A New Tool for Effective and Efficient Project Management

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December 2011

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A New Tool for Effective and Efficient Project Management

An Engineering Report submitted in partial fulfillment of the requirements for the degree of Master of Engineering & Technology Management, Washington State University Engineering &Technology Management Program

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December 2011

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To the Faculty of Washington State University:

The members of the Committee appointed to examine the Engineering Report of

JESSE ALAN WILLETT find it satisfactory and recommend that it be accepted.

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Acknowledgment

It is a pleasure to thank those who made this technical report possible. I would like to thank Dr. James Holt for his advice, guidance, and classroom instruction as one of my professors and my graduate committee advisor.

I would like to thank my family members, especially my wife, Shana Willett; my sons, Arthur and Andrew Willett; and my parents Robert and Crystal Willett for supporting and encouraging me to pursue this degree. Without their encouragement, I would not have finished my Masters degree.

Jesse Willett

A NEW TOOL FOR

EFFECTIVE AND EFFICIENT PROJECT MANAGEMENT

Abstract

by JESSE ALAN WILLETT

Master of Engineering & Technology Management

Washington State University

December 2011

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Organizations routinely handle thousands of projects per year, and it is difficult to manage all these projects concurrently. Too often, projects do not get the attention they need when they need it. Management inattention can lead to late projects or projects with less than desirable content and/or deliverables. This paper discusses the application of Visual Project Management (VPM) as a method to track and manage projects. The VPM approach proved to be a powerful management tool without the overhead and restrictions of traditional management methods.

Acronyms and Abbreviations

CCPM	Critical Chain Project Management
COTS	commercial off-the-shelf
CPM	Critical Path Method
DARPA	Defense Advanced Research Projects Agency
DOE	U.S. Department of Energy
ERB	expert resource bench
PERT	Program Evaluation Review Technique
PNNL	Pacific Northwest National Laboratory
TRL	Technology Readiness Level
VPM	Visual Project Management

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Dedication

This Masters of Engineering & Technology Management Engineering Report

is dedicated to Shana, my wife.

Thank you for all your support and belief

that I can achieve this milestone in my education.

I.   Introduction

The Kingwood project was designed to be a technology transfer project. Researchers at Pacific

Northwest National Laboratory (PNNL) created a unique capability to employ an unmanned

helicopter for specific reconnaissance missions to assess ground conditions at forward locations

without placing humans in harm's way. The researchers integrated several commercial-off-the-

shelf (COTS) products, numerous sensors, and a series of custom electro-mechanical systems

designed and fabricated at the Laboratory. Over the course of the three-year development, the

deliverable system had several spiral developments to increase its capability and reliability to a

Technology Readiness Level 4/5 (U.S. Department of Defense 2009). With the research and

development phase of the project completed, the resulting technology was to be transferred to

another U.S. government organization for field hardening and deployment.

The author of the engineering report is the project manager of the Kingwood Technology

Transfer project. The project was initiated in November 2010. The project's schedule for the

transfer allowed for a maximum timeframe of 10 months. The project had a very limited budget

to accomplish the technology transfer. Because of the limited budget, the project manager used a

recently developed management system that proved to be extremely efficient. The new

management approach, Visual Project Management, or VPM required minimal overhead, yet it

provided an accurate assessment of the status of the project and a method to know if a task was

on track or falling behind (Holt 2011a).

VPM is based on the established Theory of Constraints - Critical Chain Project Management

(CCPM) philosophy (Holt 2011b). VPM was developed by Dr. James Holt, an international

speaker and consultant on applications of Theory of Constraints. Dr. Holt is also a professor at

Washington State University in the University's Engineering & Technology Management Masters Degree program. VPM uses the strengths of CCPM while reducing the extensive managerial attention and complex computer software of CCPM. The VPM philosophy is founded on the following management control systems: a firm and aggressive schedule; frequent status updates; and a visual-based project status fever chart. VPM benefits from the use of the expert resource bench concept.

Based on the academic demonstrations of VPM, the PNNL project manager chose to implement VPM to manage the Kingwood project. The goal was to determine if the VPM methodology is a robust, efficient management tool capable of achieving the deliverable within the limited budget.

II. Background

PNNL is a multi-program national laboratory within the U.S. Department of Energy (DOE) national laboratory complex. PNNL routinely executes approximately 2,400 projects a year for DOE and a wide variety of other U.S. government agencies. Most of the projects are fiscal-year-based and have a period of performance of 9 to 12 months. PNNL is organized according to its areas of research focus, on national security, energy and environment, and computational and fundamental science. The Laboratory has built its reputation on responding to clients' unique technical challenges and delivering innovative solutions in a timely manner.

PNNL is a matrixed organization that allows project managers to reach across the research directorates to access scientists and engineers to solve clients' "DARPA Hard"[1] problems. The matrixed structure, while facilitating multidisciplinary teams, lends itself to unique management challenges. One of the management challenges is that scientists and engineers often work on multiple projects concurrently and support different project managers. Unfortunately, staff members often have to divide their attention throughout the day to respond to the multiple project demands. As a result, task durations increase because of the effort necessary to regain focus each time the same task is restarted. A task with a two-week duration can easily expand to two and a half or three weeks to complete as a result of reacquiring project focus. A second effect of working multiple tasks concurrently is that the completion dates of all of the tasks are delayed further than if each task were completed prior to starting the next task. This phenomenon is known as bad multitasking (Fox 2007). The situation of working on multiple projects concurrently is not unique to PNNL; it is ubiquitous throughout the government and the

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[1] "DARPA hard" is a set of technical challenges that, if solved, will be of enormous benefit to U.S. national security, even if the risk of technical failure is high. (Defense Advanced Research Projects Agency. 2003).

private sectors. There is a critical need for a better way to manage projects and reduce the bad multitasking.

If organizations could manage projects effectively and efficiently while greatly eliminating the bad multitasking, they could complete the projects within a shorter period of time. Accomplishing projects more quickly has numerous additional benefits including:

- increasing project throughput within a given time period

- building reputation for delivering projects within a reduced period of performance

- increasing sales

- increasing revenue.

Only a few new management techniques have evolved over the last 50 years. Notable management techniques include: Program evaluation review technique (PERT), critical path method (CPM), LEAN and Six-Sigma. These management tools greatly improve the systematic execution of projects. Although widely used, these tools do not guarantee that neither a project's individual tasks nor the overall project will be finished on schedule. Therefore, those who use both PERT and CPM techniques embed significant schedule "safety buffers" in the individual tasks to prevent slipping the overall project schedule.

 In 1997, Eliyahu M. Goldratt developed Critical Chain Project Management (CCPM). This project management technique has proven to be extremely effective by reducing the completion time of projects by up to 50 percent and may also reduce the cost of the project when compared

to traditional management techniques (Process Quality Associates Inc. 2006). CCPM is especially effective in multi-project environments.

The CCPM philosophy is distinct from traditional project management tools in several ways. Table 1 outlines the differences. It is important to note that the first and most radical distinction is that the individual tasks are scheduled for the median *aggressive* estimated task duration, thereby eliminating the schedule safety buffers at the task level. The overall project schedule safety is maintained by buffers inserted at strategic locations at the end of the project and where feeding chains intersect with the project's critical chain.

Table 1. Comparison of Traditional Project Management and
Critical Chain Project Management Methods.
(Process Quality Associates Inc. 2006. Used by permission)

	Traditional Project Management Methods	**Critical Chain Project Management (CCPM)**
1	Schedules worst-case task durations	Schedules median task durations
2	Protects individual tasks with safety time	Protects overall project completion with buffers
3	Emphasizes task progress	Emphasizes project progress
4	Starts gating tasks ASAP	Starts gating tasks when they need to start
5	Starts and finishes tasks at scheduled start and finish times	Starts tasks as soon as predecessors are done, finishes tasks as quickly as possible
6	Makes resource contention a PM "fact of life"	Resolves resource contentions explicitly
7	Makes multi-tasking a PM "fact of life"	Minimizes multi-tasking by setting priorities
8	Reacts to uncertainty by changing priorities, expediting, and creating a new schedule	Manages uncertainty by monitoring impact of events on buffer consumption
9	Makes task linkages and constraints reflect ad hoc or habitual scheduling decisions	Makes task linkages and constraints reflect only physical scheduling requirements

While each of the existing project management tools has their strengths, they share the same downfalls:

- excessive complexity

- very restrictive process

- requirement for excessive management attention

- extensive complex computer support and maintenance

- overkill for the majority of day-to-day projects.

What is needed for many projects is a management tool that is simple to use, facilitates planning a project and tracking the execution of the project, and accurately forecasts when a task or project is jeopardizing the successful timely completion of the total project.

The Kingwood project was managed using a new project management tool, Visual Project Management (VPM). VPM uses strengths of PERT, CPM, LEAN, Six-Sigma and CCPM while maintaining a simple, straightforward management approach. This paper examines the benefits, shortcomings and the lessons learned during the process implementing VPM in a real-world project environment.

III. Method of Project Execution

The success of the Kingwood project depended on completion of the various technology transfer tasks in an extremely efficient manner. The project manager also required a plan that could be implemented with minimal effort, yet be robust enough to track the progress of many tasks and forecast if a task would jeopardize the success of the technology transfer project. VPM was chosen as the management tool to streamline the management process of this financially constrained project.

The following is a brief summary of the VPM process and methodology. The first step in implementing VPM is to create a plan for the project. The project plan may be a PERT plan, CCPM plan, or even a list of tasks that need to be accomplished.

The second step is the creation of an aggressive schedule. The creation of an aggressive schedule requires involving those who actually will be performing the work. It is important that the task's aggressive schedule not contain task-level buffer time. Once the project plan and schedule are established, they are to be held firm. The only reason for the plan to be altered is a change in scope of more than 20%.

The VPM process is based on the following equations. The *Percent of Project Time Consumed* (Eq.1), the *Percent of Project Complete* (Eq.2), and the buffer status expressed as *Percent of Buffer Consumed* (Eq.3). It is possible that the calculated percent of project time consumed may be greater than 100% if the project is running late.

$$\% \; Project \; Time \; Consumed = \frac{NOW - Start \; Time}{Critical \; Chain \; or \; Critical \; Path \; Time} \qquad \text{Eq. 1}$$

$$\% \; Project \; Complete = \frac{Completed \; Critical \; Chain \; or \; Critical \; Path \; Tasks \; Time}{Critical \; Chain \; or \; Critical \; Path \; Time} \qquad \text{Eq. 2}$$

$$\% \; Buffer \; Consumed = 2 * (\% \; Project \; Time \; Consumed - \% \; Project \; Completed) \qquad \text{Eq. 3}$$

The third step is to add a buffer to the project duration. The project buffer is used to manage the aggressive schedule. The size of the project buffer is 50% of the Critical Path, Critical Chain, or the sum of the list of task durations defined in the project plan. This buffer may extend the project beyond a fixed delivery date. If that occurs, the 50% buffer is kept at its correct length. The buffer start date is moved back earlier in time so that the buffer ends on the project due date. This means the beginning of the buffer will start before the planned end date of the project. The resulting overlap of the planned project and the buffer is called "pushback." When calculating the 'NOW' value for the Percent of Project Time Consumed (Eq.1) the number of pushback days is added to the elapsed time between time = 0 and the current date. This will adjust the buffer penetration correctly and provide management an accurate status of the project. The process works even if the project would be late without any additional buffer time.

Figure 1 is an example that shows an active project at the time of VPM implementation with 6 days of pushback. At day 0, the project has (0+6)/20 or 33% of the time consumed and no project progress based on the new project schedule. The buffer consumption at time = 0 is 2*(33-0) or 66%. In the next 5 days, the project completes 5 days of work. The percent project complete is 25%. The percent time consumed is (5+6)/20 or 55% and buffer consumption is 2*(55-25) = 60%, giving the correct message to management. Figure 2 shows the fever chart

representation of pushback. The figure shows that the buffer is partially consumed at the project onset.

This pushback method applies for active projects at the time of implementation. All future projects should be scheduled so that the end of the buffer coincides with the due date.
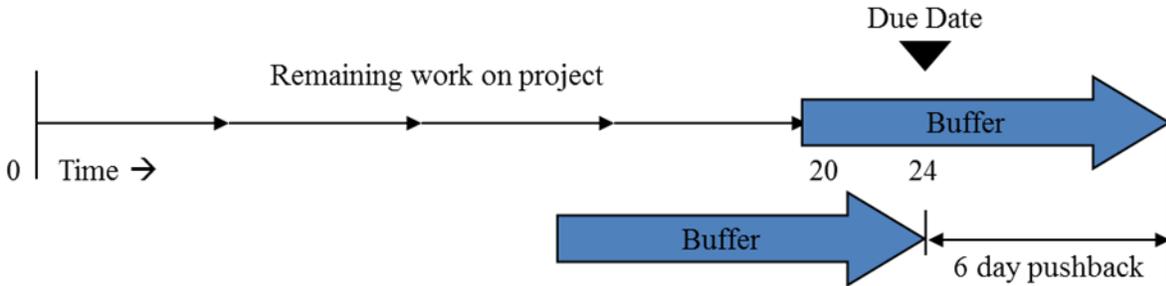
Figure 1. Visual Depiction of the Effect of Pushback to Project.
(Graphic used by permission from JR Holt.)
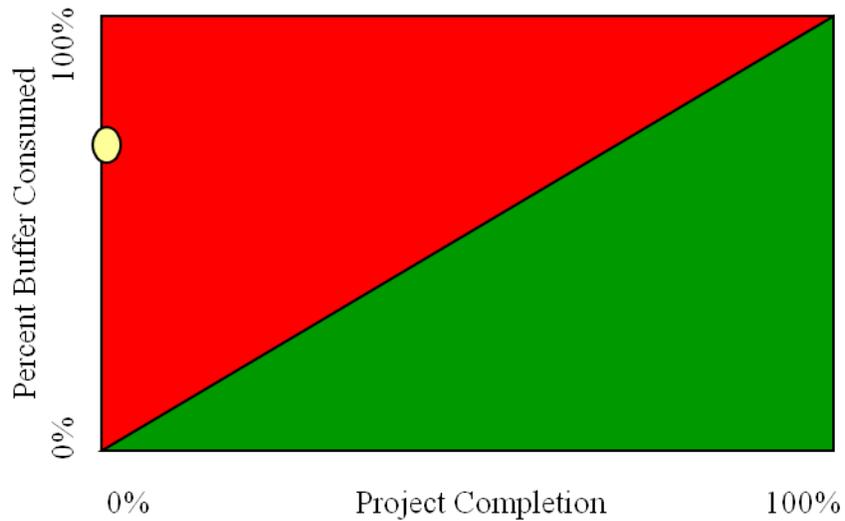
Figure 2. Schedule of Active Project with Buffer Pushback
(Graphic used by permission from JR Holt.)

The fourth step involves picking one individual to be the project recorder. The project staff sends frequent updates, on a predetermined basis, to the recorder. The recorder has access to the original project plan showing each task's anticipated duration and completion dates. As the tasks are reported complete, the recorder notes completion and the date on the project plan. If the task is on the Critical Chain, Critical Path or list, the recorder calculates the following indicators based on Equations 1-3.

Using the values calculated above, the project status is plotted in a project fever chart as depicted in Figure 3 below. The objective of VPM is to use and monitor the project buffer as needed to meet the aggressive schedule. If team members are not completing project tasks on schedule, the line on the fever chart will rise more aggressively than the ½ slope, indicating the project buffer is being consumed at an alarming rate. When the status line moves from the Green Zone to the Red Zone, the project manager should seek help to bring the project buffer consumption back into the Green Zone.
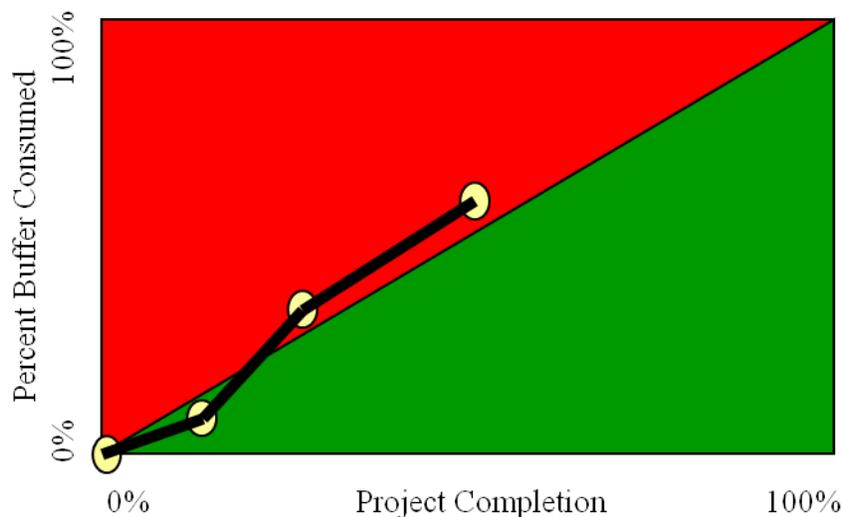
Figure 3. Individual Project Fever Chart
(Graphic used by permission from JR Holt.)

Upon completing the status update in the VPM spreadsheet, the recorder prints out updated

status fever charts. These updated fever charts are forwarded to the project manager.

The beauty of VPM is that all levels of management can quickly determine the status of the

project and the performance trend. When multiple projects are plotted on a master fever chart,

management can easily see which projects are on track and which ones are experiencing

difficulties. It is expected that most projects managed with VPM will fall within the dotted line

in Figure 4.
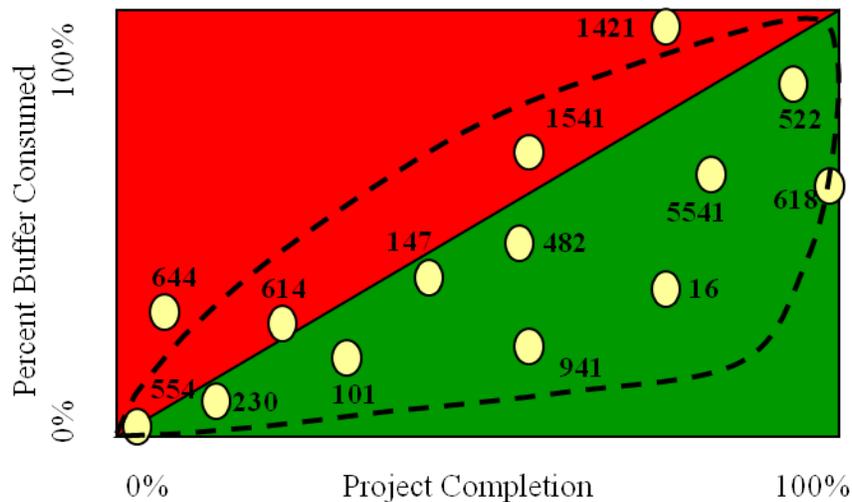
Figure 4. Multi-Project Fever Chart
(Graphic used by permission, JR Holt.)

In order to further understand the steps required to implement the VPM process in an ongoing

multiproject environment, we look to Dr. Goldratt's CCPM implementation strategy. One of the

fundamental underpinnings of CCPM is the drastic reduction of, and ideally the elimination of,

bad multitasking. Dr. Goldratt has determined that most companies, if not all, have too many

projects in place at any one time (Goldratt 2010). As a result, the staff members are forced to

multitask. On the surface, multitasking may appear to be effective, but it has been proven to

cause queuing of project tasks and delaying of each project that the multitasking touches (Lechler 2011; Santosus 2003). Multitasking effectively reduces employees' productivity and may cause significant delays in project tasks. It is far more efficient to eliminate, or strictly limit, employee's multitasking to focus on the tasks at hand until complete. If an employee comes to a standstill because he is waiting on another team member, switching to another mini-task that can be completed while waiting is productive. In contrast, stopping and starting tasks before they can be logically handed off to another team member is grossly inefficient.

The fifth step involves the project manager meeting with upper management to establish an expert resource bench (ERB). The ERB is composed of the best, brightest, and the most innovative 10% of staff. These individuals should have good communication skills paired with a history of innovative problem solving.

The ERB could be viewed as a kind of special weapons and tactics (SWAT) team responsible for improving the project deliverables, providing a fresh perspective to project dilemmas, and improving system processes. They spend time, as needed, observing the processes, functions, and tasks of employees, looking for inefficiencies, discussing project technical challenges and thinking about better methods of accomplishing the tasks. While the projects are in the Green Zone, the ERB's task is to not interfere with the project but, rather, to watch, think about and discuss the existing or potential problems and the corresponding solutions. They address questions like:

- Why is the buffer being consumed rapidly without progress?

- What is the underlying problem?

- How can we improve the system?

In a research and development environment, they may also address technical roadblocks and how to overcome them.

If the project enters the Red Zone, the ERB is called in for direct assistance. The ERB is management's first line of defense. It is empowered to address the problems and move the project back into the Green Zone. The first questions the ERB asks the project team are: "What are you waiting for?" and, "How can we help you?" If those answers and corresponding solutions don't bring the project back towards the Green Zone, ERB members address the underlying systemic or technical problems. They are also the first responders or the subject matter experts, mentors, or trainers who come and help or teach with just-in-time instruction to those ready to learn.

Management may be hesitant to assign such valuable employees to the ERB. They may fear that they will not recover the cost of losing their best employees from their other tasks. In order to put this recommendation into perspective, let us consider the following. A project that is worth doing has both high monetary and utility values to both the company and the customer. With that premise in mind, the value of the project should be considered the driving measure in pursuing the project, not just the cost to the company including the ERB members. In most, if not all projects, the value of completing the project is usually multiple times the cost of the project. If it is not, management should examine the motivation of starting or continuing the project.

The second consideration is when management is involved in the right way, and the ERB is in place, delays will be reduced. Bad multitasking within the company decreases. Task durations are shortened, resulting in projects moving quickly and more predictably, ultimately resulting in

on-time delivery; something that adds significant value to the projects. Companies that implement CCPM, upon which VPM is founded, routinely reduce the project completion time by 50% (Process Quality Associates Inc. 2006). By completing projects quickly, more projects will be completed in the same amount of time thereby generating more profit.

The third consideration is that the company culture will experience a paradigm shift. The culture will shift from solely a financial focus to that of a mind-trust where the experience of the best and brightest employees is used to enhance products and generate new innovations and breakthroughs. Mentoring will become a part of the culture. Being exposed to mentoring, innovative, and problem-solving senior employees, can assist the organization in achieving higher goals.

The bottom line is that the financial gain from adopting VPM and the ERB is expected to far outweigh the cost of the ERB. If needed, the direct cost of the ERB could be incorporated into the company's overhead structure as a vital part of the management team.

IV. Implementation

The VPM philosophy, as described above, allows for project managers to plan and efficiently track projects. As VPM is a new project management approach, one wonders if it is robust enough to be beneficial in the day-to-day world of project management. To answer that question, the Kingwood project manager put VPM to the test. VPM is designed to "…keep things moving, maintain focus on the important elements, yield predictable completion, and enable workers to deliver quality at every step…." (Holt and Srinivasan 2011). VPM assumes that projects need to be done as quickly and efficiently as possible and the technical team moves on to the next project. The Kingwood project did not fit into the standard paradigm of the VPM philosophy because it had a very relaxed time schedule. However, the project was financially constrained and only a limited number of man-hours could be charged against the budget. In order to conserve funds, each of the project's tasks were viewed as "team sprints" where the staff members would dedicate themselves to accomplishing the task in a short amount of time and then have a reprieve until the next focused activity. The approach of focused "team sprints" is an example of good multitasking that is well-planned and coordinated. This "team sprint" approach was possible because most of the tasks did not have complex interdependencies and were sequential with minimal tasks running in parallel. In order to capitalize on VPM's strength of managing projects to an aggressive schedule, the project manager decided to use VPM to manage each task as a sub-project. Each of the sub-projects was graphed on a master VPM fever chart.

In order to give the new management approach a fair evaluation, the project manager explained to the small, multidisciplinary project team the VPM philosophy. This process allowed discussion and cautious buy-in from the team. The project team outlined the sub-projects

required to complete the project. Although skeptical, the team needed to develop an aggressive schedule for the project's individual sub-projects and to add a 50% buffer for each. The successful completion of the project demanded that the sub-projects be completed quickly and efficiently.

The Gantt chart in Figure 5 showed the critical chain of the Kingwood project. Many of the sub-projects incorporated several peripheral Laboratory staff members who worked alongside the Kingwood team to accomplish the project's tasks.
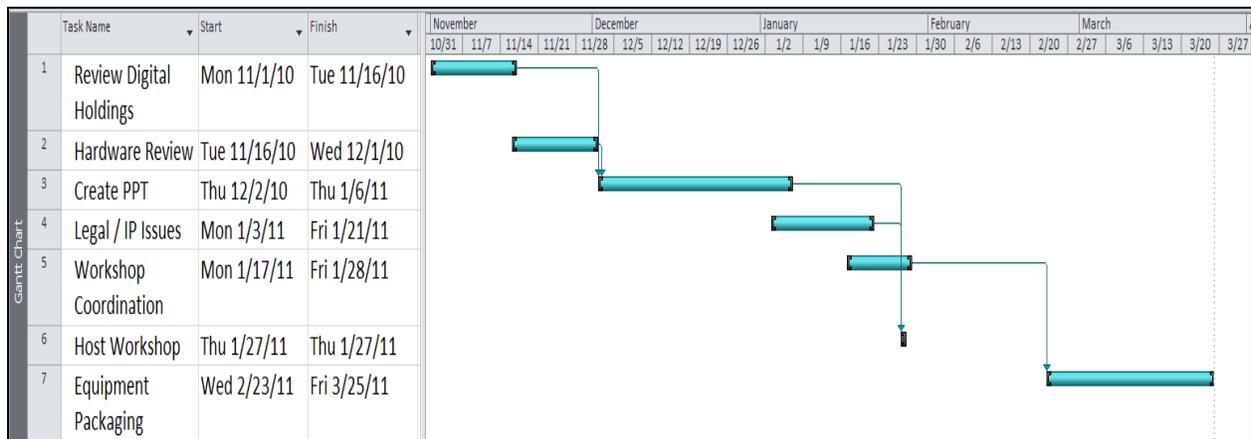
Figure 5. Kingwood Project Gantt Chart

The project was broken down into the following subtasks:

- Review of the technology developed over the prior three years. The review included creating a spreadsheet to organize the relevant project hardware, software, and sensors for transfer.

- Develop an effective method of technology transfer. After looking at multiple methods to effectively transfer the project's technology, an interactive workshop at PNNL was selected. The technical subject matter experts would present the project accomplishments, hardware, software, system demonstrations and test results. A

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PowerPoint®[2] presentation covering the technology advances, hardware demonstrations and technical reports would be used to support the workshop objectives.

- Collect digital design documentation. The digital mechanical, electrical and software design files were collected and packaged for transfer.

- Address legal issues. Project management worked with the legal and intellectual property departments to address and resolve potential issues.

- Host the technology transfer workshop.

- Package and ship the Kingwood equipment.

As the Kingwood project was a small-scale pilot implementation of VPM, the project did not have a dedicated ERB. As such, the project manager and the principal investigator acted as their own ERB.

The project was initiated with determination and focus. Each of the sub-projects was tracked frequently and regularly (daily, if the sub-project was less than a week or weekly if a longer duration). The status information was plotted on the fever charts to determine if the sub-project was in the Green or Red Zone of the fever chart. If the sub-project was in the Green Zone, the manager shared his appreciation for the diligent work. If the sub-project was in the Red Zone, the manager and the principle investigator, acting as the ERB, would determine what was causing the delay and work with the team to provide the needed assistance to get the task back into the Green Zone.

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[2] PowerPoint is registered trademark of Microsoft.

V. Documented Findings

Below are examples of VPM worksheets and fever charts for the sub-project "sprints" within the Kingwood project. The first example (Figures 6 and 7) is of a sub-project lifecycle that visually depicts how it operated within the Green Zone. Technical progress was accomplished according to plan and the sub-project buffer was consumed at an appropriate rate. The tasks were started by the suggested start date and were accomplished on time.

	A	B	C	D	E	F	G	H
1	Reporting Date	11/10/2010						
2								
3	Sub-Project Name	Review Digital Holdings						
4	Percent Complete	100%						
5	Percent Time	150%		Push Back				
6	Buffer Consumption	100%		0				
7								
8	Project	Estimate in Days		Completed				
9	Total	6		6				
10	Date Started>	11/1/2010						
11	Suggested Start>	11/7/2010						
12	Date Due>	11/16/2010						
13								
14	Project Tasks	Estimate number of working days	Number of non-working days within the time period	Estimate Total Days	Date Complete	Completed Work	% Complete	% Buffer
15	Start Task	0	0	0	1-Nov	0	0%	0%
16	Review prior PPT files	2	0	2	4-Nov	2	33%	33%
17	Review photo collection	1	2	3	8-Nov	3	83%	67%
18	Review video collection	1	0	1	10-Nov	1	100%	100%

Figure 6. Worksheet for Sub-Project 3, Review Digital Holdings
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)[3]

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[3] Visual Project Management Excel macro is available from JR Holt, jholt@wsu.edu.
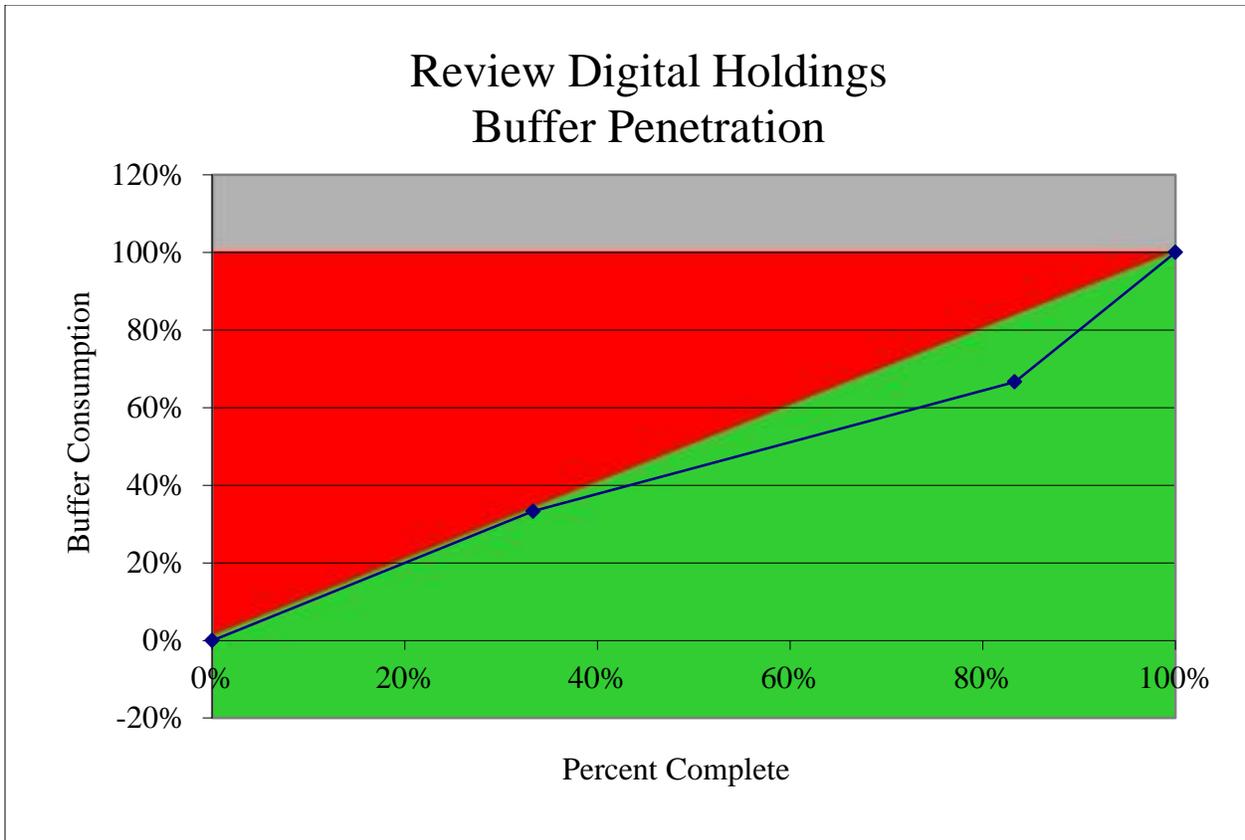
Figure 7. Buffer Consumption Fever Chart for Sub-Project 3, Review Digital Holdings
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)

The second example is of a sub-project lifecycle that used the initial "push-back" delay. The tasks were started later than recommended, which resulted in an instantaneous consumption of sub-project buffer of 31%. The staff worked diligently to recover the project buffer and finished the sub-project within the allotted amount of time.

	A	B	C	D	E	F	G	H
1	Reporting Date	1/18/2011						
2								
3	Sub-Project Name	Create PPT						
4	Percent Complete	100%						
5	Percent Time	150%		Push Back				
6	Buffer Consumption	100%		4				
7								
8	Project	Estimate in Days		Completed				
9	Total	26		26				
10	Date Started>	12/14/2010						
11	Suggested Start>	12/10/2010						
12	Date Due>	1/18/2011						
13								
14	Project Tasks	Estimate number of working days	Number of non-working days within the time period	Estimate Total Days	Date Complete	Completed Work	% Complete	% Buffer
15	Start Task	0	0	0	14-Dec	0	0%	31%
16	Create 90% Rough Cut	3	2	5	21-Dec	5	19%	46%
17	Refine 90% Presentation	2	12	14	5-Jan	14	73%	54%
18	Add Detector Technical Content	1	0	1	6-Jan	1	77%	54%
19	Review presentation with management	1	1	2	10-Jan	2	85%	69%
20	Add comments and requested changes	2	2	4	18-Jan	4	100%	100%

Figure 8. Worksheet for Sub-Project 4, Create PowerPoint Presentation
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)
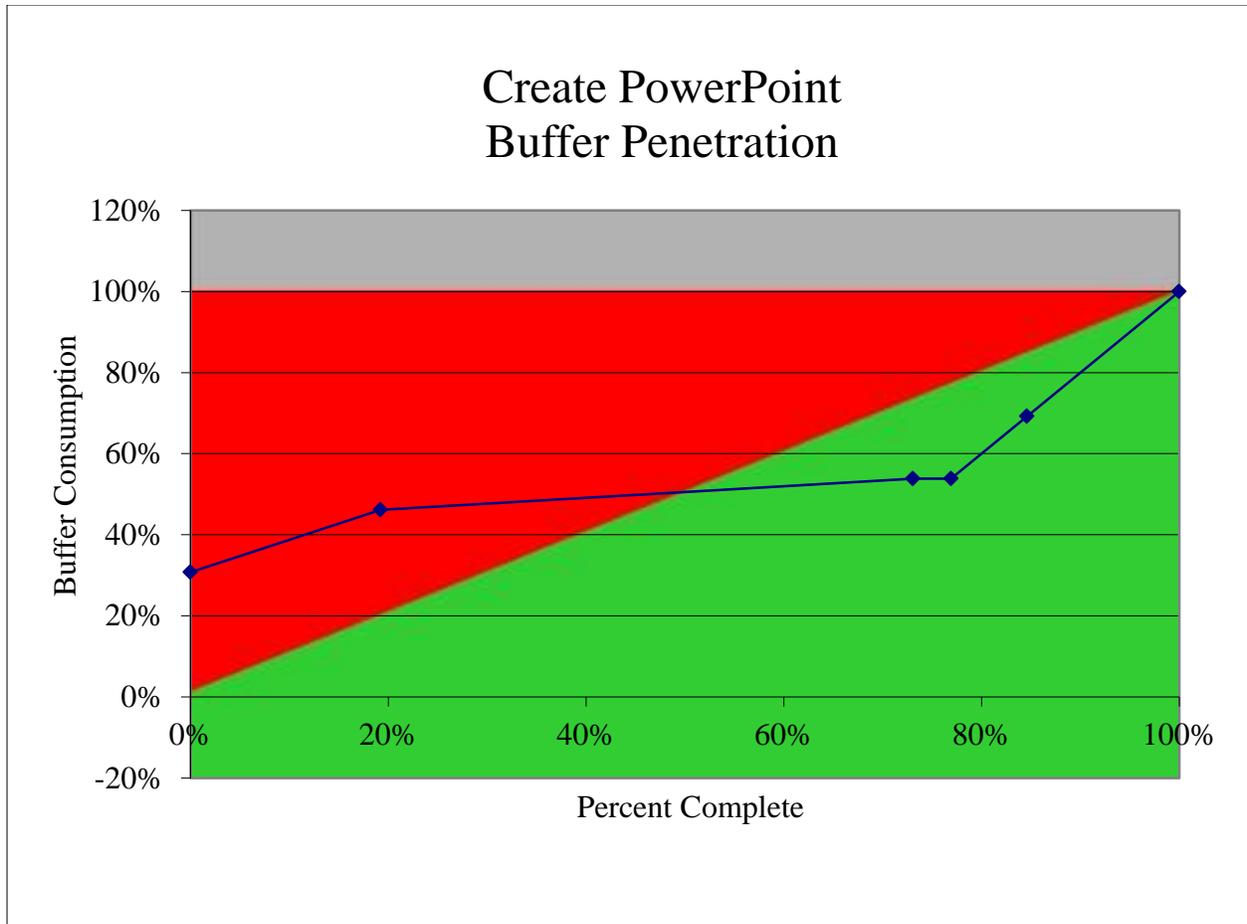
Figure 9. Buffer Consumption Fever Chart for Sub-Project 4,
Create PowerPoint Presentation
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)

The third example (Figures 10 and 11) is of a sub-project life-cycle that shows minimal buffer

penetration and was completed ahead of schedule. The tasks were started as recommended. The

tasks were accomplished quicker than anticipated resulting in a modest use of the sub-project

buffer allotment.

	A	B	C	D	E	F	G	H
1	Reporting Date	3/21/2011						
2								
3	Sub-Project Name	Equipment Packaging						
4	Percent Complete	100%						
5	Percent Time	130%		Push Back				
6	Buffer Consumption	60%			0			
7								
8	Project	Estimate in Days		Completed				
9	Total	20		20				
10	Date Started>	2/23/2011						
11	Suggested Start>	2/23/2011						
12	Date Due>	3/25/2011						
13								
14	Project Tasks	Estimate number of working days	Number of non-working days within the time period	Estimate Total Days	Date Complete	Completed Work	% Complete	% Buffer
15	Start Task	0	0	0	23-Feb	0	0%	0%
16	Receive feedback from workshop participants	1	0	1	24-Feb	1	5%	0%
17	Package requested items	3	10	13	11-Mar	13	70%	20%
18	Transfer items to shipping department for palletizing	2	3	5	18-Mar	5	95%	40%
19	Transfer items to short term storage pending shipping	1	0	1	21-Mar	1	100%	60%

Figure 10. Worksheet for Sub-Project 6, Equipment Packaging
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)
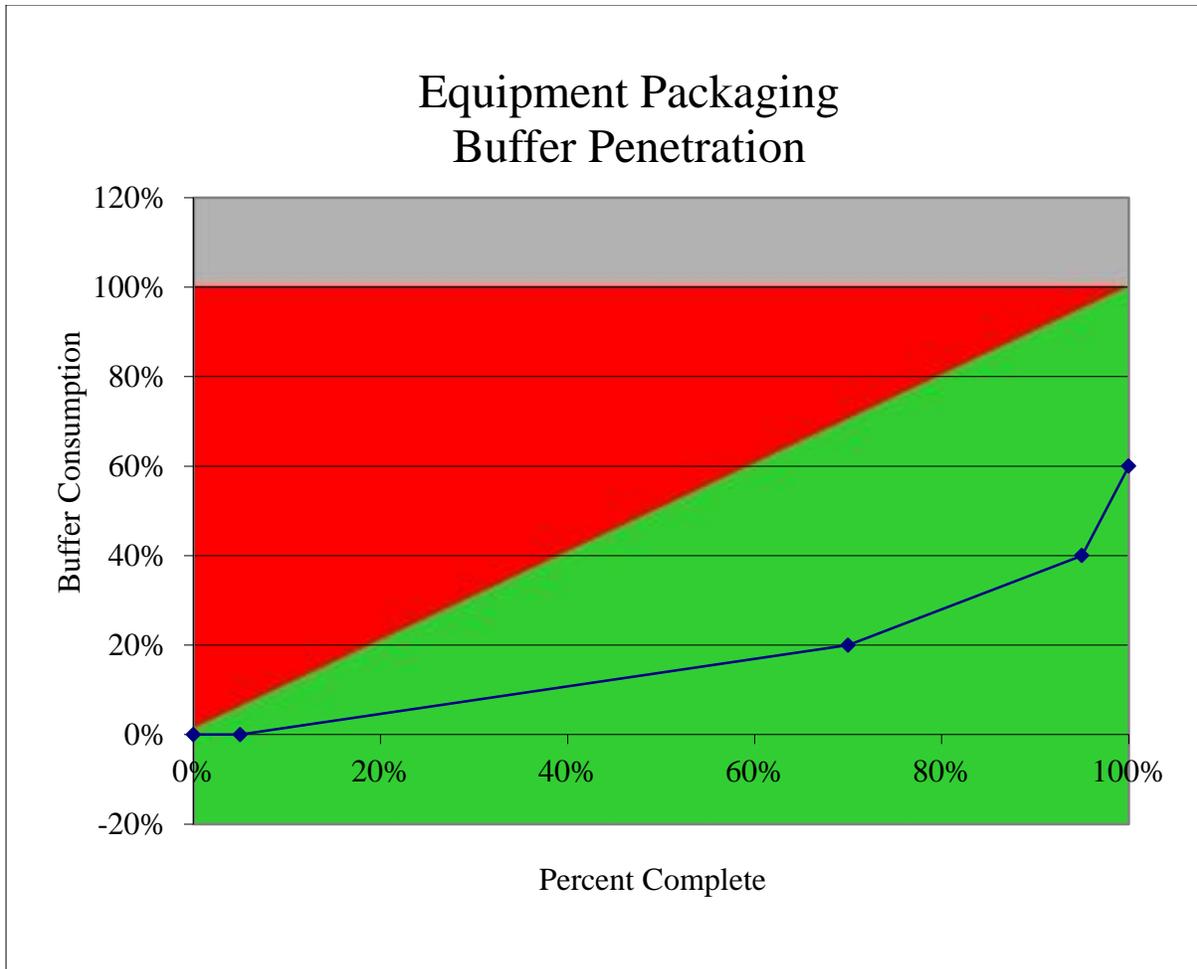
Figure 11. Buffer Consumption Fever Chart for Sub-Project 6, Equipment Packaging
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)

The VPM multiple project summary chart (Figure 12) shows the project status at on January 12, 2011. The figure shows the Review Digital Holdings, Hardware Review and Solve Legal and IP Issues completed with their respective amounts of consumed buffer. The Create PowerPoint sub-project is within the Green Zone at 85% complete and a consumption of 69% of its allotted buffer. The remaining two sub-projects have yet to be started.

Project	Hardware Review	Buffer Cunsumed	Create PowerPoint	Buffer Cunsumed	Review Digital Holdings	Buffer Cunsumed	Solve Legal and IP Issues	Buffer Cunsumed	Prepare & Host Workshop	Buffer Cunsumed	Equipment Packaging	Buffer Cunsumed
Project Status as of Today												
Current Date 12-Jan-11												
Push Back		0		0		4		1		1		0
% Complete / % Buffer Consumed	100%	80%	85%	69%	100%	100%	100%	33%	0%	0%	0%	0%
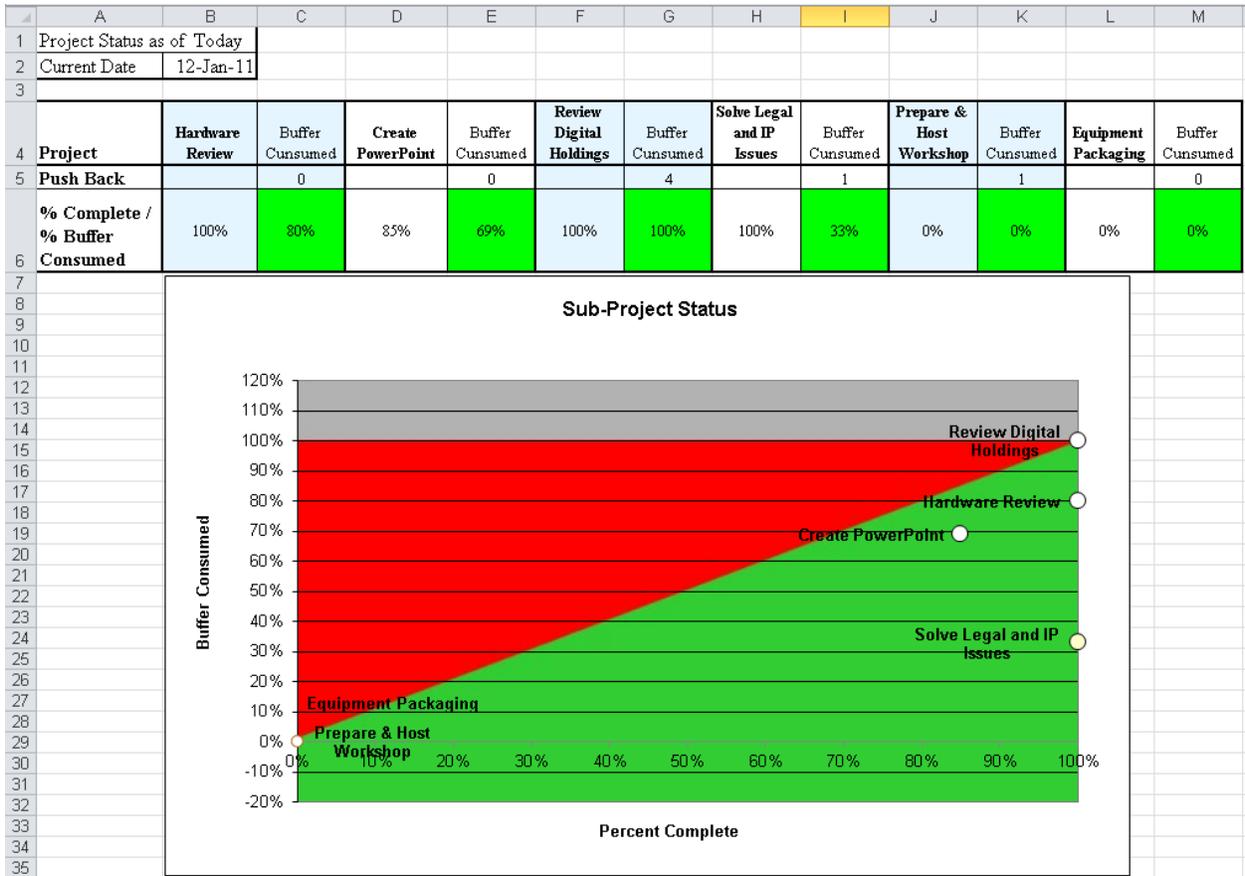
Figure 12. Kingwood Sub-Projects Plotted on the VPM Multiple Project Summary Chart Visual Project Management Excel Macro.
(Used by permission from JR Holt.)

VI. Analysis and Evaluation

During the Kingwood Project, the VPM tool worked well projecting the recommended start dates for the sub-projects and incorporated the VPM 50% time buffer. If the project started on a date later than the recommended date, the tool calculated the push-back value and adjusted the fever chart appropriately. The Hardware Review, Review Digital Holdings, and Equipment Packaging sub-projects started on time and remained in the Green Zone on the fever chart for the duration of the task.

The VPM tool correctly calculated the push-back for the Create PowerPoint, Solve Legal and Intellectual Property Issues, and the Prepare and Host Technology Transfer Workshop sub-projects. In each case, the fever charts showed the sub-project was in trouble because of a late start. Consequently, the project manager worked with the team to expedite the related tasks and bring the project back into the Green Zone. In the case of the Legal and Intellectual Property Issue sub-project, the manager and principal investigator (acting in the role of the ERB), worked with the legal and intellectual property staff to accomplish the tasks by the required date.

The Equipment Packaging sub-project had the most relaxed project schedule of the sub-projects. The low buffer consumption resulted from the longer delivery schedule. In hindsight, this sub-project did not fit the VPM model as its tasks had not been aggressively scheduled.

The VPM multiple project summary chart was a quick and efficient method to assess and update upper management and team members on the status of the Kingwood project. It combined the sub-project's percent complete and percent of buffer consumed with a graphical representation is a readily understandable format.

Based on the real-world trial of VPM on the Kingwood project, the project manager found the tool to be an effective and efficient way to plan and manage a project. The fever chart, as a reporting tool, was helpful to know when to allow the sub-projects to continue without project management involvement and when to step in to address a problem.

The identification of bad multitasking and frequent requests to minimize bad multitasking allowed the staff to remain focused on their tasks. The result was a relatively quick completion of the required tasks and the project continued to move with minimal delays.

The project manager found some weaknesses with how the VPM spreadsheet managed non-working and elapsed days, especially in short duration projects. The project manager added a column in the spreadsheet to capture the non-working and elapsed days, but the automatic buffer calculation did not take into account the non-working days in determining the buffer size. In hindsight, the spreadsheet calculations could have been modified to incorporate the non-working days.

The following are comments provided to the project manager regarding the Kingwood project execution and the implementation of VPM within the project by PNNL management and clients.

"As a project contributor, I appreciate a management system that minimizes the inefficiencies that have become widely accepted in a multi-tasking environment. As the principal investigator, I view the ERB plan as a welcomed and intrinsically valuable part of VPM." *John Smart – Kingwood Principle Investigator*.

"The Kingwood transfer project, while small, was extremely important as it was key in the final Kingwood product delivery. The project manager was able to use VPM to manage and track

resources with optimal results. Implementing VPM on the project made the best of a prior, difficult situation and delivered results to the client. Credit should also go to the project manager for recognizing the project challenges and coming up with a viable solution. It should be noted that VPM is just a tool and still requires a skilled manager to use successfully." *Steven Sharpe – PNNL client account manager.*

"The use of Visual Project Management (VPM) facilitated for a smooth transition of all technology associated with Kingwood project, starting with a presentation of all material which included a video presentation demonstrating all of the equipment to be transferred and hands-on demonstrations. Prior to the equipment transfer, detailed inventory sheets were provided to the receiving agency in a timely manner. The inventory sheets made possible the efficient tracking of the transferred material. I found this process promoted better time management and reduced expenditures." *Jon A. – Funding client within the U.S. government organization responsible for field hardening and deployment of the Kingwood technology.*

"The Kingwood Technology Transfer project was initiated in November 2010. The project manager used Visual Project Management to plan and manage the project. He developed a transition plan, summarized the prior three years of research and organized a one day workshop. The technology transfer workshop used a combination of presentations, technical discussions with staff engineers, software and hardware demonstrations to train and inform the technology stakeholders on the unmanned reconnaissance helicopter system. The training was very well done and thorough. The technology transfer package included the Kingwood system's design documentation/schematics to facilitate further development and hardening of the system. The technology transfer project was a success and was accomplished within the allotted budget." *U.S. Government Kingwood Project Funding client. Name withheld upon request.*

VII. Conclusions and Recommendations

The Kingwood Technology Transfer project was successfully managed. The technology and equipment developed over the three-year spiral development were transferred to a U.S. government organization for field hardening and deployment. The Kingwood technical staff did a remarkable job accomplishing the project within budget while delivering a high-quality product.

Visual Project Management was instrumental in the planning of an aggressive schedule and tracking the progress of the team. The approach of breaking the project into "team sprint" sub-projects was effective. This approach was in harmony with VPM's rapid execution of each task and quick project delivery. VPM mandates an extremely aggressive schedule with a project level buffer to absorb delays in accomplishing tasks.

One of the strengths of VPM is the straightforward graph charting of the project's progress. The fever charts and the multiple project summary chart allowed the project manager, staff, and upper management to track the progress of the project's tasks frequently. The fever chart was an effective visual tool for tracking the tasks' progress and determining how much of the project buffer was being consumed. The fever chart also allowed the project manager to determine when tasks were being delayed and to provide the required resources to get the task moving forward again.

As part of the VPM philosophy, the project staff members were encouraged to minimize non-productive multitasking. By staying focused on the tasks, positive momentum was maintained and the tasks were accomplished quickly.

At the time of the Kingwood VPM implementation, the VPM status tracking tool and fever chart were based on Excel®[4] and relatively young. The project manager found that the tool did not account well for non-work days when determining the 50% buffer size. This was especially an issue with short duration sub-projects spanning the Christmas and New Year holidays. Prior to marketing VPM to the general project management population, VPM needs to incorporate a feature to account for non-work and elapsed time days. At the time of publication, VPM-Lite is available through the iPhone®[5] app store[6].

Based on the implementation results of VPM in a real-life project environment, it is recommended that VPM be considered for a larger pilot study involving multiple projects. This larger pilot study would further determine the effectiveness of the new project management tool. In conjunction with the larger study, it is also recommended that a scaled ERB be formed to assist the pilot program.

In summary, Visual Project Management is a simple, as opposed to simplistic, way to manage individual and multiple projects by incorporating the proven practices of Critical Chain Project Management without the negative aspects of CCPM. VPM offers managers a tool to get all their projects moving and keep them moving efficiently towards completion. The VPM philosophy drastically minimizes bad multitasking. Through frequent reporting, VPM provides an indicator to identify when inefficiencies, including multitasking, appear in the projects. It allows for frequent status reporting without the subjectivity of other management methods. VPM has a bright future in the project management methodologies and should be considered as an effective and efficient way to manage small to mid-sized projects.

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[4] Excel is a registered trademark of Microsoft.
[5] iPhone is a registered trademark of Apple, Inc.
[6] http://www.apple.com/iphone/from-the-app-store/

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X. Appendix

The subprojects that demonstrated the VPM process are included in the body of the report. The following worksheets and fever charts are supplemental.

|	A	B	C	D	E	F	G	H
1	Reporting Date	11/22/2010						
2								
3	Sub-Project Name	Hardware Review						
4	Percent Complete	100%						
5	Percent Time	100%		Push Back				
6	Buffer Consumption	0%		0				
7								
8	Project	Estimate in Days		Completed				
9	Total	6		6				
10	Date Started>	11/16/2010						
11	Suggested Start>	11/22/2010						
12	Date Due>	12/1/2010						
13								
14	Project Tasks	Estimate number of working days	Number of non-working days within the time period	Estimate Total Days	Date Complete	Completed Work	% Complete	% Buffer
15	Start Task	0	0	0	16-Nov	0	0%	0%
16	Review boxed hardware & create spreadsheet	2	0	2	19-Nov	2	33%	33%
17	Determine what hardware to present	1	0	1	19-Nov	1	50%	0%
18	Phyical checkout of hardware to present	1	2	3	22-Nov	3	100%	0%

Appendix Figure 1. Excel Worksheet for Sub-Project 1, Hardware Review
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)
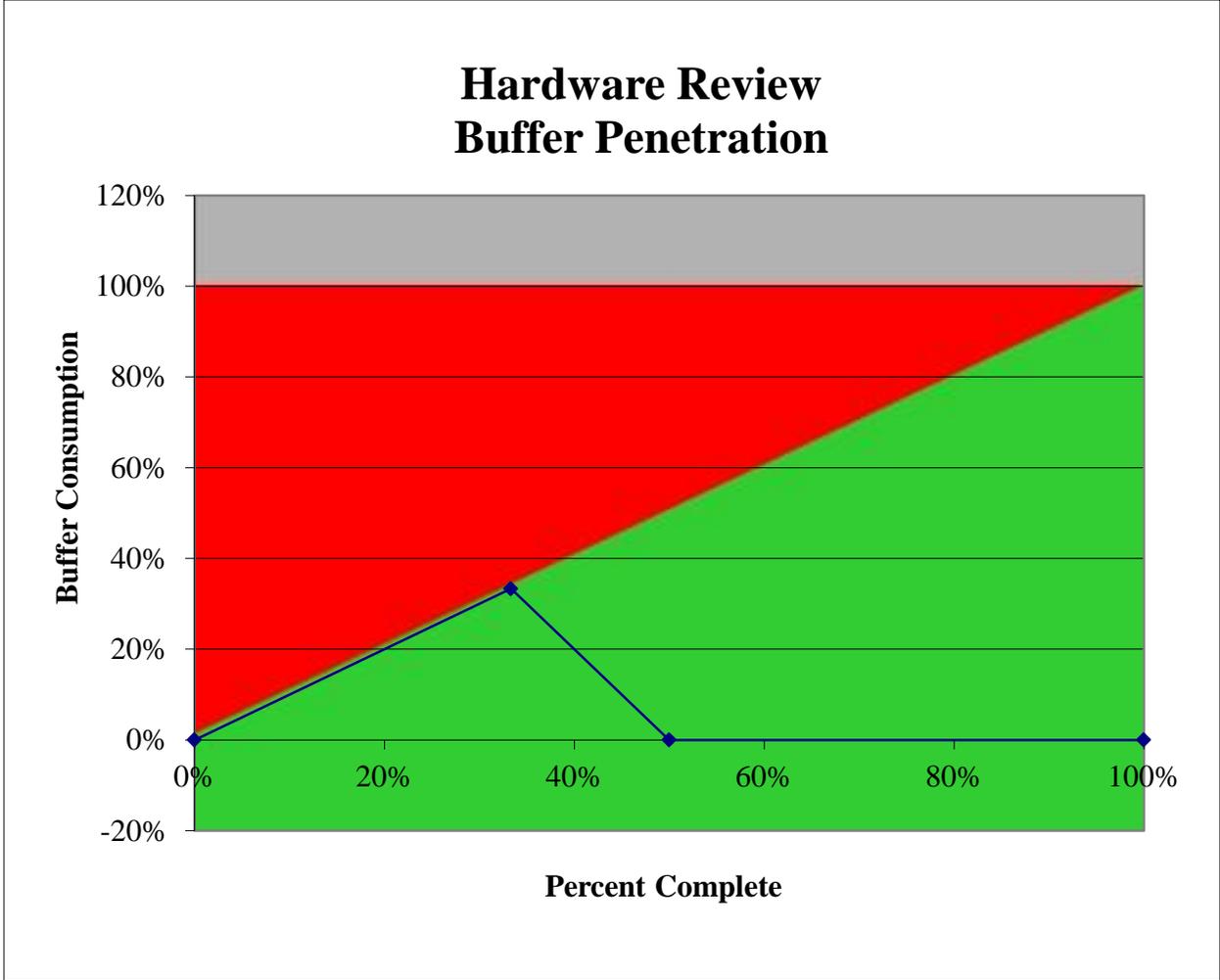
Appendix Figure 2. Fever Chart for Sub-Project 1, Hardware Review.
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)

|	A	B	C	D	E	F	G	H
1	Reporting Date	1/18/2011						
2								
3	**Sub-Project Name**	**Solve Legal and IP Issues**						
4	Percent Complete	100%						
5	Percent Time	133%		Push Back				
6	Buffer Consumption	67%			9			
7								
8	Project	Estimate in Days		Completed				
9	Total	18		18				
10	Date Started>	1/3/2011						
11	Suggested Start>	12/25/2010						
12	Date Due>	1/21/2011						
13								
14	**Project Tasks**	**Estimate number of working days**	**Number of non-working days within the time period**	**Estimate Total Days**	**Date Complete**	**Completed Work**	**% Complete**	**% Buffer**
15	Start Task	0	0	0	3-Jan	0	0%	100%
16	Explore IP / Legal transfer issues	1	1	2	5-Jan	2	11%	100%
17	Submit IP Paperwork to Legal Office	1	12	13	12-Jan	13	83%	33%
18	Receive final ruleing on IP/Legal issues	1	2	3	18-Jan	3	100%	67%

Appendix Figure 3. Excel Worksheet for Sub-Project 4, Solve Legal and IP Issues.
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)
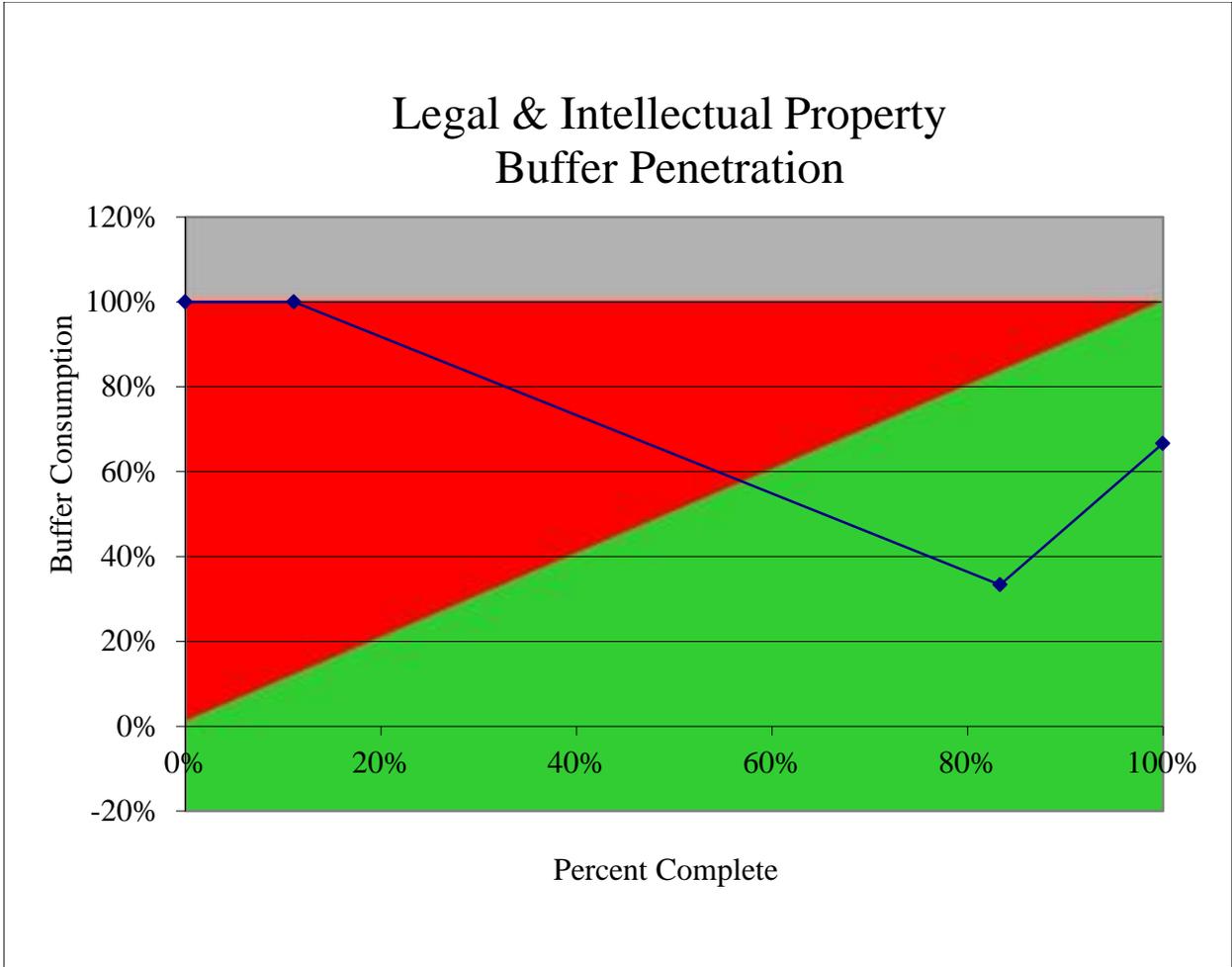
Appendix Figure 4. Fever Chart for Sub-Project 4, Solve Legal and IP Issues.
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)

	A	B	C	D	E	F	G	H
1	Reporting Date	1/28/2011						
2								
3	Sub-Project Name	Prepare & Host Workshop						
4	Percent Complete	100%						
5	Percent Time	150%		Push Back				
6	Buffer Consumption	100%		1				
7								
8	Project	Estimate in Days		Completed				
9	Total	7.75		7.75				
10	Date Started>	1/17/2011						
11	Suggested Start>	1/16/2011						
12	Date Due>	1/28/2011						
13								
14	Project Tasks	Estimate number of working days	Number of non-working days within the time period	Estimate Total Days	Date Complete	Completed Work	% Complete	% Buffer
15	Start Task	0	0	0	17-Jan	0	0%	16%
16	Submit order for printed documentation	0.25	0	0.25	17-Jan	0.25	3%	10%
17	Contract for working lunch catering	0.25	0	0.25	17-Jan	0.25	6%	3%
18	Pick up printed documents	0.25	5	5.25	25-Jan	5.25	74%	74%
19	Bring hardward to conference room / Verfiy systems function as designed	0.5	0	0.5	26-Jan	0.5	81%	87%
20	Host Workshop	1	0	1	27-Jan	1	94%	87%
21	Email workshop action item list	0.5	0	0.5	28-Jan	0.5	100%	100%

Appendix Figure 5. Excel Worksheet for Sub-Project 5, Prepare and Host Workshop.
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)
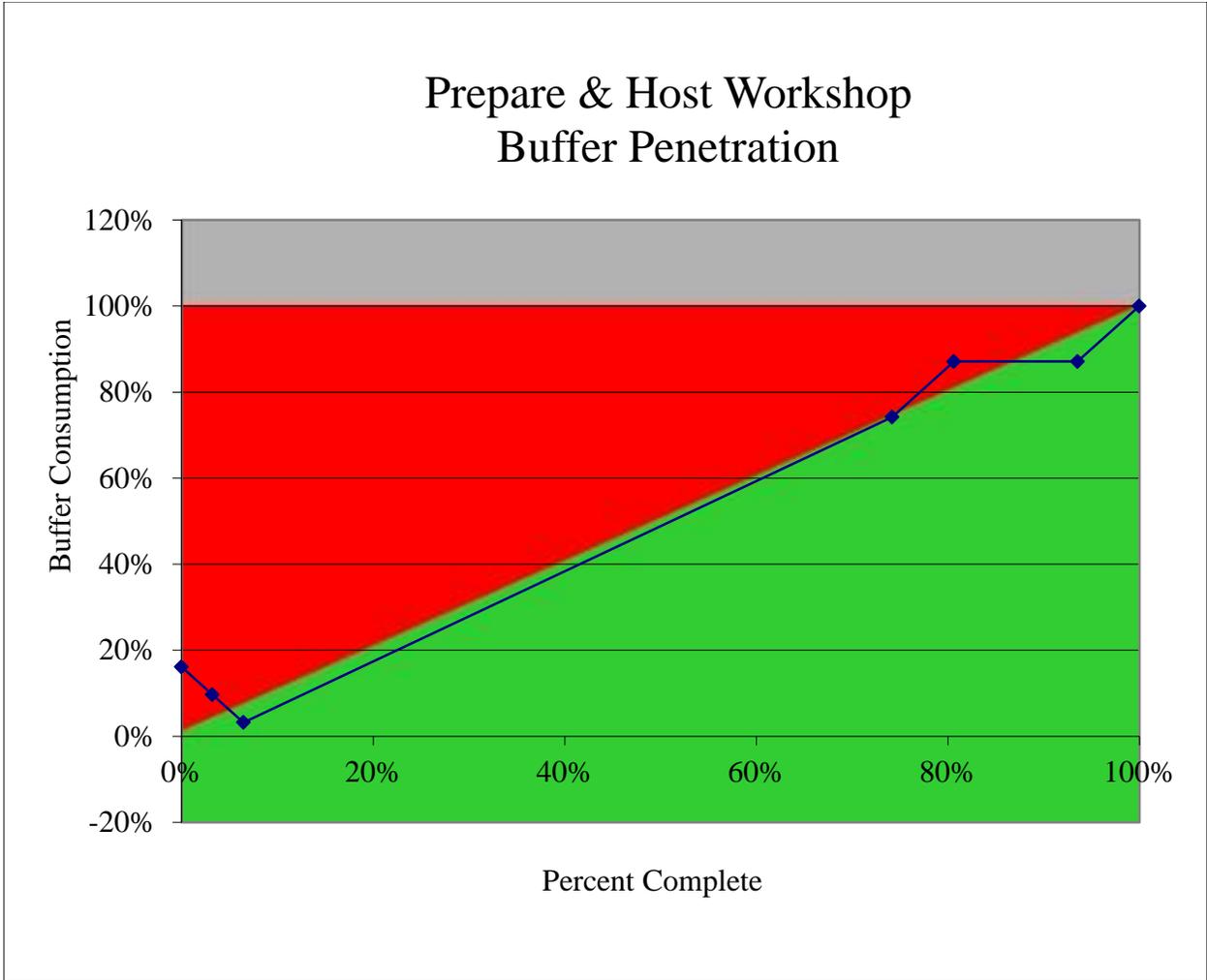
Appendix Figure 6. Fever Chart for Sub-Project 5, Prepare and Host Workshop.
Visual Project Management Excel Macro.
(Used by permission from JR Holt.)

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