

# COURSE FOR SOFTWARE TESTING

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**BS (COMPUTER SCIENCE)**

**SPRING SEMESTER**

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**FOUNDATION UNIVERSITY RAWALPINDI CAMPUS**

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**<http://www.hybriditservices.com/course/FU-BSSE-ST>**

# LECTURE 3



# WHAT IS QUALITY ?

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- **Quality**

- Quality is *conformance to requirements* and **prevention of defects.**
- The degree to which a system, component, or process *meets* **specified requirements.**
- The degree to which a system, component, or process *meets* **customer or user needs or expectations.**

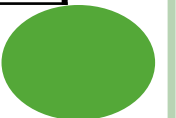


# Different Views of Software Quality

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- Perceived in different domains differently
- Views according to (*Kitchenham and Pfleeger 1996, Pfleeger et al., 2002, software quality:*) are:

User's	fitness for purpose
Manufacturing	conformance to specification
Product	inherent characteristics of the product
Value based	the amount a customer is willing to pay



# WHAT IS QUALITY ?

## Quality popular view:

- Something “good” but not quantifiable
- Something luxury and classy



## Quality professional view:

- **Conformance to requirement**

(Crosby, 1979)

- The requirements are clearly stated and the product must conform to it
- Any deviation from the requirements is regarded as a defect
- A good quality product **contains fewer defects**

- **Fitness for use** (Juran, 1970):

- Fit to user expectations: meet user's needs
- A good quality product **provides better user satisfaction**



# Different Views of Software Quality

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## ○ User View

- The basic building block on which fitness for use is built is the Quality Characteristic.
- Any feature (property, attribute, etc.) of the products, materials, or processes which is needed to achieve fitness for use is a Quality Characteristic.

## ○ Manufacturing View

- The degree to which a system, component, or process meets
  - Specified requirements, customer/user needs or expectations
  - Conformance to process standards



# Different Views of Software Quality

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## ○ Product View

- In the *product* view, the focus is on inherent characteristics in the product itself in the hope that controlling these internal quality indicators will result in improved external product behavior ([quality in use](#))

## ○ Value Based View

- In the *value-based* view, quality is the customers' willingness to pay for a software.



# SOFTWARE QUALITY ATTRIBUTES

## - External & Internal characteristics

- Dealing with Defects in early phase or later phase? i.e. testing phase

- External (Dynamic) & Internal (Static)

### External (Rely on execution)

correctness

reliability

usability & performance

completeness, consistency, usability

robustness

### Internal ( Don't rely on execution)

maintainability

flexibility & reusability

portability

availability of correct & complete documents

structured & readability

testable





# Software Quality Attributes

**Completeness** refers to the availability of all features listed in the requirements, or in the user manual. An incomplete software is one that does not fully implement all features required.

**Consistency** refers to adherence to a common set of conventions and assumptions. For example, all buttons in the user interface might follow a common color coding convention. An example of inconsistency would be when a database application displays the date of birth of a person in the database in different formats ignoring user preference.


*Difference of Term "Completeness" in Requirements and Testing Aspects?*

1. Review all internal & external attributes from the **LIST**
2. Divide the **LIST** into class of attributes Internal & External?... ..? (6<sup>th</sup> RA)



# SOFTWARE QUALITY ATTRIBUTES

**Usability** refers to the ease with which an application can be used. This is an area in itself and there exist techniques for usability testing. Psychology plays an important role in the design of techniques for usability testing.

**Performance** refers to the time the application takes to perform a requested task. It is specified in terms such as ``This task must be performed at the rate of X units of activity in one second on a machine running at speed Y, having Z gigabytes of memory." 

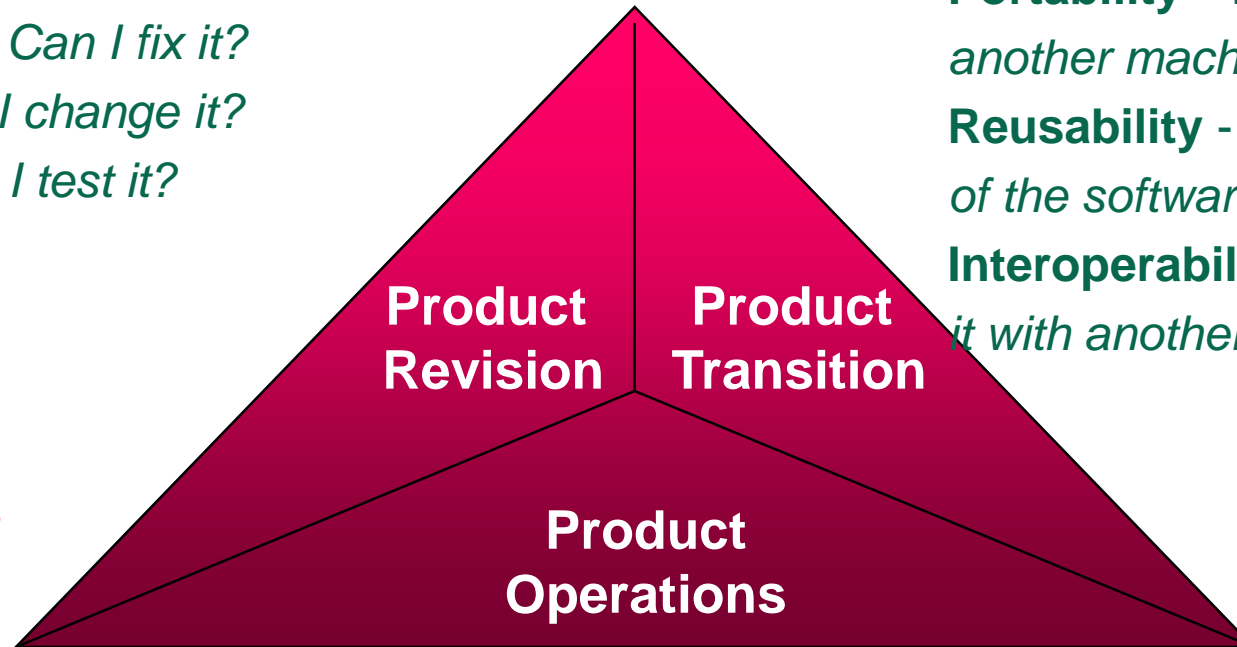
*Review Non-functional requirements?*

# Software Quality Attributes

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**Maintainability** - *Can I fix it?*  
**Flexibility** - *Can I change it?*  
**Testability** - *Can I test it?*

**Portability** - *Will I be able to use it on another machine?*  
**Reusability** - *Will I be able to reuse some of the software?*  
**Interoperability** - *Will I be able to interface it with another machine?*



The **expected quality**  
**Features and characteristics**  
of a software product  
are commonly referred  
to as **Quality Attributes**.

**Correctness** - *Does it do what I want?*  
**Reliability** - *Does it do it accurately all the time?*  
**Efficiency** - *Will it run on my machine as well as it can?*  
**Integrity** - *Is it secure?*  
**Usability** - *Can I easily use it?*

**Another Classification...**



**1, 2, 3 ..... GO!**  
**RESEARCH ASSIGNMENT!**  
[SOFTWARE QUALITY ATTRIBUTES]

- 1. Choose (2-3) types of Non-functional requirement from the List or I will assign**
- 2. Review these types of requirements in detail on basis of how these are important or critical for development of specific types or domain of software application i.e.**
  - in-house development or outsourcing
  - Customize application or marketable products
  - Information system or embedded system
- 3. You will study classifications of software types to determine the importance of selected requirement types**

*Review of Non-functional requirement?*



# Quality Team

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- In large organizations or projects, how to ensure that the required level of product quality is achieved

## Whose Responsibility?

- the responsibility of the so-called quality managers, quality team / group, Test Managers, SQA, Tester etc.
- **Quality group:** Quality Coordinator director, manager, coordinator, members of different department i.e. HR, PM, Finance



# Terminologies w.r.t. Software Quality

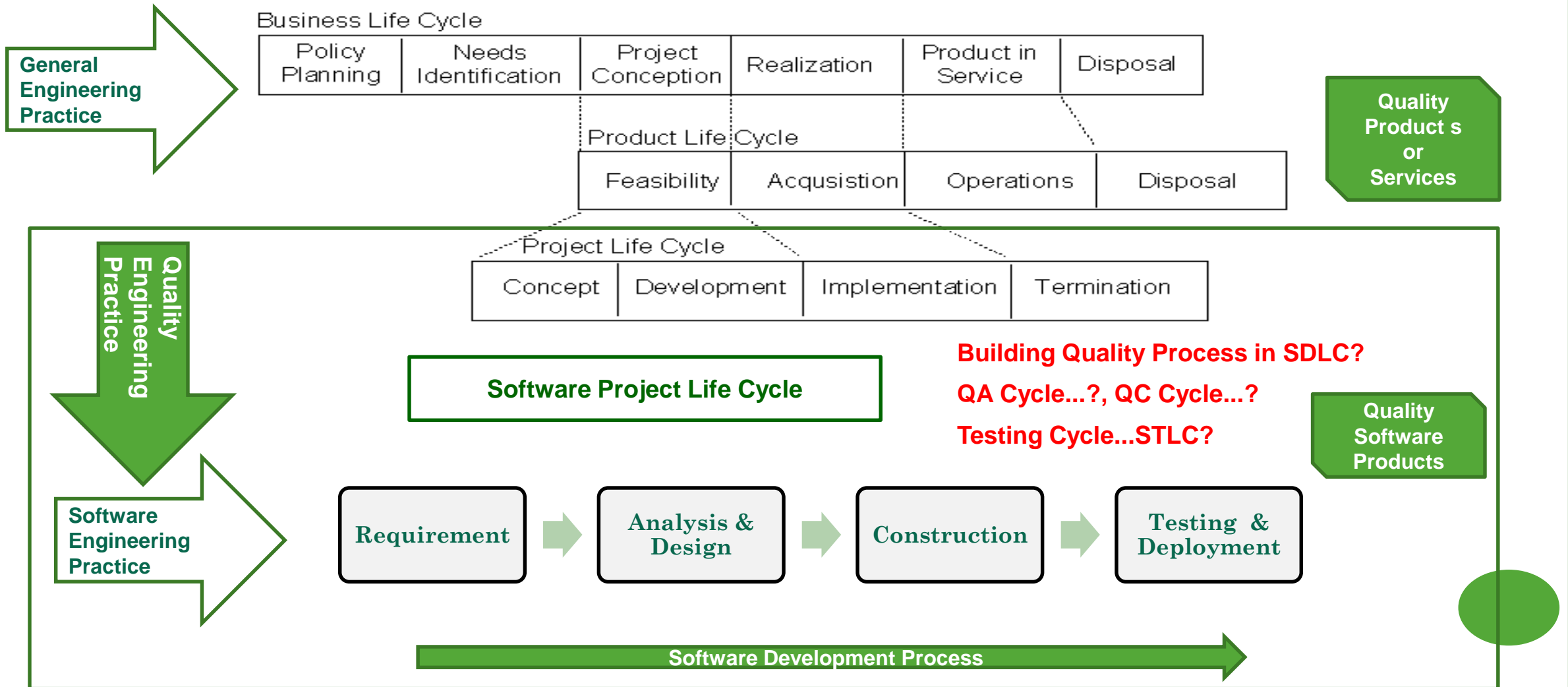
- **Software Quality Engineering SQE**
- **Software Quality Assurance SQA**
- **Software Quality Control SQC**
- **Software Testing (SQC by Only Testing)**
- **Total Quality Management TQM**
- **Quality Management System QMS**
- **Quality Improvement Process QIP**

**1. Can you differentiate first 5 terms**

**2. Differentiated between Software Testing with Software Quality?... ..? (7<sup>h</sup> RA)**



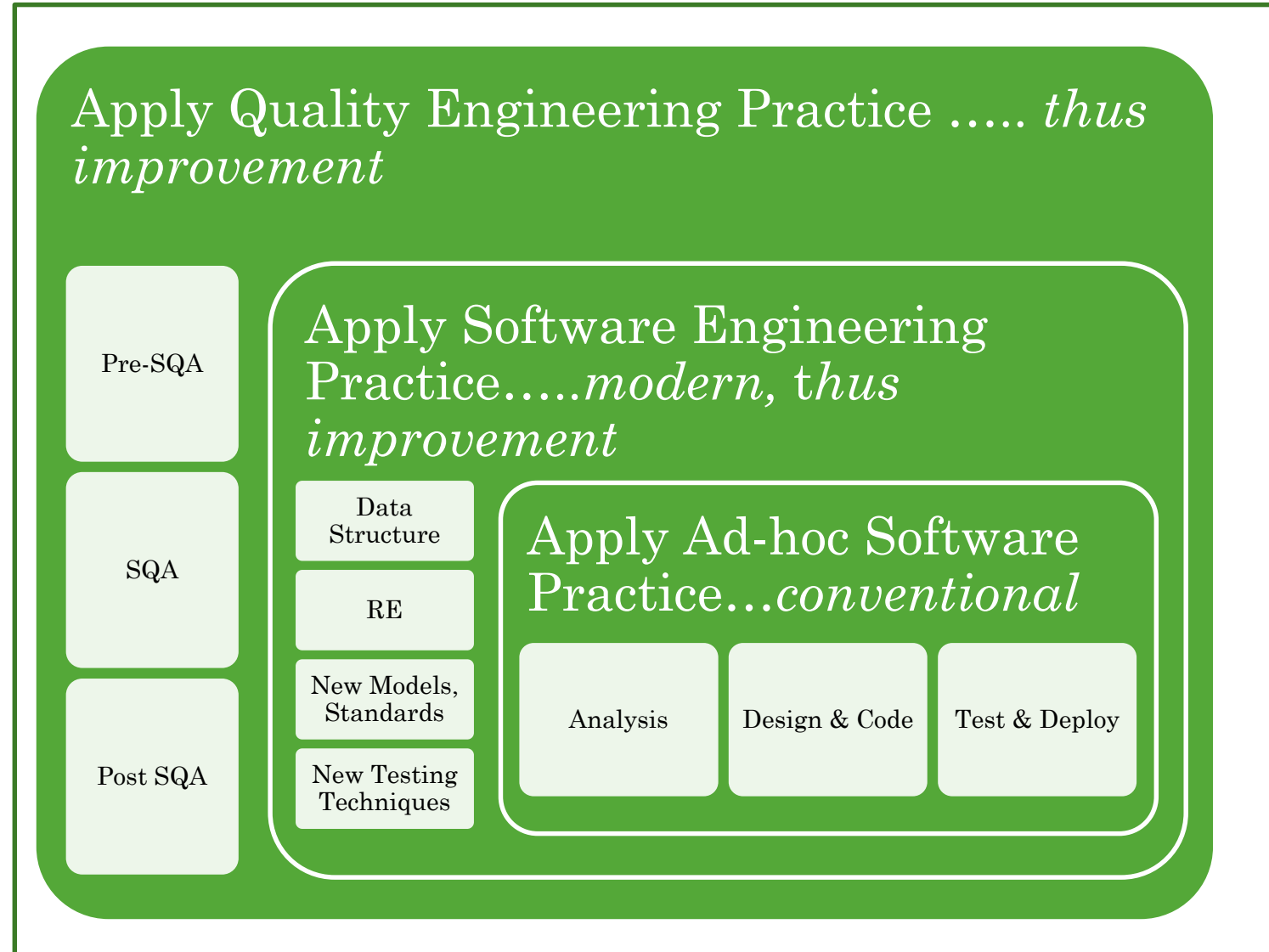
# Apply Quality Engineering in Life Cycle?



# Overall Quality Approach SDLC

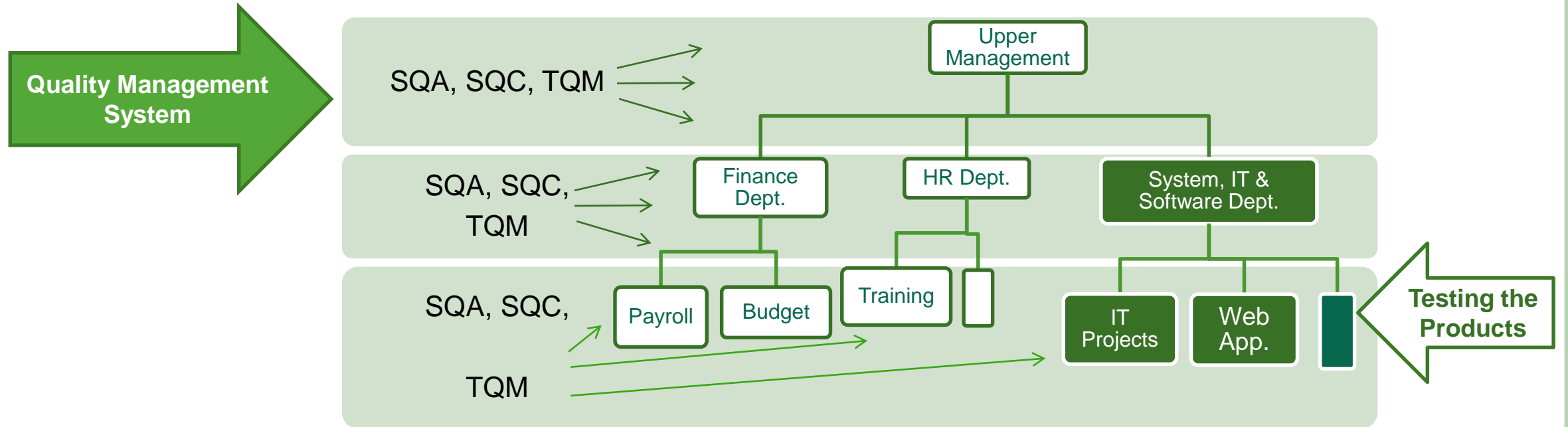


**Building Quality Process in SDLC?**  
**QA Cycle...?, QC Cycle...?**  
**Testing Cycle...STLC?**





# Apply Quality in Organization



**Building Quality Process in SDLC?**

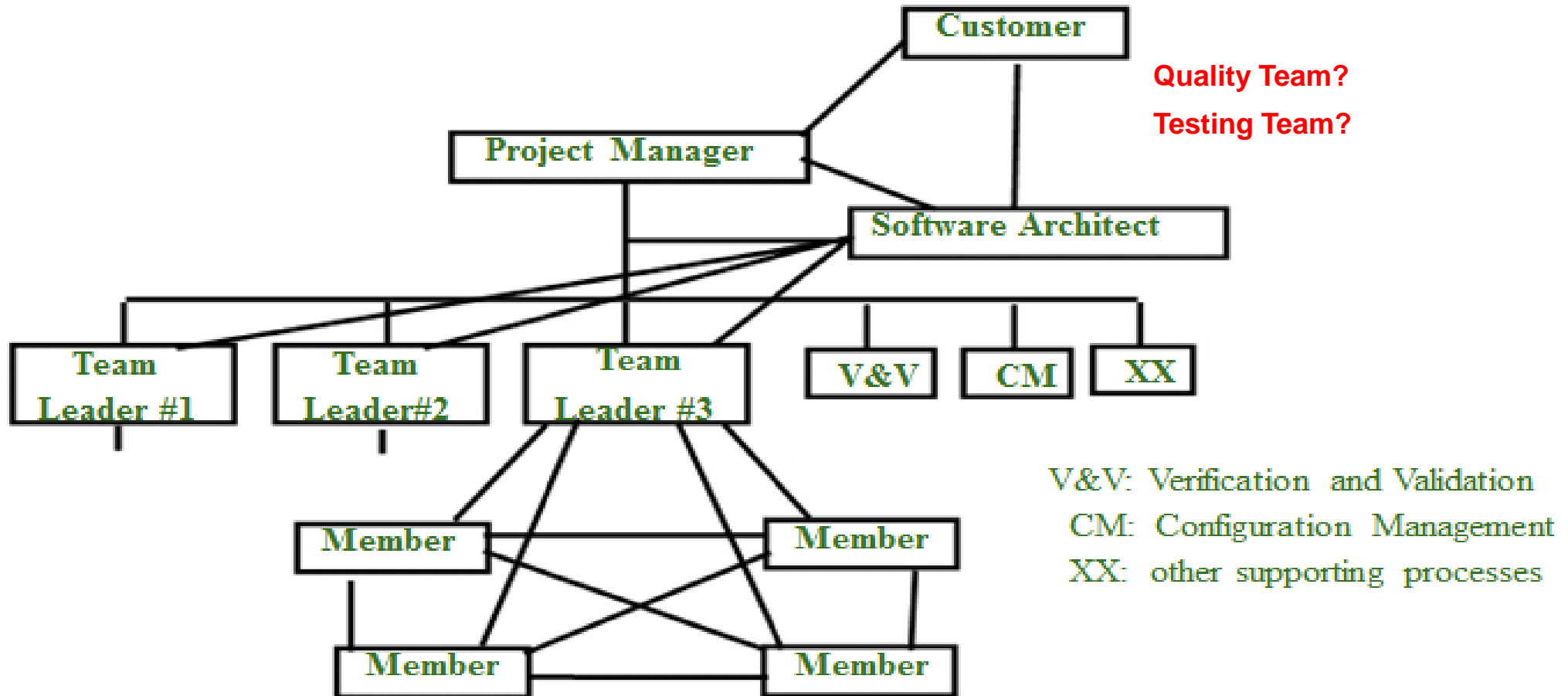
**QA Cycle...?, QC Cycle...?**

**Testing Cycle...STLC?**

Overall Quality  
in Portfolio i.e.  
Process, Service  
& Product



# An Team Structure for Software Developments



Each team has 2 to 5 members plus a team leader



# Another View



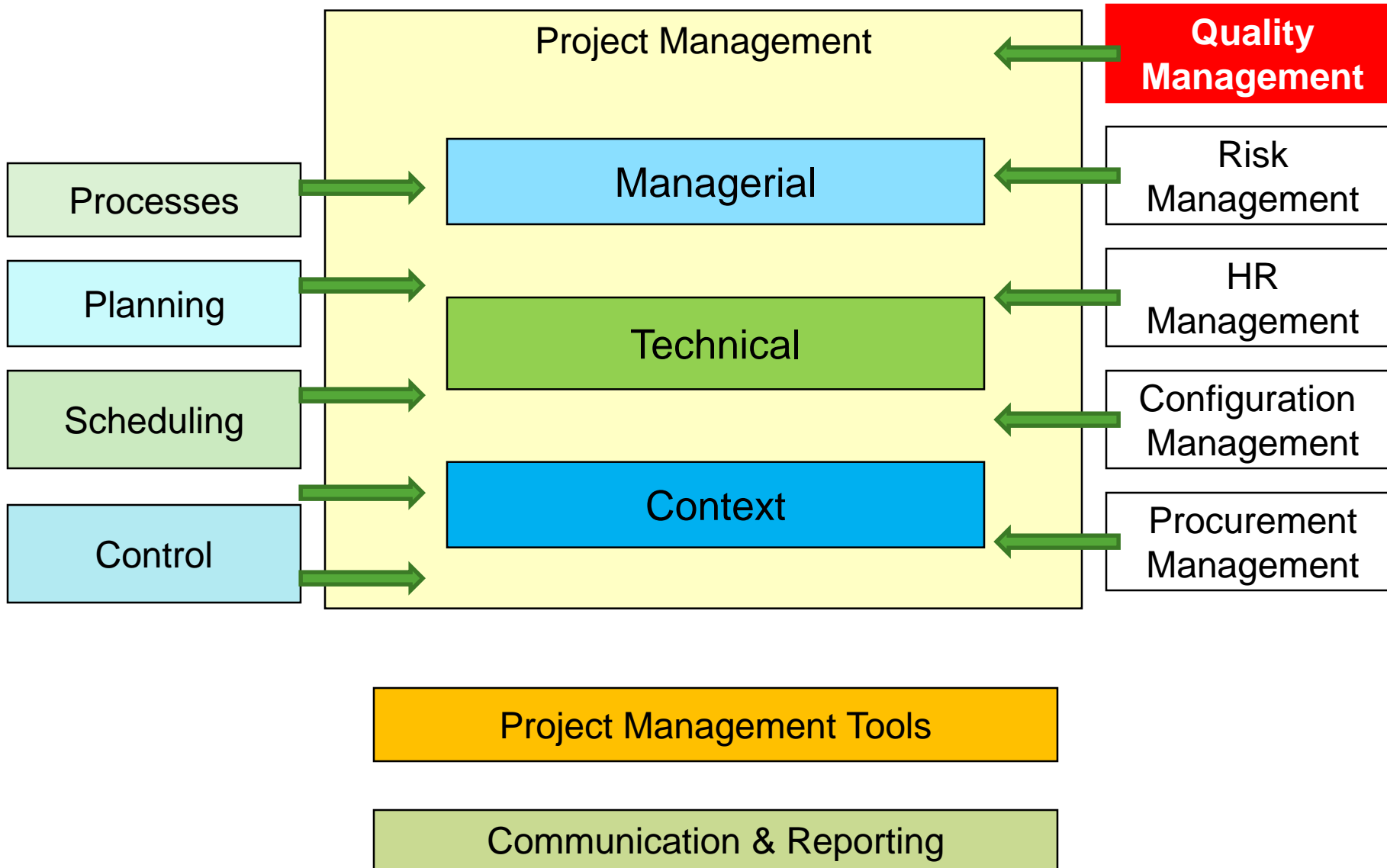
**Building Quality Process in SDLC?**

**QA Cycle...?, QC Cycle...?**

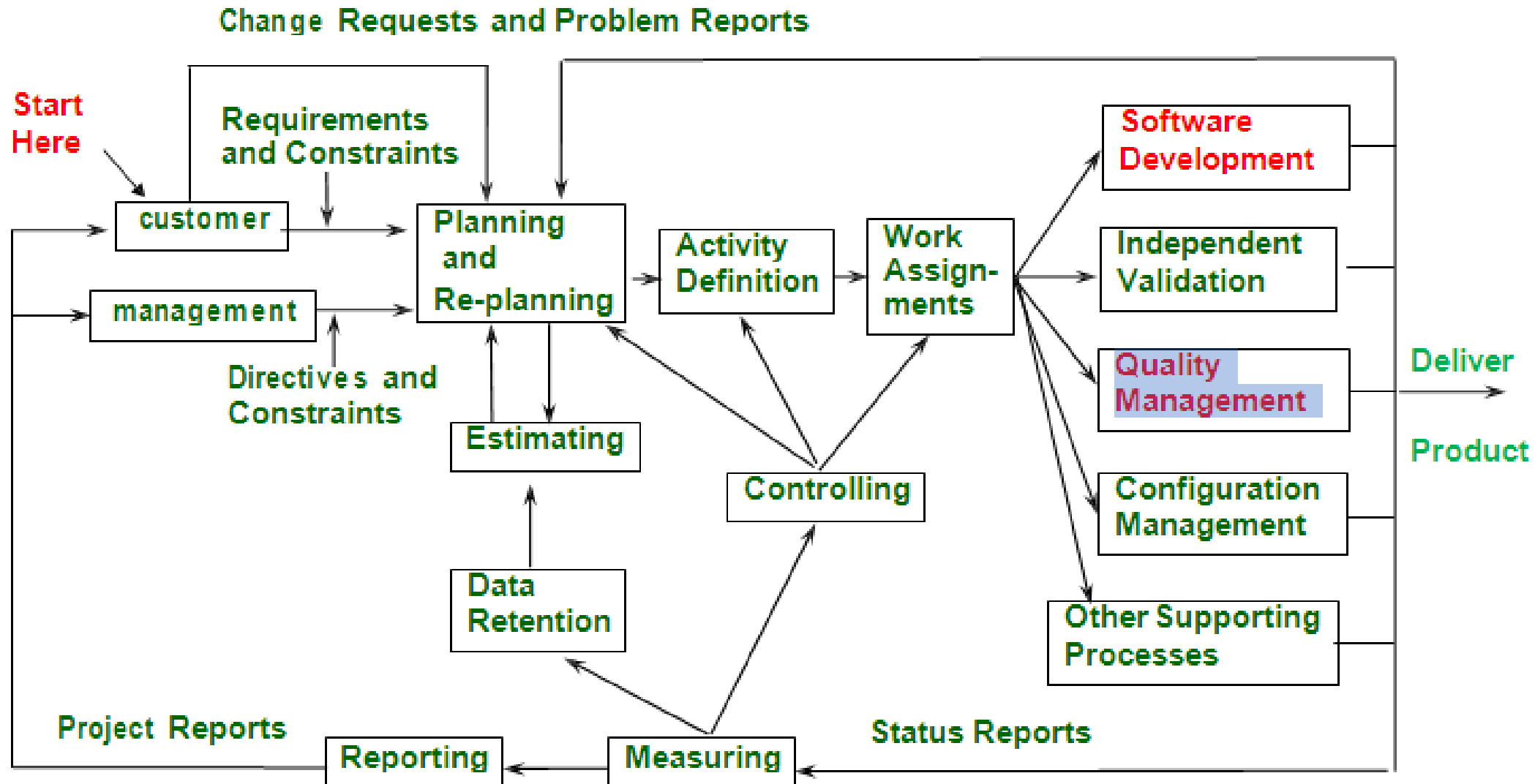
**Testing Cycle...STLC?**



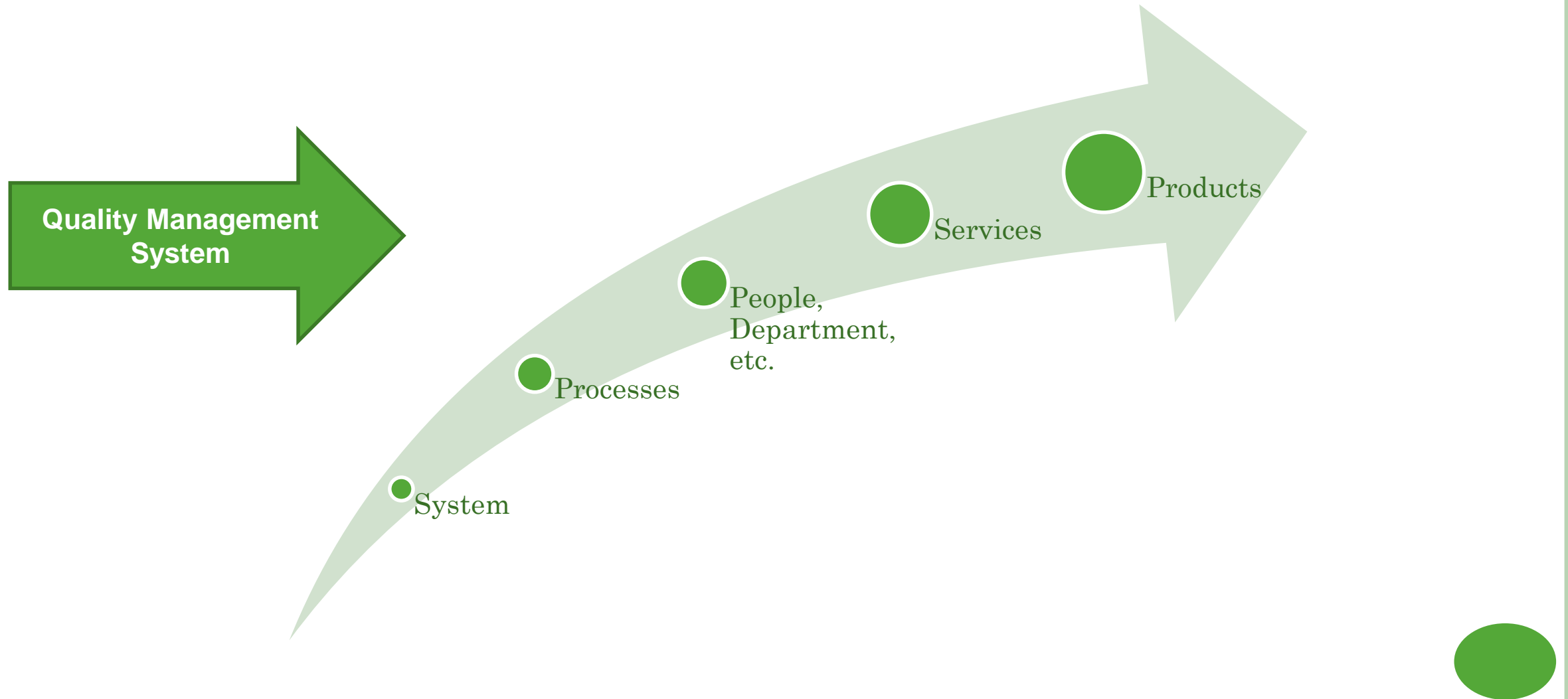
# Quality Management – Supporting Processes



# A Workflow Model for Software Projects



# Overall Improvement

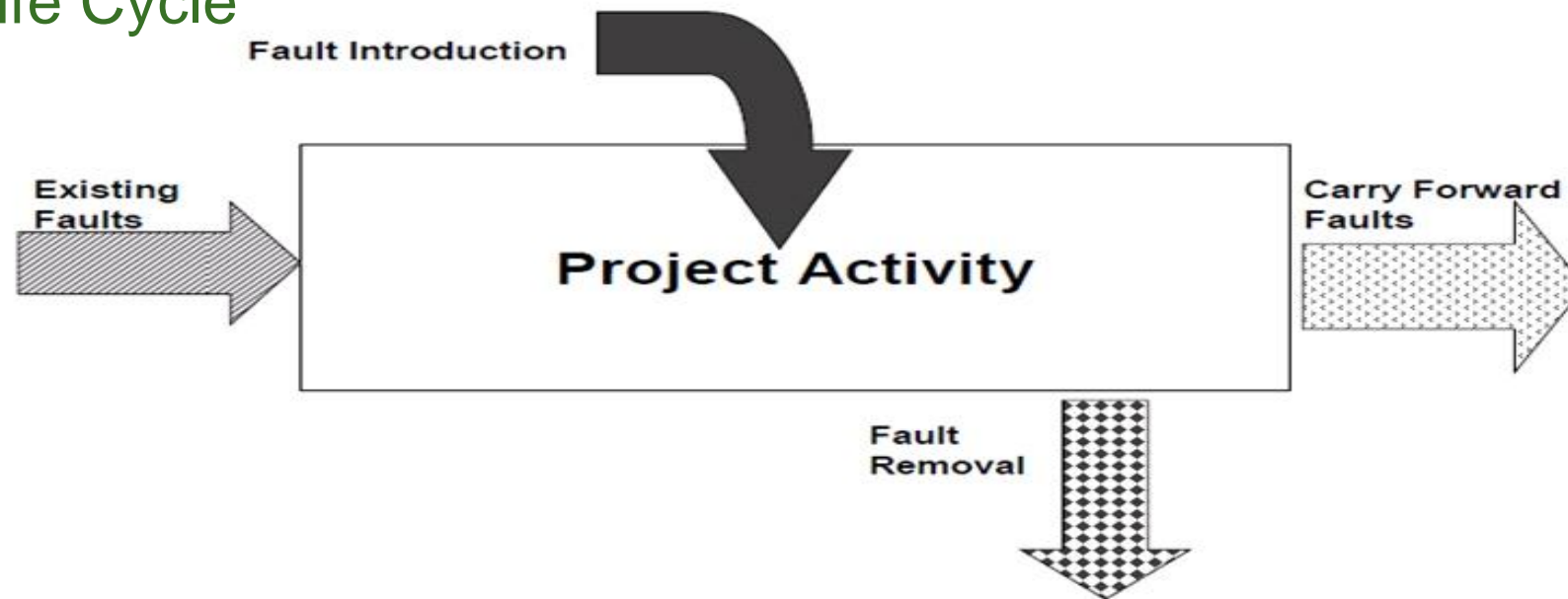


# Software Quality

## Software Quality Foundation

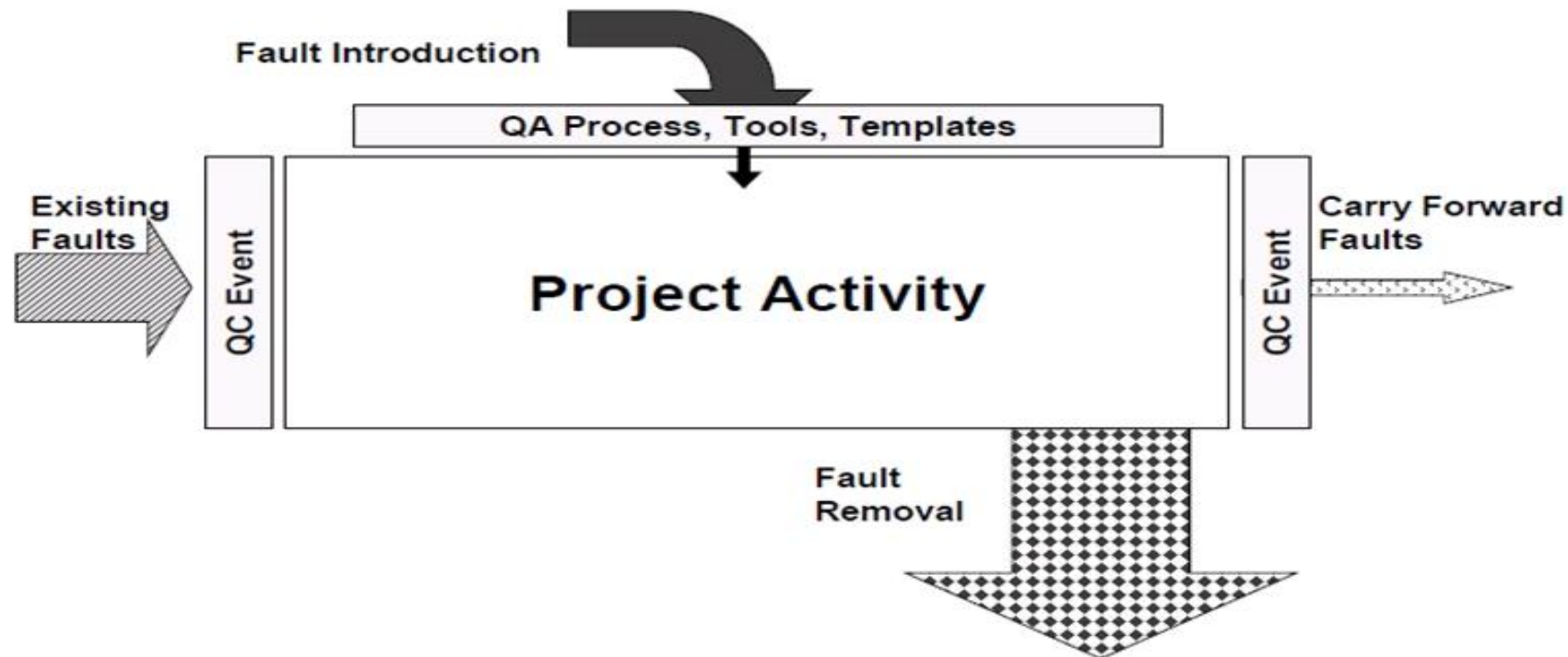
### Software Lifecycle

- Defects are introduced in software by human activities through Software Life Cycle



# Software Quality

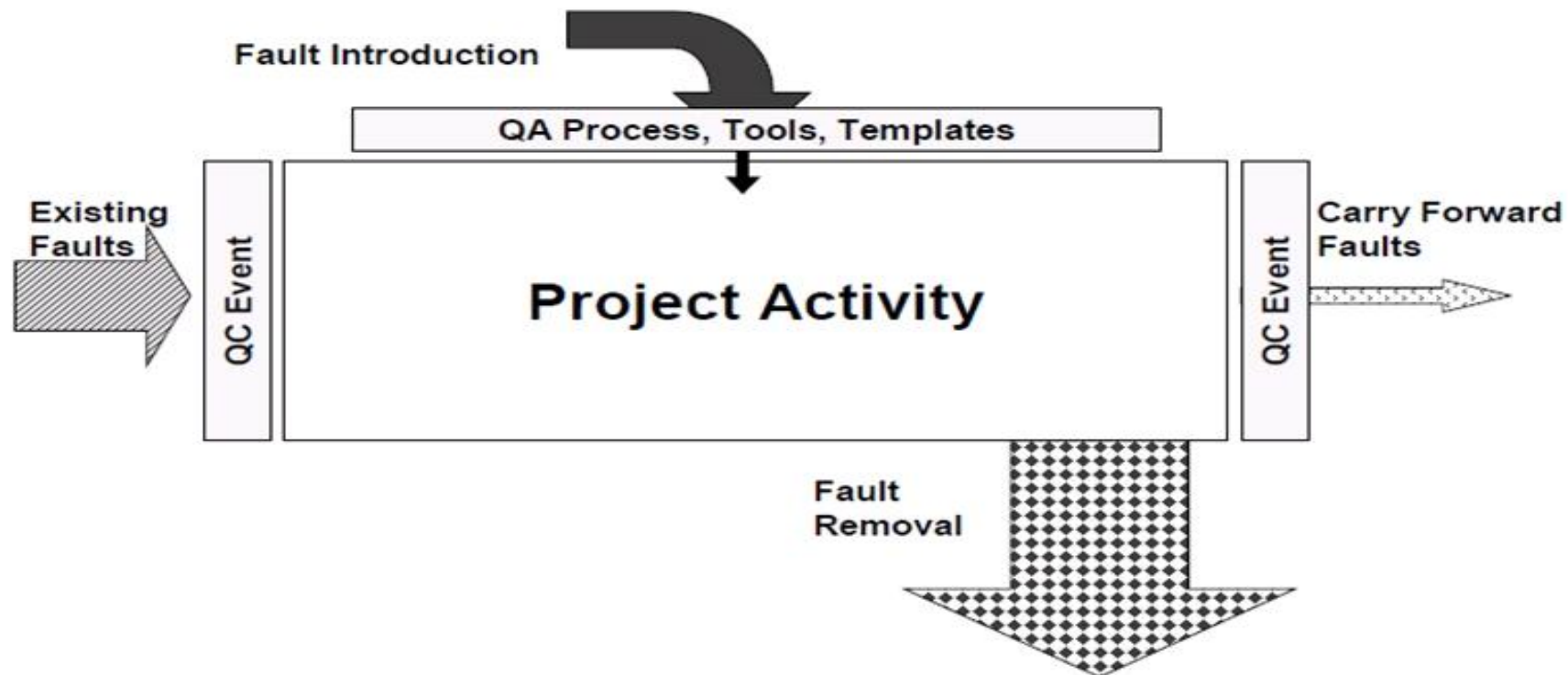
- **Quality Assurance (QA)** is fault **prevention** through process design and auditing
- Creating processes, procedures, tools, jigs, etc. to prevent faults from occurring
- Examples: Templates, checklists, guides
- **Main goal:** prevent as much as possible defect injection





# Software Quality

- **Quality Control (QC)** is fault/failure **detection** through static and/or dynamic testing of artifacts
- Examining the artifact against pre-determined criteria to measure conformance
- **Main goal:** stop leakage of defects before deployment, find, fix, or containment



# **Difference in (QA) & (QC) ?**

## **- Quality Assurance (QA)**

### **- Things done before developing software & related produces**

- Recruit Good People
- Develop Good Processes
- Provide Good Tools
- Train People to use Processes & Tools
- Provide Adequate Supervision
- Appreciate Good work
- Plan for QC
- Apply on all SDLC i.e. Apply on testing process? If testing part of QA?

## **- Quality Control (QC)**

### **- Things done after developing software & related products**

- In spite our best efforts, some mistakes will occur
- Detect mistakes & ensures that quality standards / procedures are followed, If Testing part of QC?



# Difference in (QA) , (QC) & (Testing) ?

## - Prevention process & detective process

- **QA** –those activities which develop / modify processes to prevent introduction of defects

- **QC** –those activities which find & correct the flaws

- **QA Focus** ---- Process-oriented,

Randomly Evaluate the product to confirm if process works,

Ensures if process is defined & right, *preventing defect from occurring*

*e.g. Development of methodologies & standards: Review if requirement being defined at proper level of detail?*

- **QC Focus** ---- Products-oriented ,

Continuous activity & observe if defective,

Focus on finding, detecting & correcting the defects in specific deliverables

*e.g. Are defined requirements the right requirements?*

-**Testing** ----- The process of executing a system with the intent of finding defects

- **Note:** Process of executing a system includes **test planning** prior to the execution of the test cases

-**Testing is one part of a QC activity, but there are others such as reviews, inspections etc..**



# What is Software Testing?

**Several definitions:**

**“Testing is the process of establishing confidence that a program or system does what it is supposed to.” by Hetzel 1973**

**“Testing is the process of executing a program or system with the intent of finding errors.” by Myers 1979**

**“Testing is any activity aimed at evaluating an attribute or capability of a program or system and determining that it meets its required results.” by Hetzel 1983**



# What is Software Testing?

- **One of very important software development phases**
- **A software process based on well-defined software quality control and testing standards, testing methods, strategy, test criteria, and tools.**
- **Engineers perform all types of software testing activities to perform a software test process.**
- **The last quality checking point for software on its production line: WARNS!**



# What is Software Testing?

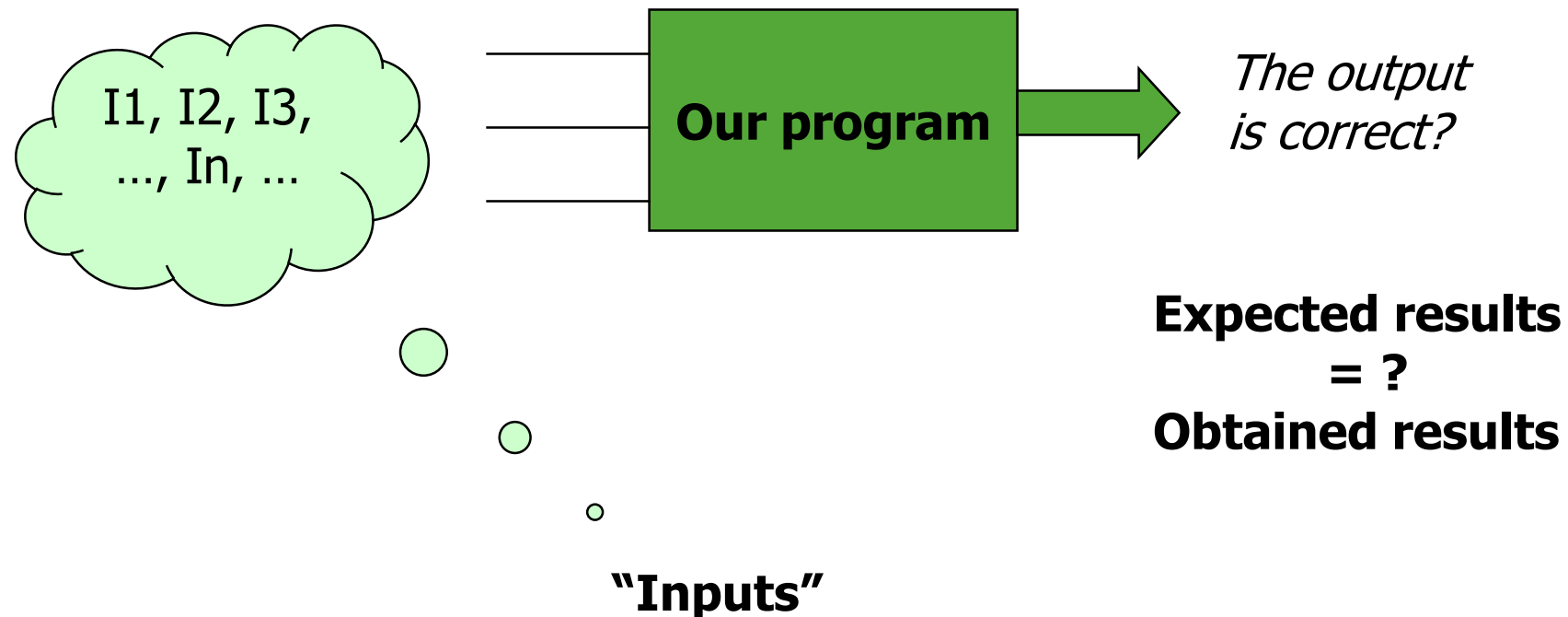
- Software testing is a popular **risk management strategy**. It is used to verify if software requirements were met.
- The limitation of this approach, however, is that by the time testing occurs, it is too late to build quality into the product

**Can you explain testing process in context of QA, & QC?... ..? (8<sup>h</sup> RA)**



# What is Software Testing?

One of the practical methods commonly used **to detect the presence of errors (*failures*)** in a computer program is to test it for a set of inputs. Testing detects errors; only exhaustive testing, usually infeasible, can prove correctness (absence of errors).

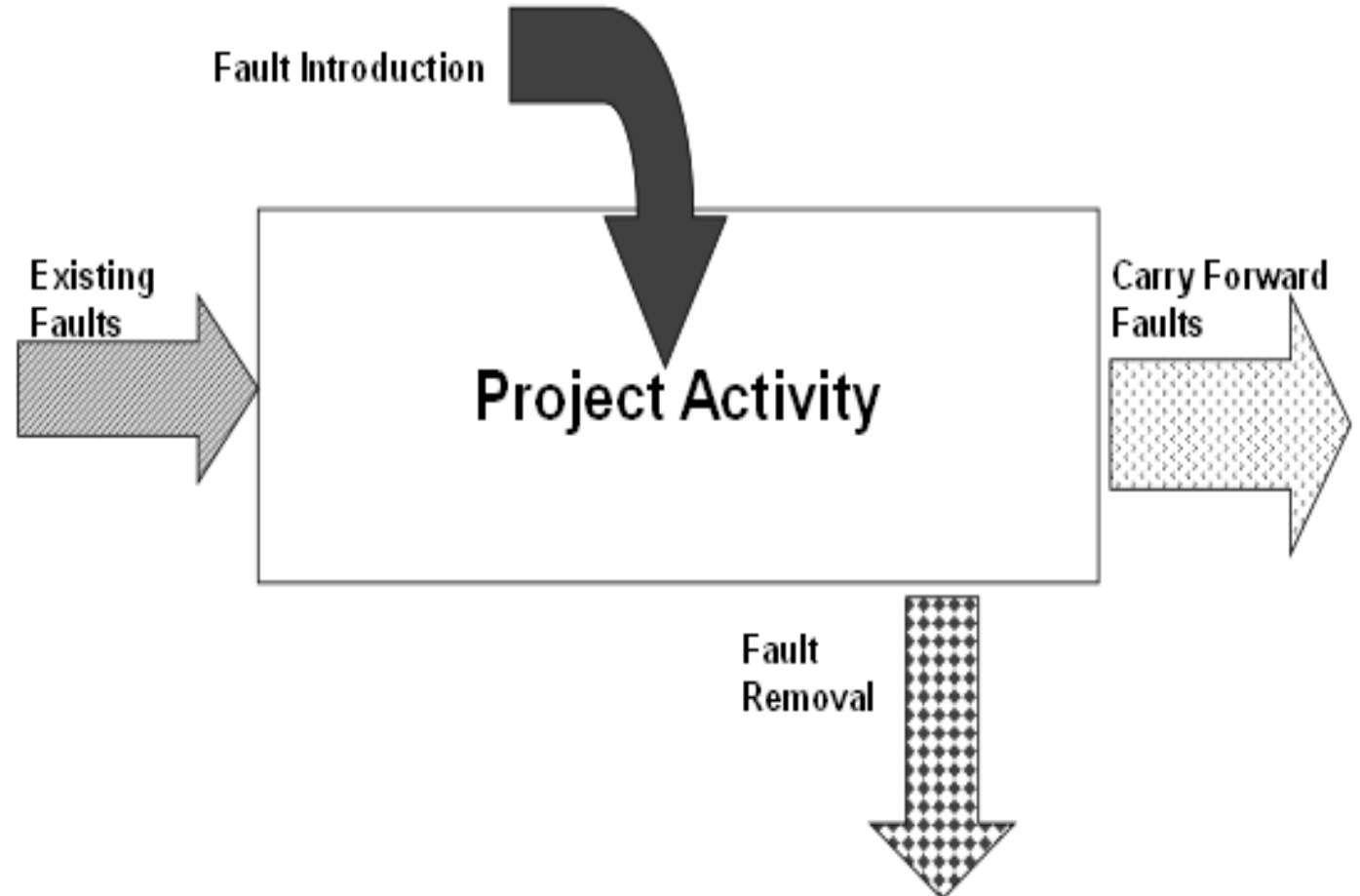
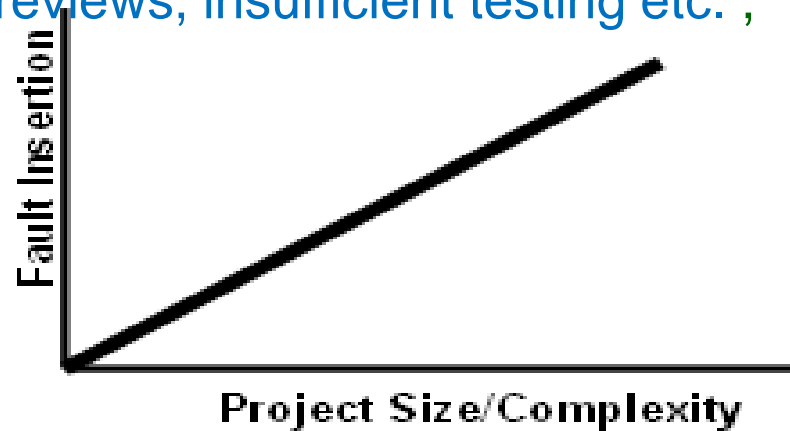


# Economy: Failures Cost?

## Saving the Cost in Testing Phase.....

### Inserting faults is the norm

High reliance on human communication, Lack of Training  
High complexity, Missing Docs  
Ignorance of standard, missing reviews, insufficient testing etc. ,



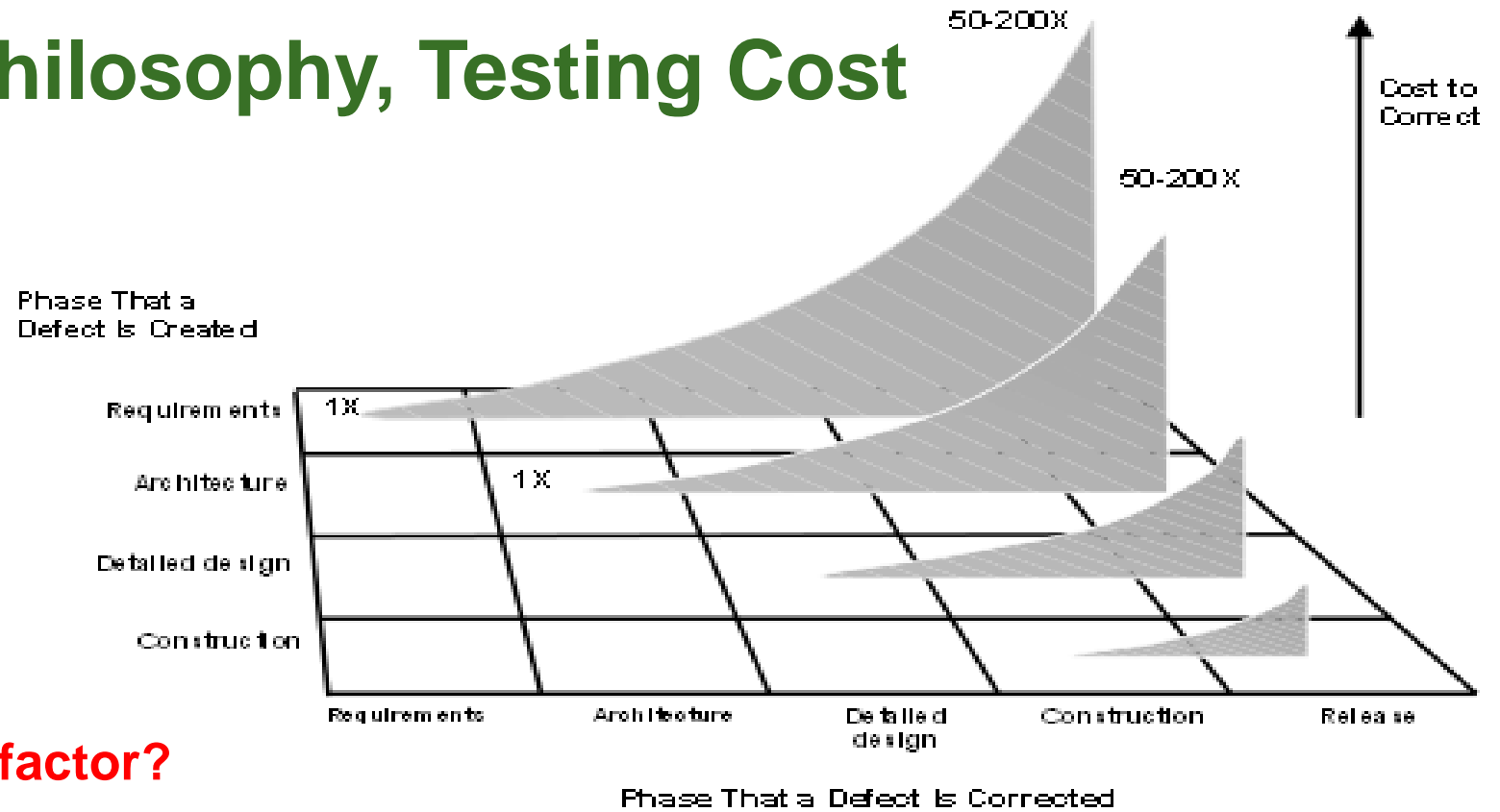
*\*As the amount of effort increases, the number of faults will increase*





# Quality Philosophy, Testing Cost

- Quality improvement cost increases as we progress in the software lifecycle ( $\leq 1x$ )
- Cost for Fixing of Defects increases as we progress in the software lifecycle ( $\geq [1x - 200x]$ )
- Difference of ratio? Or by x factor?



1. That mistakes will be made throughout the project:  
Project success depends on positioning the project team to detect mistakes early so that they can correct them quickly and easily (**Quality Control**)
2. That the way things are built greatly impacts how well they can be built:  
Project success depends also on using effective and efficient methods by the project team (**Quality Assurance**)



# Prevention , Detection & Failures & Cost ?

## Prevention

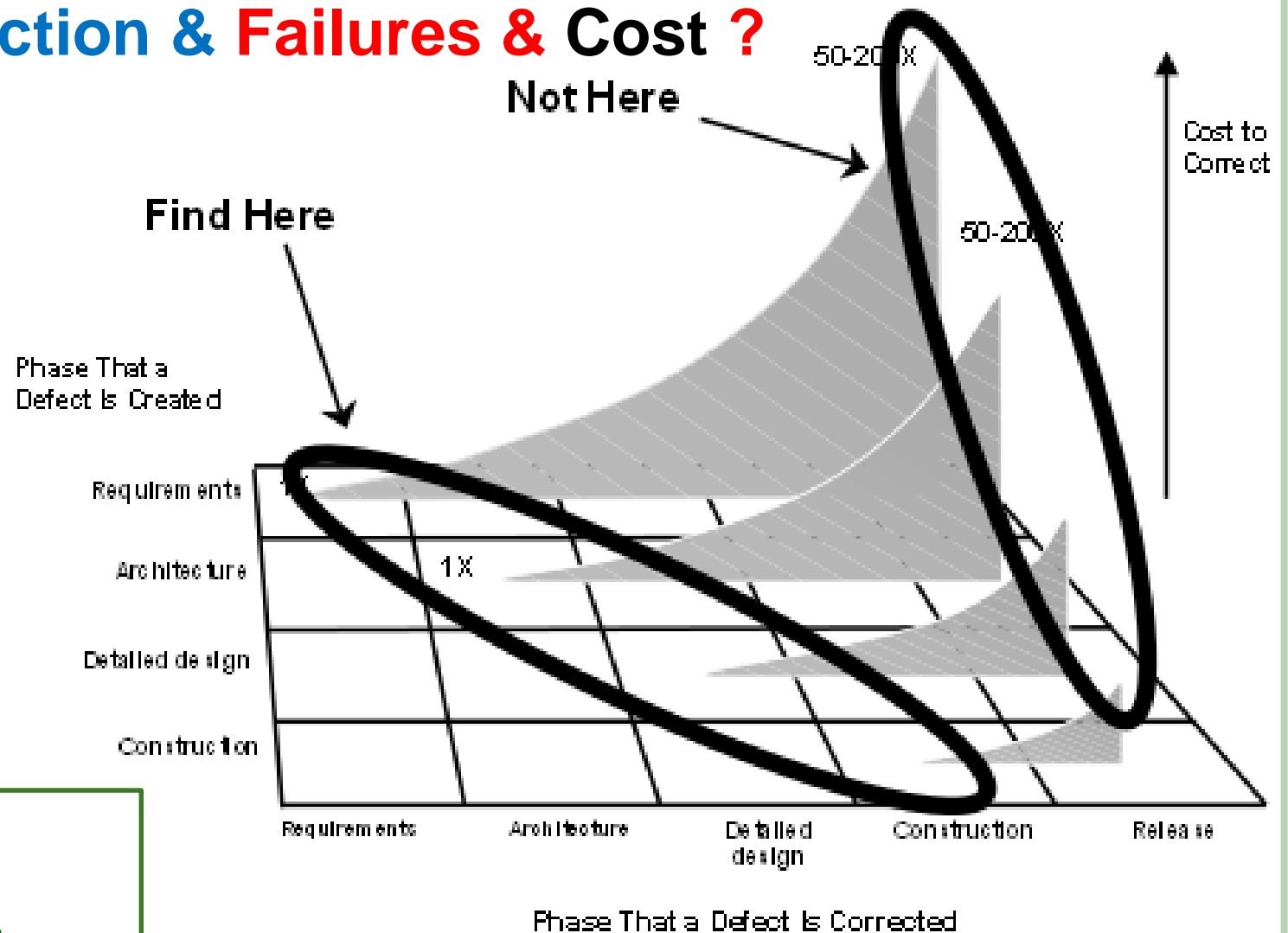
- Quality planning
- Formal process audits
- Training

## Detection

- In-process and inter- process review
- Test equipment
- Equipment calibration and maintenance
- Reviews, Testing, etc....

## Failure Costs

- Rework
- Repair
- Scrap
- Failure mode analysis
- Complaint resolution
- Product return and replacement
- Help line support
- Warranty work



Quality Improvement Cost is [  $\leq 1x$  ]

Cost of fixing defect in later phases is [  $\geq 50x - 200$  ]

# Prevention , Detection & Failures, Cost?

## Prevention

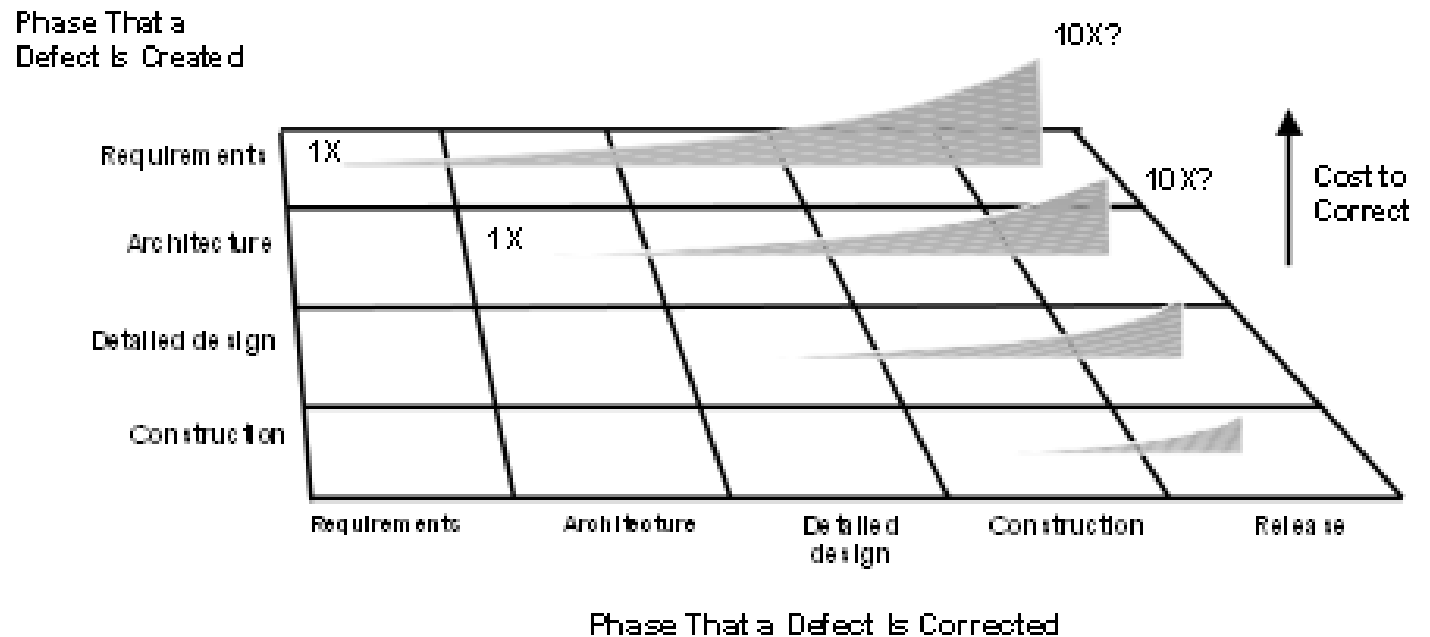
- Culture
- Professional development
- Practice toolbox selection
- Checklists & Templates
- Audits
- Quality gates
- Team structure
- Continuous process improvement

## Detection

- To get to acceptable defect removal rates requires a combination of techniques
- Unit testing, component testing, and system testing cannot remove full defects

**Neither effective or efficient!**

- Skipping reviews and/or inspections will result in high tail-end costs !



# Cost Categorization

## Prevention

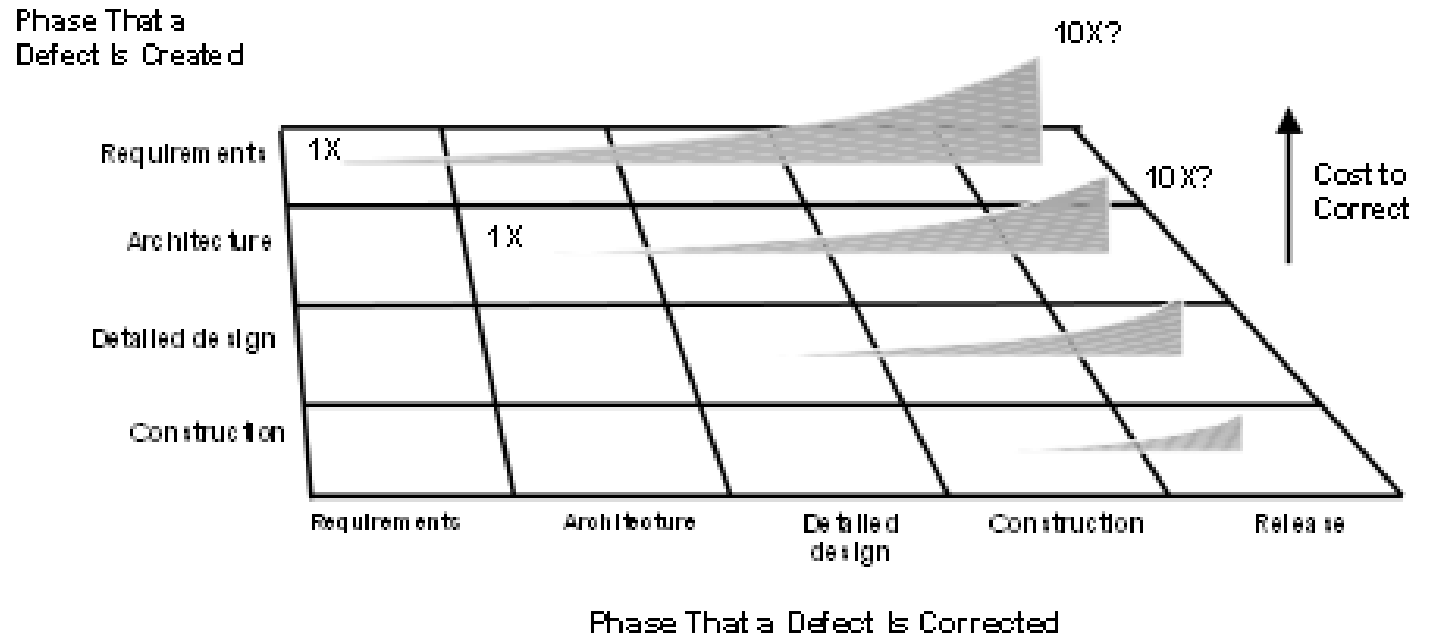
- Correct Customer Requirements
- Adequate Education
- Process Designing
- Right Selection of People & Skill

## Detection

- Reviews
- Testing
- Incoming Inspection, Failure Analysis

## Non-conformance

- Rework
- Additional Inventory
- Additional Support calls
- Contractual Penalties
- Overtime Cost
- Lost Business



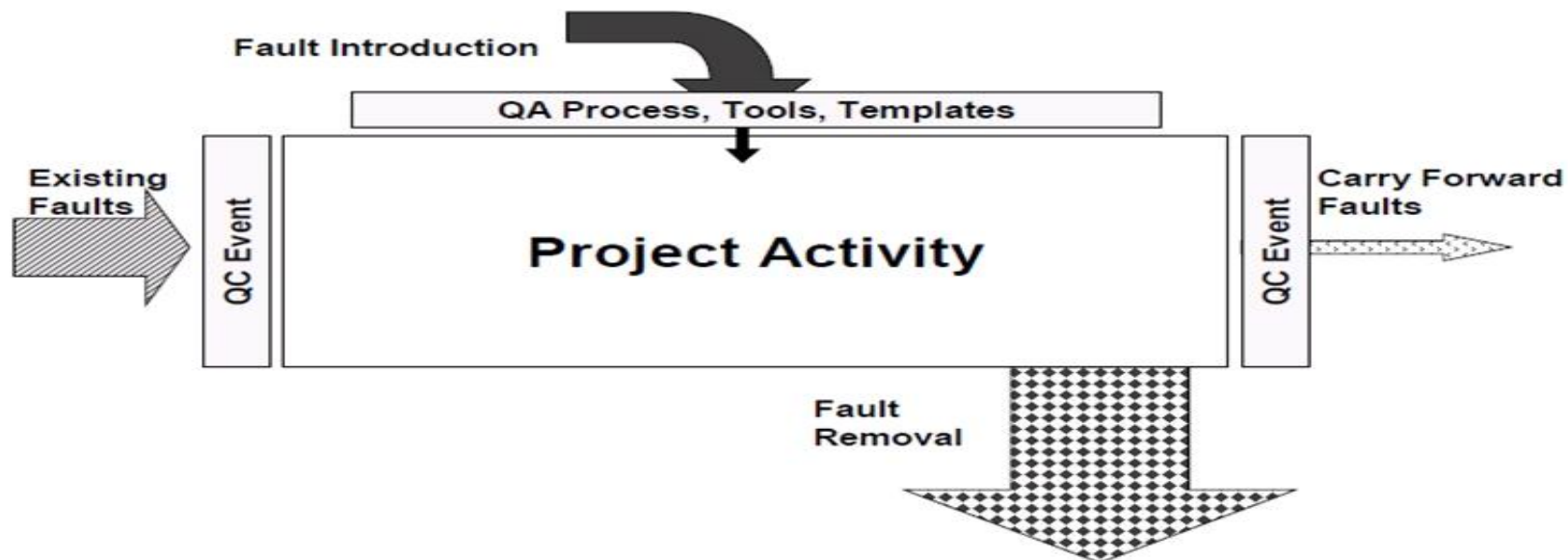
COST of correction increases exponentially as time between occurrence of error & detection error increases



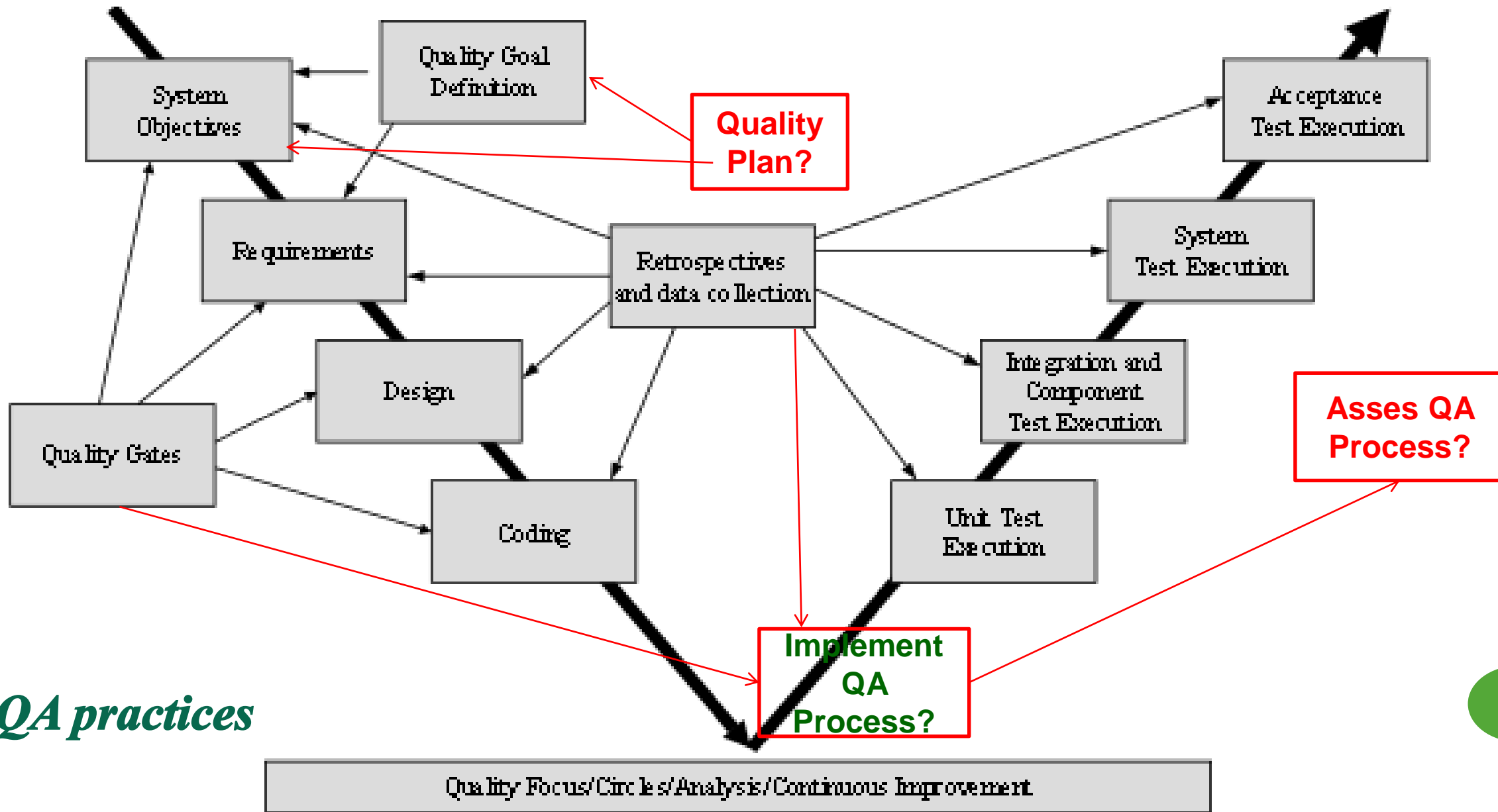
# Quality Practices in the Software Lifecycle



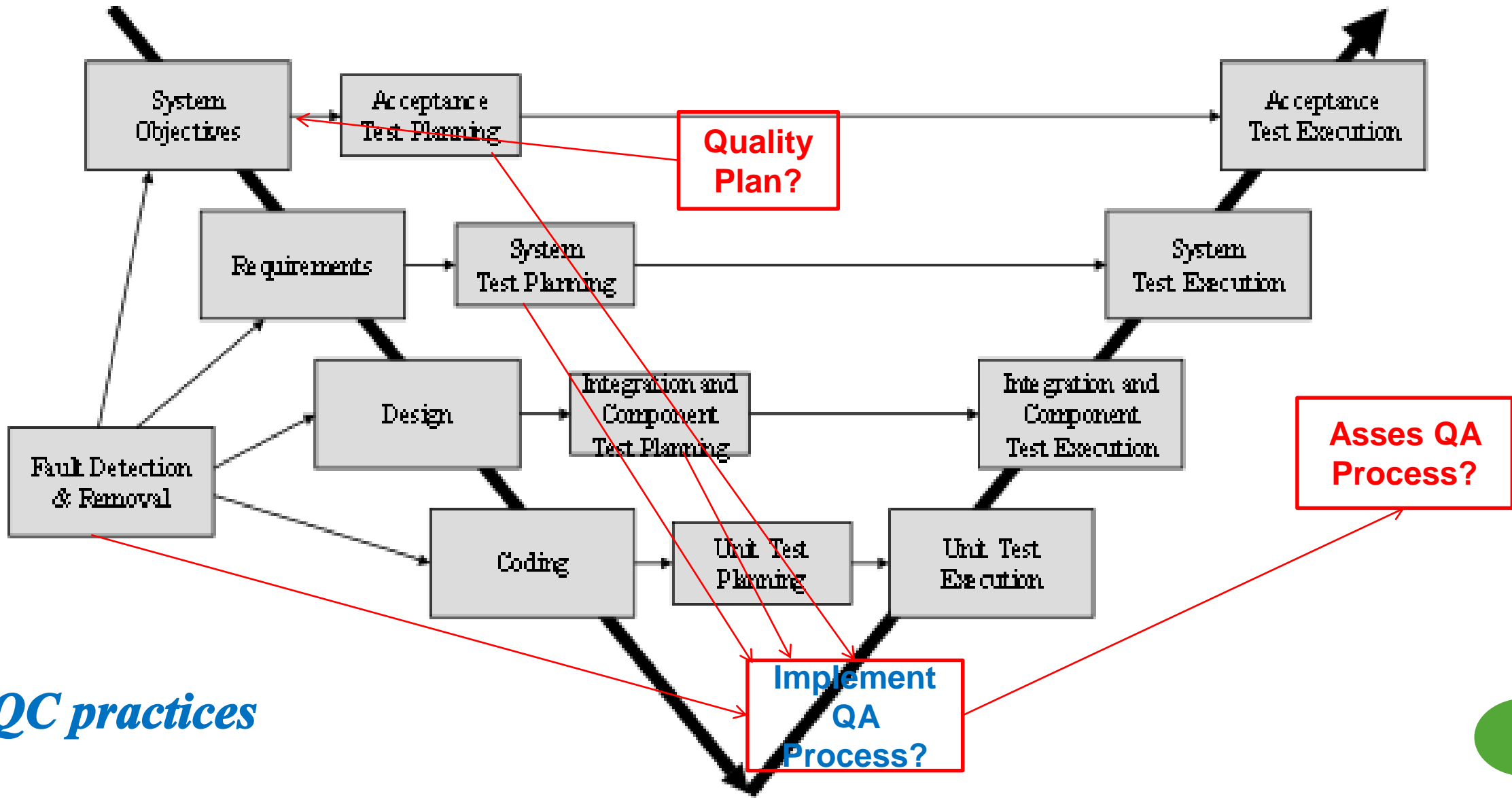
- **Pre-QA?** QA, QC, **Post-QC?**
- **Prevention - Quality Assurance (QA)**
  - fault **prevention** through process design and auditing
- **Detection - Quality Control (QC)**
  - fault **detection** through review & testing of artifacts & program



# Quality Practices in the Software Lifecycle



# Quality Practices in the Software Lifecycle



# Quality Practices in the Software Lifecycle

*Quality Plan?*

*Quality Assessment?*

QA/QC Late in the Project

QA/QC Early in the Project



*QA practices*  
*QC practices*





# Quality Practices in the Software Lifecycle

## Recalling the **Quality Definitions / Views**

- Quality is several attributes (portability, reliability, efficiency, usability, testability, understandability, modifiability) ..... Glass
- Quality is conformance to requirements ..... Crosby
- Quality is fitness for use ..... Deming
- Quality is value to some person ..... Weinberg
- Quality is whatever the customer decides..... Ginac
- Quality is an attitude or state of mind ..... Juran



## **Other Views** ..... Garvin

- Manufacturing View....Conformance to specification
- Value-based View..How much customer is willing to pay

- *Quality Goals?*



# Quality Goals

## A goal is S M A R T

Specific.... Measurable/Testable.... Attainable.... Relevant....Time-bound

- *The primary project goals must be described in the chartering process*

- **What are Goals?**

- **User View, Producer View, Quality Attributes: Reliability, Usability, Correctness ....?**

## Danger of Lack of Goal

### Repair-service behavior

- Without any clear idea of what the benchmarks are, we go in search of things that are broken and our goal becomes fixing them

### Know-how behavior

- We often don't solve the problems that need to be solved but the ones we know how to solve

### No justification for any quality action

- "I'm doing it for quality" anarchy , wasting a lot of time with no alignment



# Quality Plan



## A Quality Plan is different than a **Test Plan**?

-A quality plan is a document setting out the specific quality practices, resources and activities, relevant to particular product, process, service, contract or project.

- *Defines the **Quality Goals***
- *Realistic about where defects come from, Use Historic information for Defects Gaps*
- *Selects appropriate prevention & detection methods*
- *Set out the desired product qualities, and define how these are to be assessed ?*
- *Select those organizational standards that are appropriate to a particular process and development process.*

## **Test Plan?**

- How to perform testing, design test cases, selection of techniques? When to stop?

**Review Plan, Other Plans.....**



# Software Quality Engineering Approach?

## Three Elements of SQE

-Pre-QA activities, in-QA activities, and post-QA activities:

**1. Pre-QA activities: Quality planning.**

**Software Quality Engineering Process is driven by the *Software Quality Plan***

*These are the activities that should be carried out before carrying out the regular QA activities. two major types*

(a) **Set specific quality goals.**

(b) **Form an overall QA strategy, which includes two sub-activities:**

i. Select appropriate QA activities to perform.

ii. Choose appropriate quality measurements and models to provide feedback, quality assessment and improvement.

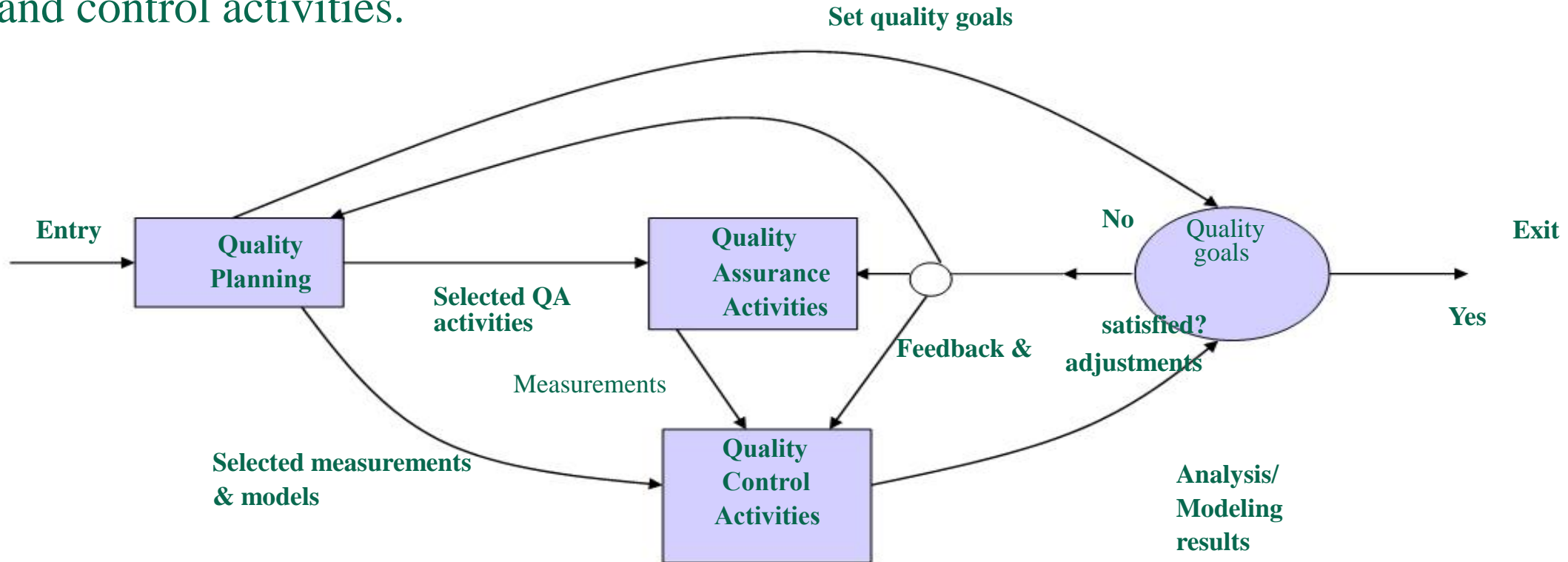
**2. In-QA activities: Executing planned QA activities and handling discovered defects.**

**3. Post-QA activities: Quality measurement, assessment and improvement**

**Primary purpose:** is to provide quality assessment and feedback so that various management decisions can be made and possible quality improvement initiatives can be carried out.

# Software Quality Engineering

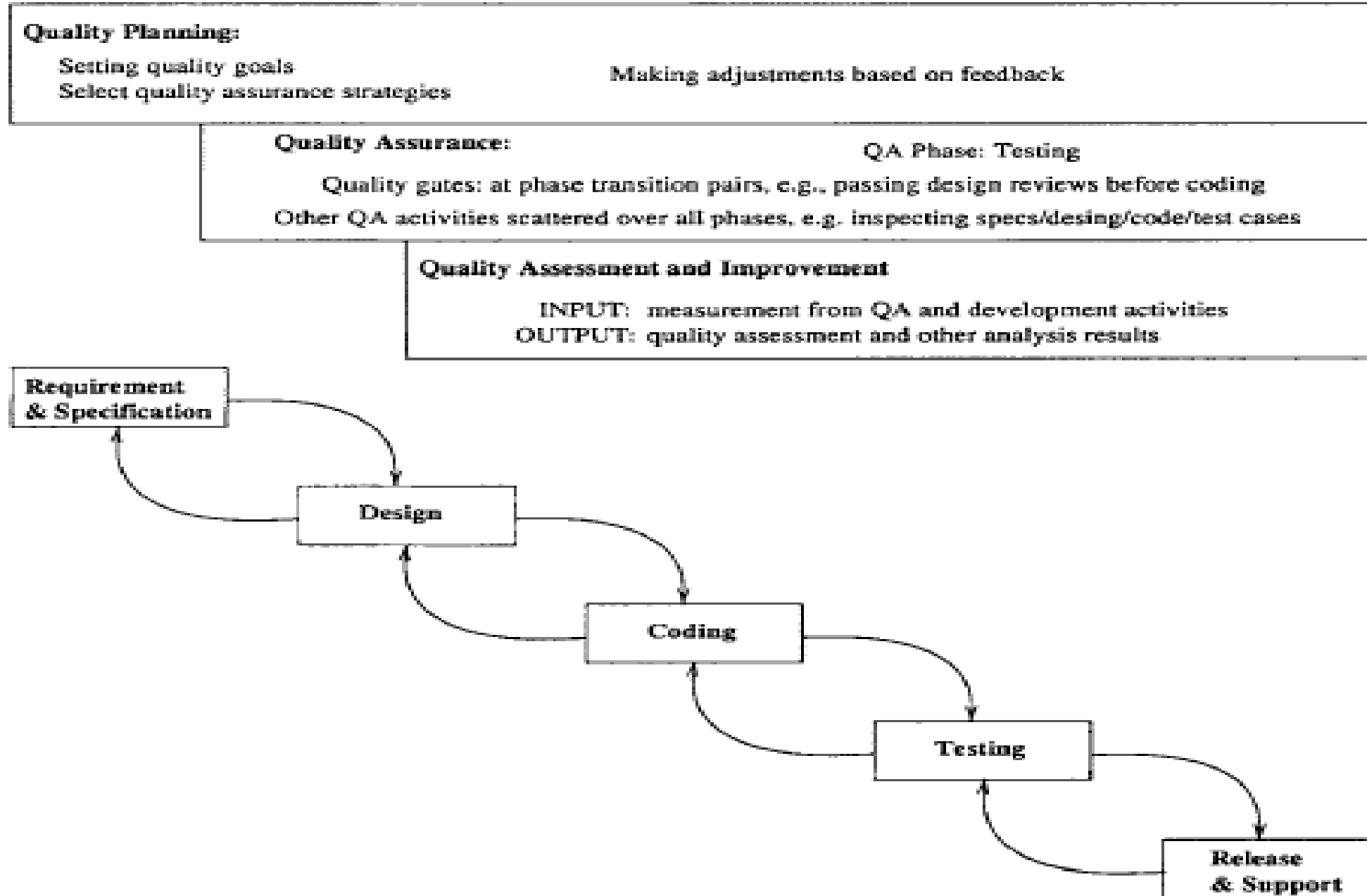
-Iterative process which combines quality planning, quality assurance, and control activities.



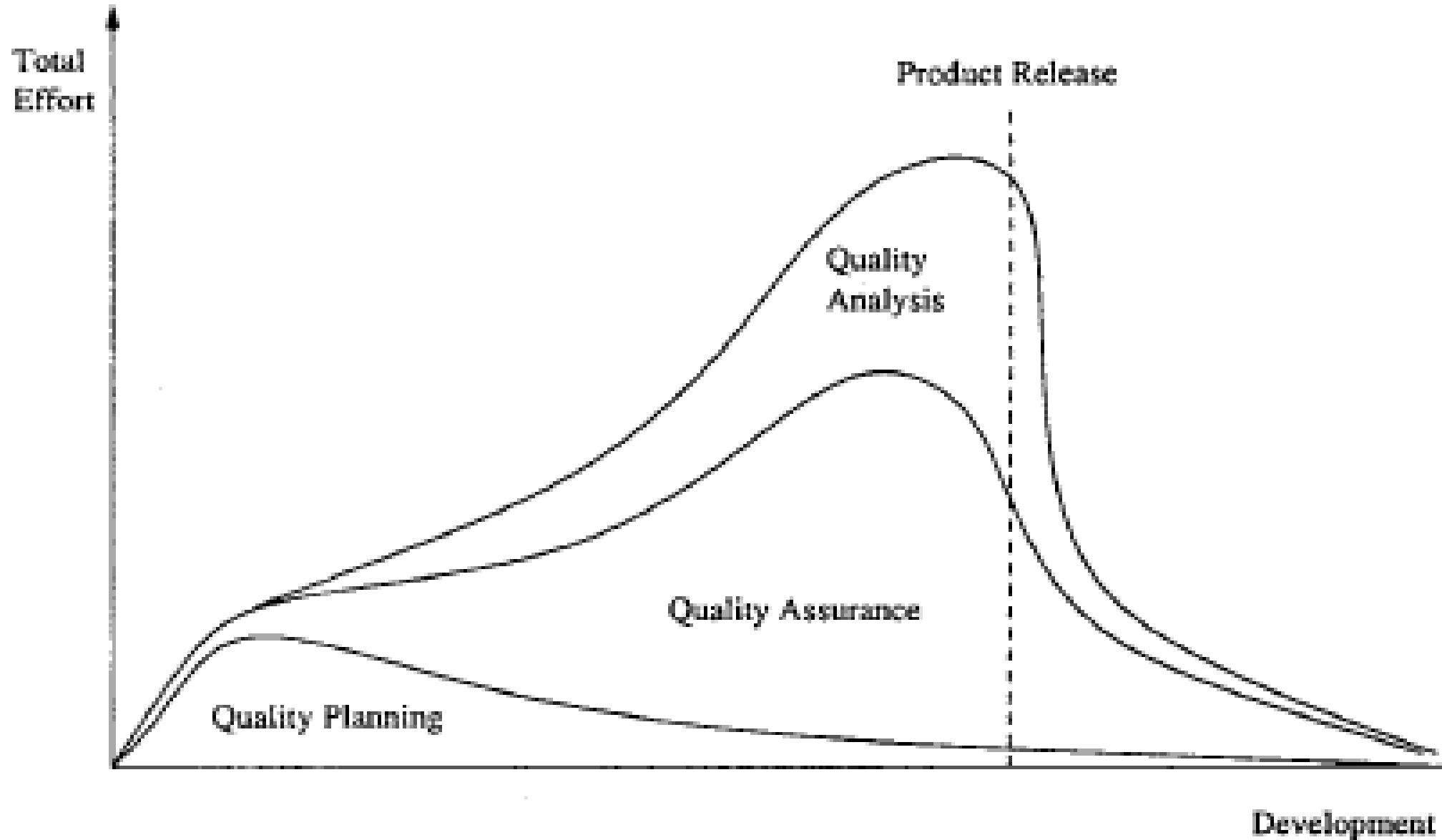
-Main goal: defect prevention, defect reduction, and defect containment



# Software Quality Engineering



# *Software Quality Engineering*



# *Software Quality Engineering*

## **-Long-Term Feedback of SQE comes from two process**

### **1. Comes from quality planning**

e.g. if **current goals** are unachievable then we have to make adjustments

### **2. Feedback to quality assessment and improvement activities:**

e.g. modeling results may be highly unstable, which may well be an indication of the model inappropriateness. In this case, new or modified models need to be used

## **Quality improvement process QIP (another model similar to SQE)**

- van Solingen and Berghout, (1999)

- quality improvement was achieved through measurement, analysis, feedback, and organizational support.

- QIP includes three interconnected steps:

1) understanding (the baseline, all future processes are measured with this baseline)

2) assessing (assessing impact and change)

3) packaging (packing the baseline data and update the process)





# Quality Management, *Overall Improvement*

## - How to Achieve Quality?

### - CULTURE?

- Define Requirements, Provide Standards, Educate, **Verify Outcome**, Encourage, **Testing Costs** money, budget of QA, level of quality, different departments, hire & assign staff, right staff, ensure quality, evaluation of quality process.....,

### - How to implement quality process in overall organization? many decisions? Who INITIATE What?

## - Now what is function of Quality Management System?

- Implements of quality approaches in all aspects of organizational operations.
- Think for whole **System** – group of elements (interrelated) organize with a purpose
  - Departments
  - Operations, Projects, Processes
  - Taking Necessary Action to accomplish Quality
  - Finally Deliver Quality Services & Projects



# Quality Management, *Overall Improvement*

- Now what is function of Quality Management System?
- Involvement of all
  - Benefit to people - every one speaks about quality, **CULTURE**
- Establishing Policies, Purpose, Objectives, Processes &
  - Policy: high level quality reporting
- Quality Approaches - Measurement of Quality
  - Implement them by Testing, SQC, SQA, or SQE
  - or including Testing only or Review with Testing.
  - or if using Statistical SQA also



# Quality Management, *Overall Improvement*

- **Now what is function of Quality Management System?**
- Manage Organization Concerns for Resources etc
  - Allocation of resources, Budget & **Costing** i.e. cost on training, various payouts
  - Process Approach: People over processes (Agile), processes over people
- QM is Organizational Process,
  - All other efforts in the organization for continuous improvement
    - SW quality being a coequal with all other efforts in the organization
  - Better customer – better satisfaction
  - Better supplier relationship enhance value to each other
  - optimization of benefit – lead to long term benefit
  - Info Sys. (Global Customer Service) – Level 5 (CMMI)

