



## Identifying best EVM-based Risk Management policies through Dynamic Simulation

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**PMI<sup>®</sup> Risk Management  
Specific Interest Group**



## Agenda

- ◆ Overview of Earned Value Management
- ◆ System Dynamics Modeling
- ◆ Developing an SD project model
- ◆ Modeling EVM-based control policies
- ◆ Practical Example: EVM vs. Traditional Control
  - ↓ Managing the impacts of risks
  - ↓ Exploring opportunities
  - ↓ Managing the project objectives
- ◆ Conclusions



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## Earned Value Management *Overview*

- ◆ The Challenge of Control
- ◆ Basic Metrics
- ◆ Variance and Performance Indices
- ◆ “At Completion” forecasts

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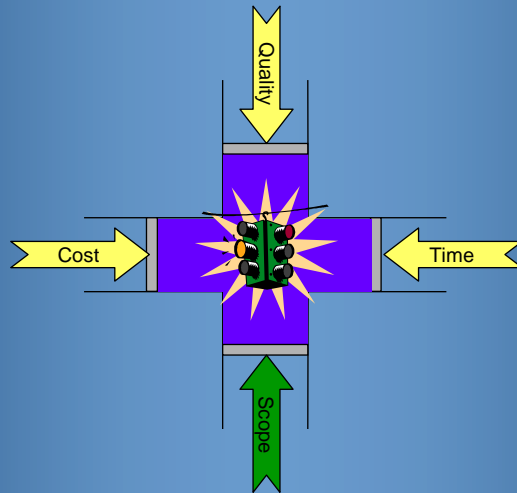
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# Earned Value Management

## *The Challenge of Control*



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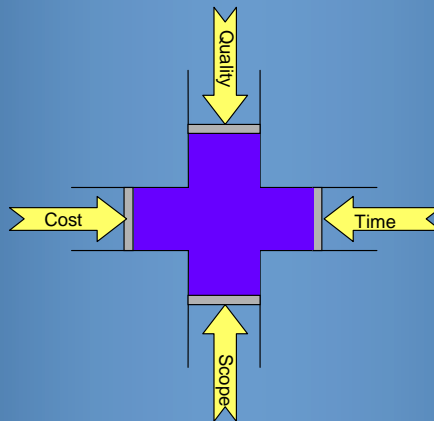
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# Earned Value Management

## *The Challenge of Control*



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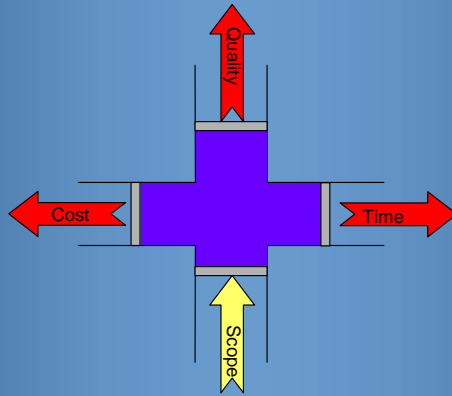
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# Earned Value Management

## *The Challenge of Control*



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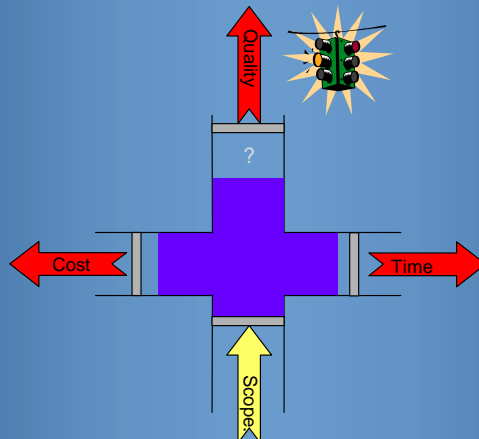
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# Earned Value Management

## *The Challenge of Control*



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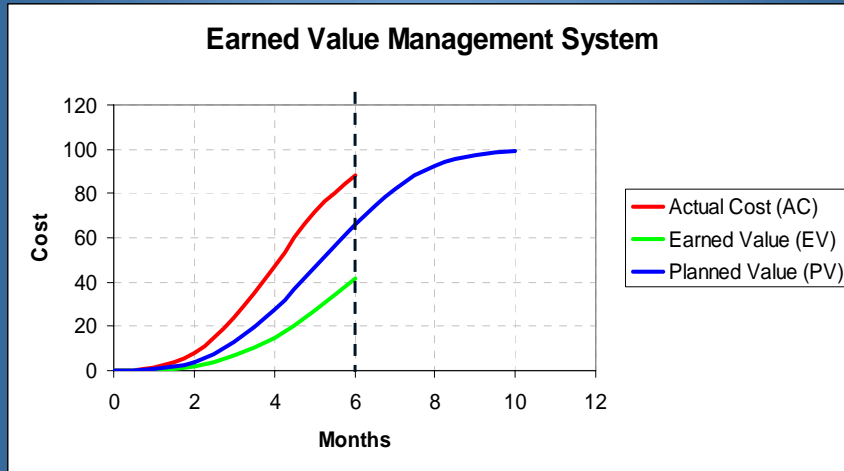
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# Earned Value Management

## Basic Metrics



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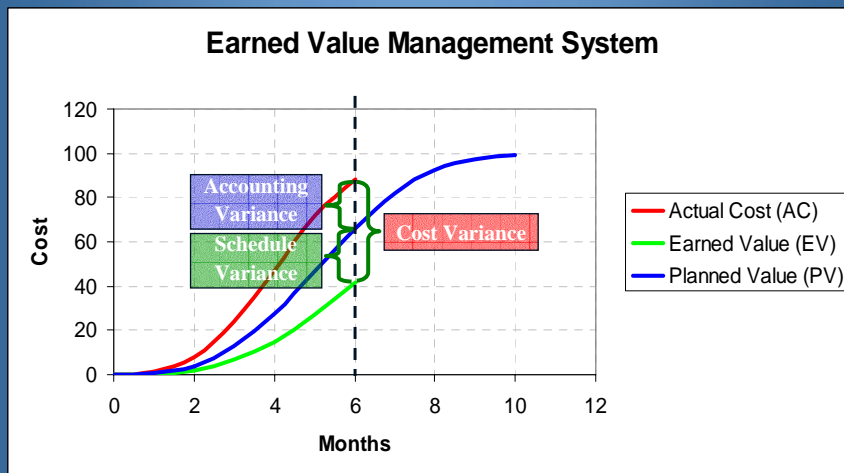
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# Earned Value Management

## Variance Indices



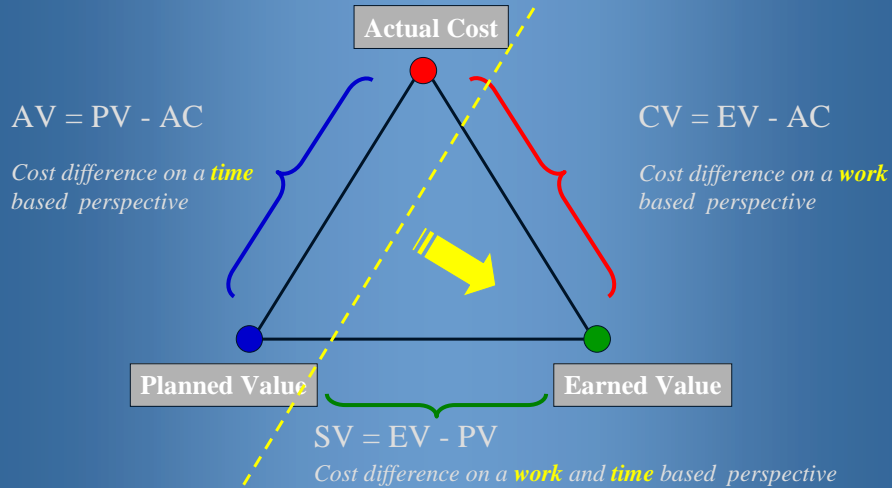
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## Earned Value Management Variance Indices



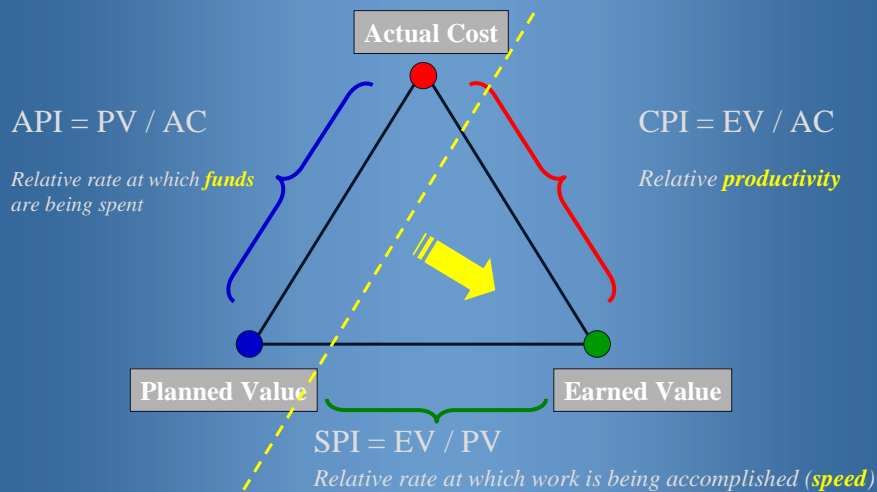
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## Earned Value Management Performance Indices



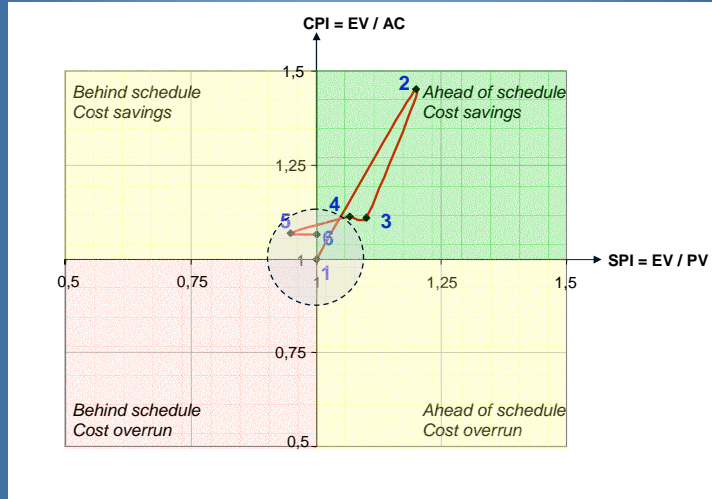
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# Earned Value Management Performance Indices



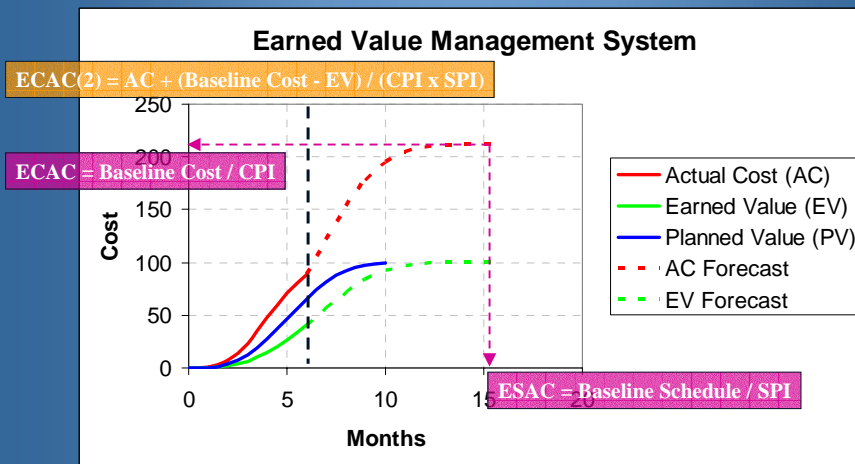
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# Earned Value Management "At Completion" Forecasts



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# Agenda

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- **System Dynamics Modeling**
  - ◆ Developing an SD project model
  - ◆ Modeling EVM-based control policies
  - ◆ Practical Example: EVM vs. Traditional Control
    - ↓ Managing the impacts of risks
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- ◆ Conclusions

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## System Dynamics Modeling *Overview*

- ◆ Introduction
- ◆ Modeling Feedback Dynamics
  - ↓ Positive Feedback
  - ↓ Negative and Positive Feedback
  - ↓ Complex Dynamics
- ◆ Feedback Dynamics in Business Systems
- ◆ Feedback Dynamics in Projects

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# System Dynamics Modeling Introduction

- ◆ Developed in the late 50s by Forrester (MIT):
  - ↓ A **simulation** based modelling approach
  - ↓ Aimed at analysing the behaviour of complex social systems
  - ↓ **Feedback structure** as the **primary responsible for behaviour**
  - ↓ Management laboratory:
    - Models supports policy improvement through **"what-if"** scenario analyses
- ◆ A two-phase modelling process:
  - ↓ Qualitative Influence Diagrams
  - ↓ Quantitative Simulation Models
- ◆ Growing application to real life business problems and to Project Management

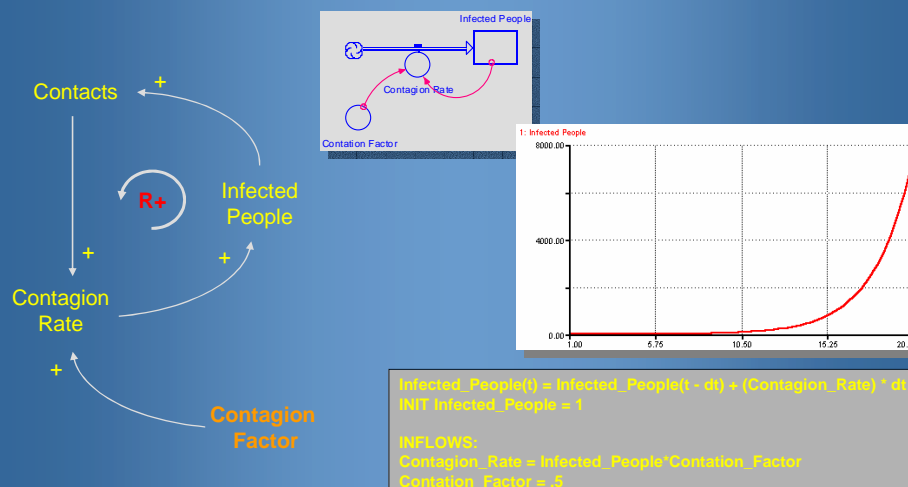
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# System Dynamics Modeling Positive Feedback



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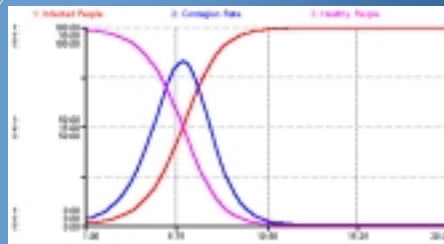
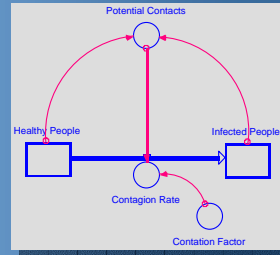
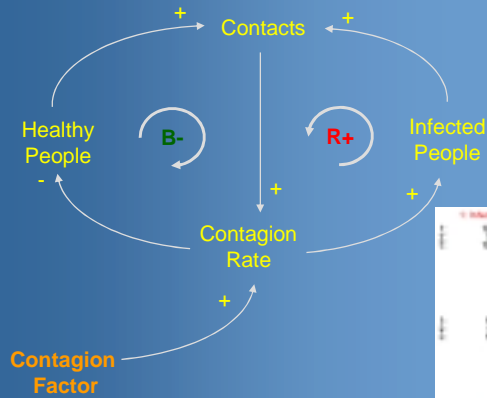
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# System Dynamics Modeling

## Negative and Positive Feedback



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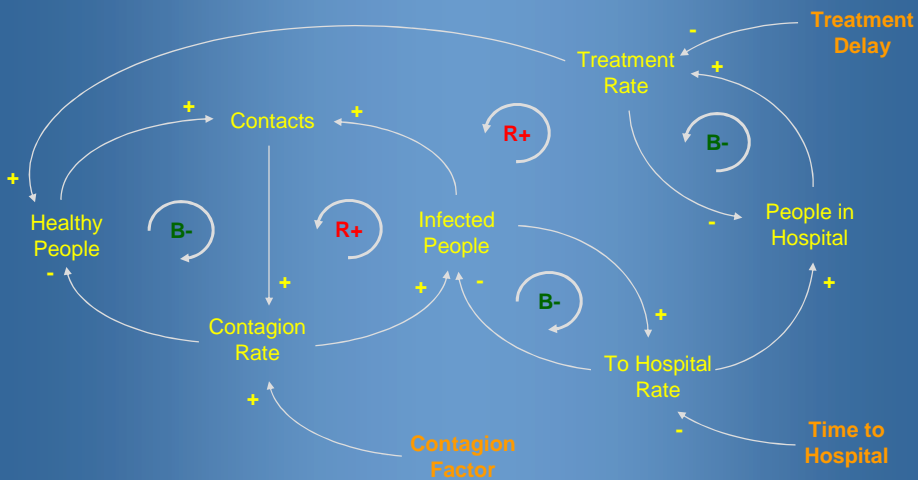
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# System Dynamics Modeling

## Complex Feedback



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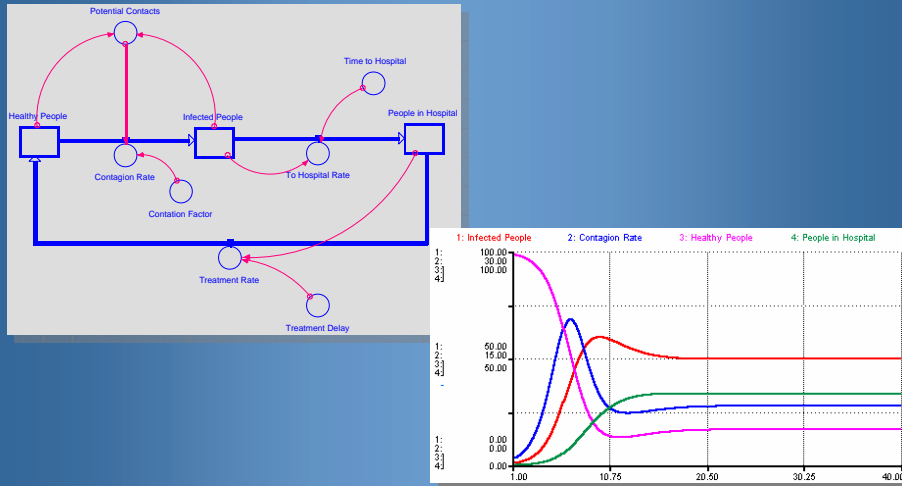
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# System Dynamics Modeling

## Complex Feedback



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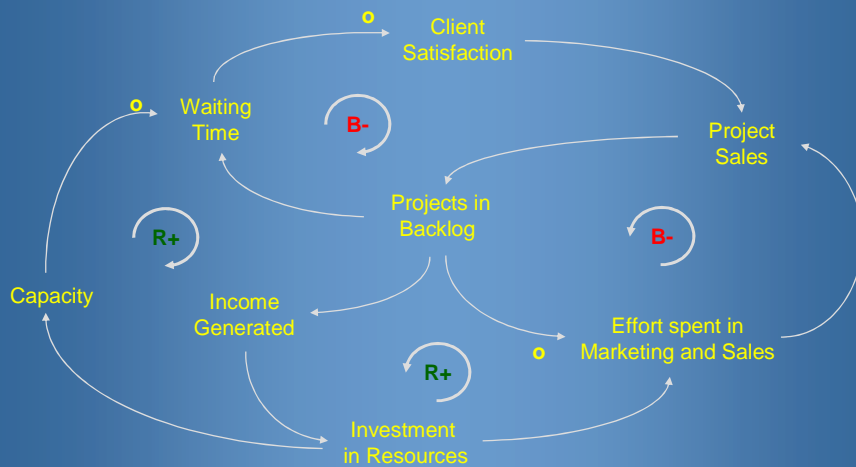
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# System Dynamics Modeling

## Feedback in Business Systems



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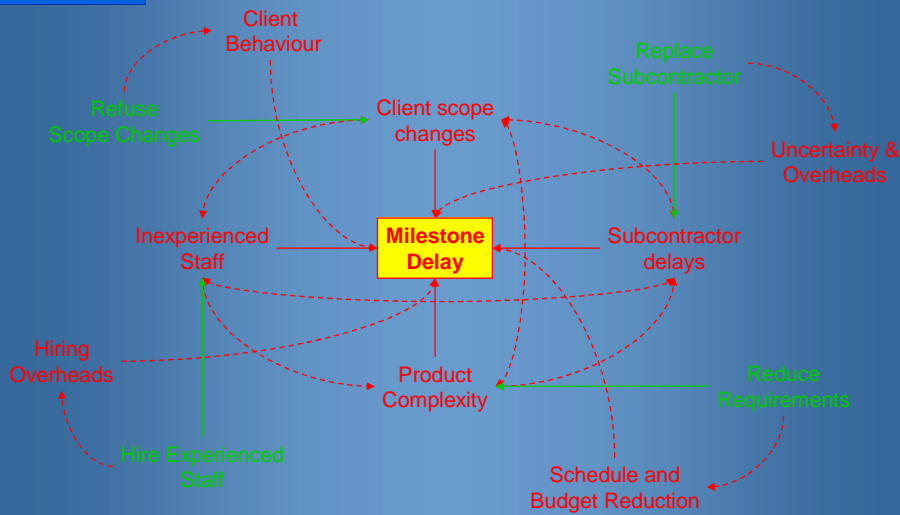
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# System Dynamics Modeling

## Feedback in Projects



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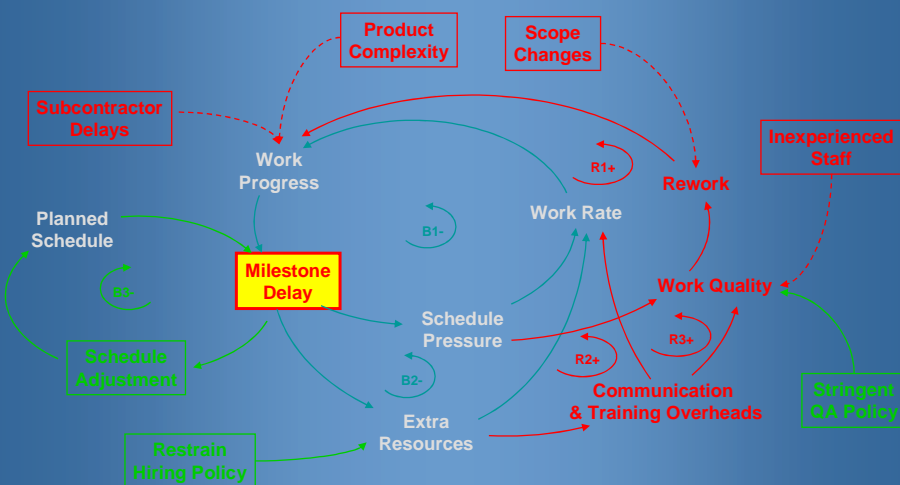
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# System Dynamics Modeling

## Feedback in Projects



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## System Dynamics Modeling *Complexity in Social Systems*

- ◆ **Systemic:**
  - ↓ Everything affects everything, directly or indirectly
- ◆ **Dynamic:**
  - ↓ They do not take place at one point in time. They unfold over-time.
- ◆ **Feedback effects:**
  - ↓ Causes lead to effects, which over-time will affect the causes
- ◆ **Long-term effects (delayed):**
  - ↓ The impacts of actions and events remain unperceived in the short-term
- ◆ **Non-linear:**
  - ↓ Relationships between causes and effects are rarely linear
- ◆ **Subjective, intangible, secondary, undesired effects:**
  - ↓ Many factors involved are of social human nature and difficult to anticipate

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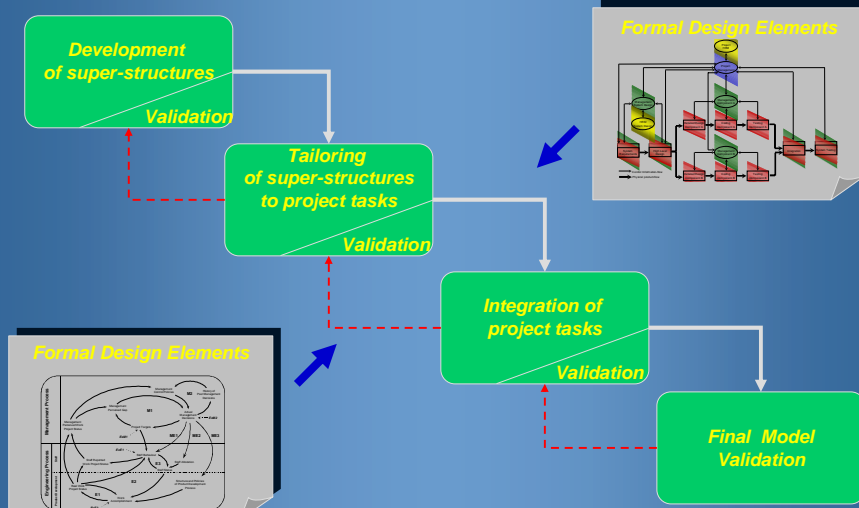
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# Developing a SD Project Model

## SYDPIM Methodology: Implementation



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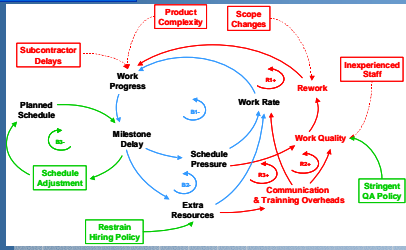
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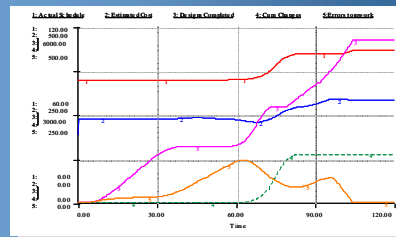
# Developing a SD Project Model

## Using the Model



1. Project **feedback structure** is identified and is captured in the simulation model
2. Project is simulated and its **behaviour over-time** is produced

3. Project **behaviour** is analysed under a **feedback perspective**
4. Solutions are devised and the SD model is recalibrated for **testing** them



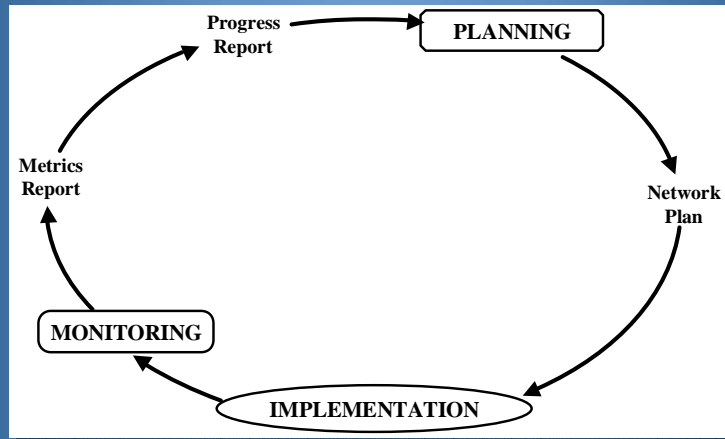
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## Developing a SD Project Model Using the Model (SYDPIM)



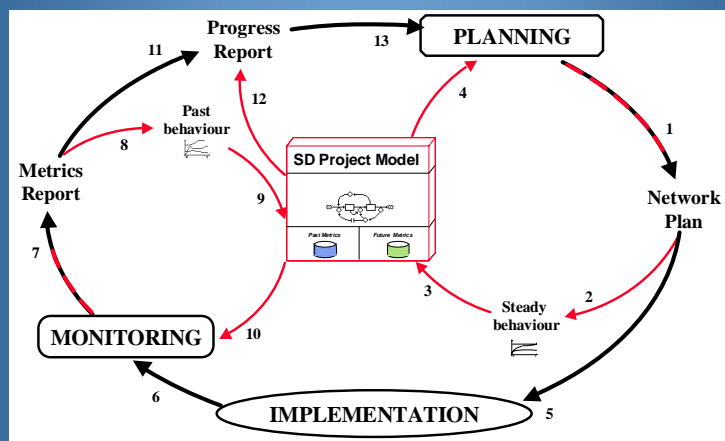
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## Developing a SD Project Model Using the Model (SYDPIM)



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## Modeling EVM-based control policies

- ◆ Concept
- ◆ Overview of the SD model used
  - ↓ Process Structure
  - ↓ Key feedback effects
  - ↓ The Project Plan
  - ↓ Base Control Policies
- ◆ Modeling of EVM Control
  - ↓ EVM metrics and indices
  - ↓ EVM in the control policies

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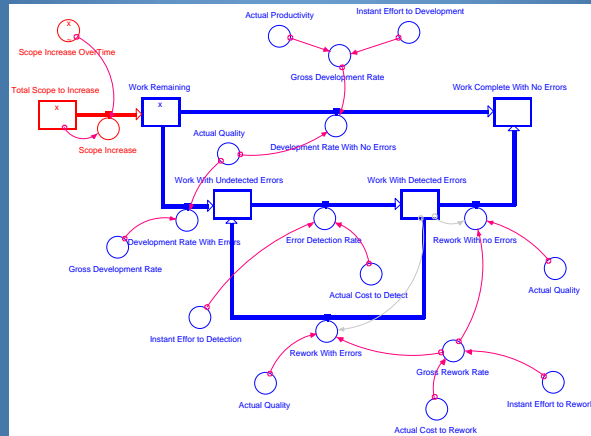






# The SD Project Model

## Process Structure (simpler)



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# The SD Project Model

## Key Feedback Effects

- ◆ Schedule pressure:
  - ↓ Productivity, Cost to Rework
  - ↓ Quality
- ◆ Communication Overheads (team size)
  - ↓ Productivity, Cost to Rework
- ◆ Work Progress
  - ↓ Productivity, Quality, Cost to Detect, Cost to Rework
- ◆ Error Density
  - ↓ Quality
  - ↓ Cost to Detect
- ◆ Managerial
  - ↓ Schedule Adjustment
  - ↓ Staff Adjustment
  - ↓ QA Level Adjustment

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## The SD Project Model

### *The Project Plan*

- ◆ Objectives:
  - ↓ Scope, Cost, Schedule, Quality
  - ↓ Priority and importance of each objective
- ◆ Staff Profile
  - ↓ Planned Allocation Over-Time
- ◆ Planned QA Effort
  - ↓ As fraction of total effort
  - ↓ Over-time
- ◆ Planned Rework Fraction
  - ↓ As fraction of total effort
- ◆ Expected Productivity Variation Over Progress
  - ↓ This the expected learning curve, which should have an impact on the Earned Value estimation based on % progress

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## The SD Project Model

### *Base Control Policies*

- ◆ Schedule Adjustment. Depends on:
  - ↓ Progress
  - ↓ Perceived slippage
  - ↓ Schedule priority
  - ↓ Delay to adjust
- ◆ Staff Adjustment. Depends on:
  - ↓ Progress
  - ↓ Perceived Staff Gap
  - ↓ Budget Priority
  - ↓ Delay to adjust (increase / decrease)
- ◆ QA Level Adjustment. Depends on:
  - ↓ Schedule Pressure
  - ↓ Quality Priority
- ◆ Weight Given to Baseline. Depends on:
  - ↓ Progress

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## The SD Project Model

### Modeling of EVM Control

- ◆ The model calculates at any point in time:
  - ↓ AC, EV, and PV
  - ↓ CPI, SPI, TCPI, TSPI, CPI Modified, SPI Modified
  - ↓ ECAC, ESAC, ECTC
  - ↓ Average Staff Level Currently Available
- ◆ Based on these EVM indices, it calculates:
  - ↓ Average Staff Level Needed to Complete on Planned Schedule
  - ↓ Staff Gap = Staff Needed – Staff Available
  - ↓ Schedule Pressure = Staff Gap / Staff Currently Working
- ◆ These metrics drive management decisions, along with the Base Policies:
  - ↓ Staff Gap drives Staff Adjustment
  - ↓ Schedule Pressure Drives Schedule Adjustment
  - ↓ Schedule Pressure Drives QA Level Adjustment

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- ◆ **Conclusions**

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## Practical Example

### *EVM vs. Traditional Control*

- ◆ The SD model was calibrated to reproduce a set of scenarios, aimed at:
  - ↓ Comparing the performance of EVM-based control vs. traditional operational control
  
  - ↓ Analyzing how the project objectives (schedule, budget quality) should be managed in terms of priority throughout the project, in order to maximize the overall project performance (which depends on the importance of the objectives)



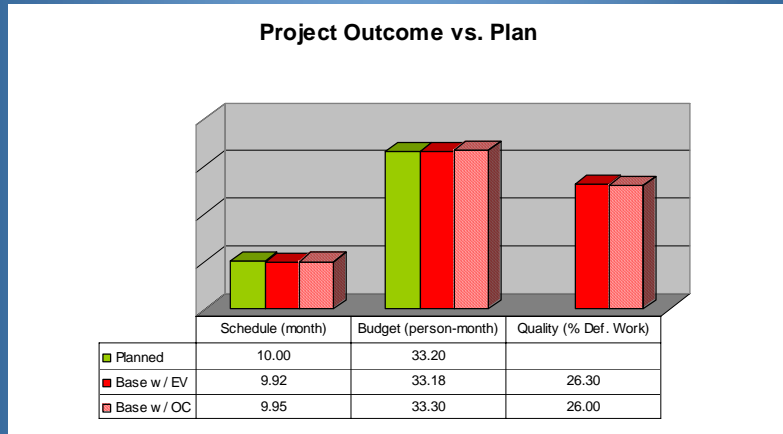
## EVM vs. Traditional Control

### *Scenarios Analyzed*

- ◆ Base Case:
  - ↓ Project implemented as planned
- ◆ Scope Risk:
  - ↓ 30% addition of new scope, over a period of time
- ◆ Scope Risk + Staff Risk:
  - ↓ Scope Risk
  - ↓ Staff leaving the project at certain moments in time
- ◆ Productivity Opportunity:
  - ↓ Constant productivity increase
  - ↓ Varying productivity increase



## EVM vs. Traditional Control *Base Case*



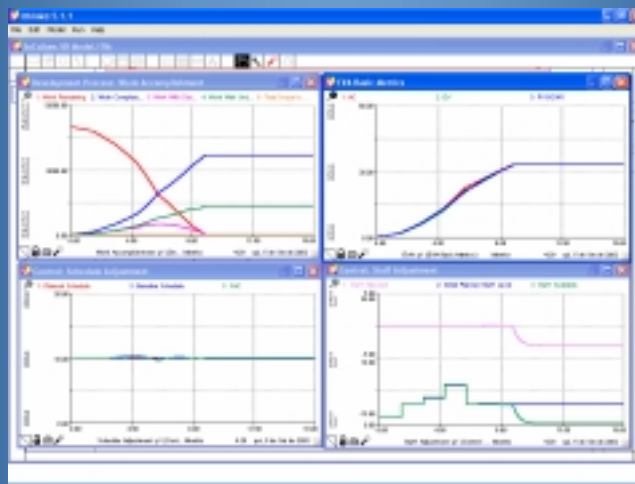
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## EVM vs. Traditional Control *Base Case With EVM Control*



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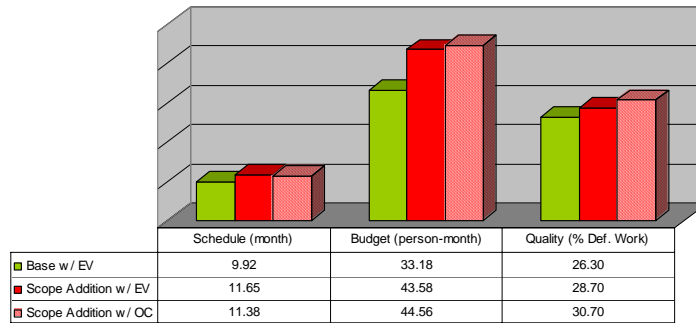
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## EVM vs. Traditional Control *Scope Risk*

Project Outcome vs. Plan: With Scope Addition



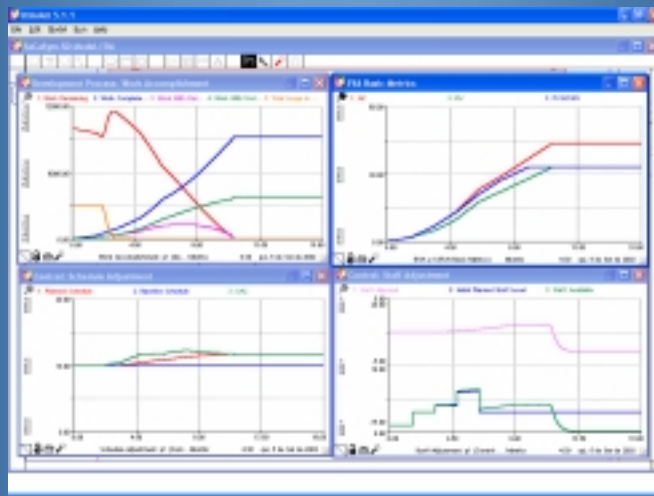
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## EVM vs. Traditional Control *Scope Risk With EVM Control*



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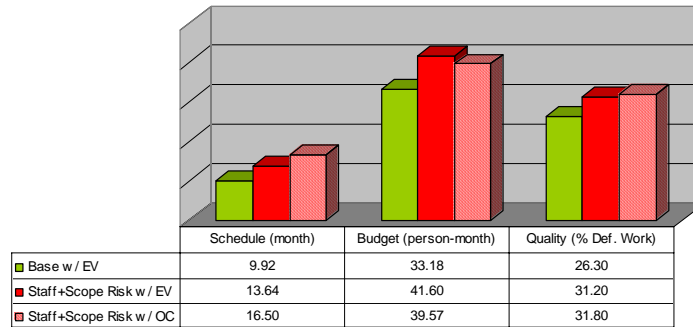
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## EVM vs. Traditional Control

### Scope Risk + Staff Risk

Project Outcome vs. Plan: With Scope and Staff Risk



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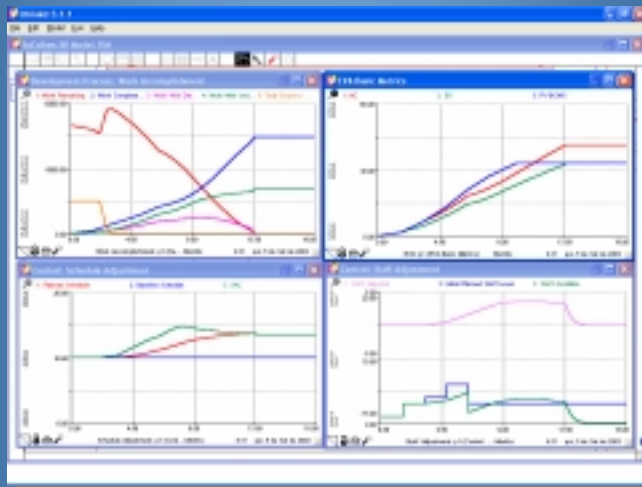
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## EVM vs. Traditional Control

### Scope Risk + Staff Risk With EVM



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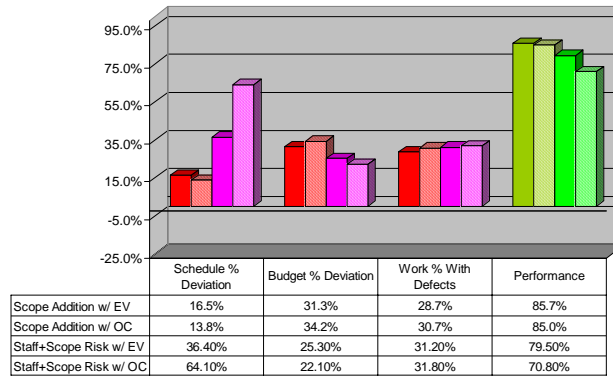
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## EVM vs. Traditional Control

### Scope Risk + Staff Risk

Project Performance: Sope and Staff Risk Scenarios



Project Objectives

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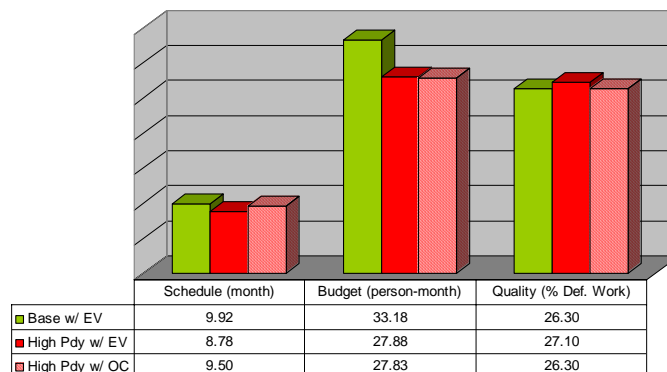
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## EVM vs. Traditional Control

### Productivity Opportunity: Constant

Project Outcome vs. Plan: Higher Productivity (Constant)



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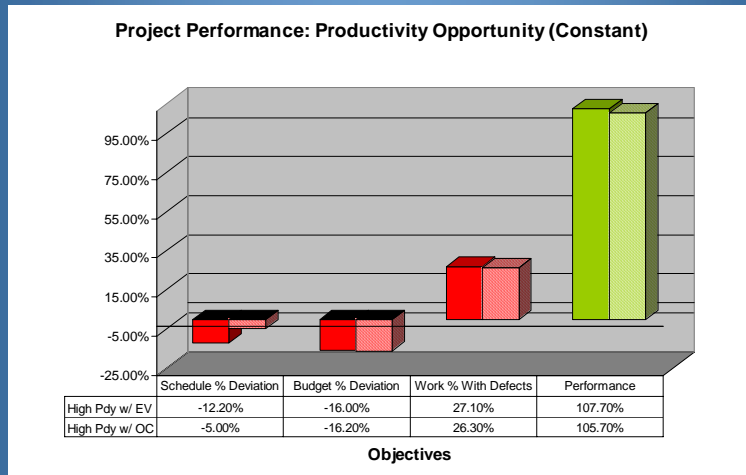
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## EVM vs. Traditional Control

### *Productivity Opportunity: Constant*



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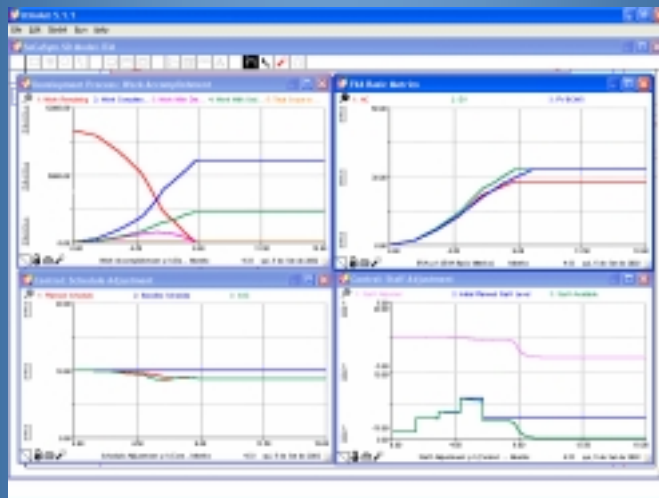
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## EVM vs. Traditional Control

### *Productivity Opportunity: Constant*



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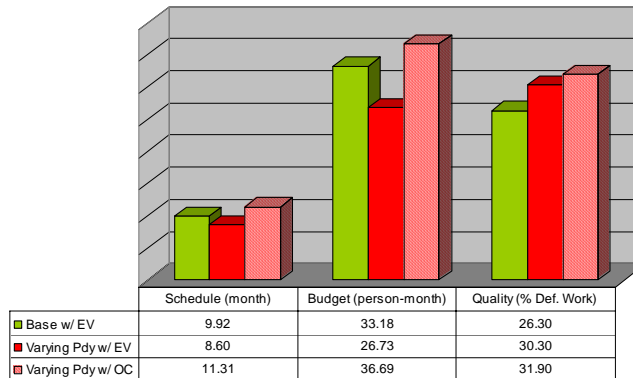
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## EVM vs. Traditional Control

### Productivity Opportunity: Varying

Project Outcome vs. Plan: Varying Productivity



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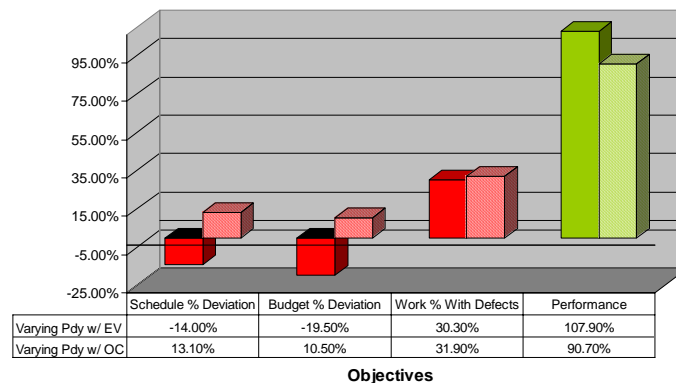
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## EVM vs. Traditional Control

### Productivity Opportunity: Varying

Project Performance: Productivity Opportunities (Varying)



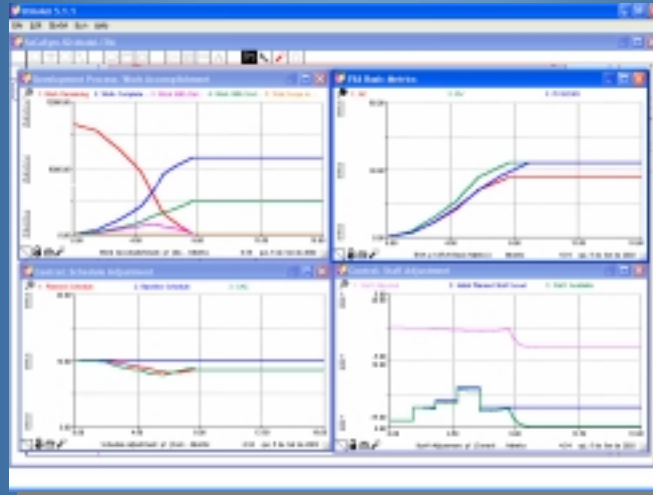
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## EVM vs. Traditional Control *Productivity Opportunity: Varying*



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## EVM vs. Traditional Control *Managing the Objectives Priority*

- ◆ The base scenario considered:
  - ↓ EVM-based control
  - ↓ Previous Scope and Staff Risks
  - ↓ Priority of the objectives equals to their importance
  
- ◆ The priorities were then changed
  - ↓ All “Very High” – full pressure to minimize impacts
  - ↓ Budget, Schedule and Quality priorities were progressively relaxed to search for an “optimal” solution

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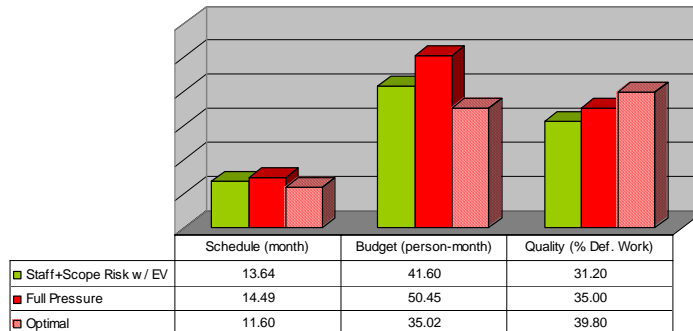
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# EVM vs. Traditional Control

## Managing the Objectives Priority

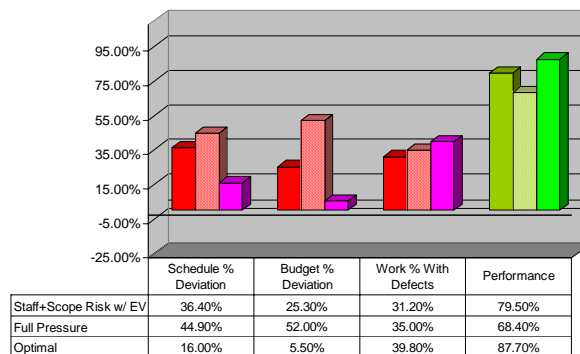
Project Outcome: Managing Objectives Priority



# EVM vs. Traditional Control

## Managing the Objectives Priority

Project Performance: Managing Objectives

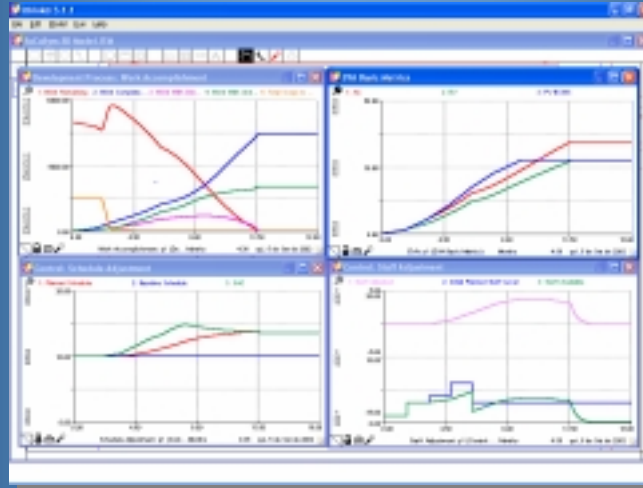


Objectives



# EVM vs. Traditional Control

## *Managing the Objectives Priority*



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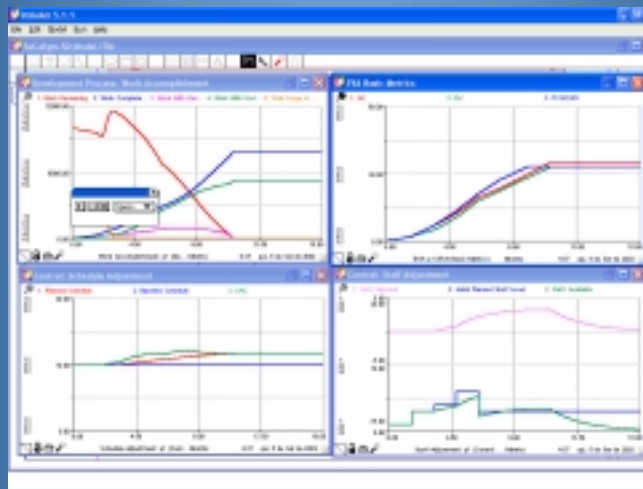
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# EVM vs. Traditional Control

## *Managing the Objectives Priority*



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- **Conclusions**



# Conclusions

- ◆ When compared with more traditional operational control, in general EVM-based control policies perform better
- ◆ In scenarios of uncertainty, EVM appears to provide robust indicators of performance on the basis of which good “at completion” estimates can be produced
- ◆ EVM provides indices of status and estimates of “at completion”, but it does not tell what you should do in face of deviations
- ◆ Simulation is essential for testing, improving and exploring control policies (it’s too expensive and slow to do it in the real world). System Dynamics modeling provides an excellent means to do this



**Identifying best EVM-based Risk Management policies  
through Dynamic Simulation**

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**Thank you!!**

***Any Questions ?***

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