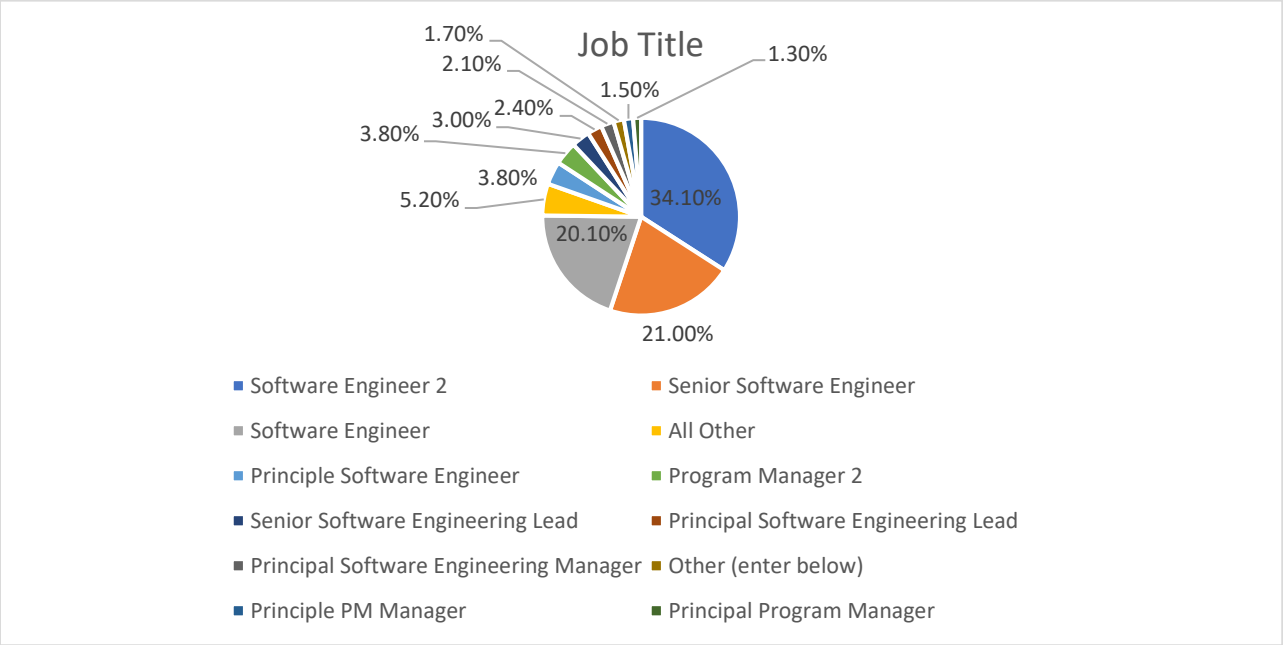
Appendix: In-Depth Survey Analysis

This document details the outcome of a survey concentrating on code review practices and communication during code reviewing. The survey was conducted by Laura MacLeod, Michaela Greiler, Christian Bird and Margaret-Anne Storey and was online in March 2015. 911 respondents shared their opinions about code reviewing, the challenges and its benefits. This section highlights aggregated data of all respondents who indicated to practice code reviewing.

Demographics

Job Title. Most of the respondents (~75%) are either Software Engineers (~20%), Software Engineers 2 (~34%) or Senior Software Engineers (~21%). The rest consist mostly of Principal Software Engineers, SE Leads, SE Managers as well as Program Managers (2 Principals). Details are illustrated in Table 1.

Table 1 Job title of respondents to the code review survey



Most of the managers (~82%) indicate to regularly participate in code reviews. Only few of the respondents manage other mangers (~7%).

The average team size is around 13 people, and the respondents indicate to work directly with 7 people on average.

Experience. 87% of the respondents indicate that they worked at least 2 years in the software industry. 70% more than 6 years, and 40% indicate to have more than 10 years of experience.

Similar, 72% indicate to work for Microsoft for at least 2-5 years, whereby 43% work at MS for at least 6-10 years. 17% indicate to work at MS longer than 10 years.

Most of the respondents (~80.3%) who indicate to practice code reviewing have at least 2-5 years of experience, whereby almost 22% indicate more than 10 years of code review experience.

Interestingly, many of the respondents who report not to practice code reviews are managers with a long experience in the industry.

Co-location. Most teams are completely co-located (73%). Only 11% of the respondents indicate that less than half or none of their team mates are close enough to get a coffee with them.

When it comes to the people respondents interact with during code reviews, we see that code review teams are more distributed than the actual team of the respondents (see Table 2 and Table 3). Still, most respondents indicate to be collocated with at least half of their peers who they interact on code reviews (86%), whereby roughly half of all respondents have all their peers close enough to get a coffee with them (48%). Only 4% indicate to have none of their peers they interact during code review near them.

Table 2 Co-location of team: Of the people you work with on a daily bases what percentage of those people work near you?

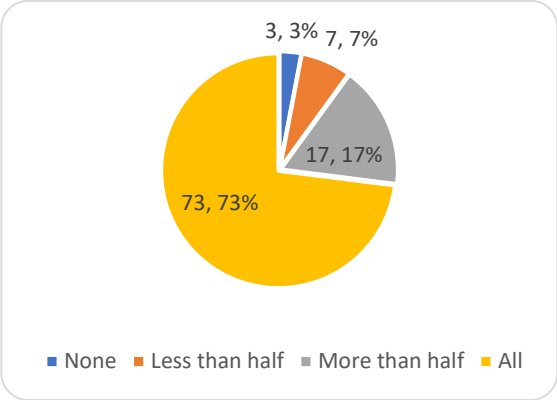
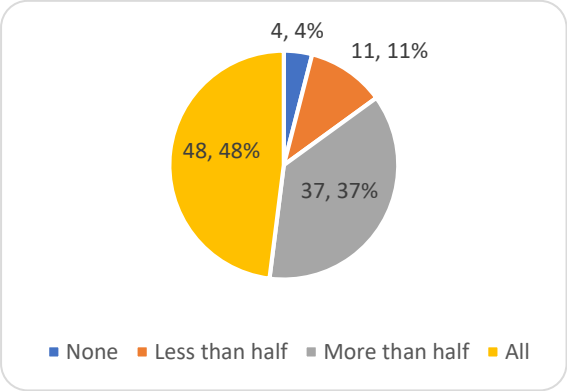


Table 3 Table 2 Co-location of code review team: Of the people you work with on code reviews what percentage of those people work near you?



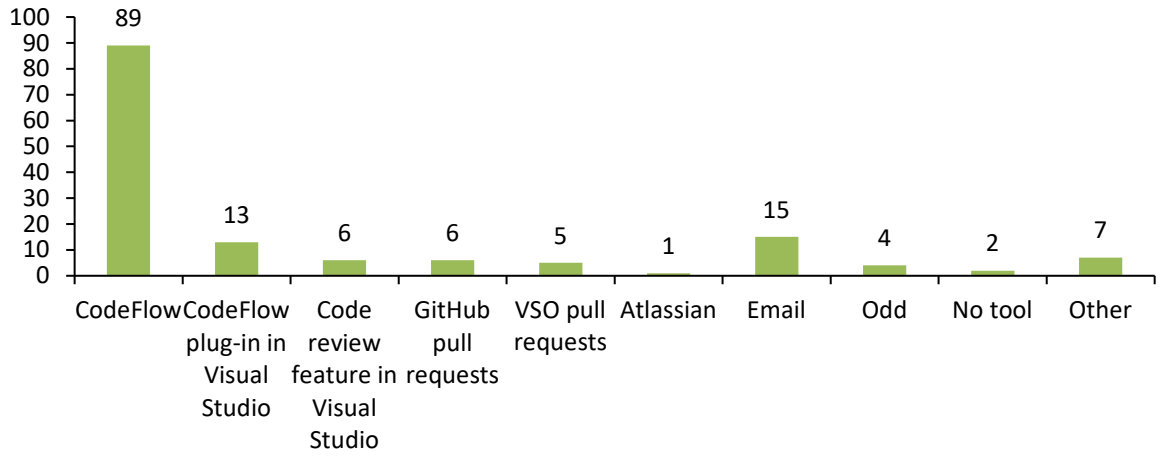
Technical set-up

SourceDepot is still the predominant version control system within the selected population (64%), followed by TFS (41%), and Git with 29%. Other version control systems only account for 4%.[1]

[1] Percentages don't add up to 100% as many respondents use more than one source control solution.

Code review tool usage. A large majority of the respondents (89%) indicate to use CodeFlow as their code reviewing tool. This is followed by Email used as code review tool (15%) and the CodeFlow extension (13%) in Visual studio. Details are illustrated in Table 4. In the category of Other: 2% use Collaborator from SmartBear, and 5% use one of the 30 other named tools.

Table 4 Code review tool usage



Development practices

A majority of the respondents indicate to use an agile development process (77%) or to practice Scrum (69%). Also, 68% indicate to use automated tool support for code checkins like Checkin Wizard.

On the other hand, only 16% indicate to practices pair programming, and even fewer (8%) say they have a formal training on code review practices.

Code reviews

Frequency of performing code reviews. Most respondents indicate to review changes of others at least once a day (39%), whereby 21% review even multiple changes per day. The other large group indicates to review changes a couple of times during the week (36%). The rest indicated to review changes once during the week (12%), or that they did not act as a review during the last week (13%).

Naturally, respondents indicate to author code reviews less often than they act as reviewer. Here, 17% indicate to author code reviews at least once a day, and of those only 5% says they author several code reviews per day. Almost half (48%) say they author code reviews couple of times during the week, and the rest either indicates to have authored a review once during the week (21%) or that they did not act as a review author in the last week (14%).

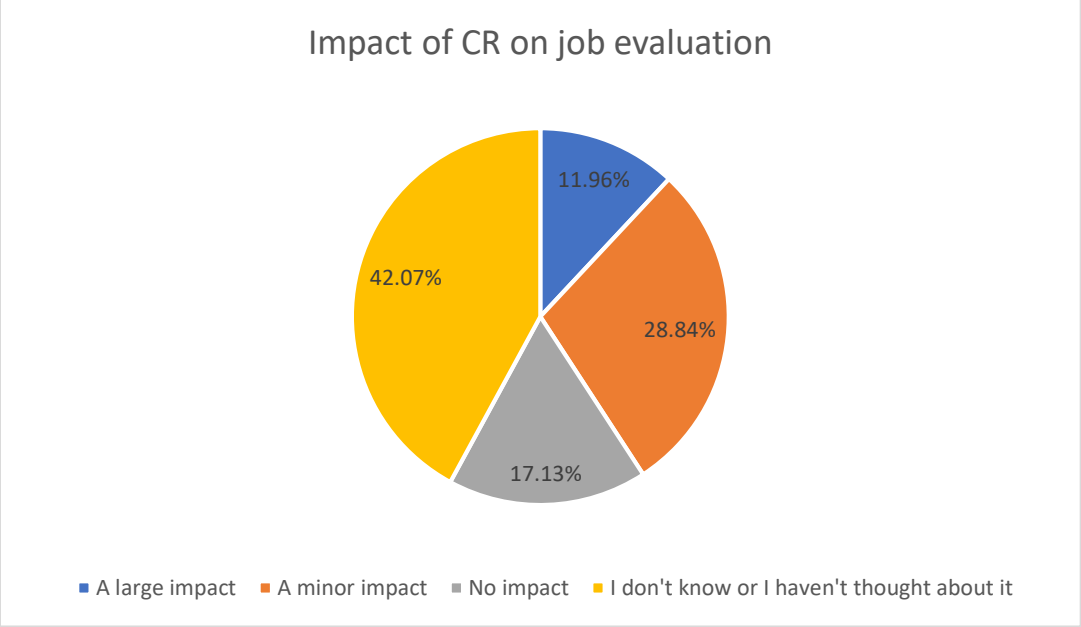
Importance of code reviews. 88% indicate that code reviewing is seen by their team as important or even very important (43%). Only 3% say that their team perceives code review as unimportant or very unimportant.

If they reflect on their own attitude towards code review, respondents paint an even more positive picture. 94% of the respondents indicate that they perceive code reviewing as very important (57%) or important (37%). Only 6% are either neutral (3%) or perceive code review as unimportant or very unimportant.

Policies. It became very clear that most teams require a code review before a code change can be checked in (94%). Also, 84.1% indicate that they have mechanisms in place to keep team members aware of each other's code reviews. On the other hand, respondents are split between those that indicate that their team has rules or policies around code reviews (54%) and those that indicate they have no policies or rules in place (46%). Similar 52% indicate that their team reflects on their code review process, and 48% say they do not.

Code review impact. A large portion of the respondents indicate that the do not know or haven't thought about to what degree their performance in code reviews impacts their job evaluation (42%) (see Table 5). Also, 29% indicate this has a minor impact, and even 17% think it has no impact on their job evaluation. Only 12% think it plays a large impact for their job evaluation.

Table 5 Perceived impact of code reviewing on job evaluation



Reasons for code reviews. The respondents had to rank several reasons that are important to them for performing code reviews as listed in detail in Table 6. The top ranked reasons were code improvements, followed by increased knowledge transfer, and finding alternative solutions.

Table 6 Ranked reasons for code reviewing

Reason for code reviewing	Score*	Overall Rank
Code improvement	2835	1
Find defects	2749	2
Increase knowledge transfer	1528	3

Find alternative solutions	1199	4
Improve the development process	979	5
Avoid breaking builds	957	6
Build team awareness	790	7
Lead to shared code ownership	717	8
Team assessment	235	9

Score is a weighted calculation. Items ranked first are valued higher than the following ranks, the score is the sum of all weighted rank counts.

In the free text, several respondents added additional or slightly different from the pre-defined reasons to review code. One of the reasons that came up most often for performing code reviews is to teach junior or less experienced developers, and let them learn from more experienced developers on the team. Slightly different but on the same track, several respondents indicated that self-improvement, learning and improvement of coding skills is an important reason for code reviewing. Another often named reason to perform code reviews is that code reviews allow the team to develop a coding culture, be exposed to what is seen as best practice within the team, and to learn new coding patterns and to avoid anti-patterns or detect issues. Code reviewing therefore allows to build coherent solutions and code bases. Similarly, several respondents indicate the need to enforce a quality bar, coding standards, enforce clean code and style guidelines. Also, increasing maintainability and readability of the code was also among the often appearing answers.

Another often expressed reason is to build awareness among the team, inform others as well as to get subject matter or area experts' opinions. Therefore, code reviews also help to put the change into perspective, i.e., to get the bigger picture. Some respondents said that the effect of knowing that others look at the changes increases code quality and accountability.

Code review as a tool to perform design, security and architecture reviews and therefore improve the code with respect to those areas was also mentioned. Also testing, especially verifying test coverage and supporting test planning was mentioned as reasons for code reviews. Few respondents said that code reviewing helps them to transition from SDETs to SEs.

Skipping code reviews. More than 400 respondents answered this free text from question on when code review can be skipped. Around 5-7% indicate in their answers that code reviews should never be skipped. During the analysis of the answer for reasons to skip code reviews several common opinions emerged. First, the most common reason respondents believe code reviewing can be skipped is for **small, trivial or minor changes**. The definition of small or minor deviates obviously, but a common understanding of a small, trivial or minor change is that it does **not change the logic of the code**, but addresses things like typos in comments, formatting issues, renames of local variables, removal of dead code, changes to string literals or style issues. Others are more liberal with their definition of small and mainly go by **lines of code touches**. Here very often respondents indicate that one line changes, or changes touching only few lines can be checked in without prior code review. Others think that such small changes

should be code reviewed by over the shoulder reviewing, so less formally than through a tool chain.

Another very frequent occurring reason for skipping code reviews are build breaks. Here, some respondents explicitly mention the time pressure of the **build break** as an additional factor for permitting skipping the code review, whereby others such focus on the size of the fix (i.e., if it is small or well-defined then skipping a CR is okay). Also quite a few respondents talk about emergency situation, including build breaks, hot fixes during odd times or issues with live sites where the **time aspect has priority** and code reviews can be skipped. Some indicate to do after the fact code reviews for changes that are related to time critical issues.

Integrations, FIs/RIs, merges without conflicts or code moves appear among the changes that many respondents indicate as valid for skipping code review.

Also several respondents say that **configuration changes** do not necessarily have to be reviewed. Here, some indicate general configuration changes, whereby others explicitly state that the changes to the configuration must be small and/or well understood.

Other situations that several respondents feel permit skipping code review are changes to code that is **non-production code, private code, prototypes, internal tools or test code**. Few also talk about low-priority parts of the code base, and that changes in those areas might skip code review.

Also code that has been developed during **pair programming** can be permitted into the code base without additional code reviewing.

Another situation which permits skipping code review in the opinion of several respondents is if the **author of the change is the subject matter expert** or the only person knowledgeable in the area or with this part of the code base. Slightly related, some respondents think that code review can be skipped if the change is small and the **developer is confident** that the change is low risk, safe and does not break anything or that **the fix is well known**.

Another category of changes that allow skipping code review has to do with the **type of the change**. Many respondents indicate that non code changes (like changes to binaries, packages, markup or data) can skip a code review. A few respondents also think version number changes, script changes, changes related to logging or build can be skipped. Also some indicate that changes to the UI that cannot break the build can be skipped during code review.

Changes that only **roll back or revert a previous change** can also be skipped according to the opinion of some respondents.

Some respondents talk about that **changes that have been discussed before** with team member or the team lead or that were reviewed otherwise can skip the formal code review process.

Also time constraints like **deadlines and tight schedules** might lead to a skip of code reviewing practices.

Less frequent named reasons for skipping code reviews are if the code is well covered with and **verified by automated tests**, if the change happens in **legacy code**, the code is the same between **several platforms** or branches.

Very few indicate to only perform code reviews for very complex or large changes.

Challenges. The five main challenges developers face during code reviewing are receiving feedback in a timely manner, the review size, managing time constraints and understanding the code's purpose (see Table 7). Other higher ranked challenges are understanding the motivation for the change, obtaining insightful feedback and disputing minor issues while more serious ones are overlooked.

Table 7 Ranked challenges faced during code review

Challenges faced during code reviewing	Score*	Overall Rank
Receiving feedback in a timely manner	1944	1
Review size	1406	2
Managing time constraints	1250	3
Understanding the code's purpose	1243	4
Understanding the motivations for the change	962	5
Obtaining insightful feedback	917	6
Bikeshedding (disputing minor issues while more serious ones are overlooked)	883	7
Understanding how the change was implemented	687	8
Maintaining code quality	686	9
Reaching consensus	548	10
Finding relevant documentation	501	11
Managing multiple communication channels	315	12
Identifying who to talk to	286	13

Score is a weighted calculation. Items ranked first are valued higher than the following ranks, the score is the sum of all weighted rank counts.

When it comes to **acting as a reviewer**, the majority of respondents (73%) indicate that reviewing changes of others improves their confidence as programmers, as can be seen from Table 8. Also 80% believe that they are thorough when looking through changes of others and 89% say that the feel their feedback is respected and that the author considers the feedback.

A less clear picture emerges from answers regarding relationships and judgmental behavior during code reviewing. Here, around half of the respondents (53%) indicate that they do not worry about others judging their abilities as programmers during reviewing. 20% are neutral,

22% agree and 5% strongly agree that they worry about having their abilities judged during code reviewing.

Respondents are split between whether or not the personal relationships with those involved in review have an impact on the code review. 44% believe this is not the case, whereby 34% believe that their personal relationships do impact code reviews, and 22% are undecided[2].

Table 8 Acting as a reviewer: Perception results

	Strongly disagree or disagree	Neutral	Agree or strongly agree
When reviewing, I worry about others judging my abilities as a programmer.	52.50%	20.20%	27.40%
It improves my confidence as a programmer when I review the changes of others.	6.00%	21.00%	73.10%
I am thorough when I review the work of others.	2.20%	18.00%	79.80%
As a code reviewer I feel that my feedback is respected.	1.70%	9.60%	88.70%
My personal relationships with those involved in a review have an impact on my code review.	43.70%	22.40%	33.80%
I am confident that the author considers my feedback.	2.10%	9.30%	88.70%

As a **review author**, almost all respondents (96%) indicate that they appreciate the feedback of the reviewers, as depicted in Table 9. Also, the majority of the respondents claim to express appreciation to reviewers (85%), indicate that reviewing improves their confidence (83%) and that they learn a lot when others review their code (78%). Also, 76% indicate that they are more thorough because they know that the code will be reviewed. On the other hand, a less clear picture emerges when respondents are asked about whether they worry about being judged by others and whether or not the personal relationships impact the code review process. Here, 34% of the respondents indicate to worry about being judged, and 31% indicate that the personal relationships impact the code review process[3].

We can observe that respondents indicate that the appreciate feedback they receive as authors more positive, as they perceive that their feedback is respected during performing code reviews.

[2] Detailed results about respondents' perceptions as reviewer can be found in the appendix Table 20 Acting as a reviewer: Detailed perception resultsTable 20.
[3] Detailed results about respondents' perceptions as authors can be found in the appendix Table 21.

Also as review authors, respondents indicate a slight higher concern about judgments of their skills then when acting as reviewers. Nevertheless, the observed differences are indeed small.

Table 9 Acting as an author: Perception results

	Strongly disagree or disagree	Neutral	Agree or strongly agree
As a review author, I appreciate the feedback I receive from reviewers.	0.70%	3.20%	96.10%
When others review my changes, I worry about them judging my abilities as a programmer.	44.00%	22.50%	33.50%
It improves my confidence when others review my changes	2.80%	13.90%	83.30%
I feel that I am more thorough because I know my code will be reviewed.	8.90%	15.20%	75.90%
My personal relationship to reviewers has an impact when I author a code review.	42.00%	27.30%	30.70%
I express thankfulness to those who review my code.	3.10%	12.00%	84.90%
I learn a lot when other developers review my code.	3.90%	17.60%	78.40%

Additional resources. To gather additional information relevant to code reviews, respondents indicate to use the following three resources most often: contact the review author (49% often, 10% always, 33% sometimes), look at the source code history in the repository (32% often, 39% sometimes and 7% always), and look at source code not in the code review (40% sometimes, 30% often, and 6% always).

On the other hand, the following three resources are not used or are used sparingly: 1) mailing lists (43% never, 29% rarely), 2) style guides (29% never, 33% rarely) and 3) design documentation (27% never, 33% rarely). More details can be found in the appendix in Table 22.

Table 10 Additional resources used during code review

Resources	**Never or rarely**	**Sometimes**	**Often or always**
Bug reports	49.00%	32.10%	18.90%
Contacting the review author	8.00%	33.20%	58.90%
Contacting subject experts (besides the author)	47.10%	35.30%	17.70%
Source code not in the review	23.90%	40.20%	35.90%
Design documentation	60.00%	27.30%	12.60%

Mailing lists	71.70%	20.50%	7.80%
Style guides	62.00%	25.80%	12.10%
Source code history in the repository	23.10%	38.50%	38.40%

Communication channel choices per task. For getting a fast response, F2F discussions (44%) and IM (38%) are the tool of preference for the respondents. Details are shown in Table 11. Especially if there are issues that might reflect badly on someone, F2F communication is preferred by 61% or the respondents compared with all other options. Whereby the code review tool is the tool of choice ([38%-48%]) for asking questions, either about the code change, its history or the reason for the change. The second ranked choice for asking questions is the F2F discussion [24-26%]. To reach a consensus, negotiate a change or find alternative solutions, respondents chose to use F2F discussions ([33-36%]) as well as the code review tool ([27-38%]). Email is the tool of choice for coordination tasks such as scheduling a meeting (72%) or coordinating with other teams (65%). Voice or video chat as well as telephone are almost never used by respondents.

Table 11 Communication channel choice for certain tasks

	Code review tool	**F2F discussion**	**F2F discussion at a whiteboard**	**Video or voice chat**	**Telephone**	**Email**	**IM**	**Responses**
Get a fast response	7.20%	43.60%	3.70%	1.80%	2.00%	4.20%	37.60%	764
Explore alternative approaches	27.30%	32.50%	23.60%	1.20%	0.30%	11.10%	4.10%	758
Communicate issues that may reflect badly on someone	8.60%	61.00%	5.70%	1.10%	0.50%	12.00%	11.20%	753
Reach a consensus	33.60%	32.80%	14.30%	2.20%	0.80%	12.20%	4.10%	760
Schedule a meeting	1.90%	11.10%	3.50%	2.50%	0.70%	71.90%	8.50%	750
Coordinate with other teams	13.30%	8.50%	4.30%	2.50%	0.50%	65.30%	5.60%	645
Negotiate changes	38.10%	35.80%	11.10%	1.70%	0.00%	8.60%	4.80%	651
Ask questions about the code in general	44.20%	25.80%	4.30%	0.60%	0.00%	13.50%	11.50%	651

Ask questions about the history of the code	38.40%	26.30%	2.60%	1.20%	0.20%	16.80%	14.50%	649
Ask questions to understand a change	48.10%	24.20%	6.40%	1.40%	0.20%	8.40%	11.30%	653
Ask questions to understand the reasons for a change	45.60%	25.90%	4.40%	0.90%	0.50%	9.40%	13.30%	652

Not all tasks are faced equally often as highlighted in Table 12. Regarding which tasks the respondents face most often during code reviews, the most often ask a question about the change (45% often, 8% always), reach a consensus (37% often, 10% always) and get a fast response (39% often, 5% always). On the other hand, the rarely or never schedule a meeting (28% never, 52% rarely), communicate issues that may reflect badly (15% never, 51% rarely), and coordinate with other teams (40% rarely, 10% never). More details can be found in Table 23.

Table 12 Frequency of tasks faced during code reviewing

Tasks	**Never or rarely**	**Sometimes**	**Often or always**
Get a fast response	12.70%	43.10%	44.30%
Explore alternative approaches	14.60%	58.60%	26.80%
Communicate issues that may reflect badly on someone	65.90%	28.20%	5.90%
Reach a consensus	14.50%	39.10%	46.40%
Schedule a meeting	79.80%	17.10%	3.10%
Coordinate with other teams	50.20%	37.90%	12.00%
Negotiate changes	22.50%	50.50%	27.00%
Ask questions about the code in general	15.90%	42.90%	41.10%
Ask questions about the history of the code	44.80%	40.00%	15.20%
Ask questions to understand a change	7.60%	39.50%	52.90%
Ask questions to understand the reasons for a change	9.80%	45.60%	44.70%

Before sending out a code review, the majority of the respondents (65%) indicate to always read through their changes looking for errors, and 48% also always run the tests. In total, 92% indicate to always or often read through changes, 79% run tests often or always before sending

out the review, and about half indicate to often or always write tests for a change. Even though respondents indicate the importance of writing a detailed description about the change, only 26% of them indicate to always follow this practice. Still, roughly half of the respondents indicate to write a detailed description either often or sometimes. 17% indicate to never or rarely write such a description. Respondents are split almost evenly on whether or not they give their peers a heads-up on the change to review (35% sometimes, 33% rarely or never, and 32% often or always). The practice less often used is to run static analysis. Here, 44% indicate that the never (25%) or rarely (19%) run static analysis before sending out a code review. The results are highlighted in Table 13and more details can be found in the appendix in Table 24.

Table 13 Tasks performed before sending out a code review

Before sending out a review	**Never or rarely**	**Sometimes**	**Often or Always**
Read through the changes looking for mistakes	2.80%	5.10%	92.20%
Write a detailed description of the code to be reviewed	17.00%	28.30%	54.60%
Get advice from subject matter experts	21.70%	40.40%	37.90%
Give reviewers a heads-up about the review	32.70%	35.40%	31.90%
Run static analysis	44.30%	16.20%	39.50%
Run tests	8.70%	12.50%	78.80%
Create tests	17.80%	28.90%	53.30%

Increase feedback speed. Almost 500 developers used the free text format to express their opinion on how to increase the feedback speed for code reviews. Among the many answers, few very clear categories emerged. The most common suggestion of respondents was to **contact the code reviewers**. Here, they either mentioned to ping or remind the reviewers about the review either F2F, or by IM, email or phone. The also suggested to organize a short code review meeting, and/or to let the reviewers know in advance that they are needed for a code review. Several said that you have to ping early and often or/and set reminders.

Another very frequent occurring suggestion is to **improve the code review** or the code review package. Improvement suggestions include to do small, incremental code reviews, to be rigorous about providing a good description, title, and eventually add comments to explain some code changes. In general, respondents highlighted the need to explain the reason, the background and the motivation for the change to the reviewers.

Another coherent category is the need to **build the right team culture** and perception about code reviews. Respondents stress that code review must be an essential part of the development process, and this includes that it can account for time and also is rewarded. Several respondents

say that code review must be seen as top priority and acted upon (i.e., code reviews are done immediately).

Several respondents also expressed the need to **ask the right reviewers** to review the code. This means to include people that are knowledgeable about the area, but also that have a stake or interest in the code change. Also several respondents stress that it is important to only include few reviewers on the code review and avoid sending out to whole teams or mailing lists.

The last very frequent occurring suggestion was to **review fast yourself** (i.e., be part of the solution not the problem).

Appendix: Survey Slices

Distributed teams versus collocated teams

Remote respondents are slightly more experienced with code reviewing i.e., they indicate less often to have less than 2 years of experience and to not practice code reviewing. Also, they indicate to have worked slightly longer in software industry, but appear to have similar working times at MS.

Remote respondents said that specific practices are used less often, in particular practices like scrum or agile methods. Remote managers indicate to participate less often in code reviews, than their collocated counterparts (68% vs. 81%).

Regarding the importance of code reviews, the remote respondents rate the importance of code reviews slightly less high in their teams' perception than collocated respondents. The same is true for their own opinion on code review importance.

Also, remote participants say less often that a code review is needed before checking in (86.7% versus 94.1%).

Respondents that work remote from their team say that they use email more often as code reviewing tool than the overall population (27% versus 15%).

Interestingly, even though less than half or even none of the immediate team works near the respondents, 10% say that more than half of the people the interact with during code review are near them, and another 5% say that all people the code review with are near them.

Distributed respondents rank "Understanding the motivations for the change" as the second most occurring challenge during code review. For collocated teams this seems less troublesome and only appears on rank 7. Also, distributed respondents rank "Understanding the code's purpose" higher than "managing time constraints" – differing from collocated teams.

Naturally, when choosing the "tool" of choice for several tasks related to code review, remote participants count more on IM, the Code review tool and Email than on F2F discussions. F2F discussions are only the main tool to communicate issues that may reflect badly on others. To reach a consensus most participants use the code review tool, and also 13% of the participants use video conversation. Remote respondents also indicate to use IM (22-23%) and Email (20-

29%) much more frequent to ask questions about a code review than collocated teams which prefer the code review tool (40-50%) and F2F conversations (25-28%).

Interestingly, remote respondents indicate to worry less about others judging their abilities as programmers when reviewing other people changes (64% remote respondents disagree to worry vs. 51% that are collocated) and also indicate that they are less worried about others judging their ability as programmers when sending out code review (59% remote respondents disagree versus 43% or collocated) (see Table 14 and Table 15).

Remote respondents also indicate to more frequently express thankfulness than their collocated counterparts (93% vs. 84%).

Remote respondents believe less that code reviewing makes them more thorough during coding (64% vs. 77% agree to be more thorough).And they also indicate to be less thorough when reviewing changes of others (68% vs 81% agree).

We tested the effects of remoteness for both, either the team of the respondent is not near or the people that are on code reviews are not near the respondent. We could see similar effects for both populations.

Table 14 Distributed versus Collocated respondents' perception about reviewing others changes

Distributed Respondents

	Strongly disagree or disagree	Neutral	Agree or strongly agree
When reviewing, I worry about others judging my abilities as a programmer.	63.51%	17.57%	18.92%
It improves my confidence as a programmer when I review the changes of others.	4.11%	13.70%	82.19%
I am thorough when I review the work of others.	1.37%	30.14%	68.49%
As a code reviewer I feel that my feedback is respected.	0.00%	9.59%	90.41%

Collocated Respondents

	Strongly disagree or disagree	Neutral	Agree or strongly agree
When reviewing, I worry about others judging my abilities as a programmer.	51.27%	20.54%	28.19%
It improves my confidence as a programmer when I review the changes of others.	6.37%	21.81%	71.81%
I am thorough when I review the work of others.	2.26%	16.69%	81.05%
As a code reviewer I feel	1.84%	9.75%	88.42%

My personal relationships with those involved in a review have an impact on my code review.	44.59%	28.38%	27.03%
I am confident that the author considers my feedback.	1.35%	9.46%	89.19%

that my feedback is respected.			
My personal relationships with those involved in a review have an impact on my code review.	43.79%	21.75%	34.46%
I am confident that the author considers my feedback.	2.13%	9.22%	88.65%

Table 15 Distributed versus Collocated respondents' perception as author

Distributed Respondents

	Strongly disagree or disagree	Neutral	Agree or strongly agree
As a review author, I appreciate the feedback I receive from reviewers.	0.00%	1.43%	98.57%
When others review my changes, I worry about them judging my abilities as a programmer.	59.42%	21.74%	18.84%
It improves my confidence when others review my changes	0.00%	13.04%	86.96%
I feel that I am more thorough because I know my code will be reviewed.	11.59%	24.64%	63.77%

Collocated Respondents

	Strongly disagree or disagree	Neutral	Agree or strongly agree
As a review author, I appreciate the feedback I receive from reviewers.	0.74%	3.27%	95.99%
When others review my changes, I worry about them judging my abilities as a programmer.	42.56%	22.62%	34.82%
It improves my confidence when others review my changes	3.27%	13.82%	82.91%
I feel that I am more thorough because I know my code	8.59%	14.37%	77.04%

My personal relationship to reviewers has an impact when I author a code review.	40.00%	31.43%	28.57%
I express thankfulness to those who review my code.	0.00%	7.14%	92.86%
I learn a lot when other developers review my code.	0.00%	21.43%	74.29%

will be reviewed.			
My personal relationship to reviewers has an impact when I author a code review.	42.35%	26.89%	30.76%
I express thankfulness to those who review my code.	3.56%	12.46%	83.98%
I learn a lot when other developers review my code.	4.30%	17.36%	78.34%

Impact in the job evaluation

Respondents that say that code review has no impact on their job evaluation are also less likely to practice some software methodologies such as scrum (63% vs. 73%), or agile development (70% vs. 80%) compared with respondents that think code reviewing has a large impact on their job evaluation. They also use less frequently automated tool support for checkins (62% vs. 71%).

Respondents that think CR has no impact on their job evaluation ($Respondents_{no}$) also indicate that code reviewing is seen as less important than the respondents that think CR has a large impact ($Respondents_{large}$). 78% of the $Respondents_{no}$ say that code reviewing is important (51%) or very important (27%), versus 94% of the $Respondents_{large}$ say that CR is very important (67.3%) or important (26.5%) in their teams perspective.

Similarly, when judging their own attitude torwards code reviewing, we see a significant shift in perceived importance between $Respondents_{no}$ and $Respondents_{large.}$ 73% of the $Respondents_{large}$ say that code reviewing is very important, compared to 43.5% of $Respondents_{no.}$ Most other $Respondents_{no}$ (47%) say it is important, compared to 21% of $Respondents_{large.}$

As to be expected, respondents that say code review has no impact on their job evaluation also report less rigorous practices around code reviews (as highlighted in Table 1Table 16).

Table 16 Slice Impact on Job evaluation: differences between code review process

CR has a large impact on job evaluation			**CR has no impact on job evaluation**		
	Yes	No		Yes	No

Does your team subscribe to rules or policies for conducting code reviews?	61.90%	38.10%	Does your team subscribe to rules or policies for conducting code reviews?	50.40%	49.60%
Does a code change normally require a code review before it can be checked in?	95.90%	4.10%	Does a code change normally require a code review before it can be checked in?	84.80%	15.20%
Does your team have mechanisms to keep team members aware of each other's reviews?	89.70%	10.30%	Does your team have mechanisms to keep team members aware of each other's reviews?	77.50%	22.50%
Does your team review and reflect on their code review process?	69.10%	30.90%	Does your team review and reflect on their code review process?	35.80%	64.20%

$Respondents_{no}$ also participated less frequently in code reviews during the last week, both as authors and as reviewers. Whereby 32% of the $Respondents_{large}$ say the reviewed multiple times a day, only 17% of the $Respondents_{no}$ indicated to do so, and 10% of $Respondents_{large}$ acted as a author compared with 3% $Respondents_{no}$. Also 19% of $Respondents_{no}$ say they did not act as a reviewer compared with 9% of $Respondents_{large}$. 20% $Respondents_{no}$ say they did not act as an author compared to 12% $Respondents_{large}$.

Respondents who indicate that code review does not have an impact on job evaluation, also are less likely to experience that their confidence is improved when the review changes of others (63% vs. 82%), they are less thorough when reviewing the work of others (63% vs. 82%), and slightly feel that their feedback is less respected (83% vs. 89%). See Table 17 for more details. Also, they indicate to learn less during code reviewing, to express thankfulness less often and are less likely to indicate that it improves their confidence when others review their changes (for details see Table 18).

Table 17 Slice impact on job evaluation: perception as reviewer

CR has a large impact on job evaluation				CR has no impact on job evaluation			
	Strongly disagree or disagree	Neutral	Agree or strongly agree		Strongly disagree or disagree	Neutral	Agree or strongly agree
When reviewing, I worry about others judging my abilities as a programmer.	56.52%	14.13%	29.35%	When reviewing, I worry about others judging my abilities as a programmer.	53.03%	21.21%	25.76%
It improves my confidence as a	4.35%	14.13%	81.52%	It improves my confidence as a	10.69%	26.72%	62.60%

programmer when I review the changes of others.				programmer when I review the changes of others.			
I am thorough when I review the work of others.	1.09%	13.04%	85.87%	I am thorough when I review the work of others.	4.55%	21.21%	74.24%
As a code reviewer I feel that my feedback is respected.	4.35%	6.52%	89.13%	As a code reviewer I feel that my feedback is respected.	2.27%	14.39%	83.33%
My personal relationships with those involved in a review have an impact on my code review.	40.22%	18.48%	41.30%	My personal relationships with those involved in a review have an impact on my code review.	37.88%	28.79%	33.33%
I am confident that the author considers my feedback.	4.35%	6.52%	89.13%	I am confident that the author considers my feedback.	3.08%	11.54%	85.38%

Table 18 Slice impact on job evaluation: perception as author

CR has a large impact on job evaluation				**CR has no impact on job evaluation**			
	Strongly disagree or disagree	Neutral	Agree or strongly agree		Strongly disagree or disagree	Neutral	Agree or strongly agree
As a review author, I appreciate the feedback I receive from reviewers.	1.15%	4.60%	94.25%	As a review author, I appreciate the feedback I receive from reviewers.	1.60%	2.40%	96.00%
When others review my changes, I worry about them judging my abilities as a programmer.	43.02%	27.91%	29.07%	When others review my changes, I worry about them judging my abilities as a programmer.	48.00%	23.20%	28.80%
				It improves my	4.00%	24.00%	72.00%

It improves my confidence when others review my changes	2.30%	5.75%	91.95%
I feel that I am more thorough because I know my code will be reviewed.	4.65%	17.44%	77.91%
My personal relationship to reviewers has an impact when I author a code review.	48.28%	21.84%	29.89%
I express thankfulness to those who review my code.	1.15%	6.90%	91.95%
I learn a lot when other developers review my code.	4.60%	11.49%	83.91%

confidence when others review my changes			
I feel that I am more thorough because I know my code will be reviewed.	12.90%	12.90%	74.19%
My personal relationship to reviewers has an impact when I author a code review.	34.68%	29.03%	36.29%
I express thankfulness to those who review my code.	7.32%	11.38%	81.30%
I learn a lot when other developers review my code.	6.45%	27.42%	66.13%

Respondents that do not see an impact of their performance during code review on their job evaluation are less likely to write a thorough description of the change, to get advice from subject matter experts, to give reviewers a heads-up about the review, or to create tests before sending out the review (see for Table 19 details).

Table 19 Slice impact on job evaluation: tasks before sending code review

CR has a large impact on job evaluation			
	Never or rarely	Some-times	Often or always
Read through the changes looking for mistakes	2.38%	7.10%	90.48%

CR has no impact on job evaluation			
	Never or rarely	Some-times	Often or always
Read through the changes looking for mistakes	4.20%	5.90%	89.92%

Write a detailed description of the code to be reviewed	14.29%	20.20%	65.48%	Write a detailed description of the code to be reviewed	20.17%	34.50%	45.38%
Get advice from subject matter experts	14.12%	40.00%	45.88%	Get advice from subject matter experts	30.51%	33.10%	36.44%
Give reviewers a heads-up about the review	23.53%	36.50%	40.00%	Give reviewers a heads-up about the review	36.97%	38.70%	24.37%
Run static analysis	37.65%	17.60%	44.71%	Run static analysis	47.06%	11.80%	41.18%
Run tests	7.06%	11.80%	81.18%	Run tests	10.92%	10.90%	78.15%
Create tests	14.12%	22.40%	63.53%	Create tests	18.49%	26.10%	55.46%
Build and run changes	2.53%	3.80%	93.67%	Build and run changes	5.56%	1.10%	93.33%

Appendix: Raw Results

In this section, the interested reader can find more details on the raw results for many of the discussed survey sections.

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Responses**
When reviewing, I worry about others judging my abilities as a programmer.	17.70%	34.80%	20.20%	22.00%	5.40%	779
It improves my confidence as a programmer when I review the changes of others.	1.50%	4.50%	21.00%	51.20%	21.90%	778
I am thorough when I review the work of others.	0.10%	2.10%	18.00%	59.40%	20.40%	779
As a code reviewer I feel that my feedback is respected.	0.50%	1.20%	9.60%	61.50%	27.20%	780
My personal relationships with those involved in a review have an impact on my code review.	14.30%	29.40%	22.40%	26.10%	7.70%	781

I am confident that the author considers my feedback.	0.40%	1.70%	9.30%	59.40%	29.30%	778

Table 20 Acting as a reviewer: Detailed perception results

Table 21 Acting as a review author: Detailed perception results

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Responses**
As a review author, I appreciate the feedback I receive from reviewers.	0.30%	0.40%	3.20%	41.20%	54.90%	743
When others review my changes, I worry about them judging my abilities as a programmer.	14.20%	29.80%	22.50%	25.90%	7.60%	741
It improves my confidence when others review my changes	0.80%	2.00%	13.90%	52.00%	31.30%	742
I feel that I am more thorough because I know my code will be reviewed.	2.30%	6.60%	15.20%	47.30%	28.60%	744
My personal relationship to reviewers has an impact when I author a code review.	14.40%	27.60%	27.30%	24.60%	6.10%	743
I express thankfulness to those who review my code.	0.80%	2.30%	12.00%	51.60%	33.30%	744
I learn a lot when other developers review my code.	0.70%	3.20%	17.60%	47.80%	30.60%	744

Table 22 Additional resources used during code review: Detailed results

Resources	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**
Bug reports	19.40%	29.60%	32.10%	17.00%	1.90%	100% (747)
Contacting the review author	3.10%	4.90%	33.20%	49.10%	9.80%	100% (754)
Contacting subject experts (besides the author)	17.20%	29.90%	35.30%	16.20%	1.50%	100% (746)
Source code not in the review	7.90%	16.00%	40.20%	29.70%	6.20%	100% (744)
Design documentation	26.80%	33.20%	27.30%	10.70%	1.90%	100% (746)
Mailing lists	42.80%	28.90%	20.50%	7.30%	0.50%	100% (743)

Style guides	29.40%	32.60%	25.80%	10.00%	2.10%	100% (751)
Source code history in the repository	6.70%	16.40%	38.50%	31.60%	6.80%	100% (749)

Table 23 Frequency of tasks faced during code reviewing: Detailed results

Tasks	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**	**Responses**
Get a fast response	1.90%	10.80%	43.10%	39.00%	5.30%	641
Explore alternative approaches	1.10%	13.50%	58.60%	24.30%	2.50%	643
Communicate issues that may reflect badly on someone	15.30%	50.60%	28.20%	4.80%	1.10%	642
Reach a consensus	1.60%	12.90%	39.10%	36.60%	9.80%	644
Schedule a meeting	27.60%	52.20%	17.10%	2.80%	0.30%	644
Coordinate with other teams	10.00%	40.20%	37.90%	11.20%	0.80%	642
Negotiate changes	1.70%	20.80%	50.50%	24.50%	2.50%	644
Ask questions about the code in general	0.60%	15.30%	42.90%	34.70%	6.40%	645
Ask questions about the history of the code	4.80%	40.00%	40.00%	14.10%	1.10%	645
Ask questions to understand a change	0.60%	7.00%	39.50%	45.10%	7.80%	643
Ask questions to understand the reasons for a change	1.10%	8.70%	45.60%	38.30%	6.40%	643

Table 24 Tasks performed before sending out code review: Detailed results

Before sending out a review	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**
Read through the changes looking for mistakes	1.40%	1.40%	5.10%	27.20%	65.00%	725
Write a detailed description of the code to be reviewed	4.50%	12.50%	28.30%	28.90%	25.70%	727

Get advice from subject matter experts	8.10%	13.60%	40.40%	28.90%	9.00%	726
Give reviewers a heads-up about the review	14.40%	18.30%	35.40%	21.30%	10.60%	727
Run static analysis	25.10%	19.20%	16.20%	16.80%	22.70%	728
Run tests	3.60%	5.10%	12.50%	30.40%	48.40%	727
Create tests	6.50%	11.30%	28.90%	32.30%	21.00%	727

Appendix: Complete Survey

For the purposes of completeness and replication, we provide the complete text from the survey deployed for this study below.

We are researchers from the Tools for Software Engineers team and Microsoft Research investigating the code review work practices of developers at Microsoft. We would be greatly appreciative if you would be willing to answer the following questions. The survey shouldn't take more than 15 minutes.

This survey is completely anonymous and all questions are optional. No personal information is required for particpation in this survey. If you have any questions or if you'd rather not participate and want no further contact, please email Laura MacLeod or Christian Bird.
For survey participation, we are also hosting a raffle for two $50 Amazon gift cards. Instructions for the raffle appear after participants submit their responses.

We invited participants by randomly selecting employees at Microsoft that fit our demographic criteria such as their role at Microsoft. We are interested in hearing from employees who have experience with code reviews (as either an author of changes, a reviewer of changes or both). If you do not participate in code reviews, we ask that you still complete the first two questions.

Demographics
The following questions ask about your background and role within Microsoft.

1) What is your title?

2) How many years have you practiced code reviewing?

( ) I do not practice code review ( ) Less than 2 ( ) 2-5 years

( ) 6-10 years ( ) More than 10 years

If you do not participate in code reviews, please scroll to the bottom of the survey and click submit so that we can still get your answers to the first two questions. Thanks!

3) If you are a manager, please answer the following questions.

	Yes	**No**
Do you regularly participate in code reviews?	( )	( )
Do you manage other managers?	( )	( )

4) How many years have you worked in the software industry?

( ) Less than 2 ( ) 2-5 years ( ) 6-10 years ( ) More than 10 years

5) How many years have you worked at Microsoft?

( ) Less than 2 years ( ) 2-5 years ( ) 6-10 years ( ) More than 10 years

Team Demographics
The following questions ask about your team's characteristics.

6) How many people make up your immediate team (including yourself)?

7) Of the number you listed above, how many people on your team do you directly work with?

8) Of those people, what percentage work near you? (i.e. you could get a cup of coffee with them)

( ) None

( ) Less than half

( ) More than half

( ) All

9) What version control system does your team currently use? (Please check all that apply)

[ ] TFS

[ ] SourceDepot

[ ] Git

[ ] Other: _____

10) For the following table, please indicate if your team implements any of the following practices

	Yes	**No**
Pair programming	( )	( )
Uses automated tool support for code check-ins (e.g., a Checkin Wizard).	( )	( )
Provides formal training on code reviews practices	( )	( )
Scrum	( )	( )
An agile development process	( )	( )

11) Based on your experiences, which of the following best describes your team's attitude towards code reviews?
They consider it to be:

( ) Very unimportant ( ) Unimportant ( ) Neutral ( ) Important ( ) Very important

Team Code Reviews
The following questions ask about your team's code review practices.

12) Please answer if your team does any of the following:

	Yes	**No**
Does your team subscribe to rules or policies for conducting code reviews?	( )	( )

Does a code change normally require a code review before it can be checked in?	( )	( )
Does your team have mechanisms to keep team members aware of each other's reviews?	( )	( )
Does your team review and reflect on their code review process?	( )	( )

13) What code review tools does your team currently use? (Choose all that apply)

[ ] CodeFlow

[ ] CodeFlow plug-in in Visual Studio

[ ] Code review feature in Visual Studio

[ ] GitHub pull requests

[ ] VSO pull requests

[ ] Atlassian

[ ] Email

[ ] Odd

[ ] No tool

[ ] Other: _____

14) Of the people you work with on code reviews (either as an author or reviewer of changes), what percentage of those people work near you? (i.e. you could get a cup of coffee with them)

( ) None

( ) Less than half

( ) More than half

( ) All

15) To what degree does your performance in code reviews impact your job evaluation? It has:

( ) A large impact ( ) A minor impact ( ) No impact

( ) I don't know or I haven't thought about it

Code Reviews
The next questions ask about why you do code reviews and for your opinions on the process.

16) Based on your experience, which of the following best describes your attitude towards code reviews?

( ) Very unimportant ( ) Unimportant ( ) Neutral ( ) Important ( ) Very important

17) Why do you do code reviews? Below is a list of **reasons developers do code reviews**. Please choose and rank your top 5 items (with 1 being the most important).

_____Avoid breaking builds

_____Code improvement

_____Lead to shared code ownership

_____Find defects

_____Find alternative solutions

_____Improve the development process

_____Build team awareness

_____Increase knowledge transfer

_____Team assessment

18) If you have other important motivations you wish to share, please briefly explain them below and indicate their level of importance.

19) Do situations occur where you find code reviews can be skipped? If so, briefly describe those situations.

20) Below is a list of challenges developers face in code reviews.
Please choose and rank your top 5 challenges to code reviews (with 1 being the greatest challenge).

_____Understanding the motivations for the change

_____Review size

_____Understanding the code's purpose

_____Finding relevant documentation

_____Identifying who to talk to

_____Obtaining insightful feedback

_____Understanding how the change was implemented

_____Receiving feedback in a timely manner

_____Managing time constraints

_____Maintaining code quality

_____Reaching consensus

_____Bikeshedding (disputing minor issues while more serious ones are overlooked)

_____Managing multiple communication channels

Code Reviewing
The following question asks about your thoughts and actions as a reviewer on code reviews (reviewing changes, not authoring them).

For the next set of questions we want you to think about the recent code reviews you have been a part of in the past week and reflect on those experiences. If you did not act as a reviewer, please answer the next question and skip the rest of the questions in this section.

21) In the past week, how often did you act as a reviewer on code reviews (reviewing changes, not authoring them).

( ) I did not act as a reviewer

( ) Once during the week

( ) A couple times during the week

( ) At least once a day

( ) Multiple times a day

22) To what degree the following statements align with your recent experiences as a reviewer on code reviews.

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
When reviewing, I worry about others judging my abilities as a programmer.	( )	( )	( )	( )	( )
It improves my confidence as a programmer when I review the changes of others.	( )	( )	( )	( )	( )
I am thorough when I review the work of others.	( )	( )	( )	( )	( )
As a code reviewer I feel that my feedback is respected.	( )	( )	( )	( )	( )
My personal relationships with those involved in a review have an impact on my code review.	( )	( )	( )	( )	( )
I am confident that the author considers my feedback.	( )	( )	( )	( )	( )

23) Thinking about your actions as a reviewer on code reviews over the past week, how often do you make use of the following resources to gather additional information relevant to code reviews?

	Never	**Rarely**	**Sometimes**	**Often**	**Always**
Bug reports	( )	( )	( )	( )	( )
Contacting the review author	( )	( )	( )	( )	( )
Contacting subject experts (besides the author)	( )	( )	( )	( )	( )
Source code not in the review	( )	( )	( )	( )	( )
Design documentation	( )	( )	( )	( )	( )

Mailing lists	( )	( )	( )	( )	( )
Style guides	( )	( )	( )	( )	( )
Source code history in the repository	( )	( )	( )	( )	( )

24) Generally as a reviewer on code reviews, indicate which communication channel you would turn to first to do the following tasks:

	Code review tool	**Face to face discussion**	**Face to face discussion at a whiteboard**	**Video or voice chat**	**Telephone**	**Email**	**IM**
Get a fast response	( )	( )	( )	( )	( )	( )	( )
Explore alternative approaches	( )	( )	( )	( )	( )	( )	( )
Communicate issues that may reflect badly on someone	( )	( )	( )	( )	( )	( )	( )
Reach a consensus	( )	( )	( )	( )	( )	( )	( )
Schedule a meeting	( )	( )	( )	( )	( )	( )	( )
Coordinate with other teams	( )	( )	( )	( )	( )	( )	( )
Negotiate changes	( )	( )	( )	( )	( )	( )	( )
Ask questions about the code in general	( )	( )	( )	( )	( )	( )	( )
Ask questions about the history of the code	( )	( )	( )	( )	( )	( )	( )
Ask questions to understand a change	( )	( )	( )	( )	( )	( )	( )

Ask questions to understand the reasons for a change	( )	( )	( )	( )	( )	( )	( )

25) Generally as a reviewer on code reviews, indicate the frequency of which you find yourself doing the tasks mentioned above:

	Never	**Rarely**	**Sometimes**	**Often**	**Always**
Get a fast response	( )	( )	( )	( )	( )
Explore alternative approaches	( )	( )	( )	( )	( )
Communicate issues that may reflect badly on someone	( )	( )	( )	( )	( )
Reach a consensus	( )	( )	( )	( )	( )
Schedule a meeting	( )	( )	( )	( )	( )
Coordinate with other teams	( )	( )	( )	( )	( )
Negotiate changes	( )	( )	( )	( )	( )
Ask questions about the code in general	( )	( )	( )	( )	( )
Ask questions about the history of the code	( )	( )	( )	( )	( )
Ask questions to understand a change	( )	( )	( )	( )	( )
Ask questions to understand the reasons for a change	( )	( )	( )	( )	( )

Code Authoring

The following question asks about your thoughts and actions as an author of code reviews (submitting changes for others to look at).

For the next set of questions we ask you to think about the recent code reviews you have been a part of in the past week, and to reflect on those experiences. If you did not act as an author, please answer the next question and skip the rest of the questions in this section.

26) In the past week, how often did you act as an author of code reviews (submitting changes for others to look at).

( ) I did not act as an author

( ) Once during the week

( ) A couple times during the week

( ) At least once a day

( ) Multiple times a day

27) Thinking as an author of code reviews this past week, how often did you do any of the following before you sent out changes for review?

	Never	**Rarely**	**Sometimes**	**Often**	**Always**
Read through the changes looking for mistakes	( )	( )	( )	( )	( )
Write a detailed description of the code to be reviewed	( )	( )	( )	( )	( )
Get advice from subject matter experts	( )	( )	( )	( )	( )
Give reviewers a heads-up about the review	( )	( )	( )	( )	( )
Run static analysis	( )	( )	( )	( )	( )
Run tests	( )	( )	( )	( )	( )
Create tests	( )	( )	( )	( )	( )
Build and run changes	( )	( )	( )	( )	( )

28) To what degree do you agree with the following statements based on your recent experiences as an author of code reviews.

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
As a review author, I appreciate the feedback I receive from reviewers.	( )	( )	( )	( )	( )
When others review my changes, I worry about them judging my abilities as a programmer.	( )	( )	( )	( )	( )
It improves my confidence when others review my changes	( )	( )	( )	( )	( )
I feel that I am more thorough because I know my code will be reviewed.	( )	( )	( )	( )	( )
My personal relationship to reviewers has an impact when I author a code review.	( )	( )	( )	( )	( )
I express thankfulness to those who review my code.	( )	( )	( )	( )	( )
I learn a lot when other developers review my code.	( )	( )	( )	( )	( )

Best practices
The following questions ask about best practices for code reviews.

29) What do you think is the most important thing developers can do to increase feedback speed on code reviews?

30) What do you think is the most important thing developers can do to increase feedback usefulness on code reviews?

31) What do you think is the most important thing developers can do to increase code review productivity?

32) Please list the top impediment to productivity you encounter on code reviews.

Thank you for taking the time to respond to our survey. We hope that the results of this study will provide meaningful feedback, leading to changes in code review tool support and practices.

33) If you are interested in participating in follow up sessions regarding this survey, or in future studies, please enter your alias below. (Note: this step is completely voluntary. If you wish to participate, but not associate your alias with the answers given in this survey, you may email us separately)

34) Please use the following text box if you have any additional feedback or comments that you feel would be helpful to our research in this area.

If you found anything unclear, or should be changed in this survey, we would love to hear your feedback.