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Pittsburgh, PA 15213-3890

Calculating CMMI-Based ROI
Why, When, What, and How?

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19th Annual SEPG Conference
March 26-29, 2007
Austin, TX

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
MAR 2007		**00-00-2007 to 00-00-2007**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Calculating CMMI-Based ROI Why, When, What, and How?	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Carnegie Mellon University ,Software Engineering Institute (SEI),Pittsburgh,PA,15213**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**87**	

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Agenda

1. **Introductions and Logistics**
2. **Why?**
   Why should an organization attempt to calculate the ROI of CMMI-based efforts? Is ROI the right way to show financial value?
3. **When?**
   When should these ROI calculations be performed? When can you compare ROI results across organizations?
4. **What?**
   What information is needed in order to calculate ROI? What information is inappropriate?
5. **How?**
   How do organizations calculate ROI? How can they do it better?
6. **Wrap-Up**

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1 - Introductions and Logistics

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How often have you heard this....?

What is the value of process improvement to our organization?

Why CMMI?

What should we focus on?

How much is this going to cost?

What's in it for me?

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Overview

This tutorial is intended to be a basic introduction to calculating the costs and benefits of CMMI-based process improvement

We'll discuss estimating, tracking, and validating ROI over the course of a CMMI improvement effort

You'll be introduced to several ways to calculate ROI, and the pros and cons of each

Implementation approaches, hints and tricks will be introduced to help you really make this work!

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Logistics

Workshop Time/Duration

Rest Rooms

Breaks

Smoking Rules

Phones

Messages

ROI can be calculated many ways

There is no single, official “definition” of ROI – it can be calculated in many ways.

Some of these include:

- Benefit/Cost ratio (typically considered ROI)
- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Payback Period (PP)/Break Even Point (BEP)

A complete ROI analysis includes all of the above.

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The Value of CMMI Improvement

Average software organizations spend 65% or more of their engineering dollars addressing quality problems!

This means that only 1/3 of the organization is actually creating something.

Leading software organizations can reduce this Cost of Quality to 40% or less, resulting in 50% or more gains in productivity.

Numerous CMM case studies conclusively demonstrate the value that can be achieved.

A rapidly growing number of CMMI case studies are duplicating & exceeding these results.

Examples

Reduced cost of poor quality from over 45% to under 30%
- 2:1 ROI over 3 years (Siemens Information Systems Ltd, India)

$2.1 Million in savings in hardware engineering processes
(Reported under non disclosure)

Reduced software defects per million delivered SLOC by over 50% compared to defects prior to CMMI
(Lockheed Martin Systems Integration)

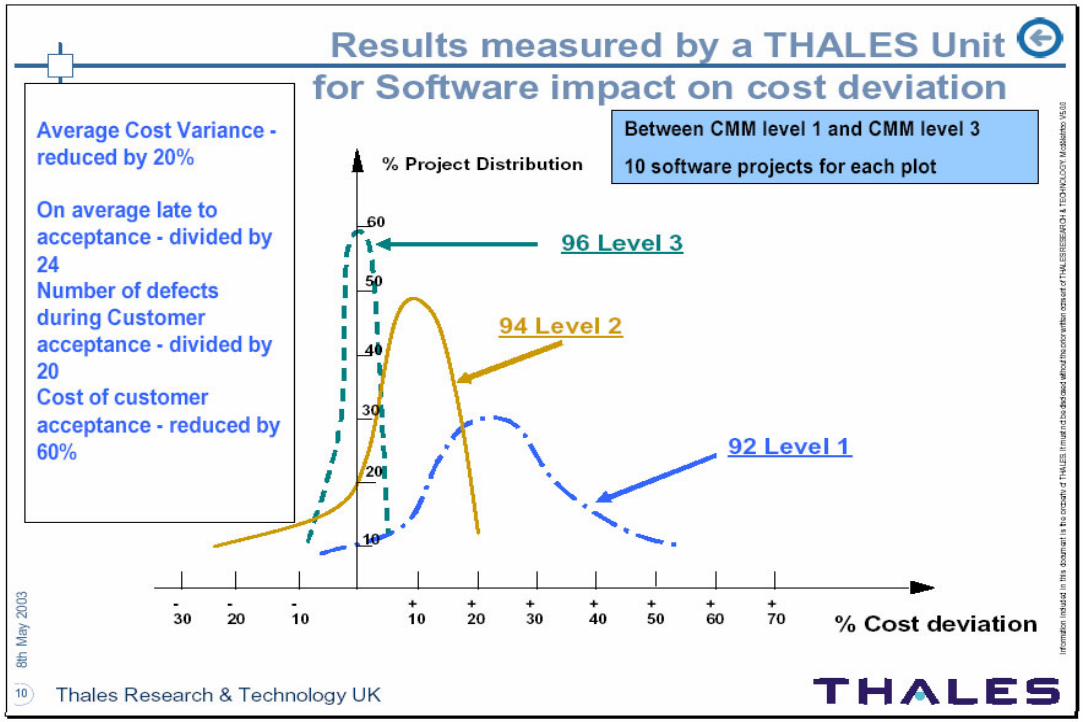
Reduced defect rate at CMMI ML5 approximately one third compared to performance at SW-CMM ML5
(Lockheed Martin Maritime Systems & Sensors – Undersea Systems)

Avoided $3.72M in costs due to better cost performance
- As the organization improved from SW-CMM level 4 to CMMI level 5 (Raytheon North Texas Software Engineering)

2.5:1 ROI over 1st year, with benefits amortized over less than 6 months (reported under non disclosure)

Thales Research & Technology

CMM data from another Thales Unit used by Thales Research & Technology as part of rationale to begin PI with CMMI.



Improvements in:

- Product cost
- Schedule / cycle time
- Quality
- Customer satisfaction

Getting Started with Process Improvement Using the CMMI®. Carol Marsh, Patrick Vigier. ESEPG 2003.

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Northrop Grumman IT

Appraised at CMMI ML 5 in December 2002

Results

- met 25+ milestones in a row
- earned a rating of “Exceptional” in every applicable category on a formal Contractor Performance Evaluation Survey

- Hours Invested: 124 in Defect Prevention (CAR)
- Hours saved: 1650 hours (15 hours per defect)
- **ROI:** 13:1

Improvements in:

- Schedule / cycle time
- Customer satisfaction
- Quality
- Cost of quality / ROI

Integrating PSP[sm] and CMMI® Level 5. Gabriel Hoffman, Northrop Grumman IT . May 1, 2003

Accenture

Transition SW-CMM to CMMI ML 3

- May 2001 to May 2002
- Transition Time: 1149 person hours

Key Content

Measurement and Analysis
DAR ➡ TS, RM, Change Control
IPPD ➡ visions, OEI
Generic Goals

Results

- **ROI**: 5:1 (for quality activities)

Costs:

Investment in Improvement

Improvements in:

Cost of quality / ROI

Innovation Delivered. CMMI® Level 3 in a Large Multi-Disciplinary Services Organization. Bengzon, SEPG 2003

Some Caveats!

No financial or accounting knowledge is assumed

The tutorial is not intended to be comprehensive, some topics are presented at a high-level only

In some cases, nuances of financial accounting and ROI determination are not addressed

We'll do our best to get you started without burying you in details!

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Audience

Executive/leaders of organizations seeking to understand the costs/benefits of CMMI-based process improvement and how to quantify them

Process improvement/EPG personnel seeking ways to communicate more effectively to senior management about the costs/benefits of CMMI-based process improvement

Personnel in organizations starting down a CMMI-based process improvement path

Project managers and engineers who need information to make better decisions about their project work.

Personnel in higher-maturity organizations seeking to transition to the CMMI, or implement higher-maturity process areas

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Introductions

Tutorial leader introductions

Participant introductions

- Name
- Company
- Position
- Expectations
  - What do you want to get out of the tutorial?
  - Do your expectations match the tutorial agenda?
  - How can we best address your concerns?

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Tutorial Approach

Interactive Presentation

Examples

Exercises

Questions and Answers

Participate!!!

2 – Why?

i. To develop the business case for process improvement
ii. Need to communicate to decision makers who understand the language of money, not CMMI
iii. ROI is the only way to show financial value

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Business Context

The first question to answer is “what is the business context in which we’re undertaking a CMMI effort?” Is it because we want to:

- Do things better, faster, cheaper?
- Increase contract award fees?
- Secure more contracts?
- Improve product quality?

We’re going to focus on the quality, project management, and productivity implications of CMMI process improvement

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System Development Costs

Costs incurred to develop the product

Examples:

- Requirements development
- Design
- Product development + unit test
- Project management
- Engineering infrastructure
- Purchased components

What isn't on this list?

Cost of Quality (CoQ) Concept

Developed by J.M. Juran and applied successfully by companies like Toyota Motor Corporation to achieve competitive advantages through the development of better quality products

CoQ represents *all costs associated with poor quality*

Source: Juran's Quality Handbook

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Cost of Quality Appraisal Objectives

- Quantify quality costs in the language management understands – money
- Identify major opportunities for quality cost reduction
- Identify opportunities for reducing customer dissatisfaction and threats to product saleability
- Expand budgetary and cost controls
- Stimulate improvement through publication
- Improve ability to deliver more to the business/market
- Reduce the functionality gap versus the competition
- Provide executives with reasons to invest in engineering improvement
- **CoQ appraisals are an easy way to understand where money is spent and to gauge the effectiveness of an organization**

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Internal Failure Costs

Costs associated with defects that are found prior to transfer of the product to the customer

Examples:

- Design corrective action
- Design re-reviews
- Purchased component corrective action
- Purchased component re-test
- Defect reporting/tracking
- Defect fixing
- 2nd and subsequent integration testing iterations
- 2nd and subsequent system testing iterations

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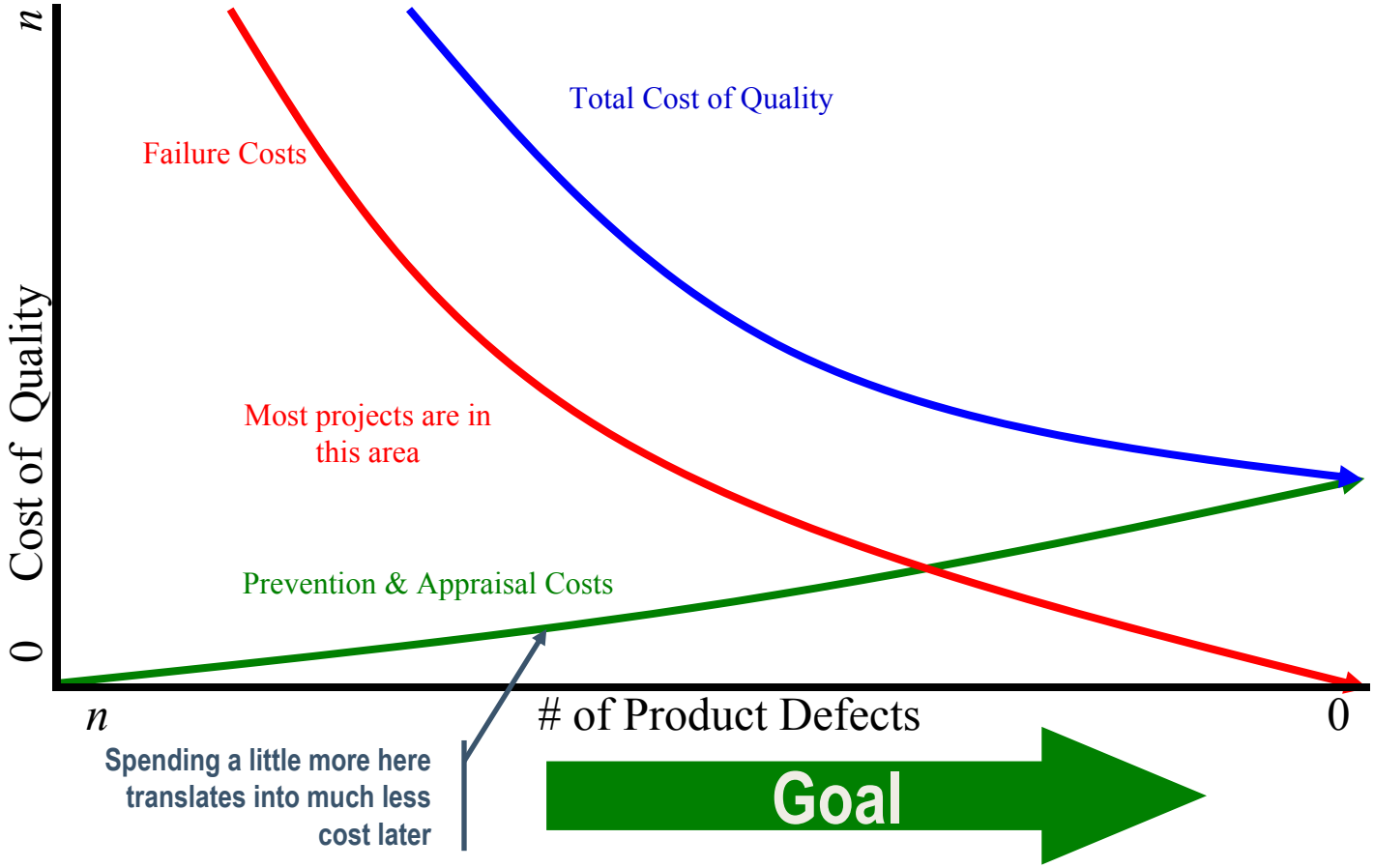
External Failure Costs

Costs associated with defects that are found after the product is shipped to the customer

Examples:

- Next release defect rework (maintenance)
- “Re-engineering”
- Technical support personnel
- Product returns
- Lawsuits
- Contract penalties
- Lost customers
- Lower marketplace perception
- Loss of pricing power
- Lost sales

Graphical Representation of CoQ



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Prevention Costs

Costs incurred to keep failure and (product) appraisal costs to a minimum

Examples:

- Quality planning
- Quality assurance
- Configuration management
- Supplier capability assessments
- Quality training
- Component/software reuse
- Requirements reviews
- Design reviews
- Code reviews
- CM tools
- External process appraisals/audits (CMMI, ISO, SPICE, etc)
- Process improvement efforts

(Product) Appraisal Costs

Costs incurred to determine the degree of conformance to quality requirements

Examples:

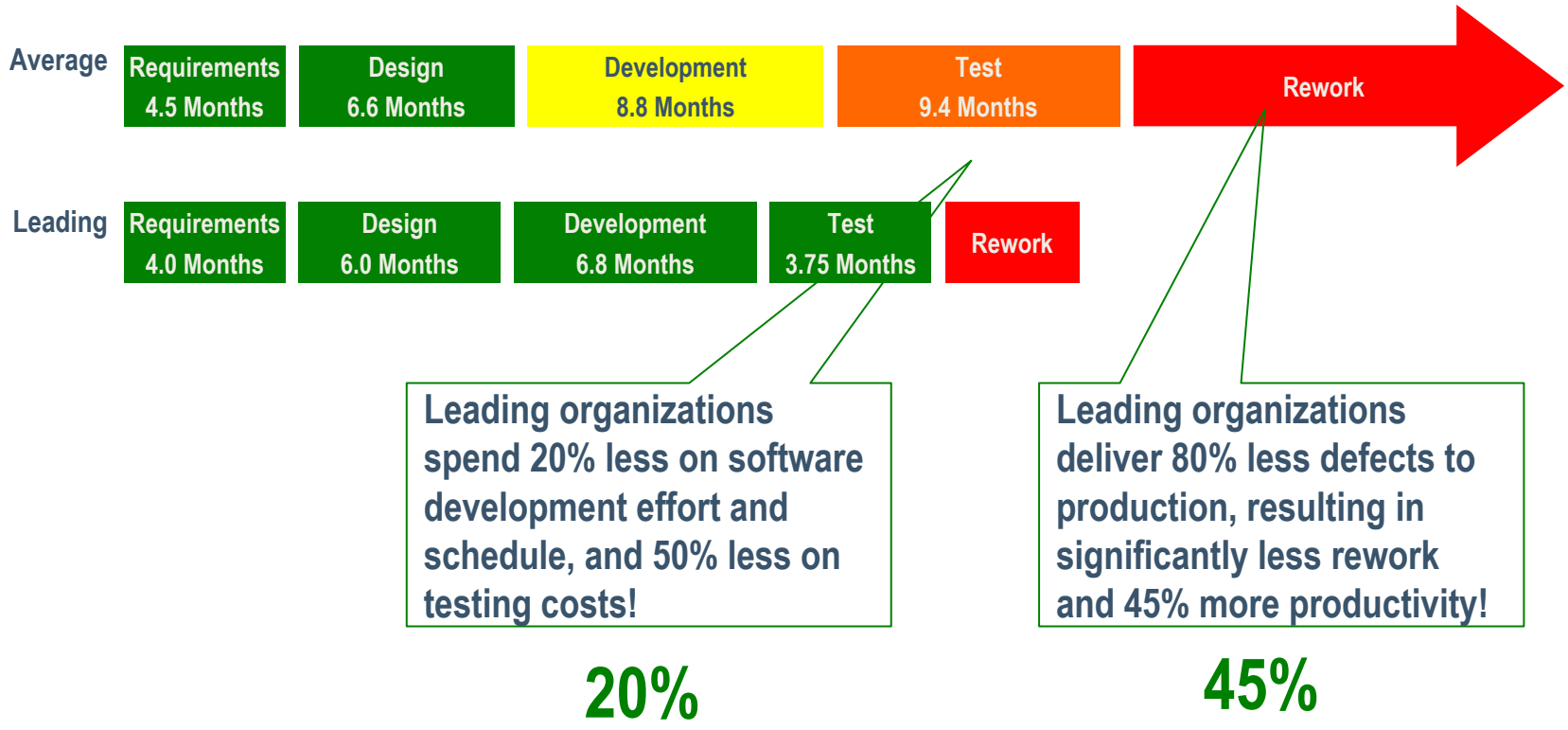
- Purchased component testing
- Defect reporting/tracking
- Test automation systems/software
- First iteration integration testing
- First iteration system testing
- User acceptance testing

Relating CoQ to Productivity

Decreasing an engineering organization's Cost of Quality directly impacts productivity:

- Fewer defects mean less time testing and reworking the product
- Less time testing means a shorter cycle time
- Shorter cycle time means more products can be developed in similar time frames
- Fewer defects also mean a smaller customer support staff – these resources can be applied to new product development

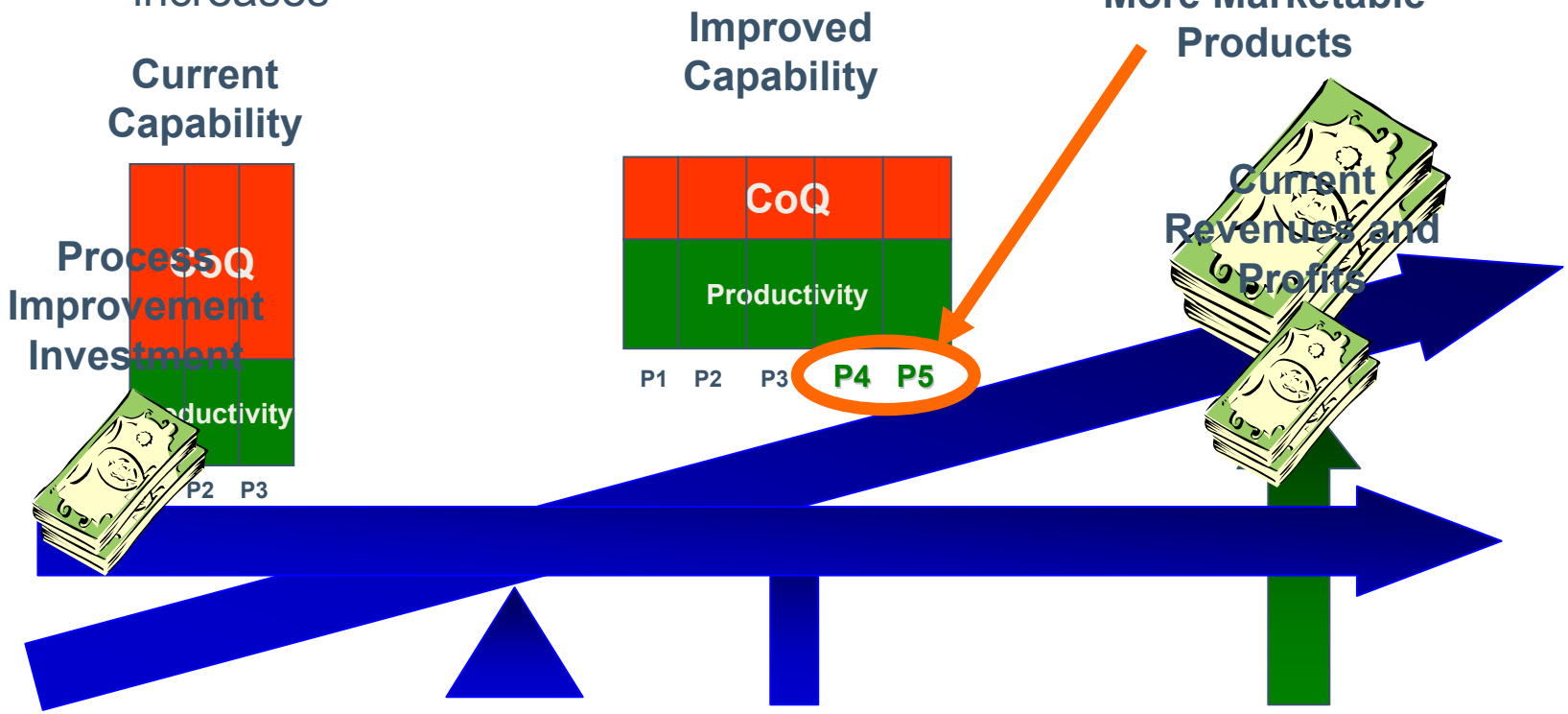
SW Example: 65% More Productivity



Average organizations spend 30% of project resources on testing, leading organizations spend 15%

Leverage

Process improvement has a leverage effect beyond just quality and productivity increases



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Communication

Executives, senior management, and other decision makers don't use CMMI language

- $ **Their language is money**
- $ Decision making is done in the context of money

  so.....
- $ Communicating the importance and effectiveness of CMM-based process improvement
- $ Champions must communicate in the language of executives – money

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Business Case

- Resources are scarce (especially $money$)
- It is impossible to execute on all opportunities available to the organization
- Executives want an “apples-to-apples” comparison of the various investment options available

Incorporating ROI analysis into a proposed or existing CMMI effort allows for comparison of efforts across seemingly disparate projects

And, the ROI of CMMI can be quite high

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Provide Focus and Tracking Capability

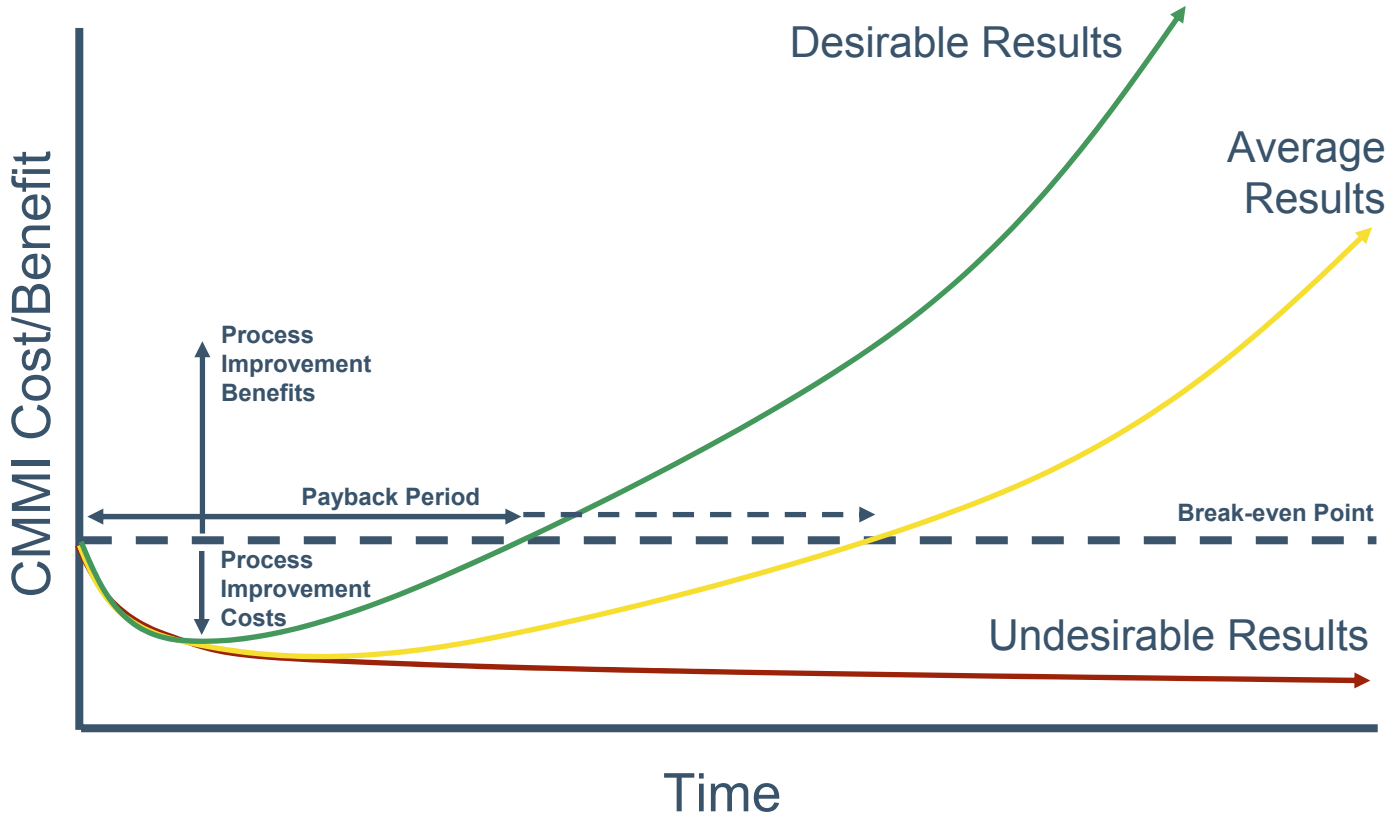
Performing an ROI analysis up-front (estimation) can

- focus the organization on concrete business objectives for CMMI process improvement,
- clarify how improvement efforts map to corporate objectives,
- establish expectations about results
- establish a baseline to track performance

Multi-year process improvement efforts need to maintain the business focus by continuously tracking

- $ the associated actual costs
- $ the related benefits

Drive Better Results



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Difficulties in Using ROI

Differing perceptions of ROI

Buy-In

Access to Data

Calculating benefits is tough

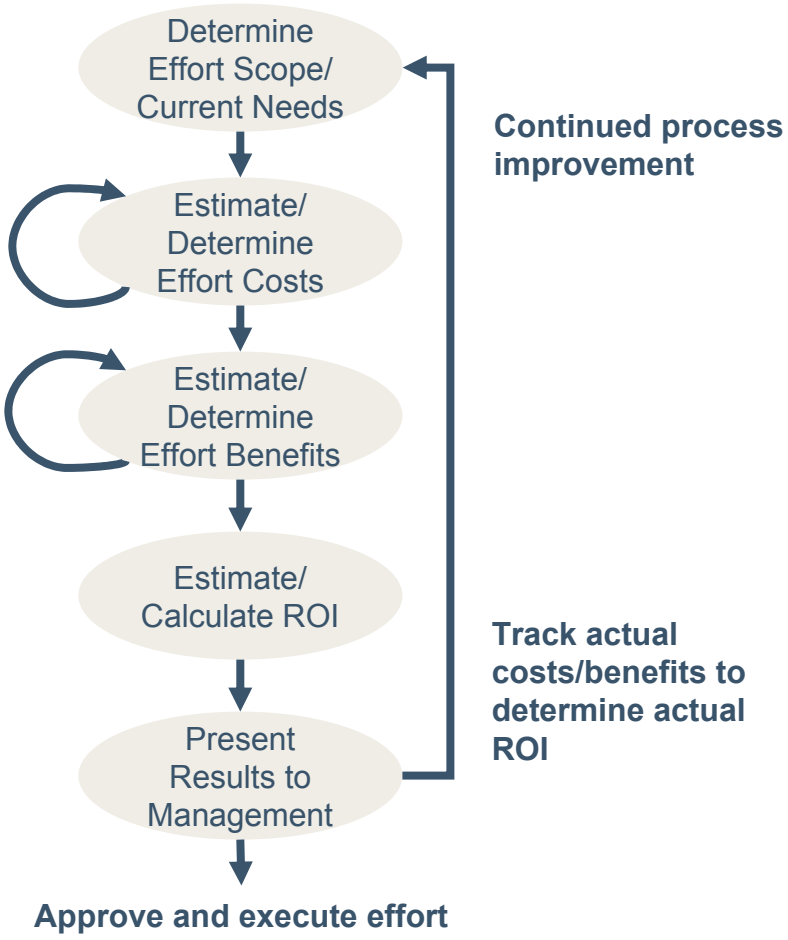
Consistently measuring ROI over time is tough

Organizations are resistant to measurement

Discussion

What other difficulties have you experienced in determining CMMI ROI? How did you overcome them?

A Process for Determining ROI



3 – When?

i. Before
ii. During
iii. After

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Before

Initially, it is VERY important to understand the potential value of a CMMI-based improvement effort to:

- Clearly understand the estimated costs associated with the effort
- Demonstrate the potential business value
- Provide a comparison against competing projects
- Establish a baseline for ongoing tracking and oversight
- Establish the expectations that benefits require time to develop, particularly for senior management
- Communicate with decision makers

At this time, other organizational indicators such as quality measurements, schedule adherence, customer satisfaction, etc. should be baselined.

During

In order to track and maintain visibility, ROI should be tracked on an ongoing basis (perhaps every 6-12 months)

At the same time, intermediate indicators such as quality measurements, customer satisfactions surveys, etc. are tracked to determine the impact of improvement activities

Doing so demonstrates that the effort is on track from a cost perspective, and continues to keep the focus on the effort.

Additionally, early wins are communicated unambiguously in financial terms – something executives like to see.

After

After a particular effort is completed, the ROI should be calculated to fully understand the true value of the effort.

This is needed to evaluate the financial effectiveness of the effort, create lessons learned, and set the stage for driving continuous improvement and institutionalization.

This forms the basis for the implementation of higher maturity process areas that support fact-based decision making.

In other words....

continuously,
throughout the entire effort!

Implementation of the Measurement and Analysis process area early in your adoption effort will facilitate this. It will also support your organization's comparison to applicable benchmarks as well as modeling and simulation.

4 – What?

i. All applicable direct costs should be identified
ii. As well, all direct benefits should be accounted for
iii. Indirect costs and benefits shouldn't be part of the analysis as they are difficult to attribute solely to the effort

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What information is needed.....

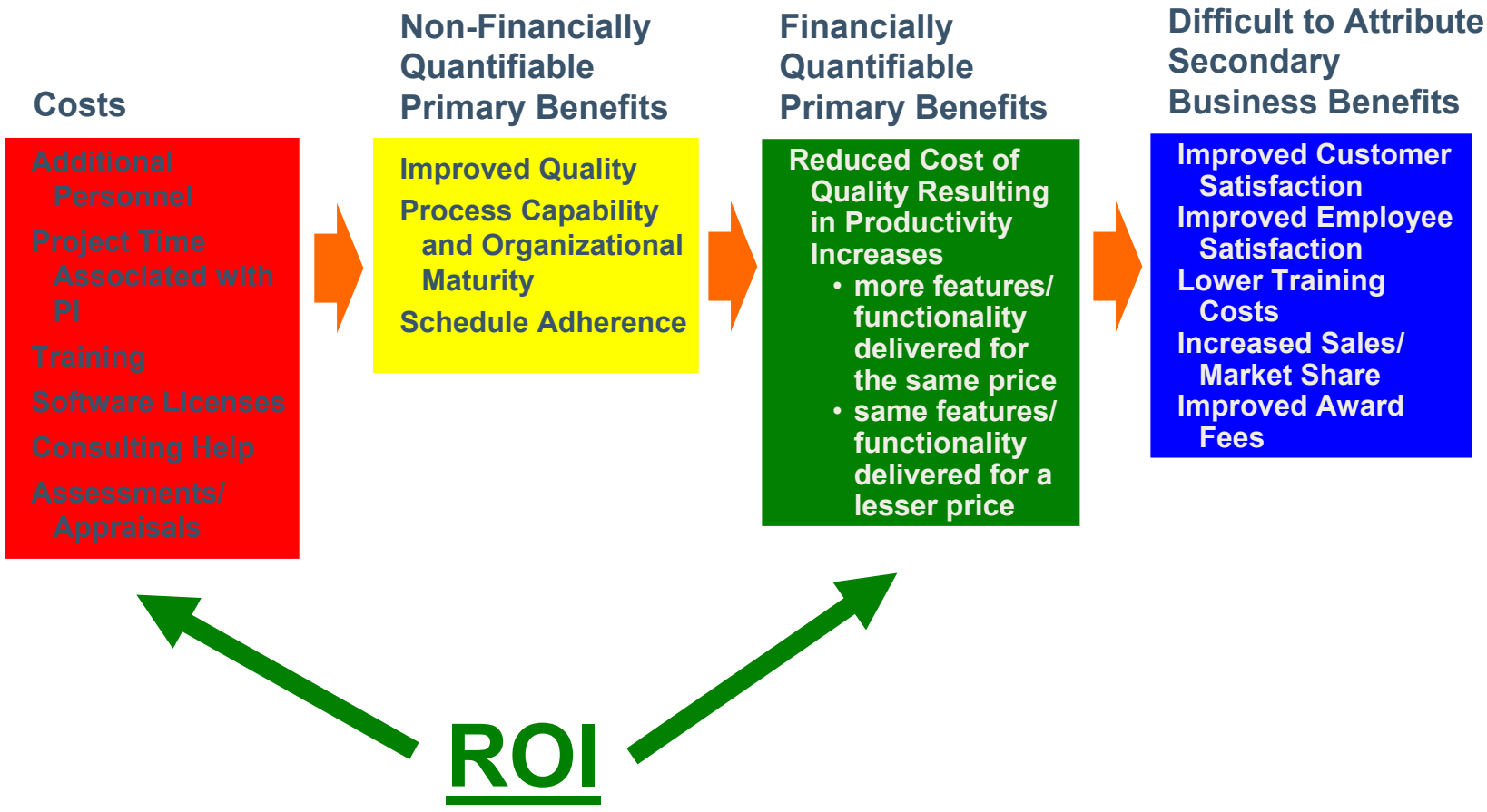
In its most basic definition ROI = A comparison of the costs and benefits of a process improvement effort across a specific organizational scope and time span.

You need to understand:

- Scope of the analysis
- Appropriate time horizon for analysis
- Relevant costs
- Financially quantifiable benefits

Remember, for a proper ROI analysis, all cost and benefit information needs to be calculated in terms of dollars and cents.

Process Improvement ROI Model



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Scope of Analysis

There are many ways to scope an ROI analysis.

- At the:
  - Organizational level
  - Project level
  - Process level
- Examples include:
  - Moving from CMM to CMMI
  - Introducing all practices associated with a particular PA
  - Implementing specific practices
  - Achieving a specific maturity or capability level
- **ROI calculations/equations won't change due to scope.**

Time Horizon

Over how much time should an ROI analysis be performed?

Organizational - Generally, organizational efforts must show net value over a 2-3 year time period and unambiguous incremental value in shorter time frames.

Project/process - must show value in a shorter period of time.

It is probably unrealistic in most circumstances to demonstrate meaningful and measurable benefit in less than 3 months time due to:

- Need to develop/implement processes
- Train organizational units
- Institutionalize the improved processes

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Scope: Exercise

At this point, we'll begin working though our fictitious example of:

- Organizational CMMI improvement effort
- 150 person engineering organization at maturity level 1
- Looking to reach maturity level 2 in 18 months
- No EPG or QA in place
- Experiencing a Cost of Quality of 65%

In the exercise, we'll utilize an ROI calculation worksheet that guides the type of information we need to consider.

First off, we need to define the scope of the effort

What Costs and Benefits?

What **costs** do you need to track?

What **benefits** are you expecting to realize?

When will costs and benefits be incurred?

How will these come together to generate **ROI**?

Key Factors

Generating Cost & Benefit Data, you need to be aware of:

- Consistency
  - in gathering over time
  - in matching costs and benefits
- Clear & detailed operational definitions
- Clearly understanding **incremental** costs and benefits
- Costs and benefits defined in financial terms

Direct People Costs of CMMI Improvement

Costs of Process Definition / Improvement	
Process definition & documentation	Interviews, meetings
MSG, EPG, TWGs	Attendance in training
Management of the effort	Process implementation
Consulting	Process institutionalization
Additional personnel	Process adherence
Project team diversion	Assessments/appraisals
Communication	Rewards and recognition

Generally counted as salary & benefit costs associated with people's time

Direct Non-People Costs of CMMI Improvement

Costs of Process Definition / Improvement	
Tools	PAL, Measurement Repository
Training	

Indirect Costs of CMMI Improvement

Costs of Process Definition / Improvement	
Loss of organizational/project team productivity	

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Other Costs to Think About

Rework due to poor quality • Prior to shipping • After shipping
Poor project cycle time
Lack of schedule predictability

Rather than consider these expenses on the "cost" side of the ROI analysis, we'll consider improving them to be part of the "benefits" side.

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Costs: Exercise

- Organizational CMMI improvement effort
- 150 person engineering organization
- Looking to reach maturity level 2 in 18 months
- No EPG or QA in place
- Experiencing a Cost of Quality of 65%

Which costs should we plan and account for?

Direct Benefits

Reductions in:	Improvements in:
Defects	Process adherence
Rework	Quality
Effort/overtime	Product features
Schedule cycle time	
Product costs	
Production costs	
Support costs	

Indirect Benefits

Reductions in:	Improvements in:
Training costs	Employee satisfaction/retention
	Customer satisfaction/retention
	Revenue
	Award fees
	Market share

Discussion

Most direct process improvement benefits can be financially quantified in terms of productivity increases

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So, How Do We Measure Productivity?

The definition of Productivity is the number of outputs delivered for a certain number of inputs.

For systems engineering, the inputs are typically people-related.

The outputs however, can vary significantly, and are difficult to compare against each other:

- Missile system
- Copy machine
- Cell phone
- Function points or SLOC (for software)

The easiest way to help understand the notion of productivity in an engineering organization is Juran's Cost of Quality concept.

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Measuring Non-Financial Benefits

As discussed, there are many non-financial benefits with different ways to measure them.

It is important to measure non-financial benefits on an ongoing basis as part of the effort in order to keep focus on other indicators of progress or value.

Keep in mind that measuring these in non-financial terms doesn't directly impact the ROI calculation.

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Using Benchmarks to Estimate

To aid in determining what costs and benefits may be expected, consider the use of industry benchmarks. For example:

- Gartner research shows software organizations spend 3% - 5% on CMMI process improvement efforts
- CMM maturity level 1 organizations typically experience a Cost of Quality of 65%
- CMM maturity level 3 organizations typically experience a Cost of Quality of 40%

Baselining the organization and using benchmarks to compare against helps in building a credible ROI calculation.

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Using Simulation to Estimate

Engineering process simulation models focus on the dynamics of engineering development and maintenance.

Modeling and simulation of the significant features of engineering processes facilitates experimentation, answer "what-if" questions, and perform sensitivity analysis.

By modeling an organization's current engineering processes and simulating improvements to them, costs and benefits can be better estimated and determined.

Example: would the cost of source code inspections add value if the input source code had an abnormally high degree of errors?

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Benefits: Exercise

- Organizational CMMI improvement effort
- 150 person engineering organization
- Looking to reach maturity level 2 in 18 months
- No EPG or QA in place
- Experiencing a Cost of Quality of 65%

Benchmarks indicate that an organization operating at maturity level 2 can reduce its Cost of Quality to 50%

How can we quantify these benefits?

Levels of Data Fidelity

The level of detail you go to in an ROI analysis will depend on the size of the effort

Multi-million dollar CMMI efforts in larger organizations will most likely require a greater degree of data fidelity than a smaller, more tactical solution on just one project.

Understand the level of fidelity needed to make a **credible** ROI analysis. Don't blow your chance with a shallow case if decision makers are expecting more details.

"Test run" your assumptions and analysis with peers and other managers before presenting the final results.

5 – How?

i. There are several ways to calculate ROI
ii. Using multiple methods provides for a multi-faceted view and allows for better decision making

ROI can be calculated many ways

There is no single, official “definition” of ROI – it can be calculated in many ways.

Some of these include:

- Benefit/Cost ratio (typically considered ROI)
- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Payback Period (PP)/Break Even Point (BEP)

A complete ROI analysis includes all of the above

Match Cash Flows and Don't Double Count

Costs must align appropriately with benefits

- Don't include costs or benefits that don't relate to each other
- Beware of "one-time" costs that should really be incurred over the entire ROI analysis time period
- Don't scope the effort's costs to a specific project but count benefits organizationally

No double counting

- For example, you can't count the value of an avoided defect *and* the productivity that's improved as a result

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Benefit/Cost Ratio

Benefit/Cost Ratio (typically considered to be ROI) is simply the ratio of benefits enjoyed by a certain effort divided by the costs incurred. i.e. 150%

Pros

- Fairly easy to compute
- Provides a “one number” method of comparing projects

Cons

- Doesn’t incorporate the Time Value of Money (TVM)
- No way to know the dollar magnitude of the return
- Don’t know how long the return took to achieve

Benefit/Cost Ratio

	Year 0	Year 1	Year 2	Total
Costs	$300	$100	$100	**$500**
Benefits	$0	$500	$500	**$1000**
Return	-$300	$400	$400	$500

Benefit/Cost Ratio in this example would be 2:1 or 200%

Time Value of Money (TVM)

Benefit/Cost ratio, while valuable, doesn't take into account the concept of the Time Value of Money (TVM).

Simply stated, the value of a dollar is less in the future than it is now.

Question: If risk-free interest rates are 10%, how much would you pay me now for $100 in 3 years?

Time Value of Money (TVM)

Answer: $75.13

	Year 0	Year 1	Year 2
Principal	**$75.13**	$82.64	$90.91
Interest	$7.51	$8.26	$9.09
Total	$82.64	$90.91	$100

Discounted Cash Flow (DCF)

To aid in corporate decision-making, the TVM is captured in Discounted Cash Flow (DCF) analysis.

In DCF analysis, future cash flows are discounted using either:

- The company's weighted average cost of capital (WACC)
- A "hurdle rate" consisting of the company's cost of capital adjusted by a risk premium appropriate for the type of project being analyzed

Discounted Cash Flow (DCF)

This risk premium can be significant (30%+) in some cases!

	Year 0	Year 1	Year 2
Principal	**$45.52**	$59.17	$76.92
Interest	$13.65	$17.75	$23.08
Total	$59.17	$76.92	$100

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Net Present Value (NPV)

Net Present Value (NPV) takes both cost and benefit cash flows and discounts them appropriately using the company's cost of capital or hurdle rate.

NPV is described as a dollar value, allowing for seemingly dissimilar projects to be compared against each other.

Pros

- Articulates the dollar magnitude of the return
- Provides a "one number" method of comparing projects
- Incorporates TVM

Cons

- Not as easy to compute
- Don't know how long the return took to achieve

Net Present Value (NPV)

With a 10% hurdle rate, our example looks like:

	Year 0	Year 1	Year 2	Total
Costs	$300	$100	$100	$500
Benefits	$0	$500	$500	$1000
Return	-$300	$400	$400	$500
Disc Return (NPV)	-$300	$363.63	$330.58	**$393.94**

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Internal Rate of Return (IRR)

IRR determines the intrinsic interest rate that summarizes the value of a series of cash flows. 0% indicates "break-even", positive percentage indicates a positive return while a negative percentage indicates a negative return.

Essentially determines the discount rate that results in NPV=0

Pros

- Provides a "one number" method of comparing projects that is independent of the company's WACC or hurdle rate

Cons

- No way to know the dollar magnitude of the return
- Don't know how long the return took to achieve
- In unusual cases, may provide multiple answers
- Not as easy to compute

Internal Rate of Return (IRR)

In our example, the **IRR is 100%**

	Year 0	Year 1	Year 2	Total
Costs	$300	$100	$100	$500
Benefits	$0	$500	$500	$1000
Return	-$300	$400	$400	$500
Disc Return	**-$300**	**$200**	**$100**	**$0**

Payback Period/Break Even Point

Determines the amount of time it takes for cash inflows to equal cash outflows, resulting in the *break even point*

Pros

- Indicates how quickly a project turns profitable

Cons

- No way to know the dollar magnitude of the return
- In unusual cases, may provide multiple answers

Payback Period/Break Even Point

In our example, the PP/BEP is Year 1

	Year 0	Year 1	Year 2	Total
Costs	$300	$100	$100	$500
Benefits	$0	$500	$500	$1000
Return	-$300	$400	$400	$500
Net Return	-$300	**$100**	$500	$500

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Exercise

- Organizational CMMI improvement effort
- 150 person engineering organization at maturity level 1
- Looking to reach maturity level 2 in 18 months
- No EPG or QA in place
- Experiencing a Cost of Quality of 65%

How do the various ROI calculations turn out for our exercise?

6 – Wrap-up

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Implementation Issues

ROI analysis won't necessarily improve a CMMI effort's results – you still have to execute!

In any process improvement effort, you should find ways to leverage organizational change best practices to overcome resistance to change.

Determining and tracking ROI as well as other measurements keeps the focus of the effort on the **business benefits**

Use the Measurement and Analysis process area early to put the focus on the business benefits from the start

Discussion

What Did You Learn?

1. Why?

i. To develop the business case for process improvement
ii. Need to communicate to decision makers who understand the language of money, not CMMI
iii. ROI is the only way to show financial value

2. When?

i. Before, During, and After

3. What?

i. All applicable direct costs should be identified
ii. As well, all direct benefits should be accounted for
iii. Indirect costs and benefits shouldn't be part of the analysis as they are difficult to attribute solely to the effort

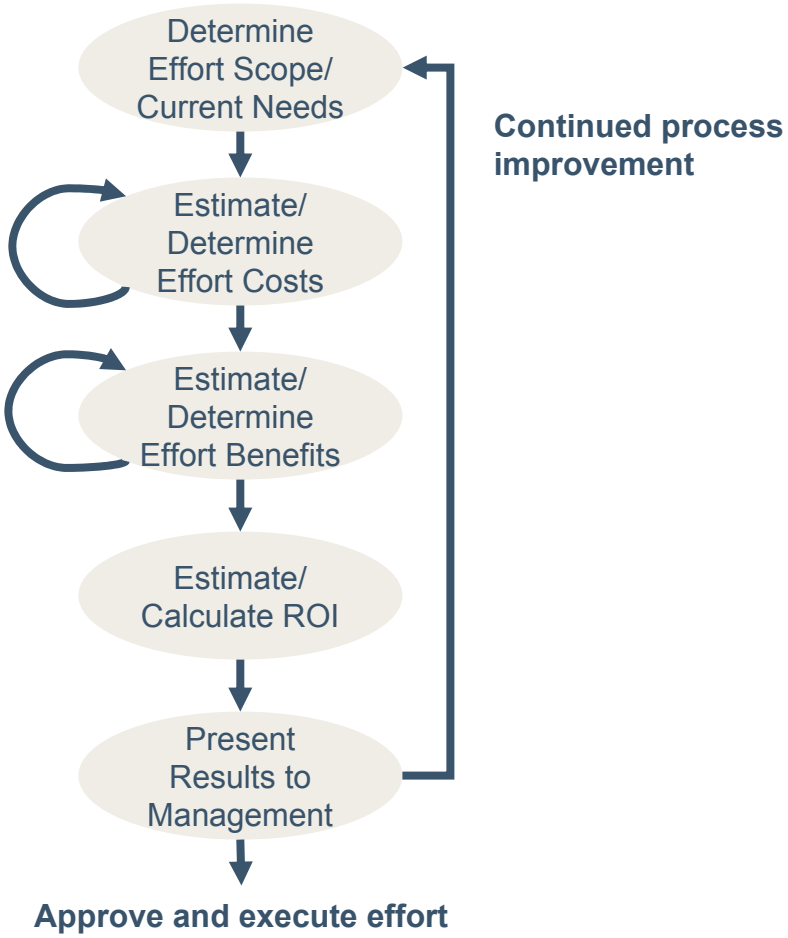
4. How?

i. There are several ways to calculate ROI
ii. Using multiple methods provides for a multi-faceted view and allows for better decision making

5. Case Study

We went through a case-study where we estimated CMMI-based process improvement costs and returns over a 3 year time period, and explored the various ways of calculating the value of the effort over the 3 years.

A Process for Determining ROI



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Parting thoughts: What's Next for You?!

Determining the monetary value of CMMI-based process improvement may appear to be difficult.

But it's not that hard.

- It does take disciplined effort
- You may have to build or buy the necessary organizational capabilities & resource capacities

And it's extremely important.

- Making informed decisions about how to invest scarce resources
- Sustaining commitment for disciplined process improvement

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Thank You!

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