The Need for Context in Software Engineering

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Software development today
What do developers do?

[Meier, Fritz, Murphy, Zimmermann, 2014]

Task Switches:
13.3 (± 8.5) times per hour

Activity Switches:
47 (± 19.8) times per hour

["Software Developers' Perceptions of Productivity", Meier, Fritz, Murphy and Zimmermann, FSE 2014]
I want to ignite your imagination...
Apple’s Knowledge Navigator

https://www.youtube.com/watch?v=umJsITGzXd0
Software development tools are *not* amplifying human intelligence

Study, definition and use of *context* can improve the flow of software development work
MISSING
EXISTS
NEED
01
10
11
What’s MISSING in Software Engineering?
Knowledge Navigator Demo

View the demo as a set of tools connected by context
You have three messages:

your graduate research team in Guatemala just checking in

Robert Jordan, a second semester junior requesting a second extension on his term paper

and your mother reminding you about your father's (cut off)

P: (interrupts by touching screen) surprise birthday party next Sunday
C: Today you have a faculty luncheon at 12:00; you need to take Kathy to the airport by 2; you have a lecture at 4:15 on deforestation in the Amazon rain forest.

P: right, let me see the lecture notes from last semester.
P = Professor
C = Computer

C: (shows notes)

P: No that’s not enough. I need to review more recent literature. Pull up the new articles I haven’t read yet.

C: Journal articles only?

P: Hmmm. Fine.
Your friend Jill Gilbert has published an article about deforestation in the Amazon and its effects on rainfall in the sub-Saharan. It also covers the drought’s effect on food production in Africa and increasing imports of foods.

Contact Jill.
“Context is any information that can be used to characterize the situation of an entity.”
— Dey and Abowd, CHI 2000 Workshop

For this talk, think about **context** as a semantic plane that tools (components, widgets) can consult when acting
Knowledge Navigator Demo

What is the effect of context?
You have three messages: your graduate research team in Guatemala just checking in.

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and your mother reminding you about your father's (cut off)

P: (interrupts by touching screen) surprise birthday party next Sunday.
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right, let me see the lecture notes from last semester.

What is the professor focusing on?

issue of current interest (not on how to access history)
C: (shows notes)

P: No that’s not enough. I need to review more recent literature. Pull up the new articles I haven’t read yet.

C: Journal articles only?

P: Hmmmm. Fine.
Your friend Jill Gilbert has published an article about deforestation in the Amazon and its effects on rainfall in the sub-Saharan. It also covers the drought’s effect on food production in Africa and increasing imports of foods.

Contact Jill.
**Context** can support the **flow** of work...

by reducing the **accidental** complexity and enabling a focus on the **essential** complexity of the problem at hand.
Where is the context in Software Engineering?
MISSING 01 EXISTS 10 NEED 11
10

What context EXISTS in SE?
Focus
on tools
where there is human interaction
Draw largely on examples from my research group.
Kinds of Context

- Static Artifacts
- History
- Dynamic Execution
- Individual Activity
- Team Activity

representative
no claims of completeness
Context as Static Artifacts
Development Environment
Context as Static Artifacts

Development Environment

Development Environment

Quick Type Hierarchy

Project

File

Interface

Context Fragment
Context as History

**Hipikat** [Čubranič & Murphy, 2003]

How have similar bugs been solved?

This completed task is similar and might be helpful

[“Hipikat: Recommending Pertinent Software Artifacts”, Čubranič and Murphy, ICSE 2003]
Context as History

“How have similar bugs been solved?”

[“Hipikat: Recommending Pertinent Software Artifacts”, Čubranić and Murphy, ICSE 2003]
Context as Dynamic Execution

WhyLine [Ko & Myers, 2004]
Context as Dynamic Execution

**WhyLine** [Ko & Myers, 2004]
Kinds of Context

- Static Artifacts
- History
- Dynamic Execution
- Individual Activity
- Team Activity

Activity-centric
Context as Individual Activity

Mylyn [Kersten & Murphy 2006]

What files was I editing for Task A?

["Using Task Context to Improve Programmer Productivity, Kersten and Murphy, FSE 2006"]
Context as Individual Activity

Mylyn [Kersten & Murphy 2006]

Development Environment

What files was I editing for Task A?

Task

File

Class

Context Fragment

content assist based on interest derived from activity

["Using Task Context to Improve Programmer Productivity, Kersten and Murphy, FSE 2006"]
Context as Team Activity

Tasktop
What is the flow time for a feature?

Context as Team Activity

Tasktop

Value Stream Dashboard
Context as Team Activity

Tasktop

Value Stream Dashboard

What is the flow time for a feature?

Business Results

$ COST

Revenue $1,200,000

New Sales $100

QA

100

10

Flow Velocity

682

flow items completed

Flow Efficiency

17%

% of cycle time spent in active states

Flow Time

18

days to close a flow item, on average

Flow Distribution

Flow Load

75

active or waiting flow items, on average

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Kinds of Context

Static Artifacts

History

Dynamic Execution

Individual Activity

Team Activity

representative
no claims of completeness
What is needed to effectively use context in Software Engineering?
MISSING EXISTS NEED
01 10 11
What do we NEED in SE to make context effective?
The fundamental need is to augment human intelligence not...
Four Steps

Recognize    Explain    Experiment    Build
Context exists in other communities...

The Context Toolkit: Aiding the Development of Context-Enabled Applications
Daniel Salber, Anind K. Dey and Gregory D. Abowd

Pervasive Healthcare and Wireless Health Monitoring
Upkar Varshney

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Recognize

Paper Analysis

Approximate analysis of recent papers in major SE conferences

Most uses of “context” are in program analysis sense

Use of “context” as in this talk are rare
What if any paper with a tool includes a section explicitly describing context?
**Inputs:**
- Recent issue history (~>300)

**Outputs:**
- Developer recommendations

---

**Context**

**Requires:**
- Active developers

**Provides:**
- <N/A>

---

The image shows a Bugzilla bug report titled "Unnecessary scrollbars in preferences." The issue details are as follows:

- **Bug ID:** 193787
- **Product:** Eclipse
- **Component:** UI
- **Status:** NEW
- **Resolution:** UNASSIGNED
- **Priority:** P3
- **Severity:** NORMAL
- **Description:**
  
  I've noticed when I click through the preferences pages, sometimes pages have vertical scrollbars even though they don't need one. The extra scroll bar isn't too bad, but it also puts the Restore and Apply buttons off the bottom of the page (requiring a scroll), even though there is usually plenty of room.
Human: Devy, I’m done
Devy: You have uncommitted changes. Should I commit them?
Human: Ok
Devy: OK, I’m about to open a pull request, should I assign Alice?
Human: OK
Context-Aware Conversational Developer Assistants

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ABSTRACT
Building and maintaining modern software systems requires developers to perform a variety of tasks, which can be supported by tools that model contextual information sources. This table lists some context model elements.

Table 2: Context Model elements.

<table>
<thead>
<tr>
<th>Current Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>ActiveFile</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Each Local Repository</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path</td>
</tr>
<tr>
<td>Version Control Type</td>
</tr>
<tr>
<td>OriginURL</td>
</tr>
<tr>
<td>UserName</td>
</tr>
<tr>
<td>CurrentBranch</td>
</tr>
<tr>
<td>FileStatus</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Each Remote Repository</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpenAssignedIssues[]</td>
</tr>
<tr>
<td>Collaborators[]</td>
</tr>
</tbody>
</table>

Other Services
- BlameService
- TestService
- ReviewerAssignmentService
Are there other kinds of context?
Determining what context matters to a tool...
What tool/system architecture will best accommodate context?
How does context relate to ontologies?
So there is lots to do....
01 Missing

10 Have

11 Need

Recognize  Explain  Experiment  Build
Thanks
to my fantastic academic and industrial colleagues, post-doctoral fellows, graduate and undergraduate students, to Mik Kersten and Robert Elves (my co-founders at Tasktop Technologies) and to the fantastic team at Tasktop from whom I have learned so much.
Current tools often cause software professionals to do as much work for the tools as the tools do work for them.
We are passing too much of the *accidental* complexity to the humans decreasing the cognitive power they have for the real problems.
We can do more to enable the humans to focus on the *essential* complexity.
One possible future...

What do you imagine to help bridge the gap?

Thanks to Jason Murphy and Kieran Murphy Vancouver 2018
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