



The Business Case For Software Quality

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Outline

- The [Sad] State of the Union
- Making the Case
- Concluding Comments





State of the Union

Software is the only product where large numbers of defects seem acceptable

- U.S. Average Defect Rate – 5.9 to 7 defects per thousand lines of code (Software Assessments, Benchmarks, and Best Practices by Capers Jones)
- Software defects rates have increased 15% in 1999-2000 compared to 1997-1998 (Meta Group January 2002)
- Average computer user experiences a crash 2.5 times a week (InfoWorld 9/17/01)





State of the Union

- Q/A and test first groups to be downsized in budget cuts
- Testing perceived as “keyboard pounding”
 - I.E. Non skilled labor
- Most organizations’ test processes not very disciplined
 - E.G., Measurable, repeatable
- Test automation not fully deployed





State of the Union

- Testing perceived to take too long, costs too much, delays project
- Testing rarely fully integrated into the development life cycle
- User/customer acceptance testing is a tail end process
- Testers are scapegoats for software quality problems
- Testers rarely have the authority to stop a release





Why the Problem Is So Bad

- 80% of technology projects cost more than they return (Computerworld.com/ROI June 2001)
- 73% of companies do not measure the success of technology spending
(CIO Insight March 2003)
- 75% of companies do not track the cost of quality
(Inside Quality survey 7/12/01)
- 48% of companies do not have formal test plans
(Information Week August 26, 2003)





Areas of Opportunity

- Software is a critical success factor to nearly all enterprises
- The failure rate for projects is enormous
- Early testing could have saved many of the failed projects
- Production defects are expensive
- Test automation reduces test costs, improves effectiveness

(Continued)





Areas of Opportunity

- IT staffing issues at critical point
- Reduce support costs, increase customer satisfaction
- Y2K was our friend
- Software liability
- ERP





Areas of Opportunity

- Outsourcing
- COTS
- E-Commerce
- Comply With Regulatory Requirements



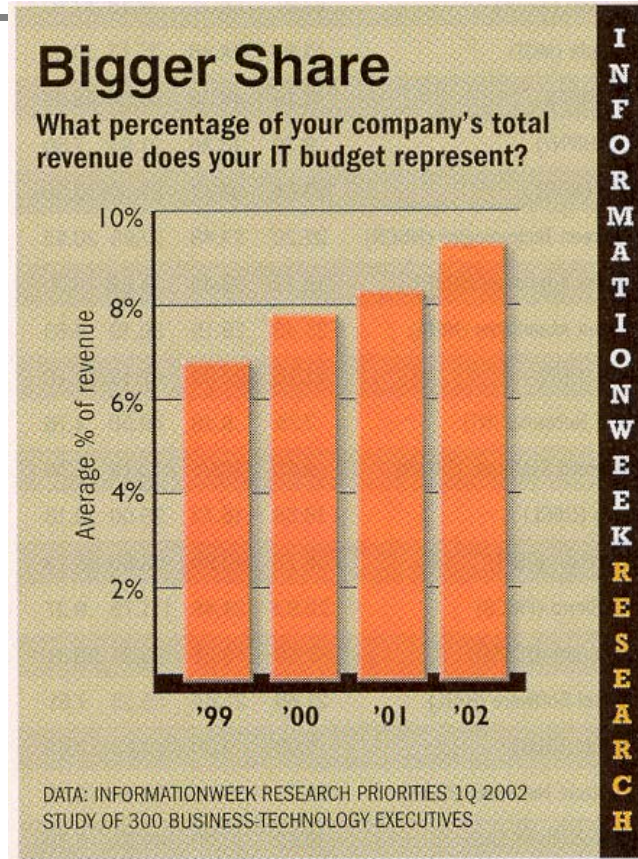


IT Spending As Percentage Of Capital Investments

- **\$667 Billion (USA)** (CIO Insight May 2001)
- **\$2 Trillion (World Wide)** (Harvard Business Review May 2003)
- **\$334 Million – Ave IT Budget IW500**
- **50% -IT As A Percentage Of Capital Investment** (Harvard Business Review May 2003)



IT Spending As Percentage Of Revenues





IT Spending As Percentage Of Revenues

- **10.52% - Average for Securities and Investment Banking** (Gartner Group Inside 12 January 2001)
- **42% - Vanguard Group** (Darwin April 2001)





IT Spending Growth

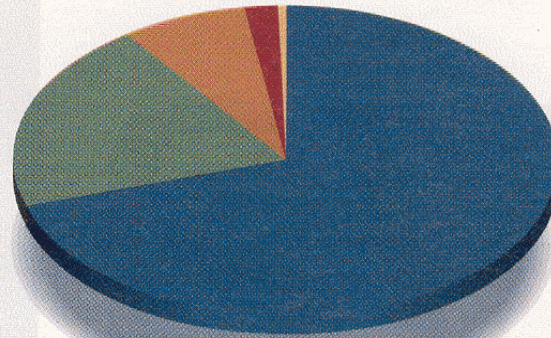
- 2000 – +12% (Day Group January 2002)
- 2001 - -1.1% (Merrill Lynch January 2002)
 - 2001 Pre-9/11 Forecast +7%
(Electronic Commerce World September 2001)
- 2002 - + 2% to 3.3% (Merrill Lynch, Yankee Group January 2002)
- 2003 - + 18.3% (Information Week November 3, 2003)



IT Essential To Business

BUSINESS ESSENTIAL

When asked to describe the value of IT to their business, executives were emphatic.



70% ■ ABSOLUTELY ESSENTIAL
20% ■ EXTREMELY VALUABLE
7% ■ MODERATELY VALUABLE
2% ■ OF MINIMAL VALUE
1% ■ DOESN'T AFFECT MY COMPANY'S OBJECTIVE

SOURCE: INFOWORLD TRUE VALUE OF IT STUDY, APRIL 2001

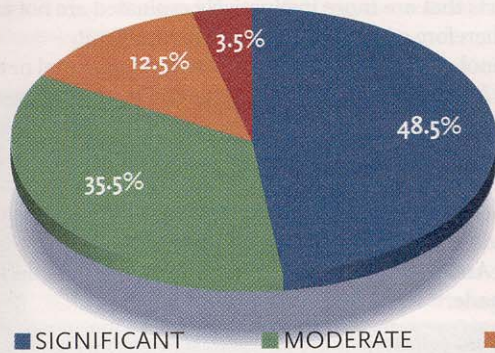


IT Essential To Business

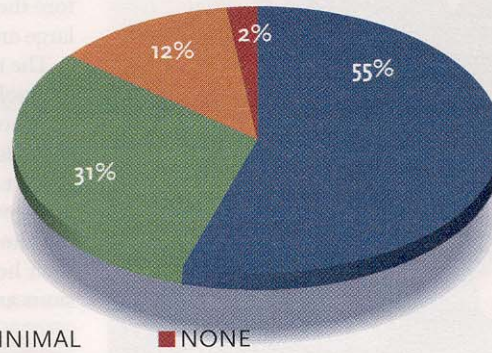
IMPACT ON BUSINESS

Respondents indicated that IT affects major business processes throughout the economy.

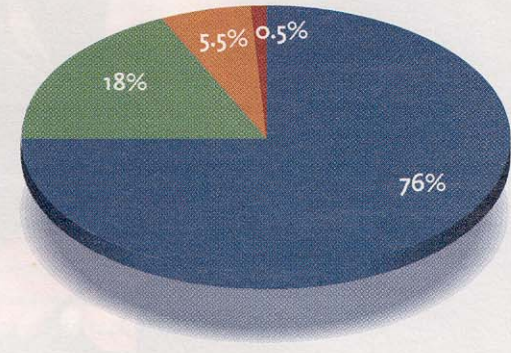
GENERATING REVENUE



STRATEGY



DAY-TO-DAY OPERATIONS



SOURCE: INFOWORLD TRUE VALUE OF IT STUDY, APRIL 2001





Software Projects Success Rate

Standish Group Statistics (on a \$300B base)

- ❖ American companies spend \$84 BILLION annually on failed software projects
- ❖ \$138 BILLION are spent on projects that significantly exceed time and budget estimates, or have reduced functionality



Some Examples Of Failed Projects

- PrimeCo Personal Communications Canceled a \$500 Million Contract With Motorola Because of Defects
(Wall Street Journal - 2/24/98)
- California Department of Motor Vehicles \$50 Million Into Project with No End in Sight. Part of \$1 Billion Worth of Project Overruns and Failed Projects at DMV
(San Francisco Chronicle - 2/18/99)
- Time Warner Communications Spent \$1 Billion on Failed Information Systems to Break into Residential Telephone Business

(Computerworld - 5/5/97)





Some Examples Of Failed Projects

- IRS – Tax Systems Modernization spent \$3.3 Billion before canceling
(Federal Computer Week March 18, 2002)
- NASA Space Shuttle Launch Control System canceled after \$274 Million
(The Post Star September 18, 2002)
- Ford Everest Purchasing Project \$400 Million before canceled (Application Development Trends 11/04)



Some Examples Of Failed Projects



- **Canadian Firearms System**
 - Initial cost estimate: \$2 million
 - Final cost: \$1 billion (Baseline July 2004)
- **HP ERP System cost \$400 in lost revenue** (Computerworld September 27, 2004)



Some Examples Of Failed Projects



- KMART takes \$195 million write off on supply chain system in 9/01

(Computerworld 1/28/02)

- \$625 BILLION in Shelfware – amount spent on unused software licenses 1998-2001

(Baseline January/February 2002 from Dept. of Commerce)



Top Reasons For Failure

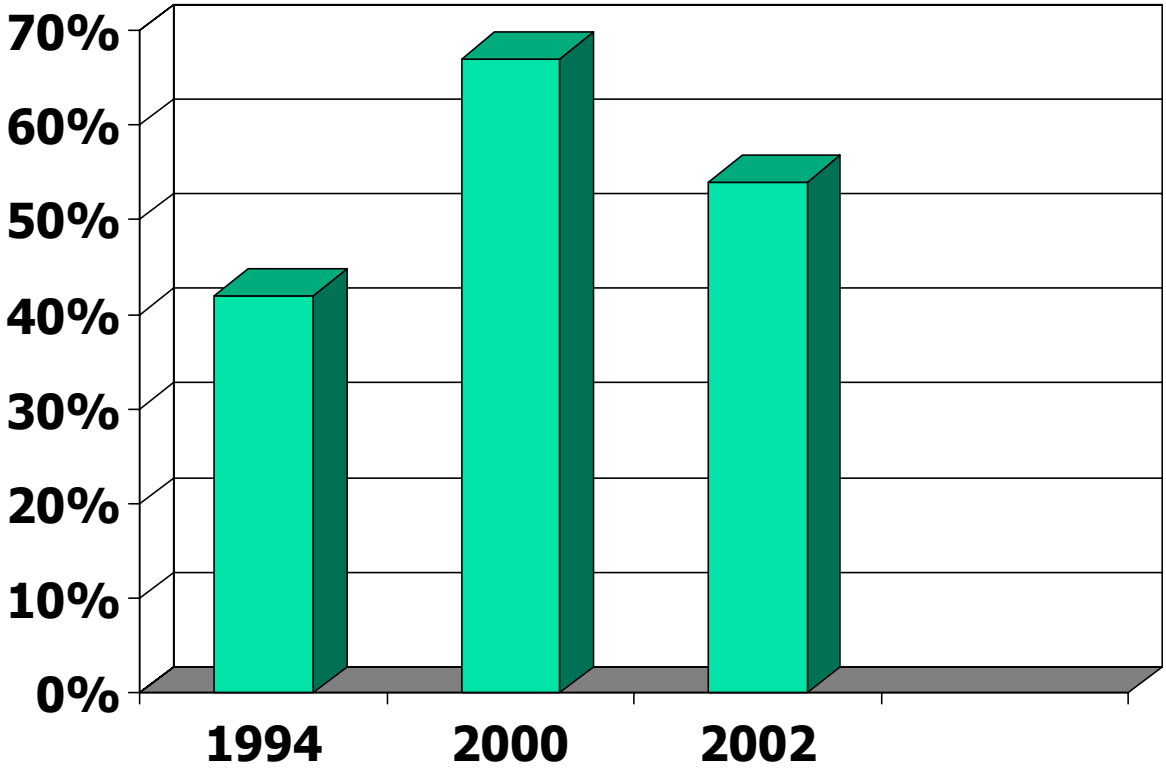


- Incomplete requirements and specifications
- Changing requirements and specifications
- Lack of user input
- Lack of executive sponsorship /commitment



(Standish Group and other studies)

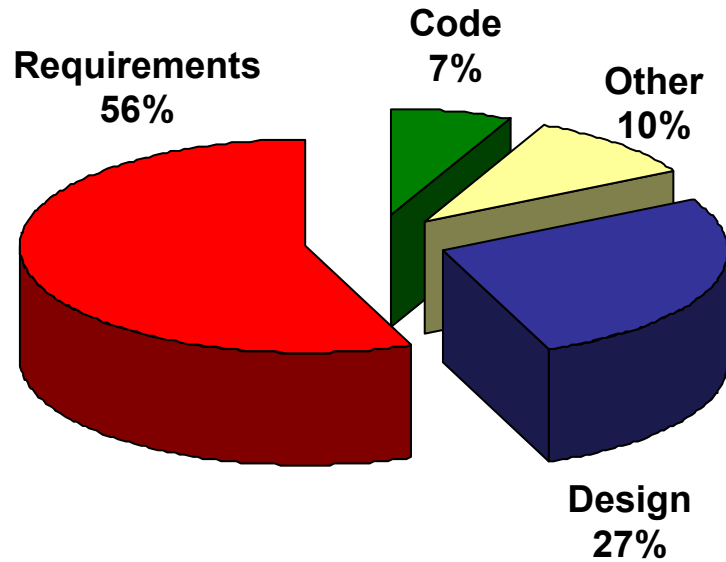
Requirements Delivery



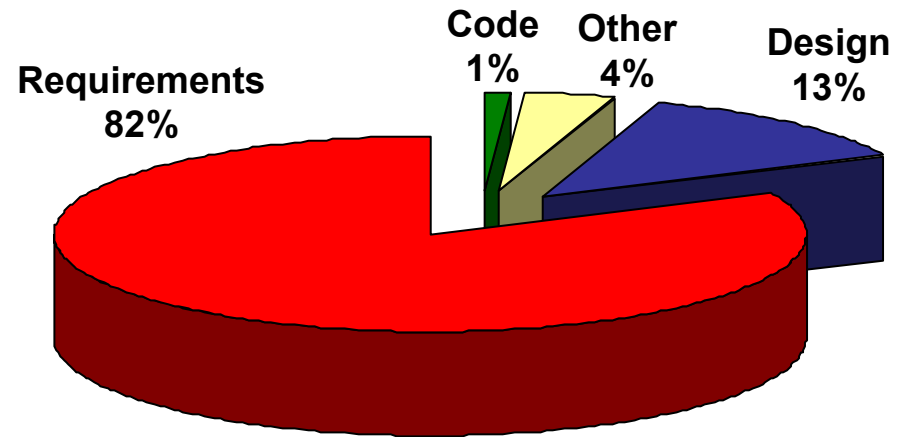
Standish Group – Crosstalk October 2004



Distribution of Bugs



Distribution of Effort to Fix Bugs



(James Martin)



Relative Cost To Fix An Error



Phase In Which Found	Cost Ratio
Requirements	1
Design	3-6
Coding	10
Development Testing	15-40
Acceptance Testing	30-70
Operation	40-1000

(IBM, et. al.)





Savings Via Early Testing

Ambiguity reviews of specifications (Bender RBT Inc.)

- Defects found
 - Mutual Funds project
 - # Functions 180
 - # Issues 1,713
 - Imbedded code project
 - # Functions 65
 - # Issues 595





Savings Via Early Testing

Ambiguity reviews of specifications (Bender RBT Inc.)

- Costs per defects found
 - .85 hour/defect
 - \$75 hour fully burdened rate (\$150K year)
 - \$63.75 per defect
- Costs if found in integration test/system test
 - \$750 to \$3,000 per defect (SEI)
- Cost if found in production
 - \$10,000 per defect (HP)
 - \$140,000 per defect (IBM)





Savings Via Early Testing

- 1/3 of software development costs are rework (HP)
- Inspections save 60% of the rework (HP)
- Total project savings - 20%

Note: Being a few months late with a key product can reduce total product revenue over the life of the product by 36% (McKinsey)





Cost of Software Errors

- Direct Cost of defects
 - Developers - \$21.2B
 - Users - \$38.3B (National Institute of Standards and Technology)
- Consequential costs
 - \$293B (Standish Group 2002)





Cost of Software Errors

- Cost to correct errors created in the manual entry of order processing, shipping, and purchasing:
 - \$40 Billion / year (Information Week June 24. 2002)





Production Defects Are Expensive

- Costs per hour for outages
 - Automated teller machine - \$14,500
 - Package shipping service - \$28,250
 - Telephone ticket sales - \$69,000
 - Airline reservation centers - \$89,500

(Association of Contingency Planning)





Production Defects Are Expensive

- Costs per hour for outages

- Catalog sales centers - \$90,000
- Pay-per-view TV - \$150,000
- Cellular Network Node- \$1.08 Million
- Credit card processing - \$2.6 Million
- Financial services/brokerage - \$6.5 Million

(Association of Contingency Planning)





Production Defects Are Expensive

NASA Mission Failures Due To Single Defects – (Sample)

- \$800 Million USAF Milstar Satellite
- \$125 Million Mars Climate Orbiter
- \$203 Million Mars Polar Lander



Relation Between Defect Levels and Reliability

Defect Levels in Defects per KLOC	Approximate Mean Time to Failure
More than 30	Less than 2 min.
20 - 30	4 - 15 min.
10 - 20	5 - 60 min.
5 - 10	1 - 4 hours
2 - 5	4 - 24 hours
1 - 2	24 - 160 hours
Less than 1	Indefinite



Source: Applied Software

Measurement - Capers Jones Copyright Bender RBT Inc. 2004



Production Defects Are Expensive

- **\$1.75 Billion**
 - Amount National Australia Bank wrote off due to defect that went undetected for two years.

(New York Times 9/01)





Production Defects Are Expensive

- Security Defects Add A New Dimension
 - \$8.8 Billion – Cost of the Love Bug Virus
 - \$17.5 Billion – Annual cost of virus to corporations

(Information Week 10/25/04)



Cost Justifying Test Case Design Tools

(Source: Bender RBT Inc.)

- Rigorous algorithms ensure consistent functional/code coverage
 - BenderRBT (aka SoftTest)
 - 100% functional coverage
 - 80% to 90% code coverage
- Significant reductions in number of test cases
 - Twice the coverage with half the tests
 - Major savings in building/running tests
- Test cases used for user reviews of specifications





Cost Justifying Test Case Design Tools

- Certain classes of specification defects identified
 - Logical inconsistencies
 - Unclear precedence relationship
 - Aliasing issues across functions
- Fewer incorrect tests
 - 10% of manually designed tests contain errors

(Source: Aonix)



Cost Justifying Test Capture Playback Tools

(All numbers from Mercury Interactive)

- Testing is 50% of the total application development cost
- Testing can account for 70% of costs during the application life
- Playback tools reduce test development costs by 30%
- Playback tools reduce test execution costs by 50%



Cost Justifying Code Coverage Monitors

- Percentage of code executed prior to production w/o monitor (Bender RBT Inc.)
(Determined by gathering all available tests and running under a monitor)
- Major financial institution -- 20 applications
Coverage range: 20% to 50%
- Major relational DBMS vendor
Coverage: 37%
- Major hardware/software vendor -- point of sale system
Coverage: 60% (the highest seen by Bender w/o using a monitor)



Test Automation

- How adequate are test automation tools?
 - Adequate - 15%
 - Somewhat adequate - 49%
 - Not at all adequate - 16%
 - Don't use - 20%

(Information Week July 8, 2002)

- 9 out of 10 developers still use manual testing

(VNUNet December 2002)

- Test tools market:
 - 1999 - \$931 million
 - 2004 - \$1.08 billion

(Computerworld 10/4/04)





IT Staffing Issues At a Critical Point

- 10.4 Million – U.S. IT Employment

(Information Week April 7, 2003)

- 600,000 – Current short fall

(Information Technology Association of America June 2002)

- 80% organizations limiting development due to resource constraints

(Information Week March 3, 2003)



IT Staffing Issues At a Critical Point

■ The Brain Drain

- Turnover rate is 10% (Meta Group May 2002)
- 50% of IT staff feel under more pressure (Optimize Research Study July 2002)
- Increasing numbers of “baby boomers” will be leaving the profession – with their knowledge and skills (45% of systems are legacy systems) (CIO Insight December 13, 2002)
- Fewer H1B Visas





IT Staffing Issues At a Critical Point

- Staffing costs

- 75% of application development dollars

(Compass America Inc - 8/98)

- Over 45% of most IT budgets – internal staff and external services

(Information Week November 8, 2004)



IT Staffing Issues At a Critical Point

Shortened schedules due to

INCREASED PARALLEL EFFORTS

Reduced resources due to

MINIMIZING SCRAP & REWORK

Improved quality due to

REQUIREMENTS-BASED TESTING

And

INTEGRATED TESTING



IT Staffing Issues At a Critical Point



- 60% Of U.S. programmers are busy fixing avoidable problems
- Factor out weekends, holidays, sick days, doomed projects, etc.

- **REMAINING PRODUCTIVE TIME: 47 DAYS PER YEAR**

(Source: Capers Jones - 7/98)



Better Testing Reduces Support Costs

- High tech companies spend 8% to 20% Of total revenues on support

(Association of Support Professionals - 4/99)

- Telephone supports costs \$3 per minute

(Cem Kaner)

- Complaints against computers and software exceed those against used car dealers

(Better Business Bureau)

- Half of all software companies surveyed scored lower on customer support than the WORST hardware company

(Prognostics Inc. - 2/99)



Better Testing Increases Customer Satisfaction

- Customer satisfaction drives shareholder value – Market Value Added (American Customer Satisfaction Index)

- Top 50% - \$42.5 billion

- Bottom 50% - \$23.2 billion

(Harvard Business Review – March 2001)



Better Testing Increases Customer Satisfaction

- A 5% increase in customer loyalty can increase profits by 25% to 85%

(Quality Digest September 2000)

- U.S. companies lose 50% of their customers every 5 years; it's 6 to 7 times more expensive to gain a new customer than to keep an existing one

(Harvard Business Review quoted in ad for the Taylor Group March 2001)

- Improved usability testing reduced customer calls 95%

(Clarity ad May 2001)





Y2K Was Our Friend

- Total cost
 - Globally - \$750 billion (Federal Computer Week 3/20/00)
 - U.S. - \$100 billion (Cutter IT Journal July 2000)
- Percent spent on testing - 50% to 70%
- Lines of code fixed - 180 billion





Y2K Was Our Friend

- Increased senior management's awareness of the criticality of software
- Increased exposure for improved methods and tools





Y2K Was Our Friend

- SEC act of 1934 lead to
 - Financial accounting standards
 - Certification by independent auditors
 - Elevated the role of chief financial officer
- SEC Y2K disclosure act could lead to similar results in software





Software Liability

- Avoiding just one major law suit, win or lose, improvement project
(Chief consul of a major software vendor)
- Most companies cannot show they have exercised reasonable due diligence In testing their software



Software Liability



- It is common for large software development companies to have upwards of 50 active cases against them (CrossTalk February 2000)





Software Liability

- 78% of IT organizations have litigated
 - 67% - poor functionality / performance
 - 56% - significant date slippage
 - 45% - software defects

(Cutter - Application Development Trends May 2002)





Software Liability

- Over the next 4 years global 2000 firms will invest significantly in improving quality to reduce litigation exposure
- More IT professionals will purchase professional insurance
(Doctors pay \$36K to \$71K per year)

(Meta Group January 2002)





ERP

- Enterprise Resource Planning
- Very complex intertwined table structures
- Requires disciplined testing
 - Emphasis on requirements based testing
 - Strong need for functional compatibility testing



ERP

- Where the money goes
 - TESTING - 26.1%
 - Planning - 19.2%
 - Installation - 18.8%
 - Training - 13.9%
 - Data Migration - 12.4%
 - Cutover - 9.6%

(AMR Research, Baseline April 2002)



ERP



- 70% of all ERP projects fail to meet their objectives (Infoworld 10/29/01)
- When supply chain problems hit the news the firm's stock price drops 8.6% on average (Computerworld ROI August 2001)





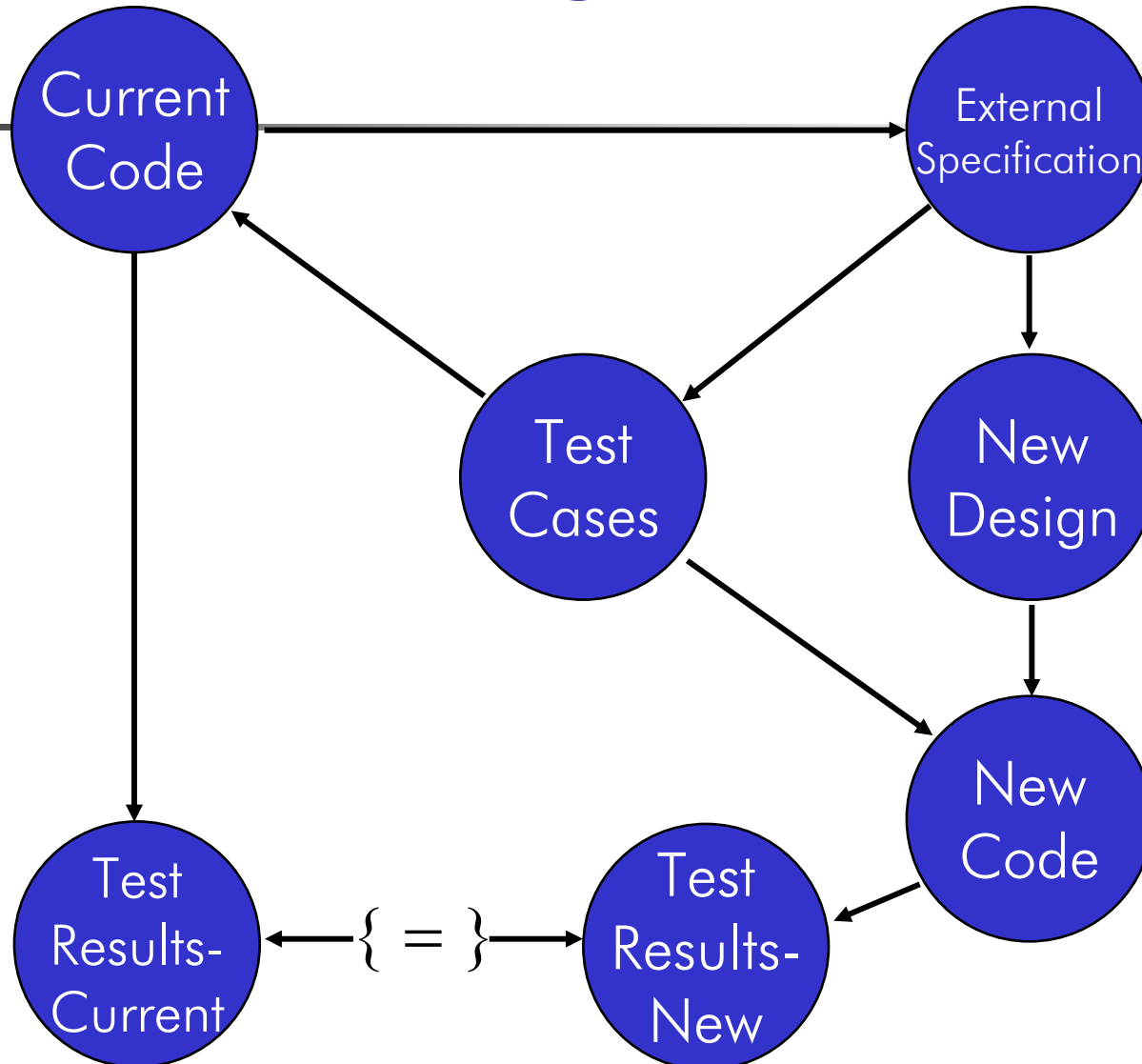
ERP

- 5 of the top 10 IT failures in Computerworld cover story were ERP projects – e.g.
 - Hershey's revenues down \$150.5 million due to ERP system problems
- Nike blames \$100 million sales shortfall on botched supply-chain software

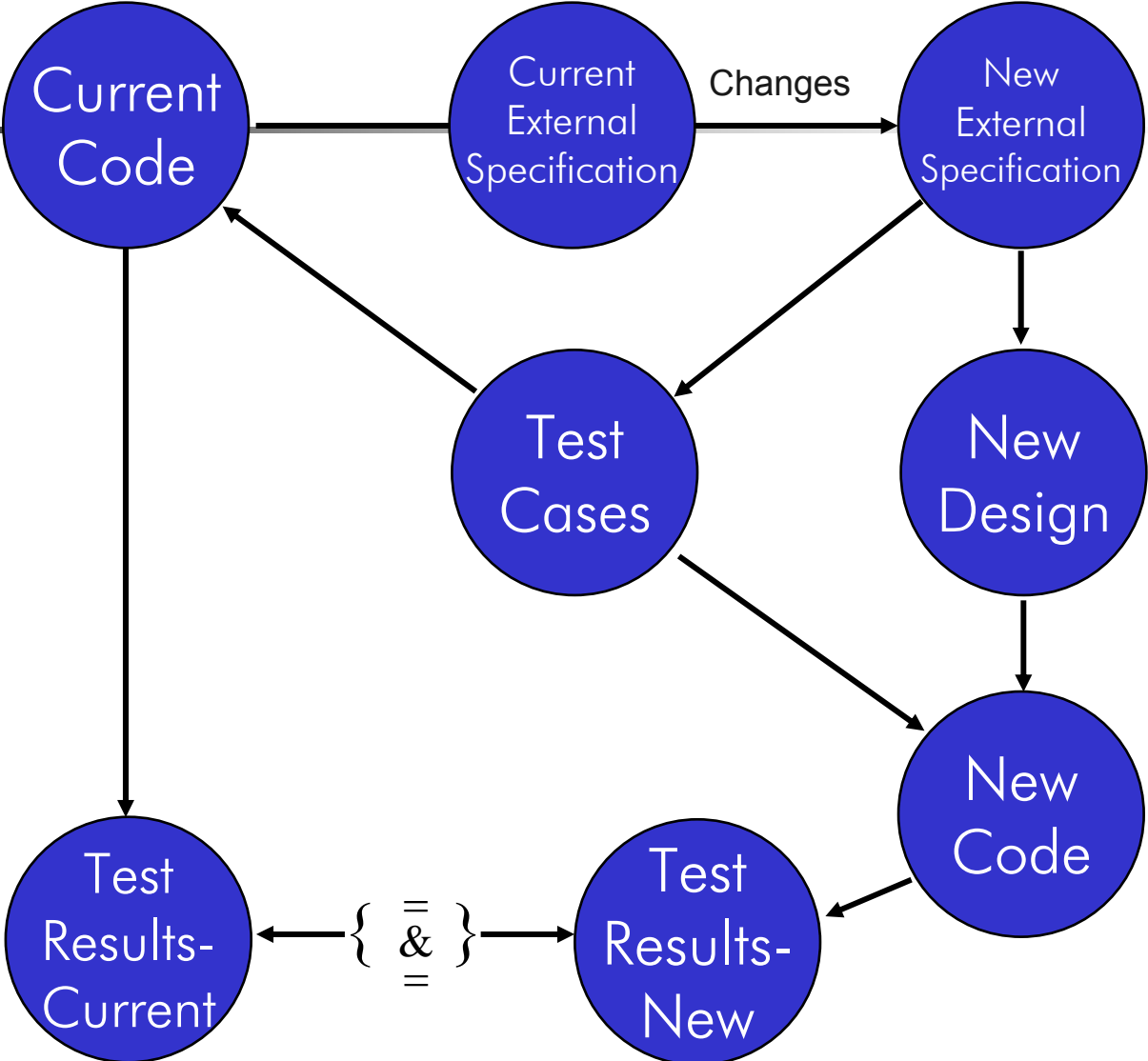
(Information Week May 21, 2001)



Testing ERP



Testing ERP



Outsourcing

- Over 70% of global 2000 companies outsource some IT services

(Information Week September 9, 2002)

- U.S. Outsourcing for 2003

- 84.7 billion
- 68% to U.S. companies
- 32% offshore

(CIO Insight March 2003)

- Percentage of IT Budget Outsourced

- 2002 – 9% (Information Week August 12, 2002)



Outsourcing

- Requires detailed unambiguous specifications – especially offshore
- Requires robust testing with verification of coverage / results
- Tests should be a deliverable



Outsourcing

- You need a supplier quality program
 - Supplier certification can reduce costs 30%
(Saddle Island Institute)
 - Xerox went from 5,000 suppliers to 300
- Make supplier quality a priority
 - Perform pre-selection quality assessments
 - Include quality criteria in contracts
 - Closely monitor suppliers' quality



COTS & GOTS

- These packages are tested just like you test your software (maybe not that good)
- “We’re spending more money to ... fix software than we paid for [it].

(Air Force CIO in Information Week March 18, 2002)

- 95% of Defense Department communications goes through COTS

(IEEE software - 4/99)

(USA Today April 8, 2003)



COTS & GOTS

- Rating the software industry's efforts at ensuring that off-the-shelf software is bug free:
 - Highly satisfactory 2%
 - Somewhat satisfactory 36%
 - Somewhat unsatisfactory 34%
 - Highly Unsatisfactory 28%

(Information Week July 22, 2002)

- Only 23% of companies have formal test plans for COTS

(Information Week June 3, 2002)



COTS & GOTS



Note: Quality missing as an explicit criteria

(Eweek August 27, 2001)



E-commerce

Size Of Market – U.S.

- Retail - 2002 - \$45 Billion in sales (EWeek April 7,2002)
- B2B
 - 2002 - \$482 billion
 - 2003 - \$721 billion
 - 2004 - \$1,011 billion (est.)

(Computerworld June 2002)





E-Commerce Quality Problems

- 93% of B2B users have encountered problems with the sites (Darwin June 2001)
- 82% of retail transactions are not completed. (Infoworld November 20, 2000)
- 42% state that web-site malfunctions were the cause. (Infoworld November 20, 2000)





E-Commerce Quality Problems

- \$25 billion in revenue lost due to poorly performing web-sites
- \$21 billion in revenue lost when customers abandon web pages taking too long to download

(Zona Research and Keynote System, Inc in CIO Insight Quickfacts 9/19/01)





E-Commerce Quality Problems

- “I feel the need, the need for speed.”
- “Specs? We don’t need no stinken’ specs.”





E-Commerce Quality Problems

- Visibility of software defects is HUGE
- First Internet Bug - Oct. 29, 1969
 - During the first demonstration of the technology the system crashed during logon (USA Today 9/1/99)
- 66% of organizations do NOT apply quality principals to e-business ventures

(Inside Quality survey 7/23/01)



Regulatory Compliance



- HIPAA
- Sarbanes-Oxley (average \$480K)
- Privacy-Security
- COOL (country of origin labeling for fish)
 - Must be in compliance by 9/30/04
 - Rules finalized 9/30/04



Industry Standard Test Completion Criteria

- **FAA 178B (1992)**

- Requirements Based – Not Quantified
- Code Based – Statement / Branch

- **FDA 21CFR Section 820 (2002)**

- Requirements Based – Not Quantified
- Code Based – Statement / Branch

- **ANSI/IEEE Std 1008-1987**

- Code Based – Statement Coverage



Maturity Level	Calendar Months	Effort (Work Months)	Defects Found	Defects Shipped	Total Cost
1	29.8	593.5	1348	61	\$5,440,000
2	18.5	143.0	328	12	\$1,311,000
3	15.2	79.5	182	7	\$728,000
4	12.5	42.8	97	5	\$392,000
5	9.0	16.0	37	1	\$146,000

In an SEI report (SEI 92-TR-24), data were averaged over 1233 separate projects in 261 organizations spanning 10 countries, to gauge the benefits of reaching higher maturity levels. (data normalized to a 200K line-of-code project).





Quality Makes A Difference

- 82% of companies factor in software quality into buying decisions (Information Week 5/26/03)
- 56% think not enough being done to ensure quality in off-the-shelf code
- 81% think it is smarter to pay more for quality products (USA Today 12/3/03)





Concluding Comments

- Select the key topics for your organization
- Gather internal numbers to supplement industry data
- Put together a pay as you go plan
- Get the data to the right level of management





Concluding Comments

Advisory Committee to President Clinton on Federal Funding for IT (7/98)

“The United States’ IT lead in the market is based on unreliable software that could inhibit the progress of the current boom in information technology and is a threat to the health and welfare of the nation.”





Concluding Comments

Survey by the American Society of Mechanical Engineers

What were the top ten greatest engineering achievements of the 20th century?

ENGINEERING CODES AND STANDARDS





Concluding Comments

- You Can't Solve A Problem Until People Agree There Is A Problem
- For Software The Evidence Is Overwhelming
- **GO MAKE THE CASE!**

