Software Engineering I: Software Technology

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Methodologies

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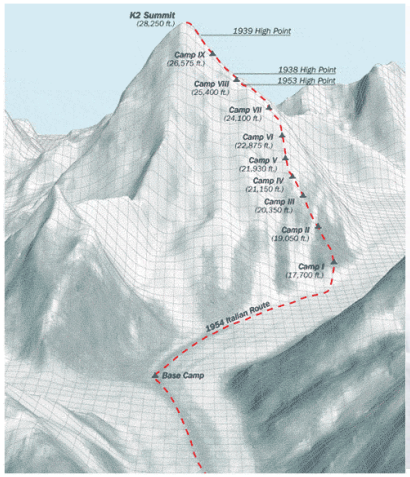
Outline

- 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

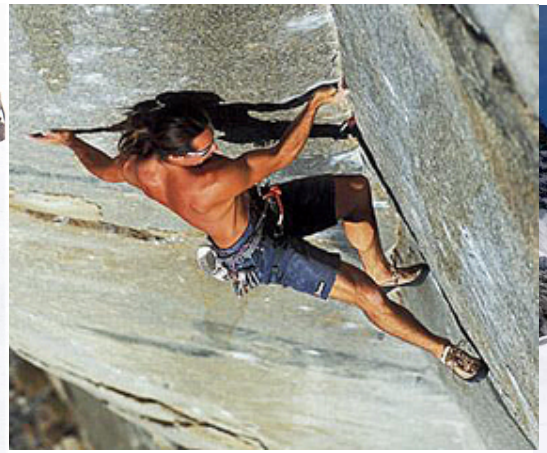
- A leader must answer several key questions to create a successful expedition
  - What mountain should be climbed?
  - What types of tools should be used?
  - Who should be member of the team?
  - Does the expedition need a leader?
- Different answers to these questions lead to different styles:

Siege style



Fixed-rope

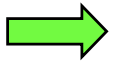
Free Solo



Alpine style

Key Parameters 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*.

Key Parameters in a 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**

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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

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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 pros and cons:
  - ↑ 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
  - ? Promise of low cost labor (Originally the reason for many offshoring projects).

Terminology (Shoring and Sourcing)

- **Off-shoring**
  - Originally used in the design of oil platforms
  - Offshoring describes the relocation of business processes from one country to another. This includes any business process such as production, manufacturing, or services.
- **Outsourcing**
  - The practice of hiring an external organization to perform functions in a country other than where the functions are developed.
- **Nearshoring**
  - Outsourcing services to a lower-wage country that is relatively close in distance or time zone (or both).
- **Downsizing, ...**
- **Check Wikipedia for these definitions**
- **Dumbsizing?**

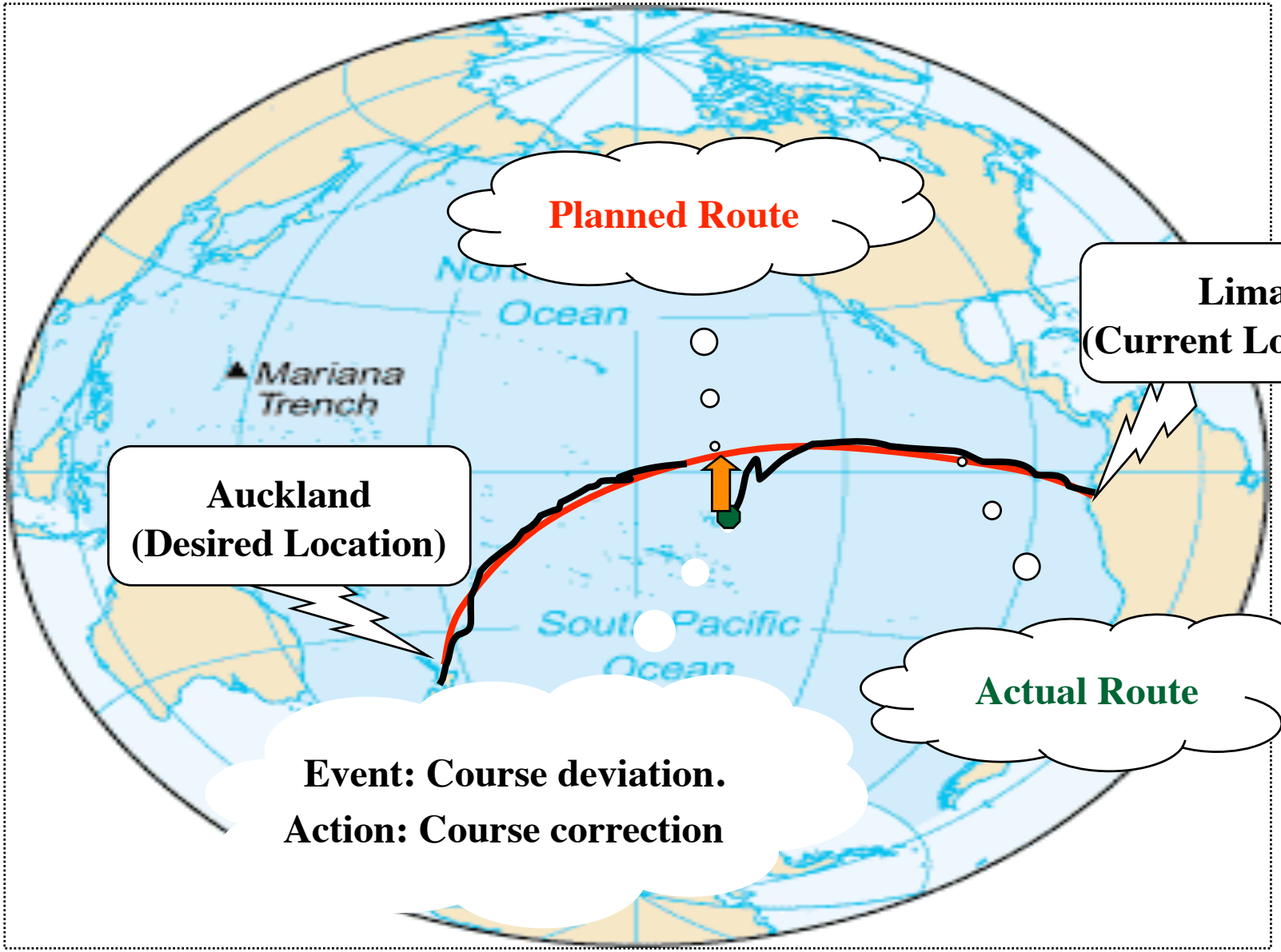
Methodology Issues 10 14 2008

- 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)



Polynesian Navigation (Situation-based)

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.

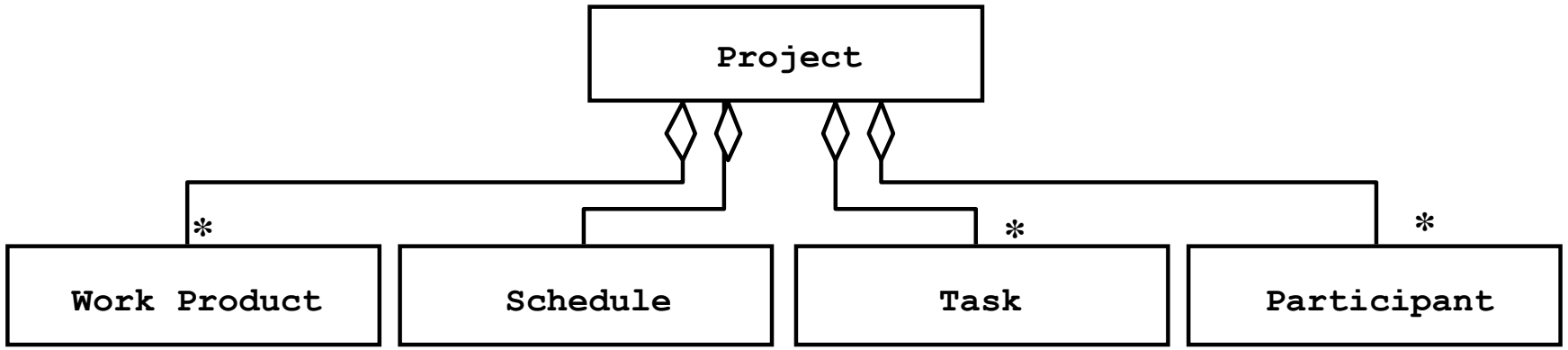
How much Modeling?

- 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.

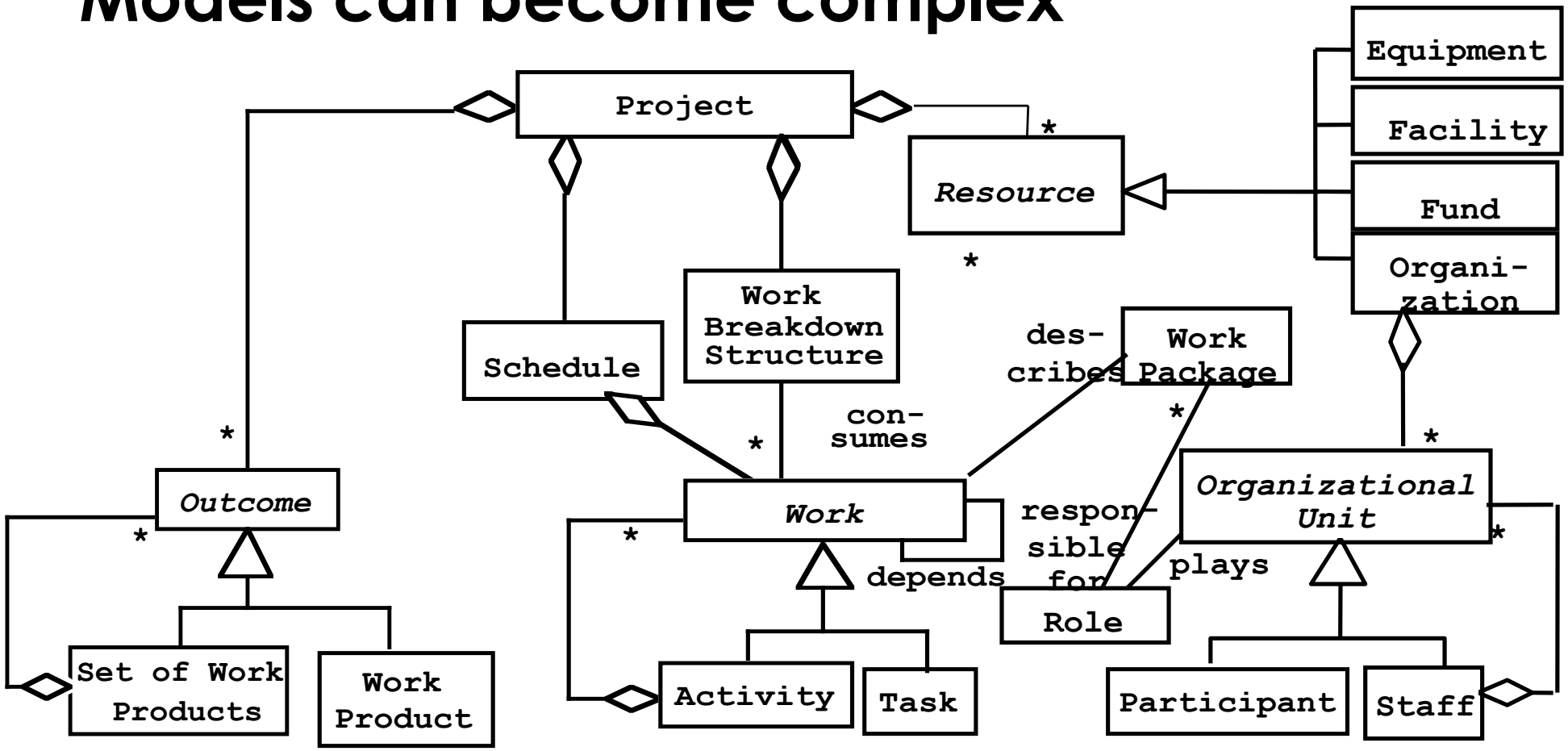
Managerial Challenges of Modeling

- 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



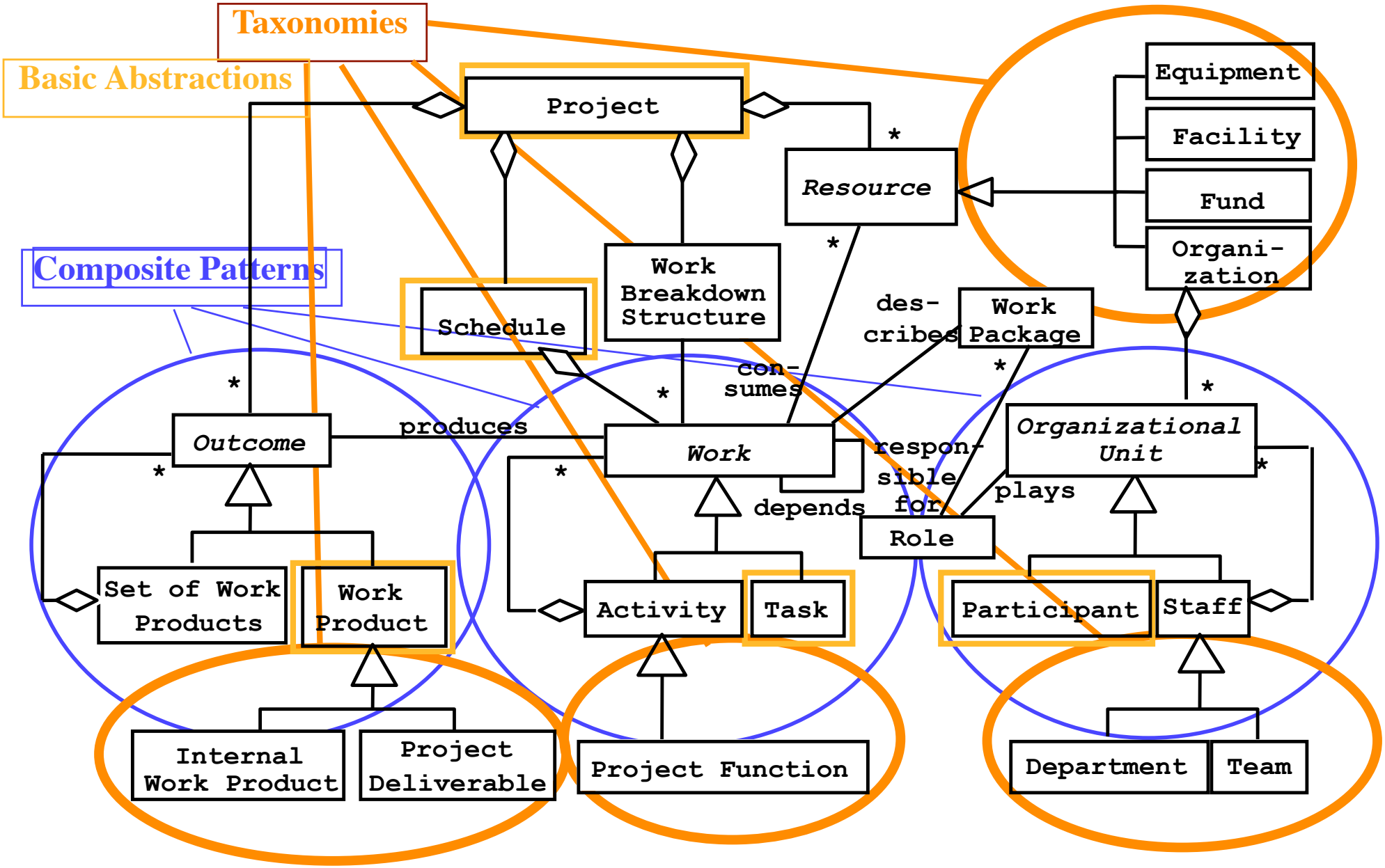
How many objects are there if you instantiate this class diagram?

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

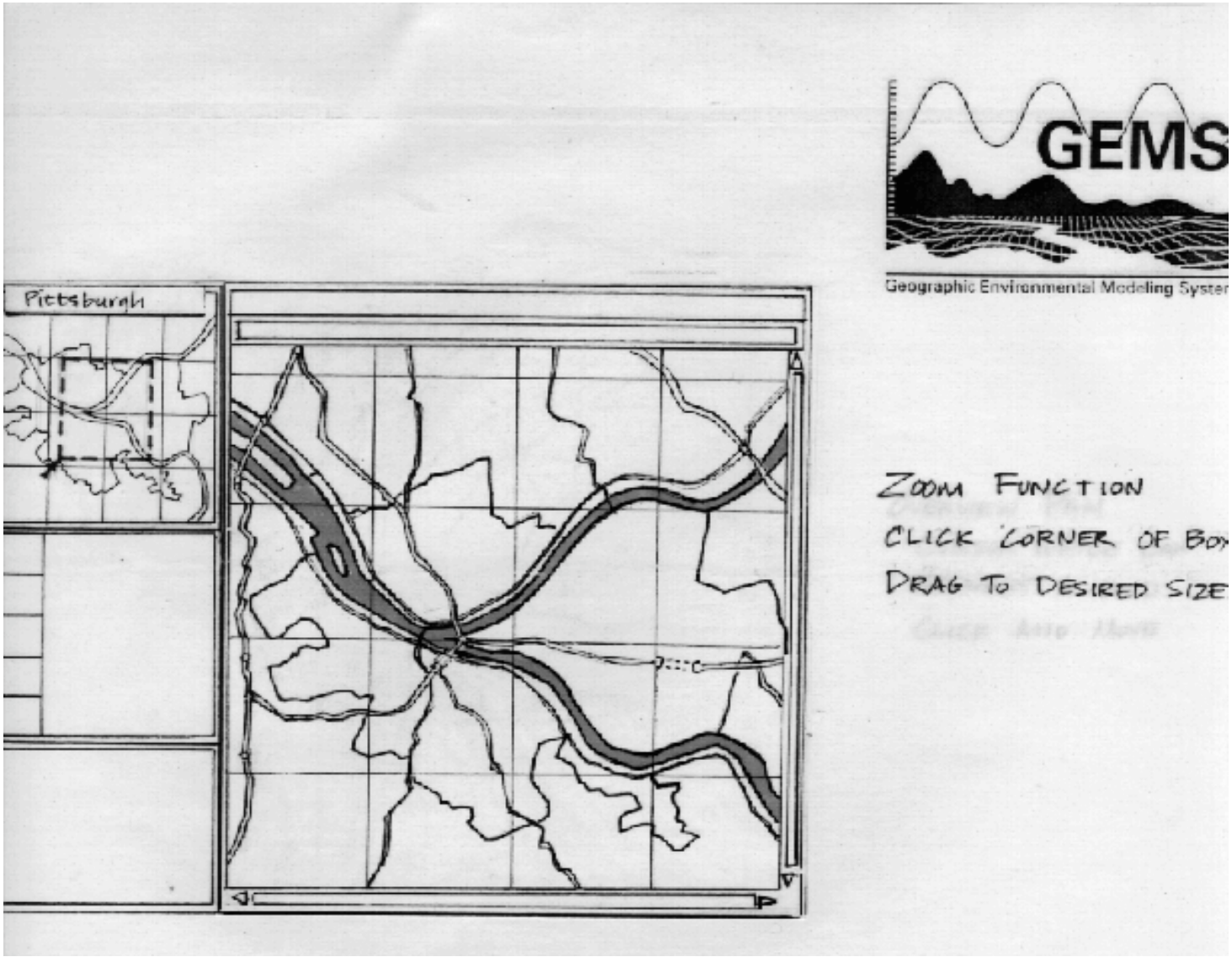
Where do we need Models?

- 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"



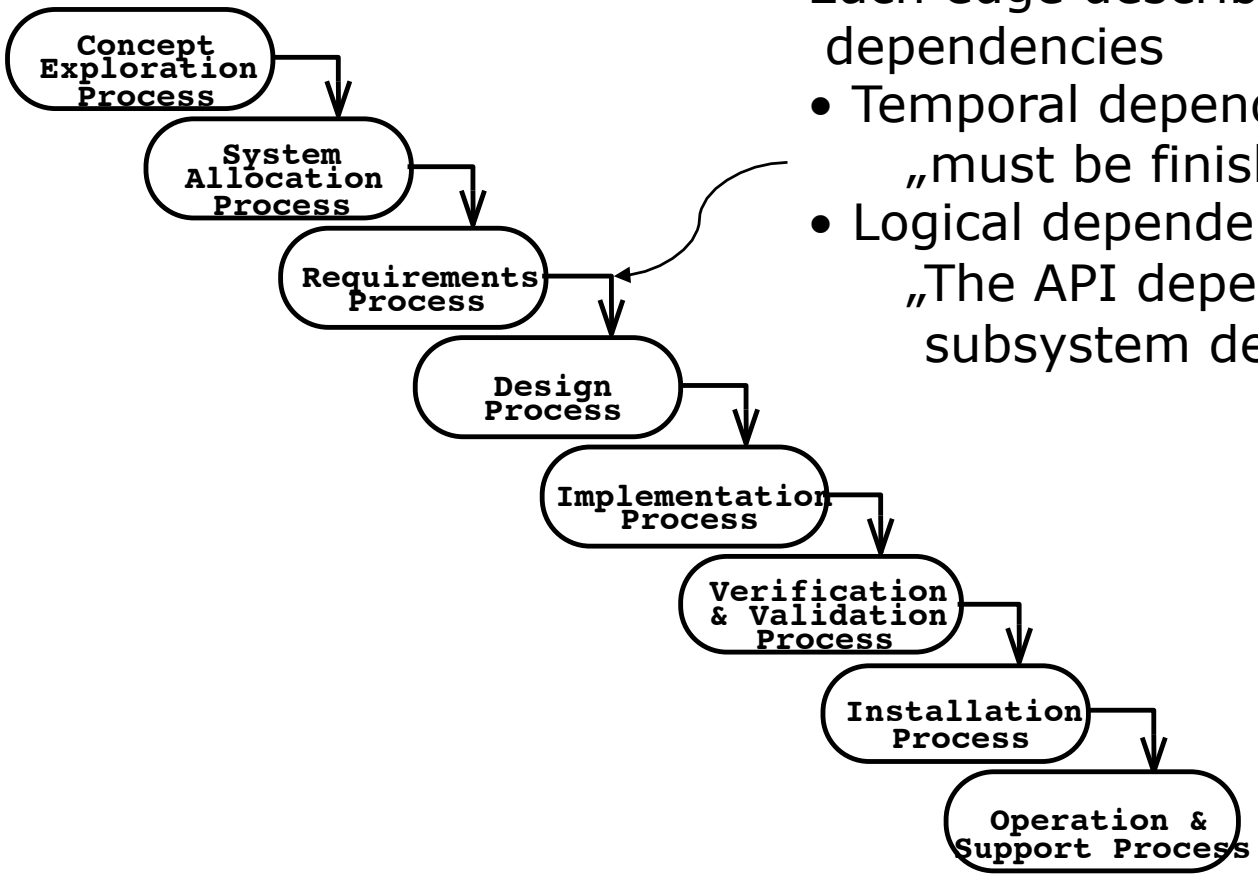
Models to support Analysis and Design

- 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

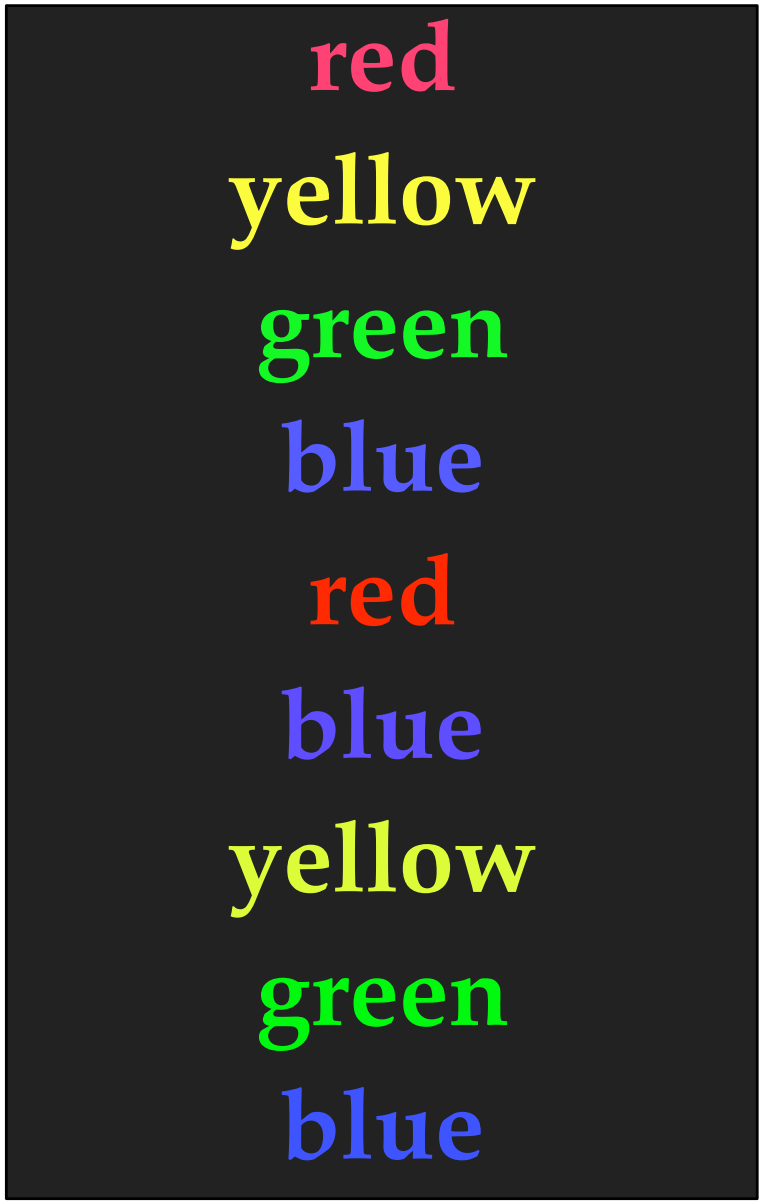


Each edge describes 2 types of dependencies

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

Waterfall Modell

The Waterfall Model is a Dinosaur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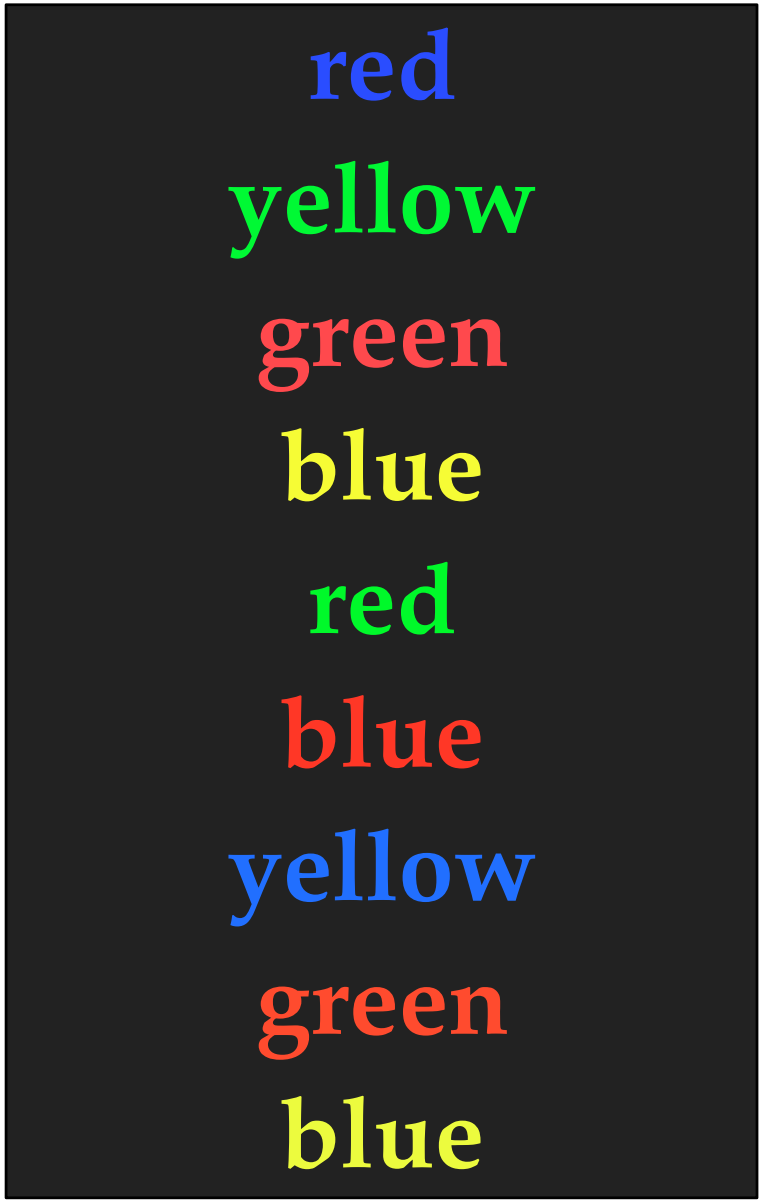
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Problem: Controlling Software Development with a Process

- How do we control software development?
- Two opinions: Maturity vs agility
- Through organizational maturity (SEI, Humphrey)
  - Repeatable process, Capability Maturity Model (CMM)
- Through agility (Takeuchi, Nonaki, 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.

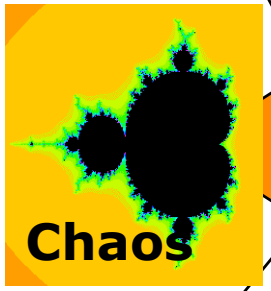
Empirical Process Control Model

- 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**)



Light

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

Heavy

Nonlinear process (**XP**)

Linear process (**Waterfall**)

Additional References

- Hirotaka Takeuchi Ikujiro Nonaka („Rugby Methodology“)
  - The New New Product Development Game, Harvard Business Review, 1985
- Watts Humphrey (Capability Maturity Model, CMM):
  - Managing the Software Process, Addison-Wesley, Reading Massachusetts, 1989
- Ken Schwaber, Mike Beedle (Scrum)
  - Agile Software Development with Scrum, Prentice Hall, Upper Saddle River, NJ, 2001
- A lot of ongoing discussion on the internet (blogs). Find your way via Google and Wikipedia. Example:
  - Development: Empirical or Planned? www.controlchaos.com/old-site/debate.htm

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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.

Backup Slides

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.