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Program Management Basics Simplified Tutorial  
For Engineering and Business Management Majors

By S. A. Siegel

About the author Stuart A. Siegel:



Stuart is a retired electrical engineer and former defense industry executive spanning a career of over thirty years helping to protect those who protect us. He has a Bachelors of Science Degree in Electrical Engineering (BSEE) from the Polytechnic Institute of New York and a Masters of Science Degree in Electrical Engineering (MSEE) from the University of Pennsylvania's Moore School of Engineering. He has written several non-fiction texts for engineers, engineering managers, and program managers providing in depth guides for managing high technology programs, for managing high technology proposals where businesses are in a competitive environment, and for learning program management basics applicable for engineering and business management majors alike.

He was born and raised in Queens New York and currently lives on Long Island New York with his wife. They have three grown children and six grand children. He enjoys skiing, sailing, and golf and in his spare time he writes. Having mostly written non-fiction educational material he is currently experimenting with writing fictional accounts of money, sex and power, within the defense industrial complex.

# Project Management Overview (Introductory Level)

With a Financial / Business  
Management Perspective

Project Example:  
Remodeling a Bathroom

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Hi All - This presentation is an introduction to program management for Engineers, MBA students, and anyone wanting to learn the processes key to managing a project. I'm making the following tutorial on Program Management Basics Made Simple available for all who have an interest in self-teaching on this topic. The impetus for my having produced this is based on what I experienced and believe is a short fall in pre-graduate engineering and business college education that is career essential. I've made the messaging simple in this tutorial by using a simple example of re-modeling a bathroom. So let's get started.

# Contents: Key Interrelated Project Management Topics

- PROJECT PLANNING & FINANCIAL MANAGEMENT
  - Project Work Breakdown Structure (WBS)
  - Integrated Master Scheduling (IMS) & 2 Key Project Plan Views – Gantt & PERT
  - Project Execution / Cost & Schedule Assessment
  - Earned Value Management System (EVMS)
  - Variance Analysis & Recovery Planning
- RISK MANAGEMENT
  - Example Risks and Risk Mitigation
  - Schedule Risk Assessment
  - Risk Quantification

**The Principles discussed herein are Scalable**

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The contents of this discussion will address project planning, tracking, and control of a program and will also delve into the important process of risk management. The goal of what you'll take-away is a solid understanding of these practices and how to apply them. It discusses the following: How to break a project into manageable sub tasks using the Work Breakdown Structure (WBS), Integrated Master Scheduling (IMS) – how to schedule & resource load the tasks using Waterfall / Gantt view, and how to manage the interdependencies of a project using PERT / a NETWORK view of a project. A key aspect of the discussion will be your introduction to the widely used process that assesses the goodness of progress on a project called the Earned Value Management System (EVMS). Also as mentioned the importance of Risk Management and Risk Mitigation will be explained.



# Preparing the Plan

Note: Plumbing is all sinks, tubs, etc. Electrical is all lights, switches etc.

## Work Breakdown Structure (WBS)

- 1.1 – Demolition – 10 hrs
- 1.2 – Buy material – 10 hrs
- 1.3 – Behind the wall work – 20 hrs
- 1.4 – Wall board & ceiling – 16 hrs
- 1.5 – Construct cabinet – 24 hrs
- 1.6 – Install cabinet – 8 hrs
- 1.7 – Finish Plumbing – 24 hrs
- 1.8 – Finish Electrical – 10 hrs
- 1.9 – Install windows – 4 hrs
- 1.10 – Install mirror – 2.5 hrs
- 1.11 – Tile work – 24 hrs
- 1.12 – Paint – 4 hrs

## Planning Steps

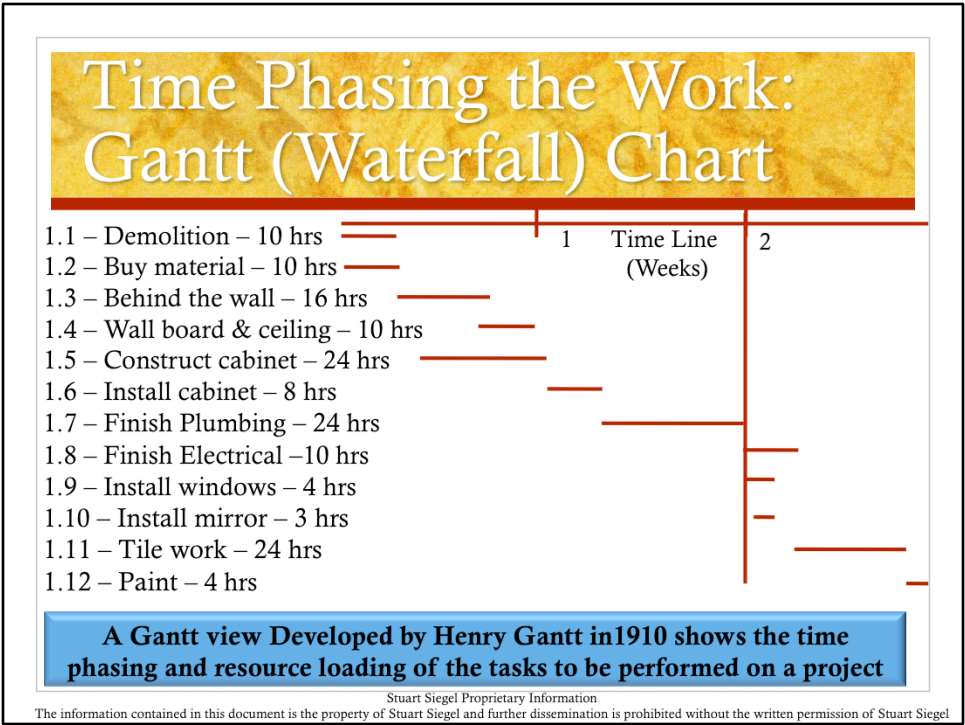
- 1<sup>st</sup> The Project Manager (PM) breaks down the scope of the work to be performed into manageable tasks producing the WBS
- 2<sup>nd</sup> The PM then prepares a schedule that time phases and resource loads the work
- 3<sup>rd</sup> The PM also produces a network diagram showing the work flow and interdependencies

**Complex projects can have thousands of WBS line items**

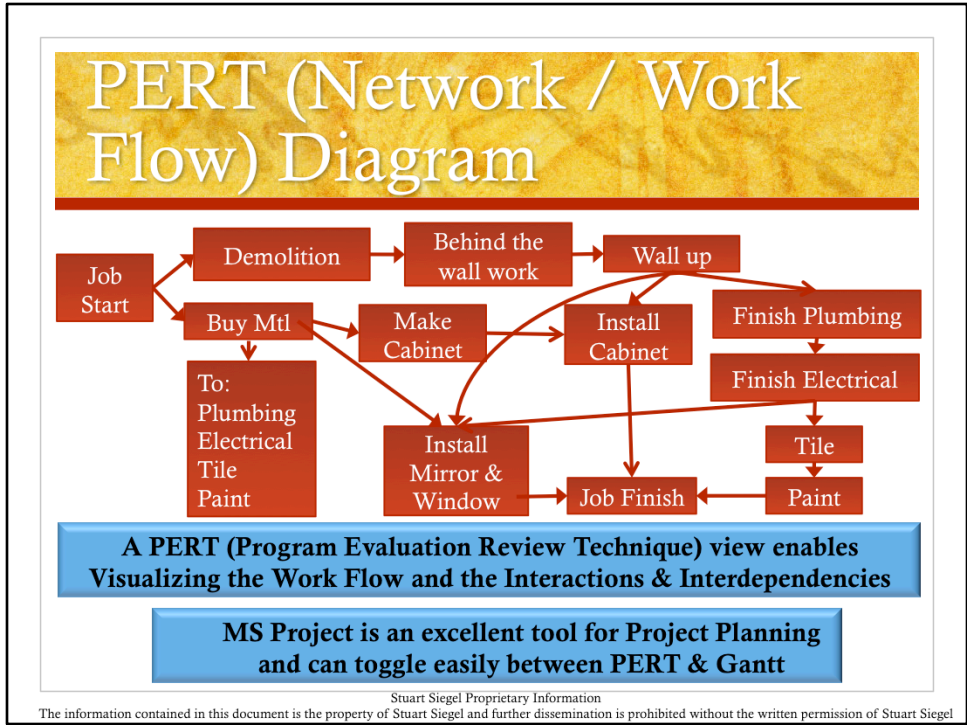
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Every project (project & program are interchangeable terms in this discussion) has tasks to occur for completion and in a particular order if the outcome is to be correct. Every program has a labor force with varying skills to perform the tasks and typically every program needs material. So the project must be thought out – by the program manager who breaks down the tasks into a logical sequence (called the work breakdown structure or WBS and estimates the resources needed. So we can see that for this example there is a listing of what is needed to accomplish the remodeling. We also see there are several labor categories – electrician, plumber, tile person and so on.



Having developed the WBS, the program manager proceeds to develop the Integrated Master Schedule or IMS for the program that time phases the activities into a waterfall or Gantt view of the project. There are clear interdependencies so some work is heel to toe and others can be done in parallel. Viewing and understanding the interdependencies is a key part of team communication and a supplemental view of the program called PERT or a Network view facilitates this as we will discuss next.



As said, a valuable tool for seeing the dependencies is a network diagram showing the work flow of the program from start to finish. Producing a diagram like this really forces the thought process of the steps to completion and is important for all the contributors to know the interdependencies between all the players. Imagine what this looked like for the going to the moon project. Remember these are the same practices used on major projects.

## Project Execution / Cost & Schedule Assessment

- Budgets are issued, work per plan is authorized
- Is just monitoring expenditures and / or schedule sufficient to know if the job is on track or if it is in trouble – E.g.
  - “We planned to complete this job in 20 days and we are 10 days into the job and spent half the money - we’re on track”
  - Not true if half the money was spent on something that should have only cost 1/10<sup>th</sup> the money and what was to be done on day 1 is still not complete
- Actuals (cost and schedule) need to be compared to plan for a meaningful assessment and Earned Value Management is a widely used process for this purpose

**Tracking is not sufficient without comparison to plan**

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A key tool to apply for assessing project in-process ‘goodness’ is Earned Value Management and the Earned Value Management System. We’ll go into this next but 1<sup>st</sup> let’s establish the key role of a Program Manager. The program manager is the single point authority for the program and is responsible for its successful conduct. So, the PM authorizes the start of work in accordance with the plan. But, how does the PM know if the job is on track and will generate the profit expected. Let’s look at the 2 inserted bullets on this chart. “We planned to complete this job in 20 days and we are 10 days into the job and spent half the money - we’re on track” Not true if half the money was spent on something that should have only cost 1/10<sup>th</sup> the money and what was to be done on day 1 is still not complete. The key take-away is that **Tracking is not sufficient without comparison to plan** and that brings us to earned value management.

# EVMS - Earned Value Management System

## ■ Key EVMS Terminology

- BCWS – Budgeted Cost for Work Scheduled (The planned dollar amount budgeted to do a task)
- BCWP – Budgeted Cost for Work Performed (The budgeted BCWS amount credited when the task has actually been performed)
- ACWP – Actual Cost for Work Performed (The actual cost incurred on a work package)
- CPI – Cost Performance Index =  $BCWP \div ACWP$  (Budgeted amount for a task  $\div$  Actual amount spent)  $>1$  is good
- SPI – Schedule Performance Index =  $BCWP \div BCWS$  (In a given time period, the Planned Value of Work actually performed in that time  $\div$  Value

**EVMS (CPI & SPI) Provides a Measure of Project Goodness via Variances to Plan**

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Understanding the EVMS terminology is important. So READ THE CHART. BCWS is the time estimate in the plan for each task. When we complete a task we take the planned amount that was estimated as credit for the work performed - BCWP. So if it is planned to do 30 hrs of planned work in 2 weeks and we only do 10 hrs of planned work it shows a schedule problem. This is a key point to get. To make a schedule assessment, we are not looking at actual hrs spent for a task – only the planned hrs to make a schedule assessment. We're saying if we planned on buying 2 apples and 4 oranges in a week and only bought 2 apples and 1 orange, we're behind schedule. No mention of the issues causing the delay or costs of the tasks is needed for a schedule assessment. We may be OK on cost. Cost issues do compare cost of what you did accomplish that is the actual cost for work performed - ACWP vs. the planned cost for what it was supposed to cost namely the budgeted cost for work performed - BCWP. So if the 2 apples and 1 orange cost what we thought they should cost then we still have money for the other 3 oranges. The 2 key indices CPI & SPI tell the story. If the actual cost was less than the budgeted cost then the CPI will be greater than 1 which is good; if the Budgeted Cost for Work Performed is greater than what was scheduled (BCWS) then the SPI is greater than 1 & is good also. Let's apply this to our example.

## Example: In-process EVMS Project Assessment

- 80 hrs into the work – how's it going (Should have completed: Demolition, Buy Mtl, Behind the wall, Wall board, Build & Install Cabinet, Finish Plumbing) Note: All labor @ \$100/hr
- Demolition: BCWS = \$1,000 (10 hrs) – Complete BCWP = \$1,000; Actual cost \$1,100
- Buy Mtl: BCWS = \$1,000 (10 hrs) – Complete BCWP = \$1,000; Actual cost \$1,100
- Wall work: BCWS = \$2,600 (26 hrs) – Complete BCWP = \$2,600; Actual cost \$2,700
- Cabinet: BCWS = \$3,200 (32 hrs) – Complete BCWP = \$3,200; Actual cost \$3,100
- Plumbing: BCWS = \$2,400 (24 hrs) – 50% complete BCWP = \$1,200; Actual cost \$1,400
- Total BCWS = \$10,200
- BCWP = \$9,000 (Only 50% credit for plumbing)
- $SPI = BCWP \div BCWS = .88$  (behind plan); Schedule variance  $BCWP - BCWS = -\$1,200$
- $ACWP = \$9,400$
- $CPI = BCWP \div ACWP = .96$  (over plan); Cost variance  $BCWP - ACWP = -\$400$

**Early In-Process CPI & SPI Warning Enables Recovery Planning**

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To ease the process, let's make some assumptions on Actual Costs using \$100 per hour for each labor category; and some assumptions on budgeted cost BCWS and actual work accomplished BCWP) to see how to apply EVMS as discussed. – Again DO A WALK-DOWN ON THIS CHART.



## Variance Analysis & Recovery Planning

- What is causing the Plumber's schedule delay – possible causes need to be looked into to determine a schedule recovery plan
  - Plumber was ill and out for a day – work overtime to recover
  - Something broke and took unplanned time to fix – challenge the electrician to make up the time difference in his work
- What is causing the Plumber's cost increase – possible causes need to be looked into to determine a cost recovery plan
  - A task was more complicated than originally estimated – make up the difference in another work package
  - Something broke and took unplanned time to fix – release some reserve to cover a realized risk

**Recovery Plans Depend on an Analysis of Variances to Plan**

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OK – we see there are issues with both schedule and cost. What can we do about it to get back on plan? The 1<sup>st</sup> step is to perform a variance analysis – to see what the causes are. The reason is to develop plans to recover and still get the job done on time and for the cost estimated to make the expected profit.

So let's look at the schedule issues and possible plans to recover. Let's read the chart

Now let's do the same for the cost issues – and read the chart

## Project Planning & Financial Management Summary

- Prepare the project WBS (Work Breakdown Structure) that breaks the job down into manageable tasks that can be resource loaded and time phased
- Develop an Integrated Master Schedule (IMS) time phasing and resource loading the tasks to be performed using both A Gantt (Waterfall) Chart & PERT (Network / Work Flow) Diagram to visualize the project's time phasing and work flow and interdependencies
- Track progress to plan for each WBS scheduled work package and budget via the Earned Value Management System (EVMS)
- Use the CPI ( $BCWP \div ACWP$ ) & SPI ( $BCWP \div BCWS$ ) as indicators of project goodness
- Perform a Variance Analysis when Actuals differ from Plan particularly if CPI is  $<1$  or if SPI is  $<1$
- Early warnings of cost and schedule issues and the variance analysis enables the development and implementation of 'Get Well' plans to recover

**Planning is key and tracking is not sufficient without comparison to plan**

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Let's summarize the steps-in-the-process about program management basics so far  
We know the 1<sup>st</sup> step is to develop the WBS followed by developing the IMS  
We know developing a PERT is key to understanding the interdependencies on a project and we've learned how to apply Earned Value Management to assess project goodness regarding cost and schedule to date  
Finally using the key CPI and SPI indices we understand the importance of performing a variance analysis which is key to developing recovery plans to get a project back on track

So now let's look at the impact of risks on a project and delve into risk management.



# RISK MANAGEMENT

- RISK MANAGEMENT
  - Example Risks & Risk Mitigation
  - Schedule Risk Assessment
  - Risk Quantification

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A key practice that enhances the probability of successful program management is applying Risk Management to the project. Early identification of potential risks and planned mitigation actions to burn-down risks and reduce the impact of risks is an essential part of program management. The reality is that any project will have issues that can arise that impact cost, schedule and performance. So in our example, could we have anticipated the 'risks' that seemed to have materialized and taken steps to mitigate them - Let's discuss the process

## What are some possible Risks and Mitigation Plans

- Risk: Something breaks; Mitigation: Develop and follow 'handle with care' procedures
- Risk: Wrong material; Mitigation: Check before install
- Risk: Installation error (e.g. – pattern of tile upside down); Mitigation: Check with customer before install
- Something leaks water after plumbing installation is complete; Mitigation: Test before walling up with tile
- Schedule Risk – (The risk associated with the veracity of our time per task estimates); Mitigation: Perform a Schedule Risk Assessment (Next Chart)

**Identify and Quantify key Risks & Plan to Mitigate them**

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So for our example let's think about possible risks and how to mitigate them. READ THE CHART

# Schedule Risk Assessment

- We've all heard 'Time is Money' so how do we assess the veracity of our estimates of the time it takes to do each task in the plan
- For Complex Projects: 3 point estimating & Monte Carlo simulations are often performed to obtain the overall probabilistic assessment of a completion date
  - Earliest possible optimistic completion
  - Latest pessimistic completion
  - Most likely completion
- Critical Path Assessment (those tasks that determine the time to complete a project that cannot be made shorter unless there is slack in the path – e.g. It takes 9 months to have a baby)
- Slack Determination – how much 'cushion' there is in the time allotted to do a task

**Schedule delays are costly - the 'marching army' keeps charging the job**

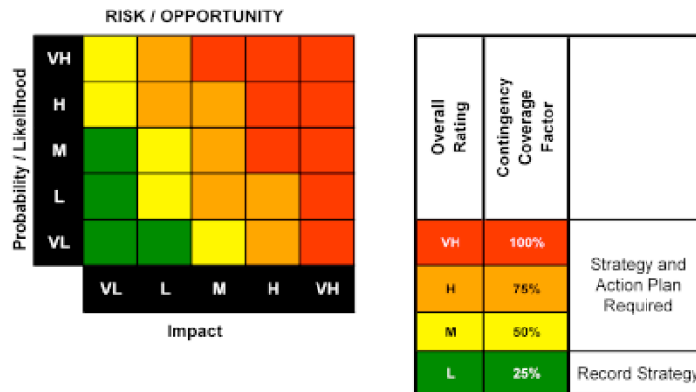
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Let's divert a bit and talk schedule risk. (READ THE CHART) Why is this done – schedule delays are costly – the 'marching army' keeps charging the job

# Risk Quantification Process

Risk & Opportunity Overall Rating Guide



**Judgment Determines Which Risks are Important to Mitigate**

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There is a process for identifying, quantifying, & mitigating risk on a program – But before we delve into this chart – let’s talk every day risk management. Hypothetically consider if one might speed on the highway. Maybe - If the traffic is doing 10 mph above the limit – ‘doing the traffic’ not too risky; but weaving in and out much more risky. Is not making a full stop at a red light before making a right on red risky? Not if there is a sign that says red light camera but could be risky if no sign and there is a camera. Maybe we should budget our finances and set aside a reserve for 1 ticket per year. The same thinking is applied to program risks and this chart helps determine the reserve to set aside for risk. Let’s discuss it. Note – I am not encouraging failing to adhere to all traffic laws – quite the opposite! This discussion is for example purposes only.

Risk management considers each risk as to its likelihood of occurrence and the magnitude of the impact should it occur. So if a risk is likely to occur and it would be impactful some reserve / set-aside should be included in the budget in case it actually happens. The amount of reserve is typically as shown in this chart. So reading this chart we see that risks falling into the green area are low overall but still should have some reserve or 25% of their cost impact included in the budget; for risks falling into the yellow area set aside 50% of the cost impact should be included and so on. Let’s see how to apply this to our example.

## Quantification Example

- Something breaks (Likelihood is medium; Impact is medium \$1,000 mtl+labor if it happens – factor is high 75%); Net risk = \$750
- Wrong material (Likelihood is very low; Impact is medium \$900 Mtl + labor if it happens – factor is medium 50%); Net risk = \$450
- Installation error (Likelihood is low; Impact is high \$2,000 labor – factor is high 75%); Net risk = \$1,500
- Leaks occur after complete plumbing (Likelihood very low; Impact is high \$3,000 labor – factor is high 75%); Net risk = \$2,250
- Schedule delay due to task complexity (Likelihood very high; Impact medium 4hrs = \$400 – factor is very high 100%); Net risk = \$400
- Overall Gross Risk = \$7,300; Net Risk = \$5,350

**Mitigation Plans are Essential**

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Let's make some assumptions about the likelihood and impactfulness of the risks we discussed earlier regarding our example project. READ THE CHART - These are the risks we can think about and should have a reserve in our budget to do the job to cover some of the risks if they materialize. Remember when a risk happens it happens for the full value. We just can't be competitive if we include the full value in our estimate for all the risks that may happen – so this process establishes a reasonable reserve. Remember – the best way to address risk is to identify them, quantify them and then take action to fund plans to mitigate them. Remember earlier we did discuss plans to mitigate these risks.

## Risk Management Summary

- Identify potential risks and mitigation plans
- Perform a schedule risk assessment to determine the risk to the schedule
- Quantify the gross financial impact should the risks occur
- Assess the “Net” financial risk by multiplying the gross impact by the Overall Rating and establish a reserve
- Develop, fund, & implement each mitigation plan

*Note: Although only risks are being discussed, this process applies equally to Opportunity Realization as well*

**Identify & Quantify Risks / Perform a Schedule Risk Assessment  
Set Aside a Reserve to Cover Risks / Develop & Fund Mitigation Plans**

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Let's summarize what has been discussed regarding Risk Management:

Each risk is identified along with its financial impact should it occur

Schedule risk is determined as well

Using the likelihood of occurrence and impactfulness of each risk, a factored value for each risk is set-aside as a reserve in the overall budget

Importantly, a mitigation plan is identified and implemented for each risk. Note: The cost to mitigate each risk is to be included in the estimate to complete the project.

# Overall Summary

## Tying it all Together

- **PROJECT PLANNING** – A relevant plan is an achievable plan that reflects cost and schedule realism, the job resources, work flow, and interdependencies along with risk mitigation and contingency planning
- **PROJECT FINANCIAL MANAGEMENT** – For EVMS to be viable the cost & schedule budget baseline (BCWS) should be realistic (not just success oriented without a reserve for risks) otherwise negative variances will be on-going from the outset
- **RISK MANAGEMENT** – A realizable plan includes a most likely outcome from a schedule risk assessment, has slack in the critical path, funds and schedules risk mitigation tasks, and has a reserve to cover the net value derived from the risk assessment process

### Key Interrelated Elements of Project Management

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## Tying it all together

Key to successful planning is the notion that a plan must be realistic and achievable. Plans that have no slack in the critical path or that are totally success oriented are destined to fail and all the processes discussed become moot since negative variances will start at day one and recovery by definition will not be feasible.

Again, my name is Stuart and if you want a copy of these charts see [managementkeyskills.com](http://managementkeyskills.com). Good luck to you all.