Methodologies

Software Engineering I
Lecture 18

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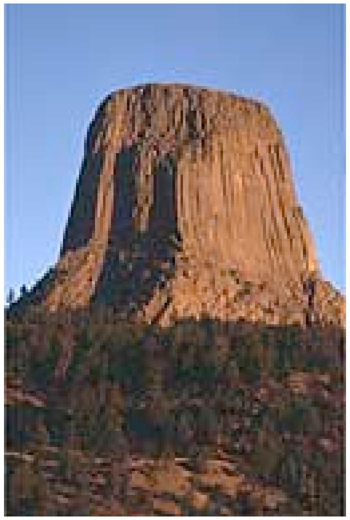
Outline

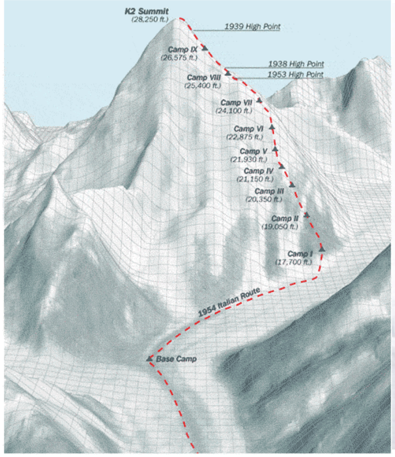
- A mountaineering example
- Project context
  - Goals, client types
  - Environment, methods, tools, methodology
- Methodology spectrum
  - Planning, design reuse, modeling, process, control&monitoring, redefinition
- Different types of planning
- Different ways to use models
- Use of processes in software development

Key Decisions in an Expedition

- A leader must answer several key questions to create a successful expedition
  - What mountain should be climbed?
  - What types of tools should be used?
  - Who should be member of the team?
  - Does the expedition need a leader?
- Different answers to these questions lead to different styles:

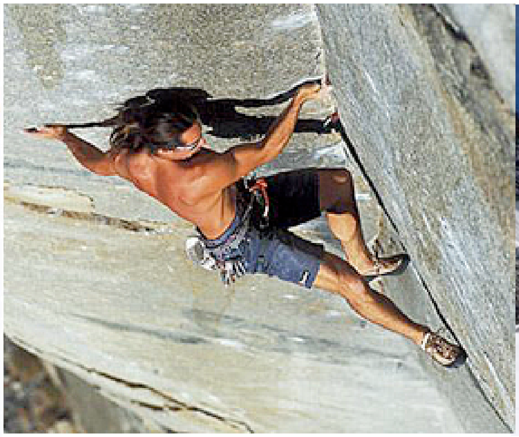


Siege style



Fixed-rope

Free Solo



Alpine style

Key Decisions in a Software Project

- Project goals
- Schedule
- Cost
- Project organization
- Software life cycle model
- Tools
- Methods
- Team members and organization

⇨ Influenced by Methodology

Methodology

Definition: Software engineering methodology

- Collection of methods and tools for developing and managing a software system to achieve a specific goal in a given project environment

Project environment

- Defined by the client and current state of the development organization. Constrains the project manager (Example: Hierarchical or project-based organization)

Methods

- Techniques to choose from in a given project environment (Example:Object-Oriented Analysis, waterfall model)

Tools

- Devices or programs that support the development and management activities (Example: CASE Tool, IDE)

A methodology specifies for a specific project environment
1) when methods or tools should be used and when not
2) *what to do when unexpected events occur*.

Project Environment

- Participants’ expertise
  - Beginner, expert, slow learner, fast learner
- ⇨ Type of Client
  - Domain knowledge, decision power
- End user access
  - No end user available, end user participates in requirements elicitation, end user participates in usability tests
- Technological climate (“technology enablers”)
- Geographical distribution
- Project duration
- Rate of change

Client Type

Domain Knowledge Decision Power	High	Low
High	➡ **Local King Client**	**Pseudo Client**
Low	**Proxy Client**	**No Client**

Local King Client

High Domain Knowledge, High Decision Power

- Can answer developer questions and make decisions without having to ask anybody else
- Has deep knowledge of the application domain (and/or the solution domain)
- Usually collocated with the project
- Does not have to report to anybody else
  - Can effectively collaborate with the project manager and often even with the developers.

Proxy Client

High Domain Knowledge, Low Decision Power

- Proxy clients are sent for the “real client”

  Reasons:

  - Real client has no time
  - Physical distance would make collaboration of the real client with the project organization difficult
- Proxy clients have sufficient knowledge of the application domain
  - They can answer clarification questions from the developers
- Proxy clients do not have sufficient power
  - They cannot make major decisions, they have to ask somebody else => time delay!

Pseudo Client

Low Domain Knowledge, High Decision Power

- The pseudo client is a member of the development organization
  - Often even developers act as pseudo clients
  - If the system is targeted at a new market segment, the pseudo client often comes from marketing
- Pseudo clients can make decisions within a short time
- Pseudo clients have a limited knowledge of the application domain.

“No Client”

- A project can start without a client
  - Example: A visionary product is developed before a market segment is opened

- In these cases the project manager should still select a client, usually a pseudo client who acts as an end user
  - The stakes of the developers can be balanced against the stakes of the future user.

End User Access

- Clients and end users usually do not have the same interests
- Clients are interested in
  - an early delivery date
  - as much functionality as possible
  - low cost
- End users are interested in
  - a familiar user interface
  - an easy to learn user interface
  - a system that supports their specific task well
- If the project success depends on the usability of the product, then
  - end users should be included in the project
  - usability tests should be conducted with the end users.

Project Environment

- Participants’ expertise
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Technological climate

- Depending on the requirements expressed by the client, a project may be constrained in the technological components it has to use. Examples:
  - A project needs to improve a legacy system
    - It deals with well-known and mature technology but the technology might be out of date
  - A project develops a first-of-a-kind prototype
    - based on a new technology enabler
    - Usually has to deal with preliminary versions of components and immature technology.

Geographical Distribution

- “Single room” projects: Participants in a single room
- Reasons for distributed projects:
  - Organization may have resulted from the merger
  - Organization is a consortium, located in different geographical locations
  - Part of the organization must be collocated with client
- Geographical distribution has advantages and disadvantages:
  - ↑ Promise of low cost labor
  - ↑ Increases the availability of skill
  - ↑ May take advantage of different time zones
  - ↓ Slows down communication and decision making
  - ↓ Lowers awareness among teams
  - ↓ Leads to loss of information between sites
  - ↓ High communication cost.

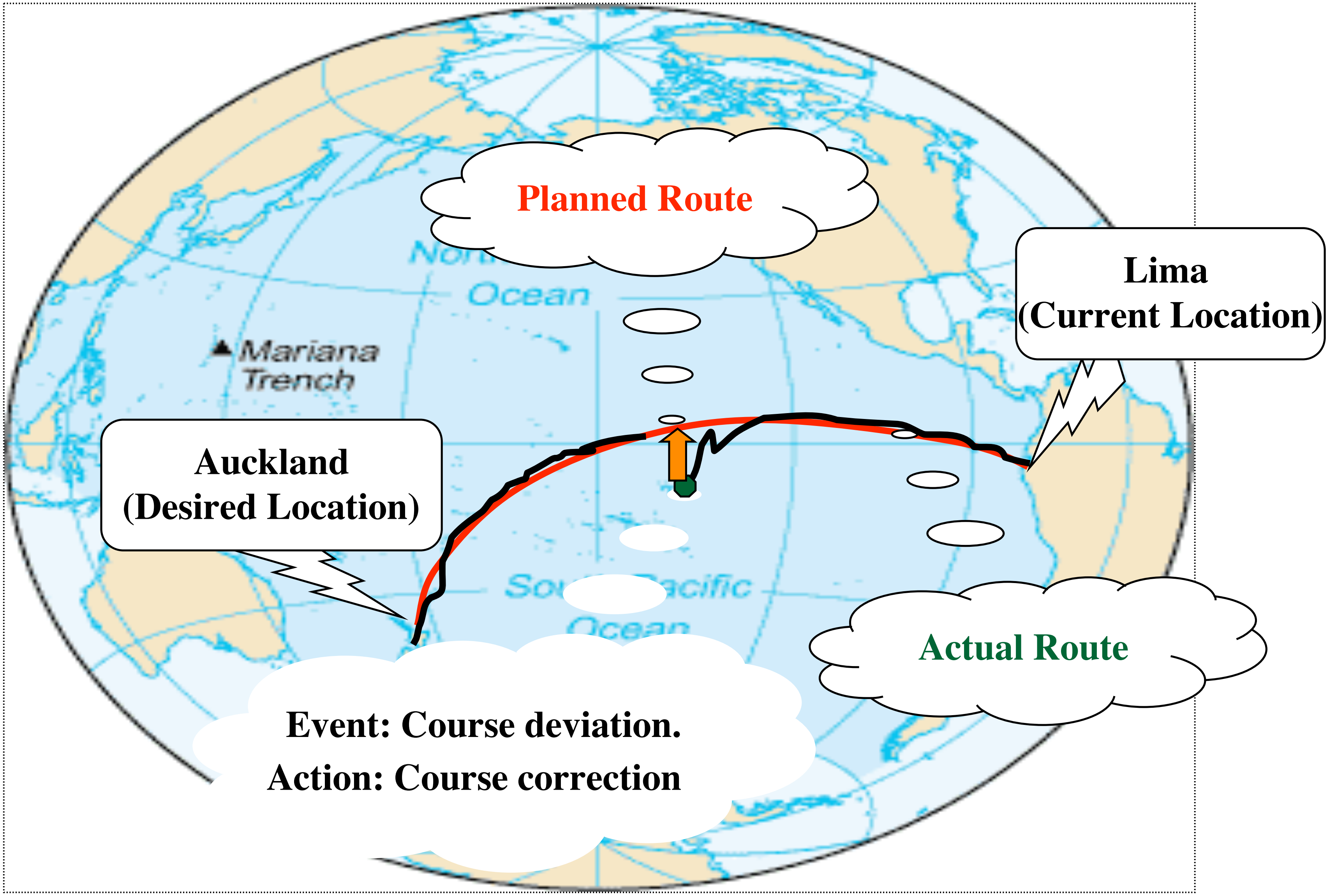
Methodology Issues

- Methodologies provide general principles and strategies for selecting methods and tools in a given project environment
- Key questions for which methodologies provide guidance:
  - How much involvement of the customer?
  - ➡ How much planning?
  - How much reuse?
  - ➡ How much modeling before coding?
  - ➡ How much process?
  - How much control and monitoring?

How much Planning?

- Two styles of navigation [Gladwin 1964]
  - European navigation:
    - Current Location and Desired Location
    - Planned Route
    - Route Deviation and Route Correction
  - “Polynesian navigation”

“European Navigation” (Plan-based)



Planned Route

Lima (Current Location)

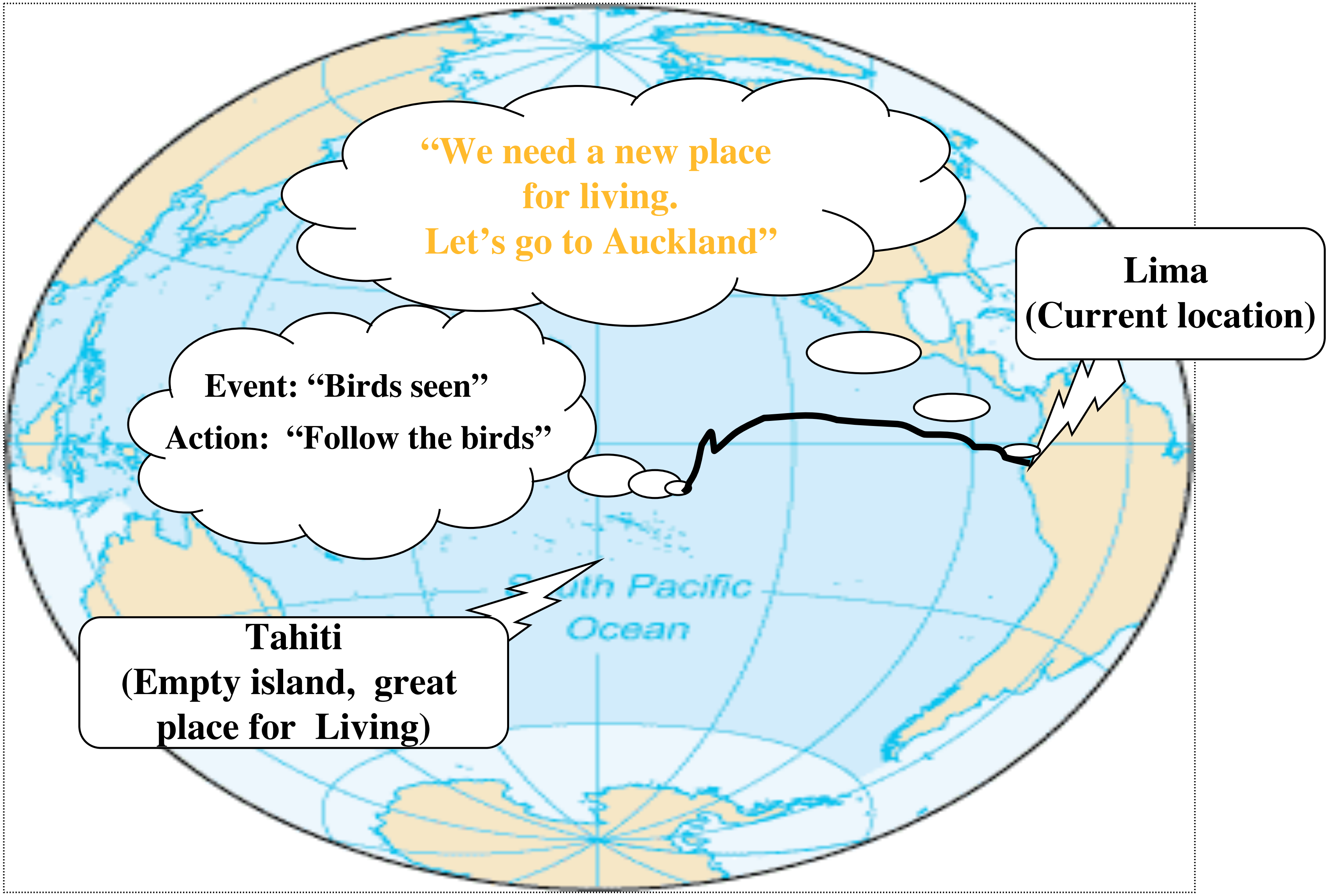
Auckland (Desired Location)

Actual Route

Event: Course deviation.

Action: Course correction

Polynesian Navigation (Situation-based)


"We need a new place for living. Let's go to Auckland"
Lima (Current location)
Event: "Birds seen"
Action: "Follow the birds"
South Pacific Ocean
Tahiti (Empty island, great place for Living)

Situated action

- Context-dependent action [Suchman 1990]
  - Selection of action depends on the type of event, the situation and the skill of the developer
- European Navigation is context independent
  - Event: "Course deviation in the morning"
    - Action: "Course correction towards planned route"
  - Event: "Course deviation in the evening"
    - Action: "Course correction towards planned route"
- Polynesian Navigation is context dependent
  - Event: "Birds seen", Context: Morning
    - Action: "Sail opposite to the direction of the birds
  - Event: "Birds seen", Context: Evening
    - Action: "Sail in the direction of the birds".

Pros and Cons of Software Project Plans

- Plus
  - Very useful to kick off a software project
  - Useful also if the outcome is predictable or if no major change occurs
- Con:
  - Of limited value to control the project when
    - the outcome is unpredictable
    - when unexpected events occur that change the project environment, tools or methods
- Examples of unexpected events:
  - Appearance of new technology unknown at project start
  - A visionary scenario turns out to be unimplementable
  - Company is merged with another one during the project.

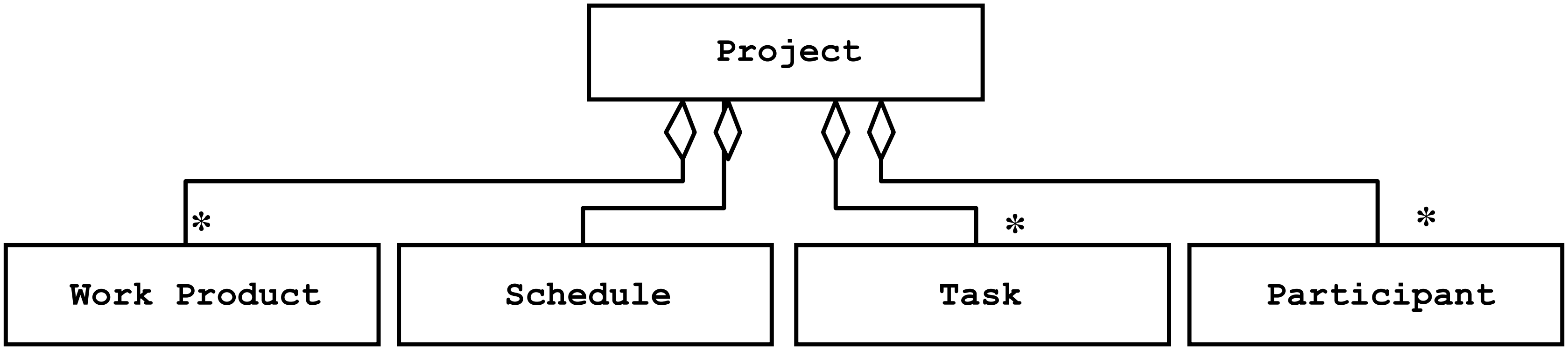
How much Modeling?

- Advantages of modeling:
  - Modeling enables developers to deal with complexity
  - Modeling makes implicit knowledge about the system explicit
  - Modeling formalizes knowledge so that a number of participants can share it
- Problem with modeling:
  - If one is not careful, models can become as complex as the system being modeled.

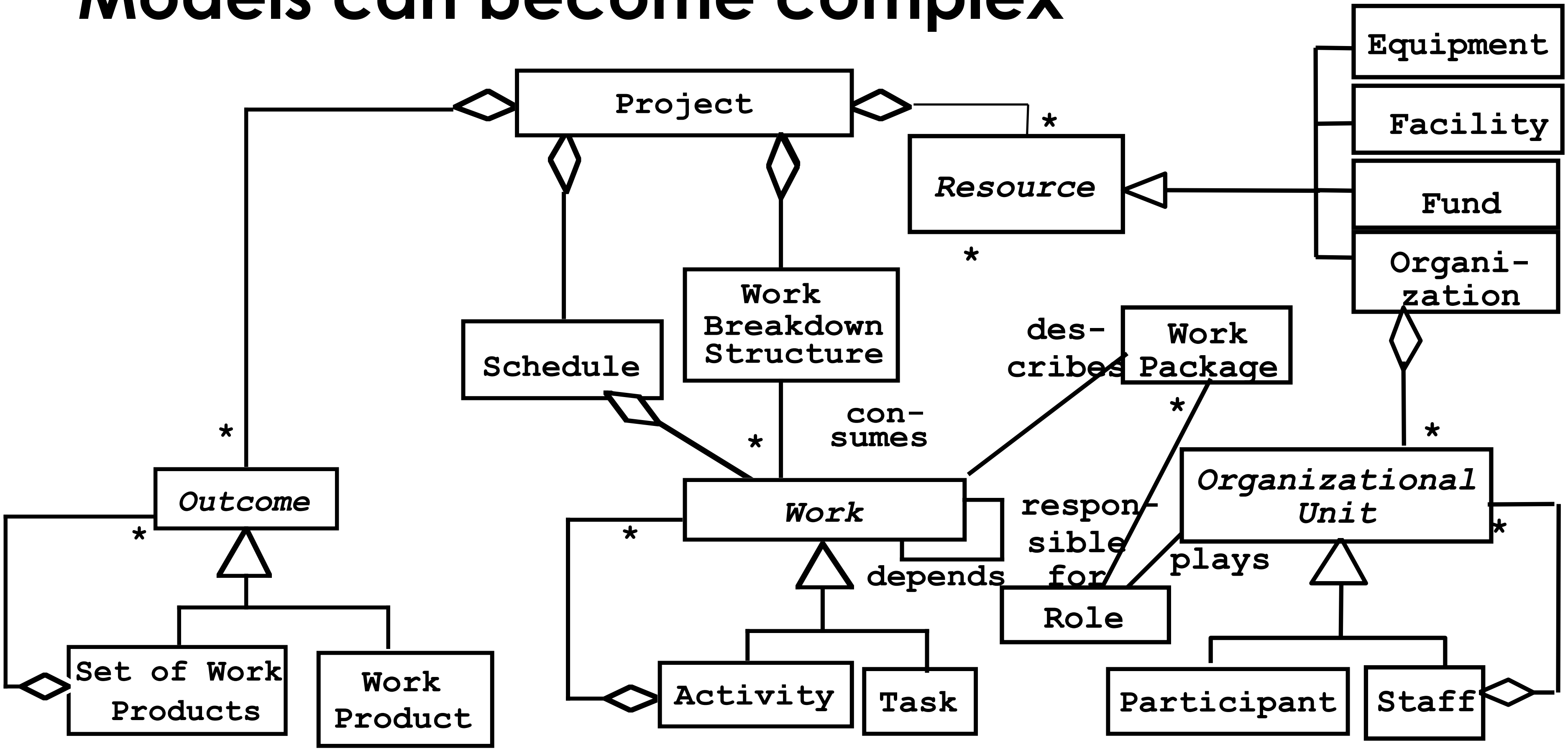
Managerial Challenges of Modeling

- Formalizing knowledge is expensive
  - Takes time and effort from developers
  - Requires validation and consensus
- Models introduce redundancy
  - If the system is changed, the models must be changed
  - If several models depict the same aspects of the system, all of them must be updated
  - If one model becomes out of sync, it loses its value
- Models become complex
  - As the model complexity becomes similar to the complexity of the system, the benefit of having a model is reduced significantly.

Model of a Software Project



Models can become complex



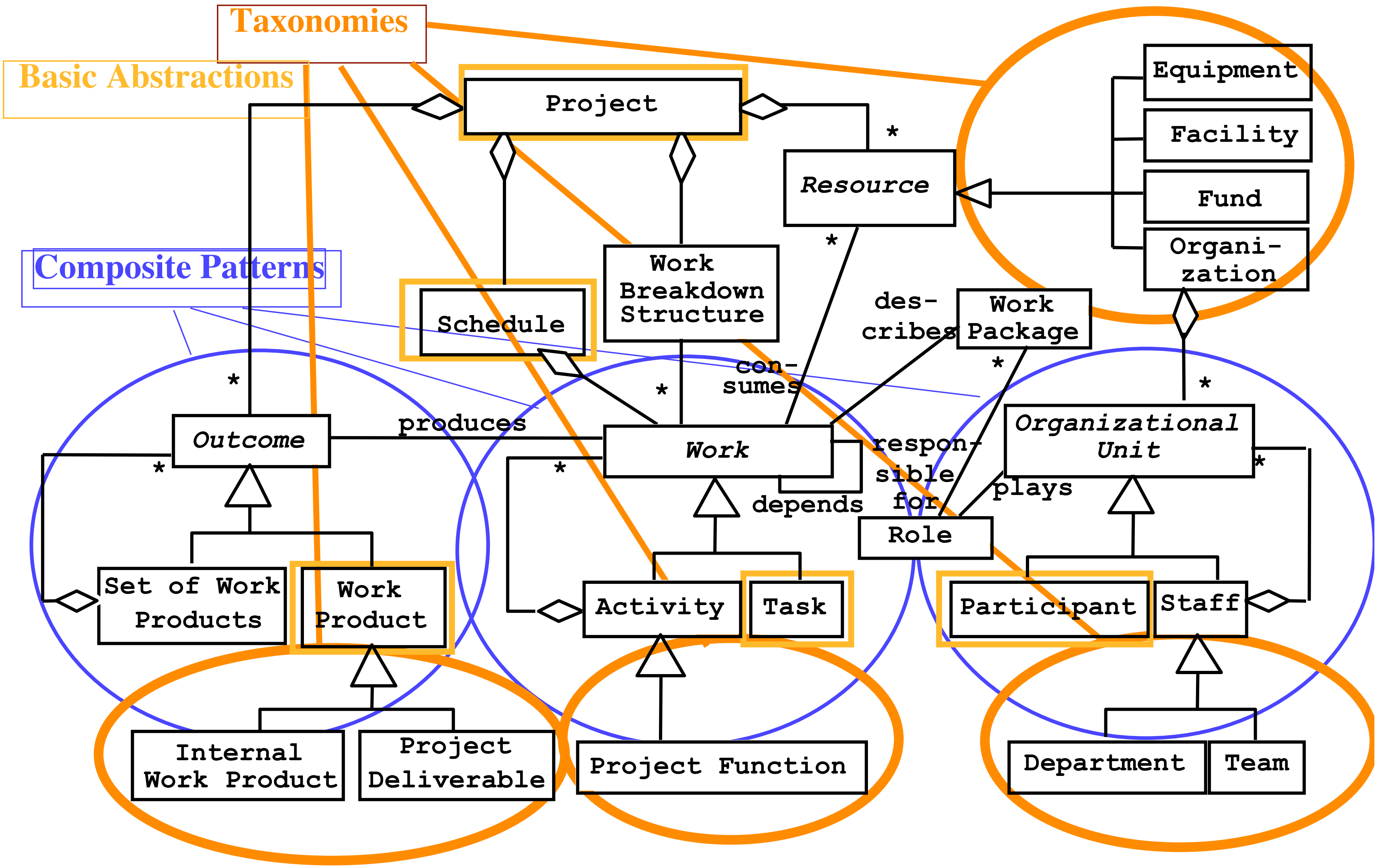
How many objects are there if you instantiate this class diagram?

Simon says 1

Thomas says 6

Oscar says 10

Use Patterns to Reduce Complexity



Reducing the Complexity of Models

- To reduce the complexity of large model we use navigation and abstraction
- Start with a simplified model and then decorate it incrementally
  - Start with key abstractions (use animation)
  - Then decorate the model with the additional classes
- To reduce the complexity of the model even further
  - Use inheritance (taxonomies, design patterns)
  - If the model is still too complex, show the subclasses on a separate page

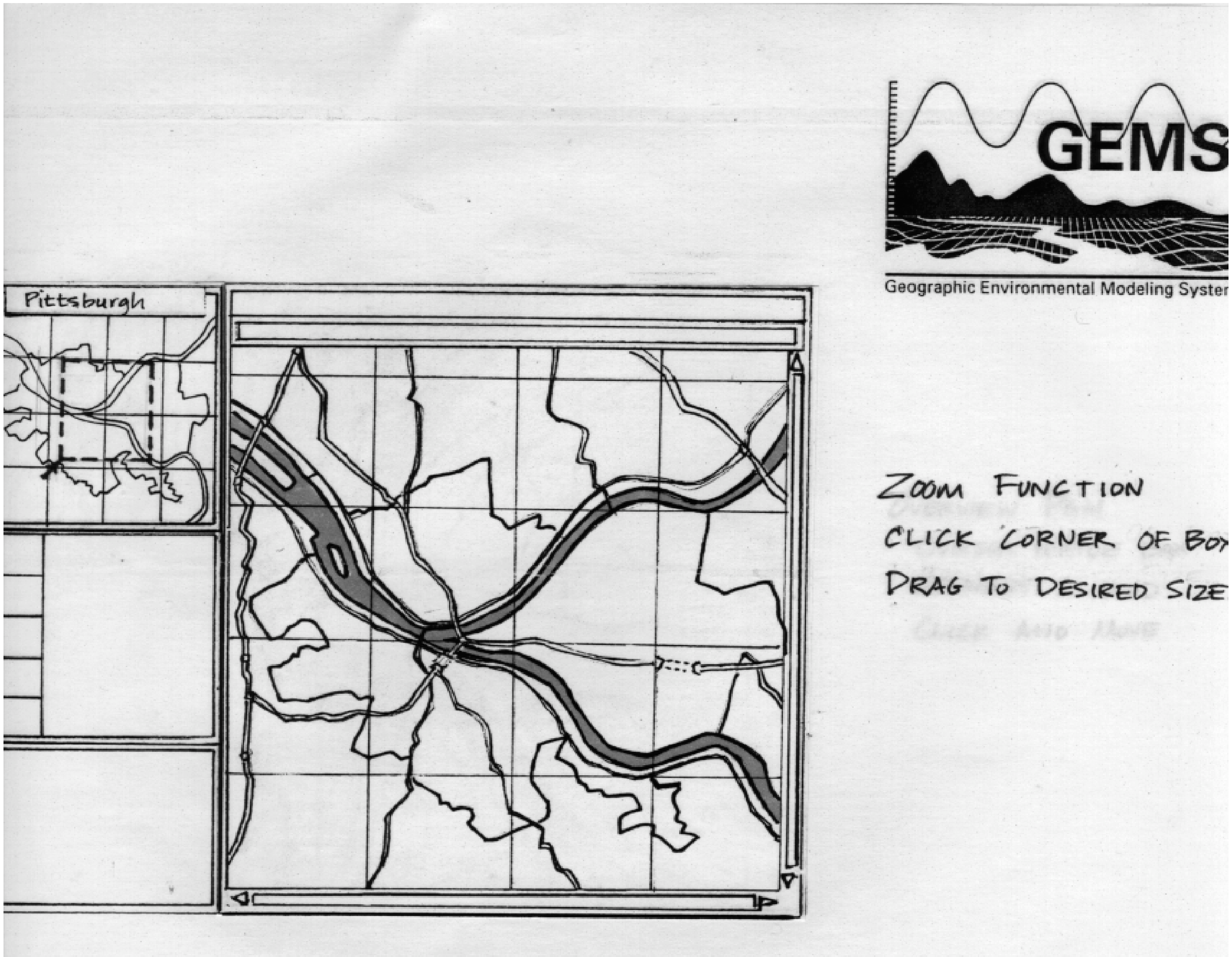
Where do we need Models?

- Models support three different types of activities:
  - Communication: The model provides a common vocabulary. An informal model is often used to communicate an idea
  - Analysis/Design: Models enable developers to reason about the future system
  - Archival: Compact representation for storing the design and rationale of an existing system.

Models to support Communication

- Also called conceptual models
- Most often used in the early phases of a project and during informal communications.
    - The model does not have to be consistent or complete
    - The notation does not even have to be correct
- The model is used only to communicate an idea to ***a person***
    - If the idea is understood, the model has served its purpose
- UML is our preferred notation for models to support communication
- Communication Media:
    - A Whiteboard, a slide or even a napkin.

“Napkin Design”



ZOOM FUNCTION
CLICK CORNER OF BOX
DRAG TO DESIRED SIZE

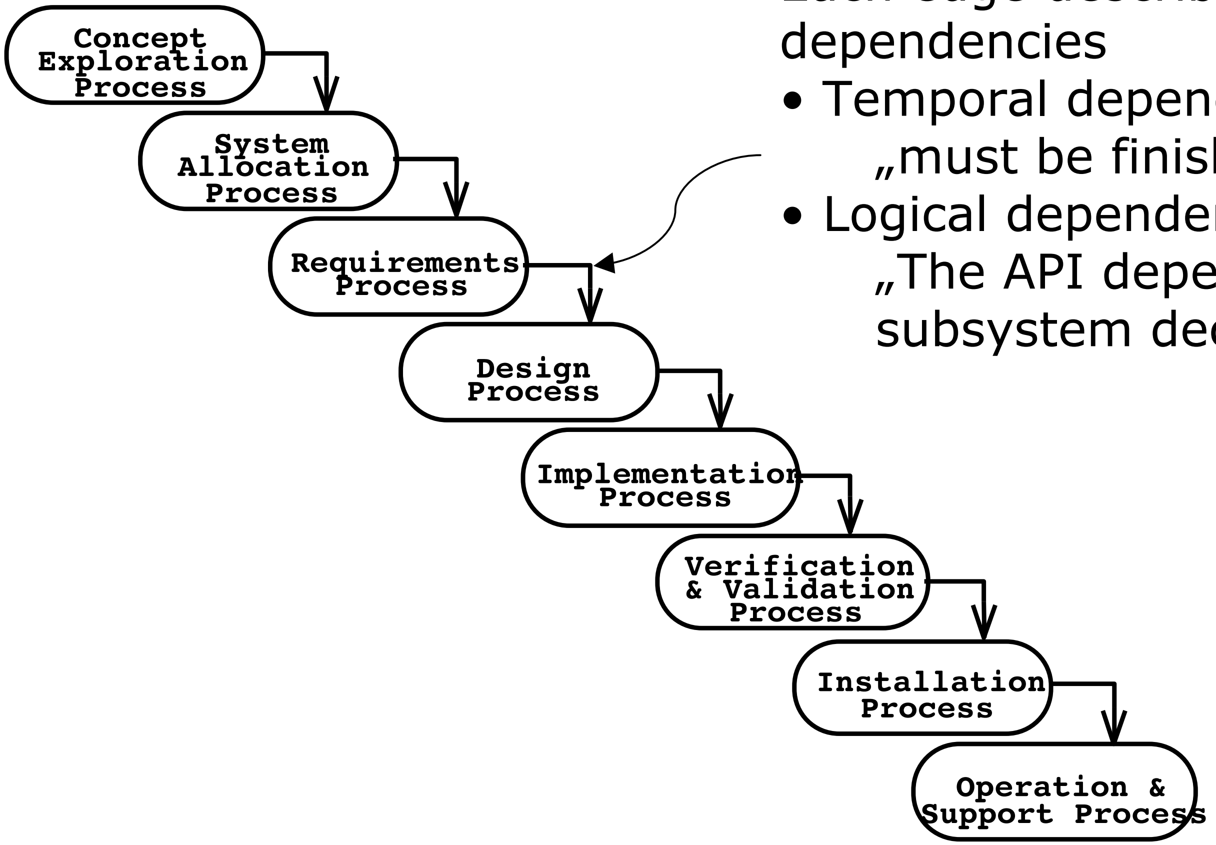
Models to support Analysis and Design

- Also called specification models
- The model provides a representation that enables developers to reason about the system
- The model is used to communicate the idea to ***a computer***
  - The model needs to be made consistent and complete
  - The notation must be correct so the model can be entered into a CASE tool
- UML is our preferred notation for models to models that support analysis and design.

Methodology Issues

- Methodologies provide guidance, general principles and strategies for selecting methods and tools in a given project environment.
- Key questions for which methodologies provide guidance:
  - How much involvement of the customer
  - ✓ How much planning?
  - How much reuse?
  - ✓ How much modeling?
  - ➡ How much process?
  - How much control and monitoring?

Problems with linear Models


Concept Exploration Process
System Allocation Process
Requirements Process
Design Process
Implementation Process
Verification & Validation Process
Installation Process
Operation & Support Process

Each edge describes 2 types of dependencies

- Temporal dependency:
  „must be finished before“
- Logical dependency
  „The API depends on the subsystem decomposition“

The Waterfall Model is a Dinosaur

Copyright © 1996 Joe Tucciarone and Jeff Poling red

yellow

green

blue

red

blue

yellow

green

blue

red

yellow

green

blue

red

blue

yellow

green

blue

Problem: Controlling Software Development with a Process

- How do we control software development?
- Two opinions: Maturity vs agility
- Through organizational maturity (Humphrey)
    - Repeatable process, Capability Maturity Model (CMM)
- Through agility (Schwaber):
    - Large parts of software development is empirical in nature; cannot be modeled with a defined process
    - There is a difference between defined and empirical process
- How can software development better be described?
    - with a defined process control model
    - with an empirical process control model.

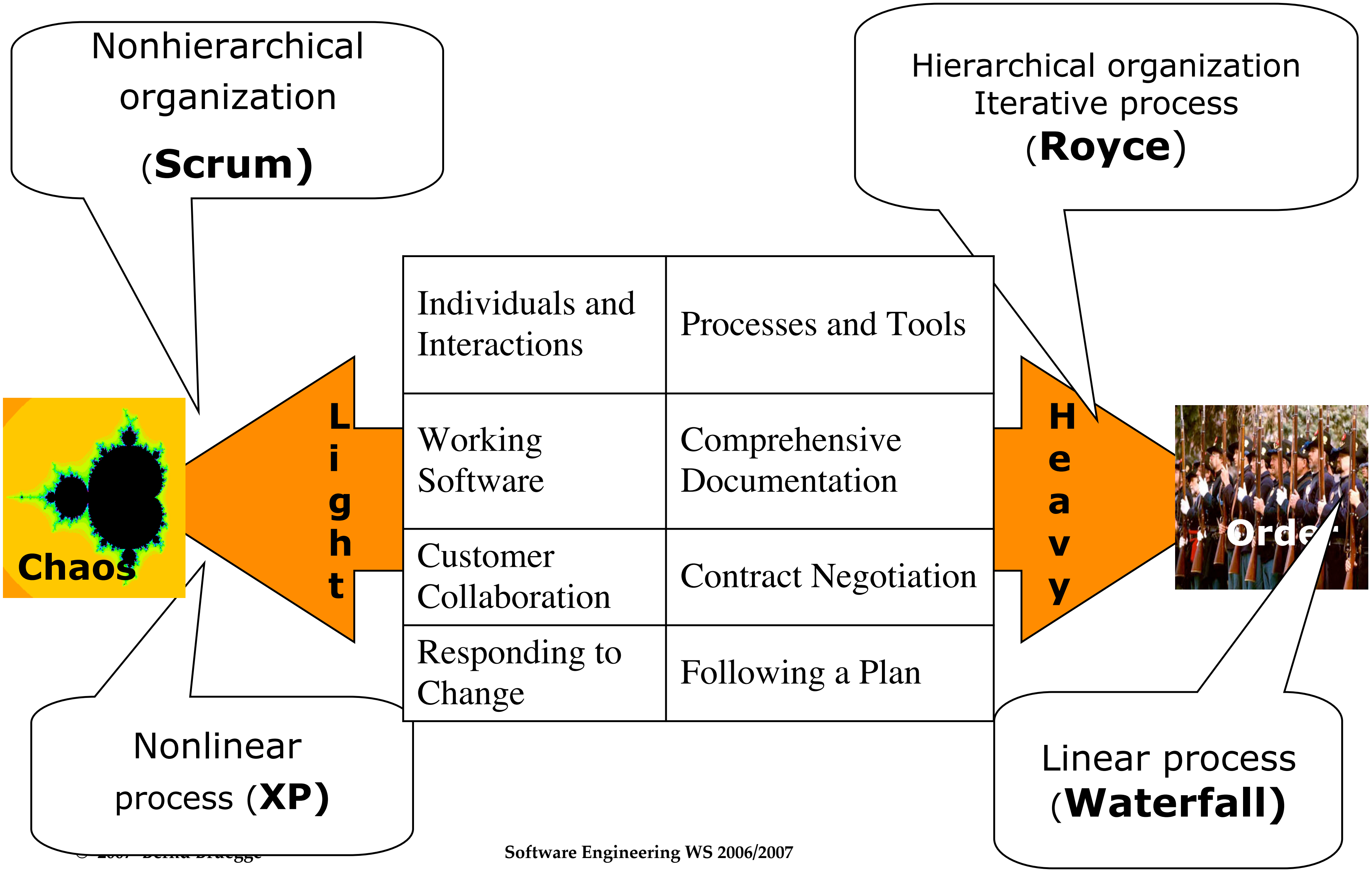
Defined Process Control Model

- Requires that every piece of work is completely understood
- Deviations are seen as errors that need to be corrected
- Given a well-defined set of inputs, the same outputs are generated every time
- Precondition to apply this model:
  - All the activities and tasks are well defined to provide repeatability and predictability
- If the preconditions are not satisfied:
  - Lot of surprises, loss of control, incomplete or wrong work products.

Empirical Process Control Model

- The process is imperfectly defined, not all pieces of work are completely understood
- Deviations are seen as opportunities that need to be investigated
  - The empirical process "expects the unexpected"
- Control is exercised through frequent inspection
- Conditions when to apply this model:
  - Frequent change, unpredictable and unrepeatable outputs.

Ways to React to Complexity and Change



Nonhierarchical organization (**Scrum**)

Hierarchical organization
Iterative process
(**Royce**)

Individuals and Interactions	Processes and Tools
Working Software	Comprehensive Documentation
Customer Collaboration	Contract Negotiation
Responding to Change	Following a Plan

Nonlinear process (**XP**)

Linear process (**Waterfall**)

Summary

- A project has many contexts
  - Goals, client types
  - Environment, methods, tools, methodology
- Methodology issues
  - Planning, design reuse, modeling, process, control&monitoring, redefinition
- Different types of planning
  - European vs. Polynesian navigation
- Different types of models
  - For communication, specification and archival
- Different ways to control processes
  - Defined vs empirical process control models.

Additional References

- W. Humphrey
  - Managing the Software Process, Addison-Wesley, Reading MA, 1989
- K. Schwaber, M. Beedle, R. C. Martin
  - Agile Software Development with Scrum, Prentice Hall, Upper Saddle River, NJ, 2001.

Final Exam

- Date: February 17, 2007
- Time: 10:00 -12:30
- Location: HS I
- Resources: Closed Book
- No electronic devices allowed (Notebooks, etc.)

Tutors for Software Engineering I in SS 2007

- 5 Tutoren gesucht. Vorlesung: Einführung in die Softwaretechnik (SE I in German!)
- **Voraussetzung**: Erfolgreiches 4-semestriges Studium der Informatik
- **Wöchentliche Arbeitszeit**: bei 4 Übungsstunden ca. 12 Stunden
- **Entlohnung**: Als studentische Hilfskraft ca. 400 € im Monat.
  - Zusätzlich wird der/die studentische Tutor(-in) mit der besten Lehre mit 500 € prämiiert.
- **Aufgaben:** Betreuung von Üungsgruppen inkl. Hausaufgaben- und Klausurkorrektur;
- **Anzahl der Übungsgruppen:** 10
- **Coaching und Supervision**: Pädagogisch-didaktisches Training (Blockseminar) vor Beginn des Semesters; Hilfe während des Semesters.
- **Studienleistungen**: Erfolgreiche Tutorentätigkeit kann in das Modul Überfachliche Grundlagen (4 ECTS) eingebracht werden.