Reifer Consultants, Inc.

Levering Measurement Data: Ten Tricks of the Trade

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Agenda

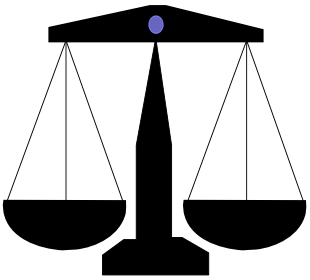
- The essential “Why’s” and “What’s” of measurement
  - Context setting information
- Ten tricks of the trade about what you can you do with your measurement data
  - Practical principles to pursue
  - Reasonable practices to adopt
  - Emphasis placed on value of measurement to your business
- Summary and conclusions

Why Is Measurement Needed?

Answer Key Questions

- Is the **project** satisfying its obligations?
- Are we delivering on-time?
- Are we staying on-budget?
- Are the customers happy?
- Is my **process** working?
- Are my **people** productive?
- Is it a quality **product**?
- Is the firm profitable?
- Are we competitive?

Process **People**



Product **Project**

Should address the 4 P's

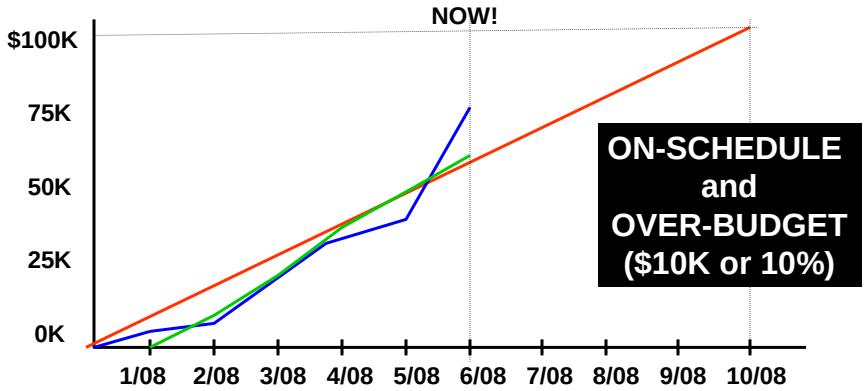
What Measures?

Domain	Indicator	Derived Measures
Project	- Effort - Duration - Progress - Risk	- Labor hours expended/task - Calendar weeks or days/task - Earned value or rate of progress - Risk identification/remediation rate
Product	- Complexity - Size - Quality - Stability - Growth	- Cyclomatic number/OO options - Function points/ESLOC - Defect rates/densities - Requirements creep - Code growth
Process	- Efficiency - Effectiveness	- Rework rate - Statistical control measures
People	- Efficiency - Effectiveness	- Rework rate - Subjective rating

1. Simpler Is Better

- When doing measurement, start simple
  - Product – size and complexity
  - Process – rework rate
  - People – turnover rate
  - Project – progress
- Tie metrics to business goals
  - Improve customer satisfaction
    - Deliver on-time and within budget
  - Increase staff retention
    - Reduce key personnel turnover rate
- Add more when you are ready

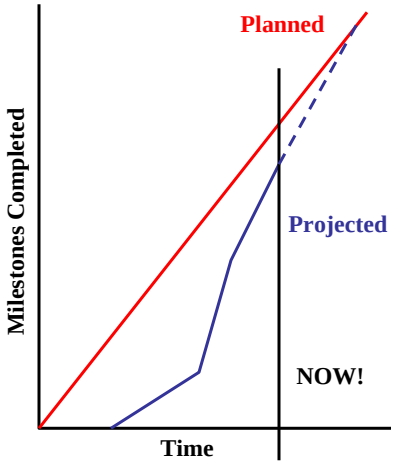
Earned Value Measurement



- **BCWS – Budgeted Cost of Work Scheduled**
- **ACWP – Actual Cost of Work Performed**
- **BCWP – Budgeted Cost of Work Performed**

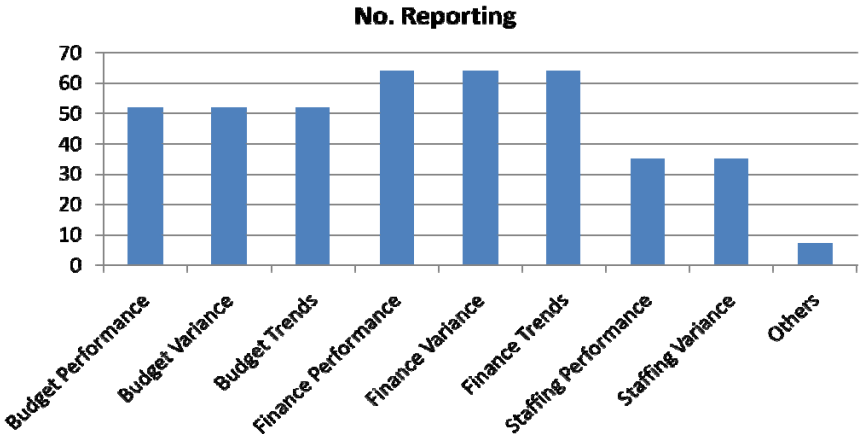
SV = BCWP - BCWS
= $50K - $50K
CV = BCWP – ACWP
= $50K - $60K

Rate Of Progress Tracking



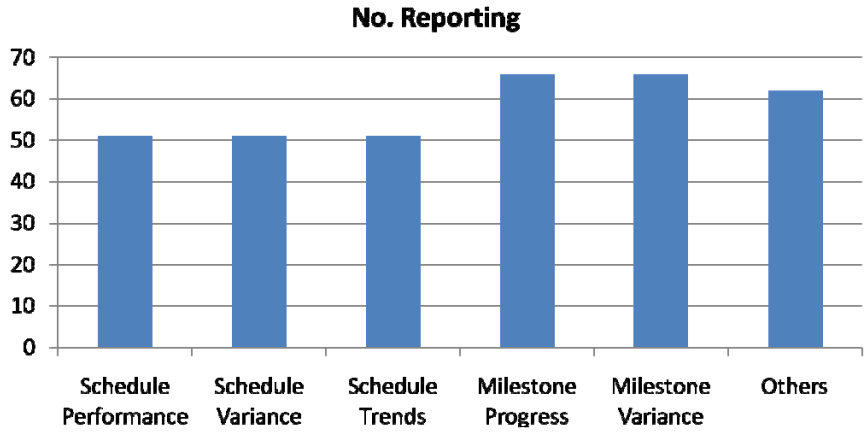
- Earned value reporting can provide useful information
- However, it can also be used to provide distorted views of progress
  - Earn value for starting tasks
  - Earn value as $$ expended
- Other indicators needed to provide reliable view
  - Milestone completion rate of progress
  - Burn rates for hours/$$$ by task completions
- Rate of progress charts are simpler than earned value

Cost Measures



Notes: 1. Most scientific and software firms tracked budget but not financial performance, while aerospace and telecomm. firms tracked both.
2. For the most part, only aerospace firms used earned value.

Schedule Measures



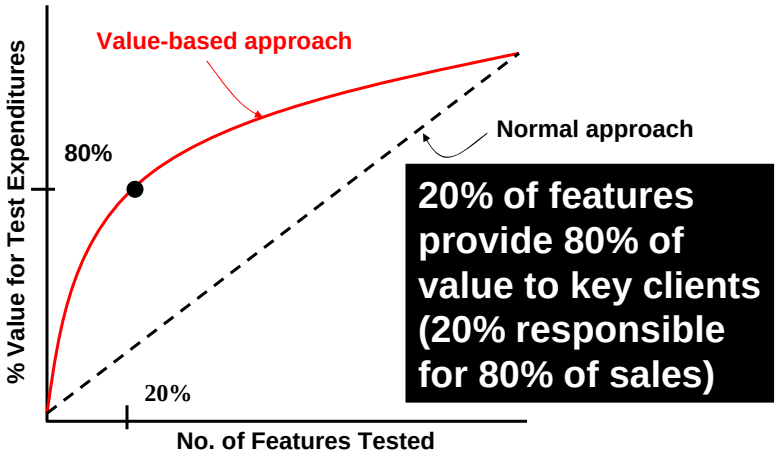
Notes: All firms tracked milestone performance, while Aerospace, business and telecomm. firms tracked both schedule and milestone measures. Those using agile methods tracked sprint progress using inch-stones.

2. Observe 80/20 Rule

Most wear 20% of their clothes, 80% of the time

- Whenever possible, use the Pareto Principle (80/20 rule) to focus your measurement activities on the vital few
  - 20% of the staff is responsible for 80% of the productivity
  - 20% of the code is responsible for 80% of the defects
  - 20% of the customers are responsible for 80% of sales
- Pareto charts used in statistical process control

Value-Based Testing

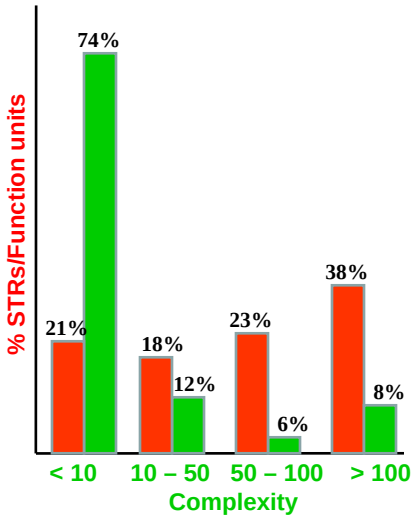


3. Aim Measurement At Gaining Insight, Not Numbers

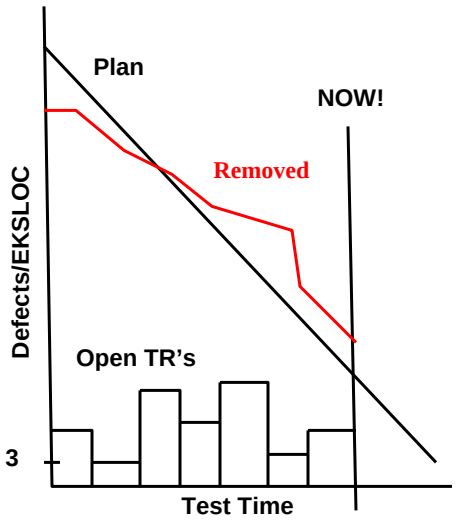
- Define your metrics and measures so that you know what they are telling you
  - Understand bounds and context
- Filter your measurement results to understand what the data is telling you about:
  - Current status
  - Issues
  - Root causes
  - Trends

Effective Use Of Complexity Data

- Strong correlation exists between software size and complexity
  - About 8% of code has cyclomatic complexity > 100
  - However, these functional units are responsible for 38% of defects in the package
- By reducing complexity, you can reduce defects
- You can also reduce cost
  - The productivity impact range for complex units is 2.38 in COCOMO II



Defect Removal Model



- **Set following criteria for release from testing:**
  - **No critical errors remaining**
  - **No Trouble Reports open**
  - **All Trouble Reports (TR's) dispositioned**
  - **Predicted defects remaining are equal to or less than 3/EKSLOC**
- **All requirements are satisfied for build, release or delivery**
  - **Verified via traceability matrices**

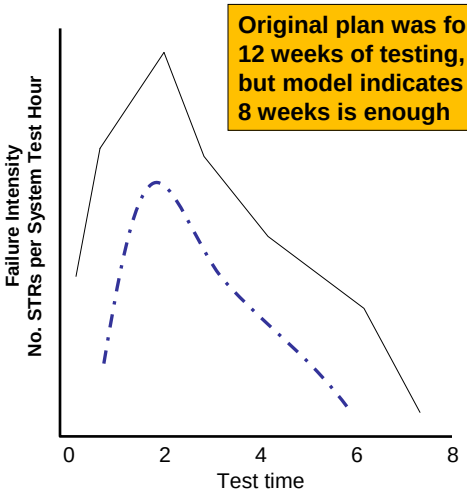
4. Use Models To Establish Comparative Basis

- Models can be used to establish comparative basis for effective measurement
  - Cost models - expected cost and duration
  - Growth models – expected size growth
  - Reliability models – expected defect distributions during integration and post-release
- Benchmarks are also useful when from credible source

Reliability Model Can Be Used To Set Defect Goals

- **IEEE/AIAA P1633/Draft 14**
  - **Appendix A: post-delivery**
  - **Appendix F: pre-delivery**
    - **Keene model –CMMI based parametric model**

CMMI Level	Defect Density
5	0.5
4	1.0
3	2.0
2	3.0
1	5.0
Unrated	> 5.0



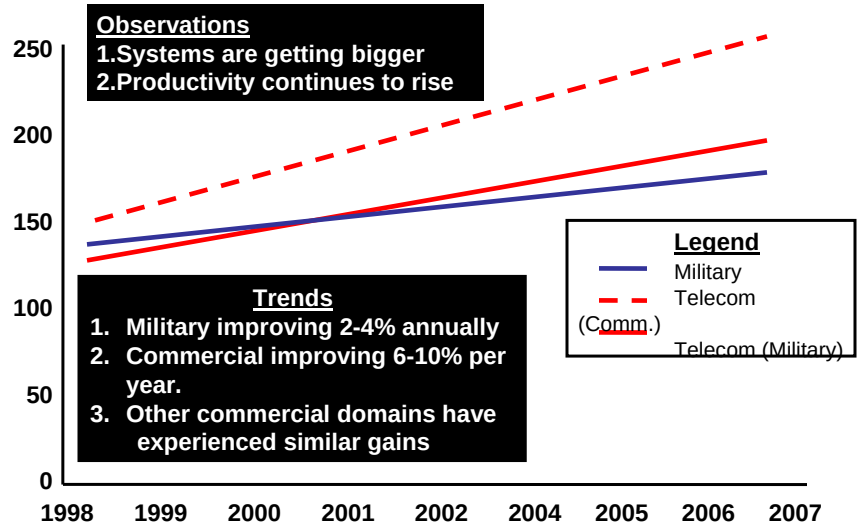
Original plan was for 12 weeks of testing, but model indicates 8 weeks is enough

Benchmarks Can Create Realistic Expectations For Productivity

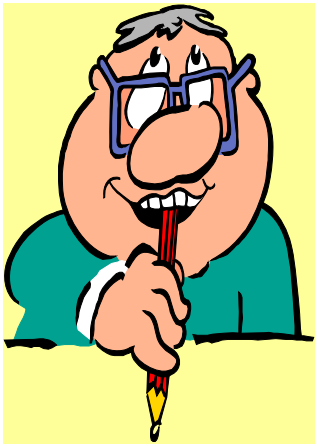
Application Domain	No. Projects	Size Range (KESLOC)	Avg. Prod. (ESLOC/SM)	Range (ESLOC/SM)	Example Application
Automation	58	25 to 785	275	118 to 445	Factory automation
Banking	112	55 to 1,000	282	155 to 550	Loan processing, etc.
C&C	55	35 to 4,500	250	95 to 350	Command centers
Data Processing	135	20 to 950	325	165 to 500	DB-intensive systems
Environment/Tools	75	15 to 7,500	400	143 to 758	CASE, compilers, etc.
Military -All	225	15 to 8,125	152	45 to 330	See subcategories
Scientific	45	28 to 790	215	110 to 450	Seismic processing
Telecom.	85	15 to 2,280	275	175 to 490	See subcategories
Test	65	20 to 800	220	100 to 485	Test equipment, etc.
Trainers/Simulations	30	150 to 1,200	255	143 to 830	Virtual reality simulator
Web Business	115	10 to 750	330	190 to 985	Client/server sites

ESLOC used as common basis for comparing productivity because it was readily

And Improvement Trends



5. Collect Data As Close To The Source As Possible



- Automate data collection whenever possible
- Make data collection part of the normal job and/or the operating environment
- If you do not capture the data at the source, forget about collecting it
  - As the work is performed is best
- Do not have engineers fill out forms – they are notably unreliable

6. Make Sure That Your Numbers Are Solid

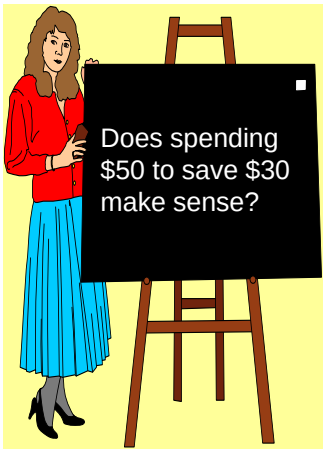
- Start by answering some basic questions:
  - Are the measures well defined?
  - How well do the results generated compare with your past experience?
  - How do they compare with industry benchmarks?
  - Can you demonstrate to an auditor that the numbers are within acceptable tolerances (± 10% of actuals)?
- Then, play the boss and ask the hard questions
  - Typically, what happens if I do this?

More On Ensuring Numbers Are Solid

- Test your numbers once finalized against:
  - Industry benchmarks
  - Organizational folklore
  - Middle management misinformation
  - Executive hangovers
  - Customer biases
- Finally, use statistical approaches to “wow” everyone with variances and distributions

7. Use Value-Based Principles To Portray Results

- Value considerations can be used to determine whether you will be successful
- “Success” is viewed in terms of stakeholder objectives
- Again, value in this case varies by industry, priority and stakeholder role and biases
- Non-monetary values can greatly influence the decisions
- Value infers getting the most bang for the buck



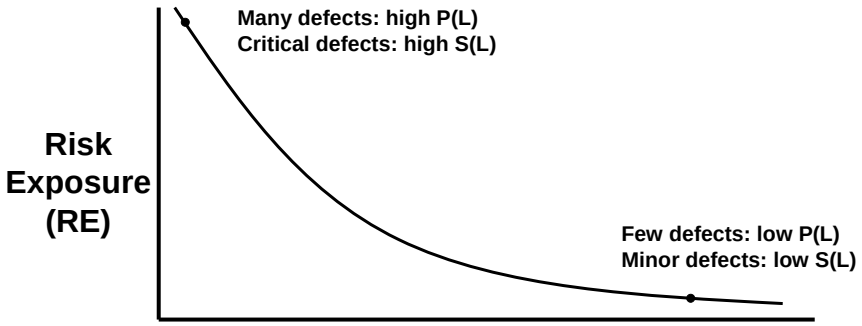
Tradeoffs Between Schedule & Quality (Using Risk Exposure)

- Completing on schedule and quality using defect risk exposure as a guide to decision-making
  - Example of metrics-driven approach that supports proper engineering and management of software development to assess the merits of the value proposition
- Risk Exposure: **RE = Prob (Loss)*Size (Loss)**
  - "Loss" – financial; reputation; future prospects, …
  - Purpose is to answer question: **"How much testing is enough?"**
- For multiple sources of loss:

$$RE = \Sigma\ [Prob\ (Loss) * Size\ (Loss)]_{source}$$

Quantifying Risk Exposure (RE) Via A Profile: Time To Ship

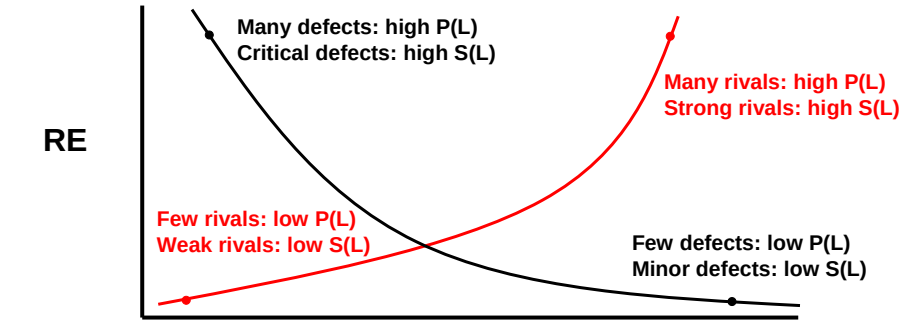
- Loss due to unacceptable dependability



Source: Boehm

Example RE Profile: Time To Ship

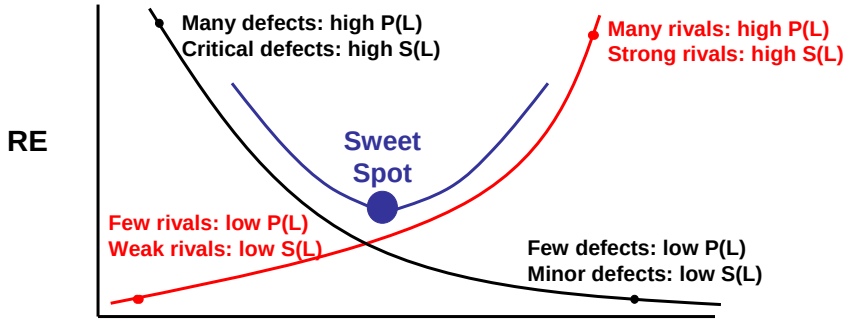
- Loss due to unacceptable dependability
- Loss due to market share erosion



Source: Boehm

Example RE Profile: Time To Ship

- Sum of Risk Exposures



Source: Boehm

Additional Value-Based Proposition Examples

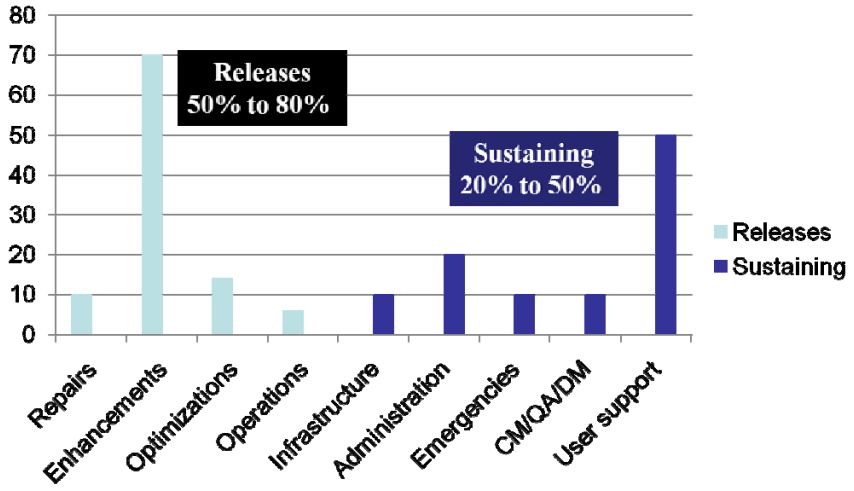
- As much as 75% of the work in maintenance phase involves testing
  - Develop regression test baseline during development for revalidation of changes
  - Automate tests using value-based approach
- Value proposition
  - Cost increase of 10% during development saves 50% during maintenance

Assess Alternatives

- Baseline requirements as soon as possible
  - Get well using ECP's
- Baseline requirements when risk of change is acceptable
  - Implement as many features as budget will sustain

Which approach leads to more business?

What Goes On In Maintenance?



Myth - Focus Of Most Of Maintenance Implements Change

Development

- Driven by requirements
- Mostly directed towards front-end activities

	Normal Life Cycle	OO Life Cycle
Requirements & Design	40%	50%
Coding & Unit Test	20%	20%
Integration & Test	40%	30%

Maintenance

- Driven by changes
- Mostly directed towards back-end activities (testing)

	Release Cycle	Emergency Cycle
Planning & Impact Analysis	15%	5%
Change Implementation	25%	20%
Revalidation & Testing	60%	75%

Another Myth – Maintenance Tooling is Readily Available

Development

- Acquire the latest methods and tools to do the job right this time
  - Few constrains on tools and technology used
- Tool solutions mostly confined to few mostly homogeneous platforms
  - Few seats, limited license cost
- Current emphasis placed on teamwork and collaboration

Maintenance

- Tool solutions must operate on a variety of often heterogeneous platforms
- Must integrate the new development tools into existing environments
- Must integrate tools with workflows and processes
- Many maintenance functions lack good tools
  - Patch management systems

Myth 5 – Maintenance is Funded based on Requirements

Development	Maintenance
• Budgets driven by user needs and requirements • Work is identified via WBS or standard task list • Parametric models are used to estimate costs • Estimates are used to establish budgets • Budgets are scheduled to satisfy delivery desires and constraints	• Budgets driven by history and folklore (past experience) – Win battles using work tasks • Estimates are often a percent of development budget – Between 8 and 10% normal • Allocations are made based on workload balancing • Deliveries are based on what you can provide within the release timeline

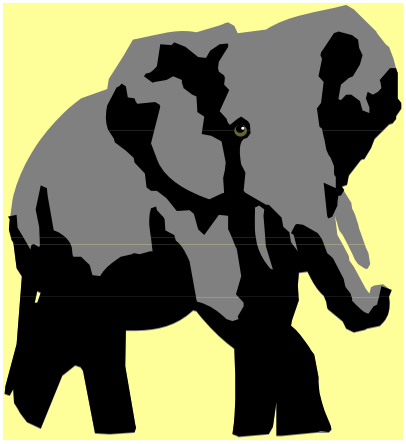
Myth 6 – Maintenance Schedules are Based on User Need Dates

Development	Maintenance
• Driven by some external milestone or need date • Once decided, deadlines are often anchored in concrete • Scheduling of budgeted resources aim is satisfying the deadline – Often, take advantage of parallel builds to do so • Critical path techniques used to control schedule risk	• Emphasis is on annual releases that incorporate as many changes as possible • Some projects driven by critical deadlines that cannot be missed – Updates to tax laws and such • Scheduling of budgeted resources aim at satisfying the deadline – Resources constrain ability

8. Spin The Numbers Positively

- How, depends on your goals, the situation and audience
- For project reviews, as an example:
  - You are rolling along OK – present the metrics/measures so that you can ask for management support (funding, advise, etc.)
  - You are in trouble – present the metrics/measures, identify facts, discuss the risks and ask for help (don't be chicken little)
  - In all cases, use **value engineering concepts** as a guide
- If you are looking for management to spend internal money:
  - Identify your need, the options and build a **business case** using the metrics to justify their spending money on you
- If you are giving an executive briefing:
  - Pre-brief their staff to get their help on what is important

When Spinning the Numbers For Seniors, Remember



- They are like elephants, they never forget a number once uttered
- They will hear only what they want to hear
- They can smell a rat – believe what you say
- Simple is better - package charts with at most five bullets

9. Ready Your Organization For Changes Using The Numbers

- Examine the following:
  - Consistency with business goals/cycle
  - Compatibility with level of process maturity
  - Consistency with corporate culture
  - Compatibility with investment strategies
  - Achievability within desired timetable
- If warranted, will management be willing to take the risk
  - The opportunity should be justifiable in terms of the risk/returns

Making Changes: Nine Lessons Learned

1. Tie improvement to organizational goals
2. Emphasize making product-oriented improvements
3. Demonstrate value that justifies improvements
4. Make your new processes the way you do business
5. Recognize major **barriers to change**
6. Change your culture to one that rewards risk-taking
7. If you don't have the talent, buy it
8. Use **business cases** to supply the numbers
9. Use numbers to overcome any post-decision dissonance

10. Use Business Cases To Win Arguments

- **Business Case** = the materials prepared for decision-makers to show that the proposed idea is a good one and that the numbers that surround it make sound financial sense
  - Most software engineers prepare detailed technical rather than business justifications
  - Many of their worthwhile proposals are rejected by management as a consequence
  - Use of business cases to complement the technical case can greatly increase their chances of success

Example – Cost/Benefit Analysis

- You want to bring in training to learn a modern set of agile methods
- How would you justify the investment?
  - Should you use Cost Benefits, ROI, ROC or other approach?
- How would you pay for the training?
  - Is this a capital, project or customer expense?
- What are the windows of opportunity and how would you capitalize on them?
  - Are State funds available? Can we partner? Is there mid-year or year-end funds available?

Performing The Cost/Benefit Analysis

Cost/Benefit Ratio = PV (Total costs ($)/Total Benefits ($))

- Non-recurring costs
  - Course acquisition ____
  - Course conduct ____

  Total ____
- Recurring costs
  - Course maintenance ____
  - Continuing education ____

  Total ____

  Total Costs ____

- Tangible savings
  - Cost avoidance ____
  - Cost savings ____

  Total ____
- Intangible savings
  - Reduced turnover ____
  - Improved morale ____

  Total ____

  Total Benefits ____

You're Not Done -Tracking Is Part Of The Measurement Job

- Just having numbers does not do you much good if they are not used
  - Budgets, schedule, etc. are yardsticks
- Plans may have to change when the sand is shifting
  - Dams can be built, but floods will happen when the rain storms hit unexpectedly
- Numbers when used right can provide early warnings

In Summary

- Numbers can be your friend
  - Help you win battles and get your boss off your back
- When using the numbers
  - Make sure they are easy to collect and solid
  - Spin them to your advantage
  - Ready your organizations to make needed changes
- When trying to get changes approved
  - Align your numbers with your business goals
  - Use value engineering concepts and business cases to help others understand what the numbers mean
  - Use both business and technical justification to win your battles and the war of the budget

Questions Or Comments

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When eating an elephant take one bite at a time.
Creighton Adams

Its time for IBM to perform and then talk, instead of talk and then perform
Louis Gerstner Jr., CEO IBM

Mongolia

Yellowstone

North Cape

Time to Make a Landing