Dependencies and Reflections in Collaborative Software Engineering

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Background

• A part of a multi-investigator National Science Foundation project managed through ISR.
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Dependencies in Collaboration

• Communication and coordination breakdowns have negative effects on collaborative software development projects especially when team members are not collocated.
  – E.g., globally distributed software development

• Many breakdowns arise over dependencies.
  – I.e., dependencies among people and between people and artifacts.

• Traditionally, software engineering techniques support managing these dependencies through formal techniques.

• In reality, participants must additionally employ informal techniques to manage dependencies (and navigate the formal techniques).
Awareness and Reflections of Dependencies

- Many informal activities pertain to maintaining awareness.
- Therefore we seek to support coordination by reflecting social and technical dependencies helping software developers to maintain awareness of and easily discover these dependencies.
- Our implementation relies primarily on visual interfaces.
Related Work

• Some are using the term socio-technical congruence (e.g. ICSE 2008 workshop by Herbsleb et al.)
  – Dependencies in the source-code (technical) create dependencies between people writing that source-code (social)

• Explicit relationship between dependencies and coordination
Approach

- Field study (ethnography) of software organizations
- Grounded theory analysis
- Development of stereotypical scenarios
- Development of software visualizations (2 versions and counting)
Site 1 - MVP

- 34 software engineers in 2 sub-teams
  - Developers
  - Quality assurance (V&V)
- Work together for about 9 years.
- Do not need to interact with external teams.
- A non-modular software
  - Changes in one part can affect almost any other part.
Site 2 - MCW

- 57 software developers in 5 sub-teams
  - Client, server, test, infrastructure, and leads
- Work together for about 9 months
- Do need to interact with several external teams;
  - Part of a large organization implementing a software reuse program
- A modular software based on S.E.’s best practices (APIs, layers, etc)
Data Collection

- Semi-Structured Interviews
  - MVP: 8 informants
  - MCW: 15 informants
  - The interview guide was reused

- Non-participant Observation (Shadowing)
  - MVP: 8 weeks
  - MCW: 11 weeks
Actual Work Practices

• Learning from Email Notifications; Personal Network; Reading Email Notifications; Impact Descriptions; Error-Checking; Back Merges; Partial Check-in’s; Being aware by attending meetings, engaging in communication; Grouping requirements; Informal Code Reviews; Holding onto Check-in’s; Notifications;

• API design review meetings; Sending Email Notifications; Pre-Testing Activities; Build Document; “Exporting” Developers; Problem Reports; Formal Code Reviews

• The reference architecture and APIs; Handling External Dependencies: APIs and Adaptors
Scenarios (1-2)

• Awareness of Evolving Dependencies
  – Managers’ lack of awareness of developers’ social dependencies
    • Gauging integration progress between team members
    • Assessing the likelihood of meeting deadlines
  – Developers’ lack of awareness of evolving technical dependencies
    • Whether an API is “being exercised”
    • Planning for last minute changes, re-designs
Scenarios (3-4)

• Finding the right people with whom to talk
  – Developer’s finding the “right” developer
    • Programming against “dummy” implementations
    • Want to find who else is implementing the same code, not who designed and checked in the interface
  – Developers finding “similar” developers
    • How to use a particular component
    • Identify similar/overlapping work
    • Who will be affected by changes to a component
    • Leverage the needs of others to request changes to a heavily used component
Responding to Scenarios

- Dependency/coordination relationship has not been fully explored
- But it should be!
  - Dependencies can be detected by automated tools
  - Dependencies, and thus coordination, can change
- We need tool support
  - The goal of Ariadne is to fill the acknowledged gap between dependencies and coordination
  - Ariadne automates dependency analysis and collection of authorship information, and generates social networks
  - Eclipse plug-in
Automated Process

- Create program dependency graph

  - Gather authorship information from CM repository
  - User associates authors with code

  - Link authorship information to create social dependency graph

- Visualize graph
Ariadne - Social and Technical Dependencies among Developers and Components
Managers’ Lack of Awareness
Developers’ Lack of Awareness
Finding the “Right” Developer
Finding Similar Developers
Feedback

• Feedback from open-source developers, running the tool on whole software project rather than subsets
  
• Problems with social network graphs
  – Layouts are not “geographically” consistent from analysis to analysis
  – Graphs do not scale well without smart filtering/zooming
  – Difficult to show social and technical dependencies together

• Explore alternate visualizations and evaluations
Goals for Alternate Visualization

- Instead of four different visualizations, one
- Preserve ease of identify connections in social network graphs
- Consistent layouts
- Showing many data at once, more scalable
- Evaluation using methods appropriate for visual interfaces
  - Lewis, Polson et al.’s Cognitive Walkthrough, Tufte’s Information Visualization Principles, Nielsen’s Heuristic Evaluation
- Evaluation with real data sets
- Evaluation with end users
Content – Problem Context

Photo googled at http://jurmo.us/2007/03/04/work-20-the-empty-cubicle/
Original source from http://www.ebertfest.com/seven/playtime.htm
Implementing Ariadne 2.0
Multivariate Analysis
Progression of Graphs to Brackets (1)
Progression of Graphs to Brackets (2)

Stretching the string allows us to see through which artifact the dependency is established.
Comparisons / Filter by Author
Comparisons / Filter by Artifact
Results

• Social and technical information is needed and can be combined in visual tools
  – Grounded on ethnographic field studies and user interface evaluation

• Tools can affect self-coordination and performance in aware-critical tasks
  – Individual differences can be overcome
Potential Users

• Project managers or researchers
  – Identify key roles played by developers
    • How do roles change over time
  – Determine coordination needs of team members

• Software developers
  – Identify the “right developer,” or owner
  – Find out which developers have started to integrate their code
Further Details of On-going Work

• Poster: Continuous Coordination within the Context of Cooperative and Human Aspects of Software Engineering
  – Students: Erik Trainer, UC Irvine/ISR, Roger Ripley, UC Irvine/ISR
  – Project Scientist: Ban Al-Ani, UC Irvine, Post-Doc: Anita Sarma, CMU (formerly UC Irvine/ISR)
  – Advisors: André van der Hoek, UC Irvine/ISR, David F. Redmiles, UC Irvine/ISR
Further Reading


