Software Engineering

Fall, 2021

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Software Working Well?

Toyota Recalls 1.9 million Prius, "Software Defects", Nov. 2014

Toyota Motors, which had been recalled due to SUA in the United States, decided again this time due to a software flaw in the Prius, a hybrid car.

Volkswagen engineers was killed by Robot. July 2015

During the assembly of vehicle at the German Volkswagen, the malfunction of a robot arm caused people death.

Software Working Well?

Heathrow Airport stoped the services, May 2017

Due to a breakdown of the ticketing system at Heathrow airport in UK, all flights of BA airlines were tied up.

Korail broblem broke out again, June 16, 2016

A large number of trains were delayed due to the failure of KORAIL's central control center. The cause of the failure was not find due to highly complex of the software systems.

Software Working Well?

Boeing 737 Max 8 Airbus, April 2019

Boeing 737 Max 8

Software Working Well?

Accidents that cause loss of life and property still occur.

- Worldwide Cost of IT Failure (2013): $3trillion
- British Airways Compensation (2017) : at least £100million

**Why is this loss constant?**

- User requirements of software are becoming increasingly sophisticated and complex.
- The level of automation is on increasing despite services becoming more and more segmented.
- Small and large changes are frequently required in the development process.
- Characteristics of System of Systems have being appeared more and more.

→ Software developers are not handling these issues well.

Why Software So Important?

Business Implications of Software

- Every contemporary business is dependent on the capability of software
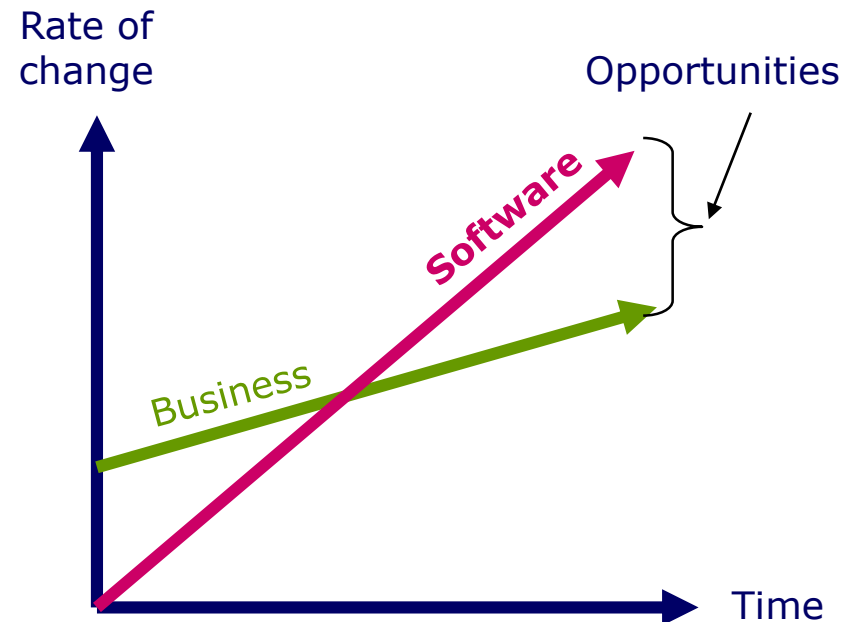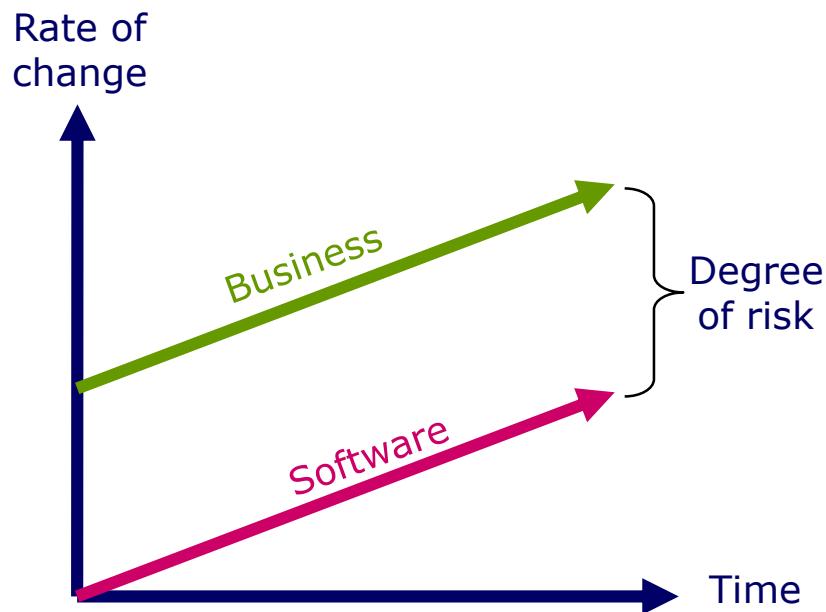
Introduction

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Software

What is Software ?

Software is a set of items or objects that form a "configuration" that includes
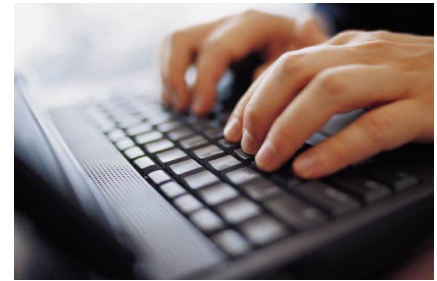
- programs
- documents
- data ...

How to Produce Software ?

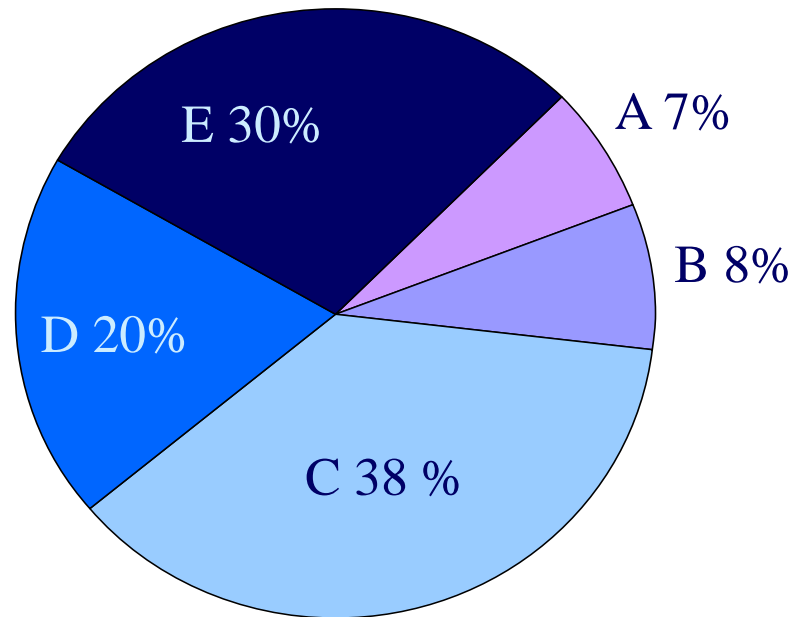Clients' Need

Writing the program code

Debugging

Any what More?

Software Crisis : Year 1980's
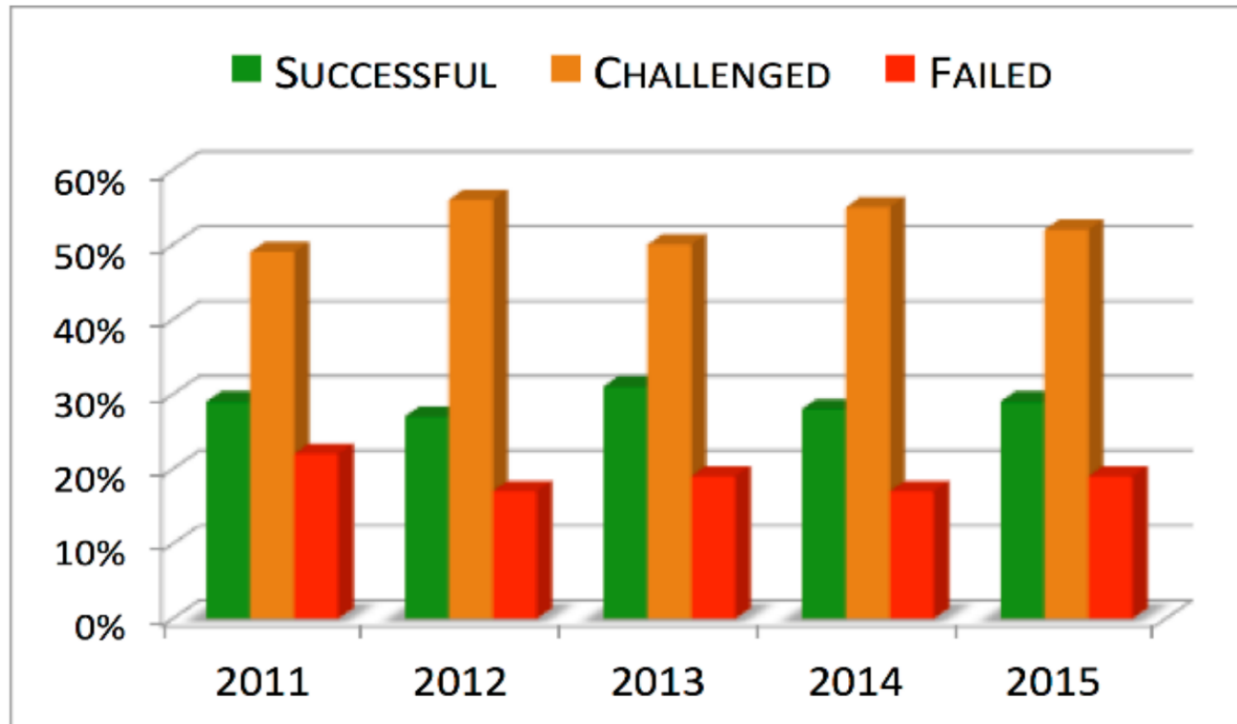

A : <u>worked on delivery</u>   .

B : <u>worked after some corrections</u>   .

C : delivered but never successfully used

D : used but either extensively reworked or abandoned

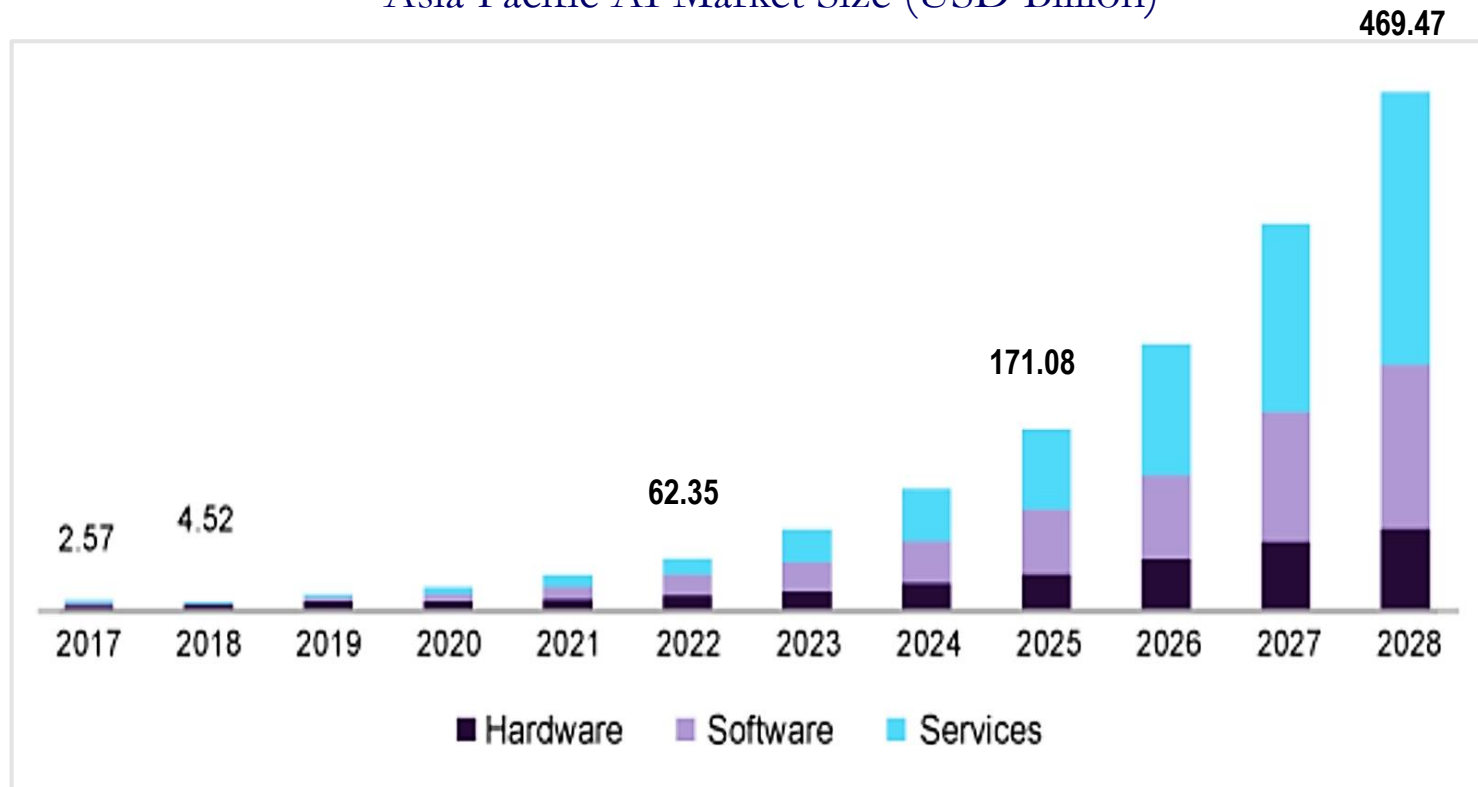**E** : paid for, but never delivered

Software Crisis : Year 2010's

Standish Group, CHAOS Report, 2017, USA

The 2nd Software Crisis ?? (Year 2020's)

Asia Pacific AI Market Size (USD Billion)

469.47

171.08

62.35

2.57   4.52

2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028

■ Hardware   ■ Software   ■ Services

Source : www.grandviewresearch.com

Why Software Development is So Difficult ?

Communications

Sequential nature of system
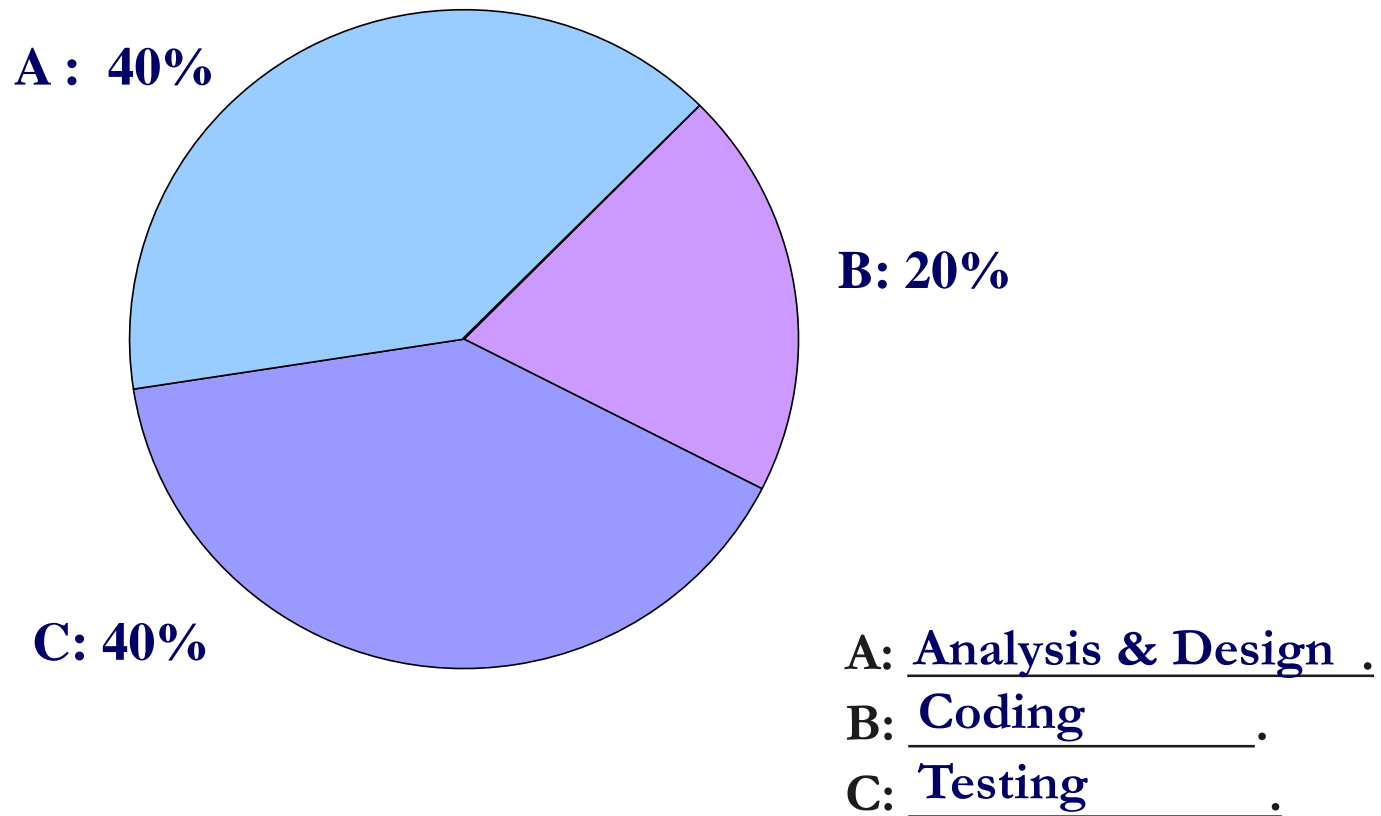
System of systems

Development

Project characteristics

Characteristics of personnel
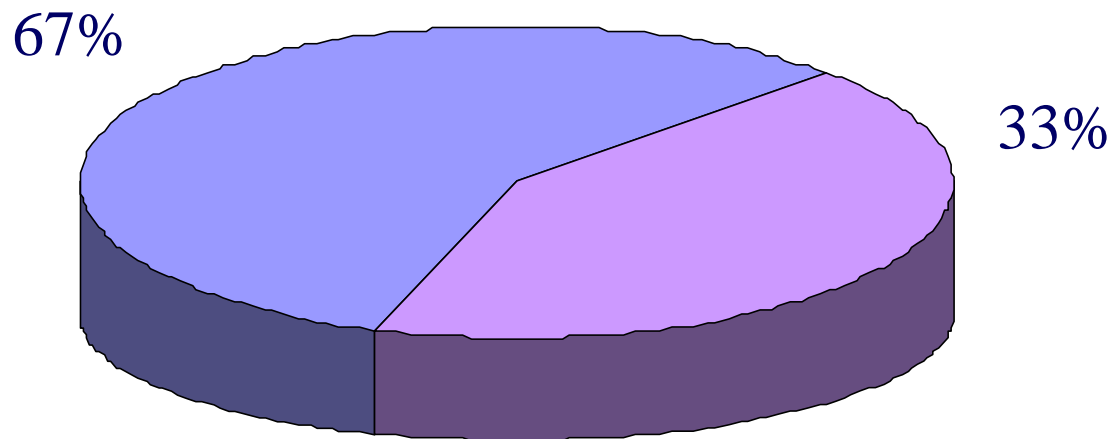
Management issues

New technologies

Costs of Software Development

A : 40%

B: 20%

C: 40%

A: Analysis & Design .
B: Coding .
C: Testing .

Development vs. Maintenance

67%

33%

▨	Development
▨	Maintenance

Sources of Errors in Software Developments

Functionality &
Misunderstanding
15%

Logic design
& Misunderstanding
20%

Documentation
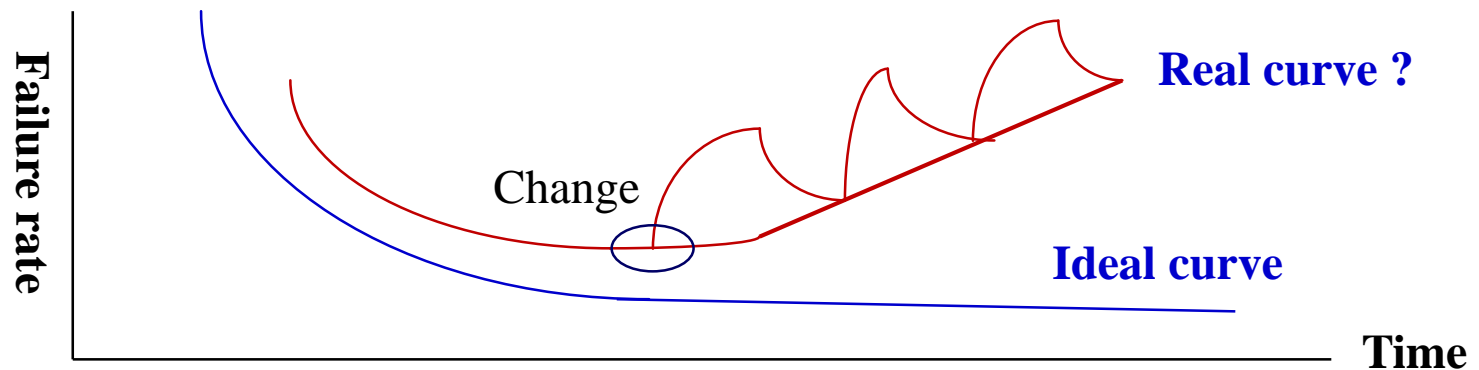& Others   35%

Coding
30%
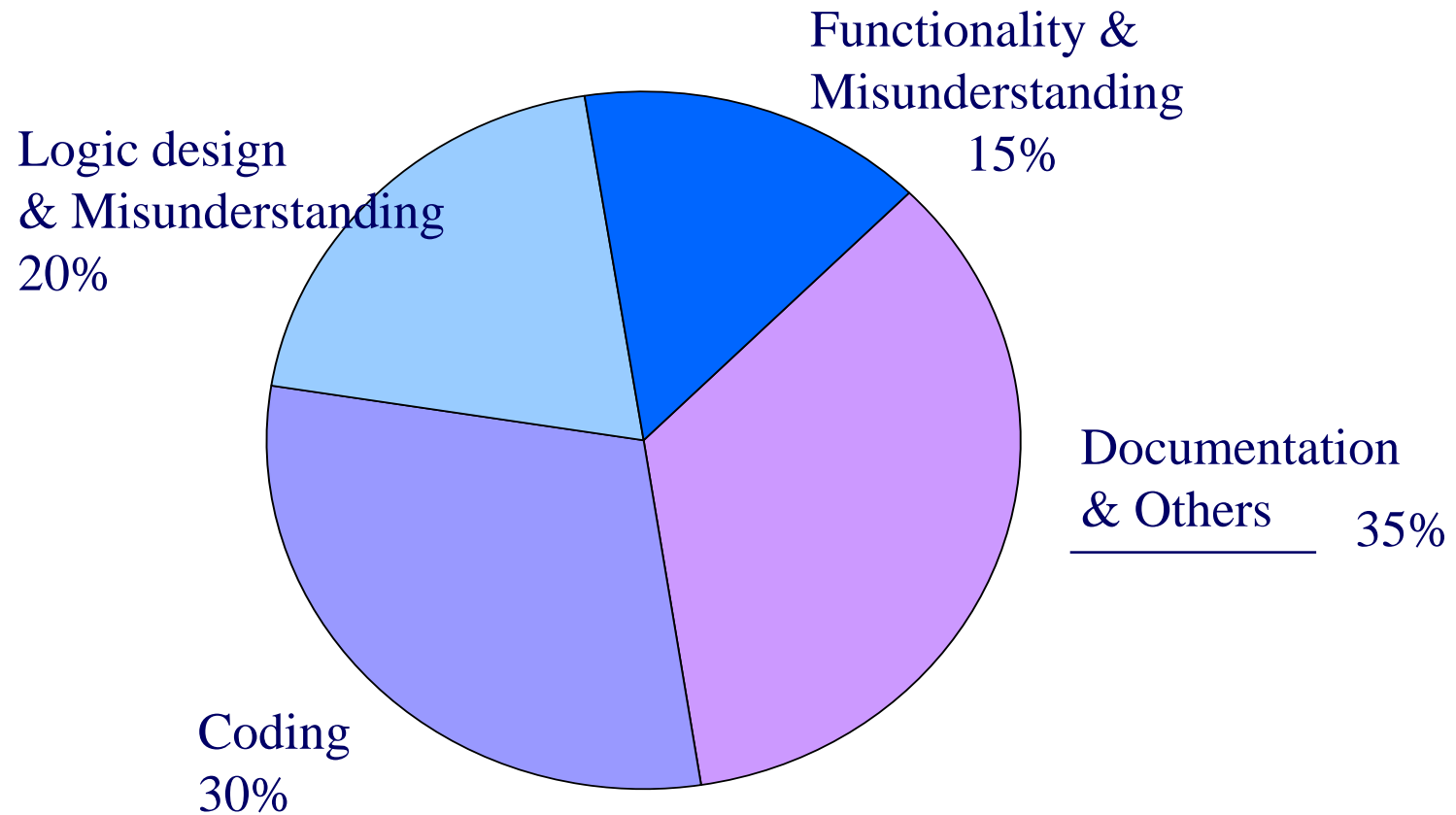
Failure Curve

Failure Curve for Hardware
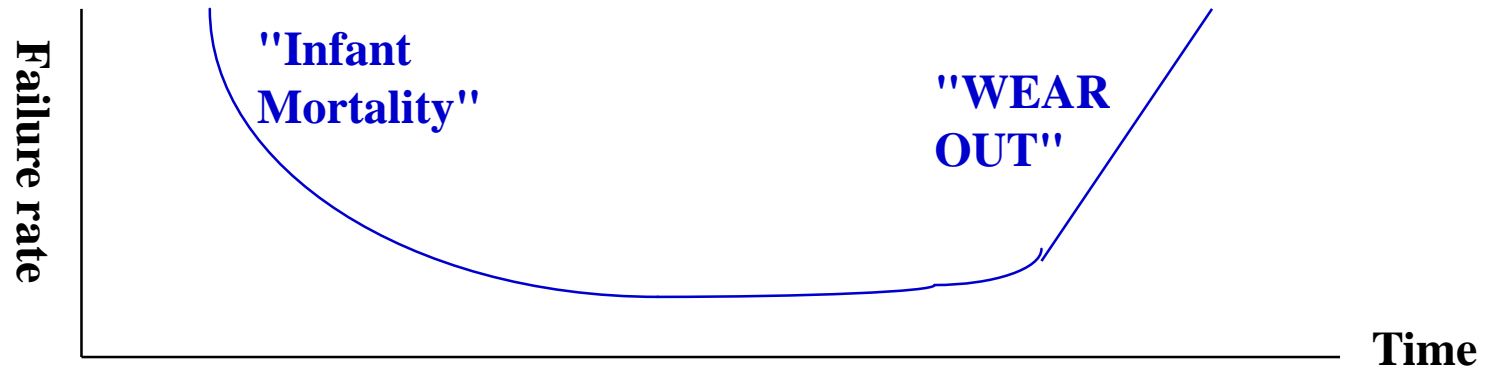
Failure Curve for Software

Software Characteristics

How is Software different from hardware ?

Software is developed or engineered, it is not manufactured, in the classical sense

- Focus on process development
- Focus on the activities by people

Most Software is custom built, rather than being assembled from existing components

- cf) Software factory (SW product line) : use of automated tools

    Open source software development

Software Applications

System software

Real-time software

Business software

Engineering/scientific software

Embedded software

Artificial Intelligence software

Web-based Software(web applications)

Emerging Software Technology & Trends

Service-Oriented Architecture

SaaS, Software as a Service
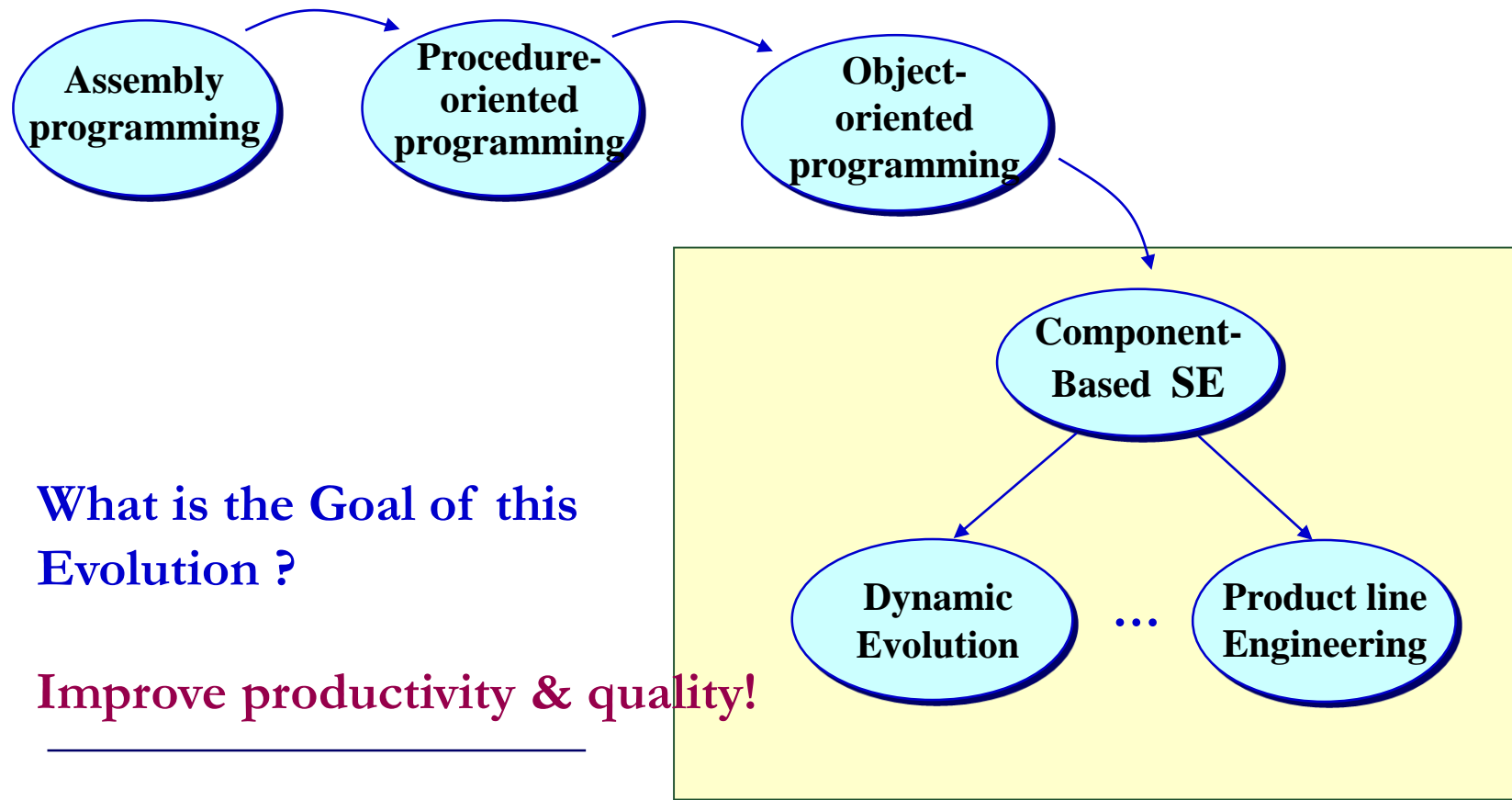
Software On-Demand

Open Source Market

Energy and Green Software

Digital Twin

Hyper_Connected, Hyper_Convergent, Hyper_intelligent

Edge computing

Programming Paradigm Evolution

```
Assembly          Procedure-        Object-
programming  →    oriented     →    oriented
                  programming       programming
                                          │
                                          ▼
                              ┌──────────────────────────────┐
                              │        Component-            │
                              │        Based  SE            │
                              │       ↙         ↘           │
                              │  Dynamic    ...  Product line │
                              │  Evolution       Engineering  │
                              └──────────────────────────────┘
```

What is the Goal of this Evolution ?

Improve productivity & quality!

What is Software Engineering

<mark>"The application of a systematic, disciplined, quantifiable approach to the development, operation and maintenance of software"</mark> (IEEE, 1991)

What you do when you have two or more people working on a project (Inst. for Information Technology, NRC Canada, 1997)

What Software Engineers do (Industri-Matematik International, 1997)

Forces Behind the Emergence of SW Engineering

The inability of organizations to <mark>predict the time, effort, and cost</mark> in software development.

The poor quality of the software.

Changes in the ratio of hardware to software costs

The increasingly important role of <mark>maintenance</mark>
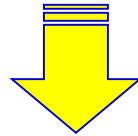
Advances in hardware

Advances in software techniques
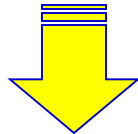
Increased demands for software

<mark>The demand for larger and more complex software systems</mark>
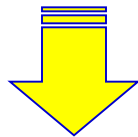
Goal of Software Engineering

Produce quality software on time within budget that satisfies user's needs

⬇

Improve quality and productivity of software

⬇

Improve quality and productivity of system, product

⬇

Improve business performance

Summary and Discussion

Definition of Software Engineering

- Systematic, disciplined, quantifiable
- Development, operation and maintenance

Goals of Software Engineering

- Quality improvement

Explain the PROCESS of software development ?

What is the engineering ACTIVITIES in the software development process ?