Return on Investment from a Software Measurement Program
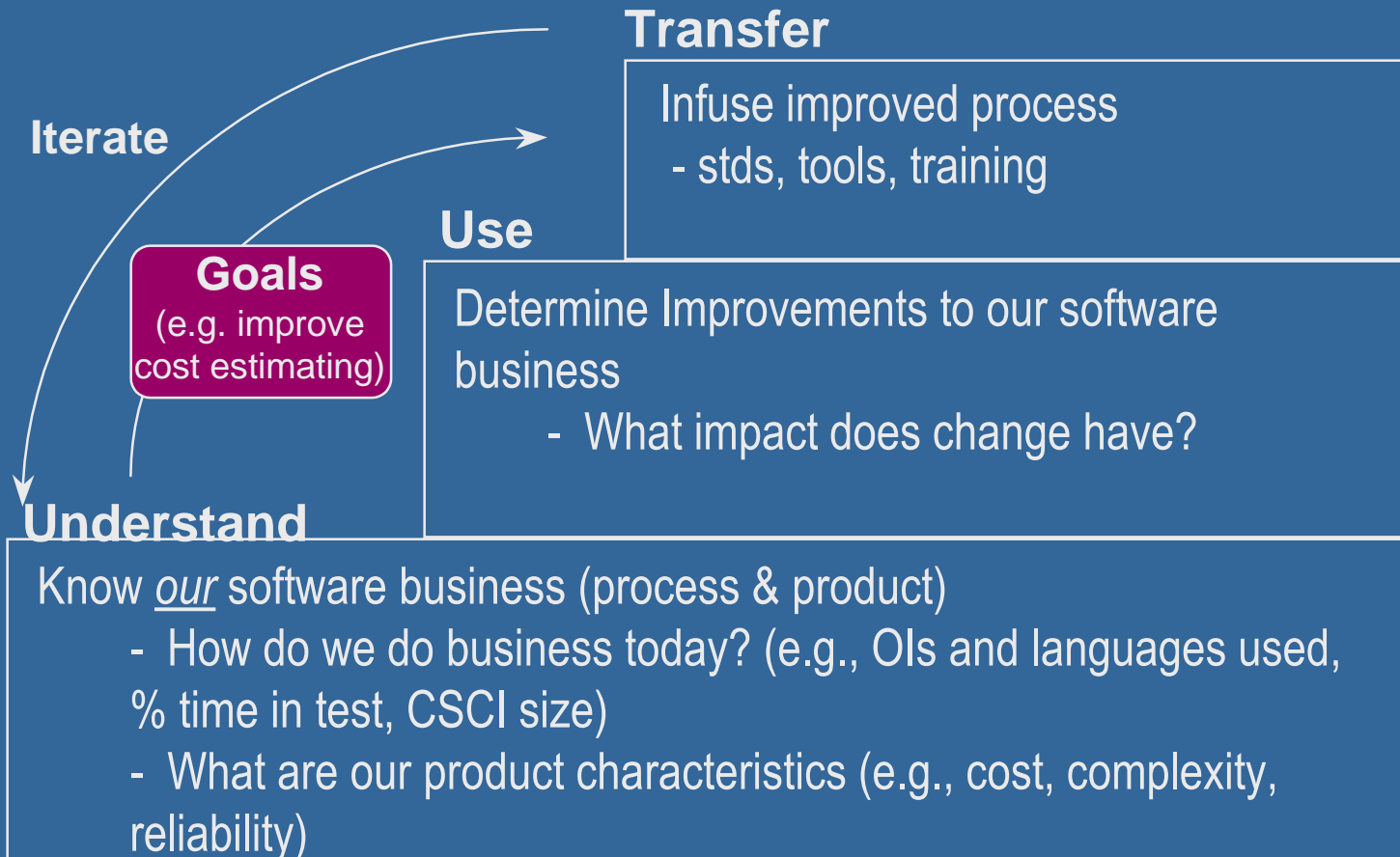
George E. Stark

21 July 1997

MITRE

Background

- Organization Became Responsible for Software Maintenance in Nov. 1994
    - Reorganized Software Maintenance Process
        - From: Several Level-of-Effort Programs
        - To: Single Organization tasked by Release
    - Conducted SEI System Acquisition Maturity Model (SAMM) Assessment
        - Improve Planning & Estimation
        - Improve Configuration Management
        - Improve Release Execution

MITRE

MWSSS Software Measurement Strategy

Iterate

Transfer

Infuse improved process
 - stds, tools, training

Goals
(e.g. improve
cost estimating)

Use

Determine Improvements to our software business
 - What impact does change have?

Understand

Know *our* software business (process & product)
 - How do we do business today? (e.g., OIs and languages used, % time in test, CSCI size)
 - What are our product characteristics (e.g., cost, complexity, reliability)

MITRE

The MWSSS Organization

**SW Maintainers
(Source of Experience)**

Staff	**30-50**
Avg Project Size	**10 SCFs**
Active Projects	**7**
Total Projects	**34**
(FY94-FY96)	

*Project
Measures*

*Process
Refinements*

*Product &
Process
Data*

**Process Analysts
(Package Experience)**

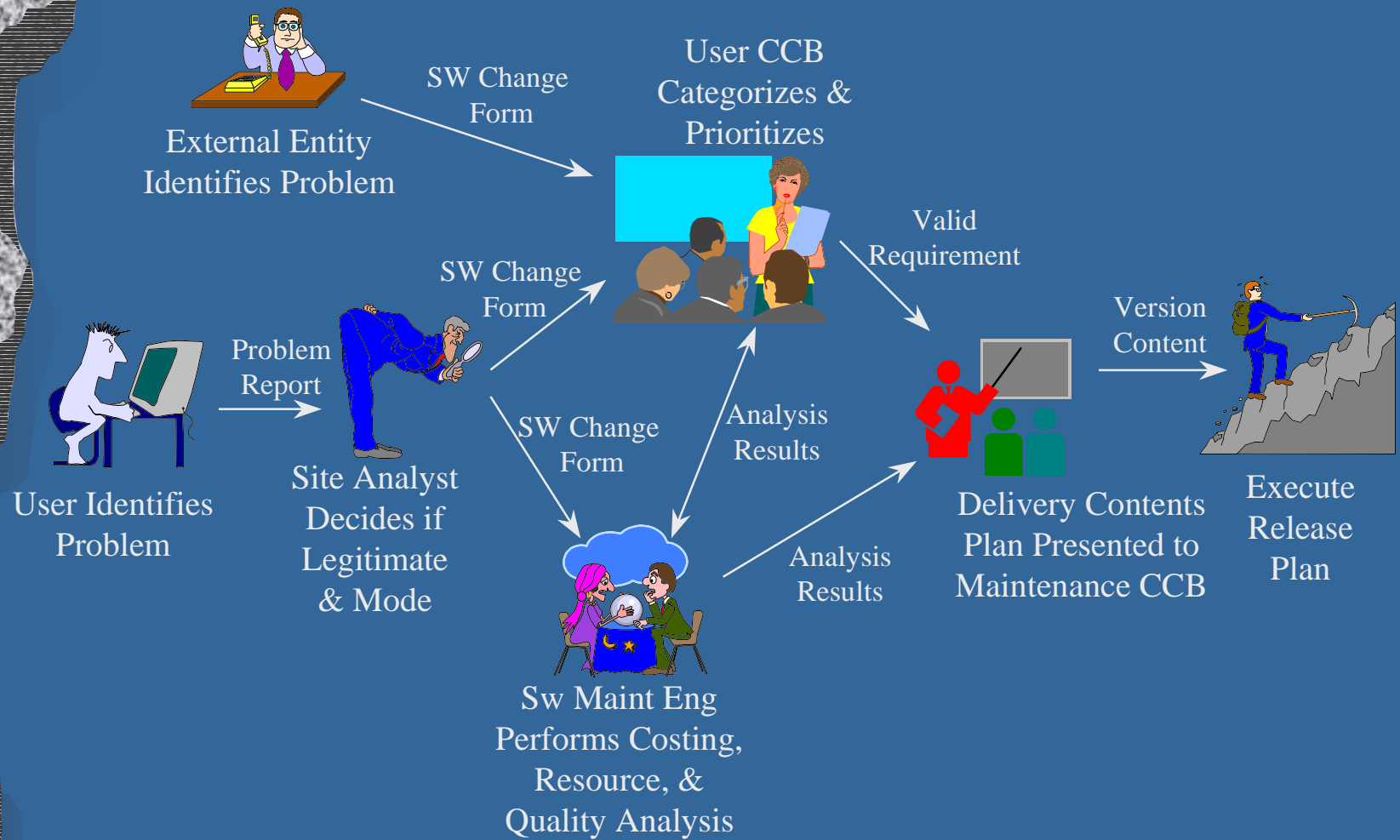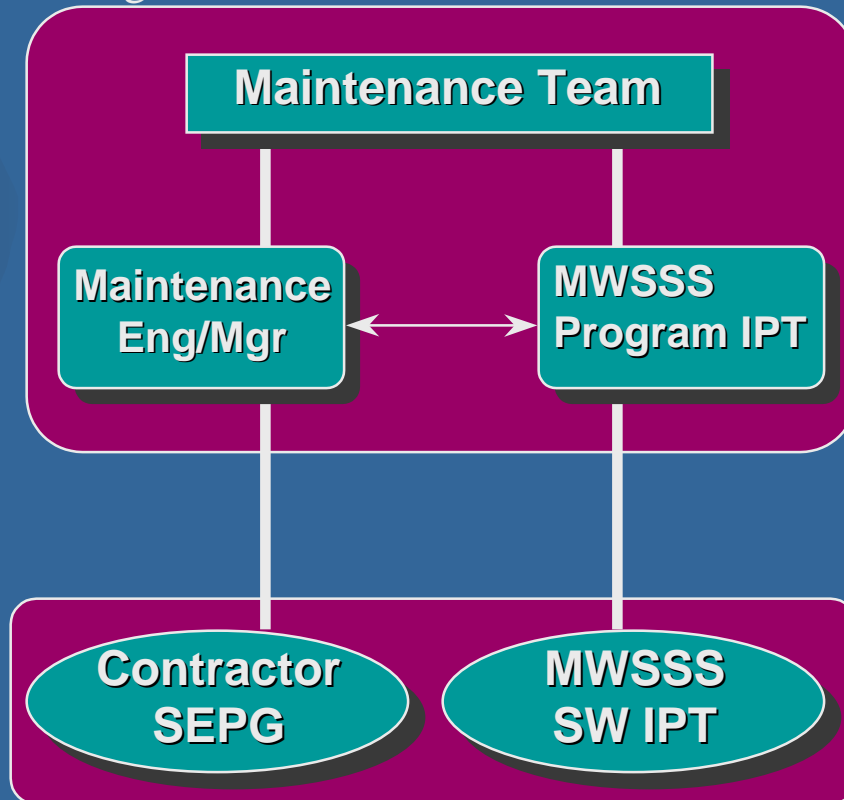|	
Staff	**0.5**
Function	
set goals/questions/metrics	
analysis/research	
refine software process	
produce reports	
Products	**5 reports**

Decision Analysis

**Maintain Experience Information
(e.g., Tools, Environment, Staff,
Documents, Schedules, Risks)**

MITRE

Software Maintenance Process

External Entity Identifies Problem

SW Change Form

User CCB Categorizes & Prioritizes

Valid Requirement

User Identifies Problem

Problem Report

Site Analyst Decides if Legitimate & Mode

SW Change Form

SW Change Form

Analysis Results

Sw Maint Eng Performs Costing, Resource, & Quality Analysis

Analysis Results

Delivery Contents Plan Presented to Maintenance CCB

Version Content

Execute Release Plan

MITRE

MWSSS Software Measurement Information Needs

Program Maintenance

AFMC/AFSPC Management

Maintenance Team

Maintenance Eng/Mgr ↔ **MWSSS Program IPT** ↔

Contractor SEPG

MWSSS SW IPT

Quarterly Reports
 Cost per Release
 Schedules Met
 Release Quality
 Current Backlog
 Product Reliability
 Risk Summary
 Requirement Volatility
Other Reports
 SEMR
 PIWG

MITRE

MWSSS Software Measurement and PSM

Common Software Issues

Measurement Categories

Measures
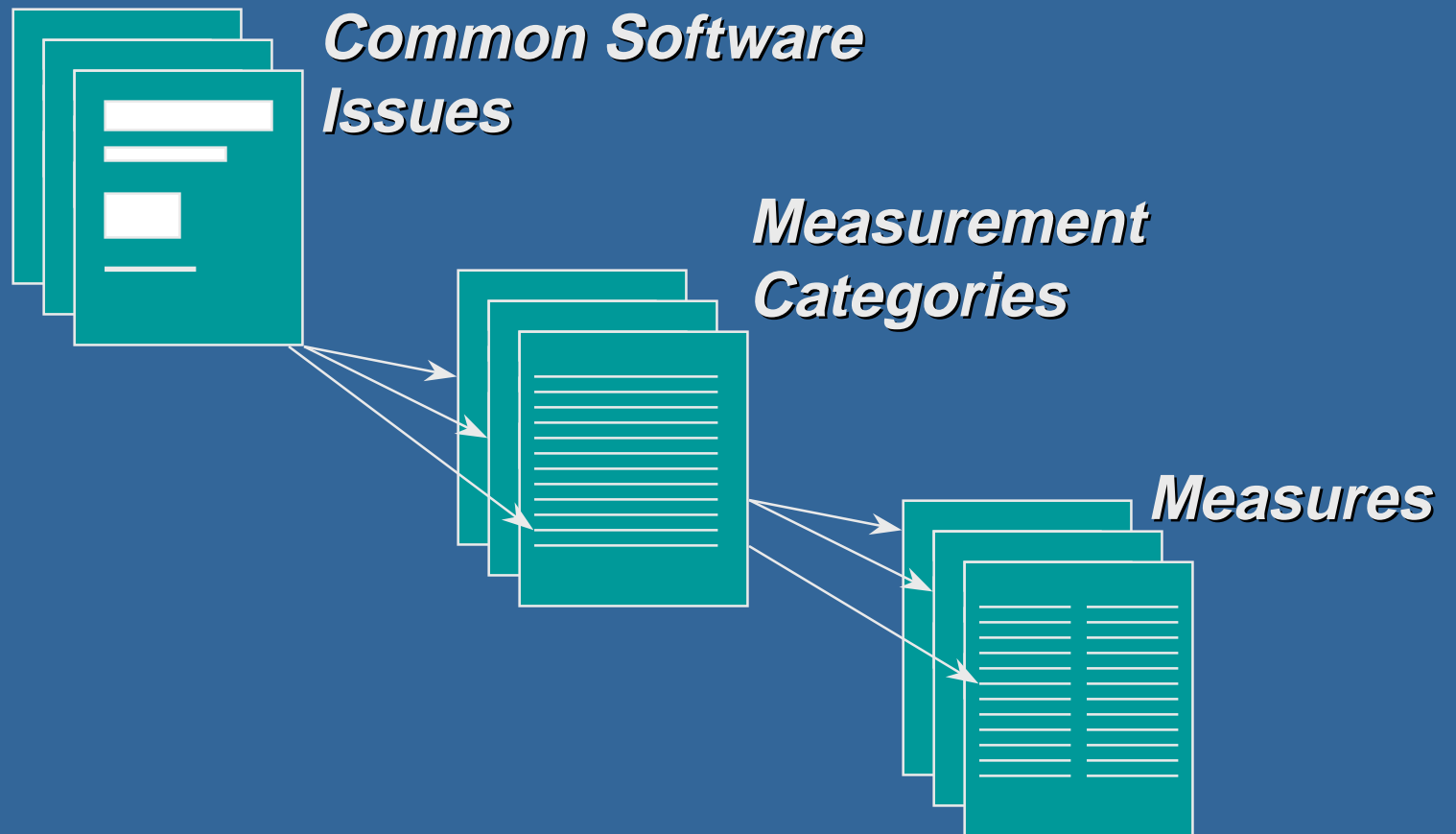
MWSSS Issues vs PSM Issues

MWSSS / PSM	Cost	Schedule	Reqmnt Volatility	Product Quality	Workload
Schedule & Progress		X			
Resources & Cost	X				
Growth & Stability			X		
Product Quality				X	
Development Performance					X
Technical Adequacy					

MITRE

MWSSS Issues and Measures

Issue	Measurement Category	Measure(s)
Cost	Cost Performance	Cost per Release Monthly Budget vs Actual
Schedule	Schedule Performance	% Schedules Met % Milestones Met
Reqmt Volatility	Rework	% Reqmts Changed after Plan % Invalid Change Requests
Product Quality	Defect Profile	Sw Reliability (failures/1000 hr) Defects per Test Period Sw Maintainability
Workload	Product Size & Stability Target Resource Utilization Process Capability	Change Request Backlog Number of Changes by Type % CPU, Memory, Disk, other Change Request Cycle Time "Complexity"

MITRE

Cost of Implementation

- 96K first year (FY95)
  - Strategy development
  - Goal/Question/Metric Paradigm implementation
  - Proof-of-Concepts: data collection, analysis, and reports
  - Tool and Guidebook development
  - "High Visibility" uses and process integration
- 50K second year (FY96)
  - Formalize data collection and spreadsheet repository
  - Train engineers and project managers
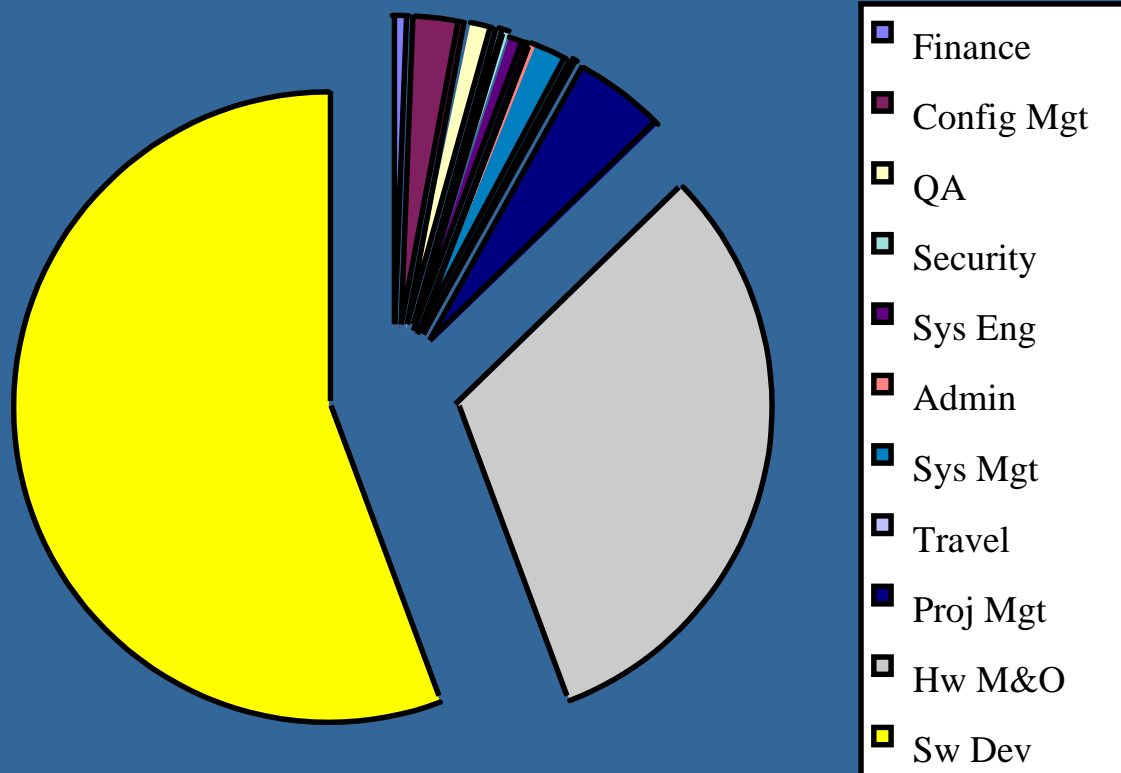 - Review measures

MITRE

Return on Investment

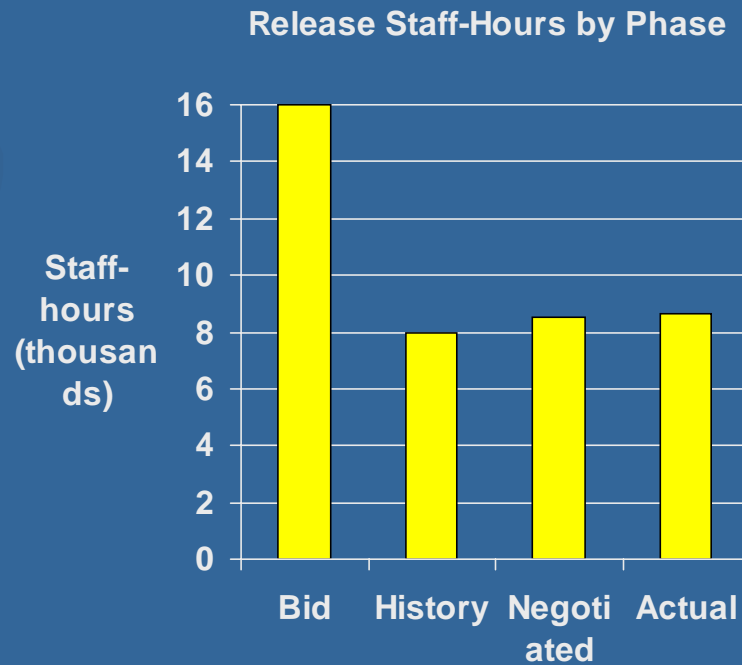|	Releases	SCFs Delivered	Average Cost (K$)	Priority Cycle Time (days)	Percent Releases on Schedule	Quality (OT&E Defects per Change)
FY94	8	98	unknown	90	0	unknown
FY95	17	139	$380	120	20	0.04
FY96	13	133	$359	135	61	0.06

FY94 data from previous organization. Fewer releases in FY96 because one system "frozen." Average cost is 21K per release lower. Priority cycle time increase due to one product and process rigor.

MITRE

What Costs were Considered?

SW Maintenance Cost by Activity

Legend:
- Finance
- Config Mgt
- QA
- Security
- Sys Eng
- Admin
- Sys Mgt
- Travel
- Proj Mgt
- Hw M&O
- Sw Dev

MITRE

Cost Avoidance Results

Release Staff-Hours by Phase

Staff-hours (thousands)

Axis values
16
14
12
10
8
6
4
2
0

Bid History Negotiated Actual

- 7,500 staff-hour cost avoidance = $500K using historical metrics for release cost negotiation

MITRE

Cost Avoidance (Continued)

- Requirement Volatility Identified as Major Cost Driver
  - Few releases meeting schedule commitments
  - One release contained seven release plans
    - 250% Requirement Change
      - Original plan contained 10 requirements
      - Actual delivery had 18 requirements
      - "Middle" versions had some deletes, some scope changes
      - 25 total requirement changes during release
    - $90,000 over budget, Delivered Seven months late, Three OT&E Defects

MITRE

Schedule Impact of Requirements Changes

Schedule vs Requirements Volatility

Percent of Planned Schedule

SQRT(Percent of Requirements Changes)

MITRE
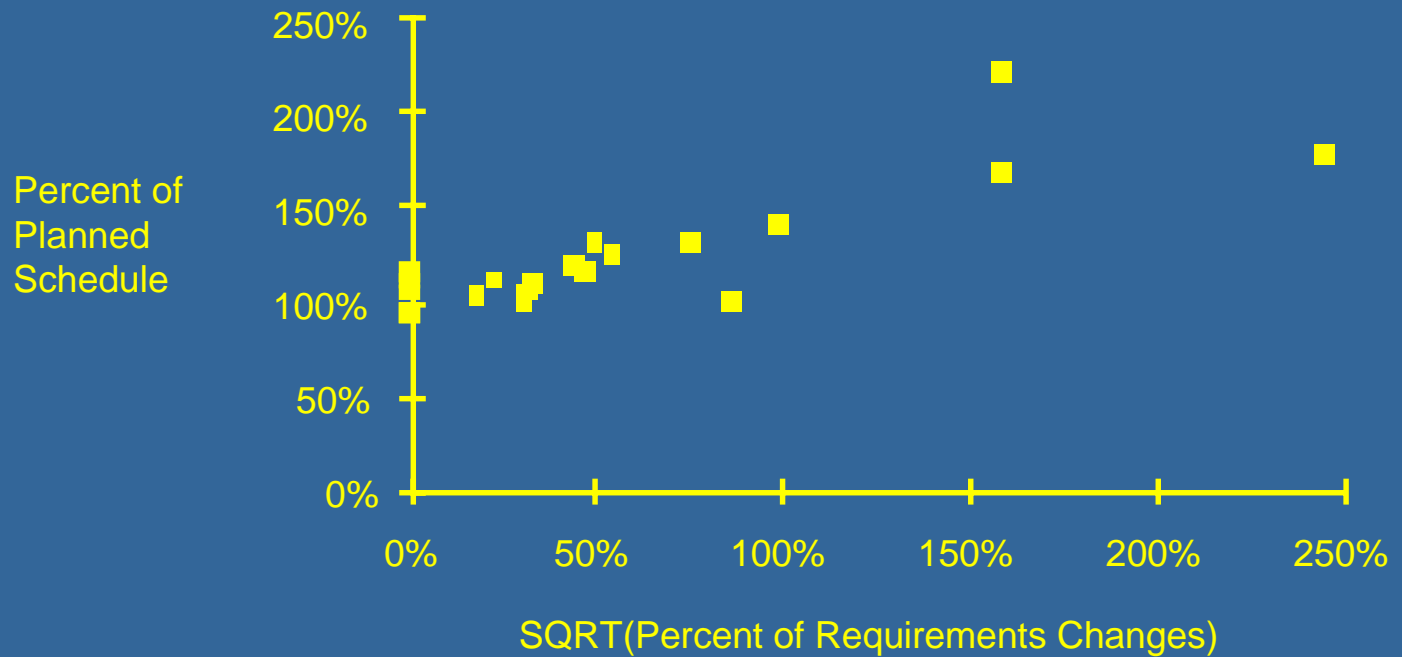
Cost Avoidance (continued)

- Customer requested change in release content for two releases. Used historical metrics to estimate cost & schedule impact
  - Release 1: $60K cost with 16 day schedule slip
  - Release 2: $50K cost with 12 day schedule slip
- Customer decided to include changes in next release
- Total Cost Avoidance = $500K + $60K + $50K = $610,000

MITRE

ROI Results & Calculation

- Over 2 years, the MWSSS measurement program has returned
  - 187% of its investment in lower software release costs
  - 418% of its investment by helping avoid costs we would have accepted in the past

$$\text{ROI}_1 = \frac{\text{Total Savings}}{\text{Investment}} = \frac{273\text{K}}{146\text{K}}$$

$$\text{ROI}_2 = \frac{\text{Total Avoidance}}{\text{Investment}} = \frac{610\text{K}}{146\text{K}}$$

MITRE

Software Measurement Products

- Measurement Guidebook
  - Training for Engineers and Project Managers (need more)
  - Quarterly Analysis since Q1 FY95
- Tool Needs & Identification
  - LOCOMO (logistics cost modeler from Sacramento ALC)
  - PC-metric (maintainability evaluation tool)
  - CASRE (Sw Reliability tool)
  - DELCOMP (Release "complexity" tool)
  - Excel (Data Repository and Analysis tool)

MITRE

Software Measurement Products

- Special Analysis Reports
  – Release Cost Analysis
  – "Complexity" Metric Definition and Analysis Report
  – Macro & Micro Requirement Volatility Analyses
  – Release Progress and Code Evaluation Reports
- Process Improvement Reports
  – Maintenance Configuration Control Board Measures
  – Program Management Review Reports
  – Release Planning Guide (draft)
  – Maintenance Process Comparison Study

MITRE

Key Impacts

- Measurement data has allowed us to perform analysis never before possible
  - Communicate more clearly with customers
  - Understand our own process
  - Build models to answer "what-if" questions
  - Substantiate cost avoidance measures
- Reduce time to answer recurring questions about software releases and specific changes

MITRE

Overall Status

- Measurement program is now an integral part of software management processes
  - Requirement validation
  - Release and change costing
  - Release planning and approval
  - Project monitoring

MITRE

Summary

- The measurement program has more than paid for itself inside MWSSS
  - Long-term maintenance requires formal planning and explicit management
  - A simple costing approach and reliability history are valuable tools for planning
  - The cost of implementing a maintenance measurement program is low

MITRE

Further Information

- A previous version of this paper is available at
  - http://members.aol.com/GEShome
- I can be reached for questions/comments at
  - gstark@mitre.org
  - (719) 556-2580 or (719) 572-8468

MITRE