Coordinating Developers

Jim Herbsleb
1-27-11
Agenda

- What is coordination, why is it a problem?
- Framing the problem
  - Face to face
  - Over time, across barriers
- Research directions
  - Congruence
  - Coordination views of architectures
  - Socio-technical patterns
  - Organizational models
  - Socio-technical ecosystems
Coordination

• Managing dependencies between tasks*

Face-to-Face Coordination

What Must a Tool Support?

(a) Ad-hoc teams formed in front of specific canvases  
(b) Clumps of interactions attracted additional participants

Figure 11: Team formation in the half-day group

Figure 14: Gesturing to another person about an item at close proximity
Figure 15: Pointing at a remote artifact
Figure 12: Maintaining personal focus on one item
Figure 13: Maintaining personal focus on multiple items
Figure 16: Inferring focus from gaze
Improving Current Tools

Figure 3: Forcing too many sticky notes into a limited container
Figure 4: Forcing excessive contents into limited canvas space
(a) The rescaling of a diagram is an opportunity to clean it up

(b) Rescaling is often a group activity
Figure 8: A canvas is updated in bursts, implicitly creating versions.
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Dual Role of Architectural Decisions

• Lessons from the history of photolithographic alignment equipment*

• Architectural decisions
  • Technical properties
  • Social engineering: shapes coordination problems

Conway’s Law

• “Any organization that designs a system will inevitably produce a design whose structure is a copy of the organization's communication structure.”

• Implication: Modularity works as a coordination strategy

• Problem: Modularity has major limitations
What about the Interfaces?

Components

Teams

Homomorphism

Software

Organization
What is Required for Effective Coordination?

Components

Coordination Requirements

Software

Teams

Organization

What kind of coordination actions are required?
Coordination Requirements: Complexity

- Examples
  - How “big” is an API?
  - How complicated are API usage policies?
  - Features with implementations spanning components
  - Challenging non-functional requirements
    - Performance
    - Security
    - Availability
    - Etc.
Coordination Requirements: Uncertainty

- Examples
  - Allocation of functionality to components
  - Modification and refinement of component interfaces
  - Volatile requirements
  - Dependencies on other systems that are changing
    - Hardware
    - Firmware
    - Middleware
    - Etc.
What determines coordination effectiveness?

Software  Organization

Congruence

Components

Teams

Coordination Requirements

Coordination Effectiveness

?
Coordination Effectiveness

- Coordination capacity
  - Relatively enduring conditions
- Coordination actions
  - Things people do
Many Factors Affect Coordination Capacity

• Organizational factors, e.g.,
  • Geographic distribution
  • Divergent processes
  • Different management practices
  • Communication infrastructure

• People factors, e.g.,
  • Experience working together
  • Domain and technology expertise
  • Language skills
Types of Coordination Actions

- Preparation, e.g.,
  - Plans
  - Specifications
  - Defined processes
- Shared representation, e.g.,
  - Metrics dashboard
  - Posting test results
  - “Living” documents
- Communication, e.g.,
  - Meetings
  - “Informal” communication
Distance Breaks Down Communication

Communication

Gap

Lack of unplanned contact
Knowing who to contact about what
Difficulty of initiating contact
Ability to communicate effectively
Lack of trust, or willingness to communicate openly

Within site

Across sites
Variation in practices
Variation in understanding
Interpretation depends on context
Lack of shared notations
Little ability to anticipate actions
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Measuring Coordination Requirements

- Dependencies among tasks:
  matrix $D$ where $d_{ij} \neq 0$ means that task $i$ and task $j$ are dependent

- Assignments of workers to tasks:
  matrix $A$ where $a_{ki} \neq 0$ indicates that worker $k$ is assigned to task $i$

- Coordination requirements:
  $ADA^T = R$, where $r_{mn} \neq 0$ indicates that worker $m$ and worker $n$ have dependencies in their tasks

Coordination Requirements for some unit of work or period of time

From Cataldo, et al, 2006
Volatility in Coordination Requirements

From Cataldo, et al, 2006
### Measuring Congruence

#### Coordination Requirements ($R$)

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#### Coordination Behavior ($B$)

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- Team structure
- Geographic location
- Use of chat
- On-line discussion in MR system

From Cataldo, et al, 2006
Summary of Findings

- Each type of congruence is associated with shorter development times
- We can measure coordination requirements and congruence
- Coordination requirements are volatile and extend beyond the team

- Tesseract

From Cataldo, et al, 2006
Some Research Questions

- Make use of congruence computations
- Expand beyond code changes
- Other (better) ways of computing congruence
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• How to measure uncertainty and complexity early?
• How to predict coordination capacity?
• Tool support for predictive modeling
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Pattern Template*

- Example
- Context
- Problem
  - Description
  - Forces influencing the solution
- Solution
  - Description
  - Diagram
- Pattern understood in terms of tactics
- Variants
- Known uses
- Consequences
- Related patterns
- Credits

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Organizational Models

• Separate by product structure
  • different parts of product potentially developed at different sites
• Separate by process steps
  • execute different process steps at different sites
• Separate by release
  • new development separated from maintenance of previous releases
• Separate into core and custom parts
  • develop a core product at a single site, and customize for different markets and customers at satellite sites
• Co-locate functional experts
  • experts in, e.g., call processing, user interfaces, etc., located together

For Each Model . . .

- Indications
- Risks that must be managed
- Coordination mechanisms, e.g.,
  - interface specifications
  - process descriptions (handoff points)
  - project management tools
- Communication practices and technologies
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Q&A