

**ADDRESSING CORPORATE KNOWLEDGE LOSS IN A UNIVERSITY
UTILITY PLANT**

by

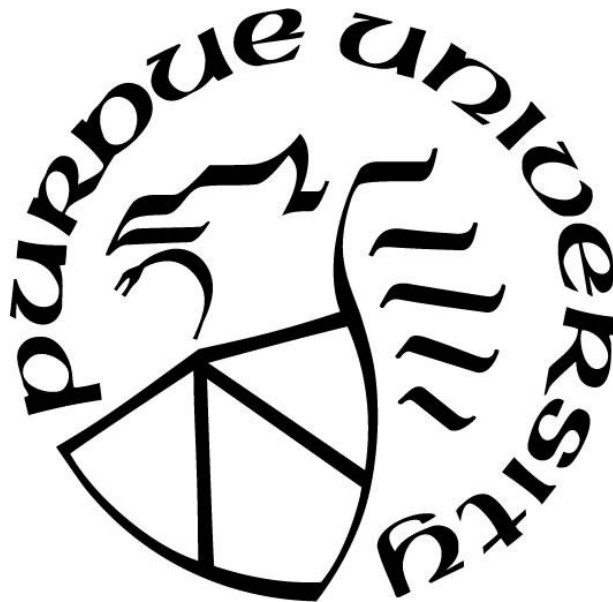
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Dedicated to God, who put all the pieces in place, my husband Mike who never stopped supporting me, my children, who always gave me purpose, Dad, who gave me high standards to shoot for, and Mom, who encouraged me to do what I loved. Michelle, Frank and Melanie, you weren't here to see this, but I know you are congratulating me from above.

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ABSTRACT

This research was a pilot study in a larger project that focused on how to retrieve knowledge from retiring long-term employees of a small university utility plant, incorporate that material into their existing training program, and during the process reduce the training time for current and future employees. Wade utility plant faced the retirement of eight employees with nearly 200 years of corporate knowledge within three years, but their current training program required seven to nine years to complete. The study utilized interviews, first-hand observation and partnership with current employees to explore how best to obtain the corporate knowledge that would be lost when the proletarian workers retired. The study revealed that the training program needed to be updated, and communication, trust and training evaluation continuity needed to be addressed. Due to these issues, trust was built through transparency by the researcher, and suggestions were made to management for moving forward. This study adds to the body of knowledge by utilizing knowledge capture techniques in a utility plant, highlighting effective knowledge capture techniques for proletarian workers, the importance of corporate planning for the effect of group retirements, and how incorporating proletarian workers into training creation can make a positive impact on company relationships.

CHAPTER 1. INTRODUCTION

Knowledge Management (KM) has been discussed and utilized for at least 35 years (Liebowitz & Paliszkievicz, 2019). Through the years KM has evolved from a contemplative thought approach, to an application for deciding what technological tools would aid companies in capturing, storing and transferring their corporate knowledge (Wang, Zheng, Tian, Qiu, & Li, 2017). Less well known are the interpersonal techniques used to extract, maintain and convey corporate knowledge. Most companies pursuing KM are large and utilize KM techniques in-house (Collison & Parcell, 2001a). However, there has been little research on how KM may be utilized for small to medium utility plants, with entry-level worker education requirements at a high school diploma level.

Employees leave a company for reasons that may include retirement, being idled, or moving to another company. As such, when a worker leaves a position, it creates a physical gap within the organization, as well as a departure of valuable knowledge and information related to the processes, operations, and culture which that worker had acquired over their employment term. The longer an employee is at a company increases the possibility of them attaining multiple positions, which in turn increases the knowledge they hold, resulting in a greater loss of resources and a higher impact to continuing operations when they leave. A worker's experience has the additional value for maintenance of the corporation's reputation, competitive market edge, supporting replacement training, and providing seamless operation of a facility for optimal customer service (Baguma, Ragsdell, & Murray, 2014). Therefore, a challenge arises for when an employee leaves, in the form of gathering and retaining the corporate knowledge these individuals attained throughout their employment term. The acquisition of this knowledge may then be used to reduce the training time for the replacement workforce, and maintain continuity for the company's customers (Parise, Cross, & Davenport, 2006). Frequently, retiring individuals are reluctant to reveal their information, especially when trust problems are present either within the organization or toward persons outside the company such as when a consultant is hired to obtain the knowledge (Reihlen, Nikolova, & Mo, 2015). This research study focused on a University utility plant without the employee resources to address their knowledge loss concern, as an effort to alleviate the problem. However, it did present unique challenges due to the worker demographics and work environment.

A majority of utility plants utilize older machinery with idiosyncrasies that are well known to employees with a long history with the equipment, but are relatively unknown to newer, replacement workers, thus creating a learning curve (Daghfous, Belkhodja, & Linda, 2013). Although mentor pairing is an ideal solution for this problem, not all workers are willing or available to convey the information (Baguma et al., 2014). Due to the relative cost of replacing equipment in a small utility plant, it becomes vital to obtain the knowledge of the equipment, its functionality, and alternative operational strategies, and then pass this knowledge along to the newer workers. Therefore, for this research study, the most effective research method devised was to partner with the long-term retirees cooperatively in order to obtain the utility plant knowledge through one on one interviews. This captured gap knowledge would then be utilized in training materials for future employees.

This research study functioned as a pilot for a larger process of renovating the company training program. This research study's primary focus was to determine the optimal method to collect knowledge from retiring, proletarian workers in a utility plant. A secondary focus of the study was to explore methods to encourage employee participation in the knowledge capture process, which lead to the purpose of capturing the knowledge. Knowledge collection is tied to knowledge retention and dissemination, thus the inclusion of them reflected to the initial purpose of capturing the knowledge and became part of this research study.

This research considered the less studied population of hands-on craft-oriented personnel and the optimal way to capture their knowledge and allowed the creation and utilization of material for the studied organization. In doing so, it provided a means to create guidelines and a dissemination product for use by others working with this same demographic. Overall, this research study served to extend and enhance the knowledge capture processes to a university utility plant employing proletarian workers. It also included creation of training materials for a small group of participants in order to preserve corporate knowledge.

1.1 Background

Employee loss also creates valuable knowledge loss that employees have procured throughout their tenure with the company. Sometimes the loss is not as noticeable as in organizations with higher number of employees. In those types of organizations, there is a higher likelihood that work positions would overlap with one another and the same knowledge is largely

shared among numerous workers. However, for a small organization, employees are likely to be knowledgeable for only their area of expertise and rarely have an opportunity for knowledge to overlap with other departments or workers. A small firm is defined in the United States as a business with less than 500 employees (Yew, W. K; Aspinwall, 2004). Furthermore, small companies at times compete directly with larger companies and for a small firm to survive, it must maintain its competitive market edge and stay ahead of its larger competition. As such, for a small company's workers, time is a precious commodity that cannot be wasted on deciphering how a certain task was done by a previous employee. This is especially true for utility plant employees, as time spent learning the idiosyncrasies of the equipment through trial and error can result in disaster during an emergency.

Small to medium utility plants have fewer employees, yet the services provided are invaluable to the utility's customers. When a university utility plant faced the loss of several employees due to retirement with a combined experience of nearly 200 years, plant management became concerned about the safety and seamless functional operation of the plant during the transition.

1.2 Statement of the Problem

Wade Utility plant faced the loss of eight long-term employees to retirement, and as a result, a loss of a combined experience of nearly 200 years. Wade plant management therefore was concerned about the safe and seamless functional operation of the plant during this transition. This study explored methods of retrieving the utility plant's potential corporate knowledge loss from the retiring employees through established knowledge collection methodology and explored methods to preserve and transfer the knowledge to junior employees.

1.3 Research Questions

The problem centered on by this study and the framework chosen will address the following research questions:

Capture, preservation and dissemination of corporate knowledge:

1. What methods of knowledge collection are effective with proletarian workers nearing retirement in a utility plant?

2. What methods of knowledge preservation and transference are effective for proletarian workers in a utility plant?

Secondary to the primary research question is the following subsequent question:

3. What method will engage proletarian workers in the knowledge capture and transference process?

1.4 Significance of the Problem

This study has value in the following areas:

The study of Knowledge Management. This study provided insights on the importance of knowledge management, how to begin utilizing it and the benefits to having an active knowledge management program. It provided the information that while many companies value knowledge management, few address it. Yet in not addressing this important corporate function, the companies create difficulties not easily overcome.

Organizations with employee turnover, specifically those with large numbers of long-term employees leaving. This study explored this issue from the viewpoint of both management and the workers and highlighted awareness of the detrimental effects to the company while suggesting venues of improvement.

Organizations with proletarian workers that rely on OJT training programs. This study is one of the few that addressed how to obtain knowledge from proletarian workers and utilize their aid in knowledge capture, retention and dissemination.

Small to medium utility plants, particularly those providing services to universities. Small to medium power and utility plants are absent in the literature regarding knowledge management. This study provided perceptions for other such organizations to pursue their own knowledge management process and highlighted the significant part these organizations play in the customers they serve.

1.5 Statement of Purpose

The purpose of this qualitative research study was to explore methods to collect corporate knowledge from retiring proletarian workers at a small university utility plant, store that

knowledge and transfer it to continuing and future workers. The university utility plant is a unique work environment in that a large population of highly educated personnel depend on the services of a few proletarian workers to effectively fulfill highly technical functions. While the positions at the utility plant are that of stationary engineers, the state does not currently require them to either obtain that degree or pass a certification for that position. The symbiotic relationship between the university and the utility plant depends on the continued conveyance of plant knowledge to current and incoming utility plant employees. Key to this transference is the collection of the knowledge, and the required engagement of the proletarian workers.

1.6 Definitions

CCHP refers to a combined cooling, heating and power plant.

Explicit knowledge is the stated rules, information and organizational structure of a company.

Implicit knowledge is applied explicit knowledge.

KM refers to knowledge management.

Project lead refers to the lead for the larger project of which this research served as the pilot.

Proletarian workers are frontline manual laborers (both skilled and unskilled) whose education level is typically a high school diploma.

Scaffolded Learning is the process of teaching or demonstrating an idea or technique and then stepping back to allow the students to become more independent, self-regulated learners.

Tacit knowledge is unwritten, unspoken knowledge that individuals acquire.

1.7 Assumptions

The following assumptions were made for this study:

1. The long-term personnel were willing to be interviewed with a recorder.
2. The long-term personnel were willing to answer questions truthfully.
3. Personnel would fill in gaps in knowledge.

4. The transcription was accurate.
5. Plant management was motivated to aid in completion of the project.
6. The researcher had access to previous training records.
7. The participants interviewed had pertinent corporate knowledge.
8. The participants were willing to complete pre-test, training modules, post-test, and survey.

1.8 Limitations

The following limitations applied to this study:

1. This study required access to the personnel who are either retiring or soon to retire at Wade Utility Plant and was dependent on that access.
2. The study required access to participants to administer the pre-test and post-test.
3. This study was dependent on participants having the capability of completing the intervention.
4. This study was dependent on at least 80% of the retirees completing the intervention.
5. This study was to be completed by March 2020.

1.9 Delimitations

The following delimitations apply to this study:

1. This study involved one specific Midwest utility plant. The dynamics inherent in this plant may be unique and therefore not repeatable.
2. While explicit knowledge was part of the information gathered, tacit and implicit knowledge was the true target of the study.
3. This study began as exploratory mixed method research and, due to events that transpired during the study, ended as qualitative research.

1.10 Summary

This chapter includes an introduction to the topic, the background of this study, the statement of the problem, the research questions, the significance of the problem, the statement of purpose, study definitions, assumptions, limitations, and delimitations. This concludes Chapter one.

CHAPTER 2. REVIEW OF LITERATURE

This research study explored the methods for obtaining knowledge from a small group of proletarian workers in a university utility plant with the company goal to shorten the current training program. The approach to the literature review was to begin with the general topic and move to specifics, including knowledge transference and dissemination as the goal for the knowledge captured. Perhaps critics would see areas lacking in this approach or too many specifics not included by the research questions, and perchance rightfully so, but this is the approach of this research.

2.1 Types of Knowledge

Knowledge has many different meanings, none of which is resolutely accepted (Bolisani, E; Bratianu, 2018). A generally accepted definition of knowledge is information that someone can recall as worthwhile. It has been categorized in order to understand it and to utilize it according to industry. Knowledge has become very important in business today, especially in our current global society, where businesses must be prepared to share information with their international subsidiaries and suppliers to achieve business goals (Gharawi & Dawes, 2010). Gorman considers knowledge to be the “most valuable global commodity” and specifies four types in delineation between “tacit and explicit: information, skills, judgement and wisdom” (Gorman, 2002). Most authors list two basic “types of knowledge: explicit and tacit” (Baguma et al., 2014; Gherardi & Nicolini, 2000; Gorman, 2002; Wyatt, 2001). A 2008 study suggested a third category; implicit which is described as transforming tacit into explicit (Frappaolo, 2008).

2.1.1 Explicit Knowledge

Explicit knowledge is routinely documented and retained by most organizations. It is easy to memorize and is regularly transferred through coursework, training, and one on one instruction. Wyatt (2001) described explicit as “facts, rules, relationships and policies” that can be clearly described in written form (Wyatt, 2001). It is concrete types of information that is written down and objectified. Examples would be, employee hierarchy, job descriptions, position pay scale, and employee evaluations (Wyatt, 2001; Collins, 2013). Most corporate standard operating procedures

(SOPs), corporate directives, and safety manuals would qualify for this explicit knowledge category. It is a type of information that is easily understood, easily passed on and used when learning is simple, such as differentiating between the types of triangles. This type of knowledge connects to a specific location within the brain (Ellis, 2016), and has to be consciously retrieved, for example when studying for a math quiz (Dew & Cabeza, 2011). Explicit knowledge is relatively easy to retain and is regularly transferred through coursework, training, and one on one instruction. It is easily codified or arranged and may be shared asynchronously (Frappaolo, 2008).

2.1.2 Tacit Knowledge

Tacit knowledge is information that is less obvious such the underlying forces at work within a company such as the knowledge of which employees are dependable, and which will procrastinate. It is information that participants glean from their time in the organization, is a valuable resource for companies and has great importance in safety procedures (Horvath, 2000; Kuronen-mattila, 2007). Tacit knowledge is difficult to imitate or transfer and rarely addressed, even in higher educational institutions (Ambrosini & Bowman, 2001; Muniz, 2014). Tacit knowledge is gained by observation over time, is personal, and unconventional (Seidler-de Alwis & Hartmann, 2008). It is a type of intelligence that cannot be easily written down and passed on in a training class: the information that comes with practice and is the most difficult to express and transfer. Tacit knowledge is based on experience, is intuitive, and shared typically via face-to-face encounters (Frappaolo, 2008). Further, tacit is at least as valuable as explicit knowledge and, at times, more valuable (van Ditmarsch, 2018). The process of exchanging explicit to tacit is critical for knowledge transfer to take place (Facione, 2016).

2.1.3 Implicit Knowledge

Implicit Knowledge is explicit knowledge applied; skills that an employee assimilates through a position at a company. It is the ability to read body language or voice tone, understanding the sounds that machinery makes, or knowing which co-worker would be able to complete a task in the time available. Implicit knowledge is generally accepted as implied knowledge; not directly transferred or defined. The implicit knowledge that an employee has often evades documentation and slides under the knowledge radar until that employee is no longer with the company (Frappaolo,

2008; van Ditmarsch, French, Velázquez-Quesada, & Wáng, 2018). Implicit knowledge is the reason why a person can remember how to roller skate, even if that person has not roller skated since childhood. It is explicit knowledge that has been changed from short-term memory to long-term memory and can be recalled without any conscious effort. Sometimes mere rehearsal of the information can transition the information from explicit to implicit (Dew & Cabeza, 2011; Ellis, 2016). Implicit knowledge is an intermediary between explicit and tacit, where tacit may be transformed into explicit knowledge and is quite valuable and flexible over purely explicit or tacit knowledge bases (Frappaolo, 2008). Not all explicit knowledge is transferred, which creates problems in education and within corporations (Dew & Cabeza, 2011; Ellis, 2016).

2.2 Knowledge Loss

An aspect explored by several studies was the results of knowledge loss or when company knowledge is not captured, stored and transferred.

Jennex (2016) noted that knowledge loss was directly due to employee loss; a breakdown in capturing the knowledge, ineffective knowledge storage and not remembering the importance of the information (Jennex & Jennex, 2016). Massingham (2018) declared that “knowledge loss caused by employee departures has become a significant corporate risk” and listed several problems associated with this dilemma: capability gaps in the workforce, performance gaps, decreased product and service quality, customer trust loss, delays and low productivity. (Massingham, 2018). In our current society, it is common for participants to stay with a company for only three to five years before changing employment in efforts to increase pay and status (Ryan, 2016). This frequent transitioning creates higher employee turnover, and as a result, a loss of corporate knowledge. The theme of minimizing or eliminating knowledge loss when employees leave has been a topic of research in many industries and is part of KM.

2.3 Knowledge Management.

Knowledge management has been discussed in the literature in several industries including health care (Dobbins, Decorby, & Twiddy, 2004), public health (Dobbins et al., 2004), aerospace (Martin, 2013), oil and gas (Grant, 2013; Sumbal, Tsui, See-to, & Barendrecht, 2017), and higher learning (Geuna & Muscio, 2009). Leonard, Swap & Barton, while preparing to write their book

Critical Knowledge Transfer, found that company interpersonal relationships, reputation, training a replacement, and often the ability of the company to move forward, were all connected to company knowledge. Universities found that knowledge transfer was a strategic issue for donor relationships and as a policy tool (Geuna & Muscio, 2009). A company has been described as a social community that is intertwined, almost as if it is a living organism, dependent on its shared knowledge and ability to transfer the knowledge (Zander & Kogut, 1995; Ajmal & Koskinen, 2008). Information transfer was found to “provide a company a competitive advantage” (Szulanski, 1996), and is vital in resource planning (Ko, Kirsch, & King, 2005). Guarani (2010) found that a global society requires knowledge sharing across the globe for all critical problems (Gharawi & Dawes, 2010).

The literature reviewed indicated many companies are concerned with corporate knowledge loss, but rarely follow through with doing something about it (Leonard, Swamp, & Barton, 2015). Knowledge management for power plants is usually focused on nuclear facilities due largely in part because of safety factors. All utility plants are important for the community they serve, but outside of nuclear power plants are often without knowledge management (Kuronen-mattila, 2007; Boyles, Circle, Kosilov, & Yanev, 2009; Wang et al., 2017; Alam, Sarkar, & Chowdhury, 2019). Technology is increasing at an exponential rate but hinges on a power source (Berman, Dorrier, 2016). If a reliable power source is not provided, not only is technology incapacitated, but highly sensitive data could also be lost. Therefore, advancements for our current society hinges on having a constant and dependable energy supply.

2.3.1 Power Plant KM – Nuclear

The literature focused on knowledge transfer or preservation of corporate knowledge within the power industry is predominantly on nuclear power plants (Kuronen-mattila, 2007). A research project on two major United Kingdom electrical utilities decried a lack of knowledge management practices, resulting in wasted man-hours searching through different interfaces for information. Some example issues were in the lack of continuity in updates to policy, inaccessibility or ignorance of vital documents, and the wealth of tacit knowledge in the experienced engineers going untapped. The study went on to design and recommend a data management system be put into place to organize corporate information (West et al., 2001). In 2005, Jennex found that utilizing an information system “improved effectiveness/productivity of

the organization” (Jennex, 2005). A 2012 study highlighted that major energy companies such as Chevron, Texaco, Schlumberger and ExxonMobil have used a type of knowledge sharing culture to improve productivity and found that combining technology with a content management system can be utilized in personnel management for tracking radioactive decay and decommissioning nuclear facilities, and further found that the idea of knowledge management can be a tactical tool for the savvy corporation in a competitive environment (Iacobone, Lerro, & Orlandi, 2012).

A recent study in the nuclear field reviewed new power plant construction which revealed a concern for knowledge loss due to attrition, and that their national human skills management must include knowledge management. Moreover, the study found that a digital-based system is the optimal management system to convert various types of knowledge into an accessible form, facilitate communication between personnel, and foster new knowledge creation. The researchers of this nuclear field study also noted that nuclear plants are very “knowledge intensive” and suggested a “full cycle nuclear power plant knowledge management framework” (Wang et al., 2017) to ensure optimal production during the life-cycle of the plant.

2.3.2 Power Plant KM – Non-Nuclear

Hydro plants place high importance on knowledge retention. A 2014 study on small hydro plants in Slovakia found it vital for companies producing technology for small hydro power plants to capture their knowledge and know-how (Caganova, Szilva, & Woolliscroft, 2014). A comprehensive study on the challenges faced in power production in all areas viewed an integrated knowledge management process as the solution to the many challenges in the field, including performance, the overall balance of power generating plants, workforce, technology, economic, and environmental (Raj, 2017). Additionally, as noted in the power generation arena, a recommendation for “a web-based decision support system” for both nuclear and conventional systems was put forth which comprised of a three-part knowledge base of a “guide to the documents available, a model of the knowledge in the domain, and a case base” (J. S. Edwards, 2008; Menal, Moyes, McArthur, Steele, & McDonald, 2000).

2.3.3 Power Plant KM –Coal-fired

A small number of fossil powered plants provided information on knowledge transfer, however most plants are aged and expend the majority of their efforts on continued operation or preparation for a shut down and subsequent decommissioning (Johnson et al., 2015). A case study focused on a coal-fired power plant discussed how the integration of corporate knowledge was becoming more of an issue in the competitive environment of a coal-fired power plant, and becoming evident in other organizations (Canonico, Nito, & Mangia, 2012).

2.3.4 Other Organizations

Within the general energy sector, Edwards found that while some individuals do a good job at knowledge management, others do not (J. S. Edwards, n.d.). He mentions that in the oil industry British Petroleum (BP) was excellent in knowledge management (Coffman & Greenes, 2000; J. S. Edwards, n.d.). However, he found that Shell's knowledge manager did not place a high value on managing corporate knowledge, stating the opinion that it was overrated (Bahra, 2001; (J. S. Edwards, 2008).

The European Space Operations Center has been collecting data but was having difficulty in transferring the information, and the research called for a comprehensive knowledge “management system for the categories of people, processes, content and technology in order to function efficiently” (Dow, 2006). In a study on the existing “knowledge transfer practices in the aerospace industry”, the findings suggested that knowledge management was not a priority (Martin, 2013). The health industry established that a lack of information retention can create incompetence in the service aspect (Smith & Hadary, n.d.) and found value in developing a forecasting method that used past data to predict future policy decisions (Glien, 2016). Additionally, even countries are interested in sharing knowledge, which implies that the country would have to manage the information first. A joint study by Delft University of Technology in the Netherlands and the University of Tehran in Iran discovered that knowledge networks were vital to current industries interested in sharing information (Sedighi & Hamed, 2014). Another study at the American University of Sharjah in Sharjah, United Arab Emirates realized that knowledge management was more complex than earlier studies and indicated that manuals, information systems, databases, and standard operating procedures were inadequate and could “lead to knowledge loss” (Daghfous et al., 2013). This

research study suggests that a more comprehensive strategy be put into place to increase tacit knowledge retention, involving a networking process complete with cross-training, and focusing on prioritizing participants with critical knowledge (Daghfous et al., 2013). Research in 2013 studied New Zealand knowledge intensive companies and found that there were specific types of knowledge losses when long-term participants left. The researchers characterized these as: participant proficiency, organizational memory, business relationship knowledge, business system knowledge and authority knowledge (Joe, Yoong, & Patel, 2013).

2.3.5 Identification of Participants with Knowledge

Identifying critical interpersonal relationships, both internally and externally, became a high priority in knowledge management. A demographic that deserved a closer look is the Baby Boomer generation. They are the largest generation to date, born between 1946 and 1964 and is estimated to include 76 million workers (Stevens, 2010). According to the Social Security Administration, Baby Boomers have been eligible to retire as early as 2008 and for full retirement since 2012 (Toossi, 2015). This generation was considered the workhorses; the last generation willing to give their whole working career to one company. Their value lies in their knowledge of the workings of the company and their interpersonal relationships. They have developed efficient methods for dealing with every issue and know exactly who to contact to achieve success. This knowledge extends to outside the company as well, to knowledge of which vendor has the best pricing and the optimal delivery time. The loss of their corporate knowledge at retirement can potentially cause major disruptions in work flow, injury to market advantage and ultimately profit loss (Facione, 2016). According to a 2011 article, up to 38% of the workforce could retire by 2030 (Neumark & Johnson, 2011).

One study detailed a process to identify key information roles in an organization by looking for significant information weaknesses in the company through employee exits, and how it would connect to other relationships within the company (Parise et al., 2006). While it has long been recognized that retirement of long-time participants leaves a critical gap in company information, the literature clearly shows that companies are not doing enough to address the problem. A 2017 study focused on how companies in the oil and gas industry managed information when long-time participants retired, and discovered that knowledge retention programs were capricious, dependent

on internal motivation, available funds, employee motivation, and even oil price fluctuations (Sumbal et al., 2017).

Corporate knowledge loss most often occurs when participants leave a company, whether due to voluntary or involuntary job change. The most difficult loss occurs when a long-time employee leaves, usually due to retirement. For example, in New Zealand, a crisis was evident when a large proportion of participants were retiring and fewer replacement participants were available. (Joe et al., 2013). Another similar situation arose in the 1990's when Delta airlines lost experienced mechanics. Repairs took longer and caused the company monetary losses (Parise et al., 2006). Burmeister and Deller (2016) identified categories of workers that would be of interest for knowledge capture: aging workers, baby-boomers, experienced workers and late-career workers (Burmeister & Deller, 2016)

Anaya (2012) conducted a demographics survey of participants to seek out high-risk knowledge gaps among employees. This clarification served to uncover essential employees and the relationship contacts that could prove to be critical to organizational success (Anaya, 2012).

2.3.5.1 Clarify Interpersonal and Organizational Relationships

Interpersonal relationships have been defined as a connection between two or more people that can last briefly or endure for decades, involving family, friends, or work relationships, and are important to the wellbeing of the emotional health of individuals (Ainsworth, 1989). Organizational relationships are an important bond, both within a company and between companies. Both interpersonal and organizational relationships can have overlap in the workplace. These workplace friendships have become commonplace and are even promoted within organizations as a pseudo sense of family. Workplace relationships as described can be both positive (Heaphy & Dutton, 2008) and negative (Bowling & Beehr, 2006). Workplace friendships are advantageous to advancement but problematic through nepotism, among other hazards. Often participants are in denial as to how closely they are associated with participants in other companies due to conflicting loyalties, yet the relationships that are built within the job environment have an effect on how knowledge is captured and transferred (Burmeister & Deller, 2016).

2.4 Capture and Transfer of Corporate Knowledge

Researchers have created technological tools for managing knowledge within companies in order to mitigate losses when participants leave, but few companies are consistently using these tools (Jennex & Jennex, 2016; Boyles, Circle, Kosilov, & Yanev, 2009; Facione, 2016; Parise, Cross, & Davenport, 2006b). Several studies suggested the main remedy for the critical process of knowledge capture is by recognizing the problem and employing a strategy to minimize loss (Leonard, Swap, & Barton, 2019, Daghfous et al., 2013, Jennex & Jennex, 2016). A 2015 article developed a five-step approach to facilitate knowledge transfer: 1. Target the critical knowledge holders; those who have the knowledge that would be a great loss to the company if they were no longer there, 2. Teach these participants how to transfer their knowledge, 3. Help younger participants learn how to draw out the critical knowledge from the ones who possess the knowledge, 4. Look for faster methods of intervention if the long-term employee will leave soon, such as knowledge mentoring, facilitated group sessions, or critical incidence debriefing, and 5. Help knowledge transfer to become part of the company mindset (Leonard et al., 2015). A 2014 study explored ways to retain tacit information within a company. The conclusions were that the process of retaining information should begin from when each employee is hired, due to the unpredictable nature of employment. The study continued on to note other methods of retaining employee knowledge; creating a sharing atmosphere, having mentoring or apprentice type programs, and implementing teams along with the more structured database types of data gathering (Baguma et al., 2014). Other studies concluded similar findings (Baguma et al., 2014; Boyles, Circle, Kosilov, Yanev, et al., 2009; Bratianu, 2013; Daghfous et al., 2013; Facione, 2016; Jennex & Jennex, 2016; Parise et al., 2006)

An important part of the process of knowledge capture is to identify who has the significant information. A study in 2006 looked at relationships with a company and found that it was not just the actual knowledge that an employee has, but also who they were connected to in the company (Parise et al., 2006). A 2010 study on using information and communication technology to retain tacit knowledge preservation, found that the older retiring participants faced challenges with handling certain technology platforms for retaining their knowledge. However, it was found that all participants “should be taught and encouraged to use information communication tools” which then may be referenced by younger participants in order to deter corporate knowledge loss (Davidavičienė & Raudeliūnienė, 2010).

Several business industries have recognized and addressed this issue of capturing corporate knowledge. In Critical Knowledge Transfer, the authors mention companies such as General Electric and Boeing that have been concerned about knowledge loss and addressed how to remedy the situation in-house (Clarke & Rollo, 2001; Leonard et al., 2015; Meso & Smith, 2000). The International Atomic Energy Agency (IAEA) nuclear energy department began researching how to mitigate knowledge loss from retiring engineers in nuclear power plants which culminated in a 2006 guide “Risk Management of Knowledge Loss in Nuclear Industry Organizations”. This publication discussed a risk assessment tool that was used to determine what knowledge was at risk. A decision was then made as to how to capture and retain this information. Overall the authors of the 2006 guide determined that the critical risk was in specialized positions that utilizes problem solving strategies, among other findings (Boyles, Circle, Kosilov, Yanev, et al., 2009). Collison and Parcell (2001) wrote about British Petroleum’s foray into knowledge management, which consisted in part of a continual learning cycle that worked exceedingly well and paved the way for a successful merger with Amoco (Clinton, n.d.; Collison & Parcell, 2001; J. S. Edwards, 2008).

Frappaola (2008) described several strategic steps that need to be taken by an organization to develop an implicit “knowledge base that can then be used to transfer knowledge” (Frappaolo, 2008). The first step is to “identify and quantify the sources and nature of the implicit bodies of knowledge” (Frappaolo, 2008). This can be difficult as a higher level of scrutiny is called for than what is used for tacit and explicit resources. He continued by discussing how an additional review of tacit knowledge resources needs to be undertaken in order “to determine whether that tacit knowledge can be codified if subjected to a type of mining and translation process” (Frappaolo, 2008). The next step required implementation of that mining/translation process. He discussed how the process of developing an implicit knowledge base can be quite an involved process, yet is invaluable for an organization, especially one where explicit knowledge is largely used. He states that “the overall goal of implicit knowledge is to transfer the knowledge gained and employ it” (Frappaolo, 2008), not to automate or replace thinking, but to enhance it. Further he clarified that the knowledge “transfer can occur if a structured approach to interviewing is used, and key elements of the human process believed to be tacit are codified to be used as building blocks for an automated or semi-automated module. This module may then be used as an accessible guide to subsequent thinking and execution for similar business situations” (Frappaolo, 2008).

Burmeister and Deller (2016) conducted a comprehensive literature review on this topic in 2016, and the results indicated that there are four basic characteristics that affect the knowledge transfer process:

1. Knowledge (what kind of knowledge the worker possesses),
2. Individual (who the person is and what position they hold (Collison & Parcell, 2001),
3. Relationship (what connections does the employee have both internally and externally) and
4. Contextual processes (companies need to implement a context of free information sharing).

Their recommendation based on these results was that immediate action is required to mitigate knowledge loss (Burmeister & Deller, 2016).

Anaya (2012) created a program to capture corporate knowledge on a large scale, conducting competency mapping through surveys to assess both key information from experienced participant and also the lacking information in junior workers in high risk fields (Anaya, 2012).

Overall, most programs developed indicated that action should be sooner rather than later, and that once a plan was developed, it should be implemented quickly, even as soon as an employee is hired (Baguma et al., 2014). One important part of the process is to find the employees that have pertinent corporate information.

2.5 Proletarian Workers

An area of concern addressed within this study is how to obtain knowledge from workers that have in the past been labeled as blue-collar workers. These are typically hourly employees with the hands-on skills needed to provide labor in many fields such as warehousing, oil fields, construction and manufacturing with little formal educational requirements. They learn through OJT (on the job) training yet can be highly specialized (Mittal, Dhiman, & Lamba, 2019). A 2011 study examined the characteristics of Chinese knowledge-based workers compared to blue collar workers and discovered that “knowledge workers have more motivating work

characteristics”(Huang, 2011) than blue-collar workers yet lower job satisfaction. They also documented that pay scale was similar between knowledge workers and blue-collar workers which may have contributed to the lower job satisfaction for the knowledge workers (Huang, 2011).

Some proletarian workers have the characteristics of tactile learning, which is useful in a machinery environment. A study on skill-mapping blue-collar workers in 2019 mention skill sets such as manual laborer, ability to operate machinery, a main driver of productivity, hired in labor intensive fields, mostly paid hourly, specialized workers, no formal education required, but instead knowledge is gained by experience, and that sometimes a two year technical degree is an educational requirement (Mittal et al., 2019). Since most blue-collar workers learn on the job, it follows that they will also train others utilizing OJT, but there is still a need to capture the knowledge that is being passed between participants, by characterizing the knowledge and verifying that it meets the company criteria.

There was a distinct lack of information in the literature regarding knowledge capture from proletarian workers. Some discussed training methods commonly used with this type of worker, such as apprenticeship programs or one on one mentoring, but the specific classification of “blue-collar” or “proletarian” was not connected to the programs (Baguma et al., 2014; Basque, Paquette, Pudelko, & Leonard, 2014; Facione, 2016; Kuronen-mattila, 2007; Lee, 2010; Muniz, 2014; Soo, 2006; Wyatt, 2001).

2.6 Knowledge Capture Methods

Knowledge capture has taken on many forms in all fields that utilize it. Explicit knowledge is most likely to be retained through documentation (Wyatt, 2001). Tacit is the more difficult to capture and requires a longer process yet is the target of this research.

2.6.1 Building Relationship With Trust

Building relationships in order to capture knowledge from the long-term employee was indicated to be significant, and also required a degree of trust (Foos, Schum, & Rothenberg, 2006). Several sources mention trust as a part of the requirement of building relationships (Baguma et al., 2014; Foos et al., 2006; McKnight, Cummings, & Chervany, 1998; Muniz, 2014; Reihlen et al., 2015).

Researchers can be viewed in the same light as consultants; they enter the company for a short period and then leave again. A study in 2015 noted that the best client-consultant relationships require trust which can be difficult to obtain. The researchers of a 2015 study developed a three part process which consisted of: “presenting ability and integrity, revealing benevolence, and forming an emotional connection” (Reihlen et al., 2015). The timing of developing trust in the relationship should be at the beginning (McKnight et al., 1998). Muniz (2014) cites trust as a deciding factor in whether the knowledge was actually obtained, whether through a mentoring relationship, interviews or even casual conversation (Muniz, 2014). Another study in 2014 mentioned being “open, transparent and trusted” in order to create the “best atmosphere for participants to share information” (Baguma et al., 2014). A study in 2006 linked together trust and a shared goal or vision as key to a free exchange of ideas (Foos et al., 2006).

Several other studies mentioned trust as an aspect in Knowledge Management (Awad et al., 2014; Burmeister & Deller, 2016; Daghfous et al., 2013; 2010; Lee, 2010; Marwick, 2001; Plazas, 2013; Sumbal et al., 2017). Sumbal (2017) found that building trust was disparate for different generations. Younger generations were found to be heavily involved in social media which had the result of creating a faster trust response, while older generations who were not using social media as much were more prone to developing trust in face to face encounters. They were also more liable to consider knowledge as a unit of power, not something to be given away freely (Sumbal et al., 2017). A 2014 study found that meaningful knowledge management occurred between employees sharing various forms of narrative which lead to the development of trust, among other positive attributes (Awad et al., 2014). Trust was mentioned as a key element in both a 2013 and 2016 evaluation of the topic (Burmeister & Deller, 2016; Plazas, 2013). A lack of it between management and workers was a factor in a 2013 study on knowledge loss (Daghfous et al., 2013). Lee (2010) found that a trustworthy environment was significant for knowledge sharing (Lee, 2010). Marwick (2001) discovered that even in cases of technology utilization, trust was still a factor in knowledge management (Marwick, 2001).

2.6.2 Software Utilization for Analysis

Software utilization to aid in the qualitative analysis process has become widely accepted as long as the researcher remains in control of the process and only uses the software as a data management tool (Zamawe, 2015).

2.6.3 Interview Format and Transcription

Creswell (2007), detailed the procedures for a qualitative interview, specifically setting up an interview script in advance, ice-breaker questions, four to five questions pertinent to the study, then asking follow-up questions and allowing subjects to expand on their answers (Creswell, 2007).

Several studies mention a process to capture critical knowledge from workers. Interviews were a common method to obtain qualitative data (Dobbins et al., 2004; Dow & Pallaschke, 2010; Foos et al., 2006; Heisig et al., 2016; Muniz, 2014; Sackmann, 1992). Semi-structured interviews were also utilized in knowledge capture (Facione, 2016; Muniz, 2014). Facione noted that it was “time consuming and rigorous” (Facione, 2016). Muniz stated that a semi-structured interview could be used to “identify and gather expressible and tacit knowledge of key administrators” (Muniz, 2014).

Semi-structured interviews are detailed in several studies in the literature process (Foos et al., 2006; Joe et al., 2013; Kallio, Pietilä, Johnson, & Kangasniemi, 2016). The 2006 study noted that “in-depth interviews provided a forum that encouraged the respondents to share as much information in an unconstrained environment” (Foos et al., 2006). The 2013 study utilized interviews of about an hour in length (Joe et al., 2013). The 2016 study used a semi-structured interview process to assess knowledge gaps, utilizing a five-step process of: “identifying the prerequisites, retrieving and using previous knowledge, formulating the preliminary guide, pilot testing, and use of the final version” (Kallio et al., 2016). Their research found that a semi-structured interview is “versatile and flexible” and can be used in both an individual and a group interview process (Kallio et al., 2016). All three studies transcribed the interviews.

2.6.4 Active Listening

Active listening is a method utilized in interpersonal relationships to encourage good communication, build deep personal relationships, and enable individuals to listen to themselves in order to be clearer in what they are speaking. Active listening should convey the idea of valuing the speaker, wanting to understand, without judgement, in order to create a change in both the speaker and the listener. An important method in active listening is not to just listen but indicate that the speaker is being heard by occasionally interjecting a word or sentence to indicate understanding. Active listening is used in many fields: psychology, education, and management.

Today it is applied to any interpersonal relationship whether at home, work or in the market (Rogers & Farson, 1957).

2.6.5 Identifying Key Information from Captured Information

The role of those leaving a company becomes significant as it links to what kind of information they have about the company. Those in serious or dangerous positions would have safety knowledge that could save lives, as in a power plant setting, nuclear or otherwise (Alam et al., 2019). The other risk is loss of power for communities. While little has been said in the literature about the connection between community power loss and knowledge transfer, it remains a critical problem. Information has increasingly been stored digitally over time. With power loss, digital information is more difficult, if not impossible to access. One study created a strategy to minimize knowledge loss in the nuclear industry by using a numerical system to rank both the personnel leaving and the knowledge they possess to create a risk factor and an overall assessment (Boyles, Circle, Kosilov, & Yanev, 2009). Burmeister and Dellar's (2016) study specified five critical knowledge types from other author's: "know-what (declarative), know-how (procedural), know-when (conditional), know-why (axiomatic), and know-whom (relational)" (Burmeister & Deller, 2016; Sackmann, 1992). Other studies identified five types of knowledge lost through older workers retiring: "subject matter expertise, knowledge about business relationships and social networks, organizational knowledge and institutional memory, knowledge of business systems, processes and value chains, and knowledge of governance mechanisms" (Burmeister & Deller, 2016; Joe et al., 2013). Each industry has critical information that should be retained and forwarded to junior employees. The challenge is to evaluate and implement best practices capture and retention.

2.6.6 Research Methodology: Content Analysis

Qualitative data analysis can take many forms. Creswell indicated that data from interviews could be analyzed in more than one way, if the analysis is systematic and organized. He suggested a dynamic interactive approach that included organizing and reading through the data to gain an overall sense of the data, choose the codes for the data that fit the best then utilize those codes with

either an electronic program or by hand, connect the themes with the data either pictorially, graphically or as a discussion, then interpret the data (Creswell, 2009).

There are many methods of research from qualitative to quantitative to a combination of the two. One such method of research is single-subject.

2.6.7 Research Methodology: Single Subject Research

Single subject research is a form of applied research that studies an individual or small number of subjects, with the goal to “demonstrate a functional relationship between the intervention and behavior change” (Richards, 2019). It is commonly used in the educational field, particularly in conjunction with behavior modification (Richards, 2019). Action research is “a systematic way to collect information to potentially improve a component of the teaching and learning process”(Mills, 2014). As this is applied to research, the steps to be taken are to 1) select the focus, 2) review the topic research, 3) select the methodology, 4) gather data, 5) analyze the data, and 6) decide on a course of action (Richards, 2019). The problems in single subject research are prediction, which results from no change in the subject, verification, which is confirmation of change in the participant, and replication, or repeatability. Since there are so few subjects in single subject research, there is also greater danger of error variance (Richards, 2019).

Once the knowledge gaps have been obtained through data analysis, methodology for retaining that data for the company becomes critical. Following is the best practices for knowledge retention.

2.7 Knowledge Retention

Best practices for retaining the knowledge from retiring experts follows a pattern of interviews and data collection (Anaya, 2012; Leonard et al., 2015) and to initialize knowledge mapping (Anaya, 2012; J. S. Edwards, n.d.; Muniz, 2014). Leonard (2015) has commercialized studies of company practices on collection of exiting employee’s “deep knowledge” (Leonard et al., 2015). To facilitate knowledge retention, Edwards advises a network approach, using a trifold method of people, technology and process (J. S. Edwards, n.d.). A 2010 study at the European Space Operations Center (EOSC) on the topic found specific steps to be helpful in obtaining group information from the various experts. These steps included setting boundaries, a specific tailored

interview process, pre-setting the question list for optimal attainment of tacit knowledge, and reviewing the material (Dow & Pallaschke, 2010). In 2014, authors noted that knowledge capture must be designed specifically for the targeted audience (VanAlbrecht & Nemani, 2014). Other studies recommend a formal, purposeful method for the complete “knowledge management process that targets tacit knowledge” (Dow & Pallaschke, 2010; Muniz, 2014) A 2014 study notes that capture strategies should take place over one to three years, especially in cases where the exiting employee has been with the company for many years, yet ideally would be part of the daily employment routine. They also noted that tacit knowledge is best captured during activity, such as shadowing or mentoring during the course of the work day (Baguma et al., 2014).

In 2014, the European Space Agency (ESA) desired to capture and preserve the data leading to the design, construction and implementation of the Automatic Transfer Vehicle (ATV). During the process, they developed a web portal for ease of access to the data, ensuring that expert knowledge was captured and readily available in future (Mugellesi Dow et al., 2016).

Awad (2014) noted that “knowledge management is not a passive or static activity, but instead dynamic, implying that knowledge management is not meant to be a collection of information that is stored, but is meant to be continually added to, updated, and transferred to current and future participants” (Awad et al., 2014).

Knowledge is not only stored within repositories of company databases and libraries, but also collectively by groups of individuals within the company. A 2007 study discussed “communities of practice” that involved groups of people that worked closely with each other, perhaps even dependent on each other. When these groups act in isolation, it becomes even more difficult to obtain the knowledge that they hold (Brown & Duguid, 2007). However, a 2019 study evaluated the links between employees’ technological soft skills and career success and found a positive connection between them. The study further showed that improved performance within an organization is linked to employee improved knowledge and career success (Giudice, 2019). Another 2019 study explored skill-mapping of Blue-collar workers, finding that the role of the supervisor was critical in aiding the workers to improve in their skills along with periodic training workshops throughout the year, and actual mapping out each worker’s skills, which benefitted the company as well (Mittal et al., 2019).

2.8 Knowledge Transference

Multiple works have been written about this topic as most people have experienced at least twelve years of information transferal during their youth. The focus of this research study is in transferring knowledge that has been obtained at the same utility plant. Muniz (2014) spoke about confidence in leadership capability and having a safe environment for this transfer to take place in higher educational institutions. The research model he developed indicated that the best setting for tacit knowledge transfer would include “low chronic stress, high activity, and high trust” (Muniz, 2014). Facione (2016) detailed how optimal knowledge transfer would include efforts to present material in a format that the generation would readily accept, how converting tacit knowledge to explicit requires a type of internalization and communication (Facione, 2016). A 2001 study indicated that “knowledge is a social construct and requires people to transform tacit knowledge into explicit”(Clarke & Rollo, 2001). Frappaola (2008) described a method for knowledge transfer which followed a pattern of transferring knowledge from explicit to tacit by way of implicit knowledge (Frappaolo, 2008).

Burmeister and Deller (2016) suggested evaluating the indicators of knowledge, individual, relationship and context when exploring knowledge transfer activities, and using dependable measurement instruments for study validity. The researchers continue further to offer the following implications for knowledge transfer: to identify the appropriate workers, establish motivation and ability to transfer the knowledge, provide opportunity to share, and create an environment conducive to transfer (Burmeister & Deller, 2016). Anaya (2012) implemented several practices to transfer knowledge: targeted selective training, structured on-the-job mentoring, job shadowing, and knowledge transfer focus group (Anaya, 2012). Nearly all the data indicates that the organization’s culture has impact on the ability of its members to transfer critical corporate knowledge.

2.8.1 Organizational Culture and Tacit Knowledge Sharing

A culture that mimics a clan has been described as one of several organizational culture’s types, such as clan, adhocracy, hierarchy and market. Business culture has been described as how organizational people operate and connect to each other both internally and externally within the organization (Lund, 2003). Clan is described as a family type of group, adhocracy is creative and

flexible, hierarchy is formal with clear lines of power, and market is competitive and productive. Clan and adhocracy cultures were identified as particularly amenable to tacit knowledge sharing during a 2011 study (Suppiah & Sandhu, 2011). Family culture typically helps one another and connects better, and adhocracy's characteristics of flexibility appears to aid in tacit knowledge sharing. The formal hierarchy culture would work against knowledge transfer as communication is not a strongpoint in that type of culture. Furthermore, the competitiveness of the market culture pits employee against employee which would also work against knowledge sharing. The literature indicated other factors that affected transfer of critical knowledge within an organization.

2.8.2 Factors Affecting Knowledge Transfer

While KM remains an important part of any organization, regardless of its product, clientele or participant, there are distinct factors that affect the process and whether it is successful. Success in KM would mean that explicit knowledge is systematically being evaluated, stored, and available to participants, and that tacit knowledge is readily being transformed into explicit knowledge for storage. Success would also be evaluated by how willingly employees in an organization share both explicit and tacit information. A study in 2014 discussed what they called a shareability factor, which is described as the "willingness to share tacit knowledge". The study goes on to discuss how too much centralized organizational control can cause problems with KM, by limiting the individual employee in information sharing (Awad et al., 2014). A study in 2006 on the disconnect between product developers found trust to be "one of the important relationship factors contributing to tacit information transfer" (Foos et al., 2006).

Lucas (2002) developed a theoretical model on factors affecting knowledge transfer, through focusing on content (the type and amount of knowledge that was being transferred) process (how it was being transferred), and the use of teams, reputation and culture as factors affecting transfer of knowledge. Teams were considered beneficial to transferring knowledge as they acted both as individuals and as a group and were more likely to share knowledge within their group. Both reputation and culture of either the individual or company were found to be either helpful or detrimental to knowledge sharing (Lucas, 2002). Other factors mentioned in Lucas's research were that "corporate monitoring could have a positive or negative effect on knowledge sharing", but that positive incentives could aid greatly in knowledge transfer. These rewards didn't have to be monetary; recognition seemed to also have a positive effect (Lucas, 2002). In a 1997

study on predicting short and long-term transfer of training, the motivation of the participant appeared to have a great impact on knowledge transfer during the training process (Carolyn, Review, & Vol, 1997).

In a 2016 research study on the method preference of retiree knowledge transfer of well-educated members of a National Laboratory, Weiss found that mentoring was the preferred method of knowledge transference, that there are barriers to the transference, and that a lack of transferring knowledge does affect productivity (Weiss, 2016). A research paper on knowledge transference within a team found that the more knowledgeable a team member was, the less likely they were to share their information (Joshi, Sarker, & Sarker, 2007). Once key data has been successfully retrieved from exiting employees, a system of conveyance to replacement personnel is necessary, typically through some form of training or intervention.

2.9 Knowledge Transference: Intervention Development

The university utility plant at the focus of this research had a written training program that acted as the vehicle to transfer corporate knowledge from employee to employee. This study utilized an intervention in the form of a revised online pedagogy hereafter noted as an intervention.

The literature has much to say about educational interventions, therefore the focus for this research study is on industrial intervention development methods as it relates to knowledge retention and transference. Kirkpatrick's four-level model is often used to evaluate how a training program is developed. The four-level model is a process of "reaction, learning, behavior and results" (D. L. Kirkpatrick & Kirkpatrick, 2005). Reaction involved the process of how participants respond to the training and was most often addressed through a survey at the end of the training. A few appropriate questions to ask are whether the intervention was valuable, if it was applicable to your position in the company, if it was engaging, and what the participants learned. The response of participants indicated whether it was an appropriate method or needed to be adjusted. The second level of learning addressed what participants learned and can be measured through a pretest and posttest format. Behavior was more difficult to assess, as it evaluated whether the participants were applying their training to their workplace.

The goal of an intervention was to "transform tacit knowledge into explicit knowledge in a process some literature works referred to as codification" (Clarke & Rollo, 2001). Lee suggested that in a situation where new participants need to have a shorter intervention period, integrating

technology into a pervasive training effort was successful in the service industry (Lee, 2010). A 2010 study on tacit knowledge preservation found that action training had more impact on transferring knowledge, continuous training of employee successors were critical, and systematic training should include technology and innovative practices (Davidavičienė & Raudeliūnienė, 2010). A 2014 study stated that real knowledge is gained through people, and employee motivation through pay or benefits will encourage loyalty. Another finding was that decentralization of knowledge and empowering workers allowed companies to be more responsive to change. Awad noted that knowledge management is not a passive or static activity, but instead dynamic. (Awad et al., 2014). Dynamic activity requires a high level of interaction by workers, including both those imparting and receiving the corporate knowledge.

Once a research methodology has been chosen, the intervention procedure should be chosen and evaluated.

2.9.1 Intervention Methodology

The instructional design used for this study was a pretest/posttest experimental design modeled after Perkin's Theory One, of "clear information, thoughtful practice, informative feedback, and strong motivation" (Perkins, 1992). "Clear information" referred to carefully describing what was expected of the employees before, during and after the intervention. "Thoughtful practice" gave the participants opportunities to internalize what they were learning, whether that entailed the opportunity to repeat the program, practice the information or just think about it. "Informative Feedback" helped the participant by some type of evaluation of the performance, which could be as simple as a grade on an assessment or as elaborate as one on one discussion of the performance. "Strong motivation gives the trainer opportunity for the trainer to give a reward to the trainee. This can come from the trainer or from the company itself, as in monetary rewards (Perkins, 1992).

2.9.2 Worker Input

There is very little in the literature regarding the involvement of workers in creating interventions. A few authors mention employee empowerment which implies that the workers are involved, but not usually in the actual training construction. Certainly, proletarians are rarely

involved in any managerial function, and training is considered a managerial function (Bairi, Murali Manohar, & Kundu, 2011). Worker trainer is a relatively new term in the literature, although reasonably common in unionized shops. In a worker-trainer article that took place in an oil refinery, one individual reported that as a worker, they had greater access to gaining the attention of other workers because they are not management. The individual continued that they are just another worker who understands the job. This article presented the idea that white collar workers do not value blue collar workers, therefore having blue collar workers trained to present safety classes to other blue collar workers is acceptable, whereas white collar workers with formal dress and language might not be accepted (Holzer, 1995). The UAW (United Auto Workers) have been using worker-trainers since the 1990's, and a 2004 article stated that "peer training increase the likelihood that trainers have specific knowledge of hazardous conditions faced by workers" and that it was a part of worker empowerment (Daltuva, Williams, Vazquez, Robins, & Fernandez, 2004). Another example of peer training is a worker who trains their substitute in the position. This is the practice in the United States Postal Service, where craft participants train new employees after their initial orientation ("United States Postal Service," 2019). However, utilizing workers within a utility plant to create training from the acquired knowledge is a new, unexplored phenomenon.

2.9.3 Effectiveness of Training Intervention

Most companies have some type of training program for new and existing employees. These can vary from classroom instruction, to shadowing, to on the job training (OJT), Many researchers have studied training in order to discover the most effective programs (Carolyn et al., 1997; Machin, 2002; Swanson & Sleezer, 1987). A 1997 study found that relevance affected later use of corporate education materials (Carolyn et al., 1997). Another study in 2002 detailed issues from the standpoint of the facilitator, listing issues that were out of their control such as any rewards given to the trainees, or assessment of the efficacy of the pedagogy, ending with the reality of training as an outside function (Machin, 2002). In a 1987 study, surveys were utilized to measure three tools for evaluation of a corporate intervention program's usefulness; how satisfied the trainees were, whether they learned the material, and how their performance was altered post-intervention (Swanson & Sleezer, 1987). A study in 2015 evaluated how to maximize the effectiveness of organizational pedagogy. Some of the factors within their model were motivation,

cognitive ability, positive rewards and negative consequences, resources and self-regulation, among others. Some of the key findings were that goal setting, especially with rewards and sanctions, were effective, along with whether the company prioritized education, and whether the participant was self-regulated enough to complete the intervention (Sitzmann & Weinhardt, 2015).

2.9.4 Evaluation of Intervention Effectiveness

The assemblage and execution of KM for participants is an important process to develop. Equally important was evaluating how effective the KM was for the participants. A power plant employee is expected to use their knowledge in a hands-on application, as situations that call for expertise to ensure safety is especially important. Therefore, a measurement system can be useful to ascertain how effective KM is for participants. A research study that evaluated a KM system's "efficacy and effectiveness in a design science context" found that the KM system used by the company was useful to the company's engineers for the technical analysis. It was also useful for the company's Chief Executive Officer and Chief Operations Office for strategic planning of the company (Kanjanabootra et al., 2013). The researchers of this study collected a combination of data comprising of document analysis, interviews, shadowing and observations (Kanjanabootra et al., 2013).

The most common method for evaluating training programs is through Kirkpatrick's "four-level model of reaction, learning, behavior and results" (D. L. Kirkpatrick & Kirkpatrick, 2005). Reaction of the intervention aids in evaluating whether they will implement any of the information into their work, while learning is best evaluated through scoring on assessments, although there are other ways to measure this step. Behavior in the model involves a five-step process of "1) systematic appraisal; 2) performance appraisal; 3) statistical analysis; 4) post-training appraisal; and 5) control group, [and results can include] using comparison studies, experimental groups, questionnaires, participant data collection and analysis, and productivity measurement" (D. L. Kirkpatrick & Kirkpatrick, 2005). While Kirkpatrick specifies the former as best practices in his model, an organization can and should adapt the model to optimize the process for their company.

2.10 Methodological Triangulation

To validate a qualitative study, a method of triangulating the data is commonly used. Denzin mentions four types of triangulation: Data, Investigative, Theory and Methodological Triangulation, where each involve different parts of a study to create the triangulation (Denzin, 1978). Carvalho and White suggest four reasons to triangulate: to add value to the study, to dispute a hypothesis, to affirm a hypothesis, and to explain the unexpected (Carvalho et al., 1997). One of the most important reasons for utilizing a triangulation method is to eliminate bias. When conclusions are drawn from only one source of information, researcher bias can control the results. This bias can destroy any deductions or indeed any useful outcomes of the research. Kennedy lists three types of bias: measurement, procedural, and sampling which is further broken down into omission and inclusion bias (Kennedy, 2009). The methodological triangulation applied to this study included interview data, current training artifacts, and researcher observation.

A further consideration for any organization implementing a comprehensive knowledge management program is the economics involved.

2.11 Economics of Implementing KM

Changes in a corporate environment such as reengineering a process or that of an employee's departure, can come with expensive ramifications. In the case of the knowledge loss due to a departing long-term employee, a company must weigh the costs and benefits of investing in the capture, storage and subsequent instruction of junior employees against the alternative of knowledge loss. Howells (2002) wrote that knowledge leads to innovation, which in turn leads to economic growth (Howells, 2002). In a 2009 study, knowledge transfer within universities were referred to as a "source of funding and as a policy tool for economic growth" (Geuna & Muscio, 2009). In a 2014 study in Taiwan, researchers found that industrial clustering and, by default, the knowledge management required for the clustering, created opportunities for economic growth that wouldn't have been realized without it (Lai, Hsu, Lin, Chen, & Lin, 2014). Although KM is typically viewed as an information technology, it should be considered as a necessary cornerstone for increasing productivity and improving worker communication, among other positive effects, and that while there are costs to conduct KM, there are also less tangible benefits (Awad et al., 2014). Knowledge management has many qualitative benefits such as preserving customer loyalty,

organization stability, company culture, etc. but the quantitative benefits also need to be considered. These include but are not limited to items such as cost savings, corporate valuation, profit margins, customer retention, etc. (Awad et al., 2014; Bergeron, 2003).

Two other studies discuss how a company or organization hires an employee based on their current knowledge and skill level in an area yet expect that their knowledge and skill will develop throughout the employee's tenure with the organization. This investment of knowledge development may be by online courses, seminars, conferences, etc., which are most often paid for by the organization to develop their employee's knowledge base. As such, the organization invests not only time but the organization's money into an employee who now possesses knowledge which transforms that employee into an asset for the company. All assets have a life span, however, and the asset life span of an employee's knowledge is volatile in our current society due to the current trend of employee transitions and technology improvements (Bergeron, 2003; Rotman, 2013). Another consideration is that an employee may choose to leave the company shortly after procuring certain knowledge that the company paid for that now is no longer an asset for the company. As such, when a company or organization invests in KM, the time and finances involved with acquiring and maintaining the information needs to be considered. Additionally, evaluating the effectiveness of an intervention program should be considered as part of KM.

2.12 Summary

Chapter two includes an overview of the literature that pertains to this study. Topics include the three basic types of knowledge including explicit, tacit and implicit, knowledge loss, knowledge management including nuclear, non-nuclear, coal fired plants and other organizations, knowledge loss, capture and transfer of corporate knowledge, including identification of participants with knowledge and clarifying interpersonal and organizational relationships, proletarian participants, knowledge capture methods, including building relationships with trust, software utilization for analysis interview format and transcription, active listening, identifying key information from captured information, research methodology: content analysis, and research methodology: single subject research, knowledge retention, knowledge transference including organizational culture and tacit knowledge sharing and factors affecting knowledge transfer, knowledge transference: intervention development including intervention methodology, worker input, and effectiveness of implementing KM. This concludes Chapter 2.

CHAPTER 3. RESEARCH METHODOLOGY

This research was proposed as a pilot to address a problem at a university utility plant. A relatively high number of employees were planning to retire within a two-year period and there were an inadequate number of employees qualified to replace the retirees. Compounding the problem, the current training program required seven years minimum to enable a new hire to obtain the top position of those retiring. This research was conducted as an experimental mixed methods study, developed through data collection and analysis, then evaluated through pedagogy and assessment (Creswell, 2009). As the study progressed, the quantitative data was insufficient to evaluate, yet provided rich data for the qualitative portion. The process led to a qualitative single subject research study and included data collection and analysis and knowledge storage and dissemination.

3.1 Study Design

The initial design for this research was an exploratory mixed methods study. The qualitative segment consisted of interviews with software and content analysis. The quantitative segment was an experimental pretest-posttest design that incorporated data gleaned from the qualitative portion into an online pedagogy in order to evaluate the efficacy of the storage and dissemination of the knowledge gaps. All of this was accomplished and is detailed in this chapter. The quantitative portion of the design did not contain enough data for adequate analysis but was included into the research as it did provide edification. Figure 3.1 details the study design process.

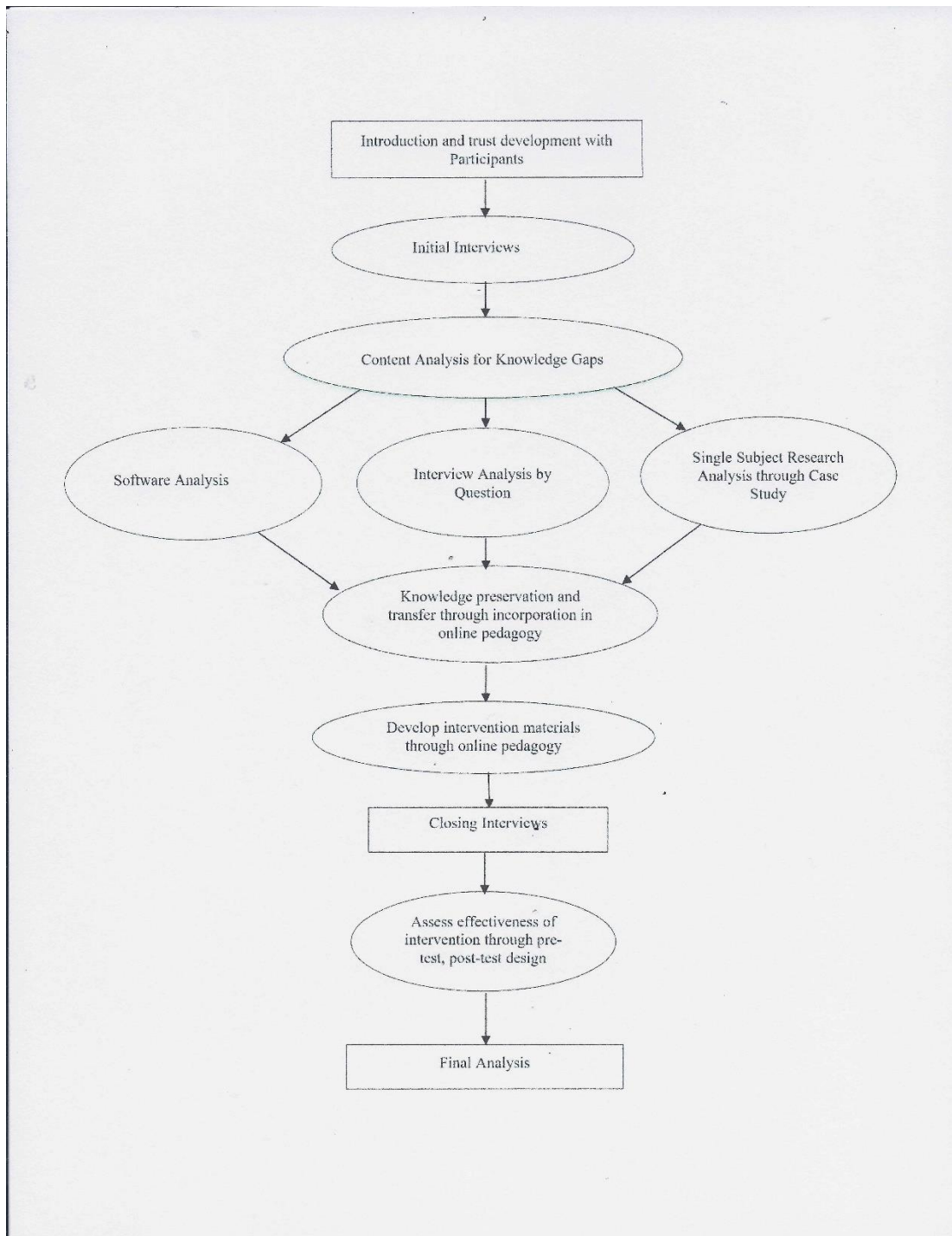


Figure 3.1 Research Methodology Timeline

Research Questions



This study addressed the following research questions:

Capture, preservation and dissemination of corporate knowledge:

1. What methods of knowledge collection are effective with proletarian workers nearing retirement in a utility plant?
2. What methods of knowledge preservation and transference are effective for proletarian workers in a utility plant?

Secondary to the primary research question is the following subsequent question:

3. What methods will engage proletarian workers in the knowledge capture and transference process?

3.2 Population

The population of retiring participants was eight. Population of all participants interviewed, which included employees with no clear timeline for retirement, was seventeen.

3.3 Analysis Procedures

The qualitative data from interviews was first analyzed by deductive qualitative content analysis (Elo & Kyngäs, 2008). A software (NVIVO) was then utilized to group into themes and then further delineated into more focused topics through a targeted analysis of interview responses. The interview responses were evaluated by individual question, then single-subject research techniques were applied to enlarge upon the themes in the form of case studies. A pre-test, post-test design was utilized to evaluate the intervention, and further analysis involved post-assessment interviews.

3.4 Permissions

This study took place at Wade Utility Plant at Purdue University in West Lafayette, IN. Permission was required from both facilities and their personnel in order to obtain data from the

location. The Institutional Review Board (IRB) was contacted to verify any permissions needed to conduct the study, and the study received a waiver.

3.5 Procedures

A collection of explicit and implicit knowledge was collected through taped interviews from retiring participants and transcribed. The data was used to create a competency map for retiring participants to ascertain knowledge gaps in the remaining employees. Further evaluations of the interviews were conducted through qualitative methods by conducting a software evaluation for themes, evaluating individual question responses, then evaluation through single subject case studies. Once knowledge gaps were established, an intervention in the form of an online pedagogy was created. As part of this intervention, video walk-throughs were conducted and video-taped with available competent workers while they were completing routine maintenance. These served to motivate retirees into participating in the knowledge collection, create preservation of the knowledge and obtain evaluation of knowledge retrieval. Completion of the intervention included quiz questions placed into a test bank, and a pre-test/posttest assessment created from the test bank and applied to participants before and after the intervention.

3.5.1 Interview Structure

The interview question development was followed by a semi-structured interview process to assess knowledge gaps, utilizing a five-step process of: “identifying the pre-requisites, retrieving and using previous knowledge, formulating the preliminary guide, pilot testing, and use of the final version” (Kallio et al., 2016). No set time was used as each participant was expected to have varying levels of input and discussion dependent on their experience and level of engagement. Secondary interviews were conducted as needed with the retirees and other personnel to verify knowledge gap themes, confirm that all knowledge had been gathered, and that the information had been properly included in the pedagogy. Informal group discussions, that weren’t recorded, were utilized throughout the collection, development, and testing periods to verify data and discuss training needs. Active listening was utilized throughout all interviews (Rogers & Farson, 1957).

3.5.2 Interview Participants

The initial interview participants consisted of eight personnel at the utility plant that have either just retired or were eligible for retirement within a three-year period. These personnel had a combined tenure of nearly 200 years and consisted of the highest risk of corporate knowledge loss. Obtaining the knowledge these individuals have gleaned from their many years of service at Wade Utility Plant drove the purpose of the study. Secondary interviews took place with junior participants in order to establish connection and discuss training needs. A total of seventeen participants were interviewed.

3.5.3 Developing Relationship Through Building Trust

Trust was a factor in this study, as the researcher was relatively unknown to the participants, which can create problems during KM (Foos et al., 2006; McKnight et al., 1998). The method used for gaining the trust of these individuals was a process of “(1) signaling ability and integrity; (2) demonstrating benevolence; and (3) establishing an emotional connection” (Reihlen et al., 2015). This was accomplished through an introduction from senior management, willingness to conduct interviews when convenient to workers, allowing them to review their interviews before releasing them to management, conversation with them to determine their training needs and strategic inclusion of the workers in the training development process.

3.5.4 Interview Setting

The interview setting was informal within the facility, for the convenience and comfort of the participants. Management was interviewed in the main building in the conference room or in their office. Plant floor participants were interviewed in the plant to aid in relaxing the participants, and to facilitate their work duties. One location in the plant utilized for interviews was the plant supervisor’s office, and the other location was the plant break room. Interviews included two interviewees; the senior project lead and the researcher. The interviews were around the beginning of each shift, so the participants would be more rested, specifically the night shift.

3.5.5 Data Transcription

After each interview took place, the recording was uploaded to a transcription service that then created a digital file of the interview, which in turn was sent back to the researcher. The service used for these transcriptions was well known as reliable and cost effective. The transcripts were reviewed by both researcher and by interview participants with a focus on accuracy. At no time were any of the transcripts out of the possession of the researchers except for the transcription service and when copies were given to the interview subject and management.

3.5.6 Transcript Evaluation

Transcripts interview and compared them to the transcripts to verify that they reflected the information and issues shared by the participant. The researcher briefly read through some of the transcripts immediately following interviews to ascertain the quality of the transcripts.

Transcripts were evaluated by the long-term participants to verify accuracy and prompt topics that may have been overlooked. Inclusion of the long-term participants in verifying the transcripts built trust and ensured were made for all recorded interviews. The researcher also took notes during the that all knowledge gaps were authentic and included.

3.5.7 Data Software Evaluation

Software was utilized to search for themes within the interview data. The chosen software was NVivo, which is widely accepted for use with mixed methods or qualitative data.

3.5.8 Knowledge Gap Evaluation: Individual Questions

Once authenticity was ascertained, the researcher performed a qualitative evaluation on answers to the individual questions asked during the interviews, by reviewing in-depth all answers to a specific question. This procedure highlighted gap themes drawn from the participants and verified conclusions.

3.5.9 Knowledge Gap Evaluation: Single Subject Research

This research utilized a single subject design as part of the evaluation of the data. The focus of it was to verify whether all knowledge gaps had been retrieved from the interviews without bias by reviewing all transcripts. The methodology for this portion of the research utilized select case studies from the retiree group of participants. Each participant chosen was justified by the following; the most critical events during their tenure, those who were willing to speak in the interviews, and those that highlighted a previously noted gap theme. The final data was gathered from the interviews through this technique of case studies, and final recommendations were made from the careful analysis.

3.5.10 Determine Gaps in Knowledge/ Needs Assessment

Before any conclusions were drawn, a summative list of knowledge gaps was assembled within theme groupings through the technology tool NVivo, appraised further through the individual interview questions, then evaluated through a single-subject research technique of case studies to delineate the themes. These were then further aligned into knowledge gaps for current and future employees.

Knowledge Gaps were determined through a qualitative process of interviews, interview evaluation through software theme grouping, individual questions, single-subject research, and final evaluation analysis. By interviewing all participants, a clearer picture of knowledge gaps was determined.

3.5.11 Development of Intervention

The gap areas after identification were mapped using content mapping techniques which incorporated a scaffolded learning technique that began with basic material and built until all material was covered and the student could demonstrate understanding and proficiency (Pol, Volman, & Beishuizen, 2010). Figure 3.2 shows a sample trial flowchart of how the subject matter progressed for the development of the training materials and how it will continue to progress after this pilot study.

The created training materials were digital, in modules, and accessible both in the plant during down time on a shift and in off hours outside of the work environment. To this end, some

of the created training material was available to download from a cell phone. The pedagogy types were brief textbook materials, summarized information written in high school level text, short video segments from the actual plant, and a lab analysis. Each training segment was followed with a short quiz for evaluation of the material. Using the scaffolding technique, the participant was required to demonstrate competency before moving to new material by an 80% proficiency level (Pol et al., 2010). This competency was cleared first through the training material and then available for verification by plant supervisors when convenient.

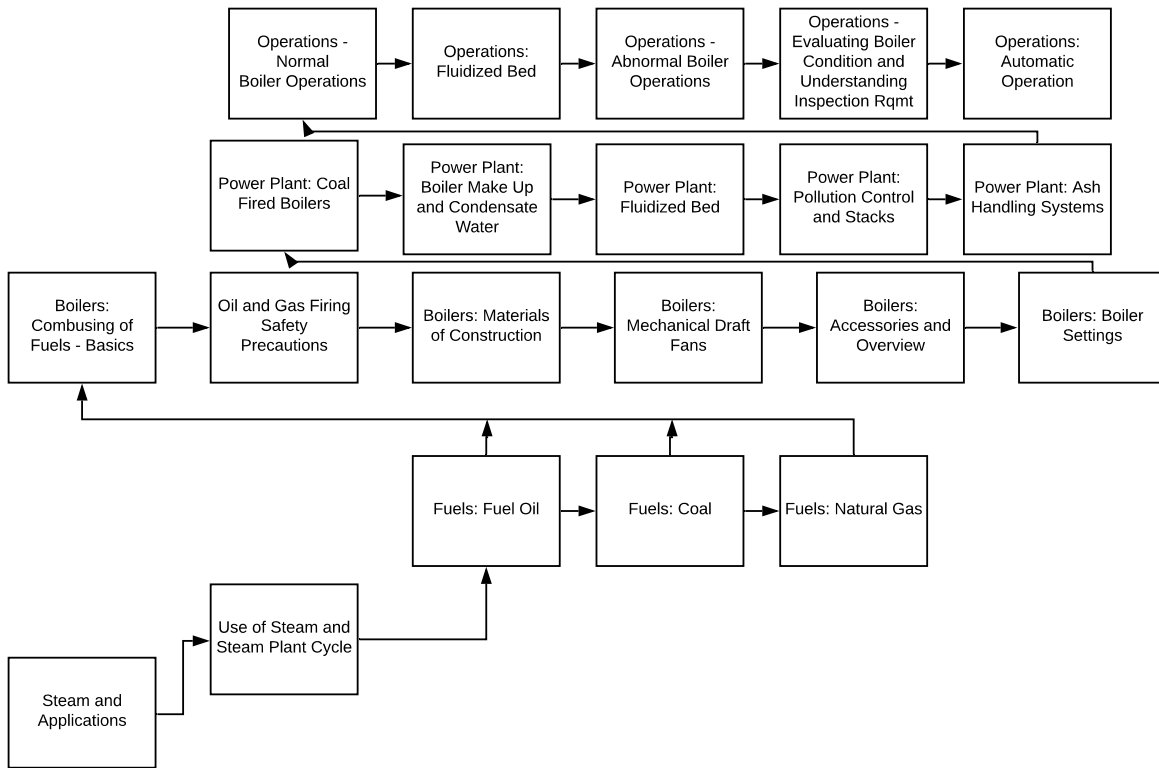


Figure 3.2 Sample Trial Flowchart

3.5.12 Development of Assessment Tools

The assessment tools consisted of short quizzes and a pretest/posttest design that evaluated both the successful retrieval and transference of gap knowledge (Mckinley et al., 2020). This was an imperfect application of the standard pretest/posttest strategy, where there is a control group that does not receive the pretest/posttest, however, the value in applying this method, even

imperfectly, provided valuable insight. The quiz assessments were created from the gap knowledge gleaned from the qualitative interviews with retirees. These questions were then grouped into a test data bank on the learning platform and the pretest/posttest questions were drawn from that test bank. Test questions for the pretest/posttest exam were multiple choice and True/False questions based on best practices found in the literature. Brame evaluated multiple choice questions as an “effective and efficient way to assess learning outcomes” and that they are versatile, reliable and create validity (Alternatives, Thinking, & Resources, 2013). A 2019 study found that multiple true/false questions more closely matched the level of learning (Brassil & Couch, 2019). The participants on the retiree list were asked to assess the test questions within the pedagogy as a validation of the pre/post-assessment tool.

3.5.13 Administration of Pre-Assessment

The pretest exam was created from the bank of questions developed for the online training modules for Wade Utility Plant and contained fifty multiple choice and true/false questions. The pretest was designed into the online program as the first assignment available.

The facility has a variety of apprentices: new personnel with no utility plant background, intermediate background who have been working in the Milestone Program, former plant supervisors from another utility plant, and others with varying levels of technical knowledge such as a background in boiler work from the navy. They were all asked to take the pre-test to determine their knowledge before completing the intervention. The participants were not informed that it was to evaluate their base knowledge, simply that they were requested to take the pretest as the first assignment (Mckinley et al., 2020).

3.5.14 Administration of Intervention

Once participants completed the pretest, the next portion of online modules would begin and continue until either the participant did not pass an assessment at 80% or until the participant stopped. Each assessment allowed for four retakes to allow the participant to reach the 80% threshold or beyond if desired. The intent behind allowing multiple attempts to pass the assessments was due to desire for proficiency in the participant.

Plant participants were requested to facilitate the creation of the newly developed intervention materials in addition to completing said materials. The objective of the inclusion of plant workers in module creation with details specific to Wade Utility Plant was twofold. First, it provided commitment of the retiree participants to aid in developing the knowledge and skills of the other participants in their current and future positions at Wade. Secondly, it would in turn serve to avert any issue that could threaten life, cause damage to the equipment, or impact delivery of utilities to the campus.

3.5.15 Administration of Post-Assessment

Participants were exposed to the online modules to obtain competency. Once the intervention was completed, the module venue would sequence participants into the post-test, which was identical to the pre-test. Data was collected from the assessment in the same manner as was the pre-test (Mckinley et al., 2020).

3.5.16 Evaluation of Intervention

Evaluation of the intervention was conducted through module scores and through phone interviews according to Kirkpatrick's "Four Level Model of: Reaction, Learning, Behavior, and Results" (D. L. Kirkpatrick & Kirkpatrick, 2005). Reaction was whether the participants found the intervention beneficial and enjoyable. This was ascertained through interviews and emails after participation in the intervention. A survey was also available as an end module in the online training. The Learning portion of Kirkpatrick's Model was evaluated by whether the intervention was implemented on the job. This portion of the model was appraised through the module, participation and whether the posttest scores were measurably higher than the pretest. The Behavior section of the model indicated whether the participant applied the intervention and was measured by post training interviews. Result, which is the degree to which the targeted outcomes occurred, was somewhat outside the scope of this research, but was measured by evaluation of all data collected. Further analysis through case studies evaluated the efficacy of knowledge transfer through the intervention modules. These findings were documented and shared along with recommendations for future enhancements to the training materials.

How the project may move forward into the future was appended to this document. To gain this information in the research, all participants were given access to a final module that contained a basic five question survey. Informal conversations took place, and scores on module quizzes during the intervention were evaluated. The training evaluation was assessed through the number of times participants accessed the online platform and how well they did in the Modules. Results included a cumulation of all the above assessments, taking into consideration the time factor involved in completing the Modules.

3.6 Summary

Chapter three, research methodology, consisted of the study design including the research questions, population, analysis procedures, permissions, and procedures which included the interview structure, the interview participants, developing relationships through building trust, the interview setting, data transcription, transcript evaluation, data software evaluation, knowledge gap evaluation through individual questions and single subject research, determining gaps in the knowledge and needs assessment, development of intervention, development of assessment tools, administration of the pre-assessment, administration of the intervention, administration of the post-assessment and evaluation of the training. This concludes Chapter three.

CHAPTER 4. RESULTS

The purpose of this research was to explore methods to collect corporate knowledge from retiring proletarian workers at a small university utility plant, store that knowledge and transfer it to continuing and future workers. This study began as quasi-experimental mixed methods research and ended as a qualitative study.

The results section of this research study highlighted the actual events as the study progressed, discussing the process of how procurement and preservation of the long-term or soon to be retiring employee's unique knowledge was captured, stored, and transferred. Throughout the process of the study, information was obtained that was pertinent to the company, helpful to the study, but not always directly related to the purpose of this research. It was included in this results section as part of this research. The initial interviews both aided in building trust with Wade employees and determined gaps in the current training program. The resulting developed pedagogy provided motivation to retiring employees to participate in the process. It was then analyzed for effectiveness of content and completion time through a developed online pedagogy. This chapter details the results of this study.

4.1 Milestone Issues, Introduction and General Observations

This study was an introductory piece of the ongoing progression of collecting and preserving decades of Wade worker's knowledge and imparted new insights as important research in the ongoing study of knowledge management. The research served as the pilot process of a much larger project and aided that project in developing an optimal method to obtain knowledge from retiring workers with the complications of the generational gaps of work habits, loyalty, and technological ability.

This study design began as exploratory mixed methods research, and as in every exploratory study, information was exposed that shifted the course of the research. Some of these factors were; lack of trust, a primary management contact left their position at Wade, the current training program needed major revisions, a joint effort between researcher and participants was required to complete the training revisions, a disconnect between the educational field and the

Wade participants, and finally a world-wide pandemic that effectively shut down the University that Wade supplies. Each of these topics affected the results detailed in this chapter.

4.2 Initial Interviews

This research began with interviews of seventeen workers of the Wade Utility Plant. Following is the systematic process of how the interviews were set up and conducted.

4.2.1 Interview Structure

The researcher made an initial visit to Wade, spoke with management, and had a guided tour of the plant prior to developing the questionnaire utilized during the interviews. This presented a baseline for the challenges of the project. With a background of industrial facilities, instructional design and instruction both in the classroom and in craft arenas, the researcher began formulating the preliminary questions, presented this question set to the senior researcher, then revised to the list found in Appendix A.

The introductory questions were open-ended, but follow-up questions were more specific. Notes were taken as the interview progressed and used to verify the results of the transcript service. The participants were assured that they would be allowed to see the transcripts before they were released to management to remove anything that might cause problems for the participant, which also allowed them to speak more freely, as a part of building trust in the relationship. Each interview transcript was reviewed by the researcher and some of the random dialog was omitted, if it was deemed to be detrimental to either the employee or Wade. An example is when negative sobriquets were used for some Wade participants and were removed from the interview transcripts. Participants were also told that the intervention was beneficial for them, and that it was hoped that they would assist in helping create the training through videos they took, and active participation from them. Two body cameras were given to one employee and it was requested that if something unusual were to happen, that it could be videotaped. Also requested was that they think about anything that might be helpful in the research process and if they had any helpful information, the researcher was open to receiving it.

All participants who indicated they would retire within two years, and junior participants who would be moving into positions vacated by retirees were interviewed (see appendices D-T).

As stated previously, interviews began with open-ended questions, then progressed to specific questions. Since these participants were actively engaged in the program, it was critical to finding the knowledge gaps that would be left from the exiting workers. Both the researcher and the senior project manager were actively asking questions during the interviews, so that all aspects would be covered during the opportunity.

The introduction of the interview was designed to put the participant at ease, along with beginning a connection. The first three questions were to ascertain the identity of the interviewee, whether they were in the required list of retirees, and if they intended to retire. If the participant was in that demographic, all the following questions were asked. If the subject was not in that group, questions four through six were omitted and the list was continued at question seven.

Questions four through six were designed to help the participant think back through their tenure at Wade and think about what Wade had meant to them. It enabled the retiree to focus on Wade and their experiences within the plant instead of why the researcher might be asking a question. This in turn was designed to put the subject at ease.

Questions seven and eight helped the researcher establish what experience the participant might have had in the plant. Critical situations and how they are resolved become the best indicator of how competent a utility plant worker might be. Daily work in a utility plant mainly consists of mundane work; reviewing the shift change blog, making rounds, monitoring equipment, checking oil and pressure gauges, writing down equipment readings, and can be managed as a matter of habit, but a true crisis at Wade becomes the barometer of whether the employee's prior training has been effective or not. In any critical emergency, employees must understand what they are doing and why in order to resolve the problem in a timely fashion. The university depends on the abilities of a handful of shift workers.

Question nine addressed their attitudes toward the current training program, an important indicator of Wade employee's proficiency. If an employee views the current training program favorably, they would be more likely to complete some portion of that training each shift they worked, even if that was training someone else. It would indicate an acquiescence of the position and the responsibilities for that position. An unfavorable attitude toward the training program would indicate denunciation of the position and its responsibilities (Ahmad, Ahmad, & Ali Shah, 2010)

Throughout all questioning, active listening was employed to relax the subject and glean as much information as possible, which lead into question ten, where the researcher allowed the subject to speak of anything that was important to the them, whether it appeared to be off topic or not. This format proved to be highly insightful into each plant worker's experiences.

The initial interviews were set up at the utility plant by the senior project manager, using a setting that was the most comfortable for the subject, to foster trust and aid in gaining the critical gap knowledge. When interviewing management, the conference room or the supervisor's office was used, but while interviewing the shift supervisors and crew, the setting was on the plant floor either in a convenient office or the break room.

The timing of the interviews was according to the schedule of the interviewees, but specifically near the beginning of each shift, while the participant was reasonably rested and clear-headed. Since management was on a regular 40-hour week, they were interviewed as close to 8:00 AM as possible, while considering any other meetings or scheduling conflicts. The utility plant workers were on a twelve-hour shift schedule due to the number of individual working, so arrival at the plant was at 7:00 AM and 7:00 PM, with interviews conducted as soon as personnel were available. The interviewees attended the interview on their timeline.

No pressure by the researcher was used to obtain any interviews, although management did request cooperation. It was generally accepted that it was time off the floor within a relaxed atmosphere. It was noted, although not specifically stated in the taped interviews, that the participants were impressed that the researcher was willing to come at the odd hours and worked around the employee schedule instead of insisting on the reverse. This also aided in fostering an atmosphere of trust with the participants.

4.2.2 Trust development

Although Wade management initiated this study, it was critical for both Wade Management and management above Wade to be included in the process of this project. Toward that end, multiple meetings, email and phone calls were conducted by the project lead, along with monthly summaries of progress. What became apparent early in this study, was that the workers in the plant felt a distrust for outsiders, management, and those with a differing education level. Participant #39 mentioned a time in the past when management took away incentives for the Milestone Program and renamed it, then when that management individual left Wade, the incentives were

reinstated the way it was originally. Participant #41 noted that communication was a big problem between the workers and management, and that raises were sometimes held up, which created dissatisfaction in the workers. The workers would come to participant #41 and ask about the raise, then participant #41 would email management and not receive an answer. Participant #41 stated that three workers left when management stopped paying incentives and noted that when names of possible new hires with pertinent background were given, no action was taken until at least one had already found a new job. Participant #32 mentioned wanting more organization and structure yet had no clear solution for obtaining it. Participant #49 expressed frustration because although this worker was very experienced from a previous workplace, management decreed the participant must wait on seniority to move ahead at the plant. Participant #38 described creating extensive notes to benefit the fellow participants and management, but the corrections and notes were never incorporated into the current training program: the Milestone program. Participant #47 believed that management would change out tags on equipment to discover whether workers had the necessary critical knowledge of that machinery.

Thus, through years of unpleasant experiences with outsiders, other workers and management, the senior project manager's initial visits to the plant were met with disinterest and suspicion.

There was a marked difference between the day shift in the utility plant and the night shift, and it became essential to gain the trust of both shifts to have a successful conclusion. The day shift had more connection to management and most newly installed equipment happened on the day shift. Participant #40, who is on night shift, spoke of a critical event that happened during finals week in 2017, but only had a vague recollection of it taking three days to fix everything as #40 only helped in the beginning and was off shift for most of it. Participant #46, who is on day shift, mentioned the same incident but said the plant was only down for half an hour. Participant #41 noted that night shift doesn't have the opportunity to train on new equipment, stating that "day shift does that". The day shift then gained valuable information that the night shift missed.

Both shifts miss some critical information. Participant #47 believes that Purdue audits to decide whether to outsource power or not happen every four years, yet management clarified and said it happens annually.

The initial driving force behind the project was a member of management that left the plant for another position. This created uncertainty for the plant workers and for the project, as that

manager was championing this research project and was favored by participant #41. As these incidents were relayed to the plant workers by the project lead, it was apparent that trust would be an important part of this study.

The following efforts were made to connect and build trust. The researcher met for interviews at the beginning of each twelve-hour shift and conducted the interviews on the plant floor, which meant early morning hours and late-night hours. The day shift worked from 6:00 AM to 6:00 PM, and the night shift worked 6:00 PM to 6:00 AM. The project lead and researcher targeted conducting interviews at 8:00 AM and 8:00 PM. Due to four to five plant workers per shift and the length of time to adequately conduct each interview, the evening interviews easily lasted until after 10:00 PM.

The researcher also went on plant walks first with a member of management and then later a worker to gain an aspect of the plant through the lens of both management and a shift worker. Being willing to wear the personal protective equipment (PPE) and cautiously follow along with the worker was apparently noted, as another worker followed behind until satisfied that everything was fine at which time the worker wandered off. When interviewing participant #41, the plant walk was brought up to which participant #41 asked whether the researcher had worn the PPE. Similar backgrounds in the senior project lead and willingness to create a team atmosphere with the plant workers appeared to have an effect. Continuing to connect in emails, phone calls and through the intervention platform appeared to also build trust, as several workers spoke freely in the interviews. Some participants revealed information that was sensitive and afterwards noted that it shouldn't have been said. In each instance, the participant was reassured that the information would be either deleted or would be kept confidential.

Once interviews were completed and transcribed, they were reviewed, edited to remove sensitive information, and a copy given to both the interview subject and participant management. This was also designed to foster trust, by giving them the knowledge that the transcripts would be edited, then following through on the edit, and presenting the document showing it was completed as previously stated.

4.2.3 Interview Coding

The university utility plant preferred that participants remain anonymous and the initial interviews, so efforts were made to honor this request. The interviews are not included in this

document although pertinent pieces are quoted as they pertain to the study. In order to protect the privacy of the participants, each interviewee was given a code number for the purposes of the research write-up, in no specific order (see Table 4.1).

Table 4.1 Wade Retirees

No:	Name	Hire Year	Expected Retirement	Shift
1	Participant #42	1982	1 - 2 years	A
2	Participant #44	1986	1 - 2 years	B
3	Participant #40	1995	1 - 2 years	C
4	Participant #33	1997	1 - 2 years	A
5	Participant #30	1989	3 - 5 years	C
6	Participant #46	1996	3 - 5 years	D
7	Participant #35	1982	1 year	A
8	Participant #43	1982	3 years	A

4.3 Interview Analysis

Themes were analyzed through NVivo software to look for trends, and individually in order to thoroughly examine the data. Some of the patterns that evolved are as follows.

All participants agreed that the Milestone Program needs to be updated, and that learning the basics before proceeding is important regardless of experience level. Most of the participants agreed that testing out of a level is fine, but they need to be knowledgeable enough to be able to test out, regardless of the time spent at Wade. Learning each position was helpful instead of just jumping into an advanced level. Some with previous experience think they know the system, but each place has subtle intricacies and new hires need to learn the ones at Wade (even if they feel demoted) before moving on to more responsibilities or “higher” ranked positions.

Most agreed that labels on the equipment as well as diagrams for the location of equipment would aid in new training. Also deemed helpful would be a laminated checklist at the equipment

and having someone walk a new hire through the plant to answer questions and point things out. Some of the older employees with 30+ years of experience know the plant well and agree that when they had emergency situations like when they had to start the plant up from nothing that they were able to because of the experience they had working up through the positions. This is an area that new hires will struggle with since they are basically getting by on trial and error and whatever previous experience they had before Wade.

The simulation idea was positively received by many of the participants, especially those who were in the Navy who encountered similar simulations. Incentives basically center on money, although some were happy with having additional education through Purdue Global.

Overall, there is a lack of unity between the employees, which is not necessarily competitiveness, but they don't seem to be working as a team except for during emergencies, when a select group is chosen to fix the problem.

4.4 Transcripts

As soon as an interview was completed, it was uploaded to the transcript service and most of them were returned within a day of uploading. Once the transcripts were received, they were read through and verified by the researcher for accuracy. Personal information was removed, and Wade participants were given a copy of their interview to also check for accuracy, and so they could verify that we removed sensitive comments. The following is a summary of the content analysis by individual questions:

4.4.1 Question 1: How long have you worked at Wade.

Sixteen participants were interviewed and whose interviews were then transcribed and detailed in this research study. The researchers also interviewed as many workers as possible including trainees. The answers to this question ranged from six months for participant #50 to 37 years 9 months for participant #35. Table 4.2 lists the how long each participant has worked for Wade at the time this research study was conducted.

Table 4.2 Participant employment time interval with Wade Utility Plant

Participant Name	Wade Employment Time Span
Participant #50	6 months
Participant #32	4 years
Participant #45	5 years
Participant #39	12 years
Participant #47	15 years
Participant #38	18 years
Participant #33	23 years
Participant #46	23 years
Participant #40	24 years
Participant #41	29 years
Participant #30	30 years
Participant #44	32 years
Participant #48	34 years
Participant #42	37 years
Participant #43	37 years
Participant #35	37 years

4.4.2 Question 2: When do you anticipate retirement?

Participants were asked when they anticipate retiring from Wade and fourteen answers were given to this question ranging from a year to within the next five years. Some participants, such as participant #46 who has several health issues, does not plan on retiring anytime soon due to maintain the health insurance attached to their employment. As of the date of the interview, participant #46 had worked at Wade for 23 years and was a night shift supervisor. Participant #46 stated that they hope to be able to move to day shift with some of the retirements.

In the beginning of this research project, management had provided the senior project lead a list of future retirees which can be found in Table 4.3. The interviews indicated that participant #42 wanted to retire by June 2020, participant #44 plans to retire in three years, participant #40 is planning to retire by June 2021, participant #30 plans retirement in 2.5 years, and participant #33 did not divulge their plans. This retirement data reveals some disconnect between Wade management and its utility plant workers. Participant #43 plans on retiring within three years, and participant #39 in a year. Although neither of these participants are shift supervisors, still they are positions that will need to be filled. The list of participants who were not on the retirement list may be found in Appendix B.

Table 4.3 shows which participants said they will retire in the next few years and how many years they have worked at Wade as of this thesis. This table shows that many of the participants who have worked at the plant for more than 20 years, and approximately 4 participants with over 30 years of experience, plan to retire within the next 1-5 years. This indicates a large amount of corporate knowledge procured by these long-term Wade employees that will be inaccessible for the newer employees once these long-term employees leave Wade.

Table 4.3 Wade participants who plan to retire and years until planned retirement

Participant	Approximate Years to Retirement	Years Worked at Wade
Participant # 35	1 year	37 years
Participant #39	1 year	12 years
Participant \$33	1-2 years	23 years
Participant #40	1-2 years	24 years
Participant #42	1-2 years	37 years
Participant #44	1-2 years	32 years
Participant # 43	3 years	37 years
Participant #30	3-5 years	

4.4.3 Question 3: What is your current position?

Participants #44, #46, and #42 stated they were shift supervisors with varying levels of experience from five months to twenty years. All three are on the retiree list, although participant #46 does not plan on retiring. Another worker, #40, is qualified to be a shift supervisor, but there is no current opening for them to move into that position. Participant #40 stated that they occasionally fill in that position, when someone is on vacation. Participant #40 also plans on retiring in just over a year. Participant #47, who is at level eight for the Milestone Program could be qualified within a year to be a shift supervisor and potentially replace one of the retiring workers. All other participants were in varying levels of positions below the shift supervisor. Some were interested in moving up, but several were content at their current level.

4.4.4 Question 4: What is the most important position you have held at Wade?

Two responses were the same for both participants # 35 and # 43 as that of Operations Supervisor. Participant #48 thought that Chiller Operator was the most important position they had held and commented “I never considered when I tripped the chiller, what affect it had on the turbine operator or my shift supervisor, as they lose about 30,000 to 40,000 pounds of steam and it affects

your generator and your boilers”. Participant #33 stated that the position of Generator Operator was the most important position they held. Three participants, # 30, 41, and #40, thought Shift Supervisor was their most important position held, while participant #42 thought all positions were all important.

4.4.5 Question 5: How do you want Wade to continue after you retire?

Several participants, #35, #48, #43, and #40, were concerned about the plant and wanted it to continue after their retirement in the same fashion it currently is.

4.4.6 Question 6: What is your best advice for your position?

Participant #35 said to trust your supervisors and give them all the tools they need for the job. Participant #48 stated the best advice was to ask questions. Participant #43 commented that you should treat others the way you want to be treated, to answer all questions or get the answers, to work the shifts that are not covered to keep the information fresh, and finally, to listen to your fellow workers and understand the source of information. Participant #40 thought the best advice was to learn how to run the plant, but with scenarios because all plant processes are linked or intertwined, and the systems affect each other.

4.4.7 Question 7: Have you had any critical experiences and what should you do for them?

For the participants who have worked at Wade and experienced critical experiences, participant # 35 said they had undergone critical experiences and that one should trust their skills in such an event. Participant #44 said one should know your machines and put safety first. Participant #46 recalled when the utility company, Duke Energy had done something and knocked Wade offline and remembered being out of power for 30-minutes during the week of final exams. Participant #46 said they had faced critical experiences, but many years ago. and said that to deal with them is a whole team concept. Participant #46 also recalled an incident where water was back-fed into the 125-steam line and it was coming through a valve. Three workers used a chalkboard to deflect the water spraying out so they could get to the valve and isolate it. Participant #46 also remembers three personal incidents of being carried out in a stretcher. Participant #47 recollected an incident where a squirrel shorted out the power lines on the switch gear. Participant #47 and

another individual were outside, saw the flash, heard the crackle, ran back to the control room and the lights were out. That one issue led to another problem as a chain reaction.

Participant #43 recalled that when the whole plant goes down, they get called to come in to help get the plant back online. Sometimes participant #43 takes one boiler and another individual will take another boiler to bring them back up. Participant #43 remembered an incident on Dec 7th, 2014, when a new director was in and a contractor flipped a switch and shut down the whole plant. They brought it back online, but then the contractor flipped the same switch again. This time it took 24 hours to bring the plant back up and running. Participant #43 stated that squirrels cause more damage than anything else, but that Duke Energy has knocked Wade offline three times in 2019 through dated switching procedures, as Duke's policy is if something goes wrong, Wade gets knocked offline. Currently, Duke Energy must notify Wade two hours before Duke Energy switches out equipment. Participant #43 also recalled an incident where maintenance had just completed a work order on the number one generator, and it was working fine. The next day the generator tripped and none of the auxiliary pumps came on, with a result of over a million dollars damage to the generator, as the bearings were destroyed. Participant #43 recalled that the damages were covered by insurance as the paperwork was all in order and ready for the claim.

Participant #41 remembers several incidents; a squirrel in the substation that knocked the plant off, someone hitting a pole and knocking the power out, electrical workers switching out equipment and knocking Wade off(six to seven of these), and one incident when he was new where they rebuilt a turbine on boiler #2 and the ID fan and governor fell apart on it. It knocked the turbine off, and the other boilers were able to maintain power for a while, but then became overloaded and so they were tripped and off-line as well.

4.4.8 Question 8: What did you learn from the critical experience?

Participant #35 says they learned from these critical incidents that the plant workers are resilient as they developed a plan and then worked it. Participant #48 believes that teamwork really helps, that you need to pay attention to your basement person when they say there is a problem and not to just skip over it and that you need to go check it out and put safety first. Participant #47 thinks that there should be a detailed log of what happened and there should be a discussion later about it and that currently there are only basic facts in the current log. Participant #43 says that teamwork is critical, and that you should use the most experienced individuals to get everything

running again as quickly as possible. Participant #40 did not have any contributions due to not been there for any of it.

4.4.9 Question 9: What do you think of the Milestone Program?

Participant #35 mentioned that the Milestone Program should be streamlined to complete within four to five years and said that the original program was designed to support the training of an eighteen-year-old fresh out of high school. Participant #44 considered it to be a ten-year long process while participant # 43 thought it should take nine years but had completed it in five years. Participant #43 mentioned that there were several vacancies coming up when hired and perhaps were needed to progress quicker to fill in a vacancy.

Most workers, when asked what they thought of the Milestone Program, had similar thoughts on the content. Participant #45 stated it was a good program but needed a review and materials updated. Participant #46 likes the program, but noted that it has redundancies, specifically that level 4 has portions that they had already been signed off on in level 1. Participant #47 asserted that the first three levels are easier to progress through since the work on shift of pulling the ash out of Boiler 5 has been eliminated, even though it is still in Milestone level 1. Participant #38 says that the Milestone program is good as an early education tool, but that the final instruction should be on the job (OJT) training. Participant #30 agrees that the Milestone program needs to be fixed and has tried to submit changes., although they were never put in. Participant #42 also mentioned that it needs an update. Participant #49 felt that everything they had learned came from the Milestone Program but that it does have redundancies.

4.4.10 Question 10 Do you have anything else you'd like to add?

This question was designed to allow participants to bring up anything that wasn't specifically addressed by previous questions, and elicited several responses, from no I don't have anything else to add, to various responses that have been included within the case studies and discussion.

4.5 Single Subject Research: Case Studies

The following chosen in-depth case studies follow the single subject research methods to analyze the behavior of ten of the total seventeen participants used for this research study. Some of the participants were selected due to their imminent retirement, and years of experience. One had already retired, returned to substitute in for others to be able to take vacations, and then was subsequently rehired. Another participant was selected due to the level of engagement, both in the Milestone and the newly creature intervention. Each provides a closer evaluation of the knowledge gaps between retirees and newer employees.

4.5.1 Participant #35

Participant # 35 has the unique perspective of being the first individual to go through the Milestone Program. This was a critical interview from the standpoint that Participant #35 was the original subject to go through the Milestone Program. Participant #35's insight into the program were important, in that the creators of the Milestone Program wanted to take someone with no knowledge of how a Utility Plant operated, with only a high school education, and take them through the Milestone Program where at the end, they would be a shift supervisor, and become in charge of the whole plant. It was an ambitious plan, and it has consequently worked well for many years. However, over time, requirements for running a utility plant have increased, and in some places, the position of shift supervisor can only be run by someone with a Stationary Engineer's certificate. When asked to answer questions from the Stationary Engineer's exam, the few that completed it had trouble with the questions. This trouble may be due to these workers only understanding the mechanics of the plant and not the theory behind how this plant is run.

At the time that the program was being created, the plant was hiring a lot of 18 to 21-year-old workers and they wanted to time the program to coincide with a shift supervisor old enough that another employee would be willing to take orders from. Therefore, they reasoned that it should take seven to nine years to complete. Based on hindsight, Participant #35 thinks that the program could be streamlined to instead, four to six years, especially now that there is a need to bring in several new employees. The initial fear that someone would complete the program at the age of twenty-five, become a shift supervisor, and not have the needed authority never presented itself, but it was a concern at the time. Currently the plant is hiring in the age bracket of workers in their

thirties, that already have some experience with this unique workplace. Participant #35 is from a generation that accepted authority without question, but the current generation wants an explanation along with the direction. This discrepancy coincides with the training participants that completed some of the modules. Participant #33 wanted to know more about what they were doing in the intervention and was very engaged.

Also discovered in the interviews was that participant #35 is the only one that investigates plant inefficiencies. Over time #33 mentioned the inefficiencies could lead into bigger problems, so it is a valuable part of their job.

Participant #35 attempted participation in the created intervention program and logged into the online platform fourteen times and completed 23% or five of the twenty-three assignments. Embedded in an email dated March 19th, Participant #35 indicated that the plant participants would need some assistance in navigating the intervention program as #35 was struggling in navigation. Comments after a portion was completed were that it “was overall ok for a pretest” and also noted that the questions regarding order of operation to start boiler 5 were “not very useful” and they “didn’t think [they] could do any better if [they] had put on that boiler several times recently”. The researcher noted that the materials for that set of questions were from Wade’s plant data. Participant #35 emailed again on March 25th and indicated a problem with loading the table of contents from the training material. Later that same day, #35 emailed with a question on how the modules scored and worked. As engaged as #35 was, they did not complete the modules or take the posttest evaluation.

4.5.2 Participant #44

Participant #44 has been a shift supervisor for twenty years, has been with Wade for thirty-two years and plans on retiring in three years. Participant #44 has experienced a lot of crises during his time at Wade but notes that each emergency was unique and required a different solution. As summarized by Participant #44, the only way to prepare for a problem is to know your systems, know your equipment and experience the process with someone else guiding you along the way. Participant #44 noted how different supervisors will have different strategies in training, and #44’s preference would be a standardization across the board for all instruction. There was discussion on the Milestone Program, and how you could work through the program, increasing your pay, yet not moving into the shift supervisor position until someone left. Participant #44 commented that

recently three shift supervisors had left, one had passed away, one had quit, and one had retired. However, three workers had already been taught and were ready to move into position. As previously noted, the original plan for training the workers who became shift supervisors was well planned. All the workers hired were expected to go through the levels of the program, but they still had to wait for an opening to be able to move up. Sometimes the openings came quickly, and, in this case, three spots opened within a short period of time. The question is whether there will be enough workers to fill the spots when eight workers retire within a short period of time. The other issue mentioned here is that even though the crises that happened at Wade are all similar, in that they lose power, the differences are that each one is a little different. These differences are due to a complex system. There are multiple boilers, generators, chillers, condensate tanks, steam lines, and condensate lines. Added to that is Duke Energy, who provides back-up power for the plant when Wade is unable to provide all that is needed for Purdue. For such an intricate system, any one unit can have a problem and create a domino effect of more problems. As mentioned in the interview with #35, a loss of condensate water can reduce the efficiency of the whole system. Furthermore, in order to troubleshoot what has happened and what needs to happen, requires multiple years of experiences. Not all the participants are receiving the experiences that they need in order to fulfill the position that they will one day be asked to do: Shift Supervisor. This participant did not complete any portion of the intervention.

4.5.3 Participant #43

Participant #43 has also been at Wade for 37 years, worked their way through the Milestone Program in five years and has moved from Shift Supervisor into Operations Supervisor. Participant #43 mentioned several ideas in their two interviews and is very proud of the Milestone Program, and given how long they have worked at Wade, they were probably in one of the first groups to complete the program. Participant #43 stated that other Universities are interested in the Milestone Program, which is considered a great compliment. Participant #43 does not think that the other workers have the same passion that #43 has for their work; they are rarely absent from work. Participant #43 said that they are on call 24 hours a day, but #43 also mentioned in another interview that someone was concerned about hours, presumably how many hours #43 has been working. There are discrepancies in some of #43's statements, as it they mentioned coming in early to the plant in order to touch base with the night shift, yet others mention communication

problems with management, and that emails receive no response. A clear theme with all the participants is that the Milestone Program needs to be upgraded, yet #43 states that a consensus among the workers needs to be reached before changes are made. Participant #43 also says that listening to the workers is a big part of their job and that the workers just need to blow off steam, claiming that you need to treat the workers the way you want to be treated. Participant #43 says that they do not pass on the workers information, but just lets the workers vent. Participant #43 had told some of the workers to turn in portions of the Milestone Program even though the workers had not been able to complete critical parts of it, such as bringing a boiler online or shutting one down. Participant #43 also mentioned that when there is an emergency, #43 is called, then #43 will call in their most experienced worker(s) and work together as a team to take care of the emergency. While there is a lot of value in keeping skill sets active, with as many potential retirees coming up (Participant #43 included), it would be more beneficial for some of the less experienced employees to be able to experience the emergencies before they are moved into the shift manager position. The worst-case scenario would be for an inexperienced shift manager to have a true emergency and not have the skills to resolve it.

Participant #43 also seemed to want recognition for doing the job, perhaps for all of the workers, commenting that “no one on campus appreciates what workers at Wade do”, stating that when individuals on campus come in a room and flip a switch, they have lights but are unaware of the people and effort it took to produce that light. When #43 described an event emergency at the plant, the words did not come easily to describe it, but it was apparent that they had the knowledge of what was needed, commenting that it was a team effort, and that an individual would need to plan what they need to do and then do it, with each worker having their own part. Participant #43 is the one who directs the workers to write in the shift blog and use red ink for anything unusual, so it catches the attention of the next shift. Part of Participant #43’s job is also keeping records of maintenance and making sure the maintenance happens when required, which was critical when an expensive piece of machinery broke and the manufacturer had to repair it, due to the paperwork being in order. Participant #43 believes that training on different shifts has a lot of value for the workers even if they get a different scenario from each person. #43 expressed that their currently held position was terminal within the plant, with no more opportunity for advancement, and appeared to be a bit disappointed.

Overall, there were some important points made by #43. Listening to the workers without judgement, making a point to connect with the night shift, using the shift blog to keep track of event and using red ink for the critical portions, such as a piece of equipment taken offline, were all great attributes for the position #43 holds. The paperwork for machinery is an essential, money-saving part of the position as warranties saved Wade a large sum of money. This participant did not complete any portion of the intervention.

4.5.4 Participant #33

Participant #33 has completed all the Milestone Program and is ready to be a shift supervisor, but there are not any positions available. #33 planned to stay at Wade and took time to learn every position very well before moving to the next level. Participant #33 mentioned that the Milestone Program has not kept up with changes in the plant. This leads to the possibility that if the updates are a paperwork job, and that the person who is responsible for it does not enjoy the paperwork aspect. Participant #33, along with several of the other participants, misses the technical training that used to take place twice a year. Participant #33 remembers that it changed to once per year and now it only comprises of OSHA requirements. Participant #33 felt that they had learned a lot at those exercises and also suggested that it should be required for when a new piece of machinery comes in or there is a design change on existing machinery, that all the shift workers should be able to come in and see how to manage it, perhaps in a separate training event. Participant #33 states that the workers get upset when information is not shared or when someone jumps ahead of them in getting signed off on. Participant #33 hinted that it could be favoritism, and that it can also destroy morale. Participant #33 also mentioned that it would be nice if someone from the day shift could stay for a bit and talk to the night shift about what happened during the day, yet Participant #43 said that they tried to connect with both night and day shift. Participant #33 matched another worker when they were advancing through the Milestone Program with a kind of competition to keep moving, but in teaching others Participant #33 became discouraged when the other workers did not want to learn. If the workers are eager, the instruction is enjoyable, but when the workers are not, #33 became discouraged. Participant #33 would really like to sit down at a table with several others and work through the Milestone Program to correct it. This participant was the only worker to complete all the intervention modules. The only portions not completed were the survey and the pretest. The pretest was accidentally clicked into and was counted as the

only opportunity to complete it. When spoken to on the phone, they were only about halfway through the online intervention program but was engaged. Mention was made of enjoying the online learning game (see Appendices R and S). This participant is engaged and focused on doing the job the best way possible, taking seriously all parts of the position. This is the type of employee that will stay for their whole career and do a great job.

4.5.5 Participant #41

Participant #41, at the time of the interview, was retired but had been working part-time at Wade as a fill-in when a worker was on vacation. #41 had some important insights into several facets, one of which was communication. Participant #41 claimed to have told a managerial person that the communication was poor between management and plant workers and between the two shifts. #41 also pointed out that there had been some issues over workers not receiving their pay for achieving a level and it had caused a lot of problems with them, to the point that some had quit. Participant #41 felt that the Milestone Program is fine, if it is tracked so the workers know where they stand on it, and when they will receive their raise. More than once, a worker was told that they would get their raise, but then it was held up for the scheduled University raise. Another issue that was brought up was how a piece of machinery was retrofitted but the controls that were on the floor were not in the control room. As such, while they are short-handed on the shift, one worker must be out checking the panel on the floor. Participant #41 felt that the new hires are being rushed through too quickly, but since Wade has several retiring, this will become a problem. Participant #41 is in favor of the current hires, thinking they will do well at Wade and be able to progress more quickly. #41 had recommended workers with a power plant background, but nothing came of it. Participant #41 reiterates that experience is the most important factor in whether a worker will be able to manage a crisis at the plant. This participant has only worked at power or utility plants for their whole career, and states “it’s all I know”. While this participant had several complaints, most of it appeared to be venting, although some issues had merit. Certainly, the participant was in touch with the night shift and the disconnect to the day shift. Communication appeared to be a major issue brought up, which is important in any field, but more so in this type of work environment. This participant completed one event in the intervention for 5%.

4.5.6 Participant #42

Participant #42 came into the interview not wanting to be there, but by the end of the conversation, was glad to participate. The main issue was that they do not feel that the Milestone Program is the problem and that the real problem is that Wade needs to hire the right individuals. Participant #42 contributed some great insights into what type of person makes a good employee at Wade, specifically, one with some mechanical aptitude, a good work ethic, and a curiosity to learn. #42 mentioned that farmers were an excellent example of a person who would do well at the plant, because it does not matter how late a farmer was up the night before, they still get up the next day and do their chores. Participant #42 was very insistent that the basics of the Milestone Program were solid, and everyone needed to put in their time on those basics to be successful at Wade. #42 was very frustrated at the quality of some of the employees and that they seem like they do not want to progress, and felt like if there was a mentor that would take responsibility for motivating and making sure everyone was progressing in their goals of the Milestone Program, then there would not be so many leaving with so few to take over. Participant #42 was one of the participants that enjoyed learning about the plant and took pride in it but does not see that in some of the employees. #42 also stressed that the workers need to put in the time to understand each position and the plant itself, so that when something does go wrong, the worker will know where to go and what to do to fix it. They underlined that the aptitude described is more important than experience at another plant, as even if #42, at a retirement age, were to go work at another plant, the first year would still be learning the machinery and layout, as previous experience only goes so far. This participant did not complete any portion of the intervention.

4.5.7 Participant #30

Participant #30 has been at Wade for thirty years, with seventeen in the shift supervisor position and had multiple years of experience with restarting boilers. He had a good understanding of the plant, and the political issues of being connected to a land grant university, commenting that “it’s Purdue, right? So [a manager]’s got about 70 people on top of him that he has to convince too”. #30 felt training was an important part of the job, stating that commonly it was one-on-one, utilizing a chalk board to diagram not only the location of the machinery in relation to the plant functions, but also the machinery function. #30 would go out with a participant to the machinery

itself to discuss and describe and required the them to diagram piping within the plant. Participant #30 considers while training, that during an emergency, may have to rely on the participant to be able to complete a critical task, declaring that it scares #30 to death to have to rely on someone who's only worked at Wade for three months. #30 commented that a requirement during shift is to rotate workers on the positions, although none of the instruction is standardized. Participant #30 is interested in the job at Wade, commenting about learning something new every day, and remembers a time when upper management took notice of the importance of each employee at Wade, by name, and realized the importance of the plant for providing utilities for the University. #30 commented on discrepancies in the Milestone, where a participant would ask about a specific piece of equipment and say what do I need to know about this piece of machinery, and #30 must tell them that Wade no longer has that piece of equipment. #30 also commented on how Wade used to have two weeks of dedicated training weeks, one in the spring and one in the fall, and now it's a one-day event on OSHA requirements, so instruction must occur on shift. #30 stated that teaching on shift with five workers is easier than with four which is usually the number working a shift now. Participant #30 sees issues with the Milestone program, but in a different aspect, by noticing that the program is standardized and not all of the trainers are teaching in the same manner: some will place emphasis on a particular issue, while another may not, creating discrepancies in the education process. #30 has notes that are utilized for everyone and has passed the notes onto each of the participants. This is an individual that takes pride in a job well done, that has been completed to the best of their ability.

4.5.8 Participant #40

Participant #40 has worked for Wade for twenty-four years and plans to retire by June 2021. #40 was in the navy for eight years than two years at another utility plant, has completed the Milestone Program and currently holds the position of generator operator, although will do the shift supervisor shift if needed. #40 must wait for a current shift supervisor to retire before moving up but is content with the current position. When asked about critical events, #40 brought up an event from two years previously in December where the plant was completely shut down for four to five days, due to contractors, but later the story changed to the plant being down for three days. #40 had some confusion on how it was resolved whether there was finger-pointing and that it was the first day of a new managerial person, but also stated that #40 wasn't there for most of it. What

was clear, however that the principles for managing crisis was to “be on your toes” and know the systems. Also clear was new instruction on new equipment was non-existent except for handouts.

4.5.9 Participant #38

Participant #38 had been employed by Wade for 18 years and was working through the Milestone Program, currently a turbine-generator operator, and half-way through the shift supervisor level. #38 has several insights into the Milestone Program, such as that it was a good program, yet needed updated. #38 had extensive notes on what needed updated, along with updated steam lines sketches and was very willing to share them with us, so much so that #38 left the interview to go get them. Participant #38 seemed very interested in working at Wade and was engaged during the interview. Some of the insights revealed were: training was performed differently by each instructor and would be better to have a single coach for everyone, that everyone has personal preferences for what temperature to run the equipment, but would be better to have standards, that some supervisors will create a small emergency to see if the trainee is capable of resolving it, that #38 is particular about following a procedures list, yet will add helpful notes into it, and hand those to the learner, is okay with giving a copy of line drawings to help the employee to start yet requires them to complete their own, and that benefits are shrinking at the plant. Some suggestions that #38 had for new apprentices were to have operator manuals at the equipment, and to have at least five workers on a shift to facilitate training. Some recommendations from #38 for what qualifications to look for in a new hire had to do with motivation, such as just being willing to learn and ask questions, and some hands-on ability or aptitude would also be helpful, plus hiring a couple every year or two to avoid the large gap in hiring currently happening at Wade. Participant #38 was very helpful and concerned about making or keeping Wade a good place to work, as a previous job had regular layoffs.

4.5.10 Participant #46

Participant #46 had been at Wade for twenty-three years, had qualified for shift supervisor two years previously, but had only become a shift supervisor five months previously. #46 didn't have any plans to retire, as health reasons required health insurance. #46 mentioned that the Milestone Program was a good program, except when management had changed it to skills

inventory and didn't give the workers their incentivized pay raises, which caused two employees to leave. #46 didn't think it should be required for employees to have to train to level up through the Milestone program, but if someone wanted to learn it, it was available. #46 was concerned about how many employees Wade currently has as vacation time can be lost, and they were so short-handed, with several retiring, that it was a major concern, along with who would be preparing, since it wasn't feasible if there were too few employees on shift. The final thought was that most of the time, the job is easy, and anyone could do it, but if retirees leave before more are hired and well taught, there will be very inexperienced people trying to handle real emergencies. #46 has concerns that most of the employees had, the future of Wade Utility Plant.

These case studies highlight the gaps between the experience of employees that are retiring and the newer employees that will be moving into their positions when they retire. While some of this information can be addressed by management, some of it will be incorporated into an online training program.

4.6 Emergent Themes

As the transcripts were analyzed a variety of themes emerged. These themes included: the variability of evaluation criteria within milestones and upon completion of milestone requirements, teaching availability and completion including hands-on training due to shift assignment, lack of updated education materials, variability of instruction depending upon assigned supervisor and shift, and finally, regular updated training days migrated from technical and equipment-based training to only OSHA.

4.7 Knowledge Gaps

As the interviews progressed, clear knowledge gaps between the retiree group of participants knowledge and the rest of the plant workers became evident. These included redundancies and gaps in the Milestone Program, missing plant labeling of pipes, valves, and equipment, inconsistent training, problems in communication, and the lack of a dedicated instructor. A further gap was discerned in that all utility workers were lacking in the theoretical knowledge required to pass a stationary engineer's exam.

4.8 Online Intervention Data

The online intervention was made available to all the Utility crew members at Wade and a couple of future management retirees that were interviewed for gap knowledge during the University spring break week. It was understood at the beginning of this pilot that all participants would be able to work on the online intervention both on shift and outside of work, so efforts were made to have it available through a log-in system that was being piloted by the University.

Prior to the beginning of the trial, a non-participant was asked to preview the intervention for issues. This individual did so and reported their findings. Corrections were made to the online intervention platform, then the intervention was made available for the rest of the interviewed participants. The platform was available to the participants through the end of March, but part-way through the trial, a pandemic was declared.

4.8.1 Worldwide Pandemic

On January 20th, 2020, a man returned to the U.S. from Wuhan China and brought Covid - 19, a severe acute respiratory syndrome coronavirus 2 with him. The first death in the U.S. was on February 29th, although since then earlier deaths have been attributed to the virus. By the end of March, all fifty states had cases of the virus. By mid-March, most school were closed, including the researcher's university. A state of emergency was declared in all fifty states on April 11th. Due to the pandemic, the researcher was unable to return to Wade to conduct closing interviews, although there was contact made through email and telephone.

Partway through the intervention portion of the study, the researcher lifted the restrictions of 80% evaluation rate that was required to progress to the next module, in order to glean more information from the intervention data. While participant #35 did complete five of the assignments, no one else engaged any more in the intervention. Participant #35 suggested in a phone interview that more information should be provided to engage the workers in the online modules. Of the nineteen participants that were invited to be a part of the online intervention, only six participated. Of those five, only one completed the program, but missed the pre-test and the survey at the end of the course.

The resulting data is detailed in Table 4. Since the participation in the intervention was low, there was not enough data to perform any quantitative analysis, so the initial exploratory mixed methods study became a qualitative study with a single subject research emphasis.

Table 4.4 Wade Cumulative Data

Day/Date	Code	Logins	#Assignments Completed
3/23/2020	30	1	1/21 - 5%
3/23/2020	31	1	1/21 – 5%
3/23/2020	32	3	3/21 – 14%
3/23/2020	33	6	22/22
3/23/2020	34	1	
3/23/2020	35	14	5/23 – 23%
3/23/2020	36	2	22/22
3/23/2020	37	12	
3/23/2020	38	2	
3/23/2020	39	0	
3/23/2020	40	1	
3/23/2020	41	3	1/21 – 5%
3/23/2020	42	0	
3/23/2020	43	0	
3/23/2020	44	0	
3/23/2020	45	0	
3/23/2020	46	0	
3/23/2020	47	0	
3/23/2020	48	0	
3/23/2020	49		
3/23/2020	50		

4.9 Summary

Chapter 4 contains the results from this study beginning with Milestone issues, introduction and general observations, the initial interviews including interview structure, trust development, and interview coding, interview analysis, transcripts with questions 1-10, single subject research: case studies including participants #45, #44, #43, #33, #41, #42, #30, #38, and #46, emergent themes, knowledge gaps, and online intervention data including the worldwide pandemic. This concludes Chapter 4.

CHAPTER 5. DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Discussion

Wade management realized that they would have eight retirees within five years but not enough replacement shift supervisors to replace those leaving. The Milestone program required nine years to bring a high school graduate to the position of shift supervisor. As this research project unfolded as an experimental mixed methods study on knowledge management, several results became clear, while other issues surfaced. What follows is a discussion on the findings from this pilot study, how this study fits into the literature, future research for this topic, recommendations for Wade Utility Plant management, and the economic impact of Knowledge Management for this study.

5.1.1 Milestone Program

The Milestone program was the most important training document in the plant. It consisted of nine levels and was designed to prepare an initial hire with a high school diploma all the way to a shift supervisor within nine years, although they could progress faster if desired. Employees gained a pay raise for every level completed, to give incentive to complete the levels. Ideally, the employees would progress through the levels and take the place of those retiring through a seniority ranking system.

According to the initial interviews, there were a few problems with the Milestone Program. Participant #39 stated, when referring to the Milestone Program “it’s a good program but messed up”. One problem indicated by plant workers was that plant updates were not reflected in the OJT training. This included machinery changes, piping changes, and procedures that were no longer necessary. As an example, when the Milestone program was created, the first position as basement person required the worker to shovel ash out of the coal boiler in the basement. At the time of the study, with upgrades to the boiler system, that task was no longer necessary, yet it remained as a step that must be completed within the Milestone Program. The interviewees also indicated that as a new piece of machinery was brought into the plant, either to replace an existing piece or in addition to existing machinery, it was rarely updated within the Milestone Program. Some of the

participants had made updates as they progressed through the program and gave the changes to the foreman. As there was time, those changes were inserted into the Milestone. However, as often happens when multiple people give information over time to change documents, some mistakes were made, and there were inconsistencies. While the Milestone Program began as an excellent education tool, and was still a good tool, a uniform overhaul was a recommendation for the plant and mentioned by several workers during the interviews. The program was a solid basis for education and a valuable document but was outdated. Multiple changes in equipment, steam lines and patchy updates all contributed to the state of the training program.

Another problem in the Milestone program was the time frame to progress through all nine levels of the Milestone. While it was projected to require nine years for a person with a high school diploma to advance through the complete program and be a shift supervisor, management was very concerned that with multiple shift supervisors retiring, no one was close enough to completing the program to replace those retired workers. The issue was being addressed on multiple fronts, and this project was one of the avenues to rectify the concern. Coinciding with this, they had hired and were actively looking for new individuals to hire that have some utility plant or boiler skills, such as a supervisor from another plant, or a navy background that had experience with boilers in a different capacity. For a time, Wade was utilizing a retired shift supervisor who was on call to allow employees to utilize vacation time or sick leave. This individual was since been rehired, also alleviating the issue somewhat.

5.1.2 Labeling

Some of the research participants noted the lack of labeling in the plant, specifically piping, valves and other equipment. #45 stated that they had just gone through and labeled all the boiler valves, but not the valve spreaders. #45 also mentioned that equipment doesn't come to the plant labeled, but instead must be labeled afterwards. #46 noted that labeling is necessary, that there used to be a couple of people that did just valves: labeling them, fixing them, and working them, but that was many years ago. #46 didn't care for the cheap plastic labels but thinks that it's helpful to learn when there are labels, and that the names of the valves are not as helpful, but numbering makes it easier to do the checklists. #38 commented that labeling was fine, but true learning takes place by walking the plant and learning everything about the equipment, specifically by drawing the lines and how the equipment runs., except that there isn't as much time to train the replacement

workers the right way. #41 stated that labeling had been tried several times, that valve labeling would be an important part, but that the steam lines should be walked by the workers to memorize and draw where they go so, they don't forget. #32 stated that labeling valves would help newer employees. #49 noted that Wade has a lot more labeling in the plant than a plant where #49 was previously employed.

5.1.3 Communications

Communication problems were only directly addressed during one interview, but indirectly multiple workers intimated that communication was a problem. Some mentioned that they would fix the milestone issues, but it was noted that the documents were then deleted as an extra file. Some would submit documentation for improvements and corrections but never saw the changes implemented. While some night crew members mentioned enjoying the quiet, they also felt left out of daytime teaching opportunities. Multiple workers revealed missed opportunities to learn during emergencies because they were never called in to assist. Some cited emails that went unanswered. Multiple workers mentioned the uncertainty of what the future held at Wade and feelings of disconnect to management.

Within the parameters of communication, a common theme that emerged from the interviews on the Milestone program was that those who sign off on the segments are variable in criteria. Participant #44 stated that the shift supervisors that sign off on the sections were inconsistent, and the preference would be to have it standardized. Participant #47 had a similar comment in that signing off should be standardized as currently it varies from person to person. Participant #38 mentioned needing to fire up or shut down a boiler as part of training progression, didn't have any opportunity to do so, but the supervisor told the participant to turn it in anyway. These comments indicate a communication issue on standardization of requirements for instruction.

Good communication is critical in any work environment, and especially so in a highly dangerous environment, in such a small workforce where employees must be able to work in teams to successfully carry out their work duties.

5.1.3.1 Shift Change Blog

A few participants mentioned a blog that they were encouraged to maintain while on shift that detailed what took place during shift, whether nothing unusual happened or a major problem occurred. Some did this on computer, and some wrote hand notes. Some workers put significant detail and insight into the notes for the future shift, such as Participants #30 and #38 but others made very minimal notations. The participants volunteered some of this information, and it included missing updates to the Milestone Program, and drawings of the steam pipelines and condensate lines within Wade. These were all requirements for the Milestone program completion, and it was noted that the drawings showed changes in piping that were also not corrected within the Milestone program. There was important information, but it appeared that it was not utilized, nor was it streamlined in the amount of detail included.

5.1.3.2 Fall and Spring Training Opportunities

Participant # 44 spoke about classes that were held in previous years, recalling one winter where they put on and took off a feedwater pump. #44 stated that there were usually two trainings- one in early spring and one in late fall. No one could take vacation during these times, and there were two because someone had to cover a shift while the others were instructed. Over time #44 stated that the classes dwindled to once per year, and now mainly covers OSHA and bloodborne pathogens, but that no technical or equipment education happens anymore. #44 commented on the chillers, stating that if there were a problem with them, someone else would have to handle it as #44 wouldn't have a clue. Participant #46 commented that the training has been bloodborne pathogens and title 5 for 23 years, when it used to be four 8-hour days, and now it's one day.

5.1.4 Dedicated Trainer

Multiple participants noted during the interviews that the plant, at one time, had a dedicated trainer that would sign off on all the Milestone steps, which according to the participants, created a uniformity within the education process and the plant workers, as every employee had to step through the program in the same way. #46 noted that it would be good to have a training coordinator but didn't think there would be money to hire one. Participant #41 mentioned an extra crew that would do operations one day per week, then the other four days would help for coaching

purposes, but that one of them died and the others were absorbed into maintenance. Participant #33 mentioned a shift trainer coordinator and said it's nice to have someone show all the same thing. #42 said that there's nothing wrong with the Milestone Program, but it needs a champion.

5.1.5 Theoretical Knowledge

A final knowledge gap was discerned during the interviews of theoretical knowledge. The position of shift supervisor indicates a level of education that would allow the employee to pass a stationary engineer's exam. Some states have this requirement before the employee can hold the position of shift supervisor, yet Wade employees gain little to no theoretical knowledge from their OJT education. The theoretical material is available for the employees within the control room, and some parts of the Milestone address theory, yet there are no requirements to pass the stationary engineer's exam. Wade has benefited from not having to certify their shift supervisors, as the hourly pay would most likely have to be increased if the employee had the certification. Indiana hasn't required this of all utility plant shift supervisors as of this document yet could do so in the future. There have been few problems from this aspect so far, yet state requirements may increase, and it would be wise for Wade to begin addressing this issue while the Milestone is being renovated.

5.2 Training Availability and Completion.

The education process itself appears to be problematic. Participant #44 mentioned having no idea how to run the current chillers as they never had education for them, yet participant #44 has been a shift supervisor for twenty years. Participant #45 prefers more detailed preparation and notes that some shift supervisors just do the minimum. Participant # 43 commented that the swing shift was best for tutoring, back when they had three 8-hour shifts as opposed to the current two 12-hour shifts. Participant #38 thinks they need direction on the new equipment, mentioning also that when training, the supervisor gives them a copy of the notes compiled on various aspects to aid them in learning the equipment. Participants that don't school under participant #38 would not have access to these notes unless they ask, as they wouldn't be in the main files. Participant #30, who is on the day shift, mentioned trying to teach on shift with only four workers, which is not enough. Participant #41 finds it difficult to instruct on shift anymore, commenting that when they have five or six workers on a shift, it was easier to do the work required per shift and teach

someone, but when they only have four on a shift, it's difficult to get any training completed. Participant #41 commented that recently one of the Boilers was reworked and has separate controls out on the plant floor instead of in the Control Room, so now when that boiler is in use, a worker needs to check those controls and that reduces the number of available personnel in the control room, making the shift even more short-handed and leaving education non-existent. At one point, participant #41 notes, there was an extra crew available to give a hand, but over time, that crew has shifted to other jobs, or been added into the regular shifts instead of hiring a new employee.

Along with the program itself were booklets and DVD's which were in effect short courses on various aspects of a utility plant such as boilers, condensate and steam lines. Each employee who obtained shift supervisor had access to this information and was required to complete the material. While most of the information in the short courses were still accurate, the written material and videos were very outdated. The decision was made, with approval from management, to completely redo the whole program and digitize it, due to the age of the program and the availability of a new learning platform that would be available to the workers both on the job and outside of work.

5.2.1 Research Questions

This study focused on the following research questions regarding knowledge capture for proletarian workers in a university utility plant. It was discovered through the course of the research that utility plants and proletarian workers are both under-represented in literature, thus expanding the realm of knowledge management.

Capture, preservation and dissemination of corporate knowledge:

1. What methods of knowledge collection are effective with proletarian workers nearing retirement in a utility plant?
2. What methods of knowledge preservation and transference are effective for proletarian workers in a utility plant?

Secondary to the primary research questions was the following subsequent question:

1. What method will engage proletarian workers in the knowledge capture and transference process?

This study approached knowledge capture, preservation and transfer from the retiring workers through a process of gaining trust, developing a relationship and interviews, which worked well in gaining the cooperation of the participants. As the relationship was built, retirees were more forthcoming with information that would help Wade continue to provide critical services.

This study also found that the motivation factor of these participants played a role in how well they participated in the knowledge capture, preservation and transfer as most were looking forward to retirement. Some of the participants were motivated by wanting Wade to continue as it had in the past and continue to serve the university well. It was noted that the retiring workers didn't respond well to the online training pedagogy as reflected in the logins to the system. Including the retirees in developing the training videos did appear to be a motivator, as some took pride in how well they trained which could be demonstrated in the videos. The videos could also serve as a legacy after retirement. Transferring knowledge appeared to be happening every shift. Some transference into written form such as the Milestone program itself was problematic as there was resistance to updating it, but blogs were a continuing database for those that would access it. The new online pedagogy was a better fit for the younger, newer workers and it was noted in the literature that knowledge must be in an acceptable form for knowledge transfer to happen (Facione, 2016). It should probably be a process over time to shift from the written Milestone to the online pedagogy, so that both formats are available until the new form is universally accepted.

This study is documented and was available for Wade management and employees, including the identified gap areas. Several methods for evaluating effectiveness may be considered such as utilizing a group consensus method to combine multiple opinions to reach a strategic answer that would benefit the group. This group consensus method may help to find gaps in the intervention modules to ascertain what and how the information should include and be presented for maximum learning. One of the participants suggested a round-table style of cooperation to update the Milestone Program in order to fill the need for a faster method to instruct the employees. This indicates a willingness for participants to assist in the intervention creation.

5.2.2 Knowledge Management for a Small to Medium Utility Plant

The results of this research study provided a preliminary look into how KM may be used for a small to medium utility plant facility. The review of literature yielded few articles on how

KM is used for power plants outside of nuclear facilities. Therefore, the results of this study are innovative for this overlooked subset of the power industry.

The Milestone program is the current Wade Training Program with nine levels designed for their employees to complete over nine years culminating in becoming a shift supervisor. This was a complete program developed in-house twenty years prior and designed to teach a person with no experience and a high school diploma from no knowledge of a utility plant to becoming a shift supervisor. Each of the nine levels had to be verified by an employee who had completed level seven or higher and each level accomplished earned the employee a raise in pay. It was generally understood and expected for each worker to progress through one level per year, although they could progress faster. Some, as previously noted, stopped progressing. The originators reasoned that someone in a shift supervisor position would need to be at least twenty-five years old to be able to run a shift, so they set up the Milestone to take nine years to complete nine levels. Over time, this was misrepresented or changed, perhaps when the participant did not have a need to replace many workers, as this question elicited varying responses on the time frame to complete all nine levels.

Upon perusal of the information, duplicate areas and redundancies were apparent. Most of the information was reliable, but it needed updating as there was equipment that was no longer in the plant, and some jobs that were no longer completed. There were updates to machinery that had not been changed or updated in the Milestone Program. Workers had submitted updates to the Milestone Program, but updates were not always documented.

Overall, participants felt the Milestone Program needed to be updated to reflect current equipment and locations within Wade. Additionally, much of the information presented was redundant and needed to be streamlined and simplified. The simplification is especially important for new hires who may have limited experience working in a power plant setting. The participants who had experienced a critical event believe that knowing the ins and outs of the plant help greatly when trying to figure out what the problem is and how to go about fixing the problem. Furthermore, for new employees, the participants recommend understanding the basics of the plant and work their way through the plant Milestone program so that when an eventual crisis occurs they can immediately start to solve the problem based on their knowledge of the plant without having to waste time looking up information. Constant practice appears to be critical in preparation for these emergency situations.

Some possibilities are available for replacement shift supervisors. One is an already retired worker with a former position as a shift supervisor, who was subbing in when needed, and has since been rehired, but has given no indication as to how long they plan on continuing to work. The plant seniority rules are in flex as recent hires are individual with military backgrounds, specifically from the Navy with some background in boilers.

Management has shared the plan that they will take less time to progress through the Milestone than previous workers. An important note to this point was that some individuals chose not to progress through the Milestone when pay raises were withheld as previously noted. Participant #39 specifically mentioned that they just did not want to learn anymore, and management should not require participant #39 to do so. This observation may be more widespread than one employee as participant #46 stated that an individual cannot be forced to move through the Milestone levels if they do not want to, implying that individuals felt the same way as participant #39.

The next possible shift supervisor is a worker who worked for twenty-two years at another utility plant that closed and had been at Wade for a year. With extensive experience as a shift supervisor from the previous position, this individual could potentially step up sooner than those who have been at the plant longer. However, there are unspoken (and sometimes spoken) barriers to promotion, except through plant seniority that require the individual to not jump ahead of other workers. While it is understood that every utility plant is distinctive with potentially unique machinery and procedures, and therefore instructing within the Wade plant is important, regardless of experience at other plants, seniority rules should be flexible enough to allow an individual with the requisite experience to be able to step into the retirees position even if seniority dictates that they have to wait.

At the time of this study, anyone at level seven or above can sign off on participants for lower levels, and shift supervisors can sign off on any apprentice's progression through the Milestone program. The participants were not clear on how long it had been since there was a dedicated Trainer, but those that mentioned the issue were clear that not every shift supervisor had the same standards to pass a level. Some were apparently more rigorous in their requirements. One participant mentioned that participants would find out who was the easiest to get a signature from and chose to go to them to get through the levels more quickly. As such, it was not clear whether upper management was aware of this practice, nor whether it had an impact on the capability of

the participants. Although the Milestone was designed to be sequential in progression, it was noted that some participants had signatures in three different levels of the Milestone at one time, due to the unavailability of some of the requirements, such as taking a boiler offline or putting one of the boilers online.

Within the aspect of the current Milestone program, many of the younger participants had never experienced key procedures in the plant. As an example, Boiler 5 is a coal-fed boiler, meaning that the fuel to create the steam which then runs the turbine and creates electricity. It is a crucial boiler at the plant, typically the first boiler to bring online and the last to go out due to the nature of the fuel, yet many of the shift workers had never been involved in either starting it up or shutting it down. Further, due to the infrequency of emergencies at the plant, many had never experienced one, where perhaps power was shut off due to a squirrel on one of the power lines, or Duke Energy shutting off power, both of which the more experienced operators have dealt with. The participants with less seniority were either off shift during the emergency, or they were not called in to help. Certainly, during an emergency at the plant, there would be little time to call in a participant to experience it. Most plant supervisors would want experienced personnel to help bring the plant back online. Customarily the incident would be written up for others to read through, but it did not appear to be mandatory to do so. Therefore, at this point in the plant, the operators experienced in dealing with emergencies are retiring, while the junior participants taking over won't have enough experience to deal with any emergencies.

Another discrepancy that was noted was the difference between the day crew and the night crew. Day shift received more managerial attention, which some workers appreciated more than others. As far as instruction was concerned, the day shift was on hand whenever new machinery was brought in or upgrades were made to equipment, as these typically happened during the day. Night shift would receive documentation on the changes but did not have the opportunity to see it or be able to ask questions. It puts the night shift at a distinct disadvantage. An odd disadvantage of the night shift is squirrels. Squirrels are daytime creatures, and cause problems for Wade. They will jump on the power lines, get electrocuted and knock Wade power off, which creates a domino effect within the plant culminating in the boilers being knocked offline. Since these emergencies happen during the daytime and happen often enough to be brought up multiple times during the interviews, night shift again misses out on critical educational opportunities. Certainly, there are advantages to being on the night shift, as it does seem that most crises happen during the day, and

management is around more during the day, but only one emergency happening at night with an inexperienced crew could spell disaster for Wade.

Participants at one time experienced a week-long education event twice per year. During this instructional event, new equipment was introduced, emergency situations were addressed and discussed, and participants from both shifts were given proper instruction in needed areas. This practice slowly dwindled to one week per year, then the week was pared down to three days, until the current practice, where the only instruction is a one-day event to go over OSHA requirements and blood-borne pathogens. While these are important parts of current facility program, they are not helpful to a participant who has not experienced a boiler emergency. This approach does satisfy managerial continuing education requirements and currently there are enough experienced operators to manage emergencies. However, as they begin retiring, those numbers of experienced operators will decline and at some point in the next two to three years, no one will be left at the plant who will be able to complete the very necessary tasks of bringing new equipment up, starting up and shutting down boilers.

An analogy is in learning CPR. One may never need to use it, because emergencies that require it are so infrequent, but if the emergency happens, you must be able to perform CPR with no hesitation as time is critical. Similarly, at the Utility Plant, if an emergency occurs, all shift workers must be well trained enough to respond quickly. Potentially, if they are inadequately educated or respond slowly, it could mean a longer outage, loss of expensive equipment, or even loss of life. The University needs consistent power: for classes, experiments, refrigeration, air conditioning, heat, and a multitude of other necessary functions. Three participants recalled a time when the power was down for over two hours during finals week. It was a critical time for a University. If the workers at the plant were not so skilled at fixing the problem, the outage could have lasted two days. While a dedicated trainer may not be the solution for all these issues, such a person could coordinate education and verify that enough seasoned employees are available for any such emergency.

Labeling is another crucial gap between the retirees and newer employees and was a repeated issue that came up during the interviews. Some labeling was indicated to be a requirement through a regulatory body, such as labeling the piping as steam, condensate, or fuel, indicated by OSHA's standard, which is: 29 CFR 1910.261 (a)(3)(ii), stating *Scheme for the Identification of Piping Systems, A13.1 – 1956*. This indicates that OSHA defers to ANSI Standards, which gives

a color scheme for pipes, depending on what it contains. What labeling and or paint that was in place is faded and needs upgraded, for either safety or schooling purposes. This creates a safety hazard in the plant as it can cause irreparable damage to machinery in a utility plant and injury or loss of life. Minor mistakes can easily be made due to mislabeling or no labeling, which is why it is such a critical issue.

Valves and gauges in the plant should be labeled as well, especially when the plant is expecting an influx of new participants as the retirees leave. Few are currently labeled, and it will make it difficult if not impossible for new hires to progress through the Milestone within the time frame needed now to replace retiring workers. All valves and gauges within the plant should be labeled to accelerate the instruction progression and improve safety within the plant. It was noted that some seasoned participants considered it a good instructional tool to leave the labeling off or even to switch labels to test the participants, but it was noted that these practices could be a safety issue, and considering that several seasoned participants would be retiring, the plant would be better served to label correctly for the newer participants.

A teaching opportunity that used to resolve some of the previous problems was a fall and spring week-long education program for the plant workers. It gave them a chance to see any updates in equipment and be able to have intensive instruction in areas that were lacking. Over time, it went to one week-long session then a few days until, at the time of this study, it was one day, covering OSHA requirements. Participant #44 wants the hands-on winter training back, which used to be two times; fall and spring. Participant #46 said that schooling used to be four 8-hour days and now it's one for bloodborne pathogens and Title 5. Participant #38 says the individuals need guidance on new equipment and brush-up or continuing education. Participant #30 brought up how they used to have two week's instruction: one week in the fall and one week in the spring with the operations supervisor to go over equipment and make sure that the workers were up to speed, but now they have to get the OSHA requirements in.

As of this study, all education was taking place on shift with sometimes only four workers. Participant #30 commented on teaching new hires just to where they were a good crew, then they get moved to another shift and they start over. Participant #30 includes personal notes that aren't in the Milestone Program but are important, and misses the plant training, the technical training, and said "now it's just OSHA". Participant #33 wants to have a roundtable discussion on how to revamp the program. Participant #49 wants the policy of how they are called in on emergencies

changed so that “anyone can come in and participate in a schooling opportunity plant-wide, and no one is pointed out”. The consensus of the interviewed retiring participants was that there is value in having plant-wide teaching opportunities.

Several plant workers mentioned wanting a dedicated trainer, like they had at one time in the plant. They felt it would solve a lot of the problems that they were experiencing and be helpful to move workers through the program and replace the retirees more efficiently. Participant #42 felt they have lost the accountability for the plant and the Milestone Program and wants the dedicated trainer. Participant #42’s statement was “We have the program here. We just have to put an engaged, competent person to be the champion of this program”. Participant #41 also mentioned wanting a full-time trainer and Participant #38 stated a preference for a single trainer. Participant #46 wanted a dedicated trainer and said that management first required two signature per month but any more is not strictly enforced. The tone from the participants was that the Milestone Program was a good program, but that over time and with various management changeovers, it has deteriorated. There was some effort to retain the quality education program as much as possible through updates, time permitting, which showed a commitment to continuity for the plant workers. This concern for continuity within the plant, both between shifts, and between management and the shifts, was also apparent through the shift change blog.

5.2.3 Demographics Impact

Furthermore, this study also showed how the educational and occupation of a participant can impact how KM should be presented to an individual. During the research, it was apparent that the Wade Plant workers were concerned about the plant, their positions at the plant and the future of their jobs, through how they were constantly either in training or training someone in a lower level. It was evident when the researcher was in the plant, as they were aware and diligent in their observations. They were also concerned with how they were educated and wanted to be involved within the process. Since each utility plant is unique, the decision was made to include the participants in the intervention creation. Body cameras, much like police officers use, were given to the participants to create videos of how they did their jobs. Once they understood how they carried themselves affected the video quality, they created some informative video clips that were in turn incorporated into the online intervention. They were able to show someone how a job within the plant was carried out, and in turn, that video could be watched as many times as the participants

needed to learn the procedure. The inclusion of this demographic proved to be an excellent method to gather crucial data from the retirees.

5.2.4 Dissonance with Educational Field

The results of this research study revealed many insights into utilizing KM for a small power plant, one of which was that the participants used for this research study had difficulty navigating the online intervention platforms. As mentioned in the literature review, some individuals had trouble navigating certain technology platforms used for KM systems.

The results found that the intervention modules material and navigation often eluded the participants of this study and prevented them from successful completion of the modules. The question material was taken from a state exam for Stationary Engineers and is primarily of a theoretical nature. By contrast participants used for this research study often employ a hands-on approach for their jobs and as such the theoretical nature of the questions may not have aligned with the hands-on visual knowledge the participants do possess. This discrepancy does not necessarily mean the participants do not know the material required for their jobs but that the theoretical representation of that same material does not transfer to the hands-on approach they employ daily for their jobs.

Furthermore, the participants effectively perform the position of a Stationary Engineer, where individuals would be required to pass a written exam before working and possessing the title. However, the questions taken from the same exam material eluded the participants of this study. This observation poses the question of whether the participants forgot certain knowledge material over the years or learned the material through a different medium? The participants used for this study primarily learn and conduct their jobs through hands-on implementation. Therefore, theoretical knowledge is not as useful in lieu of actual visual hands-on knowledge obtained through their daily work. As such, the module questions posed to the participants were mainly of a theoretical nature and as a result did not equate to the same hands-on knowledge the participants possess. The value of the single subject research provided an in-depth glimpse as evidenced in the case studies that few workers were engaged in the intervention material. A possible explanation is that since the retirees have already completed the Milestone Program, they had little interest in more tutelage, especially in an unfamiliar format. Another explanation might be the fact that the shifts are short-handed. After the intervention was almost completed, the researcher learned that

management had told the workers not to complete any intervention modules outside of work, in direct contrast to what was expected, which hampered completion of the intervention also.

Yet there is value in what was and wasn't completed. Participants #30, 31, and 41 all began the intervention, and the first portion that would have been available was a fifty-question pretest. In the educational arena, a pretest/posttest is commonplace, or even an exam with that many questions. However, these participants would have been out of school long enough that a fifty-question test would be intimidating. Purportedly, Wade entry level employees only have a high school diploma, so they are not necessarily academically inclined. They didn't appear to understand that they may not know all the questions, as in a phone interview, participant #31 stated that they needed some context to the questions, as they found the questions difficult to answer. Participant #32 completed three of the assignments, but it was mentioned in the interview that they were taking Purdue Global classes, so it wouldn't have been as intimidating. This demographic appears to be more mechanically oriented, with a more tactile learning style. This academic approach was not conducive to connect to their knowledge base.

5.3 Future Research

Several areas of future research can be pursued on the topics revealed by this study.

Future research is needed to frame the instructional material in a way that appeals to how a visual or tactile learner may gain an understanding of the knowledge material. The participants of the power plant used for this study may be able to provide visual anecdotes that might apply to the new participants that also aligns with the theoretical knowledge required for the position. Another topic of study could be whether utility plant workers need the knowledge material from the stationary engineer's exam to perform their positions safely.

Since this was a pilot program, the larger project will continue, allowing for more research into how to develop the online piece of the research so that all the participants can be comfortable with the platform. Additionally, more research could be accomplished in the KM field. As was evidenced by the literature review for this project, many arenas, even libraries, know they should be doing KM, yet are not.

Another area of study could be research into what employee requirements are critical for a utility plant worker. Research should also continue into the most effective education for proletarian workers with high school education.

Finally, continued research into dynamics at Wade Utility Plant is another area of research. These dynamics may include but are not limited to between coworkers, workers and the machines, worker and processes/techniques used, and workers and upper management.

5.4 Economics

A final point that should be brought up is the economics associated with KM. Incentives have been a critical part of the current Milestone Program but there remains a cost associated with them. Currently raises are given for every level completed, but another idea would be to give a bonus for every level completed to be distributed quarterly. So, if the module had 100 levels perhaps give a one-time bonus of \$10 per level. If they reached level 25 in the first quarter, they would receive \$250.00, and so on. Once all 100 levels were completed, they could be required to take refreshers for a lower bonus or conduct alternative continuing education.

An individual would be needed to create the training modules, and update them which would indicate a paid position, Regardless of whether Wade chooses to get a dedicated trainer, or stays with the current Milestone, the materials will need to be updated, which will require man hours. If Wade chooses the online platform, there could be a cost associated with utilizing the online platform, whether it is the current Purdue University platform, or an outside vendor. The simulations could be costly as well, so it becomes a factor in being able to obtain it, as well as any games connected to the intervention. These are all costs which should be weighed against the benefits in a cost-benefit analysis.

5.5 Recommendations for Management

Although this was a research project, several themes became clear that were more of a managerial issue but should be included in this document. First it is to be noted that some of the activities already happening at Wade are noted in the literature to be positive aspects for KM.

5.5.1 Positive Attributes for KM

Wade has several positive attributes in relation to KM. The literature suggested several ways for organizations to facilitate the capture, retention and transfer of knowledge. Some of these attributes were found within Wade during this research and should be noted. Wade has a practice

of OJT within the plant wherein more senior plant workers train the less senior ones. This training appears to be happening every shift unless something unusual happens such as an emergency. This is a form of mentoring, apprenticeship or job shadowing, which allows the junior employees to learn from those who have been in the position longer and is a highly recommended method to transfer corporate knowledge (Anaya, 2012).

The team approach is another KM methodology and appears to be happening within the plant. Each shift has a group of men that work as a team. If those teams are kept intact for periods of time, it will aid in knowledge transfer. There doesn't appear to be a lot of movement between shifts unless someone leaves or takes vacation, so this is a positive factor for the plant. Good KM never happens in isolation, so this aspect of the plant is very helpful in creating an atmosphere conducive to KM (Brown & Duguid, 2007) One caution is that the research indicates that those with higher knowledge seem less likely to share (Joshi et al., 2007).

Wade's method for training their plant workers has several positive attributes conducive to knowledge transfer. They offer raises to workers which incentivizes them to pursue knowledge from the employees with more seniority. Their training is targeted, and specific, and they have plenty of opportunities to share, as OJT happens nearly every shift. This creates an atmosphere conducive to knowledge transfer, and junior workers have opportunities to find a senior worker that is willing to share their knowledge. All of these are positive factors for knowledge management activities (Burmeister & Deller, 2016)

. The blog kept by employees also aids in retaining knowledge learned by workers on their shift and is a valuable asset in the KM activities at the plant In the past it was continually added to and that should continue as another important marker in good KM (Awad et al., 2014). Another factor that Wade does well is how they encourage workers to improve their knowledge and attain higher positions. This has been noted as another highlight of a good KM program (Mittal et al., 2019).

5.5.2 Research Themes

Several themes were repeated in the research that pertain to best practices for KM. These are included for the purposes of KM improvement targets for Wade.

One theme that was present and echoed by several participants, was the request of a dedicated trainer for the Milestone Program to alleviate the problem of having multiple instructors

with diverse styles. If the new instruction is online, part of the need for a dedicated trainer will be alleviated, although an individual will be needed to update the online platform as well. The online schooling will not take the place of the OJT on the plant floor, however and there could still be more than one-person instructing participants.

There are two aspects that can aid in correcting this problem. One possibility would be to “train the trainers”. This may be accomplished if management would set guidelines for how instruction should occur, and what the parameters should be, resulting in more consistency. A session to certify a trainer would also be helpful, so that only certain individuals would be able to sign off on an apprentice’s paperwork. This would only work, however, if there are enough workers per shift to be able to teach.

The other possible way to ensure more consistent instruction would be to bring back the fall and spring education sessions that several participants mentioned. The timing would be critical so shifts were covered, but it would relieve some anxiety on the floor for employees to be able to get specific guidance on machinery, even as an update. It could also help the night shift feel more connected to the plant. From the aspect of KM, it is critical that only the optimal knowledge for the plant be passed on to new hires. KM works but the information must be of the best quality to be effective. Standards should be set so that knowledge transfer happens optimally, and incorrect information isn’t repeatedly transferred.

A second theme of communication is a critical one for the plant, can create difficulties in nearly every relationship whether it be personal or work-related and should be addressed as quickly as possible. It is also critical for KM, and the literature encourages good communication for a good KM program. A gap in communication will provide time for negative thoughts to enter in, allow discontent to increase and increase the possibility that more employees might leave.

The night shift is a critical part of the communication theme. While some of the Wade employees enjoy the quiet of working solo, they still need to be reconnected to the rest of the workers and to management. Improving communication should improve morale and create a better team to handle emergencies.

Suggestions within the communication factor would be that electronic mail (e-mail) should be answered as quickly as possible, even if the answer is a simple “I will find out”. Monetary concerns should be also be addressed swiftly, since previous payroll problems lead to employees leaving. Another method to assist in repairing the communication problems between management

and the plant workers would be for management to come into the plant on both shifts and serve the workers a prepaid catered meal. This opens the opportunity for the workers to ask management about problems, and for management to check on how things are progressing within the plant. Walking the plant on both shifts and asking the workers how they are faring would potentially further aid in restoring communication. This will also aid in KM practices as the literature indicates that an organization should provide an environment that is conducive to sharing. Management could model this behavior to encourage the workers to do so as well.

A third theme is labeling. This is a critical issue with so much employee turnover and is a common problem for any start-up knowledge management program. When an employee has been performing the same job for multiple years, labels are unnecessary, and are a waste of time and money. Yet management at Wade would be aiding the current mentors and the upcoming participants by labeling pipes, valves and gauges, and possibly avert an accident. Best practices for KM indicates that an organization should provide an atmosphere of low chronic stress, high activity and high trust (Muniz, 2014). Labeling would reduce the stress level and increase the trust factor. Every effort should be made to not change labels in order to maintain the trust factor.

A fourth theme was the concern of employee hiring and loss. The following suggestions could assist in this, and aid in repairing communication between management and plant workers. Several participants noted the pay discrepancy between Wade and other power/utility plants. While there may not be a way to narrow the pay gap due to a tight budget, there might be other incentives to gain and keep employees. Most employees prefer monetary compensation and even evaluate positions based on pay, but there are other incentives that could help them choose and stay at Wade. Most employees would like recognition for a job well done. Management could communicate this recognition in various ways, such as verbally, with some type of contest, or in writing. If a worker has a certain number of days without an accident, that individual could earn a gift certificate or a plaque. If the plant wants workers to be observant, instead of changing tags or label, they could have a type of contest where something is placed in the plant and the first worker to notice would win a gift certificate or recognition. Another idea could be an employee of the month, with a picture put in the school paper and placed in a prominent spot. An incentive can be as simple as a greeting to the Wade employees as they begin their shift and may go a long way to raising the morale of the workers.

An annual banquet could be a productive way to encourage connection to the facility, with perhaps door prizes and giveaways. Most electric cooperatives have a day to encourage their members and Wade would do well to encourage connection in this way. A bonus might be helpful, but sometimes it puts the worker in a higher tax bracket, and as such should be evaluated carefully. The literature suggests that a clan atmosphere within a company promotes good knowledge management (Suppiah & Sandhu, 2011). The clan most closely resembles a family. While not everyone in a family gets along, they still help each other and encourage each other. This type of work atmosphere will aid in not only encouraging a positive work KM, but also good attitudes, and should be a goal.

5.6 Conclusions

Knowledge Management is a critical subject as more Baby Boomers retire, leaving the workforce with the knowledge gleaned from decades of time spent perfecting their positions. It becomes more acute for small companies without the resources larger corporations have for expensive data collection processes such as small utility plants like Wade, a nonprofit with older equipment. These organizations have a small budget yet are expected to provide power, heat, and air conditioning twenty-four hours per day. This is an overlooked industry in the literature, with perhaps not national importance, nevertheless importance to the customers they serve.

One of the challenges of knowledge collection and dissemination in these small utility plants is the level of education of its workers. Most appear to have only a high school education. It behooves Wade and any other utility plant to decide what criteria a worker should have in order to be hired. In this digital online age of instruction, the type of education to disseminate knowledge gaps gleaned from retirees should be carefully considered. Several knowledge gaps were discovered in this study, but problems arose in the dissemination. Future study into what would work best in this demographic, or how to accommodate them for the online intervention to be effective will be necessary.

Only one of the gap areas was covered in the online modules, the lack of theoretical training for the stationary engineer's exam, and it was only discovered through utilizing the training. Further study into this area will also be necessary. Many of the gaps were managerial in nature, and so can be addressed within the plant. Even the knowledge gap of the Milestone Program could

be addressed without the training program, yet the online training, as mentioned previously, could facilitate training, relieve some of the plant workers, and speed up the training process.

5.7 Summary

Chapter 5 contains the discussion, conclusions and recommendations for this study, and includes the discussion including the Milestone Program, labeling, communications, the shift change blog, fall and spring training opportunities, dedicated trainer and theoretical knowledge, training availability and completion including research questions, knowledge management for a small to medium utility plant, demographics impact and dissonance with educational field, future research, economics, recommendations for management and conclusions. This concludes Chapter 5 and this Dissertation.

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APPENDIX A. WADE INTERVIEW QUESTIONS

Introduction

Hello, I am Kelly McFall, a PhD student at Purdue University, and I'd like to ask you a few questions about your experiences as an employee at Wade Utility Plant. Would that be all right? Would it be all right to audio tape the conversation? I will give you a copy of the transcript after we receive it back, and before we release it to Wade management.

Questions

1. How long have you worked at Wade?
2. When do you expect to retire?
3. What is your current position at Wade?
4. What has been your most important position at Wade?
5. How do you want Wade to continue after you retire?
6. What is your best advice for someone in your position?
7. Have you experienced any critical situations and how did you handle them?
8. What did you learn from those experiences?
9. What do you think about the Milestone Program?
10. Do you have anything else you'd like to add?

APPENDIX B. SUMMARY OF INTERVIEW DATA

Wade interview notes/topics

Q1 How long have you worked at Wade?

#35– 37 years

#44 – 32 years

#45 – 5 years

#46 – 23 years

#48 – 34 years

#47 – 15 years

#43 – 37 years

#40 – 24 years (34 years at a power plant)

#39 – 12 years

#38 – 18 + years (half-way trained for shift supervisor)

#30 – 30 years

#41 – 29 years and 2 months, retired in Nov 2018, subs in, now rehired (12 years at Logansport)

#33 – 23 years

#32 – just over 4 years

#42 – 35.5 years (37 at Purdue)

#49 – 1 year (22 years at Logansport power plant)

#50 – 10 months- from Navy

Q2 When do you expect to retire?

#35– within a year

#44– 3 years

#45–8 years

#46– doesn't plan on retiring

#48– 6 years (when 62)

#47– 11 years

#43– 3 years

#40– 19 months (June 21st, 2021)

#39– 10-18 months

#38– 8-9 years

#30– 2.5 years

#42– by June 2020.

Q3 What is your current position at Wade?

#35 – Senior Project Manager

#44 – shift supervisor (20 years)

#45 – fireman (training for chillers-level 6)

#46 – Shift supervisor (5 months- was shift engineer for 12 years, qualified for shift supervisor 2 years ago)

#48 – Turbine Generator Operator (3 years, but must run chillers as no opening)

#47 – Generator Operator (level 8 Milestone)

#43 – Operations Supervisor (been supervisor most of his time here-took over for #35 when he moved up)

#40 – Generator operator (qualified for Shift supervisor) Op-tech? (for 7-8 years)

#39 – chiller operator

#42 – shift supervisor -15 years

#49 – Operations (level 6 from past 22 years' experience at Logansport)

Q4 What has been your most important position at Wade?

#35 – Operations supervisor

#48 – Chillers “I never considered when I tripped the chiller, what fact it had on the turbine operator or my shift supervisor, and they dumped the chiller, they lose about 30,000 to 40,000 pounds of steam and it effects your generator and your boilers.”

#43 – Operations Supervisor (on call 24 hrs.)

#40 – At the plant- Shift supervisor

#30 – shift supervisor

#41 – retired shift supervisor, since rehired

#33 - assistant chef coordinator, generator operator

#42 – all of them

Q5 How do you want Wade to continue after you retire?

#35 – seamlessly, a viable part of Purdue for years to come

#48 – would like to see Wade continue to provide for Purdue instead of outsourcing.

#43 – wants Wade to continue to be in the best shape operationally.

#40 - As it is now, satisfy the customers, running right

Q6 What is your best advice for someone in your position?

#35 (Operations supervisor)- Trust supervisors and give them all tools needed for job.

#48 – (Chillers) – ask questions,

#43 – Treat others the way you want to be treated. Answer all questions or get the answers. Work the shifts that aren’t covered to keep it fresh. Listen to your men, understand the source.

#40 – how to run the plant, but with scenarios, because all the plant processes are linked-intertwined, and systems affect each other.

Q7 Have you experienced any critical experiences and how did you handle them?

#35 - Yes, trust your training

#44 – know your machines, safety first

- #46 – Duke had done something and knocked Wade out-they were down for 30 minutes during finals. Initial scenario decides what to do. Some shift supervisors (3) have never put on a generator. No right or wrong way to train or to run the machines-there's variation.
- #48 – it's the whole team concept. It's been so many years ago. We had water back fed into our 125 line and it was coming through a valve. Three of us, it was spraying out, we had to pick up a chalkboard and use it to deflect the water away just so we could get to the valve to isolate it. Resolution: Once we got the valve shut, it just took a while to drain the water out of the line. Three accidents are the incidents he remembers- 650 steam hitting the participant.
- #47 – remembers an incident where a squirrel shorted out the power lines on the switch gear – he and another man on smoke break saw the flash and heard the crackle, went to control room and lights were out. One issue led to another issue-chain reaction.
- #43 – when the whole plant goes down- he gets called and helps get it back up or takes Boiler 5 and another take Boiler 3. Dec 7, 2014, new director was in and contractor flipped a switch and shut down the whole plant, then they brought it back up, and he flipped the switch again (labeling?) and it took 24 hours to bring it back up the second time. Squirrels cause more problems than anything. Duke has knocked them offline 3 times this year-outdated switching procedures and something goes wrong and knocks out Wade. Duke must notify Wade 2 hours before Duke switches out equipment and Wade has a sheet telling how many megawatts and so forth Wade is running. Second remembered incident- #1 generator, Maintenance had just completed a PM work order on it, and everything worked fine. Then The next day the generator tripped and none of the auxiliary backup oil pump didn't come on and did over a million dollars' worth of damage to the generator. Tore up all the bearings. The insurance company needed to know if the maintenance had been completed and Max had the paperwork- doesn't keep the filter info but does keep the maintenance (such as had been described).
- #40 – December 2017, contractors were putting in a back-up system? And shut down the whole plant (went dark) and took 3-4 days to bring it back up. He was off shift for the resolution of it- helped in the beginning. Was first day of new director.
- #41 – Squirrel in the substation that knocked the plant off, someone hit a pole and knocked the power out, electrical people are switching out equipment and knock Wade off (6-7 of those), and once when he was new they rebuilt a turbine on one of the boilers number two, the ID fan and the governor fell apart on it- it knocked the turbine off and the other boilers took up the slack, but couldn't so they were tripped.

Q8 What did you learned from those experiences?

- #35 - That the plant workers are resilient, developed a plan then worked it
- #48 – Teamwork really helps. You must really pay attention to your basement person that there is a problem and just don't skip over it, you got to go check it out. Safety first!

#47 – thinks that there should be a log of what happened, why, where, who, how, and then go over it later. Currently just basic facts in log.

#43 – teamwork- use most experienced men to get everything running again as quickly as possible. Participant #43 helps bring things up.

#40 – not much because he wasn't there for it

Q9 What do you think about the Milestone Program?

#35 - Was the first guinea pig, thinks it should be streamlined to complete in 4-5 years. Original was 7 years to do 9 levels but considered age- an 18-year-old starting the program would need to be at least 25 to run a shift.

#44 – Inconsistent grading, wants it standardized. (Ten years to get through it from zero knowledge to shift supervisor). Likes program, thinks that if he wants more money, he just needs to complete the next section.

#45 –Milestone is good program but needs updated. No problems with pay scale.

#46 – likes Milestone. Level 4 has parts that have already been signed off from level 2, so there are redundancies. Some men don't want to progress, and they shouldn't have to. He would have no problem with someone else moving up quicker due to prior experience, especially since they are short-handed as he needs to use his vacation time.

#47 - At Wade, you must be level 7 in the Milestone to be able to sign off for anyone below you. Milestone was first timed, so a period to complete something, then at some point prior experience could move you up faster, now it's "wishy washy". First three levels easier to get through now, since the work on shift of pulling the ash out is eliminated (but still in the Milestone). He thinks that signing off should be standardized- currently varies for person to person.

#43 – At the end of some Milestones is a 360- a review of the previous material. Proud of Milestone- he did it in 5 years, but it is set up to complete in nine years. He went faster because others retired- just like now. Other Big Ten schools have asked for a copy of the program and he is very proud of it.

#40 – He completed it three years ago, but it was because he couldn't move up, so he delayed completion.

#39 – He doesn't like it- it started as a good program, but it's currently messed up and he doesn't want to learn anymore. He was there when they changed the pay incentives and was very upset by it.

- #38 – Has completed step 8, ready for 9. The program is good for starting, but OJT is required to finish it out. Some steps he needed to fire up or shut down a boiler but had no opportunity to do so, and supervisor told the participant to turn it in anyway to be able to get his pay.
- #30 – tries to put notes into the start-up papers from the drive for the next guy coming up-things that the other shift supervisors can see but shouldn't need. He emails to #44 and #42. He agrees it needs fixed.
- #41 – has completed the Milestone but noted that 3 guys left because of pay issues (when they stopped paying incentives for 2 years when the program was changed). One, #32 came back due to #41 encouraging the participant to.
- #33 – completed but spent years at each position. Wrote some of the start-up procedures. Had a competition with another hire to get through the milestone, but now it's draining to train someone who doesn't want to learn it.
- #32 – has completed 6 of the Milestones (had a year in maintenance, 6 months at Indy P&L). Boiler #2 needs more info; Chiller #7 hasn't been used since he's been here. He's all right with the pay incentives, except they need to be quicker about applying them to the paychecks when they're earned. He thinks that he would prefer a walking test than a written test. He wants more labels.
- #42 – Everything he knows about the plant came from the Milestone program, but it needs updated.
- #49 – gone through 3 levels but hired in at level 6 pay (operator). He says there are some redundancies in the Milestone.
- #50 – Just through Milestone 1 but would like ways to go through the levels when that area of machinery is down, so it doesn't hold you up with completing the level. He's all right with the current incentives and thinks that it helps motivate.

Q10 Do you have anything else you'd like to add?

- #44 – can be paid as a shift supervisor if all the way through Milestone even if not performing those duties. Wants hands-on winter training back. (used to have 2X-fall and spring). Has no clue on working the chillers because no training in it. Four employees in the last year left for a higher income but one came back because of the long drive to the other company. Another tried to negotiate higher pay but wanted almost (within a couple dollars) the same pay scale of employees who had been there 32 years (#44). A recent one who quit purportedly was upset because some recent hires with more experience were making more money and he but had been there a shorter time. This individual has updated Milestone and written two boiler start-up procedures, then turned it over to the supervisor.
- #45 – The boilers are labeled, the valves for boilers are labeled, the valve spreaders are not labeled, and new equipment must be labeled by plant. He prefers more detailed

training-some supervisors just do the minimum. He enjoys gauges and would like to cross-train with maintenance. He prefers variety and doing different things.

#46 – Type 1 diabetic for 30 years, doesn't plan on retiring-needs the insurance. Milestone was changed at one point to skills inventory for 3 years and no one got their promised money for completing levels-says it was "real" bad-two people left over it. Also, he feels that you can't force someone to go through the Milestone levels if they aren't interested in learning. Management has required two signatures per month, but it isn't strictly enforced because there's no positions open to move into. He has always been on the night shift. Day shift was locked up and he couldn't move to there. The workers are big on seniority, but #46 doesn't care if a junior employee moves ahead. Wade is currently on 12-hour shifts but used to have 8-hour shifts. They need back-up because he loses his vacation every month if he doesn't use it. It will be overtime for someone to cover for the participant. #41 comes in to stop the overtime, making less than he did when he was here, and works at a lake in Monticello during the day [since then has been rehired]. He wants a dedicated trainer. He agrees that labeling is necessary. At one time there was a guy who labeled valves- just that-but is gone now. He prefers that they just be numbered instead of labeling names. Pay would be an incentive to get and keep participant. Some current participants are checking online to see what other places pay. Their training used to be four 8-hour days and now it's one day for bloodborne pathogens, Title 5 [OSHA]. #46 is on the day shift after wanting the night shift since he's been moved to nights. There's some variation in how the adjustments to which shift are made in the plant-according to comfort level. In the last ten years everyone wants the night shift- less hassle from management.

#48 – Right now, because I'm on the chillers, the most important thing would be to learn how to put on the turbine chillers because they use steam. Everything else is electric and it's pretty easy. Yeah, being in the summer mode, just got to know how to put on your turbines, how to warm them up properly. How to fill your hot well, you've got to drain it and you've got to take a sample to make sure the condensate water is blue.

#47 – He was in the navy for 9.5 years and anything you were qualified for; you could sign off for. Was on a 5-man crew (8 hours) but currently on a 4-man, 12-hour shift. He has researched extensively other positions and fields on pay. He says the University completes an evaluation every four years to see if it would be less money to shut Wade down and outsource the power [note – Wade management says this evaluation happens annually]. Says Wade is forgiving on mistakes if you are truthful- it's considered as a learning experience. He detailed about an accident that happened in his first year and was told that if he hadn't been taught wrong, he would have been fired. He compared Wade to the Navy. He suggested that some at Wade would leave valve markings off in Wade to see if you really knew the information- or switch tags to see if you were paying attention (a dangerous practice). He suggests that there should be more info on issues that have happened- to learn from them and train others as well. He says that some machinery isn't off more than once or twice per year. He notes that things should be labeled better.

#43 – individual don't have the passion or dedication for the job in the current generation, not like in his generation. He never misses work. For years it was the participant, a former worker and #35, then the former worker left and now #35 will be leaving. The plant is constantly changing. #35 has dates memorized. The training program doesn't require any knowledge when you come in the door- it's all OJT. He will come in, choose what to do, then get a trainee to walk the participant through- if the worker misses something, he asks what about this? Squirrels are the biggest problem at Wade. He feels that campus doesn't know what the individual at the plant do or appreciate the work it takes to keep everything going (needs recognition?). Wants #46 or #30 to replace the participant, as listening to the individual is important in his job- he wants a certain personality to do his job. The job used to be more relaxed, now there are more OSHA requirements. He walked through Milestone- came in completely green.

Has been having his time checked lately, regular hours 5:00 AM to 1:30 PM, but can work over to 2:00, 3:00 or 6:00 (regularly). Day's work: check in with night crew, runs coal numbers, checks in with time-keeping, checks in with the boilers and the coal, (they don't want wet coal-it plugs the chutes and can combust in the yard or in the shed, Sam works the coal to try to dry it), checks his email-both on and off the clock but only answers the ones important in his mind, morning meeting at 8:00AM, he sits with the day crew until the meeting to see what's going on, the meeting sets the tone for the day, if quiet then he works on Milestone, answers questions, listens to gripes and doesn't tell anyone, covers if someone won't be in. He mentioned when it was changed to skills inventory and went back to Milestones when that director left. He says that some of the equipment that's in the Milestone was put there by previous management and #43 hasn't had time to fix it yet. #43 is the only one that can change the Milestones- #34 can look but he can't change them. #43 prefers to gain consensus from the plant workers before making changes in the Milestone Program and doesn't approve of unauthorized copies in the file. He has trouble getting everything into the main copy due to interruptions, the long process and all the equipment changes. Swing shift was best for training, as different shifts have different things happen (squirrels aren't out at night, and management isn't around at night). Used to have 3 shifts of 8 hours each but now 2 12-hour shifts. Both have some over-time built in, so neither saves money.

Shut down on a boiler is taking the load off and letting it coast down. So, machinery has manuals and they specify certain temp ranges, but some workers think they are smarter and run it differently, then they train the people differently, so it can create problems. If the individual is trained by different people, they can then make up their own mind on the flexible parts but should stick to the start-up sheet for specs. Shifts are done by seniority.

Boiler # 5 is run the least, because gas is the preferred fuel unless another boiler is down. Depending on temperatures, they will run chillers or heat exchangers (cheaper to run). On centrifugal: #8, 11, 7. Feed pumps- have 2 turbines running, electric is always back-up. They run 7 and 9, but when 5 is fixed, they will drop off 9 and put on 5 (more capacity). Both generators are running.

- #40 – fully competent on all machinery but not familiar with it. Wants scenario discussion or what would work for it.
- #39 – thinks incentives should be pay- he’s worked out how much you can save up if you have 8-10 more per hour at another place.
- #38 – He likes to tweak the equipment to satisfy the customer with least resources. Some supervisors will knock off a turbine pump to see how you react. He wants a single trainer. When he trains, he gives the trainee notes on what he has tweaked. He gives them more than the Milestone; such as examples of schematics so they can get started on their own drawings. Best incentives: money, time off, benefits, parking passes. Wade needs guys with mechanical aptitude that want to learn, and are willing to go out and walk down the piping, etc. He needs training on the new equipment, and brush-up training or continuing education. Wade needs to stagger the hiring. He wants the operators’ manuals for the equipment.
- #30 – He’s focused on getting the next guys ready as much as possible -uses the chalkboard and then walks them around putting hands on valves to prepare them. He must rely on guys that haven’t been there long while he’s in the control room, so he wants to get them up to speed. He also rotates jobs so his crew on his shift is prepared and #30 can trust them. He recalls WC -VP of Physical Facilities would tell you how important your job was to the university. #30 was invested in his job (doesn’t see that now). He believes the most important thing is feedwater. Brought up how they used to have two weeks training- one week in fall and one week in the spring with the operations supervisor going over equipment and making sure individual were up to speed, also must get in the OSHA requirements now. So now the training is happening on shift with sometimes only 4 individuals. (He just got #50- a 5th guy on the shift- so he can do one on one training). #30 has been training his guys, then they move them to another shift, and he starts over. He doesn’t believe management. #30’s notes are the things that aren’t in the Milestone but important.
- #41 – Putting a boiler on from a cold-start takes 4 hours (start-up list). #3 Boiler is the best they have and oldest. #2 generator is the best generator and oldest. Boiler (#3?) was reworked but the controls weren’t put in the control room, so to find out how it’s doing, you have to send a guy out to look at separate controls, which means even though you’re short-handed, you are even more short-handed. When they had six on a shift, they could train, even with five you can do some training, but some shifts only have four individual-not enough. They used to have an extra crew, but it dwindled away and wasn’t replaced. Logansport brought in simulators to train people after participant #41 left – but they ended up closing it because of lack of experience, but newspapers say the cause was emission controls (EPA) that created too large a cost to keep running the plant. Wade gave the participant seven years credit on the Milestone. Inexperienced crews scare the participant because they could cause a boiler to blow. He has a person with dementia and some other problems- he must send a second person with the participant because he can’t trust the participant, and that creates a problem in work duties on the shift. Communications is a big problem- is a little better, but still a problem. He mentioned wanting a full-time trainer. He

said that management would hold up raises. “We used to have four groups. One was 3:00 to 11:00, 11:00 to 7:00, and 7:00 to three, and then this extra crew. But the extra crew went away, so then we just had them, and we only worked eight-hour shifts.” So, communication with the plant workers, especially the night crew, is faltering and the night crew is struggling. The emails are being sent but management isn’t always answering them. The previous plant manager was communicating and having supervisor meetings, but since he left, that has declined. The individual would prefer that management would answer emails, even if it is just to say, “I don’t know yet”. Supervisors need to hire people with some experience because until they have about 3 years of experience, they aren’t useful. Current trainees are being moved too quickly due to retirements. To walk in off the street and go through the Milestone and be a good shift supervisor you need some intelligence, some computer smarts and be a good listener. Mechanical aptitude would be helpful but not critical (not maintenance). Those from the military are a good choice. Night shift doesn’t get to train on new equipment- day shift does all that.

#33 – misses the plant training, technical training. Now just OSHA. He wants to have a roundtable discussion on the Milestone program to decide how to revamp it.

#32 – thinks that some mechanical aptitude would be helpful in the job. Memorizing where the valves were through walking the plant. Would like a set day to do walk-throughs and would prefer more organization and structure.

#42 – lost the accountability for the plant and program. He wants the dedicated trainer. He doesn’t like the 12-hour shifts. He thinks that it takes 12-18 months to decide if the plant is a good fit for a new hire. When he first hired in, he filled out log sheets but didn’t know what they were for, so then they started up the Milestone program to get the knowledge to the operators. You must put the work in before the emergency. Lost an experienced generator man to nights but has one now that’s motivated, which helps. “We have the program here. We just have to put an engaged, competent person to be the champion of this program.”

He thinks the valves and shut offs should all be labeled. Wade will always be cost effective because they don’t have to make a profit and they don’t have to pay taxes. So, they will remain in the top of cost-effective plants. He states that the plant is all a system that’s intertwined.

#49 – he’s the unicorn, hired in at level 6, but only gone through 3 levels. 2nd day he passed the 90-day test at 100%. Prefers the 12-hour shifts to the swing shift he came from. The morale is better here, and the job provides everything that’s needed like personal protective equipment. He was in a union shop, and Wade is non-union. He listed problems with a union shop and prefer the non-union. He said there’s a problem with the demineralizer- a pipe that needs removed. He can’t progress through the Milestone because of seniority-even though he has the experience. He wants the policy changed so that anyone can come in and participate in a training opportunity plant-wide, so he isn’t pointed out. He thinks the current plant labeling is awesome because his previous work was terrible.

#50 – plans on being here 5-15 years. Navy had everything dummy-proof, and color-coded, plus a simulation to practice scenarios. Would like to be able to upload data in real time (costly). He wants the pluses from the Navy.

APPENDIX C. SAMPLE PRE-TEST/POSTTEST QUESTIONS

Pre/Post Test

Multiple Choice: Please select the best answer.

1. Which one of the following impurities in condensed steam does not lead to failure of boiler superheaters?
 - A. chloride
 - B. hydrogen
 - C. bicarbonate alkalinity
 - D. calcium
 - E. oxygen**
2. Which of the following steps to start up Boiler #5 is out of order?
 - A. Call I & E, stroke dampers, start primary air fan, start inert feeder, start duct burner, start secondary air fan.
 - B. Call I & E, stroke all dampers, start J-Valve, set dampers, build pressure, close vents, start coal at 900-925 F.**
 - C. Walk unit, stroke dampers, start J-Valve, start induced draft fan, start primary fan, start secondary fan, put furnace draft in auto.
 - D. Set dampers and fluff bed, start inert feeder, start induced draft fan, call I & E, walk entire unit, verify start-up.

True/False Questions

Please select the best answer for When starting up Boiler #5:

All True

1. The 650-header valve should be warmed up and opened.
2. One of the first steps is to call I & E to do a calibration.
3. All bearing cooling water flow and oil levels should be checked visually.
4. Chutes #1 and #2 dampers should be 100% open.
5. Regional water supplies to bearings should be open, but local bearing water valves should be in their pre-set positions.
6. Ash stripper and ash cooler dampers should be open 100%.
7. Set dampers to 50%.
8. Set PA and ID turbine speed controls to 0%.
9. Notify West Lafayette Sewage Treatment Plant of Start Up 775-55145.
10. Open inlet vanes until "NOT CLOSED" L.S. 25% actuates.

All False:

11. The plenum flow damper should be set to 75%.
12. SA outlet flow dampers should be set to 30%.
13. SA inlet vanes should be set to "Not Closed" 100%.
14. Turn off Purge Air to Stripper/Cooler transition duct Nozzles.
15. First Floor HRA door must be opened after the PA fan has started.
16. Furnace Pressure should be set to -10 to -20" WC.
17. Furnace pressure control block must have an output of 5% or greater.
18. When setting dampers and fluff bed, coal chute dampers must be in manual.

19. When starting the duct burner, increase burner set point to 1900 F if Normal Bed Level.

CURRICULUM VITAE

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Education:

PhD in Technology	(Date to Come)
Dissertation: Addressing Corporate Knowledge Loss in a University Utility Plant	
Master of Science in <i>Technology</i>	1998
Directed Project: Productions and Operations Lab Manual Purdue University West Lafayette, IN	
Bachelor of Science: <i>Industrial Technology</i>	1996
Bachelor of Science <i>Industrial Distribution</i>	1996
Purdue University: West Lafayette, IN	

Teaching Experience:

<u>Oneida Baptist Institute Oneida, KY</u>	August 2016 to May 2020
Classes taught: Geometry, Algebra II, Technical Math, Computers 1 & 2, ACT Prep, Programming	
<u>Ivy Tech Community College Lafayette, IN</u>	Spring 2008 to Spring 2019
Adjunct Faculty for:	
• Essentials of Business English	Fall 2017
• Emerging Technologies	Fall 2017
• Business Communications	Fall 2017 to 2019
• Microsoft Excel	2014 to 2019
• Microsoft Outlook	2014 to 2017
• Introduction to Microcomputers	2008-2013, 2016
• C++ Programming	Spring 2013
• Business Law	Spring 2013
• Information Systems Fundamentals	2008
<u>Purdue University West Lafayette, IN</u>	
Instructor of Record for Engineering Analysis for Industrial Decisions	2010-2012
Graduate Teaching Instructor for Industrial Ergonomics lab	2011, 2012
Graduate Teaching Instructor for Industrial Organization	Spring 2012
<u>Purdue University SIA Training Facility Lafayette, IN</u>	
Graduate Teaching Instructor for Introduction to Lean Manufacturing	2009
Adjunct Faculty for Statistical Quality Control	1/1/2009
Adjunct Faculty for Industrial Organization	2009
<u>Purdue University West Lafayette, IN</u>	
Adjunct Faculty for Statistical Quality Control	1998-1999
Adjunct Faculty for Engineering Economy	1998-2000
<u>Purdue University West Lafayette, IN</u>	

Teaching Assistant	1996-98
<u>United States Postal Service</u>	
Rural Academy Trainer	2000-2005
Rural Carrier	1989-2009

Publications:

Laux, C., McFall, K., & Newton, K. (2011). Creating authentic laboratory experiences for lean manufacturing. In the ASEE Conference for Industry and Education Collaboration Proceedings; San Antonio, Texas.

Submitted Proposals:

Smart Fellowship	Dec 2011
Ford Foundation Dissertation Fellowship	Fall 2011
NSF TUES proposal submitted with Dr. C. Laux and Dr. E. Schmidt -declined in second round selection.	May 2011

Awards and Certificates:

2016 Microsoft Office Specialist Certification in	
• Word	June 2018
2013 Microsoft Office Specialist Certifications in:	
• Word, Excel, Access, PowerPoint	2015
IC3 Certifications	2015
MSSC Production Technician Certification (CLA)	June 2018
Recipient of the Epsilon Pi Tau Warner Award	March 2012
Recipient of the Graduate Scholar Award at the International Conference on Technology, Knowledge, and Society	January 2012
Nominated to Epsilon Pi Tau	2010
Recipient of Epsilon Pi Tau Scholarship Award at ATMAE Conference	2010
Poster presentation at The China-US Symposium on Biofuels at Purdue University	Sept 26-29, 2011
Poster presentation at Frontiers in Bioenergy Symposium at Purdue University	May 15-18, 2011
Poster and Paper Presentation at ATMAE Conferences <i>Ivy Tech Community College Lafayette, IN 47909</i>	2009, 2010
Nominated for Adjunct of the Year	2008, 2009, 2010
On-line Teaching Faculty Certification	July 2008, April, 2011
Certification: Introduction to Community College Instruction: Getting Results	March 2008

Continuing Education:

Ivy Tech:	
Title IX Sexual Misconduct Awareness & Prevention e-Learning	April 2018
Spring 2018 Mobile Device Security e-Learning	March 2018
Spring 2018 Security Essentials e-Learning	March 2018
Spring 2018 Introduction to Phishing e-Learning	February 2018

Title VII: Harassment Prevention e-Learning	January 2018
Fall 2017 Protecting Against Ransomware e-Learning	September 2017
Fall 2017 Email Security e-Learning	September 2017
Fall 2017 URL e-Learning	September 2017
Information Security User Awareness e-Learning	July 2017
Privacy and Information Security e-Learning	July 2017
IVYC251-Online Course Mentor Certification	October 2013
Using Rubrics in Student Affairs	May 2013
Conflicted: Faculty and Online Education 2012	May 2013
Reaching First Generation College Students	May 2013
Tips, Tricks and Technology Tools for Teachers	May 2013
Universal Design	Sept 2012, May 2013
Using Cell Phones in the Classroom	Sept 2012, May 2013
Basic Computing Tips	September 2012
Blackboard 9 Faculty Training	October 2012
Starfish Training 2012 CBT Confirmation	October 2012
Assignments and Safe Assign	September 2012

Activities:

Field Trip Possum Trot Christian Camp	May 2015
Creation and CEO of Possum Trot Christian Camp	2014
Presentations to Purdue summer Junior High Technology Camps	Summer 2010

Research:

Research Assistant for NSF-ATE Grant administered by Dr. Chad Laux	Spring 2012
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RELATED EXPERIENCE

Caterpillar Lafayette, IN

Researcher

May 1998

Evaluated block liner assembly job to improve ergonomic factors and productivity resulting in a written report that improved both.

Allen-Bradley Portland, Oregon