A Study of the Organizational Dynamics of Software Teams

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ABSTRACT

Large-scale software is developed by teams of engineers that work together. The teams' compositions change all the time, with engineers continuously leaving and joining. Learning about these organizational dynamics is vital to understanding how engineers acquire technical skills and business relationships throughout their career. In addition, since employee turnover can be costly to team morale and productivity, it is important for management to learn how to proactively guide the process. In this paper, we report on a study of a professional software development organization in which engineers switch teams frequently. We learned what causes engineers to consider leaving their teams, why they leave, how they learn about new teams, and how they decide which team to join. We also quantify the perceived costs and benefits of recent moves made by the engineers. In addition to reporting the answers to our research questions, we interpret our results to offer recommendations to engineers and their managers on how to ensure that both make better, happier team moves.

CCS CONCEPTS

• **Software and its engineering → Programming teams**;

KEYWORDS

organizational behavior, software engineers, employee turnover

ACM Reference format:
Michael Hilton and Andrew Begel. 2018. A Study of the Organizational Dynamics of Software Teams. In *Proceedings of 40th International Conference on Software Engineering: Software Engineering in Practice Track, Gothenburg, Sweden, May 27-June 3, 2018 (ICSE-SEIP '18),* 10 pages.
https://doi.org/10.1145/3183519.3183527

1 INTRODUCTION

Modern software is developed by teams of people working together. Software teams are not static; rather they constantly change and evolve as new team members join and leave. Within an organization, software engineers can change teams to work on new products, grow their careers, and acquire new technical skills. Team managers take steps to mitigate the impact of turnover, from practicing shared code ownership to avoid the loss of tacit knowledge [1], to supporting inter-personnel relationships which facilitate collaboration [5], to mentoring newcomers in order to enable them to ramp up as quickly as possible [2, 4]. The cost of doing this poorly can be high; some estimate even 200% of an employee's annual pay [1].

Employee turnover is well-studied in the organizational behavior literature [9, 12]. Turnover can be classified along two dimensions: voluntariness and distance. While some engineers voluntarily choose to move teams, others are moved involuntarily. Additionally, some engineers decide to leave an organization, while others simply switch teams within it. Much of the research literature looks at voluntary, external turnover, often in many work domains. The popular press often showcases involuntary turnover in knowledge worker domains (e.g. the cartoon "Dilbert," the TV show "The Office," and the 1999 movie "Office Space"). In this paper, we focus instead on the lesser-studied phenomenon of voluntary, internal turnover in the software engineering domain.

We are interested to learn how turnover manifests itself in a professional, for-profit organization, in which employees can apply for and accept internally available positions. Note that voluntary, internal moves in a corporation differ from such moves in an open source ecosystem, in which engineers have more agency over their fate. In a company, employee transfers are pervasive and dynamic, yet constrained by managers, intra-organizational politics, and availability of sufficient corporate finances. Our work offers insight into the rules of the system and the costs and benefits of such transfers, as perceived by engineers [6]. Looking within a single company helps us identify ways to develop evidence-based policies [3] that enable individuals make the best decisions for their careers, while at the same time help employers ensure they can maintain productive and effective teams to build their organization's software products.

To investigate how software engineer inter-team movement works, we ask six questions:

(1) How long do engineers stay on their teams?
(2) What events prompt engineers to consider switching teams?
(3) Why do engineers want to leave their teams?
(4) How do engineers find new teams to join?
(5) Why do engineers choose particular teams to join?
(6) What are the costs and benefits of switching teams?

To answer these questions, we conducted a study to investigate the recent organizational dynamics in a large (>30,000 person) software company. We limited our study to look at *individual contributors* (ICs) (i.e. employees who do not manage others), both to make the scope more manageable, and to avoid political decisions that affect manager transfers (especially prevalent at higher levels of the organizational hierarchy). We employ mixed methods, relying first on interviews of eight software engineers to learn their career stories in detail, and then corroborating the factors impacting their stories within a larger survey of 374 technical ICs. Finally, we triangulate

ICSE-SEIP '18, May 27-June 3, 2018, Gothenburg, Sweden

ACM ISBN 978-1-4503-5659-6/18/05…$15.00
https://doi.org/10.1145/3183519.3183527

our interview and survey findings with a quantitative study of the most recent six years of internal transfers at the company using a database maintained by its Human Resources department.

Our findings indicate that software engineers spend less than a year on a team before moving to the next. These moves are often triggered by corporate reorganizations, shipping deadlines, promotions, and role changes. About 75% of employee moves are voluntary, and most of those (63%) find their new teams by word-of-mouth. Most engineers voluntarily leave teams because they want to broaden their technical experience or because they do not like how their manager is running the team. Reasons for joining teams are similar: the technology stack is exciting, they like the manager on the new team, and/or they are interested in working for a former manager. Employee transfers incur much less cost than hiring from scratch. Though prior studies say that onboarding can take up to 2 years [2, 4], we found that onboarding onto a new team within the company averages only a few weeks. When thinking about their most recent move, a clear majority of respondents felt their moves were positive for them technically, socially, and politically, even when these moves transferred them further away organizationally and required longer ramp-up times.

In interpreting these results, we learned that there are three important factors that correlate with employee satisfaction with their moves: perceived agency (i.e., how much control the employee had over all aspects of his move process), social aspects (i.e., working with colleagues and managers who you like and growing your social network), and discovering new challenges (i.e., broadening your technical experiences by moving far away from your prior technical comfort zone). We build on our findings and interpretations to offer suggestions to managers and engineers to help them both make better, more harmonious team moves.

Our work makes the following contributions:

- We describe a set of shocks that precipitate employee transfers in software engineering.
- We provide a list of reasons that engineers give for leaving and for joining software teams.
- We identify how software engineers typically go about finding new positions.
- We quantify the perceived costs and benefits of employee turnover.
- We present a set of suggestions for employees and their managers to make better, more informed decisions when switching teams.

2 RELATED WORK

Our study and its methodology are based on theories of employee turnover from organizational behavior. The primary theory is the "unfolding" model [14], which postulated that employees only leave their teams after being precipitated by an external (and sometimes random) shock to the system (*e.g.* a corporate reorganization or a change in immigration status) which prompted them to not just think about such a change of venue, but act on it.

Once shocked, employees follow one of four decision pathways to enact their move. The shock can activate a preplanned response (*e.g.* "I would never work for that guy."), prompt the employee to think about whether to stay on their existing team, consider the merits of moving to a new team, or simply act on a growing dissonance between their current position and where they would like to be. We identify how these shocks and the decision pathways manifest in software organizations. The patterns we uncover can enable organizations to take steps to encourage or discourage particular kinds of transfers to make teams more stable and efficient.

There are several kinds of employee turnover identified in the organizational psychology literature [9, 12]. *Voluntary* turnover occurs when employees choose to leave their teams to find new work elsewhere. In contrast, *involuntary* turnover occurs when employees are laid off or teams are reorganized. The most studied kind of turnover is *external*, in which employees leave their organization entirely (i.e. they move from one company to another). In *internal* turnover, employees move between teams within the same organization. In this paper, we focus on voluntary, internal turnover. We are interested to learn how turnover manifests itself in a single, professional, for-profit, organization in which the employees can apply for and accept internally available positions. This will give us insight into the costs and benefits of such transfers, and by looking within a single company, help us identify ways that this organization's management and employees can mitigate its risks and support its benefits. Note, that voluntary, internal moves in a software corporation differ from such moves in an open source ecosystem, in which engineers have complete agency over their fate. In a company, employees' transfers are somewhat limited by management, intra-organizational politics, and corporate finances. We aim to learn how these contextual factors affect transfers.

Ghapanchi and Aurum developed a systematic literature review of employee turnover in the information technology (IT) domain [9]. As in the software engineering domain, IT workers are highly skilled, enabling them to easily find alternate employment, and making it difficult for organizations to replace them. The authors found that scores of factors have been studied to see how they lead to turnover: job-related factors such as work schedule flexibility and task variety, individual characteristics such as educational level and an intrinsic need for achievement, organizational factors such as promotions and teamwork, psychological factors such as job satisfaction and fatigue, and environmental factors such as family responsibilities and the presence of job alternatives. After reviewing the literature, they identify six gaps in the literature, two of which we address in our study. First, how does technological change affect IT employees' desires to leave their jobs? And second, how do employees' feelings about how and where they fit into their organization, i.e. job embeddedness [17], affect their intent to stay or leave? Our study contributes to our field's understanding in these two areas, helping address the research gaps.

If employees cannot find a place they feel comfortable in the company, then they will leave, leaving a company short-handed in a market where it is difficult to find talent [5]. In the Agile community, some term this a project's "Truck Factor," i.e. what is the impact to a project if its primary contributor gets hit by a truck [25]. Ricca *et al.* found it difficult to define the truck factor well enough to compute it [22]. To put the truck factor into more solid analytical ground, Rigby *et al.* applied financial quantitative analyses to uncover the amount and effects of the loss of knowledge caused by an engineer leaving for greener pastures [23], and proposed an algorithm for

identifying successors within the project to take over the role of the departed employee. Earlier, Mockus had found that employee turnover in a software team was correlated with the loss of team productivity and an increase in customer-visible defects [19]. Donadelli *et al.* reproduced Mockus' study with a new dataset, and found that the addition of newcomers to a team enhanced its quality and reduced the number of defects [7]. Additionally, Mockus explored algorithms to identify successors for code caretakers to ensure the least negative impacts to a project's quality [18].

Lin *et al.* look at five open source projects to identify what factors affect whether developers leave or stay: time to first contribution, maintaining one's own files, and the types of activities they perform [16]. Our study does not quantify employee retention, instead accepting that turnover within a team is a common occurrence. Indeed, even if employees did not regularly leave their teams, their teams would inevitably succumb to corporate reorganization due to external market forces within a year or two anyway.

While software engineers clearly have incentives to move in a way that best aligns with their personal goals, it also benefits an organization when its engineers feel that they are in a good situation. Graziotin *et al.* focus a line of research on the impact of developer happiness on productivity [11]. Through surveys, interviews, and sentiment analysis applied to their work product, they find that developer productivity is correlated with their emotional satisfaction. With another set of collaborators, Graziotin *et al.* also find that developer *unhappiness* leads to poor cognitive performance, stress, burnout, and low motivation [10]. Müller and Fritz found that happy developers work in the "flow" state more often [20] through empirical measurements with biometric sensors. As both an antecedent and effect, employee happiness is an important attribute linked to turnover. In our study, we ask employees about their satisfaction with their most recent team move to learn how happy they are due to the change in team.

3 METHODOLOGY

Our findings come from three sources: interviews with engineers, a large-scale survey, and numerical analysis of the database of employee transfers. All of the data comes from a single organization, a large software company employing over thirty thousand software engineers. At the time of the study, both authors worked for this organization. All of the study methods were approved by the organization's Institutional Review Board. This rest of this section describes our methodology and rationalizes the choices we made.

3.1 Interviews

To gain an initial sense of employee turnover, we randomly selected eight full-time engineering ICs to speak with who had changed teams at least once. They were chosen to be representative of the four divisions at the company and from each of two buckets of tenure (< 5 years, >= 5 years, an educated guess at median tenure). All interviews were voluntary and kept confidential, especially from management and human resources. Both authors conducted and transcribed the interviews.

Each one-hour long, semi-structured interview consisted of 17 questions, designed to elicit responses related to the research questions we presented above. We asked our interviewees to specifically consider their current and most recent job positions to avoid generalizing their thoughts across their entire careers. Some sample questions include, "why did you join this team?," "how did you find the team?," "what made you leave your old team?," and "how different were these teams?" In addition, we presented data from the employee database about each interviewee's moves and asked for explanations of each move and how they came to happen. The responses were then qualitatively coded into categories corresponding to our six research questions.

3.2 Survey

To corroborate our interviews, we developed a survey to be filled out by a random sample of engineering employees at the company. The 22 questions were divided into demographics (e.g. years at work, years on team, team size, role, gender), rationale for leaving and joining teams, processes for finding new teams to join, and a reflective assessment of the employee's past moves. Respondents had one week to respond, and were incentivized to participate by a raffle for USD$100. As before, respondents were assured that all data was kept confidential from management and human resources, and would only be disclosed in anonymized, aggregated form.

Since our survey was about switching teams, we filtered the full-time engineering ICs down to just those 27,000 who had changed teams at least once. We then randomly sampled about 7% of them, and after piloting the survey with four engineers, invited 1,851 new people to take the survey. 374 respondents filled it out, for a response rate of 20.2%. The respondents have worked for an average of 12.2 years in the software industry (SD = 6.1, median = 12, N=368), and an average of 8.4 years at the company (SD = 5.5, median = 7.0, N = 368). 80% of respondents were male. 80% of respondents worked at corporate headquarters; the rest worked in satellite offices. The median team size reported was 7–10 people.

3.3 Employee Database

Our final data source was human resource data about every past and current employee since 2011. It includes start date, termination date (if no longer working at the company), geographic work location, job role, and management chain. It contains a row whenever any of the employee's data fields change, including all changes of management. Overall, there are records for >30,000 engineers currently working at the company, and about twice that many when including current and former employees. The average time at the company is 8.9 years (SD = 6.0, median = 7.4, $N > 30,000$), which is similar to what the the survey respondents reported.

The raw data was not straightforward to use, so we spent some effort to clean, reorganize, and simplify it. For example, we dichotomized geographic work location into "corporate headquarters," where the clear majority of workers are, and "satellite offices," which are spread around the world. We dichotomized tenure at the company at 4 years, the median value for the engineering population, because our interviews suggested that people's team change decisions vary by their tenure.

We examined the approximately seven million table rows related to changes in employee data over time. Several kinds of corrupted data required cleaning, for example, we elided rows in which someone's manager changed, but then changed right back within 30 days

because our interviews showed this kind of change was spurious. We developed heuristics to resolve date ranges where employees were shown to have two managers at the same time. We also filtered the data to represent only technical full-time employees, removing interns, vendors, and employees with non-technical job roles. We filtered out managers, resulting in a drop to 1.3 million data rows, which we used in all subsequent analyses.

3.4 Independent and Dependent Variables

In our study, we employed a large set of independent and dependent variables. We defined 6 demographic variables: years in industry, tenure at the company (dichotomized by the median time of 4 years), working at corporate headquarters, number of managers an employee had per year since 2011, the number of people on your most recent software team, and the organizational distance between your most recent team and your current one (defined as the sum of the number of levels of management between the common ancestor manager of your old team and your new team). We had 5 survey response variables: whether you left your team voluntarily, whether you chose the team you joined voluntarily, the reasons for leaving your most recent team, the reasons for joining your most recent team, how you found your new team. Finally, we measured 5 dependent variables in our survey: time to onboard to your new team, and move satisfaction in four categories: technical, social, political, and overall.

3.5 Threats to Validity

To address our study's internal validity, we triangulated results from our interviews with our survey, and our survey with our employee database. Each dataset is 2 orders of magnitude larger than the other, enabling us to check the interpretations we made in one phase of the study with the much larger datasets in the next. Conversely, we used survey answers to validate the assumptions we made to filter the employee database to *real* team changes. Other researchers have also found identifying teams to be complicated [26]. Consequently, we talk about team moves and changes of manager semi-interchangeably, when these may differ slightly. We have no data from employees who have never switched teams (for instance, newer employees). We also never asked how people felt about their current work assignments, so if attitudes have changed in the last year, we would not be able to tell.

Our study was conducted on employees from a single company. Without replication at other companies, one should not blindly apply our findings to other organizations. Our findings do match results from organizational behavior studies of for-profit organizations. However because our employment context is significantly different from open source ecosystems, Some conclusions from these studies will have limited applicability here.

4 RESULTS

4.1 RQ1: How long do engineers stay on their teams?

In our interviews, we learned that people switch teams often during their career. They change managers as well, even during their time on a team. In an analysis of 150,000 management changes found in the employee database, we found that full-time technical employees spend a median of 1.5 years with each manager (the 95% confidence interval is 5 months to 6 years).

In our survey, we only asked people how long they had worked on their *current* team. 35% reported under 1 year, 33% reported 1–2 years, 24% reported 3–4 years, and 8% reported greater than 4 years. In summary, the median reported that they had spent 1–2 years on their current team, and 92% of survey respondents had worked on their teams 4 or fewer years. Looking at survey respondents' data in our employee database, we found that they stayed a median of 10 months under the same manager, which is in the lower half of the entire employee population. According to a recent report by Paysa, technical employees average 1.23–2.02 years at ten popular tech firms (e.g. Facebook, Google, Microsoft, etc.) [21], which fits our data as well.

> Answer: Software engineers change teams frequently throughout their careers, spending about a year and a half with each manager.

4.2 RQ2: What events prompt engineers to consider changing teams?

According to the theory, people change teams when prompted to act via an external and often unexpected event. Synthesized from various questions in our interviews and survey, we learned about the events caused people to move at our company: reorganizations, a change in product focus, a new manager, a cancelled project, layoffs, a shipping deadline, receiving a promotion, receiving an unsolicited job offer, changing job roles, and needing to move due to geography.

Completing a shipping deadline was often a trigger to search for teams that could broaden an engineer's technical experience and make them more valuable within the company. A change in the product focus could co-occur with a corporate reorganization, a change in manager, or after a shipping deadline. In each case, engineers in our interviews said that if the new focus was "not what they signed up for," they would consider switching teams.

In the company, it can take several years of impressing a manager to receive a promotion to the next level. If an engineer left in the middle, she would have to start the process all over again. Interviewees told us that they would typically stay with a team until they received the expected promotion, or until they figured out that it would never happen. Switching teams was the consequence.

When we mention layoffs as a shock, we do not just talk about the people who are asked to leave the company. Those that are left behind start to question whether their teams (especially if organizationally close to those that got let go) are a safe place for them to continue growing their careers. If the answer is no, they will look for a safer, more stable team within the company.

> Answer: There are social, organizational, political, and personal shocks which prompt employees to consider moving.

4.3 RQ3: Why do engineers leave their teams?

In our interviews, we gave engineers a list of management changes mined from the employee database and asked them to tell us the story of their career. What made them leave their teams? Was it

Table 1: The reasons chosen by survey respondents to explain why they voluntarily left a team, divided into six clusters using cluster analysis (N=234). Reasons and clusters are non-mutually-exclusive and do not add up to 100%. Clusters were named by the authors.

Clustered Reasons for Leaving a Team	%
Leave Cluster 1: Change is coming	**52.6**
I did not like the technology stack	24.6
I chose to switch teams during a reorganization	17.1
My team's charter changed	16.7
My manager left	9.2
Other team members left	7.9
The team had too much turnover	7.9
Leave Cluster 2: Seeking new challenges or location	**39.0**
I changed roles (e.g. from test to dev)	17.5
I wanted to move to a new geographical location	13.6
Wanted new challenges	6.1
Move to a specific project	2.2
Not interested in team's work	2.2
Leave Cluster 3: Dissatisfaction with manager	**31.6**
I did not agree with my manager's priorities and goals	22.4
I did not like my manager	18.0
I did not like something my manager did	14.9
Leave Cluster 4: The grass is greener	**12.3**
I wanted to try something new	3.5
New opportunity too good to pass up	3.1
Did not like management chain	1.6
Team had limited scope	1.3
Leave Cluster 5: Not a good fit	**5.3**
I was bored	3.9
The team didn't need my skills	2.2
Leave Cluster 6: Poor team dynamics	**4.4**
Team was dysfunctional	1.3
No room to grow	1.6

voluntary? One interviewee said: "*I moved because I changed roles. I changed from being a tester to a developer, so I moved to a new manager.*" From this data, we created survey questions that asked respondents to pick (non-exclusively) any number of reasons to explain why they voluntarily left their most recent team. They also had three "Other" slots to add their own answers. We received 508 answers from 234 respondents. The authors conducted a card sort to classify the "Other" answers and identified 26 additional reasons beyond the 11 choices that were listed on the survey. Answers chosen by at least 5 respondents are listed in Table 1.

The most frequent answer was that the engineer did not like the technology stack. From our interviews, we learned that this meant that the software engineers were tired or bored of using a particular programming language, API, or service to create their product. They wanted to work with something new. For example, P8 said: "*It has been three years, and if I think about the learning curve ... it had kinda flattened out. I felt that I needed fresh air.*" The next two popular answers were that the engineer did not like his manager or agree with the way work was prioritized. One interviewee told us she felt the manager micro-managed, so she was "*not feeling empowered to design features.*"

Next, we conducted a hierarchical cluster analysis on the reasons because we found that several answers were highly correlated. Our distance metric was 1−Correlation(LeaveReasonX, LeaveReasonY) for all pairs of Leave Reasons, where we counted the number of times respondents chose both leave reasons, divided by the number of times that the respondents chose at least one of the leave reasons. Using Ward's method, we found 6 distinct clusters.

We call Cluster #1, "Change is coming." It includes choosing to move during a reorganization, when the team's charter, manager, and/or other team members changed, or when they no longer liked the technology stack. Cluster #2, "Seeking new challenges or location," relates to engaging new challenges, including new roles (e.g. from tester to developer), moving to specific new projects, no longer being interested in the old team's work, or moving to a new geographic location. The next most popular cluster is #3, "Dissatisfaction with the manager," which relates to not liking the manager because of something he did or because they no longer like the manager's priorities and goals. Cluster #4, "The grass is greener," is also about trying something new. It is related to having specific opportunities to work on something new, no longer liking the current management chain, or being on a team with limited scope. Cluster #5 is called "Not a good fit," and relates to being bored, sometimes because the respondent felt the team did not need him anymore. Finally, Cluster #6, "Poor team dynamics," is connected to working on a dysfunctional team where they could not grow enough.

We conducted nominal logistic regressions to evaluate how well the leave reason clusters were correlated with our independent variables: employee tenure (less than 4 years), working at corporate headquarters, team size of the respondent's most recent team, and the number of managers per year the employee has had since 2011. The statistical data for all of our results can be found in Table 2. We found a negative correlation between the number of managers an employee had per year and Leave Cluster #2, "Seeking new challenges or location" (Table 2, Line 1). There was a strong positive relationship between a respondent's tenure at the company (> 4 years) and Leave Cluster #3, "Dissatisfaction with the manager" (Table 2, Line 4). Finally, we also found a positive relationship between team size and Leave Cluster #6, "Poor team dynamics" (Table 2, Line 3).

> Answer: There are six clusters of reasons why engineers leave their teams: they sense change is coming, they are seeking new challenges or location, they are dissatisfied with their manager, they feel the grass is greener somewhere else, their current team is not a good fit, or their team suffers from poor team dynamics.

4.4 RQ4. How do engineers find new teams?

Voluntary vs. Involuntary Moves. Some of the shocks presented in Section 4.2 trigger *voluntary* team moves in which the person considers their options and makes a choice to switch teams. However, some of them force *involuntary* moves in which the employee has little or no agency to decide where they go. Sometimes an employee has no ability to choose which team to join, either. We asked survey respondents whether their most recent move was voluntary

Table 2: Move satisfaction is a Likert scale ranging from -2 to 2. Move distance is measured in the number of managers. Onboarding time is measured ordinally from no time at all up to 4 months. $Mean_T$ and $Mean_F$ show the means of the distributions of the true and false (T/F) values of the variables in each row. We show only the statistically significant relationships between dependent (factor) and independent variables.

#	Independent	Factor	Test	Statistic	N	P-value	$Mean_T$	$Mean_F$
1.	Num Mgrs / Year	Leave Cluster 2 (T/F)	ANOVA	F(1, 218) = 8.8192	219	0.0033 ∗ ∗	T: 0.92	F: 1.1
2.	Num Mgrs / Year	Join Cluster 4 (T/F)	ANOVA	F(1, 221) = 11.0035	222	0.0011 ∗ ∗	T: 1.26	F: 0.98
3.	Team Size	Leave Cluster 6 (T/F)	Mann-Whitney	U = 1550	226	0.0013 ∗ ∗	T: 10	F: 0
4.	Tenure >4 yrs? (T/F)	Leave Cluster 3	Fisher's Exact		226	0.0267∗	T: 34.4%	F: 14.7%
5.	In Corp HQ (T/F)	Mgr found team?	ANOVA	F(1, 229) = 10.0555	230	0.0017 ∗ ∗	T: 5%	F: 23%
6.	In Corp HQ (T/F)	Move satis., social	Mann-Whitney	U = 5317	308	0.0117∗	T: 0.79	F: 1.23
7.	In Corp HQ (T/F)	Move satis., political	Mann-Whitney	U = 5202	307	0.0165∗	T: 0.65	F: 1.06
10.	Voluntary Leave? (T/F)	Move satis., technical	Mann-Whitney	U = 7003	312	< 0.0001∗∗∗	T: 1.43	F: 0.93
11.	Voluntary Leave? (T/F)	Move satis., social	Mann-Whitney	U = 6502	310	< 0.0001∗∗∗	T: 1.06	F: 0.39
12.	Voluntary Leave? (T/F)	Move satis., political	Mann-Whitney	U = 8031	308	0.0061 ∗ ∗	T: 0.83	F: 0.45
13.	Voluntary Leave? (T/F)	Move satis., overall	Mann-Whitney	U = 6150	310	< 0.0001∗∗∗	T: 1.39	F: 0.72
14.	Leave Cluster 1 (T/F)	Move satis., social	Mann-Whitney	U = 9509	223	0.0100 ∗ ∗	T: 1.11	F: 0.73
15.	Leave Cluster 1 (T/F)	Move satis., overall	Mann-Whitney	U = 9646	224	0.0133∗	T: 1.38	F: 1.09
16.	Leave Cluster 3 (T/F)	Move satis., social	Mann-Whitney	U = 5060	223	< 0.0001∗∗∗	T: 1.50	F: 0.69
17.	Leave Cluster 3 (T/F)	Move satis., political	Mann-Whitney	U = 6695	222	0.0094 ∗ ∗	T: 1.04	F: 0.63
18.	Leave Cluster 3 (T/F)	Move satis., overall	Mann-Whitney	U = 6271	224	0.0005∗∗∗	T: 1.56	F: 1.10
19.	Leave Cluster 4 (T/F)	Move satis., overall	Mann-Whitney	U = 3017	224	0.0256∗	T: 1.46	F: 1.18
20.	Voluntary Join? (T/F)	Move satis., technical	Mann-Whitney	U = 5233	305	< 0.0001∗∗∗	T: 1.49	F: 0.74
21.	Voluntary Join? (T/F)	Move satis., social	Mann-Whitney	U = 5024	303	< 0.0001∗∗∗	T: 1.09	F: 0.18
22.	Voluntary Join? (T/F)	Move satis., political	Mann-Whitney	U = 6460	301	0.0013 ∗ ∗	T: 0.86	F: 0.32
23.	Voluntary Join? (T/F)	Move satis., overall	Mann-Whitney	U = 4682	303	< 0.0001∗∗∗	T: 1.42	F: 0.57
24.	Join Cluster 1 (T/F)	Move satis., technical	Mann-Whitney	U = 4105	312	0.0109∗	T: 1.55	F: 1.12
25.	Join Cluster 2 (T/F)	Leave Cluster 6	Fisher's Exact		228	0.0066 ∗ ∗	T: 43.0%	F: 24.8%
26.	Join Cluster 2 (T/F)	Move satis., social	Mann-Whitney	U = 5127	310	0.0328∗	T: 1.28	F: 0.98
27.	Join Cluster 3 (T/F)	Move satis., social	Mann-Whitney	U = 3595	309	0.0097 ∗ ∗	T: 0.74	F: 1.20
28.	Join Cluster 3 (T/F)	Move satis., political	Mann-Whitney	U = 3689	307	0.0344∗	T: 0.58	F: 0.94
29.	Join Cluster 3 (T/F)	Leave Cluster 2	Fisher's Exact		227	< 0.0001∗∗∗	T: 68.0%	F: 30.0%
30.	Join Cluster 3 (T/F)	Leave Cluster 6	Fisher's Exact		227	0.0001∗∗∗	T: 10.0%	F: 37.3%
31.	Join Cluster 4 (T/F)	Leave Cluster 2	Fisher's Exact		228	< 0.0001∗∗∗	T: 6.7%	F: 42.9%
40.	Word of mouth? (T/F)	Move satis., technical	Mann-Whitney	U = 14258	312	< 0.0001∗∗∗	T: 1.54	F: 1.12
41.	Word of mouth? (T/F)	Move satis., social	Mann-Whitney	U = 13445	310	0.0034 ∗ ∗	T: 1.10	F: 0.72
42.	Word of mouth? (T/F)	Move satis., overall	Mann-Whitney	U = 13580	310	< 0.0010∗∗∗	T: 1.41	F: 1.07
50.	Move distance	Voluntary Leave? (T/F)	Mann-Whitney	U = 4042	247	< 0.0001∗∗∗	T: 9.3	F: 7.6
51.	Move distance	Voluntary Join? (T/F)	Mann-Whitney	U = 3088	242	< 0.0001∗∗∗	T: 9.3	F: 7.2
52.	Move distance	Leave Cluster 5 (T/F)	Mann-Whitney	U = 485	180	0.0072 ∗ ∗	T: 11.4	F: 9.2
53.	Move distance	Onboarding time	ANOVA	F(5, 235) = 3.9040	240	0.0020	No time at all: 7.5 3–4 months: 9.9	
60.	Onboarding time	Join Cluster 1 (T/F)	Mann-Whitney	U = 4000	312	0.0263∗	T: 5.4	F: 6.6
61.	Onboarding time	Join Cluster 4 (T/F)	Mann-Whitney	U = 3832	312	0.0457∗	T: 4.1	F: 5.8
62.	Onboarding time	Voluntary Leave? (T/F)	Mann-Whitney	U = 8018	312	0.0077 ∗ ∗	T: 5.8	F: 4.6
63.	Onboarding time	Voluntary Join? (T/F)	Mann-Whitney	U = 6733	305	0.0026 ∗ ∗	T: 5.6	F: 4.4

or not. The results are shown in Table 3. Around three-quarters of team moves were voluntary. We synthesized the "It's complicated" response when respondents used an optional text response to say they felt "encouraged" to leave, or made a mutual decision of where to go next with their manager.

For the 72 survey respondents whose most recent move was involuntary, we asked them to explain why. 80.5% of them said it was due to a corporate reorganization, 29.2% said their team was dissolved, and 9.7% said that their project was canceled completely (respondents could choose multiple responses).

When engineers consider voluntarily leaving a team, unless they received an unsolicited job offer, they need to look for a new team to join. Our interview participants told us that they found new positions by word-of-mouth, job postings on an internal web site,

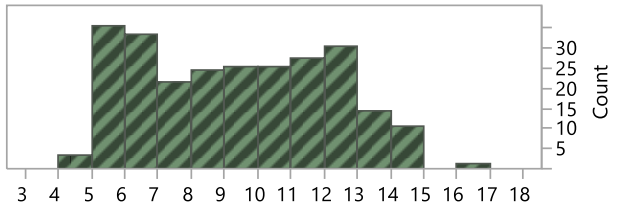

Figure 1: Histogram of the organizational distance between teams of survey respondents who switched teams (N=248).

or had their manager find them a new team. We corroborated these with answers from 202 survey respondents, and found that 63.4% of respondents found their new teams by word-of-mouth, 34.2% from internal job postings, and 9.4% through their manager.

We conducted nominal logistic regressions to evaluate how well the ways engineers found new teams were correlated with our demographic variables. We found one negative relationship between working at corporate headquarters and having your manager find your next team (Table 2, Line 5).

Organizational Move Distance. We used the employee database to discover the organizational distance of the most recent time when the survey respondents switched teams, and present its histogram in Figure 1. We define the organizational distance as the number of managers one would have to traverse in the organizational hierarchy tree to go from one team to the other at the time of the move. There is a peak in the histogram around 5–6 managers, likely representing intra-division moves. The exact number of managers traversed to move between divisions depends on exactly where each team lives in the hierarchy, so it is not possible to draw a line between intra-division and inter-division moves.

We regressed the move distance from our survey respondents against our demographic variables, but found no significant relationships. We checked for difference in the move distance if the respondent indicated that leaving the team was voluntary or not and found a positive relationship (Table 2, Line 50). We found a similar positive relationship between the organizational move distance and a voluntary choice of which team to join (Table 2, Line 51).

We then analyzed the move distance against the clusters of reasons explaining why people left their teams. We found one positive relationship between the organizational move distance and Leave Cluster #5, "Not a good fit" (Table 2, Line 52). There were no significant relationships between move distance and any Join Cluster.

> Answer: 3/4 of engineers change teams voluntarily. Most often, they find their new teams by word of mouth. If they choose their next team, engineers move further away organizationally.

4.5 RQ5: Why do engineers choose particular teams to join?

Our interview participants gave us a list of reasons why they chose particular teams to join. We created a survey question with these answers that asked respondents to pick (non-exclusively) any number of reasons to explain why they voluntarily joined their most recent team. They also had three "Other" slots to add their own answers.

Table 3: Survey respondents who classified their most recent time leaving and joining a team as voluntary, involuntary, or something more complicated.

	Voluntary	Involuntary	It's complicated
Leave (N=315)	72%	24%	4%
Join (N=308)	75%	22%	3%

We received 702 answers from 235 respondents. The authors conducted a card sort to classify the "Other" answers and identified 9 additional answers beyond the 14 listed on the survey. The answers chosen by at least five respondents are listed in Table 4.

The most frequent answer was that the technology on the new team was exciting. Many respondents also said that the move would help them broaden their technical experience. For example, P8 said: *"I had only worked on services up to that point, and I wanted to add front-end skills to my toolbox."* Third and fourth were answers appreciating the manager of the team and how she ran things.

A surprisingly high fraction (31.7%) of respondents say they were invited to join the team. In addition, a surprisingly high fraction (14.2%) say they joined the team to work with a prior manager. We triangulated this result with the team move data from the employee database. We found that out of approximately 63,000 times that technical employees changed managers in the last six years, over 9,000 of them switched teams to work with a former manager (some, many times, though, almost never to the same team they had been on together in the past). Crunching the numbers, this turns out to

Table 4: The reasons chosen by survey respondents to explain why they chose to join a team, divided into four clusters using cluster analysis (N = 235). Reasons and clusters are non-mutually-exclusive and do not add up to 100%. Clusters were named by the authors.

Clustered Reasons for Joining a Team	%
Join Cluster 1: Liked the new team or technology	**85.8**
The technology was exciting	57.7
I wanted to broaden my technical experience	47.6
I liked the manager when interviewing	38.8
I liked the way the team was run	34.8
I wanted to work on high visibility project	23.3
Join Cluster 2: Back together again	**37.8**
Someone on the team invited me to join	31.7
I wanted to work with a previous co-worker	16.3
I wanted to work for a previous co-worker	6.2
Join Cluster 3: Joined for better opportunities	**24.5**
I liked the geographic location of the team	15.9
It was the only option I had	5.3
Project domain is more interesting	5.3
I could have more impact	2.2
Join Cluster 4: I followed my manager	**14.6**
I Wanted to work for a former manager	13.7
I followed my manager to their new team	3.5

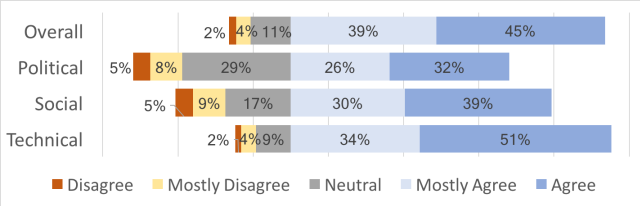

Figure 2: The percentage of people reporting that their most recent team move was good for them, technically (N = 312), socially (N = 310), politically (N = 308), and overall (N = 310).

represent 14.4% of all team moves, and is similar to the number of survey respondents changing to work for their former managers.

Next, we conducted a hierarchical cluster analysis on the reasons because we found that several answers were highly correlated with one another. We used the same method as for clustering the leave reasons. We found there were four clusters of join reasons. Cluster #1, "Liked the new team or technology," related to liking the new team's manager, management style, its technology, and the project's increased visibility in the company. Cluster #2, "Back together again," is related to how respondents found out about the team: someone invited them to join, or they wanted to work with or for a former co-worker. Cluster #3, "Joined for better opportunities" is a mix of several options: for some it was the only option they had, they liked the new team's geographic location or project domain, or it was a place they could have more impact. Finally, Cluster #4, "I followed my manager," is about working for a former manager.

We conducted a nominal logistic regression to evaluate how well the join reason clusters correlated with our independent variables. We found a positive relationship between the number of managers an employee has per year and Join Cluster #4, "I followed my manager" (Table 2, Line 2). In other words, people who choose a team because they are following a former manager switch teams more often. Perhaps, they are more easily dissatisfied with bad managers.

Next, we looked for correlations between the leave and join clusters to see if there were reasons that co-occurred using 2-tailed Fisher's exact test. We found four significant relationships (Table 2, Lines 26, 27, 28, 30, respectively). Join Cluster #2, "Back together again," is positively related to Leave Cluster #3. Join Cluster #3, "Joined for better opportunities," is positively related to Leave Cluster #2, "Seeking new challenges or location," but negatively related to Leave Cluster #3, "Dissatisfaction with your manager." And, Join Cluster #4, "I followed my manager," is negatively related to Leave Cluster #2, "Seeking new challenges or location."

> Answer: There are four clusters of reasons why engineers join their teams: they like the new team or technology, a coworker asked them to join, they joined for better opportunities, or they were following a manager they liked.

4.6 RQ6. What are the costs and and benefits of switching teams, as perceived by engineers?

There are many costs and benefits to switching teams. From the perspective of management, a change in team membership can impact the team's overall capacity, i.e. its ability to produce a certain amount of work. In the long-term, a gain of a team member can increase a team's capacity, but in the short-term, it may experience lower average productivity while someone on the team trains the newcomer. P3 relayed that *"new team members have been great for morale, but there is absolutely takes time to come up to speed. Recently a senior team member joined, and he is still coming up to speed."*

We saw that these individual perspectives fell into two buckets. The first was about move satisfaction. Was the move good for their technical skills, their social relationships, their political standing, and overall? The second related to the sense of challenge they sought. How long did it take to onboard (i.e. ramp up) to do the work on the new team? We asked these questions to our survey respondents and present the results in Figure 2 and Table 5. This question was posed to all survey respondents who had changed teams, no matter whether if it was voluntary or not.

Move Satisfaction. Overall, 84% of respondents report that they agree or strongly agree with the statement, "The move was good for me, overall." About the same number feel this way about the technical aspects of their move. A smaller number of respondents (67%) feel this way about the social benefits of their move, and only 58% feel this way about the political benefits of their move. Very few report negative effects from switching teams in any of the four questions (Range = 5%–13%).

We ran an ordinal logistic regression to see if there were significant relationships between respondents' answers to these questions and our independent variables. We found significant relationships between working at corporate headquarters and reporting lower social and political satisfaction with their move (Table 2, Lines 6–7).

Next, we ran regressions against the clusters of reasons that people report leaving and joining teams and found several significant relationships. Those who chose Leave Cluster #1, "Change is coming," reported greater social and overall satisfaction with their move than those who did not (Table 2, Lines 14–15). Respondents who chose Leave Cluster #3 reported greater social, political, and overall satisfaction with their moves than those who did not (Table 2, Lines 16–18). Those who chose Leave Cluster #4, "The grass is greener," reported greater overall satisfaction with their move than those who did not (Table 2, Line 19). Those who chose Join Cluster #1, "Liked the new team or technology," felt better about their move than those who did not (Table 2, Line 24). Those who chose Join Cluster #2, "Back together again," reported greater social satisfaction with their move than those who did not (Table 2, Line 26). Finally, those who chose Join Cluster #3, "Joined for better opportunities," felt less social and political move satisfaction than those who did not (Table 2, Lines 27–28).

We looked for relationships between move satisfaction and changing teams voluntarily. Voluntarily leaving and joining a team were both positively associated with all aspects of move satisfaction: technical, social, political, and overall (Table 2, Lines 10–13, 20–23). When participants found their next team by word of mouth, they felt better about the move technically, socially, and overall (Table 2, Lines 40–42).

Onboarding Time. Respondents reported the amount of time they thought it took them to onboard when they most recently switched teams. We show this in Table 5. We were surprised by these results. Almost 20% onboarded in no time at all. Even the

Table 5: Percentage of respondents reporting the how long it took to onboard onto their most recent team (N = 313).

	Weeks:			Months:		
No time	**Up to 1**	**1–2**	**3–4**	**1–2**	**3–4**	**5–6**
19.5%	7.7%	16.6%	24.9%	17.6%	6.4%	3.2%

median onboarding time is less than a month! The amount of time reported here is much less than seen for complete newcomers to other technology companies [2, 4]. The shortened period is probably caused by a significant overlap of knowledge required to work for different teams within the same company.

We ran an ordinal logistic regression to see if there were relationships between respondents' answers and our independent variables. We found a significant positive relationship between onboarding time and the organizational distance of the move (Table 2, Line 53). This makes sense — the further away organizationally someone moves, the longer it takes them to ramp up.

Next, we ran regressions against why people leave and join teams and found two significant relationships. Those who chose Join Cluster #1, "Liked the new team or technology," or #4, "I followed my manager," reported shorter onboarding times than those who did not (Table 2, Lines 60–61). We also found that those who voluntarily left their team or voluntarily chose which team to join reported longer onboarding times than those who did not (Table 2, Lines 62–63). These two results make sense, since voluntary moves are associated with moves to a team more organizationally distant, with correspondingly less overlap in technology and procedures, and require more time to ramp up. There were no relationships between move satisfaction and onboarding time.

> Answer: Respondents who voluntarily chose to leave their team, chose which team to join, and found that team through word-of-mouth, were much happier with the outcome of their move, but also took longer to onboard.

5 DISCUSSION

In this section, we discuss our interpretation of the findings from our study, and offer suggestions to engineers and managers on how to ensure harmonious job placement in a company.

5.1 Interpretations

Perception of Agency. Lenberg *et al.* found that a software engineers' *readiness for change* and *openness to change* are predicted by their feelings of *participation* in the change process [15]. The statistical tests in our study indicate that move satisfaction is positively related to the voluntariness of the leave and join actions (Table 2, Lines 10-13 and 20-23). However, when we looked at the data more closely, we we were surprised to find that 9.4% of employees who classified their leave and join actions as voluntary also said that their manager had found their new position for them. Perhaps, employees feel agency when they can control when they move, even if they do not control the destination. In addition, some respondents said that they chose to leave their team just prior to an impending re-organization, possibly to gain a sense of agency over their career path. This is corroborated by the same statistic as above — when employees were involuntarily moved to new teams, they were less satisfied with the results.

Seeking new challenges. We saw in our survey that many engineers said that they moved teams to find new challenges (i.e. Leave Cluster #1, "Change is coming," Leave Cluster #2, "Seeking new challenges or location," Join Cluster #1, "Liked the new team or technology," and Join Cluster #3, "Joined for better opportunities."). More specifically, they related a desire for new challenges, to change roles at the company, to expand their skills and abilities by learning new technologies and tool-chains, and to have more impact. We also see that when seeking new challenges, employees move farther and take longer to onboard. These imply that there will be a higher organizational cost to these moves. Despite the higher costs, engineers say they are highly satisfied with their moves. We feel that the diversification and expansion of employee skill sets will provide more value to the company, and justify any added costs.

Social aspects of switching teams. The Leave and Join Clusters chosen by a large fraction of survey respondents relate to the social aspects of team moves (i.e. Leave Cluster #3, "Dissatisfaction with manager," Leave Cluster #4, "The grass is greener," Leave Cluster #5, "Not a good fit," Leave Cluster #6, "Poor team dynamics," Join Cluster #2, "Back together again," and Join Cluster #4, "I followed my manager"). In addition, almost one-third of all respondents said they left their team because they did not like their manager, and one-seventh move to follow a former manager that they do like. Those that left because of their manager moved further away organizationally (likely to another department), which we know from our results in the previous section come with a greater cost of onboarding. Given the significant number of employees that move due to management, we propose companies should track this in a metric that we would call *manager magnetism*. We could define this as the number of employees that move to follow a former manager minus the number of employees that move to leave a manager they do not like. Companies should seek to minimize the number of moves due to poor management and keep neutral or increase the number of employees willing to follow good managers.

5.2 Implications

Embrace change. Our data show that software engineers change teams often, and for a wide variety of reasons. In addition, for the most part, they feel satisfied with their moves, as long as they were able to choose to do so voluntarily. Our message for engineers is to accept that change will happen. Consider switching teams during times of change, to ensure you end up on a team you like. For best results, engineers should be proactive about choosing opportunities. Managers who wish to better support their employees should recognize that internal turnover is commonplace and normal, and think of employees who leave positively, like "graduates," rather than negatively blame them for walking away. Cultivate a team culture where switching teams is expected and encouraged. When changes are happening, empower engineers to make their own decisions about which team to join.

Management preferences. We noticed that engineers who report following former managers to new teams also switch managers more often than others. Perhaps their experiences having many managers leads them to be more sensitive to management practices

they do not appreciate [8, 13], or perhaps they have a more difficult time finding managers they like. Some engineers told us that they might stay with a manager they did not like in hopes of a promotion. Note however, that switching because of management, whether good or bad, tends to increase the longer an engineer has worked at the company. Perhaps, engineers begin to recognize that *who* they work with is as or more important than what technology they work on. When employees leave a team because of management, they feel better about their move than those that moved for other reasons. To engineers, we suggest that if you are having a hard time with your manager (and you do not expect a promotion soon), consider moving to another team.

Social networking. The most common way for employees to find a new team is to learn about it by word of mouth (i.e. through their social network of friends and colleagues). In fact, twice as many employees found their position through word of mouth over the internal job discovery tool. And, those that used word-of-mouth were more satisfied with their moves than others. It would also be unsurprising to expect that managers receiving recommendations for new hires from common colleagues would be more likely to give the ideas more serious consideration. We suggest that employees should pay careful attention to building their social network. It is the best way to find your next position when an unexpected shock occurs. When corporate restructuring occurs, managers should let employees choose their next teams, instead of keeping them on teams where their prior skills lay. Employees reported greater satisfaction when moving further away organizationally, even though it took more time to onboard. For human resources, we suggest building a tool to notify employees when their former managers' or co-workers' teams have job openings available. This will facilitate lateral team moves along employees' preferred social relationships.

Recommenders. There are many recommendation tools [24, 27] for open source software engineering which match people to tasks based on an individual's past experiences and expertise. However, we found that engineers in this company seek jobs to broaden their skills and learn about new technologies, even though they require more time and effort to onboard. This suggests that if one applied recommenders that stereotype engineers by their past work in an industry context, it would inhibit engineers from broadening their technical skills and achieving their career goals. We suggest that tool builders consider the increase of diversity of technology and experiences as an important factor in ranking tasks to recommend to their users.

6 CONCLUSION

Engineers are happiest when working on software teams that they chose, developing innovative technologies, and working with colleagues and managers who share their goals and priorities. In our study, we learned what makes software engineers decide to leave their teams, and how they choose their next ones. We also identified the costs and benefits of such moves, and suggested ways that employees and managers can make better decisions to ensure they switch teams felicitously, and ultimately, enjoy a positive work environment.

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