Handover Communications in Software Operations

A Qualitative Study

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Abstract

The passing of information through handover communications is essential in many workplaces. Such handover communication is for example crucial in health care institutions, in nuclear power and in software operations. Handover communications in software operations happen on a daily basis much like in health care. Examples of handover communications in software operations include verbal or digital written handover communications that occur within a network operations center (NOC) or customer support center (CSC). Handover communications can occur during high tempo and high-stake scenarios or low tempo and low-stake scenarios and having confidence in the information and it being understood is important. The complexity and uncertainty of information provided during the handover communication in software operations can affect an engineer's confidence in understanding the current state of the system. Despite the importance of handover communications in software operations, the research into increased or decreased confidence of the engineer to understand the current state of the system after the information exchange is scarce.

In this qualitative research approach, semi-structured interviews were used to explore and gain insights into what attributes contribute to an engineers increased or decreased confidence after the handover in understanding the current state of the system. There were six engineers interviewed across two departments with a set of questions to help gain insights into their experiences during and after a handover communication.

The key findings for increased confidence in handover communications for engineers are verbal handovers, verbose handovers, handovers embedded into an engineers' everyday workflow, guidance on what information to provide during the handover, and acknowledging the handover. The key findings for decreased confidence in handover communications for engineers are inconsistent information guidance for handovers across departments, the availability of engineers after the handover, preparing a handover while balancing multiple responsibilities, the use of formal templates for handovers, and the necessity to gain more detailed information through exploration after the handover. These key findings from the research may help provide increased confidence for engineers after a handover communication.

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The passing of information between individuals is essential in many workplaces. Such handover communication is for example crucial between shifts in health care institutions, in nuclear power and in software operations. Much of the research on handover communication comes from the late 1990's by Emily Patterson and David Woods at NASA (Patterson & Woods, 2001). The purpose of Patterson and Woods research was to understand how quickly a called-in practitioner can get up to speed during high tempo and high-stake situations. Patterson and Woods used the original NASA research as a starting point to conduct further research. This further research was supported by The Department of Veterans Affairs (VA) in other work domains, such as, nuclear power generations plants (Mumaw, Roth, Vicente, & Burns, 2000), railroad dispatchers (Roth, Multer, & Malsch, 2001), and ambulance dispatchers (Chow & Vicente, 2002). The goal of that research was to understand how the handover communications were conducted in high consequence work environments to determine what can be improved during such communications. After the handover communications research was published by Emily Patterson, interest in researching the many facets of handovers within health care became popular with the intent to improve them for the purpose of patient safety.

The health care work domain has continued to be the focus for research on handover communications to the extent that the Joint Commission established a National Patient Safety Goal in 2006 to improve handover communications. The definition of a handover used in health care and in this study is:

> a transfer and acceptance of responsibility achieved through effective communication. It is a real-time process of passing specific information from one person to another or from one team of persons to another for the purpose of ensuring the continuity and safety of work situation(s). (The Joint Commission, 2017; p. 1).

In health care the frequency of handover communications between health care practitioners is quite high, estimated around 4000 handovers on a regular basis in each day at a single hospital (The Joint Commission, 2017). The estimated amount of handover

communications in health care that occur require effective communication and as described by Clark et al., (2009) encompasses the importance of knowing what to say, how to say it, and having the confidence that the information exchanged was acknowledged and understood.

While handover communications in software operations happen frequently, much like in health care, it appears that similar research is scarce. Examples of handover communications in software operations include verbal or digital written handover communications that occur within a network operations center (NOC) or customer support center (CSC). Handover communications can occur during high tempo and high-stake scenarios or low tempo and low-stake scenarios and having confidence in the information and it being understood is important. While engineers work together and perform handover communications in these scenarios, the work domain is quite demanding and having confidence in the handover is essential because expectations have increased pressure on engineers to have technology always available in systems (Sujan, Spurgeon & Cooke, 2015).

Therefore, in software operations, the complexity and uncertainty of handovers can affect the incoming engineer's confidence with the provided information (Nemeth et al., 2017). Examples are when an update is provided from an outgoing engineer to an incoming engineer about the current state of a software incident. While the information exchange and communication can be important, the difficulty can come after the handover where the outgoing engineer and incoming engineer feel confident with the information provided or further coming up to speed is necessary to understand the current state of the system (Payne, Stein, Leong, & Dressler, 2012). Another handover scenario is the incoming engineer receives information from the outgoing engineer about system state through a customer support case. The difficulty in this scenario for the incoming engineer can be understanding the outgoing engineers case notes of the issue(s) with the system, resulting in the incoming engineer having to adapt quickly.

To elaborate further about handovers and described by Young et al., (2016), the goal of handovers is transferring responsibility of a work situation while creating a shared mental model

between the giver and receiver. A mental model within the context of software operations can be constructing a current picture of the system as it is modified, updated, and recalibrated based on various events such as, software deployments or system maintenance (Cook, 2019). However, transferring that mental model is complex and can lead to information loss, distortion and therefore the risk is high for having an incomplete mental model (Young, ten Cate, O'Sullivan, & Irby, 2016) giving less confidence after the handover. In software operations it is virtually impossible for an engineer to have a complete mental model of the system for several reasons. With the rapid change of the system, the mental model of the system can become stale, and a fresh model may be incomplete as well (Cook, 2019). This is what is called Woods' theorem, which states as the complexity of a system increases, the accuracy of any single agent's own model of that system decreases rapidly (Woods, 2017; p. 1).

To summarize, it appears as if having confidence in handover communications in software operations much depends on the mental model the engineers have. Creating that mental model is however difficult, and there is not much research on this issue, as confirmed by Emily Patterson. Therefore, this study investigates engineers' confidence in the information exchange during and after the handover. As an example, when an outgoing engineer provides updates through the handover of the current state of the system to the incoming engineer helping them come up to speed with recent events. The exchange of information may exemplify attributes that occur during and after the handover communication that pertain to an engineer's confidence with the information. An example of one attribute may be that information can be lost across time, the flow of understanding that is built up doesn't continue unabated (Patterson & Woods, 2001). A second attribute example may be engineers have to make the information clear and detailed (Patterson & Woods, 2001). These attributes with others may determine the confidence engineers have after the handover communication occurs and whether additional exploration to gain further information is needed.

Despite the importance of handover communications in systems, there is a dearth of research in the area of software operations as confirmed by Emily Patterson, David Woods, Richard Cook, John Allspaw, and the literature search in Scopus and ResearchGate, see later. The study in this thesis is to provide insights into what attributes contribute to an engineer's confidence of the information transferred after a handover of the current state of the system.

With consideration of the discussion above, the research question is:

- What are the key attributes that contribute to how confident software engineers are with understanding the current state of the system after a handover in software operations is completed?

In this thesis as described by the Oxford Learner's Dictionaries (2021) confidence is the belief and feeling about the abilities or qualities of somebody or something.

Background

To address the research question, this thesis investigates handover communications in a software company. Two departments where studied, namely a network operations center (NOC) and a customer support center (CSC). For this study, the NOC is a department that operates around the clock. It performs incident resolution and internal and external incident communications for internal application incidents and customer-facing application incidents. The CSC in this study is a department that operates around the clock and answers and resolves customer-facing questions and application problems via a ticketing system. Both departments used digital communications via Slack or videoconferencing via Zoom to perform handover communications. Having these differing functions in this study of the two departments provided

a way to gain insights and experiences into how engineers made sense of the information, how they interacted with each other, and what actions were taken as part of those interactions.

In this study insights into handover communications for each department occurred through informal discussions with the heads of the departments to describe the history of handovers in their department and how they have evolved throughout the department's history. According to the head of the NOC department, they used to perform physical handovers before COVID. However, restrictions during COVID rapidly evolved the software company to become fully remote, which changed the preconditions for handover communications for the NOC. Initially, the NOC rapidly deployed a digitally written handover communication through the digital communications platform Slack. After the initial handover deployment there was a need to iterate and create more structure and formality for handover communications. The next iteration of the handover, the NOC deployed digitally written handover communications through a daily blog, which after a few months the engineers' provided feedback to the head of the NOC that it provided zero value to the handover and being done for compliance only. After the feedback from the engineers, the final iteration and currently in use is the Slack workflow functionality where the engineers input digitally written handover communication information and ask the incoming engineer to "Acknowledge" the handover communication occurred. This means that the current handover work procedures are studied, however past ones will play a role in engineers experiences and narratives.

Handover communications for the CSC used to be performed as an informal digitally written handover through Slack. According to the head of the CSC, informal handover communications mostly resulted in no "Acknowledgement" by engineers that responsibility of the case was handed over. The CSC has historically gone through one iteration, which is currently in use is the digitally written handover communication that is structured and process oriented to give greater confidence and guidance to both outgoing and incoming engineers on what is expected versus informally as mentioned previously. Even with COVID evolving the

software company to become remote, the current way of performing handover communications in the CSC did not change.

To gain an understanding of when handover communications were performed there was ample opportunity to view handover communications through some informal observations by joining multiple digital communication Slack groups where they were performed. Although, on rare occasions there would have been a videoconferencing call to join or engineers were in the office to conduct a verbal handover as well, which was considered complementary to the preferred way of using the digital communication workflow functionality for the digitally written handover communications. The handover communication observed from both these departments via Slack gave important contextual knowledge about how handovers were performed and when they occurred it was a trigger to setup and conduct interviews with the engineers.

Methodology and Method

Methodology

In this thesis, drawing on the guidance from Crotty (1998) for developing a qualitative research strategy, it is important to specify the epistemology, theoretical perspective, methodology, and methods that will be used for the qualitative research (Crotty, 1998; p. 5). This will help provide guidance on how questions are asked, how the data is collected, and how the data is analyzed in this thesis. The epistemology approach that will guide this thesis and analysis will be constructionism. Constructionism is the belief that knowledge and meaning is constructed by individuals and those individuals may construct knowledge and meaning in different ways, even if both individuals are part of the same situation. The approach in this thesis regarding the theoretical perspective will be interpretivism. Interpretivism is a qualitative research methodology that focuses on the beliefs and motivations of individuals to gain an understanding of the social situations and culture.

The approach in this thesis for the methodology is inspired by phenomenological research. This approach focuses on illuminating individual experiences and gaining perspectives by individuals in each situation. The approach that will be taken for the qualitative research method in this thesis will be semi-structured interviews. Methods are techniques used to gather data for analysis to answer the research question(s). Using this qualitative research strategy can provide the ability to gain the necessary knowledge, motivations, perspectives, and data into what key attributes contribute to an engineer's confidence in understanding the current state of the system after a handover.

Method

This thesis followed a qualitative research approach based on semi-structured interviews. In addition, a literature search was performed to gain knowledge, provide background and context of the topic, and have enough information to formulate a research question. The interviews were found suitable to address the research question because they contribute to gaining insights and capturing an engineer's experiences during and after handover communications. The interviews also enabled a focus on some questions to elicit knowledge from engineers allowing for themes to be captured of an engineer's experiences after a handover communication. The literature search focused on academic literature or studies where handover communications were performed across various industries. The literature search initially focused on handover communications in software operations to provide insights into whether any academic literature of studies have been done in this specific work domain. Additional searches went broader, then narrower, and combined specific concepts with handover communications based on reviewing and creating concept patterns from the literature of the results. As Blaxter et al. (2010) describes this qualitative approach aims to achieve in depth data from the experiences of practitioners in their work domain.

Literature Search

The literature search was performed in both Scopus and ResearchGate. Scopus is a well-known academic literature database that covers many areas and topics. Scopus allowed for broad and narrow keyword searches using Boolean operators based on topic needs. ResearchGate is well-known where researchers can create specific project topics to collect various academic papers that pertain to that topic. In addition, researchers can share academic papers for collaboration with one another. ResearchGate provided the ability to use keyword searches on fellow researchers' projects or topics they have created, such as handover communications.

The initial search in Scopus contained the keywords 'Handover' AND 'Communications' AND 'Confidence', which resulted in 68 papers and only one paper pertained to the thesis research. The one paper is set in a clinical setting where technology was used to standardized handover communications to improve health care resident confidence in the handover. The next keyword search 'Handover' AND 'Communication', which was broad to try and capture what literature was available and it returned over 5000 results. With the return of over 5000 results from the broader keyword search, it had to be narrowed down to help try and capture literature pertaining to handover communications and software systems. The next keyword search was thus focused on 'Handover' AND 'Communications' AND 'Software' AND 'Systems', which produced 176 results and only one paper relevant for the thesis. The 175 results that were not relevant to the thesis were mainly about handover communications with wireless cellphone software systems, which is a different type of handover where wireless cellphone software performs a handover of the service from cellphone tower to cellphone tower. The one result that applied to the thesis research (Patterson 2012) was a clinical setting where technology supported handover communications created shared knowledge through common ground via joint activity.

In this article there were two concepts, common ground and joint activity discussed, which seemed to be important for confidence. This led to performing a literature search for relevant literature, both for software operations and in other context. The literature search was 'Handover' AND 'Communication' AND 'Common' AND 'Ground' AND 'Joint' and 'Activity'. From that keyword search there were 276 results and only eight of the results could be helpful towards the thesis. After reviewing the eight results the theme of adaptive capacity in various work environments was frequently referenced and discussed by the authors, which seemed to be important for confidence. This resulted in the final keyword search of 'Handover' AND 'Communications' AND 'Adaptive' AND 'Capacity', which provided three results and two related to the thesis. The two results are related to the thesis because of the need to be poised to

adapt after a handover communication since practitioners may not always have the confidence in what information was exchanged during the handover.

During the literature search in ResearchGate using 'Handover Communications' as keywords it was discovered that a project was created by Emily Patterson called 'Handover Communications', which resulted in 45 articles and 16 of those articles pertained to handover communications in clinical settings where the concepts of joint activity, common ground, adaptive capacity, and confidence were referenced frequently. With the combination of keywords to narrow focus in Scopus and the discovery of only one particular project in ResearchGate, the results indicated that studies in handover communications in software systems to be scarce. The results from this literature search are presented in the theoretical framework.

Ethical Considerations

The ethical considerations regarding the participants in the research is under the guidance of Lund Universities Research Ethics (Lund University, 2021). Additional legalities have been made with the organization where the research was undertaken. These legalities are information disclosure agreements and de-identifying the data that was collected from the sources of information. According to Lund University research ethics (Lund University, 2021) the research project did not fall under the need to get an ethical review. However good ethical standards were applied and sustained throughout the research.

Data Collection

Interviews

This study aimed to interview engineers active in handovers at the NOC and CSC using a set of interview questions found in Appendix A. When reviewing the literature these concepts were the most important aspects for confidence in handover communications, which pertain to common ground, establishing a joint activity between engineers, the capacity to adapt after a handover and the confidence in the information exchange after the handover. So, therefore

these concepts were used to base interview questions upon. The interview questions were then piloted with two engineers to solicit feedback and provide the qualitative data for the research. The initial plan was to interview 12 engineers from the two departments, which would give valuable insights but also provide a reasonable workload. The interviews would be conducted with three outgoing engineers and three incoming engineers from the NOC and three outgoing engineers and three incoming engineers from CSC. However, due to some practical circumstances only six engineers were interviewed. Two engineers were from the NOC and four engineers were from CSC. Originally, the NOC was going to provide six engineers to be interviewed as part of the twelve, however attrition occurred within the team, which reduced it down to two engineers to interview. CSC is a larger department and performing interviews with six engineers would not be a problem, however, to diversify the study and obtain multiple perspectives across two departments, it was decided to interview four engineers instead of 10 from CSC to help balance perspectives from two different departments, keeping the total number of engineers interviewed at six. The target was to interview the engineers within 24 hours of the handover to allow for good memory recollection, but this was not practically feasible in three cases. The interviews were conducted and recorded, and later transcribed in English verbatim.

Data Analysis

In this study, the strategies combined to perform the analysis of the qualitative data are described as the general inductive approach (Thomas, 2006) and novice researcher approach (Blaxter et al., 2010). The primary purpose of the inductive approach is to allow research findings to emerge from the frequent, dominant, or significant themes inherent in the data, without the restraints imposed by structured methodologies (Thomas, 2006; p. 238). The novice researcher may not follow any approach for analysis of the data collected, however, the analysis can show strong similarities to more structured methodologies, such as phenomenological or thematic analysis (Blaxter et al., 2010). When the two strategies are combined in this study, the general inductive approach acts as guidance for the analysis of the data collected, which provides

the novice researcher a framework to follow when performing the data analysis. The data analysis was performed using the program Microsoft Excel. As the transcribing progressed, themes began to emerge from the experiences of the engineers.

The following procedures were used for analysis of the qualitative data (Thomas, 2006):

1. Initially transcribed the interviews into raw data and common format
2. Identified specific text segments related to the research question and literature
3. Created themes by labeling the various segments of text
4. Reduced the themes based on overlap and redundancy
5. Incorporated the most important themes

The outcome from the analytical process was a small number of themes that were identified from the semi-structured interviews. These themes linked back to the research question and research literature. A recommendation chosen for the analytical process and according to Thomas the max number of themes to have is eight (Thomas, 2006). If there are more than eight themes then the researcher may have to further combine themes or make difficult decisions on choosing the most important themes (Thomas, 2006). Therefore, this thesis presents six themes, first with an overarching theme and then sub-theme(s) for each overarching theme.

Theoretical Framework

This chapter is the result from the literature search and here are the most important theories that have been used in the research.

Joint Activity

As described by Klein et al. (2005) to achieve a joint activity it depends on inter-predictability of the participants' attitudes and actions. Practitioners engage in joint activities for various reasons. As part of a joint activity, there needs to be what is called "The Basic Compact". The basic compact between practitioners is an agreement set forth that both parties will participate in the joint activity and will carry out the responsibilities as part of coordinating work and communication (Klein et al., 2005). The way the basic compact works, is it is a continuously renewed agreement between engineers and not something that occurs once, and it is done. One of the key ingredients of the basic compact is that when one practitioner decides not to participate any longer the other party is informed of the decision because part of the basic compact is a commitment made between practitioners that secured interdependence.

Common Ground

According to Klein et al. (2005) common ground supports interdependent actions through practitioners having mutual set of beliefs, assumptions, and knowledge, which are important to establish common ground. Symbolic language or short-hand language for communication is a rite of passage with common ground since it allows people to use forms of communication that is abbreviated (Klein et al., 2005). The reason there is such a focus on establishing common ground is the importance of it between practitioners for both work and communication situations. In these various situations there can be a breakdown in common ground because it is always either eroding or being repaired continuously. The most common and repeated breakdown is known as "The Fundamental Common Ground Breakdown". As

Klein et al. (2005) describes this troublesome situation, it is when a party defects from the joint activity, however, the other party's belief is that the basic compact is still intact with the understanding that common ground is still established.

Adaptive Capacity

According to Woods (2019; p. 53) the definition of adaptive capacity is the potential for adjusting patterns of activities to handle future changes in kinds of events, opportunities and disruptions experienced, therefore, adaptive capacities exist before changes and disruptions call upon those capacities. Systems possess a variety of adaptive capacities, one variety is described by Cook & Long (2021), which is specialized human skills sharing adaptive capacity across the organization during anomaly response. Another good example as described by Woods (2019) is studies on military organizations and the handling of surprises. The shorter meaning of adaptive capacity is whether the system is poised to adapt and the readiness for a potential change to how things currently work in the system. It is important to point out as described by Woods (2019), adaptive capacity does not mean the system is in a constant state of change based on what is planned.

Confidence

This is the way confidence is viewed in this thesis as described by the Oxford Learner's Dictionaries (2021), confidence is described as the belief and feeling about the abilities or qualities of somebody or something. Confidence is a skill that can be acquired and improved over time. According to Psychology Today (2021) confidence is not all encompassing and in one area there can be increased confidence but in other areas there can be decreased confidence. For confidence, honing one's abilities, practicing, and getting advice from experts can help the practitioner and others that a practitioner interacts with in both working and communicating with somebody or something.

Findings

The findings in this study aimed to understand what key attributes contribute to an engineer's confidence during and after handover communications. To capture these findings, interviews were used to elicit insights into the engineers' experiences with handover communications. The engineers interviewed from the NOC had a background in systems engineering with a focus on investigating service disruptions and engaging other engineering teams to help with these service disruptions. The engineers interviewed from the CSC had a background in production support engineering with a focus on supporting external customers through resolving support cases.

Organizational Context of Handover Communications

Engineers' experiences with different types of handovers

The engineers from the two different departments experienced different types of handover communication during their work-cycle shift. For example, most of the handover communications were digitally written handover communications, however, verbal communication was used to complement the digitally written handovers in some cases. These verbal communications were used before or after the handovers to provide additional context, but the digitally written communications from the study are considered the main form of communication. Many engineers seem to prefer verbal handovers, which they think are of better quality as described from their experiences with the types of handover communications:

> *[Engineer 2]: I think the best is verbal honestly. I tend to be both a verbal communicator and a learner, so it just helps me to hear it more than read it. But if they are written, do the reading which helps me make sure everything's included again.*

[Engineer 3]: […] I am a vocal learner and I like to work through problems verbally but with written it's a struggle, because I don't always understand what they're typing about. So good and bad you know.

Reports of Inconsistent Communications

The two departments in this study have two separate ways of performing handover communications and from the engineers interviewed is that inconsistencies exist among the various departments. One engineer expressed frustration about getting different answers from the departments about what information to provide for the handover. The engineer also said they felt pressures in having to remember what information to provide per department. One engineer describes the experience with a semi-structured procedure:

[Engineer 2]: From the experience I have, […] I think, even as bubble gum and toothpick built as our hand-offs are, it's still a lot more solid than hand-offs that I've seen in the other departments mainly because they appear to be inconsistent. For example, inconsistent hand-offs exist when transitioning from one commander to another and I don't know who the new commander I'll be working with as the communications lead.

Evolving Handover Communications

Continuous Improvement of Handovers

As the handovers have evolved, the engineers reported that handovers have improved over time to be easier when performing them. One engineer gave a timeline of how handover communications have improved over time. When the team was in the office pre-COVID handovers were verbal, then during COVID there was an iteration of handovers. The initial iteration was just posting a message in the digital communications platform Slack and collaborate,

then the team started using workflow functionality within Slack. With the team heavily relying upon Slack beyond handover communications it embedded naturally into everyday work, making the handover communication easier by having pre-defined field to fill-out prior to having the Slack workflow post to the group. One engineer describes the experience with how handovers have improved:

> *[Engineer 6]: But I think what's gotten better about it is previous it was just direct message a bunch of people and see who can take it or like anybody willing to, but then my team lead was really good about let's make this a process. So, tag the team, write down what's going on, what's the cases, if you have any links or anything and post that and then you know go from there. So, I feel like my confidence level has gotten better with it just because it's gotten more like it'll get taken care of versus the shoot in the dark kind of thing that it used to be…*

Information Exchange

Coming up to Speed

Many engineers describe in the interviews that after the handover, the information exchanged can be out of date, which resulted in the engineer working to come up to speed with the various work situation(s). Coming up to speed (Patterson & Woods, 1997) is adapting, coping, and reframing the engineer's mental model to understand the current situation(s) that are occurring and changing within the system. One engineer said after the handover occurs, they look at the case notes, which are records of events and interactions of a particular support case to get an idea of what is going on and the details provided in the Slack communication post when coming up to speed. One engineer describes their experiences with coming up to speed after the handover communication:

[Engineer 4]: […]so I want to have a clear backstory usually what I'll do is I'll take the case number I'll go read the transcript or the emails and then kind of read back again, you know what does let's say engineer 3 giving me a case, what does engineer 3 want from me I'll make sure I understand it, and then go talk to engineer 3. Just to kind of confirm it.

Verbosity vs Brevity

The amount and degree of detailed information provided during the handover communication can be helpful to make the handover successful or unsuccessful. The engineers described that they are depending on detailed information in getting them up to speed and it provides confidence with the various work situation(s) the engineers may be engaging in as they settle into the workday. In both departments, two engineers described they want verbose handover communications and that this provides confidence for the engineers versus brief handovers where the engineer felt like the handovers are "worthless", and they will have to look for additional information after the handover:

[Engineer 2]: It would be the brevity of it would be the biggest summary of what makes the handover lousy. Basically, when it's missing what the customer impact is and what I need to be keeping an eye out for it. We, the rest, I can find quick, if I must, but if it's missing either of those two things, especially it's all but worthless.

[Engineer 5]: When the detailed information is provided from the jump from the moment it is transferred, it is provided right at the top, and not in the email thread so like when it's provided to us either directly or in the case notes that's what makes a huge difference…

Preparedness for Handover

Informal Artifact Gathering

As the day progresses many of the outgoing engineers in the study from each department described that they gather artifacts and captured notes throughout the workday with the goal to confidently communicate the most up to date information with the incoming engineer as part of the handover communication. Two engineers described how they go about preparing for the handover:

> *[Engineer 2]: As for every incident, I have a set of virtual desktops. I basically have four full monitors dedicated to it, […] One of the windows I have dictated on each of those is that form that I just keep filled out and up to date of this handoff. So, as the day goes on, if there's major changes in it, if I do any postings, I fill it out, I updated I delete the parts that are no longer relevant I add next steps as I capture them so it's kind of my own running log of here's what's important. But that's pretty much the only pre hand off of anything that I do, and I don't think we have anything formalized.*

> *[Engineer 6]: In my case notes I preface exactly what's going on… so we have action, resolved, follow-up, and support article and for me what I always do is under resolved if it's not, yet I say ongoing and that's how someone can tell like you know this person might have more to say or reply to or whatnot and then typically I'll add in my case notes.*

Balancing Blended Responsibilities with High-Workload Demand

Many engineers in this study described that they have blended responsibilities within their work domain where they seem to balance their high-workload demand with handover communications. Blended responsibilities can include working on multiple projects, managing a team, managing multiple incidents while also being responsible for prepping and conducting a handover communication when the engineer's workday is over. The engineers from both

departments in the study described the complexity and difficulties of having blended responsibilities and balancing their workload demand while preparing for handover communications. One engineer described having blended responsibilities and workload demand they've experienced with preparing for handover communications:

> *[Engineer 1]: It does get complex, yes, especially if we're blending responsibilities so if we're on a day, where we have an ongoing IT incident we're helping with communications and a couple of P&T incidents and all those things are long running the handover does get very complex[…]So, how do you prepare for the handover right and make it easy for the individuals that might you know might be working late at night.*

Guidance for Handover Communications

Formal Handover Templates

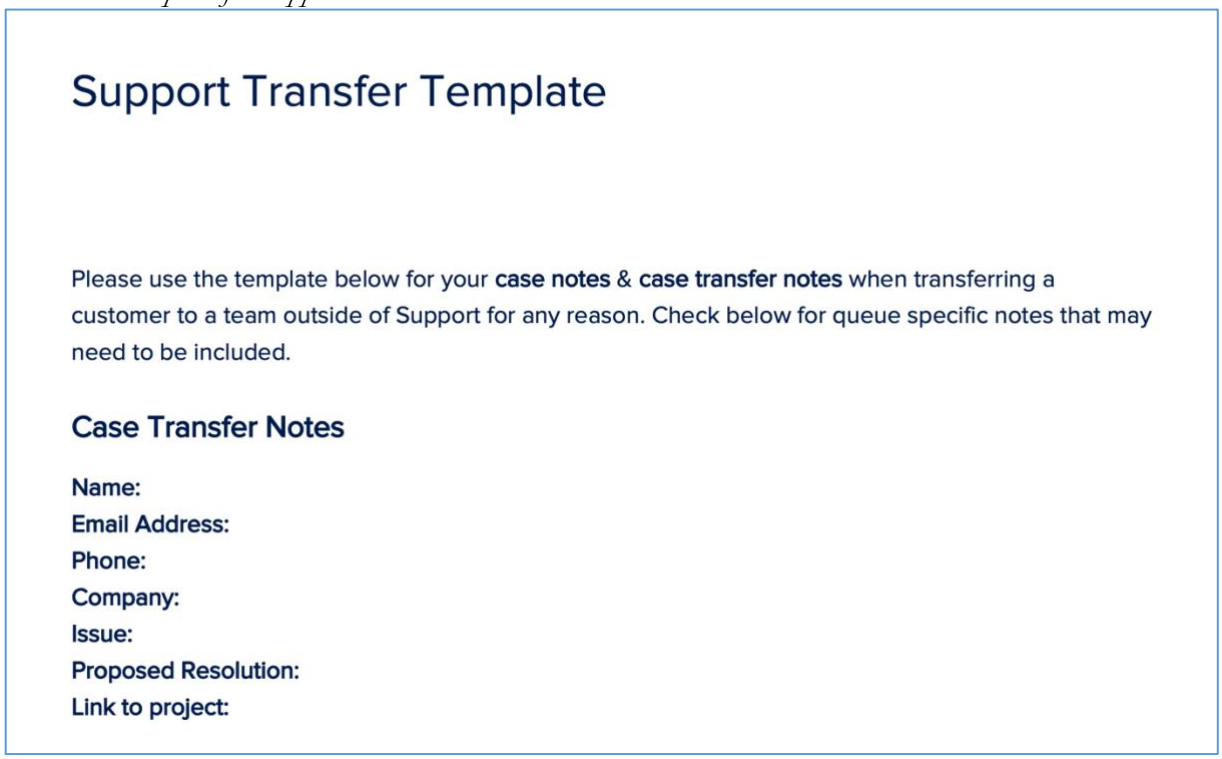
The engineers from each department described from the interviews that formal templates as shown in the figure below are used as part of the information exchange during the handovers. In this study engineers mentioned both benefits and drawbacks of the formal template. An example of a drawback is once the template is filled out by the outgoing engineer, the template of information is viewed as having all the detailed information needed, but that is not always the case and the engineers felt from the interviews they would like to have follow-up questions and communication. An example of a benefit is the template has pre-defined sections where basic information is provided to help the incoming engineer gain an understanding of the current work situation(s). Two engineers provided their experiences with having a handover communication formal template:

[Engineer 3]: I think that, because they fill out the template there isn't that follow up because they don't have to go back and ask questions and communicate and have that sort of like oh yeah okay yeah, I'm all caught up I'm all up to speed. I think it's just assumed that the next person will get it, and I think that we cut that out when the template was brought back, and I think that somehow not exactly sure, adding that back in would improve the handover process.

[Engineer 4]: […]so when we post in one of our product channels there's a format that we follow where we typically, have a case number, a brief summary, and then we would put a link to the project that's considered kind of the basic three that you need if you're going to get help from another engineer.

Figure 1

Handover Template for Support Case



Limited Processes and Requirements

Handover communications in this study have limited or no process requirements and many engineers interviewed from the two departments wanted more guidance or some set of requirements across the various departments about what information was needed as part of

standardizing the handover. Two engineers described their experiences about the need for guidance or requirements regarding the information needed for a handover:

> *[Engineer 6]: Yeah, I think, maybe making a requirement if you're going to hand it off things you need to include kind of like when we transfer our case to, we have that guru card for support transfer template like when we're transferring from our queue to somebody else's queue rather than to another engineer. I would want to make sure that was a requirement, you had to have this much information before you send it to somebody so, then they don't have to wander or wait I need more context.*

> *[Engineer 3]: There's a process, they like you to follow for transitioning cases and it's not always met just because everyone has a slightly different way of doing things not quite standardized, but we are working towards it currently, but there's a template you fill out with the information of the name of the client and why they're chatting in, and so the standard information that you would need to kind of pick up the pace of the case quickly and we're standardizing that so that the transfers are easier to pick up and there's less of a dissonance between the client and that case owners.*

Closing the Loop

Acknowledgement of the Handover

To close the loop on a handover communication within the two departments studied an acknowledgement is made through an automated Slack workflow, or a comment of acknowledgement is made either digitally written, emoji, or verbal during the handover communication between the two engineers as shown in the figures below. Many of the engineers reported that the acknowledgement of the handover was sometimes done satisfactory and sometimes done unsatisfactory, if at all, making confidence of a successful handover difficult. Two engineers give their insights about the acknowledgement of a handover:

[Engineer 2]: Overall went pretty well in the past, depending upon who I've had handing off to and just overall schedule workload for the day. Sometimes they hang there a little longer and don't get that acknowledged button pushed right away, which is kind of disconcerting, especially if it's like guys I've got to go to try to beat rush hour or kids waiting at home or I've got an appointment, or something like that, so I can't really wait for someone to click it got click right away good I know it was acknowledged […] But the biggest thing that really made it nice was that I knew someone immediately was on it. I got that feedback.

[Engineer 3]: Typically, when you think of the ERP transfers, specifically, when you post in the ERP channel and someone is like okay, I'm taking a look…you go ahead and send the case over to the ERP queue and it'll be picked up, so in that case I feel comfortable with sending it over and confident that it will get handled. Sometimes if people don't comment on your post after a certain amount of time, I have less confidence in the handover.

Figure 2

Slack Workflow Handover Acknowledgement

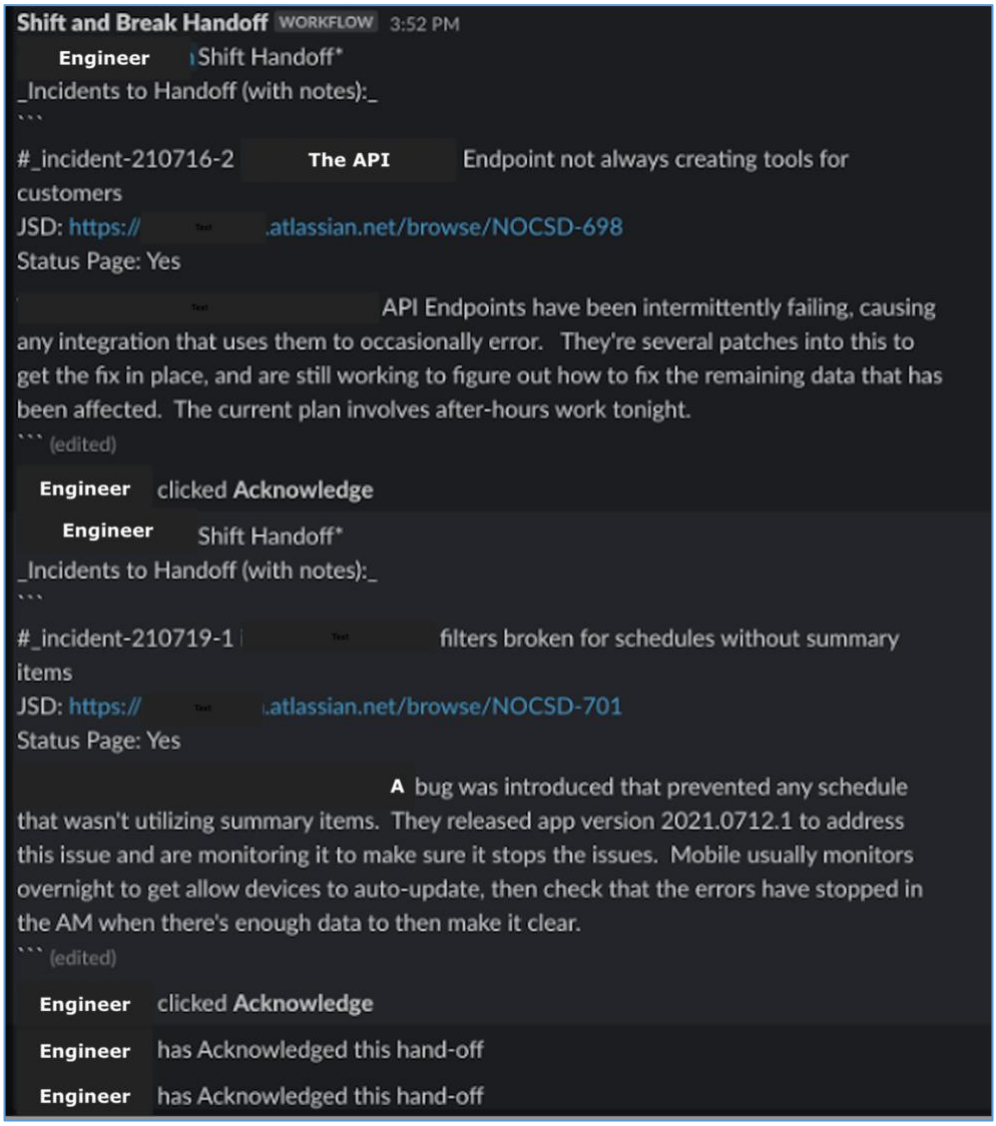
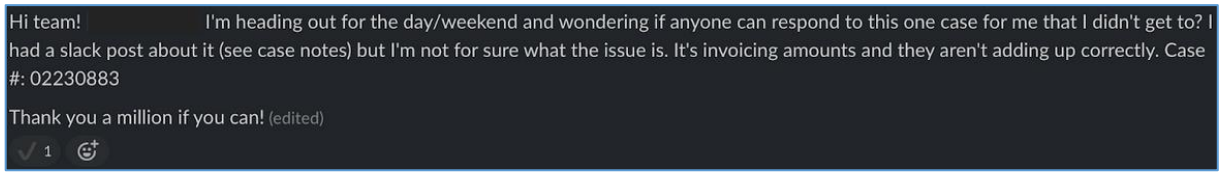


Figure 3

Digitally Written Handover Acknowledgement with emoji



Availability after the Handover

To provide a level of confidence in the handover communication for the incoming engineer, having the outgoing engineer stick around after the handover to answer questions and provide additional commentary as described by the engineers can be beneficial to both engineers. This applied to both departments. One engineer said because the outgoing engineer did not stay and just left after their shift was over, the engineer had no chance to ask additional questions to gain more context. The only way to get a hold of the outgoing engineer per the engineer was to call the outgoing engineer on their cellphone provided they answer and are available. One engineer provided their experience with the outgoing engineer availability after the handover:

> *[Engineer 2]: Yep, my biggest, thought, which I touched on a little bit earlier. It's so close to the end of shifts of posting this out and then okay I'm out, and I do this myself, but you don't even have that opportunity to ask them any questions. So, it's more the lack of an opportunity to follow up and to poke and prod. You know, here's how I've had to do it to get information out of it, so that I don't even have the opportunity to try. I don't necessarily think we need a lot of time where we do communicate very well and very quickly in Slack but if it was you know even 5 or 10 minutes before heading out, I think that would probably give you time to yes acknowledge it, am I missing anything No, you know you've just a couple sentences back and forth of with be all we really need, but we don't even have today.*

Discussion

The results from this study can be categorized as findings that support engineers to have increased or decreased confidence in their understanding of the system after a handover. The interviewees mentioned an increase or decrease in confidence in their understanding of the system, however, this is not quantified in any sense in this thesis but referred to as reflections from the interviewees.

In this study, confidence is connected to what will be called "handover attributes", here representing key aspects of handover communications that have emerged as having an impact on the confidence of the engineers. The handover attributes that appeared to contribute to engineers' increased confidence in the system after the handover consist of verbal handovers, verbose handovers, handovers that are embedded into the engineer's everyday workflow, guidance on what information to provide during the handover, and acknowledgement of the handover by the incoming engineer. The handover attributes that appeared to contribute to engineers' decreased confidence in the system after the handover consist of inconsistent information guidance for handovers across departments, availability of engineers after the handover, preparing the handover while balancing multiple responsibilities, use of formal templates for the handover, and necessity to gain more detailed information through exploration after the handover. These attributes are discussed below about the engineer's confidence and whether the handover attributes that appeared contribute to increased or decreased confidence in understanding the system after the handover.

Increased confidence after Handover Communications

Verbal handovers

Verbal handovers provide the engineers from this study with more confidence in understanding the current state of the system over digitally written handover communications, even though digitally written handovers are the dominant type for performing handovers in the organization. Engineers felt that verbal handovers established a stronger common ground (Klein et al., 2005) because they are able to establish a vocal conversation to learn by quickly asking contextual questions, receiving quick answers, and reducing the difficulty of trying to interpret the meaning of a digitally written handover when trying to understand the current state of the system.

Verbose handovers

Regardless of whether the handovers are verbal or digitally written, the engineers describe that it matters if they are verbose or brief. Verbose handovers are explained as vital for the engineers to have confidence in their understanding of the current state of the system. Having verbose handovers between engineers serves important aspects, such as building trust, rapport, and confidence with the information that is being provided. The findings from this study make it clear from many engineers that if the handover is brief and provides little detail then the handover is rather useless requiring the engineer to use other adaptations, such as reviewing the incident communication notes, asking inquiring questions to other engineers engaged with the incident or reaching out to the customer to gain an understanding of the current state of the system. The incoming engineer on the receiving end of a brief handover gets the impression that with little to no preparation for the handover, there will be a lack of information to create a mental model of the current state of the system resulting in decrease confidence, hence the need for handovers to be verbose.

Handovers embedded into the engineer's everyday workflow

Findings from this study indicated that handovers embedded into the engineer's workday through an automated workflow for frequent routine task via a digital communications platform, such as Slack, removes the need to switch to another system to complete the handover communication. The embedded workflow can reduce the cognitive load (Young, ten Cate, O'Sullivan, & Irby, 2016) for the engineer because the need to transition and remember what system is required to complete the handover is no longer needed with an embedded workflow. Engineers from the study indicated that having an automated workflow that is embedded into their workday increases their confidence and the quality of the handover because with the Slack workflow, the engineer can be constantly updating the information up until the handover is executed, creating a more verbose and up to date handover through the Slack workflow.

Guidance on what information to provide during the handover

Findings from this study suggests there is a need for guidance for engineers regarding what information to provide as part of the handover communications. Having guidance or some sort of standardization across all departments about what information to provide per handover could be beneficial to convey information more efficiently (Patterson, 2008) and with higher confidence in understanding the state of the system. An example as suggested from the engineers in the NOC and CSC is guidance or documentation on what to input into the verbal or digitally written handover communication, such as, subject, detail of current status, detail of current alerts, customer impact, any website link that adds more information, workaround (if exist), and proposed resolution (if exist). This type of guidance across the organization with slight room for adjusting what information is provided could give the incoming engineers confidence that no matter what part of the organization they are working with that when performing handovers, the same guidance is followed when it comes to what information is provided.

Acknowledgement of the handover by the incoming engineer

As Klein et al. (2005) describes, establishing common ground is interdependent actions among people with mutual knowledge, beliefs, and assumptions among them, which in the case of acknowledging a handover in this study established common ground between two engineers. The findings in this study imply that acknowledging a handover by clicking the "Acknowledge" icon in the Slack workflow, stating "Acknowledge" as a comment, or using an emoji gives the belief that common ground was established helping to increase the confidence level of the incoming engineer after the handover. Therefore, in this context, acknowledgements are interpreted by the outgoing engineer as having confidence that the incoming engineer has the most up to date information from the exchange but that may not always be the case. If an acknowledgement is delayed or does not occur after common ground was established, it can create stress for the outgoing engineer, and they are not able to disengage from the current work situation(s) until the handover was acknowledged by the incoming engineer. There may need to be more guidelines put in place for acknowledging the handover after common ground was established for either digitally written or verbal handovers after they are completed. However, having guidelines in place to acknowledge handovers does not necessarily mean the incoming engineer will not have to adapt after the handover. Although, acknowledging the handover by the incoming engineer can increase the confidence of the engineers' understanding of the current state of the system and provides confirmation the information exchange occurred.

Decreased Confidence after Handover Communications

Inconsistent information guidance for handovers across departments

Findings suggest that engineers' confidence in understanding the current state of the system decreases when there is no consistency among the departments about what information is

needed for every handover. When an engineer must remember how to do a handover a specific way per department it may increase cognitive load, as described by Young et al. (2016), coordination cost, and increased pressure on the engineer to remember and coordinate such information across many departments. While this not only may lead to decreased confidence in the information provided to understanding the current state of the system, it can also suggest, as described by James Reason, the blaming and shaming of the human for their inability to juggle the workload (Reason, 2000; p. 768). A suggestion to increase the confidence for the engineers is to create some guidance at the organization level of what information to provide in handovers regardless of the department. A secondary part of the suggestion, it can be important to meet with frontline engineers regularly to discuss their difficulties with handovers to shore up gaps in the guidance.

Availability of engineers after the handover

In this study, when the outgoing engineer does not have 5-10 minutes of availability after the handover occurs, the incoming engineer will not be able to ask additional questions or gain additional context about the current state of the system in coming up to speed as described by Patterson & Woods (2001). An alternative approach that can be adopted to increase confidence of engineers with the current state of the system is similar to the handover study done by Emily Patterson and David Woods at NASA. Both incoming and outgoing controllers, would stay engaged with each other after the handover for one hour to gain a richer understanding of the current state of the system (Patterson & Woods, 2001). Even if handovers in the context of software operations often occur at the end of shifts and it may not be possible to require outgoing engineers to stay for a long period of time, it is nevertheless suggested to investigate the possibility of meeting such recommendations of 5-10 minutes after the handover. This suggestion is to reduce uncertainty and bring clarity of understanding the current state of the system as part of the handover.

Preparing the handover while balancing multiple responsibilities

As engineers prepare for an upcoming handover, the findings from the study suggest they balance a multitude of responsibilities while gathering the artifacts to have a successful handover. What inherently happens as described by Sujan, Spurgeon & Cooke is 'high-workload situations' where the outgoing engineer didn't really have sufficient time to gather the detailed artifacts for the handover leaving the incoming engineer with the minimal amount of information about the current state of the system (Sujan, Spurgeon & Cooke, 2015). It implies that this leads to the incoming engineer having decreased confidence in understanding the current state of the system after the handover. This decreased confidence can be due to the lack of information or artifacts available because the outgoing engineer was balancing multiple responsibilities versus the incoming engineer coming in fresh to work ready to engage in work situation(s). Suggested guidance is to determine ways to help incoming engineers 'come up to speed' quickly when outgoing engineers have excessive workload or critical situations where they are not able to gather the detailed artifacts needed for a handover (Patterson & Woods, 2001).

Use of formal templates for the handover

While formal handover templates offer named sections to fill out with information, that does not always mean it is consistent or has enough information to provide confidence to the incoming engineer about the current state of the system. The findings from this study suggest that the absence of informal communications between two engineers, which may not be information divulged in the formal handover template creates decreased confidence in understanding the current state of the system. The outgoing engineers can get into a repetitive habit, where filling out the formal handover template and then performing the handover is viewed as done, however, this can potentially lead to the reduction of information for the incoming engineer. The outgoing engineer may assume that all the information for the exchange has been supplied in the formal handover template to the incoming engineer and informal

communications is not needed. While the formal handover template may have all the information needed at times, it is suggested that the outgoing and incoming engineers maintain common ground (Klein et al., 2005) and couple formal handover templates and informal communications together for increasing confidence in handover communications. This provides a two-fold opportunity between the incoming and outgoing engineer. First, the basic information about the current state of the system is written on the formal handover template and reviewed by the incoming engineer. Second, the incoming engineer can communicate informally by asking clarifying questions about what may be unclear on the formal handover template to gain further confidence about the current state of the system.

Necessity to gain more detailed information through exploration after the handover

After a handover occurs the incoming engineer must determine whether the information exchange provided the relevant detail and whether additional exploration is needed in coming up to speed as suggested by Patterson & Woods (Patterson & Woods, 2001). When additional exploration may be necessary, then the handover that just occurred between engineers suggest there is decreased confidence in understanding the current state of the system after the handover. From this study, it can be implied that the incoming engineer has the readiness and capacity to adapt to situations where engineers may consider all the detailed information was provided in the handover but was not.

Incoming engineers, as part of their preparedness for handover communications, could benefit greatly by engaging early in reviewing the work situation(s), such as the current system state, reviewing dashboards, error logs, customer service tickets, and engaging engineers to come up to speed sooner, which may increase their overall confidence in understanding the system and may reduce the need to explore after the handover.

Validity and Reliability

According to Blaxter et al. (2010), validity has to do with whether the methods, approaches, and techniques can be related to or measuring the issues being explored. Reliability is about how well the research project has been carried out. For example, if a researcher were to use the same questions in the same setting would they come up with the same results. If this is true, then the work may be judged as reliable.

This is qualitative research, and the findings are limited to two departments in a single organization. The original selection of interviewees was a total of 12 with six handovers that occurred, with the idea was to have a sample size of six from one department and six from another department. However, after selecting the two departments some unforeseen circumstances occurred in one department reducing the total of interviewees to six. With the interview count reduced to six, the selection of interviewees was to interview three from one department and three from another department totaling three handovers that occurred. That was limited as well since one department only had two engineers performing handover communications and the other department had many engineers performing handover communications. Having a higher number of interviews may have increased the quality of the results significantly (Blaxter et al., 2010) but as mentioned there was practical circumstances as to the extent of not having more interviews.

As for the interviews they were one hour with a set of questions based on the role of the engineer in the handover of either becoming the incoming or outgoing engineer. With the limitation of only interviewing six engineers, it was advantageous to ask all the questions regardless of the role the engineer played in the handover. Depending on that role in the handover the engineer may have to answer questions in which they did not play that role in the current handover but played that opposite role in the past resulting in biases and recalling a handover from memory limiting the value from the interview.

The author of this thesis was employed at the software company at the time of the interviews. This means that there is a risk for researcher bias, however, there are advantages and disadvantages. Looking specifically at interviews, the advantages were understanding the work domain and terminology when performing the interviews. The disadvantages were expectations and opinions may interfere with objectivity when performing the interviews.

Performing interviews virtually versus in-person during the COVID-19 pandemic had limitations and a strength. The limitations virtually were being able to view the day-to-day conversations about the handover as direct messages between two engineers even though the initial handover was communicated in the organization's public Slack. There were difficulties during the interviews to notice non-verbal communications that may have triggered more questions to gain additional insights, which may have provided more results. The strength that became apparent as the research progressed is the interviewees were excited to talk about handover communications, especially in the NOC, the engineers in the NOC had previously been thinking about handover communications since they were iterated upon on multiple times to improve them during COVID.

In searching the literature and using keywords, such as, handover communications there was a plethora of papers but there were limitations on how much time can be spent looking through for example, 5000 papers. Having this many papers to review was just not feasible and so the literature searches had to be limited to handover communications combined with concept(s) to narrow the field of results pulled back. Concepts were chosen based on reviewing papers from the literature search and conversations with Emily Patterson and David Woods. The one other limitation was there was little to no prior research using combined keywords of handover communications and software operations, which limited the literature available to reference.

Generalizability

As described by Myers (2000) the qualitative research approach continues to be criticized for its lack of objectivity and generalizability, however the knowledge generated from qualitative research can be noteworthy to the entire population. In this study of two departments in a single organization the qualitative research approach provided a view into engineer's experiences and insights both during and after a handover communication. The results from this study can potentially contribute to knowledge to the wider digital services community to improve handover communications in software operations, especially if those digital services companies are operating in the same context.

Conclusion

This thesis aimed to identify key attributes that contribute to how confident software engineers are with understanding the current state of the system after a handover in software operations is completed. The findings were related to an increased or decreased confidence in understanding the current state of the system. While much has been written about handover communications and some literature about confidence with handovers, this thesis addressed a gap in the literature about handover attributes in software operations, which contribute to an engineer's confidence in understanding the current state of the system after a handover. These are the key findings in this study from the interviews that show the key attributes for increased confidence and decreased confidence in understanding the current state of system after a handover communication.

Increased confidence after a handover communication

- Verbal handovers need to be in support of digitally written handovers.
- Detailed handovers whether verbal or digitally written are of the utmost importance
- Creating an embedded workflow or process for the handover as part of an engineer's everyday work can help reduce the switching of context
- While each department can have its own unique ways of working, the need to have guidance about what information to supply for each handover needs to be consistent across all departments.
- It cannot be stressed enough that acknowledging the handover by the incoming engineer is a must and it can be done by stating the word "acknowledge", writing the word "acknowledge", pressing a button with the word "acknowledge", or using an emoji, such as "ack" to provide a hearing or visual queue confirmation to the outgoing engineer.

Decreased confidence after a handover communication

- Inconsistency among the departments about what information is needed for every handover.
- When the outgoing engineer does not have 15-30 minutes of availability after the handover occurs to ask additional questions or gain additional context about the current state of the system
- Balancing a multitude of responsibilities while gathering the artifacts in preparation for a handover, which may result in reduced information to the incoming engineer
- Formal handover templates offer named sections to fill out with information, however, that does not always mean it is consistent or has enough information to provide confidence to the incoming engineer about the current state of the system.
- When additional exploration may be necessary, then the handover that just occurred between engineers may result in decreased confidence

It seems reasonable for organizations or other industries to test these key findings in the future, it may be important to ensure aspects of handover communication are still being maintained such as, establishing a joint activity, maintaining common ground, having the capacity to adapt when necessary, and confidence in the information exchange after the handover. These key findings from above may help provide increased confidence engineers have after a handover communication but further investigation may be needed.

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Appendices

Appendix A

Handover Communications Interview Questionnaire

1. From your point of view can you describe the handover that just occurred?

2. How much experience do you have with handover communications and the process of them at <organization name>?

3. How was your recent experience with the handover?

4. Before the handover what prior understanding did you have of the situation(s) at work?

5. What were your understanding of the situation(s) at work post-handover?

6. Once the handover was completed and you've settled into your work, was there any additional catching up to do to understand the various work situation(s) (e.g., use of tools, dashboards, etc...)?

7. What do you find difficult or challenging with the handover?

8. How have handovers evolved over time (e.g., face-to-face, videoconferencing, digital communications)?

9. What has the experience been as the handover has evolved?

10. How does the outgoing engineer ensure you (incoming engineer) have all the information you need?

11. How do you (outgoing engineer) ensure the incoming engineer has all the information from you (outgoing engineer)?

12. How does the handover change when completed during a high-tempo/high-stakes situation versus a low-temp/low-stakes situation?

13. How much prep-work of the various work situation(s) are done prior to the handover starting?

14. What, if anything would you change about the current handover process?

15. What makes for a successful handover from your experiences?

16. Have you experienced an unsuccessful handover and if so, tell me what made it unsuccessful?