The Essence of Software Engineering Process

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Objectives

- **Software engineering process vs software process**
  - Align software engineering with other engineering disciplines.

- **Basic concepts in software engineering**
  - Understand the extent of software engineering practices.

- **Quantitative and qualitative measurements of software engineer activities**
  - Understand and improve software engineering practices

Software Process Evolution

- **Software management method   (1980)**
  - **Software life cycle processes**
    - **Waterfall, spiral, incremental etc..**
- **Quality assurance approach   (1990)**
  - **Assessement of software practices**
    - **CMM, CMMI, SPICE, ISO9001, etc**
- **Software development techniques   (2000)**
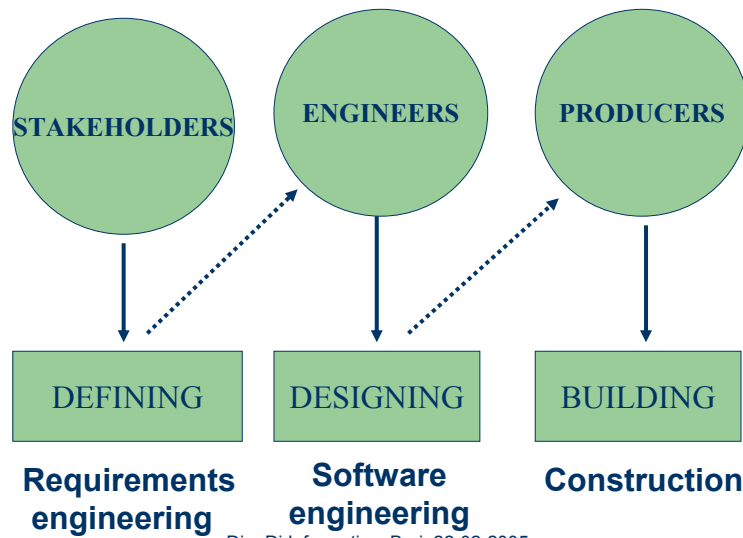 - **Methodology related to modeling of software**
    - **OO, UML,**

CMMi view
Capability Maturity Model integrated

- **Based on process area,**
  - **cluster of related practices which satisfy a set of goals.**
- **Process areas are grouped into four categories:**
  - **process management,**
  - **project management,**
  - **engineering**
  - **Support.**
- **Engineering process areas cover the development and maintenance activities**
  - **requirements development,**
  - **requirements management,**
  - **technical solution,**
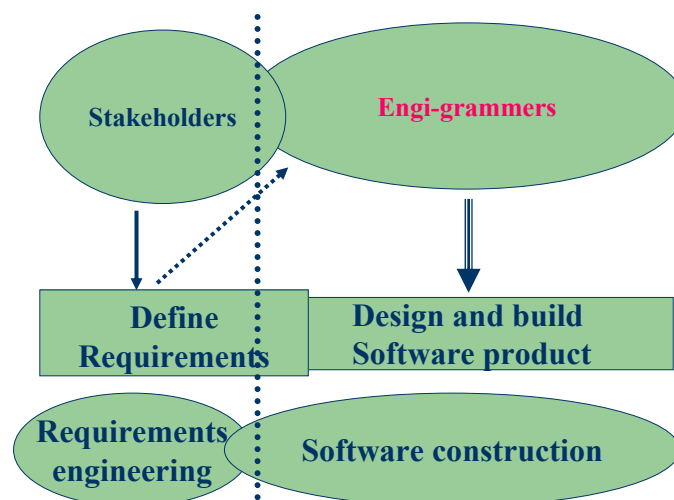 - **production integration,**
  - **verification and validation.**

Basic engineering activities

STAKEHOLDERS

ENGINEERS

PRODUCERS

DEFINING

DESIGNING

BUILDING

Requirements engineering

Software engineering

Construction

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Software engineering activities

Stakeholders

Engi-grammers

Define Requirements

Design and build Software product

Requirements engineering

Software construction

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Process definitions

- **Software process:**
  - **ensemble of practices, artifacts and roles performed by software developers.**
- **Practices:**
  - **ensemble of prescribed activities realized by developers.**
- **Artifacts:**
  - **ensemble of manmade texts, diagrams, and codes.**
- **Roles:**
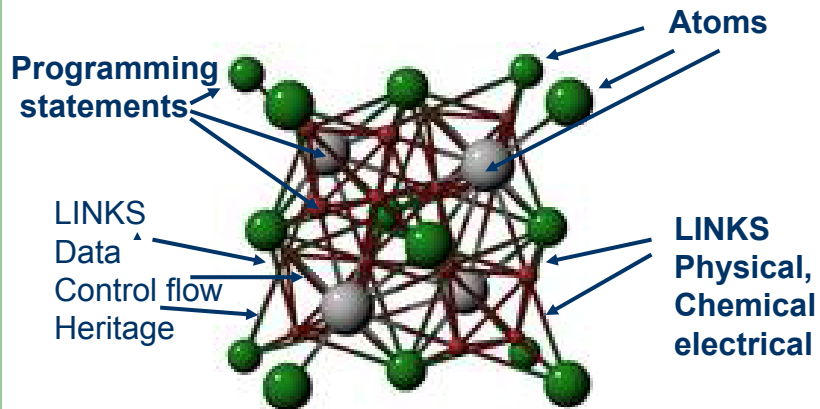 - **labels put on agents while they are performing activities**

Terminology

- **Cognitive action**: a natural mental function
  - read, write, draw, code, discuss, ..
- **Practice**: accepted way of doing something
  - peer review, unit testing, change request
- **Discipline:** domain of practices
  - requirements, analysis and design, management
- **Task**: assigned work with start and end dates
  - implement module, Integrate system X, test
- **Activity**: performed element of work
  - generic term for task, practices and any human related work behaviour

Crystallizing knowledge

Atoms

Programming statements

LINKS
Data
Control flow
Heritage

LINKS Physical, Chemical electrical

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What are the basic concepts that enable crystallization of the information

?

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CONCEPT
Life-cycle

Phases of car life-cycle construction

**LIFE-CYCLE PHASES
BELONG TO THE PRODUCT**
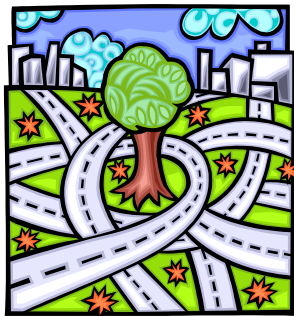

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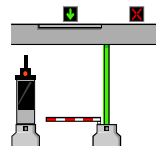

CONCEPT
Problem solving

Requirements   vs   Design

**Solving
traffic problems**

**Solving
road construction
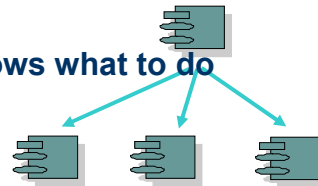problems**

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CONCEPT
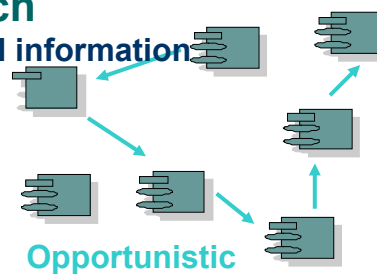## Opportunistic activities

Systematic approach
> Experience designer that knows what to do
> Breadth-first approach

Opportunistic approach
> Decisions based on partial information
> Depth-first approach

Opportunistic

**HOW can we measure human activities
to better understand
the impact and usefulness
of these concepts
in software engineering**

?

Measuring

- **Is the thinking process of software engineers different from other engineers?**
  - understand, read, write, draw, analyze, evaluate, review
- **What kind of measurements can be done?**
  - practice assessment,
  - quantitative measurement of activities and
  - qualitative measurement of cognitive actions

Type of measurements

- **Assessment**
  - **Check list of the various practices**
- **Quantitative measurements**
  - **Recorded or self-recorded activities or artefacts outputs**
    - Time slips, time elapsed, error rate, number of bugs
- **Qualitative measurements**
  - **Video and audio recording of human behavior**
    - read, write, code, discuss, review

Assessing Software Process Practices

- **Investigation carried out to determine the current state of a software development process practices**
- **First step toward process quantitative and qualitative measurements**
  - **defines the environment within which the quantitative and qualitative measurements will be made**
  - **enables the interpretation of the results obtained form the analysis of the data.**

Quantitative measurements

- **Measuring effort or analyzing time diaries**
  - **required managerial practice for controlling development activities.**
- **Monitoring effort involves dealing with people,**
  - **taking into consideration numerous social and psychological aspects; ,**
- **Various ways of measuring effort**
  - **Questionnaires,**
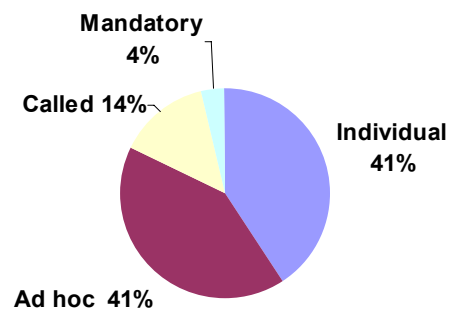 - **Direct observations,**
  - **Time slips**
  - **Video-audio**

Quantitative measurement findings

- Basili et al
  - Measuring selected practices efficiency
- Lanubile et al
  - Measure artefact outputs based on given practices
    - Active guidance vs defect detection
- Perry et al
  - Measure effort for specific activities
- Robillard et al
  - Measure effort activity distribution in software project

Measuring collaborative activities

Mandatory 4%

Called 14%

Individual 41%

Ad hoc 41%

UPEDU vs Agile

Process	Cognitive activities	%Effort
Construction	Code, Code & test Test, Integrate & test	59%
Engineering	Write, Draw Think, Read Browse, Search	30%
Interaction	Discuss Inspect	11%

Qualitative Measurements

- **The idea of observational studies is to capture firsthand behaviors and interactions that might not be noticed otherwise**
- **Observational studies lead to the qualitative measurements of cognitive actions.**
- **Approaches**
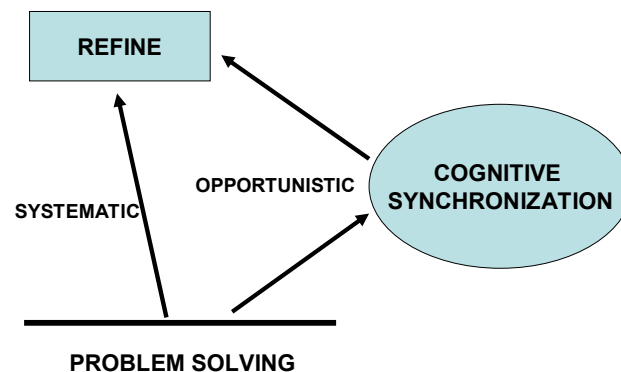 - **Independent observer**
  - **Think aloud**
  - **Protocol analysis**

Qualitative Measurements Findings

- **Seaman**
  - **Participant observations, Interviewing, coding,**
  - **Data analysis methods**
- **Mayrhauser, Vans**
  - **Reasearch on coding scheme**
- **Herbsleb**
  - **OO vs procedural cognitive model**
- **Robillard** *et al*
  - *Communications patterns during review meeting*

Role of cognitive synchronization

REFINE

OPPORTUNISTIC

SYSTEMATIC

COGNITIVE
SYNCHRONIZATION

PROBLEM SOLVING

Benefits of process measurements

- **Assessement**
  - Identify the prescribe practices
    - Which are the practives in used?
- **Quantitative measurements**
  - Quantify the effort among the various practices
    - What is the importance of a given practice?
- **Qualitative measurements**
  - Understand the real cognitive activites
    - How a given practice is being done?

Concluding remarks

- **Software process is needed to design and build reliable software products**
- **Software process is linked to many other concepts**
  - Life cycle, project management, problem-solving, opportunistic vs deterministic activities
- **Software process activities must be measured to obtain significant improvements**
  - Assessment, quantitative and qualitative measurements

ÉCOLE
POLYTECHNIQUE
MONTRÉAL

Mille grazie
per la vostra
attenzione

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