A Qualitative Evaluation of Situation Awareness in the Operations Management Context

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For the degree of Master of Science in Industrial Engineering

Is approved by the final examining committee:

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Approved by Major Professor(s): Mark R Lehto

Approved by: Abhijit Deshmukh 10/15/2015

Head of the Departmental Graduate Program Date
A QUALITATIVE EVALUATION OF SITUATION AWARENESS
IN THE OPERATIONS MANAGEMENT CONTEXT

A Thesis
Submitted to the Faculty
of
Purdue University
by
Timothy Loescher

In Partial Fulfillment of the
Requirements for the Degree
of
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West Lafayette, Indiana
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ABBREVIATIONS

SA  Situation Awareness
MSA  Managerial Situation Awareness
HCD  Human-Centered Design
TSA  Team Situation Awareness
SAGAT  Situation Awareness Global Assessment Technique
SART  Situation Assessment Rating Technique
GDD  Goal Directed Design
ABSTRACT

Loescher, Timothy M.S.I.E, Purdue University, December 2015. A Qualitative Evaluation of Situation Awareness in the Operations Management Context. Major Professor: Mark Lehto.

The goal of this research was to develop a model of Managerial Situation Awareness (MSA) and to determine if there is promise in further exploration of this theoretical model. In this thesis, I showed that situation awareness (SA) is applicable to the management context and may be useful as a focus for designing systems used by managers. To achieve this, I developed a simulation of an operations management situation and I conducted a two phase qualitative study in this environment. In the first phase, participants spent an expedited day acting as an operations manager of a manufacturing plant. The goal of this first phase was to determine the information needed to improve managerial performance. After the simulation, these participants completed a Situation Awareness Rating Technique (SART) survey and were subsequently interviewed. I developed a grounded theory and used the interview data to design an MSA augment. I evaluated this visualization against a list of heuristics and incorporated the augment into the simulation. The second phase of the study was the same as the first with the addition of the MSA augment. The goal of this second phase was to determine if the design had a positive impact on the participants performance. The qualitative results of this second phase validated the original grounded theory as well as validated the idea that the MSA augment improved performance. From a quantitative perspective, the Phase 2 average and median performances were higher than the Phase 1 average and median performances. These measures of performance, although non-statistical, provide context to show that there is potential for further exploration.
1. INTRODUCTION

The role of a manager is a difficult one. Like any other employee, a manager has a set of tasks and duties that they need to perform including budgeting, attending meetings, staffing, planning, disseminating information, and improving operations. However, unlike many employees, managers have the added general role of managing large systems or sub-systems. An operator in a factory is solely responsible for monitoring and controlling their machine, but their manager is responsible for knowing where all the resources that they manage - human, capital, technological, industrial, and material - are distributed at any time and how those resources are performing [1].

Keeping all this information up to date and being proactive against issues is difficult. It is dependent on maintaining a systems-focused mental model that remains intact as the manager is distracted and pulled into their other individual tasks. Interestingly, the act of maintaining this mental model of the system over time seems to lean on a construct known as situation awareness (SA). In the 1990’s, a large effort in the human factors community was directed towards defining, measuring, and designing a scientific definition for SA. SA was a “folk” term previously used to casually discuss a sense of what was going on around oneself, but its prevalence in literature has prompted a more formal discussion of its true meaning [2]. The work in SA originally orbited around the aviation domain [3–12], and though there has been contextual mapping to other domains and industries [13–24], the management context is not among them. In this paper, I am addressing that problem by mapping SA to the management domain. My goal in this thesis is to develop a model of Managerial Situation Awareness (MSA) and to determine if there is promise in further exploration of this theoretical model.
The previous lack of the application of SA to the management context is an area that is worth exploring. Systems designed for managers may have elements of SA augmentation, but SA has never been pointed out as the construct behind the system design. Therefore, I make the assumption that these systems are not designed with SA in mind. It is important to recognize the role of SA in management as the workforce becomes increasingly automated [25] and as managers become the first and last line of human decision making in systems. In addition, managers are increasingly pushed to utilize data and metrics in their decision making [26,27], and therefore the access and understanding of process and system information in applications such as business intelligence dashboards becomes critical. With more information and governance loaded on top of the same managerial responsibilities, stressed cognitive resources are divided in more directions than ever before. SA has been shown to impact the safety and success of pilots in aviation, and I believe that it just as directly impacts successful decision making and management in manufacturing, professional, healthcare, and government sectors. The gap that I seek to address in this paper is to discover if designing for SA can impact managerial performance.

I propose that SA is a key factor in managerial success, and that systems can be designed in such a way to augment SA and improve managerial performance. I have been working in a consulting capacity over the past two years with a variety of manufacturing companies and have seen numerous instances where problems have arisen from a lack of SA. In addition, my past experiences as a healthcare process engineer have shown similar trends. My distribution of skills as a systems engineer, experience designer, and web developer puts me in a prime position to recognize the impact of SA in management and to describe the importance of designing a system that improves the measure.

To tackle this problem, I conducted a two phase study. The first phase consisted of an experiment which simulates a managerial task. The simulation requires the participant to understand the entire system’s status while performing attention distracting tasks to make situation awareness difficult to maintain. I recruited a criterion
sample of senior and recently graduated Industrial Engineering and Management students. This sample had the education needed to perform adequately in a managerial context and the training for the simulation was easier for them to understand than those without that knowledge. The simulation was observed, SA was assessed with a survey, and follow up interviewing with the participants discovered their challenges in the task, their personal strategies, and how to improve their task performance. I analyzed the interview data qualitatively and designed a new system specifically built with an SA focus. Then, in Phase 2, I ran the experiment again with new participants, this time with the SA augment included. I quantitatively measured the changes in SA and performance, and I used this as context to discuss the qualitative impact of the design.

In the remainder of this work I first present relevant literature in the SA and management science domains. In Chapter 2 I also discuss human-centered design (HCD) and qualitative research methods. I then proceed to present the methods used in my work in Chapter 3, both in the assessment of MSA and in the designing of an SA solution. I then present my results and discuss the implications in Chapters 4 and 5 respectively. In chapter 6 I present the limitations of my research and the recommendations based on my results, and in Chapter 7 I finally conclude by summarizing my work and discussing its key implications.
2. BACKGROUND

2.1 Situation Awareness

2.1.1 Overview

SA is a construct that was heavily discussed in the human factors literature in the 1990’s. SA predominantly emerged in the context of military and commercial aviation [3–12]. The construct has been defined and redefined a number of times [2–5, 8, 9, 28], but the most widely accepted definition (and the definition I subscribe to in this paper) is that of Dr. Mica Endsley. Endsley defines SA as:

“the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future” [3,5,10].

SA is broken down into three hierarchical levels, each describing a level of integration of information. Level 1 SA is the awareness of data from both the environment and the supporting systems. This includes system readouts such as speed, attitude, air pressure, temperature, and time as well as sensory data such as sounds and smells. Level 2 SA is the awareness of the meanings of those data points combined together. This provides the operator with an understanding of the current situation. To understand Level 2 SA, think about someone using a complex business dashboard. A novice user might be able to read out signals and monitors and get the data, but without experience that user may not be able to understand the implications of the current situation based on that data. Level 3 SA is the projection of possible future states and their likelihoods to determine best course of action. To do this an operator needs to combine the lower levels of SA to understand the current state of the system with a temporal aspect to allow for future projections. Although SA is considered a
snapshot model of the situation at a given time, this temporal aspect is also important to consider.

While it may be confused with general knowledge, SA is different in that it lacks established rules, procedures, etc.; it only looks at the dynamic elements of the environment [3]. Additionally, SA is separate from decision making and performance, as even the best trained decision makers may make poor decisions based on imperfect SA. Similarly, someone with good SA may make poor decisions based on a lack of training or perform poorly because they can’t take the appropriate action due to external factors [3]. Studies comparing SA to performance have had mixed results depending on the methodology used [6–8,12,13]. This interaction is further discussed in the SA measurement section later in this chapter.

Figure 2.1. Endsley’s theoretical model of SA [3]
SA works as shown in Figure 2.1. The operator assesses the current situation at the three levels and compares that current state mental model to a list of relevant schemata developed over time. This allows the operator to determine to which prototypical scenario the current situation most closely aligns [3, 29]. It should be noted that situation assessment - the process of achieving, acquiring, or maintaining SA - should be differentiated from SA itself [3, 4, 28]. Once the mental model has been mapped, the operator follows the trained actions of the accompanying script to continue in the best course possible toward the current goal. The result of this decision causes both the state of the environment and the operators situation within that environment to change, and the process is repeated continuously.

Based on this description of SA, it is clear that it is neither a simple vacuum construct operating independently of other constructs, nor is it a higher level combination of other constructs. Time, space, training, perception, attention, memory, automaticity, and goals all play integral roles in the understanding of and development of SA [3]. While in depth explanations are given of all these constructs in Endsley’s definition paper [3], I will provide some simple explanations of each element and where it fits in with SA.

2.1.2 Time

As mentioned previously, time is an important factor of SA because although SA is taken as a snapshot in time, it is developed over time [3, 4, 7]. The monitoring of the situation builds up a cumulative understanding of the situation. The current SA snapshot only can be used with the temporal context that it is taken in, namely the SA snapshots over a past period of time and the future projection state based on the Level 3 SA definition. Without this temporal context, Level 3 SA is unobtainable and the current SA gives no indication as to what the next action should be. However, just as time provides context for SA, so too do the spatial relationships of agents in the environment.
2.1.3 Space

In many contexts, spatial relationships are very important for SA. Typically, objects in the near-space and their parameters are more important to an operator’s SA than those further away due to their relevance to the operators’ immediate tasks and goals [3]. For example, if you are driving on the interstate, you care more about the cars near you than you do those at the horizon driving in the opposite direction. However, combined with the time element mentioned above, it is clear that as time passes, objects’ spatial relevancies will likely change as well. Therefore spatial understanding, while not necessarily an element of SA, drives the operator’s attention to particular elements of importance. Attention is an important factor in SA and is further discussed in the next subsection.

2.1.4 Attention

The construct of attention is described as a limited commodity that has to be allocated across a number of objects [3, 4, 30]. As an operator attends to one panel, sensor, data point, etc., they must divert their attention from another object. This can put a strain on SA if generating a model requires a large amount of information, or if the operator is distracted while attempting to maintain the model. When an operator diverts their attention away from one point, that information may change and the operator loses their up-to-date sense of that information [30]. This is the main area where I theorize that maintaining SA becomes a challenge for managers. Distractions force operators to drop items from their short-term and working memories, and this increases reliance on other aspects to compensate for that loss.

2.1.5 Short-term and Working Memory

As expected, the ability to maintain this information as attention switches from one point of information to another is driven by short-term and working memory.
Once perceived, information must be integrated with the existing information to develop and maintain the SA (Level 2). Similarly, the future state SA (Level 3) must be computed in short-term memory by reconciliation with recent SA snapshots [3]. This heavy load on short-term memory is hypothesized by Fracker to be the main bottleneck of situation assessment [31].

2.1.6 Long-Term Memory

Practically, SA cannot always be fully computed in short-term memory. To circumvent these limitations, long-term memory can be used by matching schemata - information subsets - to the currently assessed data. These schemata can be combined into mental models, and similar to the use of chunking to aid in short-term memory [30], instead of integrating all the small data points, the operator simply matches schemata to a mental model and uses that model as the SA. This top-down model allows for much quicker situation assessment. Although it may not provide a perfect picture of the situation, it skips past the heavy load placed on working memory and allows for rapid matching. This long-term memory approach only works, however, if the operator has a good repository of schemata, mental models, and scripts, all of which are developed through training and experience [3,6,7].

2.1.7 Training and Experience

Training and experience can result in better identification of a mental model, determination of a plan to reconcile with that model, and recall of the appropriate script to execute that plan. Training may not be tied to Level 1 SA, but Level 2 SA and Level 3 SA are both understandably improved with experience. Experience also directly affects perception. When an operator has a large body of knowledge, they perceive data differently according to their awareness of other elements in their environment [6,7]. Alternatively, a novice collects all the data in a vacuum and then
combines that information into the appropriate model. This allows the experts to build and adapt their mental models far more quickly than novices.

2.1.8 Automaticity

With so many data points for an operator to attend to, many systems utilize automation to do some or most of the processing required. This can greatly ease the cognitive workload of the operator, but poses an alternative risk. If operators simply follow the automatic processing of the system, they may miss connections overlooked by the programming [3]. They also are subject to lowering their vigilance and therefore reacting more slowly to issues when they eventually arise due to a lag in understanding the issue and the system context [3, 25].

2.1.9 Goals

The determination of where to direct attention and the way that the data is perceived is heavily driven by the immediate and long-term goals of the operator. A pilot with a goal of a targeted strike will use certain information to ensure he is on track, but if an enemy aircraft comes to intercept, then his goal changes to survival and very different information becomes important [3, 4, 28]. This goal-directed aspect of SA makes it critical to understand the operator’s tasks and goals when designing a system.

2.1.10 Management Context

As mentioned before, SA has been primarily applied to the context of aviation [3–12]. In this paper I argue that SA is a critical factor that needs to be discussed and designed for in the context of management. Instead of reading a display of sensors and dials, a manager must understand how to read a set of employees (Level 1 SA), understand the status of those employees work and their progress toward the goals
of the department (Level 2 SA), and be able to accurately predict the future state of the progress of their work (Level 3 SA) to be able to aid, intervene, or report to their respective supervisors. While this abstraction of SA to the management context has not yet been explored, it is notable to mention that team situation awareness (TSA) has been discussed loosely in this context.

TSA involves the same process described above, with the constraint added that each team member is trying to achieve their sub-goals and integrate them together. This means that different team members attend to different pieces of information at different levels at different times, but must understand enough about each other's individual SA to be able to integrate their mental models [15, 28]. Strategies for the improvement of TSA have been discussed such as team training to align mental models and facilitate communication [14,15,28]. TSA as discussed is similar to what I am proposing, but differs in that the TSA models suggest that all team members work actively toward the same end goal (e.g. a sports team trying to win or a flight squadron trying to accomplish their mission). Alternatively, in MSA the individual operators typically only have stake in their own work and are mostly siloed apart from and indifferent to the manager’s and other employees’ goals (e.g. manufacturing operators to their line manager and restaurant waiters to their maître d’). In addition, the manager has his own work to perform alongside the work of ensuring his employees can and do perform their roles well, so his awareness of his employees situations is impaired, as discussed above, by the fact that he cannot fully attend to the environmental factors spatially distributed across a floor, restaurant, ward etc. No work has been done to explore the effect of this context of MSA or to explicitly attempt to design for this issue.

2.1.11 Measurement

A final factor heavily discussed in the SA literature surrounds measurement techniques. While a large number of methods for measuring and assessing SA have been
brought forward, only two stand out in the forefront: the Situation Awareness Global Assessment Technique (SAGAT) and the Situation Assessment Rating Technique (SART) [6–8, 12, 13]. SAGAT is a freeze-probe technique in which the operator is stopped mid-simulation, their displays are cleared, and they are asked to answer a battery of SA questions that are task-relevant [6, 7]. Their responses are checked in real time against the simulations frozen values to test for accuracy. To do this properly, before conducting the study, a task analysis must be performed to determine which types of data are needed at each level to make decisions and develop the relevant question battery. Alternatively, SART is a post-trial subjective rating test in which the subject simply answers a questionnaire post-task regarding his self-perception of SA [8, 12]. This is clearly a less expensive, simpler, and less intrusive method; however, that comes at a cost of poor recall and sensitivity. An interesting finding regarding these measures, foreshadowed in my earlier discussion of SA, is that the SA measure from SART is correlated to performance while the SAGAT SA measure is not [13]. In addition, while SAGAT is more task-knowledge specific, and SART is a more generalized, global measure, the two SA scores are correlated [13]. A number of authors have studied and compared the two measures and the conclusion seems to be the SAGAT is preferred [6, 7, 10], but SART is valid (albeit weaker) if the expertise, time, and resources are not available [13].

2.2 Management Science

2.2.1 Micromanagement

An argument against MSA might stem from a misunderstanding in thinking it the same as micromanagement. Micromanagement is bad for production efficiency and effectiveness [32, 33], burnout [33], as well as employee dissatisfaction and perceived lack of autonomy [34]. However, micromanagement is defined as overbearing and excessive management and “evaluat[ing] under close scrutiny” [34]. MSA is different in that high MSA does not guarantee action. In fact, by maintaining high SA as a
manager, one can predict future states (level 3 SA) given current running conditions and see that no action is needed. If action is needed, it is typically preemptive and collaborative. Either way, with a good MSA support system, there is no need for the manager to hover over the operators because they can manage passively while accomplishing their other work.

2.2.2 Split tasks

In management, as mentioned, the manager has their personal tasks (budgeting, scheduling, documenting, attending meetings, etc.) as well as the responsibilities involved with maintaining system operations. This requires a cognitive tradeoff between a narrowed focus on task work and maintaining situation awareness over the system to make proactive management decisions [30]. If the focus is too intent on the individual tasks, the manager is forced to react to problems in the system rather than act proactively to prevent issues from arising. However, if she focuses too much on the system-level view, it is possible that the individual work is done poorly or simply doesn’t get done. The development of a support structure for MSA should therefore aid in this effect of attentional diversion.

2.2.3 Decision making

Decision making is a key aspect of a manager’s roles. Because in most of this paper I frame the problems in decision making as arising from a lack of SA, it is important to discuss the construct of decision making for context. Managers are involved often in dynamic decision making, a term which means that a series of decisions are required to achieve the goal, the decisions are not independent, the problem changes both autonomously and as a result of the decisions, and the decisions must be made in real time - sometimes with unknown effects [35–37]. Control theory has been discussed as a potential framework for dynamic decision making as it suggests that there must be a goal, it must be possible to ascertain the state of the system, it must be possible to
affect that state of the system, and there must be a model of the system (which can be explained as the direct links between humans and machines and their interaction options) [35]. In this paper, I assume the goal and model exist, and I assume that managers can indeed affect the state of the system, while I am exploring their ability to ascertain the current state.

2.2.4 Management Support Systems

It is important to look into understanding what management support systems already exist. Work done on manufacturing support systems thus far has involved production planning, simulation, and communication systems for operations and management [38–40]. Tracking boards are utilized in healthcare environments to communicate the status of all patients, physicians, and rooms to ensure the care teams can effectively understand what, where, and when things should happen [41]. Some decision support systems are used to collaborate across business units, leadership, and other teams to come to consensus decisions, and yet others are utilized by individuals to clarify information pertinent to decisions [42]. All these aforementioned systems are used in some capacity to improve SA. This is done by increasing the amount of data available or the ease of access (Level 1 SA), synthesizing the information into knowledge packets (Level 2 SA), and/or using that data to project future states at future times (Level 3 SA). These higher levels often impose a tradeoff issue between automaticity and cognitive load as discussed previously.

However, it should be noted that while many of these systems increase SA, it is not the designer’s primary design goal. The systems seem to unintentionally increase SA by proxy, and their effects on SA have not been explored. Baker et al. was the only exception; however, their design was introspective and not human centered, and they did not provide any kind of validation or test for improvement [14]. I assert that this is a byproduct of the absence of the management context from the SA literature. It is
important to assess these effects because focusing on them can benefit management support system design.

2.3 Qualitative Analysis

2.3.1 Epistemology

I approach this paper and my research from a social constructivist perspective [43]. I maintain the philosophy that reality - the way that everyone sees the world - is built upon a ground of socially accepted truths rather than objective universal truths. Therefore, my research reflects this in an interpretivist way [43]. For example, I use the most widely accepted definition of SA. This does not mean, for example, that Endsley’s definition is objectively true [3, 5, 10], but rather that it is an accepted theoretical ground that I build on. Along this same vein, I will view and analyze the data from my point of view and not that of some omniscient third person. This point seems like it may not matter as much in quantitative research, but it is necessary to point out for qualitative research [43]. I will consciously try to bracket away my opinions, political biases, and stakeholders in the research, but it is impossible to not involve oneself when coding and classifying qualitative data. Similarly, when designing, the designer has to make design decisions. I attempt to resolve this by interpreting the subjects’ opinions, thoughts, and actions into personas and driving decisions by imagining what that person would benefit from. For similar statements of interpretive paradigms, see Wang, Cash, and Powers [44] and Cilesiz [45].

2.3.2 Trustworthiness

With this discussion in mind, this paper should be assessed by analyzing the logical flow of decision making and interpretations rather than by the scientific rigor of sample sizes and statistical significance by which quantitative research is judged. In qualitative research, sample sizes are not used to achieve significant statistics, they
are used to achieve consensus [43,46,47]. The goal is to collect enough data that the ideas put forth by the individuals embody the ideas that people from similar situations would hold. When new ideas stop emerging, that is when the data has reached saturation and enough people have been sampled [48]. However, a complication arises in that some quantitative measures are used. I am acknowledging here that the sample sizes are small and do not have the statistical rigor that large sample sizes afford. However, they were collected with good reason. Due to Bayesian hypothesis testing, if a prior belief is strong, the posterior evidence does not have to be as strong to support that initial claim [49]. By adding more triangulation sources, they each can respectively provide weaker evidence because they all cumulatively provide large evidence. In this situation, because the primary focus on the work is to show how to design with SA in mind, the quantitative data is simply used to provide some context to the discussion. I will not make any statistical claims, rather I will let the qualitative data speak on behalf of the numbers to assign merit. I have intentionally provided my background in this thesis to provide relevant information not for self-promotion, but rather to point out my background, my credibility, and my assumptions [47]. I have taken an active role in playing devils advocate in regards to the methods I used [47]. I have triangulated my interview data with supporting observational data, with quantitative data, and with a follow-up second study [46,47]. All of these factors should be taken into consideration to help afford me some trustworthiness.

2.4 Human-Centered Design

2.4.1 Overview

Arnott and Pervan found in reviewing the entire decision support system domain that it should include high-quality “design science-based” research [42]. HCD is a design methodology in which the designer keeps the user at the central point of focus [50,51]. As the system is conceptualized, every design decision is based on what the user of the system needs (rather than what the users say they want or what the
designer prefers). This can be done generally in two ways. In participatory design, the users actively participate in the design process, contributing their own ideas and creating their own prototypes [52–54]. Alternatively, with ethnographic methods, the designer creates one or more archetype user personas based on qualitative research and drives design decisions through empathy with that persona [51]. Typically, there is a guiding strategy for the design that keeps the scope relevant in these design sessions. If not, things can quickly deteriorate trying to solve a large number and range of problems for the user. This can lead to a solution too costly or difficult to implement. Participatory design is a robust methodology, but it is also expensive [52–55]. It is good for generating buy-in with the users, but when system buy-in is not necessary it is not objectively worth the extra design costs.

Another approach to HCD is Goal Directed Design (GDD) [51]. This is not mutually exclusive with the other types; rather it is an alternative perspective on the design philosophy. Instead of looking at the persona as a person and going through what that person would emotionally enjoy, there is a slight shift in thought toward that person’s goals. With GDD the focus of the persona moves to the persona’s end goals and walking through ways to help achieve their goals. This pairs very nicely with SA, as the operator relies on their current goals to apply context to the situation. Therefore, the system needs goal information to properly aid in assessing the relevant information to augment SA.

2.4.2 Empathy

The first stage of ethnographic HCD is the process of understanding the humans that will use the system that is being designed. Cultural probes [56], ethnographic and non-ethnographic interviewing [43,51], and focus groups [43] all serve as ways to collect qualitative data about people. This data can be processed via thematic analysis [57], content analysis [58], affinity diagramming [51], or with other methods to build a sense of who the people are as well as their goals, their problems, and their
ideas. This knowledge can be summarized in a set of user personas, which can be critical for guiding HCD [51]. Personas afford empathy and drive design decisions to be made in the contexts of the users and not just in the minds of the designers. Personas are central throughout the next stage - design - for grounding the creative elements in the interpretive truth of the users’ needs.

2.4.3 Design

The design stage involves going from a persona or set of personas to a list of product requirements, and then it continues on to a number of system models for testing [51]. The personas are hypothetically walked through one or more scenarios in which they interact in the context of the problems that the design is attempting to solve. As they move throughout their day they are faced with issues, and the designer tries to decide what can mitigate or solve these problems. In doing this the designer develops a feature set of technical, data, and functional requirements [51]. Then the designer considers these requirements and sketches out a few ideas for how the requirements could be satisfied in different ways. These conceptual sketches are integrated together into sketch mockups which are subsequently validated.

2.4.4 Validation

The final step, design validation, can take many forms. The most well known method is usability testing [51,59–61] in which users are given tasks to perform, and their workflows are evaluated as they interact with the system. However, experts can also test without users with good results. Heuristic evaluations [62–66] and cognitive walkthroughs [67, 68] are just a few of the other analytical methods available for evaluating a systems usability.

Regardless of the tactical choice of method, strategically there are two focuses in testing systems and validating them: formative and evaluative focuses. Formative studies look at the system and discover how to improve the product, whereas eval-
uative studies break down what is and what is not working with the product. As the system is tested, things are changed and improved and the model is re-tested. In the meantime, as problems start to dissipate, the system’s fidelity is increased to wireframes, full-color static pages, static web pages, interactive prototypes, and live systems. Iteration is critical in design, and validation is the key to successful iteration [50,51].

Now that I have discussed the framework of design methods, the greater philosophical choice of qualitative research, and the literature surrounding MSA, in the next chapter I explain what I did in my two phase study. Following Chapter 3, I present and discuss the results in Chapters 4 and 5. Then, in Chapter 6, I present my study limitations and my recommendations. Finally, I conclude in the final chapter, Chapter 7, by summarizing the work done and its implications.
3. METHODS

3.1 Overview

As proposed in the introduction, I conducted a two phase study. In Phase 1, sampled participants worked through a simulated day as a plant operations manager and were interviewed about their experience. I transcribed and inductively analyzed the data from these interviews to discover strategies and issues that affected their performance. I also looked at their responses to a SART survey and their task performance, though this was primarily to provide context for given discussion results. The core concepts were identified and I pieced the data together into a concept map. I then included those concepts in a MSA augmentation design that I in turn incorporated into the simulation. Then, in Phase 2, I recruited a new group of participants sampled in the same way. I had them work through the simulation - this time with the MSA augment - and interviewed them. I again analyzed their responses, this time deductively, to see if the model improved their actual and perceived performance and to see if the augment was responsible.

3.2 Sampling

My goal in sampling was to recruit participants with a similar breadth of contextual knowledge in manufacturing or operations management. To get this, I recruited recent alumni and students from Industrial Engineering and Management programs who graduated less than a year before this study was conducted or who are on track to graduate within a year following this study. I required participants to be able to speak English as well. Geographic location was not important as my simulation could be conducted in person or online so long as we had a method of video conferencing.
Participants were recruited via first and second degree personal acquaintances, via emails sent by the undergraduate advisors of the schools of Industrial Engineering and Management, via social media posts to relevant groups, and via snowball referrals from those initial participants. Participants were told that they would receive performance based compensation ranging between $12 and $20 dollars.

3.3 Simulation

I developed a manufacturing operations management simulation on a web platform. The content and visuals are built on HTML and CSS and the simulation logic is controlled with JavaScript. To see and understand the simulation, reference the simulation instructions in Appendix A. The simulation operates by having the participant work as a plant operations manager for a day accelerated to 25 minutes. Their job in the study was twofold: to route an unknown number of incoming job orders to different lines and to complete five excise managerial tasks. These tasks were sitting in three meetings (1.5, 2, and 2.5 minutes), a budgeting task (an accounting of revenues and expenses), and an employee scheduling task (a logic problem). In the study, the participants’ performance (and payment) was measured by the following formula:

$$\$12 + \$8 \times \left( \frac{\# \text{ of completed jobs}}{40 \text{ total jobs}} \right) \times \max\{0, \frac{\# \text{ tasks completed} - 2}{5 \text{ total tasks} - 2}\}$$

(3.1)

In the simulation, the plant can produce six different products on four different lines. Each line is equipped similarly to build any product, but different workers have their own skills allowing them to build different products at different speeds. When switching between product types on lines, there is a set-up time required specific to that part. Before the page loads, the simulation randomly selects 40 products from a uniform random distribution and 40 interarrival times from an exponential distribution characterized by the parameter $\Lambda = 33$ seconds. This makes the expected arrival time of the last job 22 minutes, leaving 3 minutes at the end to represent a cutoff time after which any incoming orders are not be able to be processed until the
following day. These lists are tested at a rapid speed upon the program’s initialization to ensure that by following some rudimentary routing rules that the participant should be able to finish their processing task in the allotted 25 minutes. This made sure that for my study every participant had a fair chance of successfully routing every job and achieving maximal performance. Once a valid sequence of jobs and times is found by the program, the simulation can be started. I observed participants as they worked through the simulation and took notes on their task paths as well as time stamps when those paths changed. Taking the observations allowed me to be more aware of the participants decisions and by the end of each simulation I typically had a good sense of the participant’s employed strategies.

In my study, while the simulation was loading, the participants reviewed the instructions and consent form and were allowed to make any plans and strategies they wished. They were each allowed a calculator and scratch paper. Once they felt prepared, they started the simulation. Throughout the simulation I observed their actions and took notes of their timelines. At the end of the 25 minutes, they immediately proceeded onto a SART survey. Upon opening the survey link, their performance metrics were recorded and sent via email to me. The participants were then given a break, after which we had an interview which is discussed in more detail below.

3.4 SART Survey

The SART survey, briefly discussed in Chapter 2, is a subjective self-report of SA broken down into three domains: Demand, Supply, and Understanding. At the end of a given task, the subject is asked to answer 10 questions on a scale from 1 to 7 via a survey as shown in Table 3.1 [8,12]:

SART is a technique that has some benefit tradeoffs. It is based on workload and knowledge, so as workload increases it impacts the assessment accordingly. This aligns with theoretical frameworks put forth by Endsley [3]. It is also easy to administer,
as the tester gives the assessment at the end of an activity. Unfortunately, this comes at a loss of “real situation awareness” [10, 13], as it relies heavily on long-term memory rather than working memory (where SA is theorized to live). The competing methodology is SAGAT, which freezes the simulation at random intervals and asks the participant to answer questions about certain values [6, 10]. This disrupts the task and becomes a challenge to administer with a performance-based compensation structure. SAGAT also lengthens the duration of the study, which introduces an additional financial cost as well.

3.5 Interviews

After finishing the survey, the participants were given some time to relax. Then, I conducted a semi-structured interview with each participant. A semi-structured interview consists of a set of questions that the participant answers through a natural conversation with the researcher. When points of interest come up, the researcher can take tangential conversations to drive down to nuanced meanings. The questions serve as guiderails to move toward an understanding, but there is less rigidity than a structure interview when only the questions asked can be answered [43]. The primary goals of these interviews were to identify the participants goals and their strategies for achieving those goals, their perceived performance and reasons for that performance, and the information and skills that they thought had helped them or to which they wished they had access. The interview schedule is included in Appendix B. Each of those questions served as a launching point for discussion in which I would probe deeper for understanding. In interviews, I made sure never to lead the participants or to encourage certain answers over others. The reason for the study was kept from the participants until after the interviews. Many participants seemed to think that the study was looking at the validity of the simulation as a training tool for managers. Although this was never intentionally implied, it seemed
to help elicit honest, unadulterated answers so the idea was not explicitly discouraged. Each interview was audio recorded and transcribed as well.

### 3.6 Analysis Methods

When the same themes kept coming up in the interviews on a number of topics, it was clear that data saturation was being reached and I stopped collecting data. I used the grounded theory approach to analyze my data [69]. Once all participants were done for each phase, the transcribed interviews were read and re-read at least three times. This allowed certain concepts to emerge and those were noted across each interview. For the first phase, I used inductive open coding to assign codes to my data and build a ground-up set of concepts to assign to my transcriptions. I noted these concepts across all the interviews and combined them axially into categories. I cross-referenced these categories against my observations to ensure there were no inconsistencies, and then the categories were all integrated together to build a theoretical framework that was grounded in the data. Then, for the second phase, I looked at the data deductively through the lens of the first phase’s theoretical model. This allowed me to determine any shortcomings and the impact of my design while also validating my initial theoretical framework [69]. Essentially, the first phase served to build a grounded theory and the second phase (with the MSA design) served to validate that theory.

### 3.7 Design Methods

I used my participants’ goals and strategies along with my theoretical framework of MSA to design an MSA augment. Traditionally, I would put together some personas based off my interviews, but I didn’t see that as a valuable exercise in this context. My participants were all inexperienced as managers and the goal was to design for them as if they were managers. This incongruity between my design-focus manager
persona and my actual user base seemed too large to justify using any formal persona to guide my design.

What I did do, however, is start out with some conceptual sketches. I pieced together the ones that fit best with the conceptual framework to build a low fidelity sketch. Once I had a solid concept, I created a higher fidelity wireframe mockup and implemented it into the simulation. The goals were to make the tool aid all three levels of SA, require minimal interaction, and be omnipresent. I used Nielsen’s Heuristic Evaluation model [62] once I had a high fidelity model to ensure no major design rules were being violated. Once I realized that half of that model didn’t apply based on the design criteria, I looked for a more applicable heuristic evaluation model. I found a set of heuristics compiled by Zuk et al. [63–66] that focused on information visualization, which I applied with more success. Another way I evaluated my design was by conducting Phase 2. This second round of subjects was primarily validating my theoretical framework, but because my design was grounded in that theoretical framework the participants were also informally evaluating my design.
<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instability of</td>
<td>How changeable is the situation? Is the situation highly unstable and likely to change suddenly (High) or is it very stable and straightforward (Low)?</td>
</tr>
<tr>
<td>Situation</td>
<td></td>
</tr>
<tr>
<td>Complexity of</td>
<td>How complicated is the situation? Is it complex with many interrelated components (High) or is it simple and straightforward (Low)?</td>
</tr>
<tr>
<td>Situation</td>
<td></td>
</tr>
<tr>
<td>Variability of</td>
<td>How many variables are changing within the situation? Are there a large number of factors varying (High) or are there very few variables changing (Low)?</td>
</tr>
<tr>
<td>Situation</td>
<td></td>
</tr>
<tr>
<td>Arousal</td>
<td>How aroused are you in the situation? Are you alert and ready for activity (High) or do you have a low degree of alertness (Low)?</td>
</tr>
<tr>
<td>Concentration of</td>
<td>How much are you concentrating on the situation? Are you concentrating only on the situation (High) or are your thoughts on many other things outside the situation (Low)?</td>
</tr>
<tr>
<td>Attention</td>
<td></td>
</tr>
<tr>
<td>Division of Attention</td>
<td>How much is your attention divided in the situation? Are you concentrating on many aspects of the situation (High) or focused on only one (Low)?</td>
</tr>
<tr>
<td>Mental Capacity</td>
<td>How much mental capacity do you have to spare in the situation? Do you have sufficient to attend to many variables (High) or nothing to spare at all (Low)?</td>
</tr>
<tr>
<td>Information</td>
<td>How much information have you gained about the situation?</td>
</tr>
<tr>
<td>Quantity</td>
<td>Have you received and understood a great deal of knowledge (High) or very little (Low)?</td>
</tr>
<tr>
<td>Familiarity with Situation</td>
<td>How familiar are you with the situation? Do you have a great deal of relevant experience (High) or is it a new situation (Low)?</td>
</tr>
</tbody>
</table>
4. PHASE 1 - RESULTS AND DISCUSSION

4.1 Participants

Once again, the first phase of the experiment involved participants running through the simulation. There were 8 participants to run through this phase. Their demographics are broken down in Table 4.1.

Table 4.1. Phase 1 participant demographics

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Nationality</th>
<th>Major</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>F</td>
<td>American</td>
<td>Industrial Engineering</td>
<td>Senior</td>
</tr>
<tr>
<td>21</td>
<td>M</td>
<td>American</td>
<td>Industrial Engineering</td>
<td>Senior</td>
</tr>
<tr>
<td>21</td>
<td>M</td>
<td>American</td>
<td>Industrial Management</td>
<td>Senior</td>
</tr>
<tr>
<td>21</td>
<td>F</td>
<td>Chinese</td>
<td>Industrial Engineering</td>
<td>Senior</td>
</tr>
<tr>
<td>21</td>
<td>F</td>
<td>Chinese</td>
<td>Industrial Engineering</td>
<td>Senior</td>
</tr>
<tr>
<td>21</td>
<td>F</td>
<td>American</td>
<td>Industrial Engineering</td>
<td>Senior</td>
</tr>
<tr>
<td>21</td>
<td>M</td>
<td>Indian</td>
<td>Industrial Engineering</td>
<td>Recent Alumnus</td>
</tr>
<tr>
<td>22</td>
<td>F</td>
<td>American</td>
<td>Industrial Engineering</td>
<td>Recent Alumnus</td>
</tr>
</tbody>
</table>

4.2 Quantitative Analysis

4.2.1 Overview

As a reminder, the focus of this study is predominantly qualitative, but some quantitative measures were collected. I do not see these as statistically relevant data points, but rather a set of contextualizing metrics to be associated with the
qualitative information gathered. The two measures collected were performance and SART survey response values. In reporting the quantitative results, because the sample size is quite small, I am providing both the average and median values.

4.2.2 Performance

The first quantitative measure I will discuss is performance. As a reminder, in this study performance was measured and paid according to the following formula:

$$
12 + 8 \times \left( \frac{\text{# of completed jobs}}{40 \text{ total jobs}} \right) \times \max \{0, \frac{\text{# tasks completed} - 2}{5 \text{ total tasks} - 2} \} \tag{4.1}
$$

The average performance across Phase 1 was 13.25 ($\sigma = 1.49$) and the median was 12.50 (out of a possible 20). As shown in Equation 4.1, this value is made up of the number of jobs completed and the number of tasks completed. For the number of jobs completed, the average score was 33.87 ($\sigma = 8.28$) and the median was 39 (of 40). This means that the participants for the most part did quite well in handling the jobs and routing them properly as they came in. Alternatively, the average number of tasks completed was 2.375 ($\sigma = 0.99$) and the median was 2.5 (of 5). The task completion was clearly the part that held the participants’ scores down. In Equation 4.1, the reader can see that the total number of tasks completed is a critical element. If the participant completed less than 3 tasks, they were held to a multiplier of 0, keeping their final score at a minimum.

In conducting these studies, I did observe what seems to be a reason for the excellent job routing completion rate and the contrasting poor task performance. This reason is that participants would route jobs immediately as they arrived. They would stop, refer to their notes, and send the jobs to the planned lines. The participants went to the floor sparingly, and because of this, they were unsure what jobs were on which line. The participants avoided going to meetings for fear that they might have inactive lines and they were often distracted from their other tasks, keeping them from building much momentum on any individual tasks.
4.2.3 Situation Awareness Rating Technique

The other quantitative measure captured were the SART survey results. The average and median SART scores are shown in Table 4.2 and the complete data set can be found in Appendix C. The SART scores provide some insights into the participants self-perceived SA. It is interesting to note that the participants overwhelmingly reported themselves as having limited familiarity with the situation. They also reported the simulation as being fairly complex with many variables changing, and they reported that the simulation was mentally arousing and required a fair amount of concentration, leaving them with a limited amount of spare mental capacity. This seems to provide some credence to my explanation of the low performance scores. The participants were experiencing a dynamic, complex system that required most of their attention to process data and convert it into information. This left very little room for Level 3 SA - future state prediction - which meant that the users were not often comfortable enough to focus on distraction tasks. However, this quantitative data should not be given too much weight, as its purpose is really to support the qualitative analyses.

4.3 Qualitative Analysis

4.3.1 Overview

The qualitative data is summarized and shown in Figure 4.1. I began to reach data saturation with the 7th participant, and conducted one more study to increase my confidence. Ultimately in Phase 1 I collected in 8 interviews 3 hours of dialogue. When transcribed, this amounted to approximately 16 pages of transcribed data. As I read through the transcribed interviews and began coding recurring concepts, I began to see a pattern of elements. The theoretical framework is grounded completely in the data. Each participant had their own background, experiences, and skills. Those independent variables (which I tried to hold constant by selecting participants
Table 4.2.  
Phase 1 SART scores

<table>
<thead>
<tr>
<th>SART Measure</th>
<th>Average</th>
<th>Median</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instability of Situation</td>
<td>3.88</td>
<td>4</td>
<td>0.78</td>
</tr>
<tr>
<td>Complexity of Situation</td>
<td>4.75</td>
<td>5</td>
<td>0.97</td>
</tr>
<tr>
<td>Variability of Situation</td>
<td>5.00</td>
<td>5</td>
<td>1.66</td>
</tr>
<tr>
<td>Arousal</td>
<td>5.38</td>
<td>5</td>
<td>1.41</td>
</tr>
<tr>
<td>Concentration of Attention</td>
<td>5.75</td>
<td>6</td>
<td>1.20</td>
</tr>
<tr>
<td>Division of Attention</td>
<td>4.13</td>
<td>4.5</td>
<td>1.83</td>
</tr>
<tr>
<td>Spare Mental Capacity</td>
<td>2.88</td>
<td>2.5</td>
<td>1.54</td>
</tr>
<tr>
<td>Information Quantity</td>
<td>4.38</td>
<td>4</td>
<td>0.86</td>
</tr>
<tr>
<td>Familiarity with Situation</td>
<td>3.00</td>
<td>2.5</td>
<td>1.41</td>
</tr>
</tbody>
</table>

with similar backgrounds) combined to develop strategic plans and methodologies at different intervals, and the execution of those strategies resulted in the participants meeting (or not meeting) their decision making goals.

4.3.2 Judging managerial decision making

In this study, I first wanted participants to talk about their perspectives on assessing managerial and decision making quality. There seemed to be two main perspectives that emerged from that subject. Participants talked about their goals when making decisions and about the measurements that really indicate whether those goals have been met.

Decision making goals

The study participants posited that good decision makers use data and other people’s insight to make timely decisions. For example, one participant said,
Figure 4.1. Grounded theory model of SA in management
“I normally make data-based decisions. I have never actually been a manager, but I know that a big part is dealing with people and listening to their problems, so it’s more than just data and stuff then. I know that time loss is sometimes a big issue, but I would say that I am quick to make decisions.”

This suggests the goals that participants use to try and achieve in order to make good decisions. However, these are binary parameters that are either met or not met. To determine the actual quality of a decision, we must rely on a series of lagging indicators or metrics.

**Decision making indicators**

There are three indicators in the model that seem to capture whether decisions made in the simulation were good or not. First, a simple self-assessment can help a decision maker determine if they are confident in having made the right decision. For example, if after making a decision you have a “lack of courage [and] unwillingness to stick to [your] choice” as one participant put it, you are “not a very good decision maker.” To make a good decision, confidence is a good way of immediately assessing your choice. Second, a simple survey of whether or not all the tasks were accomplished in time will allow you to determine if you made any glaring mistakes. Third, hard number outcomes become important. Metrics such as “satisfaction,” “financial performance,” and “quality” are all parameters that participants used in describing how they knew if they made a good or bad series of decisions.

**4.3.3 Predictors of performance**

The next question is what predicts this decision making performance. The second part of my theoretical framework refers to independent variables. Each participant was selected in an attempt to hold these variables constant, but there is certainly
some uncontrolled variability in the participants’ individual experiences, mentalities, and developed skills.

**Individual characteristics**

Individuals have any number of varying individual characteristics in terms of experiences and mentalities. These are exemplified by a number of quotes pulled directly from interviews with participants:

- “Attitudes in the office from internships [helped] - if you can’t excel at everything, at least meet basic expectations.”
- “IE 383 helped with scheduling. I also took 343 [which helped with] budgeting. That was pretty simple, but just general money stuff . . .”
- “Experience and knowledge in queuing systems or decision making helped with putting jobs into the right line.”
- “Well I have never been in that position or really had to use any of those skills . . .”
- “I think it’s kind of my habit to stick to one thing until it’s done.”
- “Yeah, I worked in a plant one summer so I kind of understood the scheduling department [...] so at least I knew what the situation was going to be like.”

All of these statements describe different participants’ mentalities and work or class experiences. The participants each related these individual characteristics to their ability to perform well or to develop strategies for better performance. That being said, a participant’s past experiences and mentality can not alone drive performance. These things help a participant know what skills and strategies to use and when to use them, but if those skills and strategies are not developed well their use may be lackluster.
Developed skills

For a participant to perform well, they need to not only have the supporting mentalities and experience, but also have developed skills like time management and careful planning. I have identified these separately from the mediating situational strategies in the following section because these are skills that are constantly being developed throughout our lives. These skills go far beyond the situational context of this simulation. This makes them seem like individual characteristics, but they are just as unique from the experiences and mentalities that allowed them to be developed as they are from other situational strategies.

For example, as one participant pointed out, “Preparing helped a lot. If I hadn’t taken the time to come up with a strategy I would have done a lot of work thinking [while doing other tasks].” This careful planning is not something that everyone did, and it is not an experience. It isn’t situation-specific strategy either, yet it was a large factor in an individual’s success. While I didn’t empirically track how long participants planned, I can confidently state that those who did not plan performed worse than those who did plan. Similarly, a participant noted that one of the reasons that they did not do so well was because of their “really poor time management.” This is not really a strategy employed mid-simulation as much as it is up front planning and care.

4.3.4 MSA related situational strategies

The independent variables are indeed critical to achieving good results on the performance indicators, but they are not the direct causes. A user’s individual experiences and skills drive the decisions that they make at any point in a situation. For example, based on your contextual knowledge, you might have a better sense of how and when to build up a queue of jobs by routing them to a line and when to hold on to some jobs in case a duplicate will arrive. Strategies used by participants in this particular management scenario are listed below with a paraphrasing of participants’ insights.
- Know the relative importance of jobs and tasks. This allows you to prioritize your task list and modify it as you go.

- Consider the shortest setup and processing times, and use those to optimize your processing efficiency.

- Balance the loads on the lines. Keeping everything even makes it less likely that you will be overwhelmed as variables change.

- Don’t underestimate task difficulty. If you get sucked into a single difficult task, it can hurt your performance just as much as missing a minor task.

- Go or don’t go to the floor often. Try to not go to the floor so that you can spend your time doing value-added work. However, if you do not know what is going on you will likely make more mistakes and/or take longer to make decisions.

- Maximize concentration and momentum. If you can be comfortable doing so, don’t allow incoming jobs to distract you. At the very least don’t bounce between tasks easily.

- Stay flexible. As things change do not be afraid to diverge from your original plan. New variables and information may invalidate your original plan.

- Be confident in your decisions. There is no value in thinking back to previous decisions and worrying. Move forward and make the best decisions with what you know.

- Work in meetings. In this simulation meetings are wasted time, so make use of them by taking notes and then working in the meetings.

- Keep track of the line statuses. If you know what is happening on the lines, you will be far better off planning and deciding accordingly.

- Manage stress and confidence. You can use the meetings as breaks to check yourself, take a breather, reflect on decisions, and maintain confidence. Getting
stressed and doubting yourself is never going to help you improve, and only can hurt you in the long run.

4.4 Critical information

Tangentially related to this theoretical framework is the list of supporting information that came out of the thematic analysis. All of the aforementioned strategies will only work if the information they are based on is up-to-date and correct. In my interviews with participants, my number one interest was to determine what information was missing that could have helped them improve their performance. Table 4.3 denotes those ideas along with the levels of SA to which they represent and the strategies to which they relate.

Table 4.3.
User suggested decision support information

<table>
<thead>
<tr>
<th>Information</th>
<th>SA Levels</th>
<th>Number of Associated Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>An understanding or prediction of task difficulty and priority</td>
<td>N/A</td>
<td>3</td>
</tr>
<tr>
<td>A feed in the office with the numbers and types of jobs in each queue</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>A prediction of finishing times for each queue</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Alerts at key times in the simulation</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>A line suggestion for each job</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>
4.4.1 Task difficulty and priority prediction

One of the things that participants volunteered as an item that would help is a better understanding up front of how difficult different tasks would be or how long they would take. For example, one participant said this:

“In the budgeting I didn’t know how organized or unorganized the data was going to be. Another thing I have seen in simulations or things online are it gives you an expected time or difficulty to guide which tasks to do.”

This participant noted that if he had a better sense of what to expect in each task that he would be able to plan and execute along a better timeline. Similarly, another participant said, “Had I realized how in depth that budget task was I would have written some stuff down, gone to meetings, and gotten work done in those meetings.” This participant is implying that if he knew more up front it would have driven him to use a different strategy than he did.

While it would certainly be useful information for planning purposes, I don’t see this as improving SA. Giving this information up front might help the person plan better, but in the situation it is not going to help provide them with any information of the status of the system or of their role in the current state of the system.

4.4.2 Queue information in a feed

Another thing that I heard from participants was that in the real world some companies have “a managerial screen where it is telling you what is running on the different lines.” As one participant told me:

“The time it takes to go look at the lines wouldn’t necessarily be worth it because it would cut into your ability to do the tasks so much. But if I had a live update of the lines right there in the office that would probably allow me to do that strategy and have it pay off.”
Not knowing what was going on on the lines left participants feeling “blindfolded” and “not very confident.” A feed as described would simply show what is on each line, and that is basic data. This means that providing a feed like this would improve participants’ Level 1 SA, but not much else.

4.4.3 Queue finishing times

Participants also wished they could be more confident in their assessment of when a queue was done. One participant told me, “by the end of [the simulation] I wasn’t sure if I had completed all the jobs or not [...] If I had kept track like this I would have known.” That participant was showing me the notes that she was taking during the simulation. Her notes displayed estimates of when each queue was going to end, but stopped about 5 minutes into the simulation. This is something that would take a human a lot of work to keep track of but a computer can be programmed to do quickly. This kind of information processing gives Level 2 SA because it looks beyond the data to tell the participant what the data means.

4.4.4 Time alerts

In addition to those previously mentioned, participants suggested that getting periodic alerts would help them better keep track of the time. Even though the clock is always visible, they suggested that they would get really focused on a task and lose track of time. One participant said, for example, that they wished that time was somehow more visible, and that if it were that she “would have seen how much time [she] was spending and it would have helped budget time better.” Another participant said that she wanted to wait to put a product on a line in case another line came in, and said that she would “have probably waited until 5 minutes left, then [she] would have sent [the other job].” Without any real alert mechanism though, she was worried that she would get distracted and miss the window. In my eyes, surfacing time at periodic or triggered intervals is really just a way to improve Level 1 SA as
it is making a data element - time - more visible. The participant would have to combine this with different data to determine if he was in trouble or not (Level 2 SA), and use that knowledge to predict future states and determine the appropriate action (Level 3 SA).

4.4.5 Line suggestions

Finally, participants suggested that when routing a job, the system could give a recommended line. One participant went into detail, saying the following:

“If there was some software that could plot what kind of job should go next so instead of having to think through it from scratch you kind of have something to help you make decisions and you say ‘Yeah, I agree with that decision’ or ‘lets swap these jobs’ or something.”

This is an implementation of Level 3 SA. The system would have to see that a job is up (Level 1 SA), understand what the impact of that job would be on all the lines (Level 2 SA), understand the further impact it would make on all other jobs not yet routed, and decide which line would be best (Level 3 SA). The prediction of future states to suggest the impact of placing the job on any line could get very sophisticated, even using “past historical knowledge of how many jobs to expect, the product mix”, and the times to expect the products’ arrivals.

4.5 Design

Once I combined the theoretical model, the participants’ noted informational improvements, and the SA-focused design goals of the study, I began ideating with some conceptual sketches (Figure 4.2 and Figure 4.3). These ideas all centered around the same informational aids that came from the data. The artistic side of the design process governed the data presentation, but the functional elements themselves - the list of jobs in the queue, the current job, the remaining time on the job, etc. - were man-
ified as requirements that came from the data. Then I identified common themes from the sketches and developed a higher fidelity wireframes (shown in Figure 4.4). This design was then taken straight into markup and implemented into the simulation. A picture of the design in the simulation is shown in Figure 4.5. I used a mobile design due to “technical” considerations. Since this was a simulation, I could have technically implemented the SA augment in a number of ways, but because I wanted the simulation to mirror the real world, I had to decide between a desktop and mobile application. A desktop application would have only allowed the user to view that information while at their desk. Because people mentioned their interest in working in meetings and their perceived wasted time in between tasks, I deduced that having the information available at all times - via a mobile application - would be beneficial.

Essentially, the design is a dashboard that gives you eyes on the floor at all times. The display shows information relating to each of the four lines. At the surface level, the display shows the line number, what is currently being processed, and the projected finishing time for the entire queue. In smaller print below are listed the
Figure 4.3. More cohesive design sketch models

Figure 4.4. Wireframes with some color showing full functionality of design
Figure 4.5. The MSA augment implemented in the simulation

number of jobs in the queue along with what those jobs are. In addition, for each line a status icon, denoted by a colored dot, gives immediate information as to whether the queue is empty (red), has one job lined up (yellow), or has a number of jobs lined up (green). Finally, every five minutes, an alert slides down from the top on the display to tell the user how much time is left.

This design covers three of the critical missing information areas: queue information in a feed, queue finishing time predictions, and time alerts. The list of task difficulty and priority wasn’t incorporated as it didn’t seem to directly affect SA and was more related to the upfront information provided. I wanted to hold the foreknowledge constant between phases (aside from the added instructions regarding the design shown in Appendix D). The other piece that was not included was a suggestion of where to send the next job. This was a harder decision to make, but I ended up excluding the feature because in the context of the designed system architecture, there was no linkage between the order routing and the status of the lines. I felt that the only way that such information would make sense would be if the routing of the
jobs could be done through the same system that was analyzing the lines. This would imply either (a) jobs to be routed at any point - not just in the office - by including them in a mobile app or (b) the line information to only be visible in the office via a desktop app. I didn’t want participants to further abuse meeting time for routing, but I wanted to improve at least Level 1 SA at all times, so a desktop (office only) application wouldn’t work.

To evaluate the designed system, I began using Nielsen’s Heuristic Evaluation, but I quickly discovered that because of the limited interaction the user would have with this MSA augment, I needed some more relevant evaluation criteria. Of the list of 35 heuristics compiled from multiple sources [62–66], Table 4.4 shows the 24 relevant heuristics for evaluating my system. Of these, my system violates three, but I decided not to change it for the following reasons.

First, I decided that “color blindness” could easily be mitigated by simply asking all participants if they were color blind. None said they were, and so there were no issues resulting from that heuristic being violated. This is only an issue in that the colored dots show the line status at a glance. To alleviate the color blindness burden, I would have had to use symbols or text as well as colors, and that would have violated the “Aesthetic and minimalist design” heuristic.

Next, my design does not help the user “formulate cause and effect.” I could have gone to a detailed level in each line to show how long each job in the queue is going to take and how that adds up to the final end time. However, I never heard any interest in this information in my interviews with the users. As I was designing for my users, it seemed like “extraneous ink” to include information that they may not be interested in.

Last, my design doesn’t allow users to “confirm hypotheses.” This heuristic refers to the ability to test hypotheses based on the data set available. Applied to this system, that would be implemented by allowing users to perform what-if analyses before committing jobs to lines. I considered including this as an intermediate solution instead of having the MSA augment suggest a line for you to send each job to, but
<table>
<thead>
<tr>
<th>Heuristic</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visibility of system status</td>
<td>OK</td>
</tr>
<tr>
<td>Match between system and the real world</td>
<td>OK</td>
</tr>
<tr>
<td>Error prevention</td>
<td>OK</td>
</tr>
<tr>
<td>Recognition rather than recall</td>
<td>OK</td>
</tr>
<tr>
<td>Aesthetic and minimalist design</td>
<td>OK</td>
</tr>
<tr>
<td>Ensure visual variable has sufficient length</td>
<td>OK</td>
</tr>
<tr>
<td>Don’t expect a reading order from color</td>
<td>OK</td>
</tr>
<tr>
<td>Color perception varies with size of colored item</td>
<td>OK</td>
</tr>
<tr>
<td>Local contrast affects color &amp; gray perception</td>
<td>OK</td>
</tr>
<tr>
<td>Consider people with color blindness</td>
<td>X</td>
</tr>
<tr>
<td>Preattentive benefits increase with field of view</td>
<td>OK</td>
</tr>
<tr>
<td>Put the most data in the least space</td>
<td>OK</td>
</tr>
<tr>
<td>Remove the extraneous (ink)</td>
<td>OK</td>
</tr>
<tr>
<td>Consider Gestalt Laws</td>
<td>OK</td>
</tr>
<tr>
<td>Provide multiple levels of detail</td>
<td>OK</td>
</tr>
<tr>
<td>Integrate text wherever relevant</td>
<td>OK</td>
</tr>
<tr>
<td>Overview first</td>
<td>OK</td>
</tr>
<tr>
<td>Details on demand</td>
<td>OK</td>
</tr>
<tr>
<td>Relate</td>
<td>OK</td>
</tr>
<tr>
<td>Expose uncertainty</td>
<td>OK</td>
</tr>
<tr>
<td>Concretize relationships</td>
<td>OK</td>
</tr>
<tr>
<td>Determination of domain parameters</td>
<td>OK</td>
</tr>
<tr>
<td>Formulate cause and effect</td>
<td>X</td>
</tr>
<tr>
<td>Confirm hypotheses</td>
<td>X</td>
</tr>
</tbody>
</table>
I ultimately decided not to implement this feature. My concern was that users - who already were taking a lot of time routing jobs - would get more distracted by their routing task and get even fewer of their other tasks done, thereby negatively impacting their performance.

After considering and justifying these violated heuristics and omitted features, I felt comfortable enough with the designed system to put it into practice and test it with users. The results of this second phase are presented and discussed in Chapter 5.
5. PHASE 2 - RESULTS AND DISCUSSION

5.1 Participants

After Phase 1 was completed and the new MSA augment was designed, I began recruiting for the second phase of my study. In this phase, six participants went through my management simulation. Their demographics are presented in Table 5.1.

Table 5.1.
Phase 2 participant demographics

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Nationality</th>
<th>Major</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>M</td>
<td>American</td>
<td>Industrial Engineering</td>
<td>Recent Alumnus</td>
</tr>
<tr>
<td>21</td>
<td>F</td>
<td>American</td>
<td>Industrial Engineering</td>
<td>Senior</td>
</tr>
<tr>
<td>23</td>
<td>M</td>
<td>Malaysian</td>
<td>Industrial Engineering</td>
<td>Senior</td>
</tr>
<tr>
<td>25</td>
<td>M</td>
<td>German</td>
<td>Industrial Engineering</td>
<td>Senior</td>
</tr>
<tr>
<td>23</td>
<td>F</td>
<td>American</td>
<td>Sales Management</td>
<td>Recent Alumnus</td>
</tr>
<tr>
<td>22</td>
<td>M</td>
<td>Chilean</td>
<td>Management</td>
<td>Senior</td>
</tr>
</tbody>
</table>

5.2 Quantitative Analysis

5.2.1 Overview

Once again, the focus of this study is predominantly qualitative, but some quantitative measures were collected. I do not see these as statistically relevant data points, but rather a set of contextualizing metrics to be associated with the qualitative information gathered.
5.2.2 Performance

Again, due to the small size of the sample, I am providing both the average and median values. Performance was measured and paid according to the same formula as before:

\[
12 + 8 \times \left( \frac{\text{# of completed jobs}}{40 \text{ total jobs}} \right) \times \max\{0, \frac{\text{# tasks completed} - 2}{5 \text{ total tasks} - 2} \} \quad (5.1)
\]

While the average performance in Phase 1 was 13.25 (\(\sigma = 1.49\), Median = 12.50), the Phase 2 average was 15.5 (\(\sigma = 2.58\), Median = 14.97). As shown in Equation 5.1, this score is made up of the number of jobs completed and the number of tasks completed. For the number of jobs completed, in Phase 1 the average number was 33.87 (\(\sigma = 8.28\), Median = 39) while in Phase 2 this number stayed about even at an average of 32.83 (\(\sigma = 10.38\), Median = 39.5). This means that, just like in the first phase without the MSA augment, the participants did quite well in routing the jobs in Phase 2. The overall improvement, however, came from the participants completing more of the excise tasks. In Phase 1 the average number of tasks completed (out of the 5 possible) was 2.375 (\(\sigma = 0.99\), Median = 2.5), but in Phase 2 that number increased to 3.67 (\(\sigma = 0.94\), Median = 4). I conducted F-test on each value and all three failed to reject the null hypothesis that the variances were the same between the two populations. I used this information to conduct t-tests on each and found a significant difference between the two phase results in terms of task completion (\(p=0.041\)). While I reiterate that the small sample size should keep us from making sweeping statistical generalizations, the jump from 47.5% average (50% median) task completion to 73.5% average (80% median) task completion is something to note.

In my discussion of Phase 1 results, I noted that it seemed like the poor task performance had to do with jumping between tasks and routing often. In this Phase 2 study, the MSA augment seemed to allow the participants to have the confidence to ignore incoming jobs for a time and focus on the task at hand. This may be one of the key reasons for improvement, and I will further explore this when I discuss the qualitative data later in this chapter.
5.2.3 Situation Awareness Rating Technique

The average and median SART score comparisons between the two phases are shown in Table 5.2 and the complete data set for Phase 2 can be found in Appendix E. Once again, drawing conclusions between the phases is dangerous, and most of the values are quite similar, but there are two interesting items of note. One is that with the MSA augment, even though the variability in the system is the same as it was in Phase 1, the participants seem to feel that there are less variables changing within the situation. I would suggest that this has to do with a greater sense of confidence and control over the the queues that the MSA augment provides. The other interesting thing to note is the perceived increase in spare mental capacity the participants reported. This is easy to imagine. If the participants no longer have to remember everything that is queued up on all lines at all times, that would certainly alleviate some of their cognitive load. It can be noted that by treating the qualitative results as prior support for the hypothesis of the performance with the MSA augment is better than that without, Bayesian reasoning affords a smaller data set to provide credence to an improvement when triangulating with that posterior quantitative data. I conducted the same statistical analyses on the SART data as I conducted on the performance data and similarly found no variances to be significantly different between populations on any of the values. From the t-tests, I was only able to show one value as statistically different from the others: spare mental capacity increased from phase 1 to phase 2 (p = 0.048).

5.3 Qualitative Analysis

5.3.1 Overview

The reader may notice that there were 8 participants in Phase 1 and only 6 in Phase 2. This is because from a qualitative perspective, Phase 2 interviews reinforced many of the same themes that Phase 1 brought to the surface. When interviews were
Table 5.2.
Phases 1 and 2 SART score comparisons

<table>
<thead>
<tr>
<th>Phase</th>
<th>1</th>
<th>2</th>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Standard</td>
<td>Median</td>
<td>Average</td>
</tr>
<tr>
<td>Instability of Situation</td>
<td>3.88</td>
<td>1.66</td>
<td>4</td>
<td>3.33</td>
</tr>
<tr>
<td>Complexity of Situation</td>
<td>4.75</td>
<td>1.41</td>
<td>5</td>
<td>4.83</td>
</tr>
<tr>
<td>Variability of Situation</td>
<td>5.00</td>
<td>1.20</td>
<td>5</td>
<td>3.50</td>
</tr>
<tr>
<td>Arousal</td>
<td>5.38</td>
<td>1.41</td>
<td>5</td>
<td>5.67</td>
</tr>
<tr>
<td>Concentration of Attention</td>
<td>5.75</td>
<td>1.20</td>
<td>6</td>
<td>5.67</td>
</tr>
<tr>
<td>Division of Attention</td>
<td>4.13</td>
<td>1.83</td>
<td>4.5</td>
<td>5.00</td>
</tr>
<tr>
<td>Spare Mental Capacity</td>
<td>2.88</td>
<td>1.54</td>
<td>2.5</td>
<td>4.50</td>
</tr>
<tr>
<td>Information Quantity</td>
<td>4.38</td>
<td>0.86</td>
<td>4</td>
<td>5.17</td>
</tr>
<tr>
<td>Familiarity with Situation</td>
<td>3.00</td>
<td>1.41</td>
<td>2.5</td>
<td>4.00</td>
</tr>
</tbody>
</table>

not yielding any new insight, I became comfortable and confident in the validity of my original framework. By the 4th participant, I had heard very few new insights, and after 6 participants I stopped, resulting in 1.5 hours of interviews and 13 pages of transcriptions. Upon reaching data saturation there was little value in collecting
more of the same reinforcement. The total number of interviews (14) needed to reach
data saturation was consistent with the findings of Guest, Bunce, and Johnson, [48].
Rather than re-explaining the same theoretical framework discussed in Phase 1 in a
new context with new quotes, I believe what would be more valuable would be to call
out the themes Phase 2 interviews carried that are different from what was discussed
in the Phase 1 framework.

5.3.2 Decision confidence

In Phase 1 discussions, confidence was a concern among many of the participants.
The following list of quotes all serve to show the prevalence of that issue:

- “I was sending jobs based on a rough idea so I wasn’t 100% sure on how the
  jobs were doing, felt kind of blindfolded.”

- “Eventually I got lost in how many products were in each queue and which ones
  were in each queue.”

- “I was surprised on a floor check that some of the lines had been going well.”

- “I was trying to do the budgeting work and then I would be glancing down at
  the inbox to see if a job was coming in.”

- “[I would] catch myself thinking about not performing well as opposed to the
  task that I was trying to finish.”

All of these quotes show, latently or explicitly, the general sense of discomfort with
not knowing exactly what is actually happening on the lines. It is easy to imagine the
attention that discomfort can manage to direct away from the other excise tasks. If a
participant is constantly worried about not doing well in the routing, they will focus
far more on responding to new orders and taking their time to figure out where those
orders should go. Unfortunately, this often comes at a cost of frequent distractions
to the other managerial tasks, which results in mistakes and concentration loss.
Interestingly, in Phase 2 there were no quotes like those previously listed. The reasons given for poor task performance were often attributed to the participants not reading the directions, to their planning, or to a personal characteristic. For example one Phase 2 participant said, “I might have been too focused on completing the budgeting. I might have looked at the scheduling task, but I like to stick with one thing until I get it.” The only people who said or even implied that they were not confident in their routing decisions were those who didn’t read the instructions well enough or have enough contextual knowledge to know how to do the routing task properly. It was not a lack of SA that caused their hesitation; these particular participants were not confident in the task as a whole.

5.3.3 Going to the floor

One of the more contentious strategies in Phase 1 was if, when, and how often to go to the floor. In asking Phase 1 participants what they would have done differently if they did the simulation over again, one of the most common responses was “maybe I would have gone to the floor more often” because “it was hard to keep it all in my head.” However, some people also added a disclaimer to that comment stating that “it’s not really worth the time it takes to go down to the floor.” The idea here was that for that task, an estimate in the participants head was “good enough” to do well.

As the reader might expect, with the addition of this augment for MSA, the need to visit the floor is entirely eliminated. In fact, the only comment I received relating to visiting the floor in Phase 2 was a participant who said:

“I thought the phone was good, good to have that. But on, I don’t know, I guess I didn’t really see the need to go to the shop floor when I had it on my phone. [...] It was pretty easy. I liked having it there.”

This single quote exemplifies the disappearance of that strategy from the Phase 1 list, as having the floor information live at all times eliminates the need for time
consuming trips. Obviously, this quote also provides validation of the design, as feedback specific to the phone was entirely unprompted yet positive.

5.3.4 Triggers for meetings

The most prevalent theme that emerged from Phase 2 was something that was never even mentioned in Phase 1. Almost all the Phase 2 participants mentioned that a key strategy for them was to only go to the meetings once they had a large enough queue on all the lines. In Phase 1, the decision to go to a meeting seemed fairly arbitrary. It was just considered a wasted time slot that a smart person could do some work in if they planned accordingly. However, in Phase 2 the participants seemed to plan when to attend meetings around their queue. These participants wanted to minimize any wasted time on the lines. They would try to have “all lines active before working on a daily task” because they “never wanted to be in a meeting if [they] didn’t have one of the machines full.” As one participant was laying out his strategy to me, he said, “When I had people working on all the products I just went to the meetings, and then when I got back they were all done with their tasks.” Another participant lamented after the fact that she had the phone positioned on top of where the length of the meeting was shown, so she didn’t know how long different meetings were. She said if she were to do it over again, she “would have made sure the machines had enough queue that they wouldn’t run out while [she] was at the meeting.” The prevalence of this new theme is an interesting validation of the system’s design. If surfacing more information allows people to come to agreement on a best practice strategy, surely that is important information and the system is doing its job well.

5.3.5 No missing SA information

Finally, the most validating theme that emerged was that the only information people suggested would help in Phase 2 was predictive data on distribution of jobs
and when they would emerge. I explained in my discussion of Phase 1 that I left this information out because it doesn’t have as much to do with improving situation awareness as much as it has to do with planning. The lack of mention of any other missing performance-enhancing information speaks volumes to support the MSA augment. Until seeing it in action, I left it out of the theoretical model. However, having seen it influence strategies which in turn seem to improve performance, if not with statistical significance than at least enough to warrant investigation, I am including it as a moderator to my proposed theoretical framework in Figure 5.1. Now that I have presented my final framework, I discuss the study limitations and my recommendations in Chapter 6 and I conclude the work in Chapter 7.
Figure 5.1. Updated grounded theory model of SA in management
6. LIMITATIONS AND RECOMMENDATIONS

6.1 Limitations

There are a number of limitations with this research. Some of these were known up front and were included by design, while others arose during the course of study and had to be worked around. In this section I will describe these limitations and the impact they each have on my research.

6.1.1 Statistical power

One limitation that I knew about up front was that I was going to be collecting performance data and self-reported SART survey data but I wouldn’t be able to draw any truly meaningful conclusions off of that data alone. Because there was no grounded theory looking at MSA as a factor in decision-making performance, I felt that I was better off approaching this research from a rich qualitative approach. Doing so requires much more time with participants, which makes recruiting participants more expensive. I still collected the quantitative data, however, and discussed it in my analysis, but I did so openly and with the clear expectation that it is used for context and not to make statistical claims.

6.1.2 Reactivity

The participants in this research were observed as they planned for and worked through the simulation. This presence of an external observer exposes the research to reactivity. Reactivity is a phenomena where individuals do not act representative of themselves in some way due to an external factor [46]. A common example of
this in the literature is the Hawthorne effect, in which employees worked faster under observation by their manager [70]. I attempted to minimize the reactivity of my studies by observing quietly, and often remotely by having the participant share their screen online rather than meet in person, however there was no way to eliminate this effect altogether.

6.1.3 Sampling

Another limitation I imposed on myself knowingly was my sampling method. Ideally I would have worked with professional managers with years of experience. As previously mentioned, by setting the stage for an SA discussion and by holding that discussion, I had to allow for a significant time commitment from each participant. Time is more expensive to professionals than it is to students. On top of the financial issue is an issue around participant access. As a college student, it is far easier for me to access a sizable sample of participants in college than it is for me to access the same size sample of professionals. Based on these two factors, I decided to target students in my sample. However, it was important to me to create some level of contextual relevance, so I only opened this to people with similar work and educational experiences - students from Industrial Engineering and Management who either will graduate in less than a year or who have graduated in the past year. In this way, I minimized the impact of this sampling limitation, but I do recognize that the limitation is still present.

6.1.4 SART

Research shows conflicting opinions on how useful SART is as a predictive measure. Opponents have suggested that because it is delivered after the fact, and because it is all self-reported values, that there are too many variables that get in the way between true SA and what the SART results say [13]. A more widely accepted method of measuring SA is SAGAT, which freezes the simulation and asks the participant to
answer questions about the situation at the time of freezing. Those values can be cross checked with the true values, which can then provide a real sense of how well the participant knows what is going on. I decided to use the less expensive method over the method that nets a better picture of SA. This made more sense when I considered the fact that the quantitative measures are simply to provide context, not to draw statistical conclusions.

6.1.5 Design methodology

If this were primarily a design project, I would have approached design process with more rigor. Due to the timeline and focus on assessing if SA is really a factor in management, I decided to perform an expedited design workflow. Ideally, I would have worked with actual managers to first build personas and use case scenarios. Then I would have designed in the context of those personas and use case scenarios. I would have had multiple other designers perform the heuristic analyses independently and looked at the combined results to assess if things needed changing. I also would have had conversations with my Phase 1 participants about the proposed MSA augment to determine if there were ways to further improve it before Phase 2. However, all of these methods would have increased my timeline and budget, and I decided that my methodology was an appropriate middle ground between good design practices and completing the project in the required time frame.

6.1.6 Simulation and study

The above issues were all identified and planned around before the study began. However, there were also problems that occurred mid-study that had to be acknowledged and worked around that may have limited the study’s success. All of these problems had to do with the study itself, most as technical problems with the simulation.
Bugs and glitches

There were two major bugs/glitches in the system that had the potential to impact results. One was that if a user accidentally hit the back or refresh buttons on their browser before finishing the simulation, all the data would be lost. This was only an issue once, and when it occurred the data had to be thrown out. The other major glitch was that in Phase 2, the first time the phone was moved, it would jump far away from the mouse. One participant didn’t move the phone until the last 7 minutes, but when he did it flew off the page and he could not get it back, potentially impacting his results.

Phase 2 rendering issues

Another problem with the study was that on some computers, the phone in Phase 2 rendered large and would cover up a quarter of the screen. The participants had to move it around a lot and spend most of their time either not viewing the whole screen of the phone or not viewing the whole screen of the simulation. This obviously may have impacted performance in some way.

Browser compatibility

One discovery later in the study was that the simulation would not work on Safari browsers. Users who typically only use Safari had to download another browser, typically Google Chrome, in order to participate. I do not know if that may have impacted performance, but it certainly was an unexpected issue in the study.

Inbox visibility

An interesting problem in the study was that a few people did not open the inbox until late in the simulation. These people either had not read the instructions very well or the interface confused them, but they typically discovered the inbox in the last
5 minutes or so and in a rush sent jobs to lines. This obviously had an impact on their performance, and I wrote it off as a matter of planning and reading the instructions carefully up front because that is what the participants reported. However, it is possible that they said this because the system had a poor affordance and they just wanted to avoid risking insulting me.

**Budgeting and scheduling task**

A recurring problem was that the budgeting task was very challenging. There were a lot of variables that all had to be summed, multiplied, or subtracted, and it was possibly unnecessarily difficult. This is especially true, because if the answer was incorrect, the participant had to essentially start over. Breaking it into two, smaller, contained tasks may have made more sense in retrospect. Similarly, though to a lesser extent, the scheduling task confused some people as well. There is a lot of reading and deductive reasoning that was involved that may not have been necessary.

**Meetings**

Another issue was that meetings were seen either as a waste of time, which is not externally valid, or as a time to work on other tasks, which is even less externally valid. This is a limitation that I didn’t think about that probably could have been countered by asking the participant to watch a short video or read a short paragraph and answer a few questions about it afterwards.

**Critical events**

Finally, a noted limitation and missed opportunity was a lack of a surprise event. Often, managers will have to deal with a critical event in the plant such as an injury or machine breaking down. Throwing in a random variable like this would not only help
test the participants’ SA, but also make the situation more realistic and externally viable.

6.2 Recommendations

Based on the discussed findings and noted limitations of this study, I propose the following recommendations. First, I would propose that there is evidence enough to warrant further work in applying the SA model to the context of operations management, and possibly other areas of management. This work was exploratory in nature, and it has uncovered an interesting hypothesis that needs further exploration: a design focused around SA will allow for better performance than those without any system. The next steps I would propose in this avenue would be to design a more externally valid simulation for this or another management context, test it with a large sample of real professionals from that context, use the SAGAT methodology to collect more comprehensive, statistical data, and show the real issues with SA in management. Following that work, I propose a participatory design project that brings the managers into the design process to create an ideal MSA augment. I would then recommend including that augment in the improved simulation and studying the SA measures again to show the improvement such a system could provide. Finally, I have some recommendations for managers who do not have the time or resources to do this work, or for designers who do have the time. These individuals should strive to come up with a method of improving access to the kind of data displayed in the application (what is on each line, when is it expected to finish, etc.). Additionally, these people should focus on what data allows the managers to optimize their path between tasks by clarifying what is important and when to perform certain tasks. The work I have done up until this point is only the first step to validate that this is a field of study worth exploring. I believe that I have achieved that goal.
7. CONCLUSIONS

In this thesis, I have shown that, to an extent, SA is applicable to the management context and may be useful as a design focus for improving performance. The goal of the research was to develop a model of MSA and to determine if there is promise in the further exploration of this theoretical model. To achieve this, I developed a simulation for an operation management situation and I conducted a 2 phase qualitative study in this environment. In the first phase, participants did not have any situation awareness augment. They completed a SART survey and were interviewed. I conducted a thematic analysis on their results and determined the strategies along with the information that informed them of which strategy to use at which time.

This information was used to design a MSA augment which was evaluated based on heuristics and incorporated into the simulation. The second phase of the study was the same as the first with the only exception being that in Phase 2, the MSA augment was present. The qualitative results of this second phase further validated the original grounded theory developed through the Phase 1 thematic analysis. The results also validated the idea that the MSA augment improved performance through the data it provided. The quantitative measures of performance, although, non-statistical, show that there may be potential for further exploration, as the Phase 2 average and median performances were noticeably higher than those measured in Phase 1.

This work is important because it can help inform future design work on business intelligence platforms, ERP systems, electronic whiteboards in hospitals, and more. By leveraging the knowledge and testing methodologies used in the SA domain, we may be able to improve designs - and by extension performance - in many management contexts. In this world of growing automaticity, managers have to rely more on systems thinking which requires them to be more aware of their environment and the
current situation. This work should serve as the foundation for the importance of this body of knowledge. There is certainly a way to mitigate some of the cognitive burden, and I believe that this thesis shows that applied MSA designs are worth further exploration.
REFERENCES
REFERENCES


Michael Quinn Patton. *Qualitative research*. Wiley Online Library, 2005.


APPENDIX A
SIMULATION INSTRUCTIONS
In this study, you will be simulating the role of a manager in a manufacturing system. All orders come into your office to check and route through to the plant floor. Your primary job function is to handle the efficient routing of these jobs throughout the day. However, as a manager you have been assigned other tasks and responsibilities for the day that you must complete. The day has been accelerated so that the full day’s work is to be completed in 25 minutes (your 10 hour management shift is sped up so that 1 simulation minute represents about 24 actual minutes). The products are tested and selected so it is possible to route all jobs to be completed by the end of the 25 minutes.

Your system has 4 lines that can produce all 6 products that your company sells. Each line processes these orders at different rates, but the setup for the machine’s tooling takes the same amount of time regardless of the machine. When a line switches to a new type of product, it has to be retooled. Below is a cheat sheet for the processing and set-up times (in simulation minutes). It is recommended that you print out or copy down this information.

**PROCESSING TIMES / SET-UP TIMES**

<table>
<thead>
<tr>
<th>Product</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
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<tr>
<td>Line 1</td>
<td>60</td>
<td>50</td>
<td>65</td>
<td>70</td>
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<td>Line 2</td>
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<td>Line 3</td>
<td>30</td>
<td>90</td>
<td>60</td>
<td>70</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Line 4</td>
<td>60</td>
<td>75</td>
<td>65</td>
<td>60</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>Set-Up</td>
<td>105</td>
<td>45</td>
<td>195</td>
<td>180</td>
<td>105</td>
<td>150</td>
</tr>
</tbody>
</table>

During the simulation you are permitted to have paper in front of you to take notes and a calculator to do math, but please do not use any other methods of recording or computation (e.g. photos, web search, excel, etc.)

After the time runs out in the simulation, you will be prompted to complete a short survey. Please do so immediately while the simulation is still very fresh. After the simulation, you can take a break before our interview. You will be paid at the end of the study by this formula:

\[
$12 + $8 \times \frac{\text{# jobs completed at end of 25 minutes}}{\text{total # of possible jobs}} \times \text{Maximum} \{ 0, \frac{\text{# tasks completed} - 2}{5 \times \text{total tasks} - 2} \}
\]

Therefore you will be paid no less than $12 and no more than $20. Your simulation performance will determine the exact amount.
This is the list of tasks to complete. This is the list where incoming jobs come across your desk. Clicking this button will take you to the plant floor.

The instructions for completing the individual task currently selected will show up here.

This is a countdown for the time remaining in the simulation: 24:41.
Click a job to pull up its routing menu
Pick a line to send the job to and press send. Clicking “x”, cancel, or out of the box will close the box and not send anything. Once sent, the job is removed from your list and immediately transferred to the selected queue on the plant floor.
Getting around the site takes time. Allow 10 simulation seconds to walk in the halls between the office and floor and the office and conference room.
Each line has an inbound queue and a job in process field. The jobs are added to the queue first in-first out, but if you add a job to a queue with another job of that type they are grouped together to avoid set-ups.

This tells you what is in process at the moment and what time was on the simulation clock when it was started.

If there is nothing in process at any given time because the queue is empty, the most recent job type will show for tooling purposes and the start time will show as “--:--“.
There are three meeting tasks that each take a portion of time and block out your ability to route jobs (because you are in the meeting room). Clicking go to meeting will take you there. Once started there is no getting out of the meeting until it concludes.
Current location: Meeting Room

Time remaining in meeting: 1:25

22:01
The budgeting task will have you doing some basic accounting math to work out the month’s profit. Enter the value in the text box and click out of it or hit enter to check. If you are correct it will turn green and lock in.

Completing a task will cross it off of your to do list.
The scheduling task will have you planning next week’s schedule by following certain rules. You must consider all points. Once the whole week is correctly solved, all values will turn to green and lock in.
APPENDIX B

INTERVIEW SCHEDULE
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

What do you think contributed to your performance in the simulation? How?

What information would have helped you improve your performance? How do you think would this have helped?

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?
APPENDIX C

PHASE ONE PARTICIPANTS
<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Sex</th>
<th>Nationality</th>
<th>Major</th>
<th>Status</th>
<th>Instability of Situation</th>
<th>Complexity of Situation</th>
<th>Variability of Situation</th>
<th>Arousal</th>
<th>Concentration of Attention</th>
<th>Division of Attention</th>
<th>Spare Mental Capacity</th>
<th>Information Quantity</th>
<th>Familiarity with Situation</th>
<th>Tasks Completed</th>
<th>Jobs Completed</th>
<th>Score</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>21</td>
<td>F</td>
<td>American</td>
<td>Industrial Engineering</td>
<td>Senior</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>6</td>
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<tr>
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<td>M</td>
<td>American</td>
<td>Industrial Engineering</td>
<td>Senior</td>
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<td>5</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>6</td>
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<td>3</td>
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<td>14.67</td>
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<tr>
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<td>M</td>
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<td>Senior</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>6</td>
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<td>2</td>
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<tr>
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<td>Indian</td>
<td>Industrial Engineering</td>
<td>Recent Alumni</td>
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<td>5</td>
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<td>7</td>
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<td>4</td>
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<td>Industrial Engineering</td>
<td>Recent Alumni</td>
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<td>5</td>
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<td>5</td>
<td>2</td>
<td>1</td>
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</tr>
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</table>

| Average     | 3.88 | 4.75 | 5.00 | 5.38 | 5.38 | 4.13 | 2.88 | 4.38 | 3.00 | 2.38 | 3.38 | 2.88 | 3.38 | 13.29 |
| Median      | 4.00 | 5.00 | 5.00 | 6.00 | 4.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 12.50 |
| Standard Deviation | 0.78 | 0.97 | 1.66 | 1.41 | 1.20 | 1.83 | 1.54 | 0.86 | 1.41 | 0.99 | 1.41 | 1.41 | 0.86 | 1.49 |
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

Never been in that position or really had to use any of those skills so probably wouldn’t think I’m the best manager- generally good decision maker.

If everything that needed to be done got done in the right amount of time and it was done up to a good standard, like efficiently.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

Mainly focused on the inbox – probably because I kept seeing the numbers escalating and I also did the budget because it was something that was pretty quick and I was able to do but the scheduling –toward the end just because it was taking most time. Plan of attack – if I started working on something and gaining momentum, I wanted to continue on that. I didn’t want to linger too much on one thing so I would move on to next section. But if I wasn’t getting anywhere or getting confused, I would move on to the next section. Ummm, yeah, I wish I would have done maybe, I dunno I thought that lingering on scheduling would have gotten it, but it think I was over thinking it and took up too much time. Wish I would have moved on to more of my todo list. It would have helped but deviating from plan hurt.

What do you think contributed to your performance in the simulation? How?

Well, when I started I was a little unsure exactly what I was doing, but then i just started doing stuff. I did the meeting right out of the way because it was something easy I could do. But then once I started doing the scheduling I started getting frustrated and overwhelmed and I felt like I wasn’t doing very good, so that’s why I switched to the budgeting because I know that’s something I could do. So then as I was doing budgeting then my confidence got better, so after that I went to the inbox, and then since I felt alot better with how I was doing. I felt like I was better at decisionmaking for the inbox jobs and kinda when I did my plan of attack with the times and everything. So then I thought that I could go back to the scheduling and it would be better and then I looked at it and it wasn’t (laughter). If I wasn’t very sure about something, if I wasn’t feeling that great then I kinda would get more frustrated and catch myself thinking about not performing well as opposed to the task that I was trying to finish.
What information would have helped you improve your performance? How do you think would this have helped?

Wish that the time was clearer, but maybe that would have made me more nervous, so maybe not. Would have seen how much time I was spending and it would have helped budget time better. Would have rotated so how ever many seconds I would have gone to inbox and done a certain number and come back.

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

I would have gone to the to do list more and made sure that I got done the things that I needed to get done. But then I also would have scheduled jobs quicker at start, I did them quicker at the end and it worked fine. But I was more hesitant at the beginning and wish I was a bit quicker.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

Well, ive never been a manager. Not as pressed for time in real life. Alot is going on, but 8 hours is a lot of time and I can do some of this outside of work. I guess that lines could have broken down, injuries, etc. no surprises. Just things in life that you can’t really plan for.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you
define your success in these capacities?

Pretty good manager/dm. Puts a lot of weight in people suggwestions and ideas in dm. team
project-esl-took the reins. Judged by the grade but not just that – also how the team looked at
him. Beyond the outcome – a good reception is key

What were your primary goals in the task? How did you decide on your plan of attack? Did the
execution line up with your expectations?

Primary goal get jobs done- worked in three plants with internships and had daily tasks and
things but always heard manager say their main thing is that the work needs to get done –
didn’t expect the jobs to be as difficult. Put the most mental effort into making sure I got the
jobs done. Initial plan was to determine shortest processing time. Only ran C on line 2 because
the set up time was so long. Halfway through noted B was a short setup time so bounce it
around as a float. I didn’t go to the floor often because for the most part I could remember
where things were, but when I did go to the floor it kind of help me remember where I put
things and I wrote down at one point just trying to keep track of that stuff. I was surprised on
floor check that some of the lines had been going well and I hadn’t realized I put B there.
Surprised a bit but it was a good surprise – I had been following what I meant to do but hadn’t
realized that I had been doing it.

What do you think contributed to your performance in the simulation? How?

First thing was to go to a meeting because anywhere I’ve worked in a plant I’ve always had a
meeting pretty soon after I’ve got to work just kindof like a run down of, because usually you
know they analyze what happened the day before, so I figured you know it would be good to
you know go to that meeting. However, in terms of this simulation, that wasn’t the best idea
because meetings area good time to get work done. Had I realized how in depth that budget
task was I would have written some stuff down, gone to meetings, andf gotten work done in
those meetings. Thought I was done with the scheduling and I left it – had a minute left and
didn’t have time to fix it. Tried to align with what I knew in the past.

What information would have helped you improve your performance? How do you think would
this have helped?
Was there a screenshot of the budgeting screen? I didn’t read that close enough. Underestimated the task. Better calculator. When I was trying to do some complex math its hard to do on a one line calculator. I honestly think I had enough info for the routing. I was pretty well suited with the information. I was trying to do the budgeting work and then I would be glancing down at the inbox to see if a job was coming in. So like and I didn’t really spend a whole lot of time sending because I would just quickly refer to the sheet so I really think I just underestimated the tasks. Some of that time would have come in the meetings. Routing wasn’t too difficult.

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

Time in the meeting would be used to crunch numbers. Maybe done this( points to notes on routing) a little more, started this a little erlier (Asked: gone to the floor?) well, I didn’t necessarily need to go to the floor oft- maybe go to the floor at , a little bit after the first time I sent it in – sent in the orders. Keeping track of this more, instead of doing it all mentally, um make sure hat I did it. Cuz you know, by the end of it I wasn’t sure if I had completed all the jobs or not, I didn’t know if I had done well or had done poorly, but had I kept track of it like this I would have known it would have helped me know the set up time more accurately. Wrote the line job down to keep it clear, would have been more confident in my job performance. Keeping a better note of it rather than try to do it all mental cuz there is really just no way – I mean I tried to the best of my abilities but there is no way I was going to be 100% right with knowing where I put things?

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

Biggest one is definitely the meetings. If iam sitting in the meetings I really shouldn’t really be doing work. Going down to floor. You don’t have to be on the floor to loike look at, the stuff could be computerized. There is a way to look at a managerial screen where its telling you what’s running on thdiffent lines – you don’t have to be physically looking at them. It would look very similar to what it showed in – well before someone put in a job on the floor they would type A and hit enter and on a screen in my office it would show what’s running on each line because its what they would input. IT would have been something I would have used a lot – would have wanted to find a system that does that.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

Fairly analytical – start with a chart to lay out thoughts on paper. Avoid analysis paralysis. Make quantified decisions is possible, but won’t invent quantities that do not directly apply. You usually get eh most feedback from your employees and also the results of if it got done in time – that’s kind of binary with yeah it did or no it didn’t, but people under you will tell you a lot about things that happened and where you could try new things.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

Primary was sending out jobs as soon as possible from when they came in without breaking my concentration too too much on the task. I figured part of it was I didn’t know the frequency or distribution of jobs- are they all going to come in at the beginning? Or are they going to trickle in as the day continues. I wanted to always keep as many lines open for the potential of a big surge worst case scenario. Never really paid off I don’t think, im pretty sure that by the time the exercise was done all were idle (39 were in fact done). It never paid off as much as it could have. Deviated from original strategy to compensate for lack of Ds. And job B had shortest setup time so could be more flexible in case a D came in.

What do you think contributed to your performance in the simulation? How?

Preparing helped a lot. If I hadn’t taken the time to come up with strategy I would have done a lot work thinking ok what really makes sense to send this job. Coming up with a strategy helped avoid anxiety as the jobs built up more. In tasks, uh I did pretty crappy (laughs). What probably helped, well in retrospect should have looked at them and figured out the order first. Higher and lower rates of potential failure.

What information would have helped you improve your performance? How do you think would this have helped?

If I had a complexity rating given or description, this is complex or this is fairly simple. Distribution of jobs coming in would have been huge, time and types. Previous managers’ data could be used to compute complexity.
If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

In terms of tasks wouldn’t have done meeting first – I should have written out my numbers and while I was sitting in the meeting I could have done some numbers in meetings. Same with logic, looked at logic, thought about it in the meeting – assuming meetings aren’t productive.

Without the distribution data I would have done the same thing in routing the jobs. You can go and do a little more analysis to do a complex ranking system but I would need to keep track in my head what each line is doing or going to see that. The time it takes to go look at the lines wouldn’t necessarily be worth it because it would cut into your ability to do the tasks so much. But if I had a live update of the lines right there in the office that would probably allow me to do that strategy and have it pay off.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

Not a ton of real world experience in this particular thing but would say that probably having the meeting times being whenever is a bit strange. I guess if you are the head honcho that does make sense. Could have forced a lunch break.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

Manage but not a very good decision maker? I dont see myself very sure about a decision – lack of courage – stick to my choice Task done- on time – correctly – how to manage relationship between employees.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

The tasks done and jobs done as well. Got too caught up on scheduling task. I tried to get jobs done as they came in. I recorded which job I put on which line and tried to keep just one job type on one line so that I can minimize the setup time. Intuitive, based on setup times on lines and based on their completion times on line. If setup is long, keep it on the one line by itself – not adding jobs on to that one line. I didn’t go back and check on the floor. I didn’t really get the tasks done. I got really caught up. I didn’t realize the scheduling would take so long. I guess I should have done the meetings first of the experiment.

What do you think contributed to your performance in the simulation? How?

I took IE 383 last semester so I think that that kind of helped scheduling jobs. I think its kind of my habit to stick to one thing until it’s done. I still think I shouldn’t really do one task, its really poor time management.

What information would have helped you improve your performance? How do you think would this have helped?

Setting up periodical alarms for the day, like when there are 10 minutes or 5 minutes. Sketch plan for the orders. I should have listed the order for the tasks so I could have pulled myself out of the tasks. Writing down the times for the meetings for a plan for the tasks. Maybe regularly check on the floor – at least once - throughout the day. I think the one left was just the time wasn’t finished. Length of queue # jobs. Because I put at most two jobs on one line. I only put F on 3 for long set up, but im guessing that the last F was done a long time before the last product arrival. I could have put C or B on 3 as well if I knew it was empty. Would have known that a line was completely empty and could be used for other jobs. (Asked if they
would have left it empty or put another on it) I probably will move it at maybe if there is only 5 simulation minutes left at the end of the day.

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

I would definitely change the order that I would complete the tasks. Some of the tasks are fixed time so I would be sure to get them finished and then could spend the rest of the time on the more difficult tasks. I would try to write down some of the task information on paper while in meetings.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

I have never had a managing experience before, but I think it is pretty well done. Dynamic list keeps coming in is awesome.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

I can’t really multitask well. I have to focus on one subject and switch to another one. I probably prefer the tasks that are easier to do first, get them done first, and then go to the more complex ones. I guess the performance outcome, the quality of work being done, and also the efficiency. Satisfaction from the boss or the customers.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

To get the jobs sent to the floor so that no machine was sitting idle – that would be the priority. I basically looked at the processing times and basically marked the ones that took the least amount of time for each product and sent same products to the same line to avoid the setup times as much as possible. Meeting would go first because it usually contains teamwork or information that is important, and then I was going to say scheduling but I didn’t actually do that first. I thought I would have enough time for all of them, so I just went through list. Didn’t do meeting first so that the lines would get jobs while I was in meetings. Hoping I could do better on the number of the tasks I completed. On the jobs, I think the turnout would be fine. Didn’t check while sim was running because it takes time to actually go to the floor. But I think I had a brief idea idea of where all the jobs were going I think.

What do you think contributed to your performance in the simulation? How?

Experience and knowledge in queuing systems or decision making helped with putting jobs into the right line. And one reason I did not do so well in budgeting because usually I do not do calculations in a calculator, I would use an excel sheet or an existing model. I think the timer really helped on the bottom, it showed how much time left so I could choose what to do depending on time available. In last 5 minutes of time looked at the remaining tasks and decided based on their times to decide what to do.

What information would have helped you improve your performance? How do you think would this have helped?
On notes she was writing when she added jobs and was predicting finishing times. It took too long to do in head so she just stopped using it. It is a lot of stress. 25 minutes is not a lot to do for all of the tasks. It’s a little bit distracting.

Set up table to avoid walking to the floor but took too much time to do in head. Able to adjust how to put the jobs onto the floor depending on how the jobs are looking. Sending jobs based on rough idea wasn’t 100% sure on how the jobs were doing, felt kind of blindfolded.

Maybe there should be certain priority numbers to go with each task. I kind of randomly picked which one. In reality different tasks have different importance so I might give up on one in favor of another.

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

Do the same thing based on what’s provided. I don’t think I could get more jobs done but I think I could get more tasks done. Do scheduling first then do meetings, do budgeting at end.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

It’s pretty accurate for the most part, except lunchtime is usually more fixed.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

Normally make data-based decisions. Never been a manager but a big part is dealing with people and their problems and not just data and stuff, I'd say that I am quick to make decisions. I know that time loss is sometimes a big issue. Reevaluate the decisions made and see what influences or effects that they had, see if a different decisions would have been better. Decisions are often predictions, in future you can look back and see if it was good, see what you did, and use that to make better decisions in the future.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

Clicked button, got stuck in a meeting. Didn’t totally get the instructions. But my plan of attack was once on a task I would complete it before I went on to the next one. Figured out what products, I just circled the minimum 2 products for each line. I also knew that product B had shortest change over so could go anywhere. Basically just picked the number one – if I could choose any one which would I choose – by the time I got there there was so little time that I didn’t worry too much about changeover. I expected to complete all 5 tasks, within each task it was what was expected. Honestly I didn’t know exactly what I would do, happy with it, felt it was about average, if I could do it over, I would do it differently.

What do you think contributed to your performance in the simulation? How?

Dr. Yih’s class (383) helped with scheduling. I also took 343 for budgeting, that was pretty simple, but thinking about money stuff. Something that hurt it was not multitasking, when I went to one task I just did it fully, would have helped to pay attention to more things. I think reading the directions better would have helped. Figuring out the (routing) by making the chart and circling the fastest jobs planning for routing tasks. When working on the people like on the schedule, what made me get it eventually was trying to figure out what day people are off, not on.

What information would have helped you improve your performance? How do you think would this have helped?
I think that it had most of the needed information you need to be successful. One thing I didn’t realize is that you could toggle between tasks without penalty. I feel like all the information needed for each task was in there. For routing it would have been nice to have some kind of diagram or showed like queue of each line cuz eventually I got lost in how many products were in each queue and which ones were in each queue and I just started dumping them in cuz I was way behind so that one it definitely would have been helpful if there was some kind of visual with it to show what was happening with it. (didn’t realize she could go to the floor). Would have been looking at how many were in each queue, and what was the product mix for each line. Trying to specialize each line.

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

Yes, start routing right away, and do it continuously. Looked at budget or looked at the scheduling and gone to meeting to think it while at the meeting or in lunch so I would have essentially had more time. I definitely think I would have done way better, I would have used the meeting time more effectively, could have completed all five tasks and done better on routing. It would have made me less stressed because more time. Maybe putting breaks somewhere in between to break, distribute those within the 25 minutes.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

I think that I mirrored the real world pretty well, budgeting was simple – not much critical thinking, scheduling was real world, but gather that information is the hard part. Routing was real world with processing time and changeover. The whole thing was pretty real world with different tasks throughout the day with breaks.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

I see myself as a decision maker that tries to basically optimize something with a bunch of constraints – just tries to make everyone happy with the performance and try to complete the tasks that I am asked to do. I set weights to different things, for example I saw that you need to complete at least 3 tasks to get above threshold. Other than that I had to schedule different jobs and accomplish everything else. I try to work from the ground up. I first try to meet everybody’s minimum expectations first, then do best as I can. It depends on different perspectives. It depends on your boss, it depends on you financial performance. I just try to get feedback from as many people as possible and I try to quantify it and see if I can improve, and if I do improve I consider that as a success.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

It was just to route as many different parts as possible and complete everything possible in the limited amount of time. I used the same approach I mentioned before. I looked at formula from the instructions and figured out the minimum to do and built upon that. Make sure I get the minimum for that task and then focus on the routing. I just noted down the shortest processing time lines for each part, prioritize each based on that. I also noted set up times for each as well to try to put similar products together to try to reduce setup times. Meetings took least manpower giving more time to think about what I am going to do next so I could spend more time focusing on scheduling and budgeting. I think I was doing well in the beginning but underestimated the budgeting unorganization. Half of the budgeting time was to find out which was which and how to set up problem. I was not as successful on that end of things, but at least when it came to routing and getting the minimum standards and going from there, I think I did a good job with that.

What do you think contributed to your performance in the simulation? How?

I think there are lots of little things. I can’t point out one thing. Biggest things: classes (finding out lowest set up and processing times for each of the products were just some rough heuristics to help outline thinking), attitudes in the office/internships – if you can’t excel at everything, at least meet basic expectations.
What information would have helped you improve your performance? How do you think would this have helped?

Maybe a bit more information about what kinds of numbers dealing with. In the budgeting I didn’t know how organized and unorganized the data was going to be. Another thing I have seen in simulations or things online are it gives you an expected time or difficulty to guide which tasks to do. Not crucial, but big advantage to be exposed to miniature versions of the tasks beforehand so that when you are in a full day you understand the situation better.

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

I would change my approach to budgeting and scheduling. I wasn’t thinking clearly in last few minutes. So maybe one thing I would do differently would be – I am a better scheduler than budgeter. I don’t know if I would actually do this or not but maybe go to the shop floor more often to see which processes are busy and how many jobs had gone through, to check what’s going on, where bottlenecks are, and how my strategy is failing. That way I could find gaps and how to change. But there is a time issue associated with that of going to the floor and coming back. Basic data, which are longest, which queues are they waiting in, is it possible to change focus on different lines. We could think of different strategies of what to use throughout the day. Iterative process – try the strategy, see the results, change, and iterate. Always a good investment because things are always changing, regardless of how good or bad you think you are doing – things are always changing in the workplace. You always learn something looking at the lines, talking to the workers, seeing these queues. Sometimes best strategies come out of the line worker feedback – not manager office. Talking to the line operators is helpful because you get to see things first hand rather than looking at just a spreadsheet.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

Came close. I wouldn’t say it is perfect. In terms of mental state it puts you in id say I give it a 8.5/10. Trying to fulfill so many things at once is a characteristic of modern workplace. You can just stick to one task and do it all day – you have to keep doing many things at once. Disadvantage was some tasks weren’t as representative of the work. Maybe other tasks like site visits. Monitoring floor by other means – email, skype, sharing excel data, just trying to get an understanding from a distance. Not covered by all the different types of data concerned. Also didn’t have enough thinking in meetings. They just seemed like a resting time and from my experience they can be just as stressful as the shop floor sometimes.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

Take a lot of time to make decisions, like to come back and forth. Take longer than other people but feel more qualified. Fast decisions might miss the big picture. Success if considering everyone’s perspectives and make the most people happy at once. Want to finish what your trying to accomplish which leads to next project/project. Sometimes have to rearrange priorities. Look at whole process not just outcome.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

Goal was to get the jobs done – also to-do list. I didn’t get very far. I had tried to balance the lines. One job at a time based on shortest setup time. Started looking down the line to group things together. Ran out of time pretty quickly. I was writing down how long it would take on each line. I would keep track of what time the lines were at. Then I started looking at multiple products at once. Saving time on one product to save setup times. I think it lined up. Looking at one job at a time was good for a single job. Multiple at a time was better holistically. Making sure they were more balanced across the lines. Saved time thinking about it.

What do you think contributed to your performance in the simulation? How?

Yeah I worked in a plant one summer so I kind of understood the scheduling department. I worked really close with them but never really understood the situation so I cant say that it really helped me in performance, but I at least knew what the situation was going to be like. In 383 with Yi – we always used to make those optimization graphs and Gantt charts to know what to pick next line. I was just thinking that I was hoping to have done more of the todo list. Have to balance big project with small projects, not doing all the job doesn’t make a very good manager, so that was in the back of the mind as well.

What information would have helped you improve your performance? How do you think would this have helped?

I kind of thought that in the strategy meeting thought i would be given hints, I guess I just misunderstood that. The way it was kind of set up sometimes it was moving very fast and I think that if I had a dashboard that was showing me instead of going out to the floor – what
was inbound, what was actually being set up, having something that was showing me what was going on on the same screen would help. And I was just thinking that, well what this would look like in real life I guess, I was thinking that if there was some software that could plot what job should go next so instead of you having to think through it from scratch you kind of have something help you make decisions and you say yeah I agree with that decision or lets swap these jobs or something.

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

I think I would try to get the jobs done faster – inbox be emptier. Added unnecessary stress that if I had worked faster. And I would have had a better way of writing down to be able to keep better track. I think I would have been able to get more jobs done, be less stressful, finished more tasks on the to-do list.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

I think one thing not as realistic would be that there would be random things popping up like “Oh no there’s a fire in the plant” so you’d have to drop what you’re doing and go solve that. Otherwise its pretty realistic. You’d probably know on a daily basis you would have an idea of what the jobs would be like.
APPENDIX D
SIMULATION INSTRUCTIONS - PHASE 2 ADDITIONS
You have a mobile app that is connected to your ERP system. Your employees enter information on their lines and the app merges that with historical information to try and predict times. You can click and drag your phone to any part of the screen.

<table>
<thead>
<tr>
<th>Line 1</th>
<th>Setup B</th>
<th>10:37</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 in queue: B C D D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This status light is an indicator of the length of your queue

<table>
<thead>
<tr>
<th>Line 3</th>
<th>Setup F</th>
<th>2:57</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in queue: F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This is an indication of the line and what is currently in progress

<table>
<thead>
<tr>
<th>Line 4</th>
<th>0:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 in queue:</td>
<td></td>
</tr>
</tbody>
</table>

This is a time estimate for when your queue will be finished

The bottom line shows the actual queue of jobs
When a line is done, the last job run on the line shows as in progress to show what the line is set up for, but the time shows as 0:00

Periodically throughout the day, your app will notify you of the time left in your work day. You can clear the notification by clicking the X button.
APPENDIX E

PHASE TWO PARTICIPANTS
| Participant | Age | Sex | Nationality   | Major             | Status           | Instability   | Situation Complexity | Variability of Situation | Arousal | Division of Attention | Concentration of Attention | Division of Attention | Mental Capacity | Information Quantity | Familiarity with Situation | Jobs Completed | Tasks Completed | Completed Jobs | Completed Score | Average Score | Standard Deviation | Median | Average | Median | Standard Deviation | Median | Average | Median | Standard Deviation | Median | Average | Median | Standard Deviation |
|-------------|-----|-----|---------------|-------------------|-------------------|---------------|---------------------|----------------------|---------|---------------------|--------------------------|-----------------------|----------------|------------------|--------------------------|----------------|----------------|----------------|------------------|----------------|---------------------|--------|--------|--------|---------------------|--------|--------|--------|---------------------|
| 1           | 22  | M   | American      | Industrial Engineering | Recent Alumni    | 2             | 6                   | 3                    | 6                   | 7                   | 5                        | 4                   | 6                   | 4                   | 6                   | 4               | 2                   | 39            | 40            | 20.00          | 0.75                  | 12            | 0.69      | 11.25     | 0.76                | 13.75     | 0.82          | 1.37          | 0.76                |
| 2           | 63  | F   | American      | Industrial Engineering | Senior           | 3             | 5                   | 3                    | 6                   | 7                   | 4                        | 4                   | 6                   | 4                   | 6                   | 4               | 3                   | 40            | 39            | 14.6            | 1.25                  | 15.50          | 1.37          | 1.25          | 1.37                | 4.00      | 1.83          | 0.76          | 1.37                |
| 3           | 23  | M   | Malaysian     | Industrial Engineering | Senior           | 5             | 4                   | 4                    | 3                   | 7                   | 4                        | 4                   | 6                   | 4                   | 6                   | 5               | 3                   | 40            | 39            | 14.6            | 1.25                  | 15.50          | 1.37          | 1.25          | 1.37                | 4.00      | 1.83          | 0.76          | 1.37                |
| 4           | 25  | M   | German        | Industrial Engineering | Senior           | 5             | 4                   | 3                    | 6                   | 7                   | 4                        | 4                   | 6                   | 5                   | 5                   | 5               | 3                   | 40            | 39            | 14.6            | 1.25                  | 15.50          | 1.37          | 1.25          | 1.37                | 4.00      | 1.83          | 0.76          | 1.37                |
| 5           | 23  | F   | American      | Sales              | Recent Alumni    | 4             | 5                   | 6                    | 4                   | 5                   | 5                        | 4                   | 6                   | 6                   | 5                   | 5               | 5                   | 40            | 39            | 14.6            | 1.25                  | 15.50          | 1.37          | 1.25          | 1.37                | 4.00      | 1.83          | 0.76          | 1.37                |
| 6           | 22  | M   | Chilean       | Management         | Senior           | 4             | 5                   | 6                    | 3                   | 6                   | 3                        | 4                   | 5                   | 4                   | 4                   | 5               | 4                   | 40            | 39            | 14.6            | 1.25                  | 15.50          | 1.37          | 1.25          | 1.37                | 4.00      | 1.83          | 0.76          | 1.37                |
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

Like I do all the delegation stuff well, but I did not prioritize my own tasks as much. I do all the stuff that needed to be done right in the moment but I’m sure in the business world I probably could have done the budget stuff later at night when I didn’t need to do it during the day. I think I got all the jobs done that others depended on me for, but not my own tasks. So I would say I was successful in supervision but not in my own tasks. I dunno how to describe it.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

I was gonna get the budget done and while I was doing the budget I would keep an eye on my phone and when I saw a job come through I would just do it right then. Except sometimes I got too focused on the budget and some built up, but that also helped sometimes because maybe a multiple would come through – say two Fs – so I could route those together. Um, but yeah I would say I prioritized the budget most of all, then after I... Well, ok, so first of all I was limited by my calculator – I have never felt so bad without a graphing calculator. I could have done that so much quicker. I had to write down every individual sum, but anyways while I was doing that, and then I wrote out all the individual parts so like the costs, and the labor costs, and the sales, and while I added those up I went into the meeting so I could do it while I was waiting for that. I guess I probably could have looked at logic puzzle, I don’t know what it was called, scheduling one I think, so maybe I could have done at least part of that, and then up that to the budget. I was frustrated with the budget, but I kinda liked to get whatever I was working on done so I wanted to get at least the budget right instead of working on a few things. Picked one and finished it to completion. No should have read the directions for the budget because not only did I go back and check those numbers I also went back and checked all the rest of the numbers too so that took a lot of time. I was expecting to get all the things done but only got one of them done plus the jobs.

What do you think contributed to your performance in the simulation? How?

Yeah so your calculator is probably not what you are looking for in an answer but that was definitely actually a big part of it. But anyways, besides that, I would say even just in working for like 3 months now, there are a lot of times that I am expected to do a lot of things all at once. Like I might have to prepare for a meeting that is day as well as do like an autocad drawing. So I just have to prioritize what needs to be done first. Which in this case, wasn’t
always obvious like if you put a constraint on “the budget needs to be done by 20 minutes” or something like that maybe it would have helped prioritize even better but I’d say my slim working experience has guided me the most. I wouldn’t say classes very much because there wasn’t too much real calculations but in the exams themselves for classes there is definitely a time crunch – and I would often take honestly a different approach where I would try to get a lot of partial credit as opposed to what I did in this simulation which is just get one thing all the way done. So I don’t know how you can explain that but I don’t know, it my have been different.

What information would have helped you improve your performance? How do you think would this have helped?

Um I thought the phone was good, good to have that. But on, I dunno I guess I didn’t really see the need to go to the shop floor when I had it on my phone. So I dunno, I dunno what the constraint there was but it was pretty easy. I liked having it there. I know you wanted to keep the matrix separate and it helped a little bit that cuz I would schedule items after B cuz it has a way shorter setup time, or I would put B after things because it had a short set up time. But yeah I don’t really know what other information could have been good.

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

Yeah, I would probably, well definitely read the directions on the budget thing better, for sure I was getting monthly but I probably would have looked at all of the tasks first. So I would have looked at the logic to know what is expected because I didn’t look at it until the last minute. And I would have tried to throw in another one of the meetings once I had a good enough queue built up, because I never wanted to be in a meeting if I didn’t have one of the machines full. So I could have either sacrificed that or just gone into a meeting even if I didn’t have one of the lines doing something, just to get another thing done, it’s something I could have done. Definitely read all the things clearer, or go visit all of them before – right at the beginning. Well I would have known, well the scheduling thing looked pretty intense, I didn’t get a chance to read it all but maybe I would have seen hat and just one away because the budget thing is purely numbers and you’re either going to get it right or you’re not, and I was at least able to get the budget thing right. Maybe I would have avoided it like I did, but if it had looked easier I could have knocked it out pretty quickly. I don’t remember what the incentive was on the meetings and things but yeah, getting those done as opposed to the jobs.
How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

Pretty well, cuz there was a lot of different things going on. Although, ok, mirrored it well, but at the same time you can work in the real world longer than business hours. Your boss kind of expects you to work longer than the time constraint, so like I said the budgeting thing could have been done at a different time, also you can work in meetings or skip meetings sometimes but like the fact that it was an obligation it would still look bad if you skipped a meeting or something like that still resonated like it wasn’t good that I didn’t get all the things done but I think some sort of prioritization is necessary. Maybe someone will be able to do it all in 25 minutes but it was definitely a lot to go through.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

I would say from a people aspect of it I guess that I like to work with alot of people and I like to talk to ever person that I manage personally. I am logical and I like to analyze all courses of play before I make a decision. I do not like uninformed decisions. I would say I define my success by how well my team can achieve and go beyond expectations of the project and how good my team feels while working on it, yeah. I always like to do better than is expected.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

My primary goals were to complete all the tasks on the to-do list and a still though keep a constant eye on the inbox so that the jobs were scheduled as quickly as possible. I think that it’s kind of my natural way of working. I make a checklist and make it my goal to get everything on the list done but then as new urgent things come in I get them taken care of as fast as possible to make sure they aren’t in back of my mind bothering me. I think so because I completed all the tasks, that was the goal.

What do you think contributed to your performance in the simulation? How?

I think just my day to day experiences here at Purdue helped me with planning. Because I also have a very tight schedule here. As far as classes the two exercises – scheduling or budgeting weren’t necessarily things I learned in classes, more of puzzles and common sense. No maybe I have just done a lot of puzzles where you enter in the variable options or whatever (logic puzzles).

What information would helped you achieve maximum performance? How do you think would this have helped?

Well the having the processing times helped and also knowing that if a part was working in the machine and if the same letter came up that I could put it there and it would run it next and not run the setup again, that helped. I guess the accounting knowledge helped with the budgeting problem.
If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

I guess I didn’t realize, because the phone was so big I couldn’t see, that for each meeting it said how long the meeting was so I just picked a meeting at random and went in to it – I would have looked at the meeting times – I would have made sure the machines had enough queue that they wouldn’t run out while I was at the meeting.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

I mean I think it mirrors well. Sometimes there’s even more tasks that need to be accomplished, but you also have a lot, well I mean I guess it’s scaled, but you also have more time. I liked that it had the time to walk between meetings and how when you’re in a meeting you can’t do [routing]. I think that people try to do that like when they are in class but you really shouldn’t be so that was good.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

I guess like the task that were given if I had a little bit more on what to do that would let me organize and manage it. But given this I have all the daily tasks and while I manage those daily tasks I do like the scheduling part like especially during the meetings. I guess it takes time to get used to what I do.

Pretty easy, I just go with what outcome is the best and just go for it. That how I usually decide whether or not it’s a good idea. In terms of planning I usually do my planning like days ahead if I know what I’m planning for. And so I’m usually on time and make sure I have ample time, I’ve prepared before performing the task basically. As a manager, it depends on what I’m managing, I have to make sure I have good rapport with the people I am managing so when you give them a task or when you schedule something it makes it easier – at least you have full complete trust in the people that you’re managing and you know that they would do it within the timeframe. They would do it with little to no knowledge what they are doing.

If I accomplish ultimately what I want to accomplish, so I set a goal at the start and my decision is based on goals – it could be a short term goal or could be a long term goal – that I would say it would be successful. There might be some minor hiccups but those hiccups will teach at least me or my team what to avoid in the future.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

My primary goals were to get rid of or schedule all the products as soon as possible so I make sure that all of them are they are all in the lines while I work on the daily tasks. And I guess the goal is to complete all the daily tasks but I failed to complete most of it. I mean I completed like 3/5 so in a way I failed one of my goals. The products I guess – when you schedule things, while the things are getting produced in the meantime I could focus on something. So my goal was to schedule all and at least oh have like all lines active before working on a daily task. Um and once I am done with one daily task I go back and see what I could put back on a line instead of having all the time, so that was my plan of attack, so that I could multi-task and make sure that I could [unknown]. Task was a little challenging in a way it’s actually a lot of math. But that took quite a bit, and even during that I did one part of it – I calculated a profit and then stopped before I went and calculated the loss.

I guess I was looking, I guess I focused too much on the lines to like see what products are on what lines it is. So I was looking through and comparing which product should go to which
line and so if a different product comes out what should I schedule the others so that took a little bit of time. I think I spent a good minute or two just figuring out which product should go to which line and whether to just put a new product on this line. I guess at the 4 minute mark there isn’t really much products coming in and I didn’t know that so I [unknown] when potentially, there might be a product A request which is ideal for line 3 so those are things that could be mastered if I had prior knowledge, like if I run through a couple times.

What do you think contributed to your performance in the simulation? How?

I guess it’s uh the experience in school. You have a lot of things going on at the same time, you have deliverables that you have to complete within a certain timeframe so planning basically like your plan of what to study, when to study, when do you have time, when to do which project. Those skills come in handy when you are scheduling lines and at the same time trying to complete your daily task. IE 383 – what’s the best line most risk/less risk, I can’t remember the terms? That class pretty much helped me decide which product goes to which line.

What information would have helped you improve your performance? How do you think would this have helped?

What the demand is like in the past, like past demands. So I noticed like Product A is usually the most in demand but E comes in just like once in a while then that would help scheduling help me better schedule in the future so I would know like what lines should I keep empty for what products, so like a demand planner. Prior experience, like if I had an experienced professional or if I had someone with wisdom tell me what’s the best sequence or what’s the best line for products then that would help me figure out like fast on like the scheduling side. And at the same time with like the math part what to expect or like with the scheduling part when you have to schedule four workers in a row they could tell you what’s the best combination that would be ideal. So having someone that would have the experience telling me in the past what was successful. Like good case practices would definitely help. Past information, past success, strategies. So if you tell me like, ok the math will take a long time, you know what you should do? Focus on something else first. Or maybe if you tell me like the products, ok like the inbox will be filled at like 10 minutes and will slow down after that. If you tell me information like that it will help me know what’s coming next. Like getting an insight of what’s going to happen next instead of trying out the system and first trying to perform best rate in your first try.
If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

Yeah, at least I would know where is the best place to put that little phone screen, because like before that it’s kind of annoying like it is blocking some numbers its always blocking something, like if I could do it I would put it in an ideal spot which doesn’t interfere with what I am working on. I would probably set a time limit like every 2 minutes to check the inbox, then come back so that way at least I am on schedule, and at the same time I could focus on the planning part, the daily task part. And so now I am familiar with what type of products goes best with what lines, that would definitely help me in the future so I could right away go straight and see product A ok well that’s line 3, and now that I know that the product types usually come in groups, it’s like ABAAAA so like knowing that it definitely helps me in the scheduling part. So knowing little things like that definitely helps.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

I would say pretty well. But in the real world it pretty much could be done virtually, like you could schedule you could tell your workers virtually what to work on next. Even during your meetings you could schedule things. Multitasking occurs even more in the real world than in the simulation. So that is definitely one thing. And then in the real world, even if I’m the manager and whatnot there are more experienced professionals out there who would share their knowledge of what works best. Plus in the real world there is variations in production times, it’s not a set thing – set up times usually change between one and another so that is the kind of thing you have to take into account more In the real world. Plus defects especially, because we’re just assuming that the products made are 100% defect free.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

I would say I am pretty fast at making decisions which isn’t always good so it’s like do and see what happens. By the results, if there is a required task or, I don’t know, it is my goal to achieve the tasks that is given. I think it’s important to both have the workers on your side like they are happy but I think even more important to at end of day produce a positive profit, be profitable as a manufacturing plant.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

Get my plant going, so I had to know, I don’t know what it is called, when nothing is going forward? Then did my tasks, my to do list. (Decided by) Intuition, I didn’t really think about it before. And then I decided to first do the scheduling because it seemed easier for me to do than the calculating. I tried to put in the meetings when they fit in, so when I knew I had all my jobs in order then I went. I think I could have done better if I prepared the calculating and scheduling better for my meetings. So I wasn’t able to use the time of meetings very well, but since I got 4 of the 5 tasks done I think I did very well.

What do you think contributed to your performance in the simulation? How?

I think mostly experience and mindset. Because I can’t really name any class that fits that specific task. So I see classes more like you prepare yourself and you develop your own mindset and then you try to [unknown] by experience. I think through my internships I think I learned how to align tasks, and that its the goal to get everything done by end of the day. As I said the choice of which task was more of an intuition and mindset thing.

What information would have helped you improve your performance? How do you think would this have helped?

Maybe those jobs, no but not really no – it was more like learning by doing things. If I would have known like the times at which the jobs come in, but that’s not how it works so no I don’t see how any basic information that could be changed or how it could be given.
If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

I would take notes from scheduling, then go to meetings, then fill in the blanks, same with counting. And I would use the calculator not the computer – there were way more numbers and I had to click it in instead of type it in.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

I think for a simulation its pretty good because you see you got your bigger projects going on like the budgeting and like the scheduling, then there’s the day work that comes in over the day and you have to learn to get your todo list done and you have to learn to get your concentration on one block at a time, and if you do it her or do it in the real world theres no big difference, except he real world gets more complex because you have a longer to do list and bigger jobs coming in.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

Never been a manager before but when I’m making decisions I try to plan it out and see which would be the best decision to do, how to prioritize my time, I guess. I try to plan out which is most important and do that first then go down the line. I feel like I have been pretty successful. Like I usually I will write out all of the things I have to do and number it based on which is the most important and which I need to get done first. I am usually pretty successful with doing that.

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

So it didn’t really work out but I was trying to, like before the simulation I was trying to figure out which product would take the most time to go though the process and I was going to go through that line and get the product that took the most time done first and then just go through that but it didn’t really work out. When I had people working on all the products I just went to the meetings and then when I got back they were all done with their tasks so I probably should have done something different.

What do you think contributed to your performance in the simulation? How?

I feel like I didn’t really do this type of thing in my classes, but um, I got caught on that one task. I was working on (the scheduling) most of the time. Well, since I was so focused on that I think I didn’t really always realize when the lines were open, so mean if I focused on both of them instead of just scheduling I would have gotten a little bit more done.

What information would have helped you improve your performance? How do you think would this have helped?

Well the financial, budgeting or whatever, I had no idea what to do with that so maybe some more guidance on that. I feel like maybe I have done something like that in accounting but its been so long that I couldn’t remember how to do it. And maybe if there was one hint button on the scheduling just to, if you were stuck to figure out what you were doing wrong. Oh so, I was never really quite sure where the products were at so I just kind of, at first I was focusing on the product that took the most time, but then sometimes products just wouldn’t show up
so I started doing whatever was first in the inbox. Never knew where they were at in the inbox. Well because, don’t the products have, like are they never actually done being produced, or...? (She was confused about how a manufacturing queue works).

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

Um well I would definitely pay more attention to the product lines and I would start assigning the lines right at first. I think when I first started I just went to a meeting right away and I just kept the lines open. And then probably start looking at the scheduling earlier on, probably wouldn’t go to the meetings unless all the lines had a significant amount of time left on them. Probably, more stuff would have gotten done since when I started the simulation I went to a meeting and nothing was getting done and then as you said with the scheduling I was almost there but not quite so if I had started that earlier I probably could have figured it out.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

Well I mean I guess I wasn’t really actually having meetings, I just had to sit there as the time went by and the lines would be open and I couldn’t do anything about it. But I mean that’s the only thing that I can think of that wouldn’t mirror the real world. You wouldn’t just be sitting there.
Interview Questions

How would you describe yourself as a manager? What about as a decision maker? How do you define your success in these capacities?

I still have a lot of things to learn but I think that I have a rough idea of how management works. Well its really, you have to be focused on different things at once and its really challenging. I’m focused to completing objectives and doing my best to, trying to move group helping them to achieve goals instead of pushing them to do so. I think the key thing to understand - how your peers work – because this is not individual work –and having the ability to build synergy between them is the main goal toward achieve your objectives, it’s the key thing

What were your primary goals in the task? How did you decide on your plan of attack? Did the execution line up with your expectations?

First was understanding how the dynamic worked –because instructions are not sufficient until you face the real challenge, I think that works in anything – and then was completing the tasks individually but then I found out with the spare time I had I could multi task for example in the meetings, the idea was to start thinking about them in that wasted time. It took me a while really – first I was going in order of appearance, but then I realized there was that time in the meetings and I thought that It would be a good idea to start thinking of the other goals I had to achieve in the simulation. No I think I did worse that I expected – the reason is I didn’t pay attention to the inbox, which was one of the really important variables in the simulation - took care of that really late and that had an impact on my overall performance

What do you think contributed to your performance in the simulation? How?

Things that I have lived – because courses give you a blank notion of what works, but experiences really give you an understanding of how you operate in the management world – experience is more important maybe than knowledge at least maybe in the most complex areas. I have worked in different simulations so how to approach them is really different. There is always like a learning period which for me this time was long. My experiences have taught me that you have to pay attention to different variables you much have an action to direct performance. You also have delays, and you have to pay attention for that.

What information would have helped you improve your performance? How do you think would this have helped?
My main problem was paying attention to the inbox. In real life I think that would be maybe someone would have told me that maybe in email, so I can notice that before. I would have started production much earlier, and without delays I could have focused more into the task I didn’t finish which was the scheduling. As data delays it took more than 5 minutes to complete, could have done more time on scheduling. Also I could have written down the scheduling constraints so in the meetings, which was a waste of time, I could have figured out how it was solved.

If you were to do the simulation all over again, would you change anything? What impact do you think that would have?

Yeah I know how it works now, the learning curve its pretty clear. I will start maybe with the budgeting which is really direct, then write down scheduling restrictions, go to meetings, figure out how the scheduling was to be, and complete it. Also considering that I could have started my production line. I think I would have completed all the tasks and increase production as well, so that has impacts on the profit.

How well do you think the simulation mirrored real world? What in specific stood out as accurate or inaccurate?

I think it helps to let you know there are many variables you have to know when managing a company. However there are some differences. The meetings are not a waste of time at all. They will be to direct your main strategies in getting higher profit, and in this case it was time for thinking of other things. Schedule restrictions may be inaccurate, if you have a really, you may be more flexible, may be able to talk to your partners and be able to pay some compensations in order to have extra work or days they can work. And if in this simulation I was the manager maybe if it’s a big company I wouldn’t do the accounting, that’s a specific area.