

# CS 4530: Fundamentals of Software Engineering

## Lesson 7.1: Teams

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# software engineering must encompass 3 Ps:

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**PROGRAMS, PROCESSES, AND PEOPLE**

# Learning Goals for this Lesson

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- At the end of this lesson, you should be able to
  - Explain key advantages of working in a team and sharing information with your team
  - Describe the HRT pillars of social interaction
  - Understand why small teams are effective for agile processes
  - Apply root-cause analysis to construct a blameless post-mortem of a team project

# Why Teams? “The 10x Engineer”



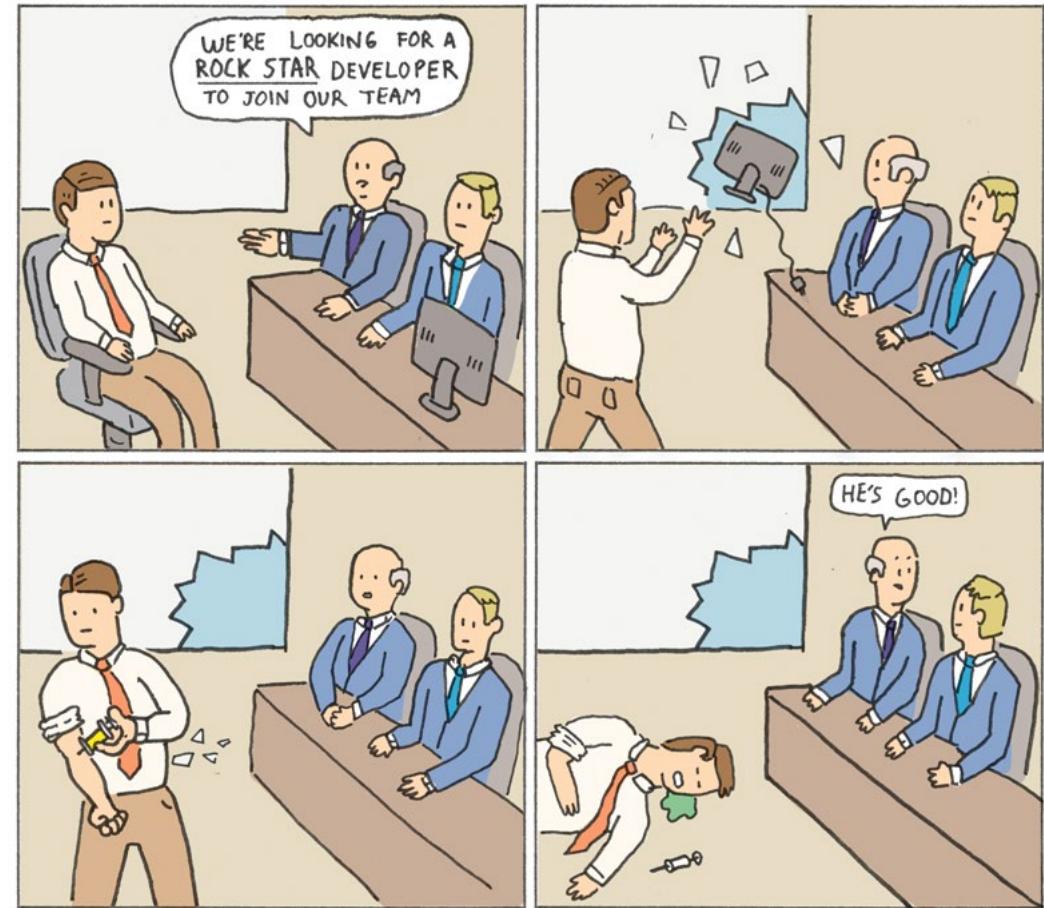
## What makes a 10x Developer?

#10xdeveloper #productivity #beginners #career



Davide de Paolis Mar 11, 2019 • 6 min read

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# Why Teams? Software Engineering Draws on Many Skills

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- Nobody is an expert in *everything*:
  - Product management
  - Project management
  - System-level design and architecture
  - Unit-level design
  - Development
  - Testing
  - Operations
  - Maintenance

# Why Teams? The Bus Factor

Even if one person *can* own all of a project,  
they shouldn't be relied to

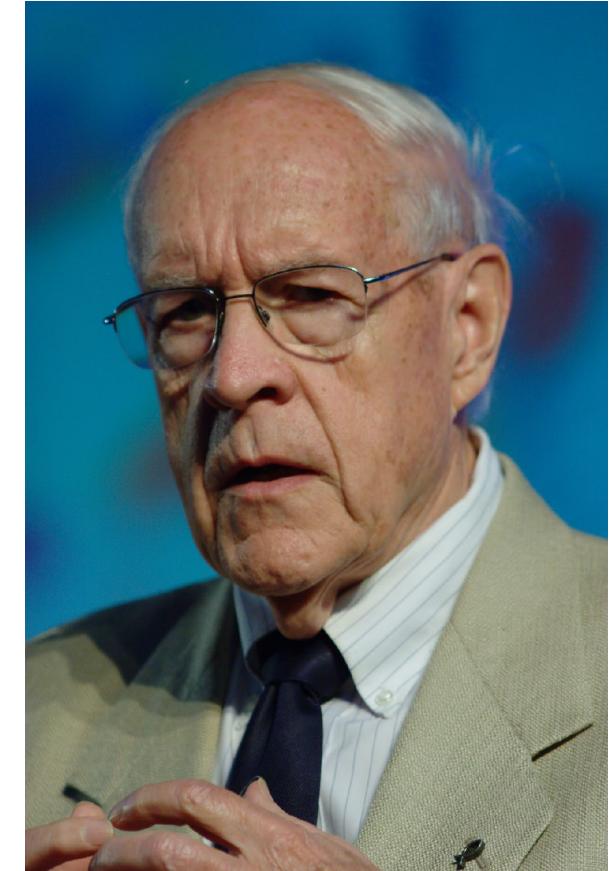


# Teams are hard: Brooks' Law

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“Adding manpower to a late software project makes it later”

Fred Brooks, 1975



# What goes wrong with teams in software development?

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- How do you structure teams effectively?
- How do you encourage teams to share knowledge and collaborate?
- How do you encourage team-members to treat each other well?
- How do you respond to failures?

# How do we structure teams efficiently?

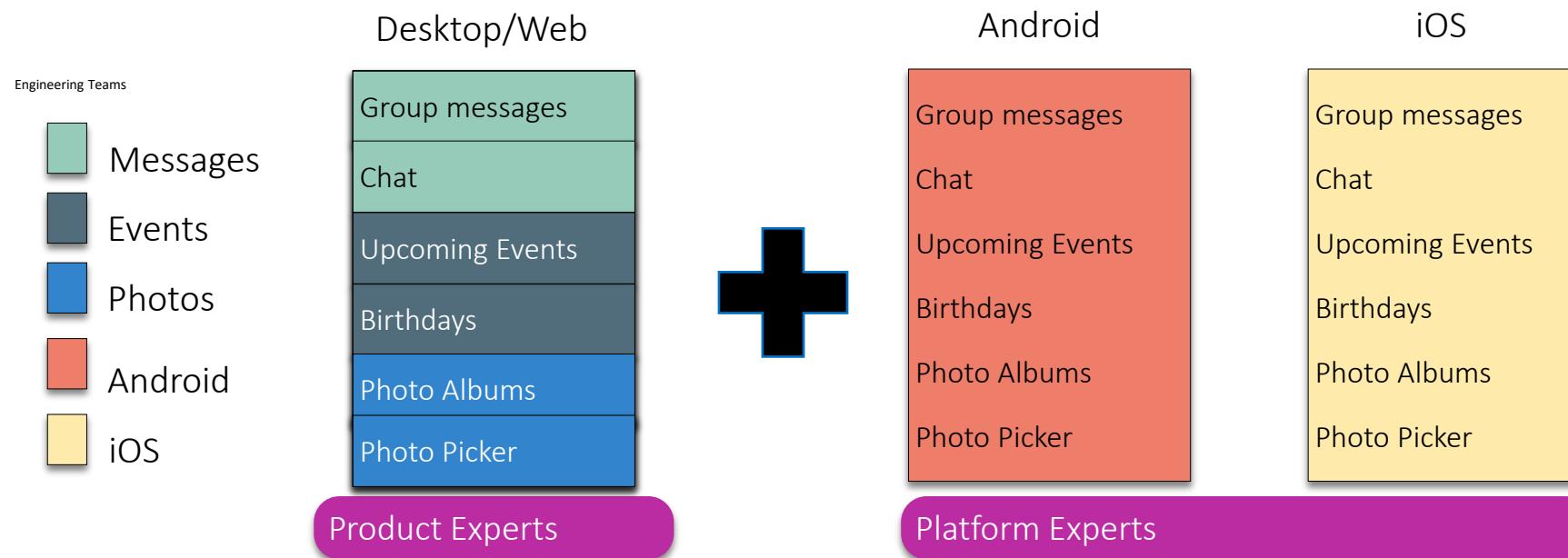
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- Examining Brooks' Law: "Adding manpower to a late software project makes it later"
- How many communication links are needed to finish a task?
- Self-organizing teams have proven more effective



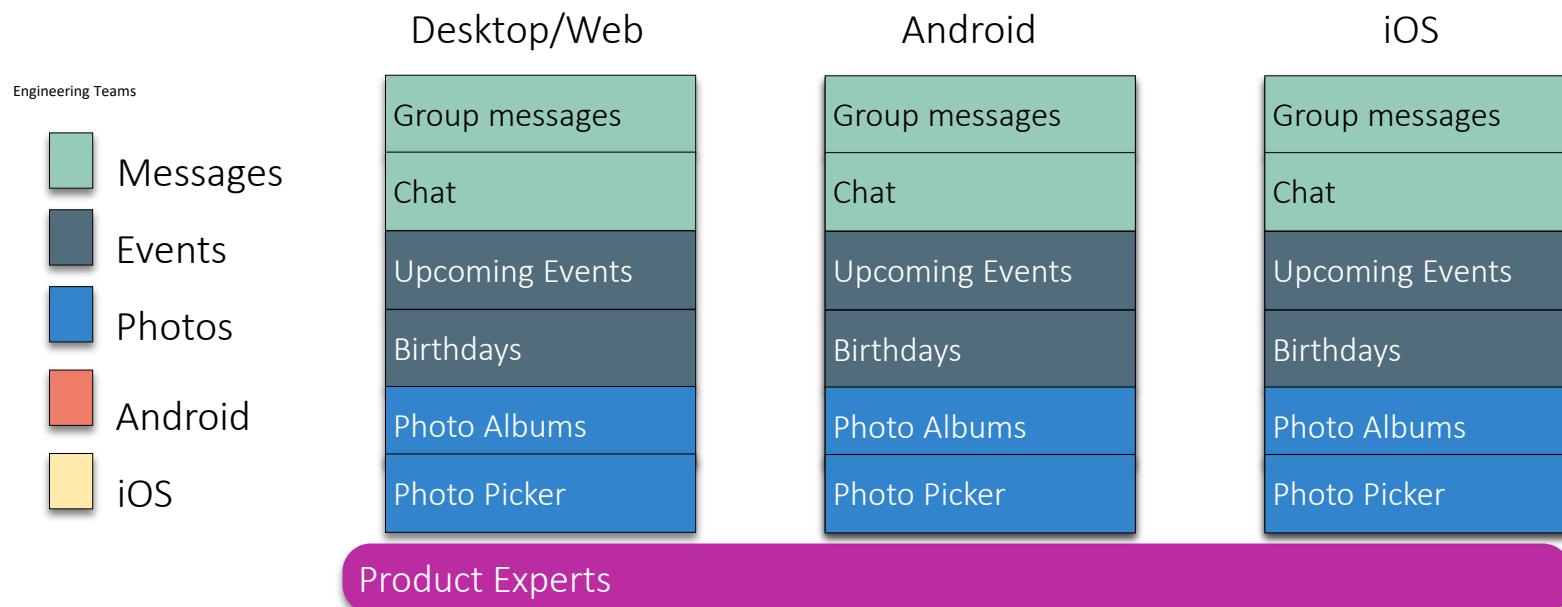
# Facebook originally organized teams by platform each managed the app on their own platform only

- If you work on the android teams, you work on putting all of the apps on android



# But they eventually switched to "product" teams...

- If you are in the chat group, you work on the chat feature in all platforms



# Good Teams create Intentional Opportunities for Knowledge Sharing

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- Ideally, scale linearly (or sub linearly) with org growth
- What kind of approaches do you think could help improve knowledge sharing?
  - "Two Pizza" Teams
  - Pair Programming
  - Code Reviews
  - Multiple sharing channels



## “Two-Pizza” Teams make knowledge sharing easier

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Q: How many people on a team?

A: “No more than you could feed with two pizzas”

Rationale:

- Decrease communication burdens
- Focus conversations to relevant topics

# Pair Programming is a Knowledge Sharing Activity

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- Two programmers work together at one computer, one “driving,” one “navigating”
- Survey of professional programmers (2001):
  - 90% “enjoyed collaborative programming more than solo programming”
  - 95% were “more confident in their solutions” when pair programmed
  - Provides long-term benefits: reduces defects by 15%, code size by 15%
  - Increases costs by 15% to 100% compared to single developer on the task

# Pair Programming Improves Tool Diffusion

- Peer observation and recommendation shown to be more effective at discovering new tools than other knowledge sharing approaches
- Examples: Hot keys, especially for CLI; IDE tricks
- Most common in 2011 survey: “Open Type” feature in Eclipse, developer tools in web browser

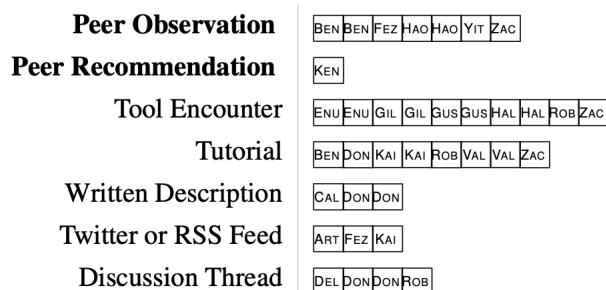


Figure 2: Histogram of the most frequent discovery modes.

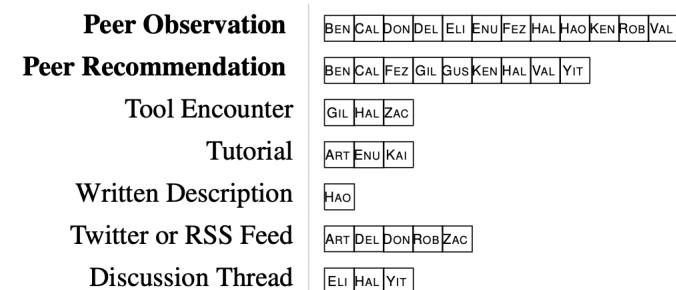
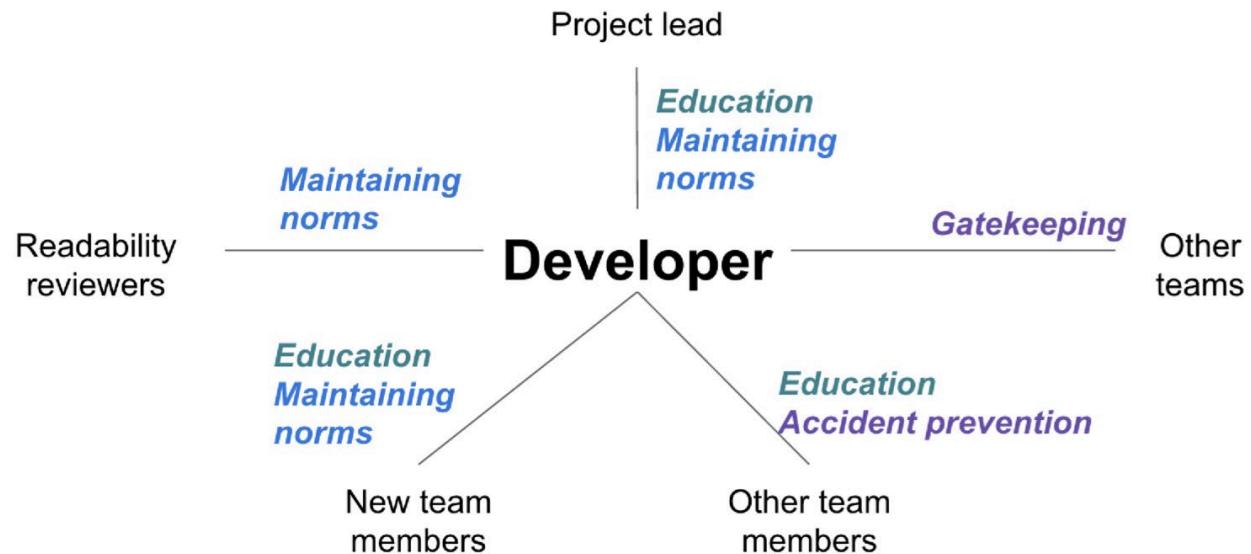
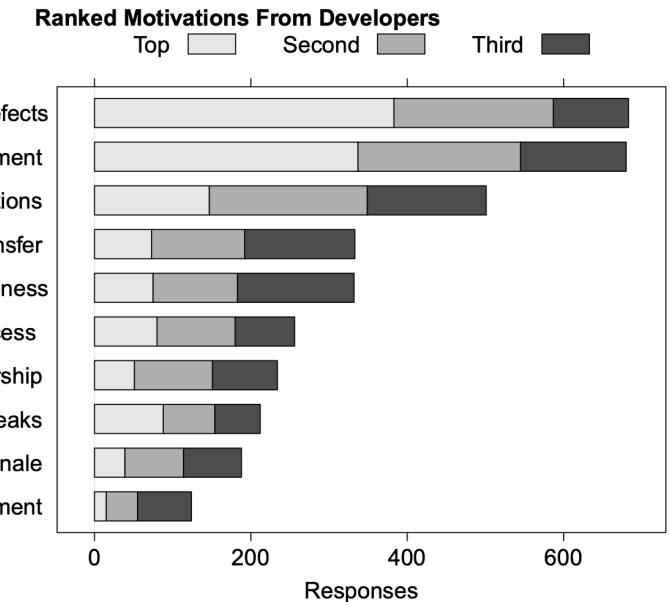


Figure 3: Histogram of the most effective discovery modes.

# Code Review is a Knowledge Sharing Opportunity



"Modern Code Review: A Case Study at Google", Sadowski et al, ICSE 2018



"Expectations, Outcomes, and Challenges of Modern Code Review", Bacchelli & Bird, ICSE 2013

# Scaling Communication linearly requires multiple channels

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- Knowledge sharing needs to scale linearly (or sub linearly) with org growth:
  - Mentorship
  - Q&A
  - Mailing lists
  - Tech talks
  - Documentation

# Standardize and Document Best Practices

## Wikis, blogs, tech talks scale-out more than 1:1 mentoring

- Rule of thumb: once you have explained something to more than two people, maybe you should write a blog post
- Effective organizations cultivate programs to organically collect and share knowledge and best practices
- Example: Google “Testing on the Toilet” (c 2006)
  - significantly increased and sustained adoption of the tools advertised on flyers in toilets

Episode 284  
April 30 2013

*Testing on the Toilet Presents... Healthy Code on the Commode*

**Automatic formatting for C++**  
by Daniel Jasper in Munich

Are you tired of hitting space and backspace more often than anything else while coding? Are you annoyed by fighting over parameter and comment alignment in code reviews?

Consistent formatting allows readers to quickly scan and interpret code, dedicating their attention to what the code does and how it works. Without this consistency, effort is wasted parsing the wide variety of personal styles code might follow. However, keeping your code formatting nice and shiny is not a good task for humans. Luckily, we now have clang-format, which can do this tedious task for you.

Clang-format produces both readable and Google style-compliant code:

```
$ cat file.cc
int a; // clang-format can ..
int bbb; // .. align trailing comments.
#define UNDERSTAND_MULTILINE_MACROS int cc; int d;
LOG(INFO) << "... align operators\n" << "... and many more things";
$ clang-format file.cc -style Google
int a; // clang-format can ..
int bbb; // .. align trailing comments.
#define UNDERSTAND_MULTILINE_MACROS
    int cc;
    int d;
LOG(INFO) << "... align operators\n"
    << "... and many more things";
```

Conveniently integrating with your editor, you can format the current statement or a selected region (available for vim, emacs and eclipse - [go/clang-format](#)). You can also reformat unified diffs, e.g. in a CxC client, by:

```
$ g4 diff -du0 | /usr/lib/clang-format/clang-format-diff.py
```

In addition to making the editor-based code development faster and more fun, consistently using clang-format provides other advantages:

- Code reviewers don't even need to consider whether all your spaces are correct
- Source files become fully machine editable, e.g. for API maintenance

So, give it a try and see how much fun it is to just type everything into a single line and let clang-format do the rest. If you encounter clang-format messing up the formatting, e.g. producing style guide violations, please file a bug on [go/clang-format-bug](#).

**clang-format**  
Learn how to use clang-format in your workflow.  
[http://go/clang-format](#)

**Scythe**  
Want to see your dead code and automatically get rid of it?  
[http://go/scythe](#)

Find out more: [go/CodeHealth](#)

Read all TotTs online: [http://tott](#)

# Communicate Development Activities with Different Channels

- On average, developers use *eleven* channels to stay up-to-date on development activities

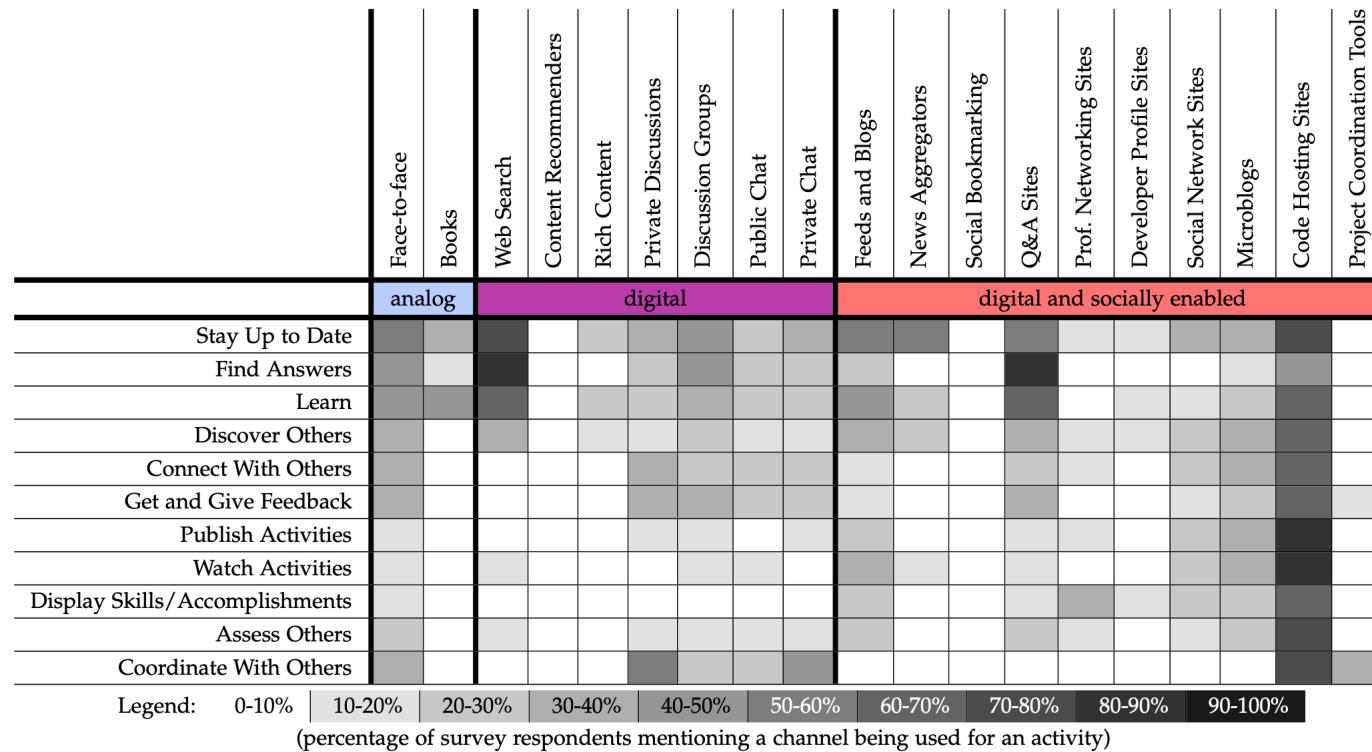


TABLE 4  
Channels used by our respondents and the activities they support.

How do you encourage team members  
to treat each other well?

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# Three Pillars of Social Skills

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- Pillar 1: **Humility**: You are not the center of the universe (nor is your code!). You're neither omniscient nor infallible. You're open to self-improvement.
- Pillar 2: **Respect**: You genuinely care about others you work with. You treat them kindly and appreciate their abilities and accomplishments.
- Pillar 3: **Trust**: You believe others are competent and will do the right thing, and you're OK with letting them drive when appropriate.

# HRT Example: Code Review

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This is personal

Is this really that black and white?

“Man, you totally got the control flow wrong on that method there. You should be using the standard foobar code pattern like everyone else”

Are we demanding a specific change?

Everyone else does it right, therefore you are stupid

# HRT Example: Code Review

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“Man, you totally got the control flow wrong on that method there. You should be using the standard foobar code pattern like everyone else”

‘Hmm, I’m confused by the control flow in this section here. I wonder if the foobar code pattern might make this clearer and easier to maintain?’

Humility! This is about *me*, not you

# Responding to Failures

In software, in humans, and in processes.

How do we learn:

- What went well?
- What went wrong?
- Where we got lucky?
- How do we prevent it from happening again?



# How Not to Respond to Failures

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1. Some engineer contributes to failure or incident
2. Engineer is punished/shamed/blamed/retrained
3. Engineers as a whole become silent on details to management to avoid being scapegoated
4. Management becomes less informed about what actually is happening, do not actually find/fix root causes of incidents
5. Process repeats, amplifying every time

# Blameless Post-Mortems

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- What actions did you take at the time?
- What effects did you observe at the time?
- What were the expectations that you had?
- What assumptions did you make?
- What is your understanding of the timeline of events as they occurred?

# Lessons Learned

## What went well

- Monitoring quickly alerted us to high rate (reaching ~100%) of HTTP 500s
  - Rapidly distributed updated Shakespeare corpus to all clusters
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## What went wrong

- We're out of practice in responding to cascading failure
- We exceeded our availability error budget (by several orders of magnitude) due to the exceptional surge of traffic that essentially all resulted in failures

## Where we got lucky<sup>166</sup>

- Mailing list of Shakespeare aficionados had a copy of new sonnet available
- Server logs had stack traces pointing to file descriptor exhaustion as cause for crash
- Query-of-death was resolved by pushing new index containing popular search term

# Blameless Post-Mortems: Real World Example

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## Summary of the AWS Service Event in the Northern Virginia (US-EAST-1) Region

**December 10th, 2021**

We want to provide you with some additional information about the service disruption that occurred in the Northern Virginia (US-EAST-1) Region on December 7th, 2021.

### **Issue Summary**

To explain this event, we need to share a little about the internals of the AWS network. While the majority of AWS services and all customer applications run within the main AWS network, AWS makes use of an internal network to host foundational services including monitoring, internal DNS, authorization services, and parts of the EC2 control plane. Because of the importance of these services in this internal network, we connect this network with multiple geographically isolated networking devices and scale the capacity of this network significantly to ensure high availability of this network connection. These networking devices provide additional routing and network address translation that allow AWS services to communicate between the internal network and the main AWS network. At 7:30 AM PST, an automated activity to scale capacity of one of the AWS services hosted in the main AWS network triggered an unexpected behavior from a large number of clients inside the internal network. This resulted in a large surge of connection activity that overwhelmed the networking devices between the internal network and the main AWS network, resulting in delays for communication between these networks. These delays increased latency and errors for services communicating between these networks, resulting in even more connection attempts and retries. This led to persistent congestion and performance issues on the devices connecting the two networks.

This congestion immediately impacted the availability of real-time monitoring data for our internal operations teams, which impaired their ability to find the source of congestion and resolve it. Operators instead relied on logs to understand what was happening and initially identified elevated internal DNS errors. Because internal DNS is foundational for all services and this traffic was believed to be contributing to the congestion, the teams focused on moving the internal DNS traffic away from the congested network paths. At 9:28 AM PST, the team completed this work and DNS resolution errors fully recovered. This change improved the availability of several impacted services by reducing load on the impacted networking devices, but did not fully resolve the AWS service impact or eliminate the congestion. Importantly, monitoring data was still not visible to our operations team so they had to continue resolving the issue with reduced system visibility. Operators continued working on a set of remediation actions to reduce congestion on the internal network including identifying the top sources of traffic to isolate to dedicated network devices, disabling some heavy network traffic services, and bringing additional networking capacity online. This progressed slowly for several reasons. First, the impact on internal monitoring limited our ability to understand the problem. Second, our internal deployment systems, which run in our internal network, were impacted, which further slowed our remediation efforts. Finally, because many AWS services on the main AWS network and AWS customer applications were still operating normally, we wanted to be extremely deliberate while making changes to avoid impacting functioning workloads. As the operations teams continued applying the remediation actions described above, congestion significantly improved by 1:34 PM PST, and all network devices fully recovered by 2:22 PM PST.

# Conducting Postmortems

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- Apply this technique after any event you would like to avoid in the future
- Apply this to technical and non-technical events
- Focus on improvement, resilience, and collaboration: what could any of the actors have done better?
- [Google's generic postmortem template](#)

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