

- A System Operates for 7067 minutes and has 60 minutes of downtime during that period.
 - What is the availability? *-Very?*

Good Availability

$$A = \frac{7067 - 60}{7067}$$

~~$$.9915$$~~

Availability

- If the repair time averages 5 minutes, how many failures can we have during the timeframe asked?

$$\lambda = \frac{(1-A)}{A t_m}$$



$$1 - .9915$$

$$\underline{.0085} \times .08333 \dots$$

$$\lambda = .10287$$

Mean Time Between Failures

- MTBF =

$$MTBF = \frac{1}{\lambda}$$

$$MTBF = 9.7205$$

hours



12:02 - 12:07 am

12:21 - 12:25 am

→ www.walterSchilling.or
www.walterSchilling.us

→ 192.168 Fixed IP

Failing at sometime



Software Quality Assurance

Costs of Software Quality

Objectives

- Justify the need for better quality from an economic standpoint
- Draw a model showing the impacts of the cost of software quality
- Explain the balance between software quality level and costs
- Explain the relationship between failure rates and quality
- Construct the classic model of the costs of software quality
- Explain techniques that work at aiding in quality development

Real World

Data!

My website
access

The case for software quality

- 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)

The costs of software

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

Not Good!

Costs of Software Errors

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

Costs per hour of outage

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

CTD Ameritrade

Relationship between defect levels and reliability

Defect Levels Defects per KLOC	Approximate Mean time to Failure*	
More than 30	Less than 2 minutes	
20 - 30	4-15 minutes	
10-20	5-60 minutes	
5-10	1-4 hours	
2-5	4-24 hours	
1-2	24-160 hours	
Less than 1	Indefinite	Extremely Rare

More than 30 Defects / KLOC

Capras

Jones: Applied Software Measurement

• What impact the cost of software?

Related

Size of project

- time frame

- Quality Needed

- Complexity

- Regulations

- Quality of Employees

Discussion

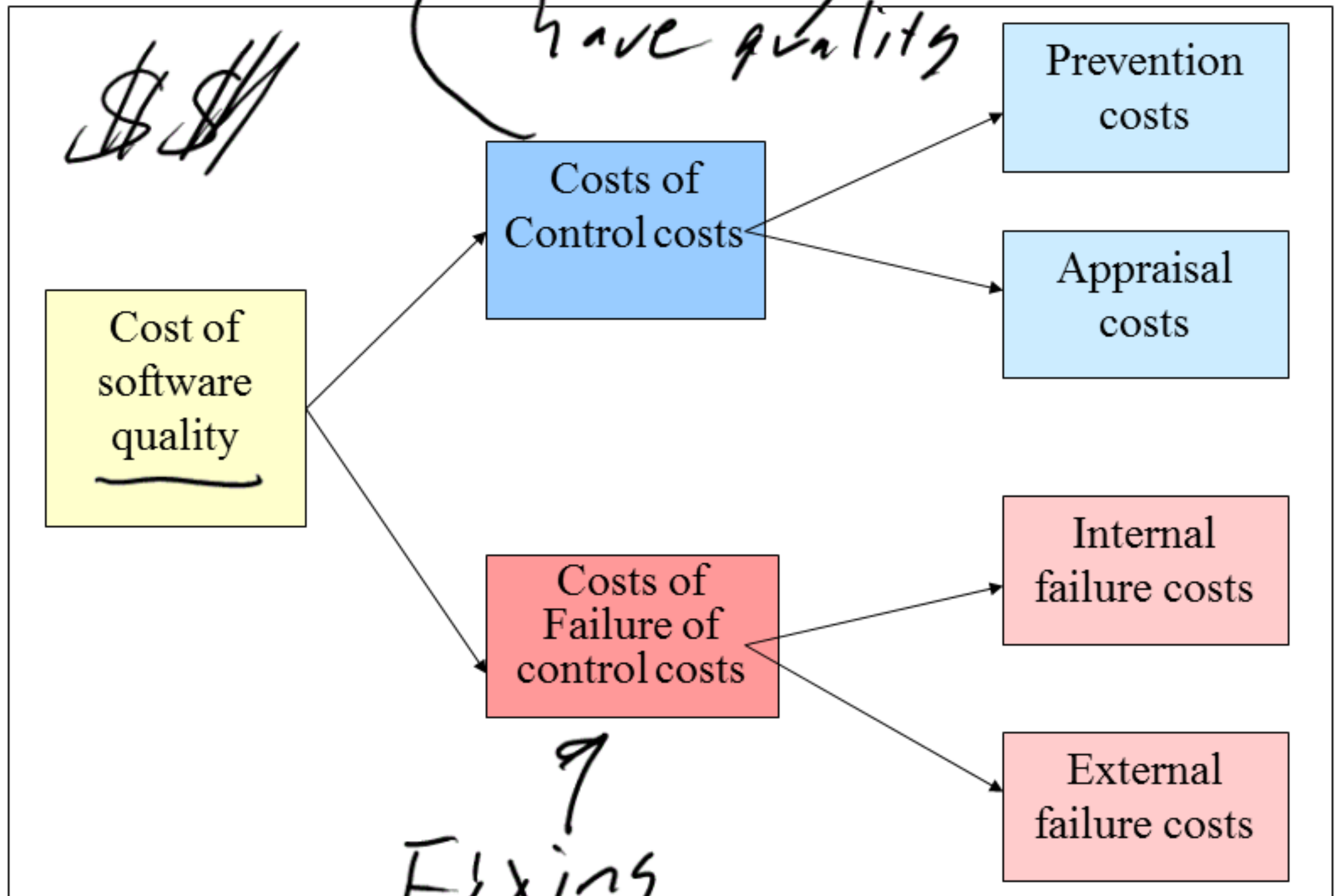
Legal Expenses

Fixing Defects in the field.

Contractor Costs.



Classic Model of CosQ



Prevention Costs

Two pieces to software

quality cost

- Costs of control
 - Prevention acts
 - Infrastructure
 - Organizational Activities
 - Appraisal Acts
 - Acts to detect software errors
- Costs of the failure of control
 - Internal Costs
 - Costs of correcting defects
 - External Costs
 - Costs of correcting mistakes after the customer has it

Making sure mistakes do not occur.

— Finding Problems

Fixing Mistakes.



Prevention Costs

Prevention Costs

Investments in development of SQA infrastructure components

- * Procedures and work instructions -
- * Support devices: templates, checklists etc -
- * Software configuration management system -
- * Software quality metrics -

Regular implementation of SQA preventive activities

- * Instruction of new employees in SQA subjects *Training*
- * Certification of employees ↗
- * Consultations on SQA issues to team leaders and others -

Control of the SQA system through performance of

- * Internal quality reviews -
- * External quality audits -
- * Management quality reviews -

Reviews/Audits

Appraisal Costs

Appraisal Costs

Costs of reviews:

- * Formal design reviews (DRs) —
- * Peer reviews (inspections and —
walkthroughs)
- * Expert reviews \Rightarrow External

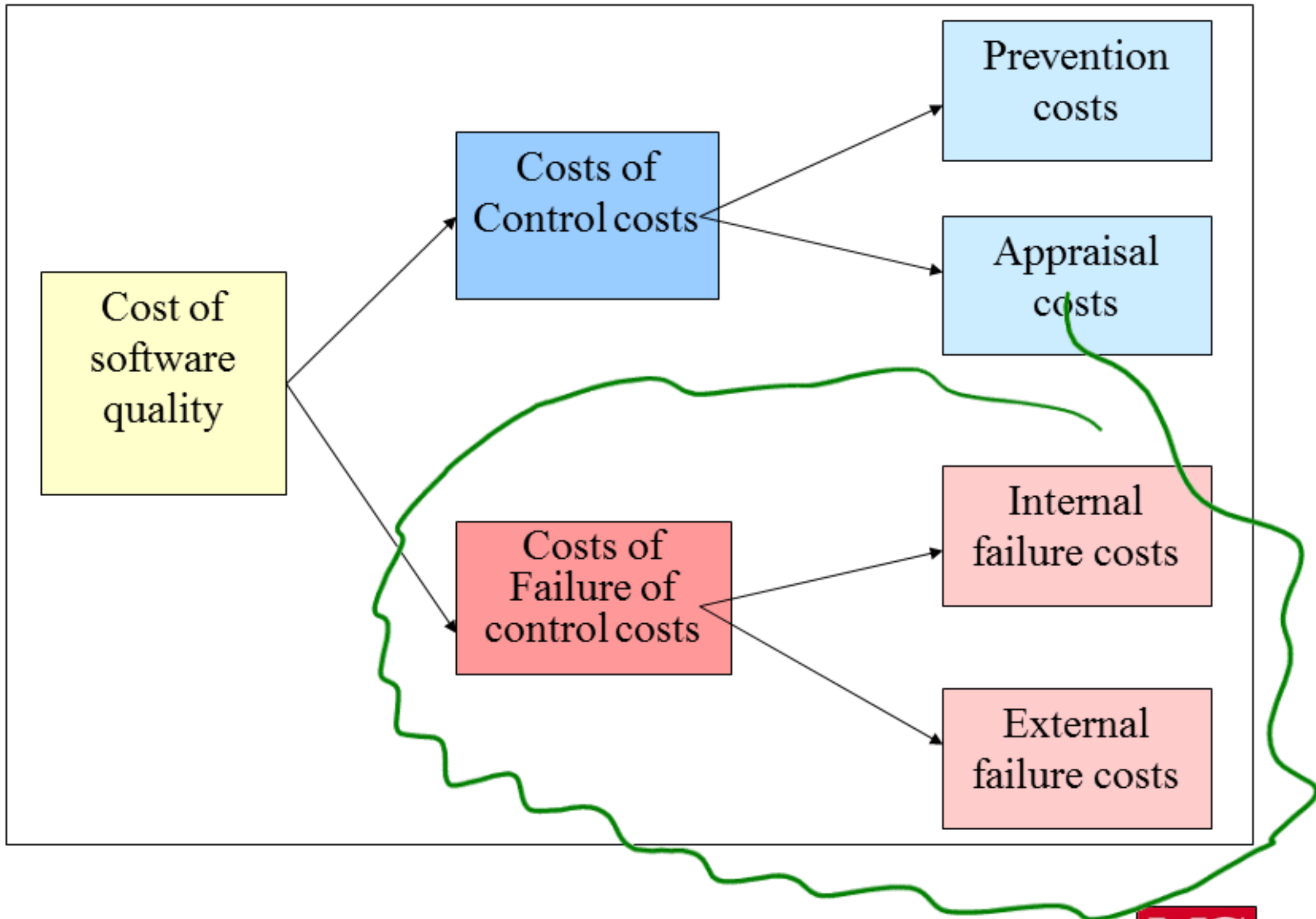
Costs of software testing:

- * Unit, integration and software system tests
- * Acceptance tests (carried out by
customers)

Costs of assuring quality of external participants

consultants

Classic Model of CosQ



Internal Failure Costs

Internal Failure Costs

- Costs of redesign or design corrections subsequent to design review and test findings — Fixing our bugs
- Costs of re-programming or ~~correcting~~ programs in response to test findings
- Costs of repeated design review and re-testing (regression tests)

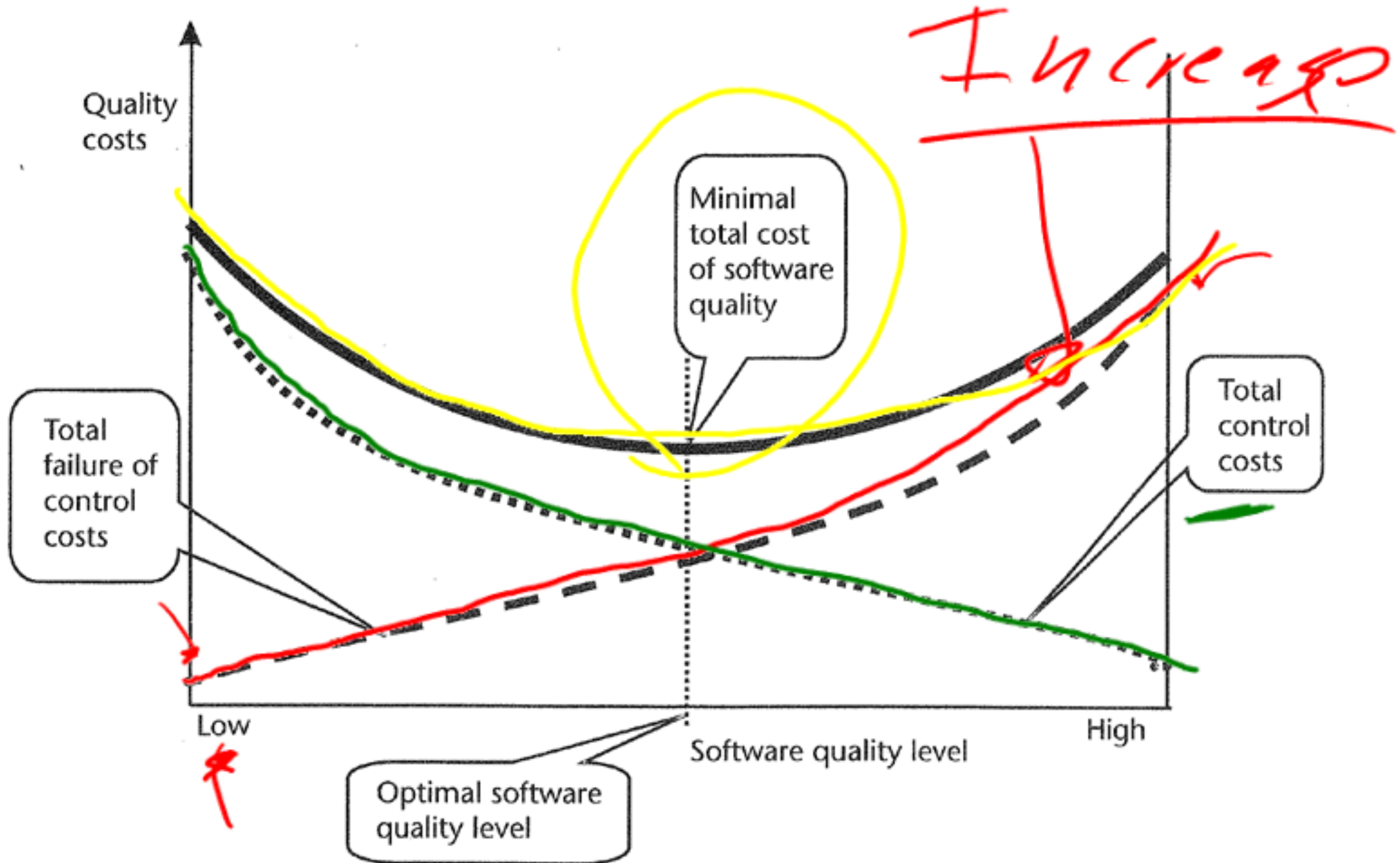
↳ Exploratory Testing

External Failure Costs

External Failure Costs

- Resolution of customer complaints during the warranty period. —
- Correction of software bugs detected during regular operation. — *Problem w/ SW.*
- Correction of software failures after the warranty period is over even if the correction is not covered by the warranty. — *Recall*
- Damages paid to customers in case of a severe software failure. — *Toyota*
- Reimbursement of customer's purchase costs. —
- Insurance against customer's claims. —

Relationship



What do we know works

- Quality requirements —

17% reduction in cost.

- Reviews

Significant Savings

- Static Analysis

90% ROI_{time}

Quality Requirements

- 40-50% of the costs of projects is spent on rework
 - Good Requirements vs. Mistakes Rework, Brad Egeland
- Requirements errors are the greatest source of defects and quality problems.
 - (Schwaber, 2006; Weinberg, 1997; Nelson et. al, 1999) Inadequate.
- “Deficient requirements are the single biggest cause of software project failure.”
 - (Hofmann and Lehner, 2001)
- Up to 1/3 of development costs are spent fixing bad requirements

Reviews

- “Rework to fix defects accounts for between 40 and 50% of total development costs. Formal reviews (i.e., inspections) typically find 80% of defects as they happen (walkthroughs typically find 60%). When effectively used, formal reviews can make an enormous difference to program cost, schedule and quality.”
 - Program Manager’s Guide to Software Acquisition Best Practices
- “Experience has shown that the cost of executing software tests to catch and correct problems is at least an order of magnitude greater than if such items are found and corrected earlier by using Inspection.”
 - Tom Gilb & Dorothy Graham, Software Inspection
- “An 8 work-year development, delivered in 5 increments over 9 months for SEMA Group found 3512 defects in Inspection, 90 in testing, and 35 (including enhancements) in the field. After two evolutionary deliveries, unit testing was dropped because it was no longer costeffective”
 - Dennis Leigh, British Computer Society

Static Analysis

- “An average of 17% cost savings would have been possible if the static analysis tool was used.”
 - Baca, D., Carlson, B., and Lundberg, L. 2008. Evaluating the cost reduction of static code analysis for software security.

Determining the best way to proceed

- Return on investment

What you get back

$$ROI = \frac{(\text{Gain from Investment} - \text{Cost of Investment})}{\text{Cost of Investment}}$$

*How much
does it cost?*

Determining the best way to proceed

- Return on investment

$$\text{ROI} = \frac{2000 - 1000}{1000} = 100\% \text{ ROI}$$

Determining the best way to proceed

- Return on investment

$$\text{ROI} = \frac{1.2\text{m} - 150,000}{150,000}$$
$$\frac{1.05\text{m}}{150,000} \Rightarrow 22700\% \text{ ROI}$$

Alternatives and return on investment

	A	B	C	D
1	Testing Investment Options: ROI Analysis			
2				<i>3 UNIT</i>
3		No Formal	Manual	Automated
4	Testing	Testing	Testing	Testing
5	Staff	\$0	\$60,000	\$60,000
6	Infrastructure	0	10,000	10,000
7	Tools	0	0	12,500
8	Total Investment	0	70,000	82,500
9	<i>writing code</i>			
10	Development			
11	Must-Fix Bugs Found	250	250	250
12	Fix Cost (Internal Failure)	2,500	2,500	2,500
13				
14	Testing			
15	Must-Fix Bugs Found	0	350	500
16	Fix Cost (Internal Failure)	0	35,000	50,000
17				
18	Customer Support			
19	Must-Fix Bugs Reported	750	400	250
20	Fix Cost (External Failure)	750,000	400,000	250,000
21				
22	Cost of Quality			
23	Conformance	\$0	\$70,000	\$82,500
24	Nonconformance	\$752,500	\$437,500	\$302,500
25	Total CoQ	\$752,500	\$507,500	\$385,000
26				
27	Return on Investment	#N/A	350%	445%

