Software Engineering

- The application of a systematic, disciplined, quantifiable approach to development, operation, and maintenance of software; that is, the application of engineering to software (IEEE, 1990)

- Software engineering is an engineering discipline that is concerned with all aspects of software production from the early stage of system specification to maintaining the system after it has gone into use. (Ian Sommerville, 2007)

- “Systematic, disciplined, and quantifiable”
- “Adaptability and agility”

System Engineering

- An interdisciplinary collaborative approach to derive, evolve, and verify a life cycle balanced system solution that satisfies customer expectations and meets public acceptability (IEEE, 1984)

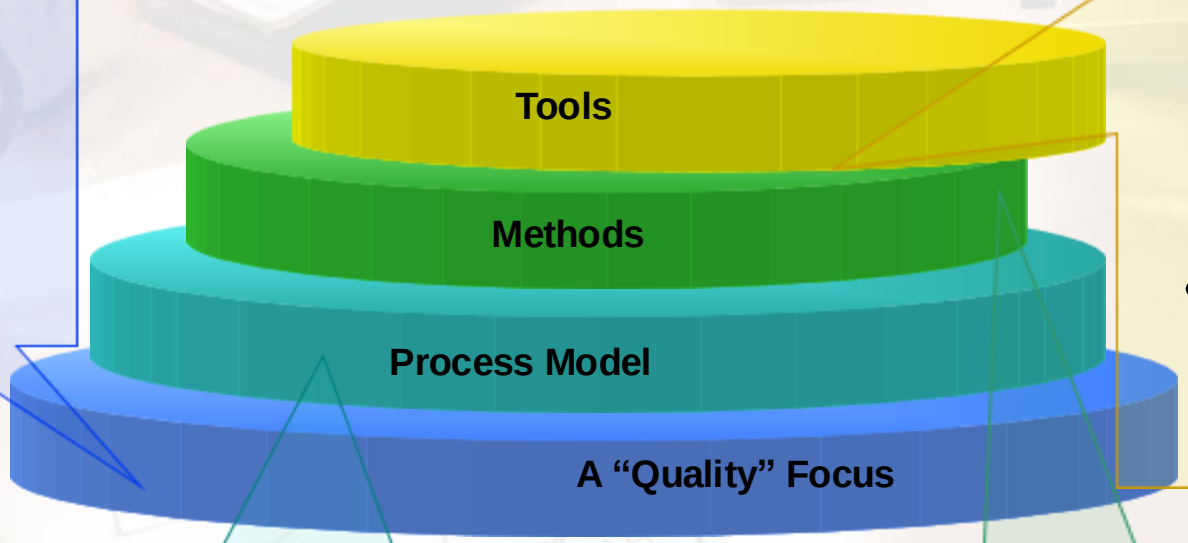
- Software engineering is a part of it.

Software Engineering Layers

A "Quality" Focus

The bedrock to support

- Continuous process improvement
- Concept Development



Tools

- Automated or semi-automated support for the process and the methods
- CASE (Computer Aided System Engineering)

Process provides basis for

- Work products
- Key Process Areas (KPAs)
- Project Management
  - Planning
  - Milestones
  - Quality Assurance

Methods involves how-tos / tasks

- Technical Activities
  - Requirements Analysis
  - Construction & Testing
  - Support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What is Software?

- Computer programs and associated documentation such as requirements, design models, configuration files, and user manuals
- Software products may be
  - **Generic** - developed to be sold to a range of different customers e.g. PC software such as *Excel* or *Word*.
  - **Bespoke (Custom)** - developed for a single customer according to their specification.

Software Types

- Types of software products
  - Application software
  - System software
  - Single application
  - Suite of application
  - Business software products
  - Consumer software products
  - Software as a service
  - Etc.

Roles of Software

- "Software is both a product and a vehicle for delivering a product"
  - Pressman (2001)

What are the Attributes of Good Software?

- The software should deliver the required functionality and performance to the user and should be maintainable, dependable and acceptable.
- **Maintainability**
  - Software must evolve to meet changing needs
- **Dependability**
  - Software must be trustworthy
- **Efficiency**
  - Software should not make wasteful use of system resources
- **Acceptability**
  - Software must be accepted by the users for which it was designed. This means it must be understandable, usable and compatible with other systems.

What do you need to build a software product?

- Software development process
- Software development methods
- Software engineering standards
- Software engineering tools (CASE)

- More importantly, you need good People and good Management.

Software and Engineering

- Software is a work product of software professionals.
- Software engineering contains a software engineering process and tools for building software.
- Software engineering goals are to build high quality complex systems in a timely manner.
- Work products include programs and content/data.

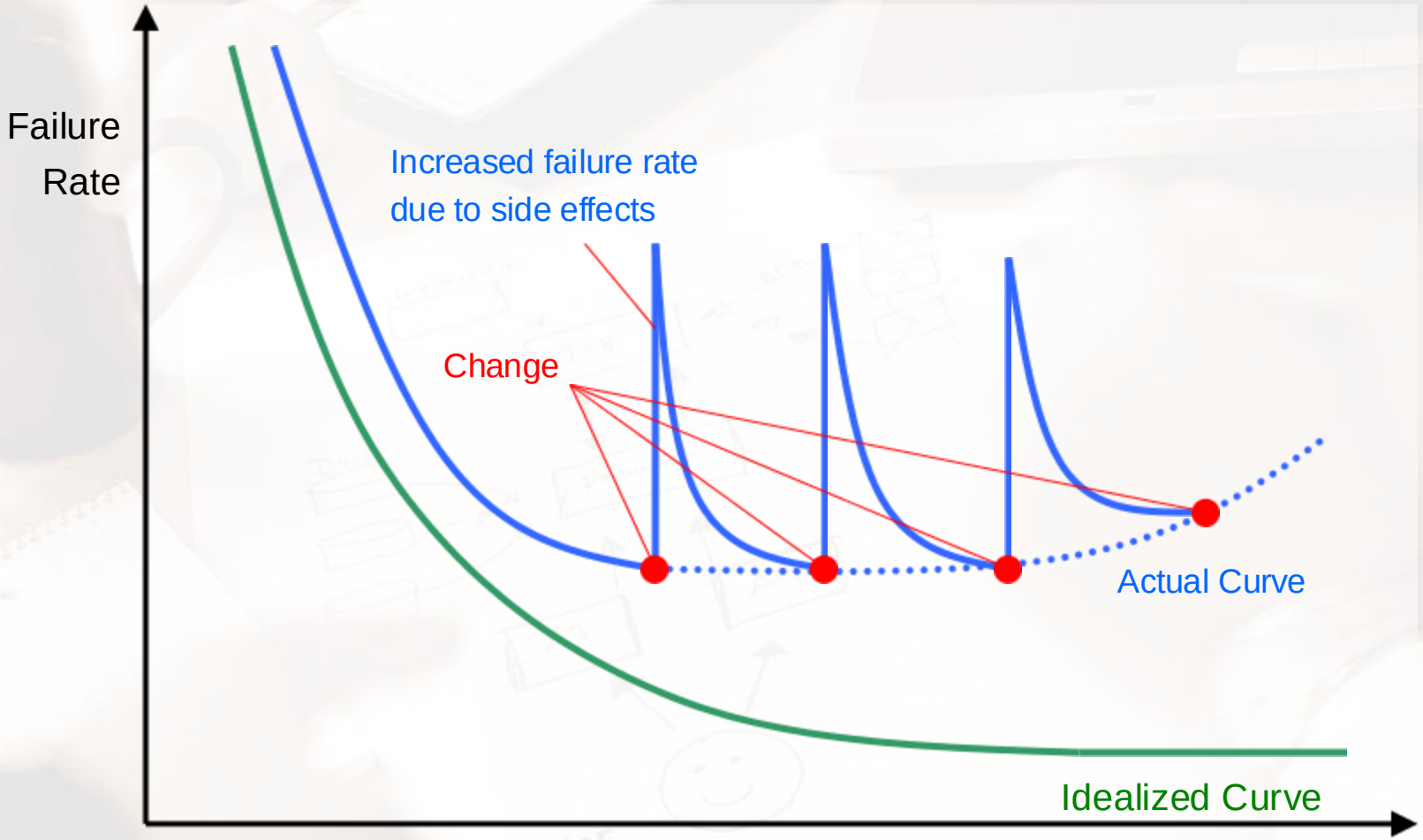
Software domains

- System
- Application
- Engineering/Scientific
- Embedded
- Product-line
- Web/mobile
- AI
- Etc.

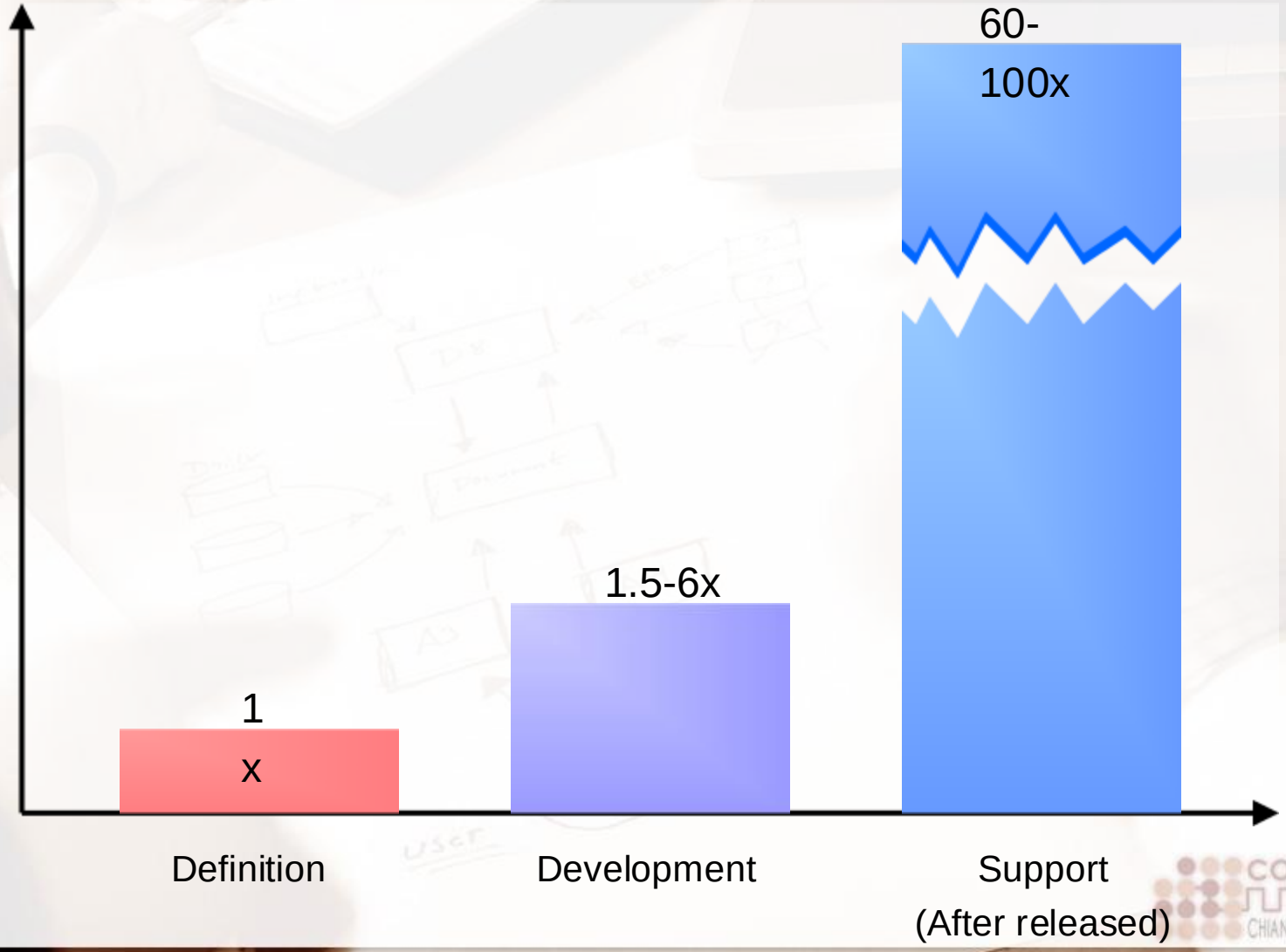
Legacy Software

- State-of-the-art software
- Legacy software
  - Developed decades ago.
  - Continuously modified to meet changes.
  - Subjected to adaptation, enhancement, extension and re-engineering.
- Changes are inevitable.
- Software evolve over time.

Software and Failure



Changes and Cost



Problems

- Costs
- Complexity
- New technologies
- User expectations
- Improvement

Software Engineering Errors: A Survey

- According to Prof. Thomas Huckle from Institut für Informatik in Germany
  - INTEL: no more than 80-90 Bugs in Pentium.
  - Standard Software: 25 bugs per 1000 lines of program.
  - Good Software: 2 errors per 1,000 lines.
  - Space Shuttle Software: < 1 errors per 10,000 lines.
  - Cellular Phone: 200,000 lines of program, up to 600
  - errors.
  - Windows95: 10 million lines, up to 200 000 errors.
- software are all buggy ?

Software Engineering Failures: A Survey

- **Ariane 5 Rocket Explodes**
  - Approximate loss: $370 million

  - **Lesson learned:**
    - Reuse of anything can be dangerous. The changes and their consequences must be fully analyzed before implementing reuse.
    - Test cases must be developed for real environment.
    - Software systems must be robust to errors and exceptions.

Software Engineering Failures: A Survey

- **Airbus 380 Delivery Delays**
  - Approximate loss: 4.8 billion euros.
  - Two CEOs of Airbus resigned.

  - Lesson learned:
    - Standardize of software tools is important.
    - Loss in communication can cause tremendous loss in time and money.

What is A Software Process?

- A set of activities whose goal is the development or evolution of software.
- Generic activities in all software processes are:
  - **Definition** - what the system should do and its development constraints
  - **Development** - production and testing of the software system
  - **Support** – maintenance and changing the software in response to changing demands.

Software Development Terminologies

- **Methodology (or method)**
  - A specific collection of principles/practices
- **Framework**
  - An outline that requires customization
- **Model**
  - A description that can be implemented using any method/framework

Software Engineering

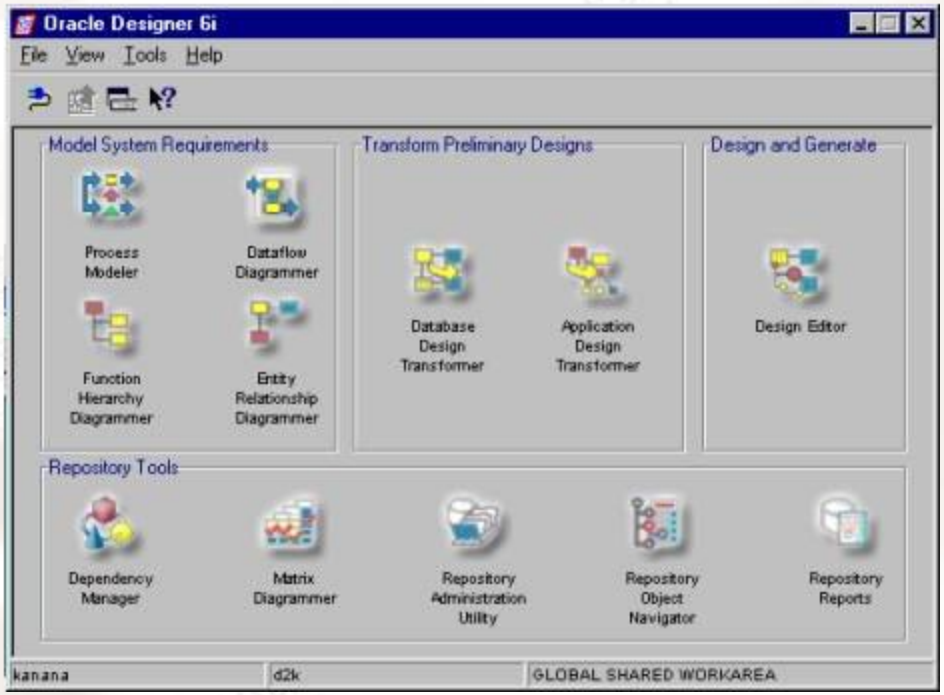
- Professional standards
  - e.g. IEEE 12207
- International standards
  - e.g. ISO 25000 (Quality), IEC 15504 (SPICE)
- Industry standards
  - e.g. XML, UML, CMMI

CASE Tools

- Computer Aided Software Engineering
- Any computer-based tool for software definition, development, and support
  - Structured Analysis (SA)
  - Structured Design (SD)
  - Editors, Compilers and Debuggers
  - Code Generators
  - Documentation Generators
  - Project Management
  - Scheduling and Tracking
- Upper-CASE
  - Tools to support the early process activities of requirements and design
- Lower-CASE
  - Tools to support later activities such as programming, debugging and testing

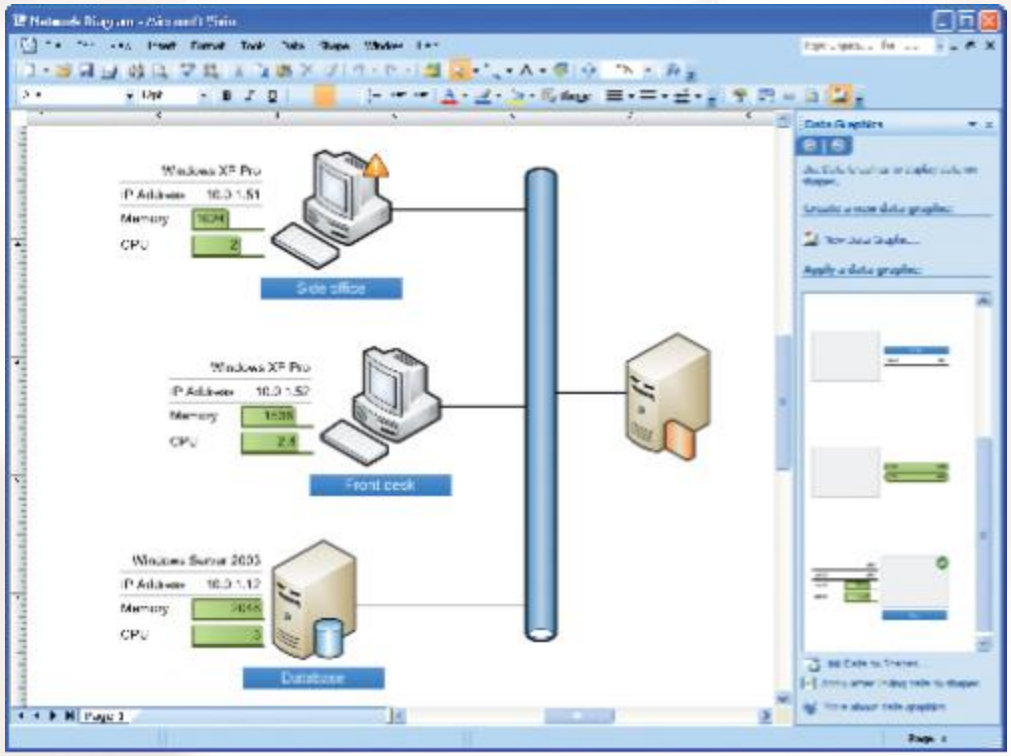
CASE Tools: Examples

- ORACLE Designer
  - Design and generate an information system



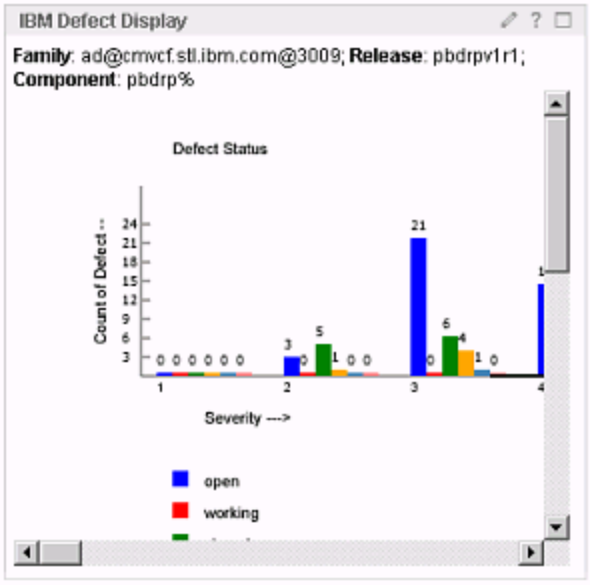
CASE Tools: Examples

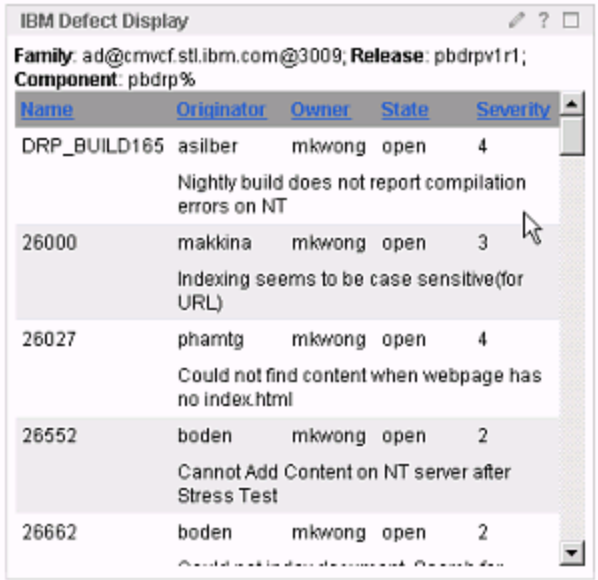
- Microsoft Visio
  - Diagramming



CASE Tools: Examples

- IBM Rational ClearCase
  - Revision control of source code and SD assets



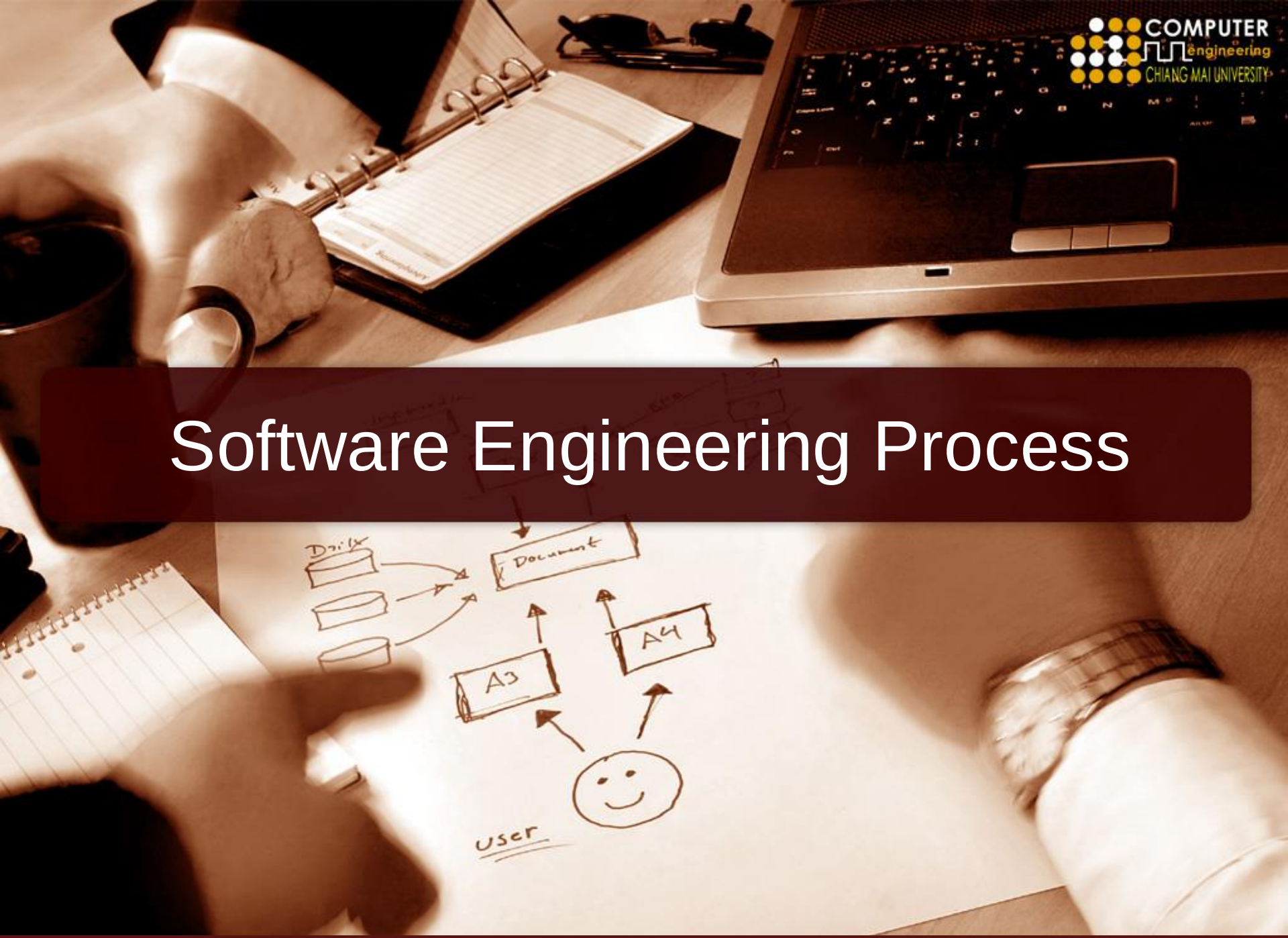


Management


Onsite PM
TEST Team
T Lead
P Manager
SOLID
BORN BRAVE
Developer
BUG

Project Management

- Cost estimation
  - Budget
  - Time
  - Staffing
- Quality assurance
- Measurement and metrics
- Process improvement



Software Engineering Process

A Generic View of SE

- Engineering is analysis, design, construction, verification, and management of technical (or social) entities.
- Entity computer software
- A software engineering process must be defined:
  - Definition phase
  - Development phase
  - Support phase

Software Engineering Phases

What?

- What information is to be processed?
- What function and performance are desired?
- What system behavior can be expected?
- Identify key requirements - Interface, design constraints, validation criteria

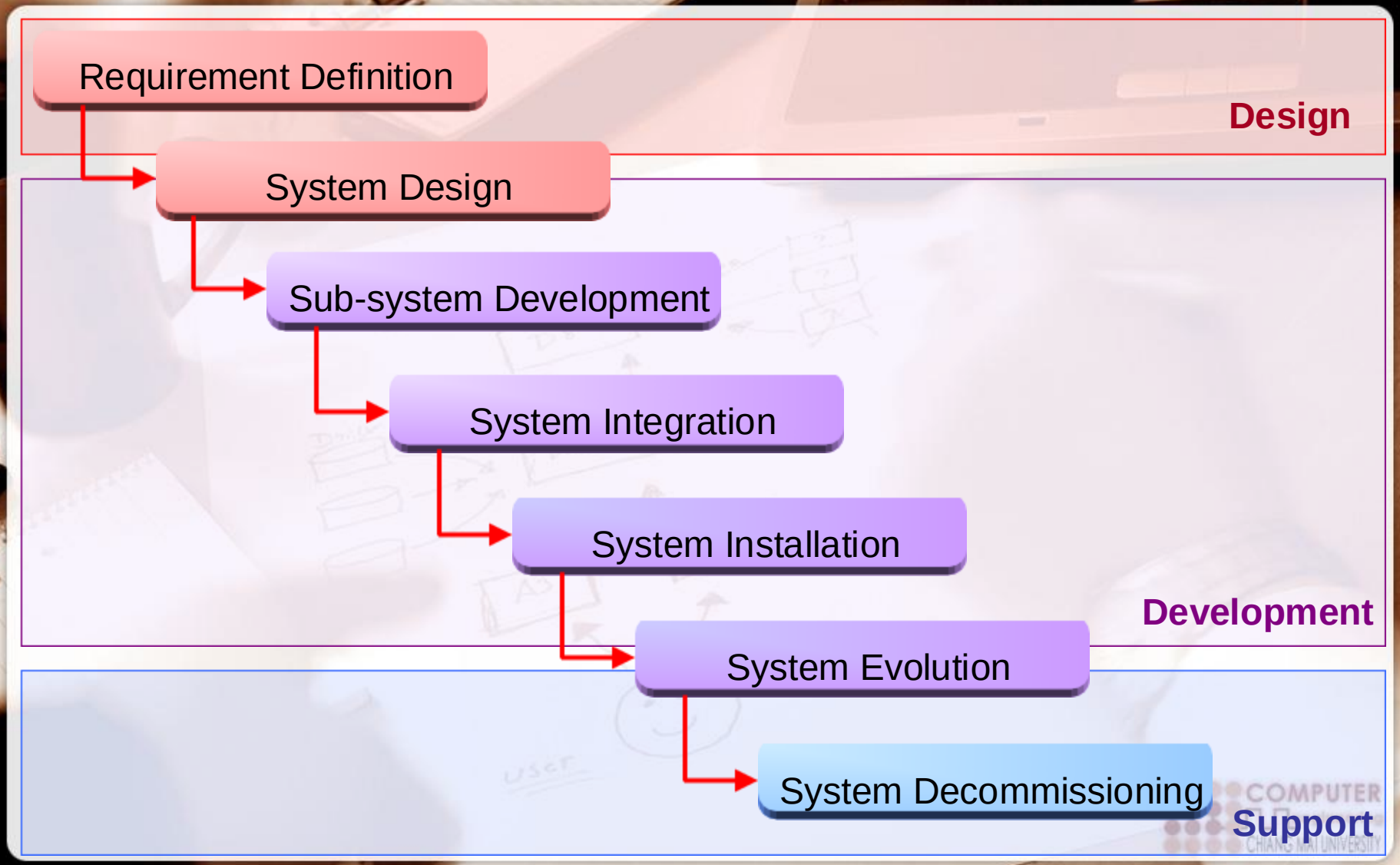
How?

- How data are to be constructed?
- How function is to be implemented within a software architecture?
- Procedural details, interfaces, design, programming, testing

Change?

- Focuses on “change” associated with error correction, adaptations, changes.
- Correction, Adaptation, Enhancement and Prevention (Reengineering)

Software Engineering Process

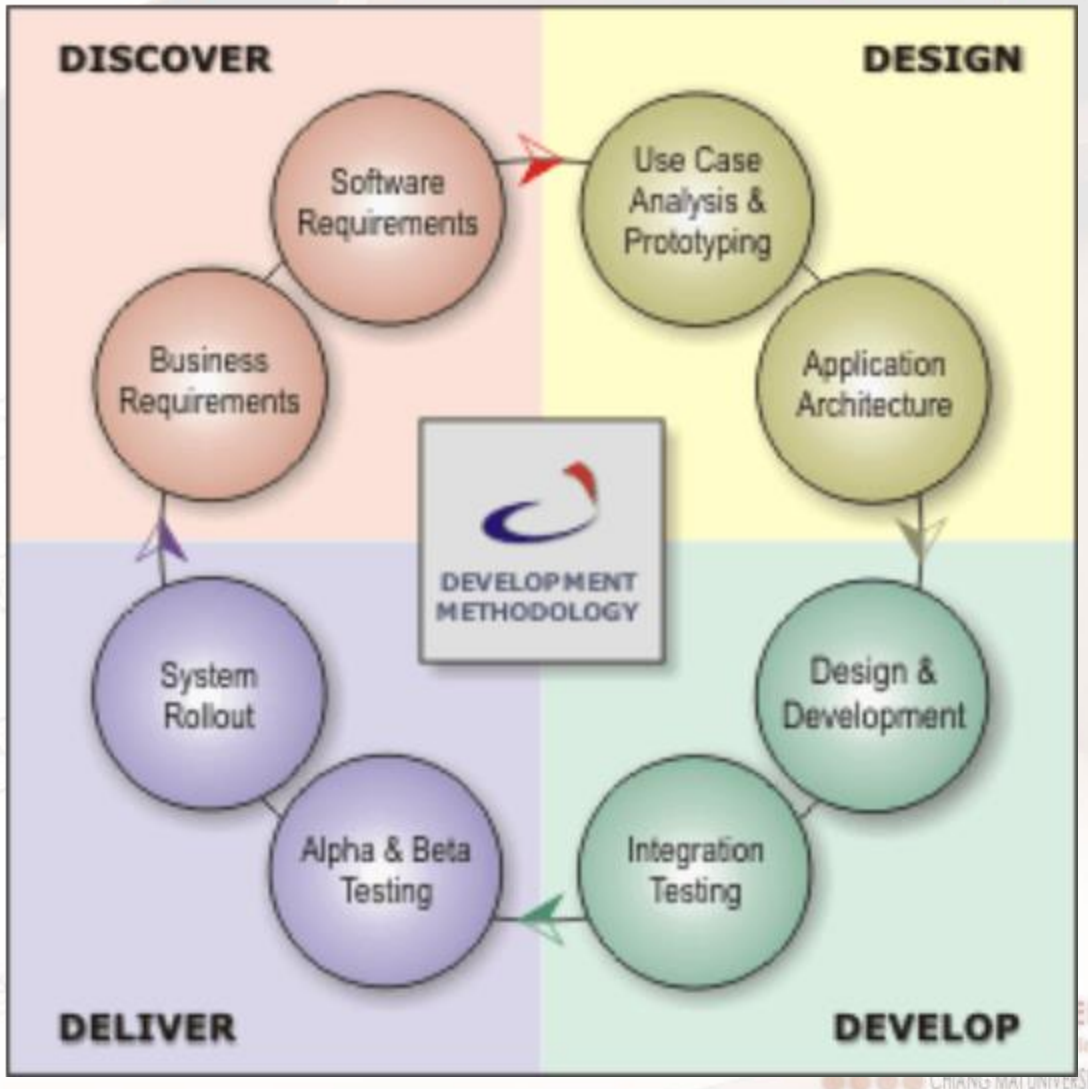


SE Phases Example

- Product life cycle from Cogzinant Technology Solution (http://www.cognizant.com/industries/telecom/telecom_sv.htm)

SE Phases Example

- Product life cycle from Diyatech (http://www.diyatech.com/devmetho.htm)



Software Engineering Challenges

- How do we ensure the quality of software we produce?
- How do we meet growing demand and still maintain budget control?
- How do we upgrade aging software?
- How do we avoid disastrous time delay?
- How do we successfully institute new software technologies?

Software Challenge

Software Challenge

Related activities

- Activity 2
- Project information sheets
- Group sign-up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Summary

- Software engineering is an engineering discipline concerned with all aspects related to software development.
- Software life cycle
  - Definition
  - Development
  - Support