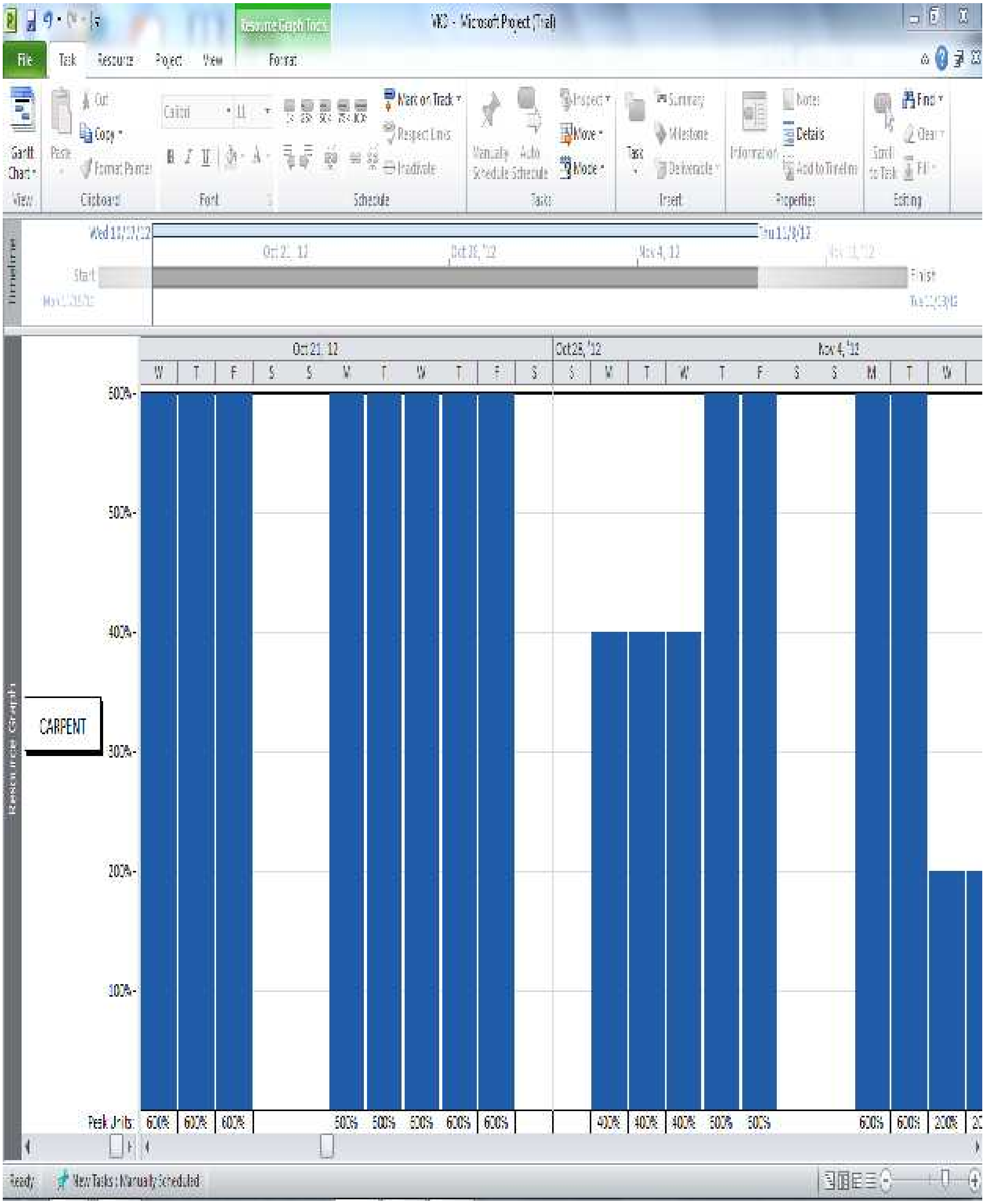
Critical path analysis:

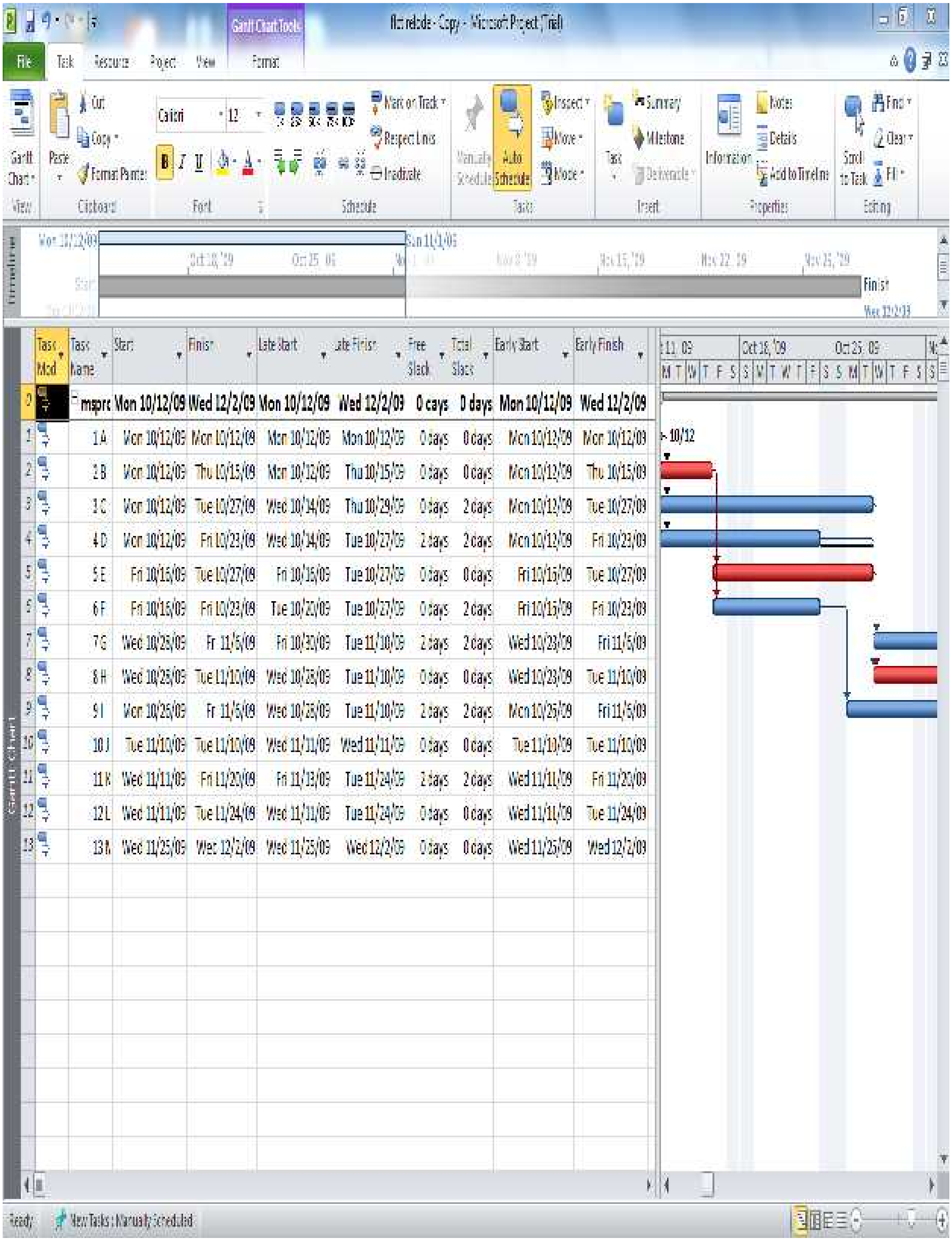


- **Resource Histograms and resource smoothing:**

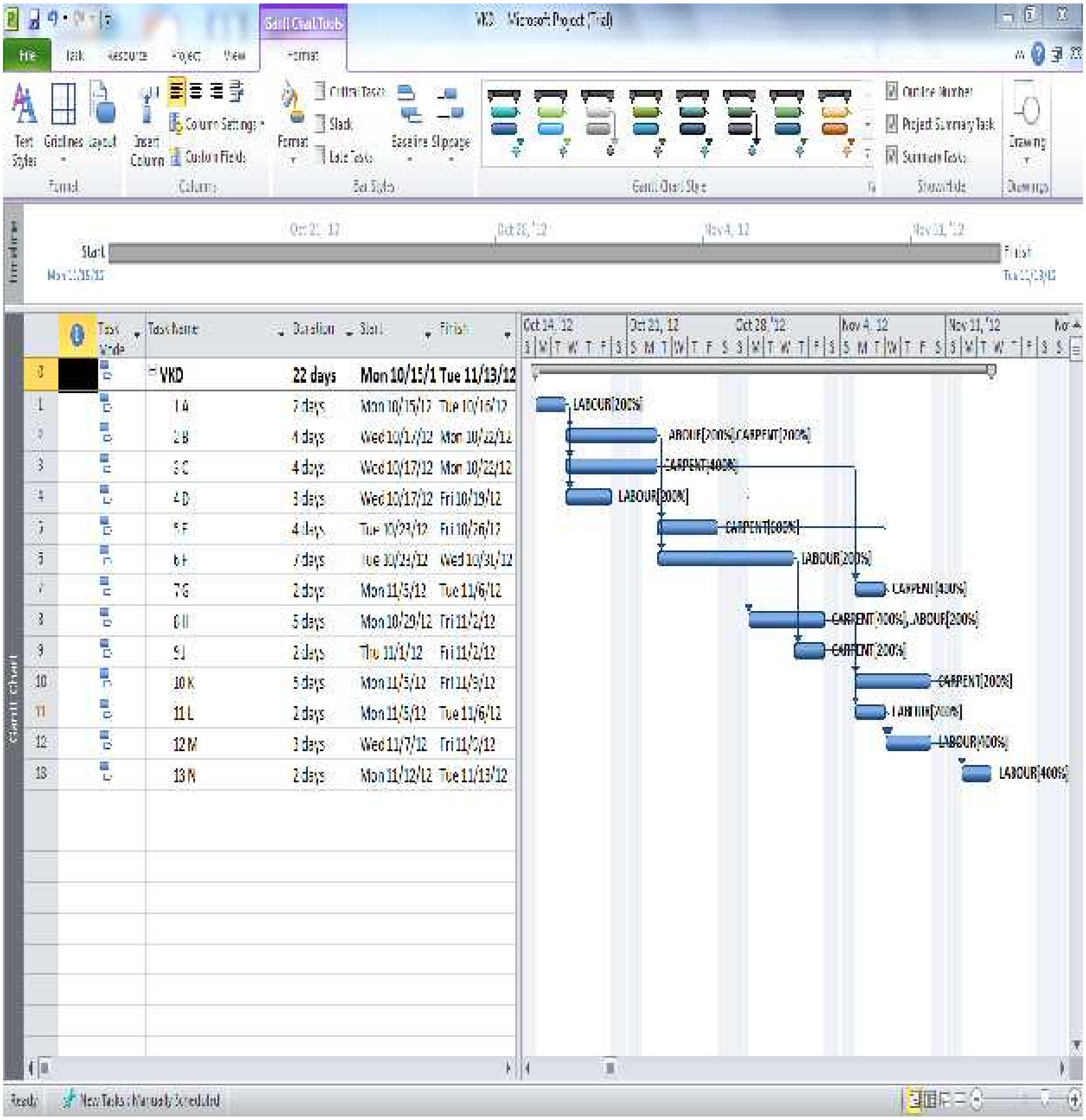



File
Task
Resource
Project
View
Format
Mark on Track
Details
LABOUR
400%
350%
300%
250%
200%
150%
100%
50%
Oct 21, '12
Oct 28, '12
Nov 4, '12
Peak Units:


File
Task
Resource
Project
View
Format
Gantt Chart
Paste
Copy
Mark on Track
Details
Find
Oct 21, '12
Oct 28, '12
Nov 4, '12
CARPENT
400%
300%
200%
100%
Peak Units:
Ready
New Tasks : Manually Scheduled



	Task Name	Start	Finish	Late Start	Late Finish	Free Slack	Total Slack	Early Start	Early Finish
0	mspro	Mon 10/12/09	Wed 12/2/09	Mon 10/12/09	Wed 12/2/09	0 days	0 days	Mon 10/12/09	Wed 12/2/09
1	1 A	Mon 10/12/09	Mon 10/12/09	Mon 10/12/09	Mon 10/12/09	0 days	0 days	Mon 10/12/09	Mon 10/12/09
2	2 B	Mon 10/12/09	Thu 10/15/09	Mon 10/12/09	Thu 10/15/09	0 days	0 days	Mon 10/12/09	Thu 10/15/09
3	3 C	Mon 10/12/09	Tue 10/27/09	Wed 10/14/09	Thu 10/29/09	0 days	2 days	Mon 10/12/09	Tue 10/27/09
4	4 D	Mon 10/12/09	Fri 10/23/09	Wed 10/14/09	Tue 10/27/09	2 days	2 days	Mon 10/12/09	Fri 10/23/09
5	5 E	Fri 10/16/09	Tue 10/27/09	Fri 10/16/09	Tue 10/27/09	0 days	0 days	Fri 10/16/09	Tue 10/27/09
6	6 F	Fri 10/16/09	Fri 10/23/09	Tue 10/20/09	Tue 10/27/09	0 days	2 days	Fri 10/16/09	Fri 10/23/09
7	7 G	Wed 10/28/09	Fri 11/6/09	Fri 10/30/09	Tue 11/10/09	2 days	2 days	Wed 10/28/09	Fri 11/6/09
8	8 H	Wed 10/28/09	Tue 11/10/09	Wed 10/28/09	Tue 11/10/09	0 days	0 days	Wed 10/28/09	Tue 11/10/09
9	9 I	Mon 10/26/09	Fri 11/6/09	Wed 10/28/09	Tue 11/10/09	2 days	2 days	Mon 10/26/09	Fri 11/6/09
10	10 J	Tue 11/10/09	Tue 11/10/09	Wed 11/11/09	Wed 11/11/09	0 days	0 days	Tue 11/10/09	Tue 11/10/09
11	11 K	Wed 11/11/09	Fri 11/20/09	Fri 11/13/09	Tue 11/24/09	2 days	2 days	Wed 11/11/09	Fri 11/20/09
12	12 L	Wed 11/11/09	Tue 11/24/09	Wed 11/11/09	Tue 11/24/09	0 days	0 days	Wed 11/11/09	Tue 11/24/09
13	13 M	Wed 11/25/09	Wed 12/2/09	Wed 11/25/09	Wed 12/2/09	0 days	0 days	Wed 11/25/09	Wed 12/2/09



X. CONCLUSION

Project management is a systematic approach to making the best use of limited resources while achieving program goals. Microsoft Project 2010 makes applying project-management principles to any nonprofit's endeavor easy and rewarding. Project 2010 can handle the smallest projects that need resource allocation, scheduling, and progress tracking, but it’s also capable of managing extremely elaborate and large-scale projects & by using a function of crashing program we easily to crashing the project in a TCT application in a weathering condition.

REFERENCES

Construction Scheduling with Primavera Project Planner by Leslie Feignbaum Publisher: Prentice Hall Managing with Microsoft Project by Lisa A. Bucki, Gary Chefetz Publisher: Premier Press

Microsoft Project Bible by Elaine Marmel Publisher: Wiley Publishing, Inc.

Microsoft Project for Dummies by Nancy Stevenson Publisher: Hungry Minds, Inc.

Step by Step Microsoft Project version 2002 by Carl Chatfield, Tomothy Johnson Publisher: Microsoft Press

Construction scheduling with Primavera enterprise 1.2 by David A. Marchman

Trouble Shooting Microsoft Project by Bonnie Biatore

Microsoft Project inside Out by Teresa S. Stover

Special edition using Microsoft Project by Tim Pyron

Construction Scheduling with Primavera Project Planner by David A. Marchman / Delmar Leaviy

Project Management Handbook by Uddesh Kohli & K K Chitkara Publisher: Tata McGraw-Hill

Project Management by Jack R. Meredith & Samuel J. Mantel, Jr. Publisher: Wiley India

MENEZES, Luis C. de M. Gestao de Projetos. Editora Atlas, 2. Ed., Sao Paulo, 2003.

RAGSDALE, Cliff T. Spreadsheet Modeling and Decision Analysis – A practical introduction to management science. 3 ediçao, Sooth, western college publishing, New York 2001.

SANDRONI, Paulo. Novissimo Dicionario de Economia. Editora Best Seller, 3. Ed., Sao Paulo, 1999.

VARGAS, Ricardo V. Microsoft Office Project 2003 - conhecendo a principal

Ferment de gerenciamento de projetos de Mercado. Rio de Janeiro, Brasport, 2004.

WHITTINGTON, Richard. O que e estrategia. Trad. Maria Lucia G. L. Leal e Martha

Malvezzi Leal. São Paulo: Pioneira Thompson Learning, 2002.

WRITH, Almir. Planejando, replanejando e controlando com MS Project 2000. Editora

Book Express, 2. Ed., Rio de Janeiro, 2002.

Construction Scheduling with Primavera Project Planner by Leslie Feignbaum Publisher: Prentice Hall

Managing with Microsoft Project by Lisa A. Bucki, Gary Chefetz Publisher: Premier Press

Microsoft Project Bible by Elaine Marmel Publisher: Wiley Publishing, Inc.

Microsoft Project for Dummies by Nancy Stevenson Publisher: Hungry Minds, Inc.

Step by Step Microsoft Project version 2002 by Carl Chatfield, Tomothy Johnson Publisher: Microsoft Press

Construction scheduling with Primavera enterprise 1.2 by David A. Marchman

Trouble Shooting Microsoft Project by Bonnie Biatore

Microsoft Project inside Out by Teresa S. Stover

Special edition using Microsoft Project by Tim Pyron

Construction Scheduling with Primavera Project Planner by David A.

Marchman / Delmar Leaviy

Project Management Handbook by Uddesh Kohli & K K Chitkara Publisher: Tata McGraw-Hill

Project Management by Jack R. Meredith & Samuel J. Mantel,Jr. Publisher: Wiley India

Project Management by Clifford F.Gray & Erik W. Larson Publisher: Tata McGraw-Hill

Project Management for Business & Technology by John M. Nicholas Publisher: Eastern Economy Edition

PROJECTS by Prasanna Chandra Publisher: Tata McGraw-Hill

Brunnhoeffer & Celik (2010), "Crashing the Schedule – An Algorithmic Approach with Caveats and Comments".
Proceedings of Associated Schools of Construction 46th Annual International Conference, April 7-10, 2010, Boston,MA.
Demeulemeester, E. L., & Herroelen, W. (2002). *Project Scheduling: A Research Handbook.* New York, NY, USA:
Kluwer Academic Publishers.
Lima, M., Silva, L., Vieira, R. (2006) "Project Crashing and Costs Laws in the Knowledge Age". Third International
Conference on Production Research. America's Region 2006.