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A Comparative Analysis of Defensive Routines and Theories-In-Use of Engineering and Non-Engineering Managers

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Abstract- *Engineering managers are managers who have an understanding of both the technical and business aspects of organizations. However, the success of an engineering manager depends on being knowledgeable in both the business and technical functions of an organization. There is a perception that engineers experience challenges in areas such as communication, conflict resolution, and leadership. Defensive routines are actions implemented as a result of being in an embarrassing or threatening situation. This research uses a case study approach to measure whether defensive routines are more common in engineering managers or non-engineering managers. 27 managers created case studies based on their unique experiences as managers. These case studies were scored and the results show that defensive routines are more common in engineering managers than non-engineering mangers.*

Keywords: *Defensive Routines; Engineering Management; Engineers; Model I; Model II; Leadership*

1. INTRODUCTION

Successful engineering managers are able to work in technology-based organizations with rapid production cycles (Farr and Brazil, 2009). Corporations consider being successful as delivering a quality product ahead of schedule and/or below cost, leading a team to be as efficient as they can, and motivating the team to reach their highest potential. Research indicates that to be an effective manager, communication and trust are key indicators that should be present (Kennedy, 2009; Farr and Brazil, 2009). In addition, other skills such as leadership, collaboration, and active learning (Farr and Brazil, 2009) are needed to be an effective manager. There has been a plethora of research on engineers and their behaviors but there is a need for research that focuses on developing engineer to assume leadership roles in technology-based organization (Farr and Brazil, 2009). Much of the research supports that the engineering education has a direct effect on how engineers operate in the working environment. The transition from an engineering student to a working engineer or engineer to manager can be difficult. Some engineers believe that engineering education prepares them to take the data provided to them and calculate answers from the information (Kennedy, 2009). Universities are criticized for producing technically competent students, but not training students for the real world work environment (Farr and Welsh, 1997). According to Wyrick (2003), the way engineering is taught dictates how engineers process information during his or her careers as well as how technical organizations develop their cultures. Universities are capable of generating extraordinary technical professionals; however, these engineers are not equipped for real-world engineering (Farr and Brazil, 2009). In order for engineers to be prepared for leadership and management, the training should occur early in their careers, as early as during the undergraduate education (Farr and Walesh, 1997). Some believe that engineers move into management because the technical path is truncated once a certain level is achieved (Roberts and Biddle, 1994). Research suggests that there are certain leadership skills needed to be productive and successful as an engineer or engineering manager such as communication, leadership, collaboration, and active learning (Farr and Brazil, 2009). However, engineers are taught to solve problems quickly and efficiently. Research has shown that effort is needed to integrate new engineering graduates into the work environment through socialization. This method allows new engineers to learn their roles, attain knowledge of the job skills as well as assimilate into the organization (Farr and Brazil, 2009). Many engineers are rewarded for doing great work. However, when engineers do not perform at superior levels, they may start to act defensively in order to save face when their work is considered average or less than superior. Is there a possibility that there are certain

behaviors or "defensive routines" that engineers exhibit that make the transition to management difficult? Defensive routines are defined as actions or policies that prevent individuals from experiencing embarrassment or threat (Argyris, 1990). According to Argyris (1995), defensive routines are developed early in life, as early as 12 years old. Behaviors that are called defensive routines may vary; however, the approach is using these behaviors is consistent (Argyris, 1995). Defensive routines are a result of "Model I" behavior, which is based on the desire to win and minimize negative feelings while "Model II" behavior focuses on seeking valid information through inquiry and making an informed choice regardless of who wins or loses (Argyris, 1989). This research investigates whether defensive routines are more prevalent in engineering managers than in non-engineering managers. This is important to the engineering management profession because it brings awareness to organizations enabling them to be more proficient at ensuring their leadership is effectively leading and motivating their team. The goal of this study is to determine if these routines exist in engineering managers more than non-engineering managers.

2. LITERATURE REVIEW

The literature review is divided into four sections. Organizational defensive routines, individual defensive routines, self-monitoring behaviors, and engineering manager behaviors are each relevant to the research question of are defensive routines more prevalent in engineering managers or non-engineering managers.

2.1 Organizational Defensive Routines

Defensive routines are defined as "any policies or actions that prevent the organization from experiencing pain or threat and simultaneously prevent learning how to correct the causes of threat in the first place" (Argyis, 1986). Organizational defensive routines often become rooted into the organizations causing difficulty in the ability to change organizational cultures. Organizational traditions are familiar and can trigger resistance due to moving outside of organizational norms (Riley et al., 2013). The most common defensive routine used in organizations is mixed message. Mixed messages are known as messages that are designed to be inconsistent (Argyris, 1986). Organizational defensive routines originate from individual defensive routines matriculating through an organization to the top levels of leadership.

2.2 Individual Defensive Routines

Argyris (1986) suggests that defensive routines are developed early in life. Some common defensive routines are self-censoring, face saving, unilateral control, bypass, mixed messages, protective support, and fancy footwork. Self-censoring is a routine used to keep negative thoughts to one's self (Argyris, Putnam, and Smith, 1985). Face-saving is used when an individual does not want to point out someone else's mistakes. This can be accomplished several ways. One way is for someone to point out something negative about himself or herself as opposed to the other person. Another way to demonstrate face-saving is to disguise criticisms through ambiguity. Unilateral control is another routine that is used. This is performed by stating one's opinion in such a forceful way that the ability to question the validity of that opinion is eliminated (Argyris, Putnam, and Smith, 1985). Bypass is a routine to avoid dealing with threat. Bypass utilizes two methods. The first method is to be direct and "tell it like it is" (Argyris, 1985). The second method is to "ease in". This is a strategy used when individuals want to appear passive when in actuality they are active (Argyris, 1985). Mixed messages are used when one wants to hide the true message (Argyris, 1985). Protective support is defined as a method used to appear supportive of individuals but still seeking control of the situation (Argyris, Putnam, and Smith, 1985). Fancy footwork is defined as switching one's viewpoint to defend his or her position but act as if the switch did not happen (Argyris, Putnam, and Smith, 1985).Chris Argyris is the founder of "Action Science". Action Science is defined as a theory that explains individuals' interactions based on their espoused theories and theories-in-use (Wilson, 2001). Argyis and Schon concluded that the human action is based on theories of action (Argyris, 1976). The theory of action is defined as the actual behavior exhibited in a particular situation (Argyris, 1995). Espoused theory is defined as the theory that the individual wishes to execute while theory-in-use is what is actually used (Argyris, 1995). More often than not, the espoused theory is incongruent with the theory-in-use. Argyris (1976) states that Model I Theory-In-Use has four governing values, which include (1) define unilaterally the purpose of a situation, (2) maximize winning, and not lose, (3) suppress negative feelings, and (4) be rational. The strategies that are often used with these governing variables are to advocate one's position to remain in control and to save face. The consequences of these actions are miscommunication, mistrust, protectiveness, self-fulfilling prophecies, self-sealing processes, and escalating error (Argyris, 1985). Model II has three governing values including (1) valid information, (2) free and informed choice, and (3) monitor effectiveness of one's actions. The strategies that are often used with these governing variables are to advocate one's position and combine with inquiry and testing in order to minimize face saving behavior. Defensive routines can inhibit ones learning, which is the ability to detect and correct errors. It can also take place when there is a match between one's intent and what actually happened (Argyis, 1985). There are two types of learning that can take place: single loop and double loop. Single loop learning corrects the problem, but does not address the underlying issues. Double loop learning corrects the problem by examining the underlying assumptions that created the problem.

There is literature that discusses how single loop learning yields different behaviors termed Model I and Model II in both individuals and organizations.

2.3 Self-Monitoring

Self-monitoring is similar to Argyris' espoused theory and theory-in-use. Self-monitoring is defined as the process in which people manage their public impressions consistent with the demands of the situation or from their own stance (Webb et al., 1989). Acute perception, discernment, and understanding of social behaviors are all characteristics of self-monitoring (Flynn et al., 2006). However, there is one key difference between self-monitoring and theory-in-use. Self-monitoring implies that the individuals are making an effort to modify their behavior; whereas with theory-in-use, the behavior is often times not realized and, therefore, not monitored. Considerable research has been performed on self-monitoring behaviors in an attempt to bring awareness to individuals who may need improvement and the opportunity for correction. Self-monitoring behavior is divided into two categories: high self-monitoring and low self-monitoring. High self-monitors are as individuals who focus on their social context, are more responsive to social cues, and are very attentive to the behaviors of others (Nauman, 2010). High self-monitors attempt to impress others in order to win their approval and respect (Flynn et al., 2006), and focus on the perception of how they are viewed in the image of others. Research has shown that high self-monitors' desire for social status can affect their decision-making (Flynn et al., 2006). High self-monitors are sensitive to situations, can adjust their behaviors accordingly, and typically have better communication skills. Research shows that high-self monitors tend to perform better in jobs, emerge as leaders, and are more likely to solve problems through collaboration and compromise rather than avoidance and competition (Blakely et al., 2003). These behaviors are very similar to the governing variables in Model II behavior. Low self-monitors are a contrast to high self-monitors. Low self-monitors are not as sensitive and less concerned with their impact on others. Low self-monitors operate according to their internal feelings instead of external factors. (Blakely et al., 2003). This implies that low self-monitors may be more introverted which is a common description of many engineers. The most common tool for evaluating self-monitoring behavior is the self-monitor scale. In 1974 by Mark Snyder developed this measuring tool (Snyder, 1974). The self-monitor scale is a multidimensional, complex scale that is composed of 25 items to be measured. In 1986, Lennox and Wolfe developed a revised shortened version of the self-monitoring scale. The shortened version focuses on items that are above 0.15 on the first un-rotated factor (Briggs and Cheek, 1988).

2.4 Engineering Managers

There has been an abundance of research conducted on engineering managers regarding the type of characteristics and behaviors they should exhibit in order to be successful as managers. Engineering managers must not only be technically competent, but they also must understand the business aspects or organizations. Some believe that engineers move into management because the technical path is truncated once a certain level is achieved (Roberts and Biddle, 1994). Roberts and Biddle (1994) discuss the human resource perspective of why engineers move into management. Organizations believe engineers move into management because the upward mobility of technical professionals is limited (Kowtha, 2008). Within the study, Roberts and Biddle (1994) ask a series of questions on the transition to management regarding who gets promoted, if technical workers make good managers, if individuals return to the technical track once they leave, and if the best technical workers leave because of limitations in upward mobility. Organizations are faced with decisions of who is moved into management and for what reasons. In order to keep the best technical people in technical jobs, organizations may move average or below-average employees into management positions (Riley et al., 2013). There has been research that focuses on the learning styles needed to be an effective team leader and engineering manager (Wyrick, 2003). Wyrick (2003) states that understanding how engineers process information and how others process information will make us more effective. However, there was no literature found that connects the engineering manager with defensive routines. These areas are studied as separate entities. Therefore, there is a gap in the literature review. This study serves as a means to fill that gap by examining if defensive routines are more prevalent in engineering managers than non-engineering managers.

3. METHODOLOGY

3.1 Description of the hypothesis

The hypothesis of this study is defensive routines are more prevalent in engineering managers than non-engineering managers. This hypothesis was developed based on several reasons. First, many engineering education programs do not adequately prepare engineering students for corporate team environments (Farr and Welsh, 1997). In addition, other variables in engineering education can further develop the defensive routines. For example, high pressure grading evaluations can contribute because the student does not want to fail. Often schoolwork consists of yes or no answers; this eliminates the ability to manage ambiguity. Since the ambiguity is not there, there is no reason to inquire. Model II behavior is based on the ability to inquire. These are all factors that are related to defensive routines and research exists that supports this behavior. For example with "high pressure grading", there is work on motivation that suggests that highly extrinsic motivation drives people toward only wanting to solve

simple, unambiguous problems so they can get the reward such as the good grade (Katz 2005). Second, engineering managers are more prone to product and process development as opposed to visionary thinking. Third, engineering managers struggle with the acceptance of failures of system implementation (Argyris, 1991).

3.2 Participant Packet

Upon confirmation of their participation, the managers were sent a copy of the participant packet. This packet was comprised of an introduction letter from the researcher, a consent form that is in alignment with the Institutional Review Board's (IRB) requirements to confirm anonymity, a questionnaire to capture more demographic information about the individuals, and the case to complete. The participants were given two weeks to complete the cases. The survey data is used to capture some background information about the managers and is used to examine any commonalities and trends that might surface in the data. The survey asks the following questions:

1. What is your undergraduate degree in?
2. Do you have an advanced degree(s)? If so, what is it in?
3. How many years of experience in management do you have?
4. How many total individuals do you manage?
5. Do you manage engineers? If so, how many?
6. Do you manage other managers? If so, how many?
7. Have you received any in-house management and/or non-credited management training? If so please describe briefly.
8. What is your age?

This research examines the results of two case studies that the managers may have encountered. The first case study is a pre-determined situation based on the manager addressing challenges with the Office Administrator. This scenario was based on a study of Argyris and Schon's theories of action (Rossmore, 1984) and was selected because many managers have to work with an Office Administrator. The goal of having a pre-determined situation provides the opportunity to see various responses of the managers when addressing with the same situation. In addition, having a difficult conversation may cause threat or embarrassment, which could trigger defensive routines. The second case study is a situation that the manager may have encountered with their manager, employee, or colleague. The cases follow the structure of case studies from Argyris (1982). Each case begins with the description of the problem then proceeds in the following format:

1. **Cause of the problem**

What do you think happened to case the problem? Who or what is primarily responsible for the problem? (If someone or something is)

2. **Goals**

Describe the goals/objectives of the people involved. How certain of this are you?

3. **Strategy**

Describe what your strategy would be for obtaining these goals. Please be as specific as possible.

4. **Scenario**

This section is where the dialogue is captured and uses the Left Hand Column approach. On the left side of the paper, the managers write down their private thoughts and feelings, while writing what was actually said on the right hand side of the paper.

3.3 Participant Demographics

The participants for this study were all managers who were known to the researcher. These managers were selected because the assumption is that they would be truthful in their responses to the case studies and be without fear of retaliation from their employer. The managers represent a diverse cross section of industries. The participants were contacted via email or phone call from the researcher requesting their assistance. The managers were requested to reach out to additional potential research participants. The engineering managers are classified as managers who have an educational background in engineering disciplines such as but not limited to electrical, mechanical, civil, aerospace, etc. The non-engineering managers are managers who have undergraduate degrees in areas such as finance, human resources, business, etc. However, there was a third category of managers that was considered. These are managers that do not have degrees in engineering, but they do have scientific backgrounds such as physics, mathematics, or computer science. As such they were analyzed separately. For this study, 55 managers were contacted to participate, 41 managers confirmed their participation, and 27 packets were received. This yields a response rate of 49%. This study uses a small sample size in order to decrease the ability to draw broad conclusions (Riley et al., 2013).

3.4 Scoring Packet

This section describes the scoring packet that was developed by the researcher to obtain quantitative measures. The scorer packet was provided to the scorers for scoring the completed packets. The packet contained an introduction from the researcher, the categories to be scored, instructions on how to code the paragraphs, the behavior tally sheet, and an example of a case that has already be scored. The data was scored based on the scoring method developed by Marasigan-Sotto to determine whether an individual is operating in Model I or Model II behavior (Marasigan-Sotto, 1980). This scoring method was developed specifically to score whether or not an individual is operating in Model I or Model II behavior. However, there were some enhancements made to the scoring categories to account for additional defensive routines. The scoring packet was enhanced to add the following categories: Bypass, Face Saving, Fancy

Footwork, Mixed Message, Protective Support, Self-Censoring, and Unilateral Control. The process of scoring the packets was outlined in the scoring rubric for the scorers' reference. The packets were coded using roman numerals, capital letters, and numbers. The approach was to count the behaviors that were used. The two categories were Model I Theory-In-Use and Model II Theory-In-Use and each contained several subcategories. The choices for Model I Theory-In-Use were bypass, face-saving, fancy footwork, mixed message, protective support, self-censoring, un-illustrated evaluation, un-illustrated inquiry, un-illustrated attribution, and unilateral control. The categories for Model II were advocacy, attribution, evaluation, inquiry, and testing. Under each category is an example of a type of tactic that might be used in the particular routine. The common cues can be described with key indicators or through certain types of examples. Some of the defensive routines are identified based on the perception of the reader. The public dialogue section was the portion of the packet that was scored for the defensive routines. This section outlines the conversation that took place between the manager and the employee. Only the dialogue of the managers was scored. The dialogue of the employee was not scored because there was not enough background on the employee to make an accurate decision on which behavior was being exhibited. Each line of dialogue of the manager was assessed against the defensive routine categories in the packet to determine which behavior was exhibited and recorded on the Behavior Tally Sheet. The sum of the Model I and Model II categories were then determined. Whichever behavior had the highest count according to the behavior tally sheet was the behavior that was captured for that manager. To address the biasing in the scoring and determine inter-rater reliability, two additional scorers were recruited to score along with the researcher. The scorers were comprised of one graduate student and one undergraduate student, who both have about the same level of knowledge as one another regarding defensive routines. Two additional scorers were utilized in addition to the researcher to address inter-rater reliability and to reduce the bias as much as possible. Inter-rater reliability is defined as the extent information is being collected is being collected consistently (Keyton et al., 2004). It focuses on ensuring that there is a certain level of agreement among those examining the data. The typical level of agreement is 0.7 (Krippendorf, 2004). There are some methods and best practices that can be employed to improve the inter-rater reliability. The key measuring factor is the rater. Raters who are familiar with the constructs should be chosen and thoroughly trained in the scoring and coding of the data (Keyton et al., 2004). Another best practice is to ensure that the raters understand the coding procedures (Wilson, 2001). The scorers were provided a two and a half hour training session with the researcher in which the scoring packet was reviewed in detail. The two additional scorers were not familiar with this type of data analysis. During this training session, the researcher reviewed the scorer packet with the additional scorers placing emphasis on the definitions and the types of categories that would be scored. After reading through this information, the first case study response was scored together to ensure consistency in the scoring methods. The scorers agreed on this packet. After the training session, the scorers were provided copies of the case study as well as copies of the behavior tally sheets to complete their scoring. The scorers were given a week to complete their scoring. Before the week had expired, there was a conference call with the scorers and researcher to review an additional case to ensure consistency, as well as answer any questions that they scorers may have had. At that time, the group scored packets 2 and 3 of the case study and there was 100% agreement on the theories-in-use of the managers. After gaining a clearer perspective of inter-rater reliability and reviewing additional literature, the initial approach of using percentage agreement was found to not be the best approach. Percentage agreements do not take into account chance agreements since chance is likely to inflate the agreement (Grayson and Rust, 2001). The key differences in the coding results stem from how each dialogue line was coded. Because the results were obtained from a count, there was no margin to account for those managers that fell on the borderline of Model I and Model II. To increase the inter-rater reliability and reduce the level of chance agreement, the scorers met again to re-score the cases together to ensure that there is a common level of understanding of the data. Initially, the scorers scored the data separately. The scorers were provided additional literature to review regarding defensive routines to supplement the scoring packet. The goal of scoring the cases together is to encourage open dialogue as to how results were reached. Once the case studies were scored completely, the inter-rater reliability was calculated. The inter-rater reliability was calculated as shown in Equation 1:

$$\text{Inter-rater Reliability} = \frac{\text{Number of Packet Agreements}}{\text{Number of Packets Scored}} x100 \quad (1)$$

4. RESULTS

This section discusses the results of the case study and takes an in-depth look at the demographics of the participants and provides a summary of the responses to the questionnaire data to provide an overview of the type of managers that participated in the case study. The first step was to determine how many respondents were actually engineering managers and how many were non-engineering managers. In this study, engineering managers were defined as managers who had completed the requirements for a Bachelors degree in an engineering field such as electrical, mechanical, industrial, etc. Non-engineering managers were classified as any other degree

completed. However, there were a number of managers who completed degrees in technical and scientific areas such as computer science, physics, information technology, mathematics, and others. These managers were analyzed in a separate group defined as "Other". Therefore, 17 of the managers managed other engineers while 10 of the managers did not.

5. DEMOGRAPHIC ANALYSIS

The data from the questionnaire was analyzed to determine if there were any patterns based on the various generations. Table 1 shows a tabular view of the information received from the questionnaires. Of the 27 packets submitted 10 were male managers and 17 were female. The age of the managers ranged from 26-62 years old. The average age was 44 years old. The median age was 45 years old and the standard deviation was 9.81. The managers were asked about their educational backgrounds. The highest percentage of undergraduate degrees was in business at 26% and the highest number of graduate degrees was Masters of Business Administration degrees at 33%. There were three managers who were awarded doctorates in Nuclear Physics, English, and Organizational Leadership. The participants were also asked how many years of management experience they had. The average years of management experience was 13.85 years. The lowest number of years of management experience was 1 year, the highest number was 30 years, the median was 14, and the standard deviation was 9.00. There was a wide range of the number of individuals that the managers supervise since the participants represent different levels of leadership within their respective organizations. The average number of individuals that the managers supervise is 27.11. The least number of individuals that the managers supervise is 0, maximum is 250, median is 12, and standard deviation is 48.06. The engineering managers were defined as individuals who not only have engineering education, but also manage engineers. Of the participants, 17 of the managers supervised other engineers while 10 of the managers did not. In addition, those managers who supervised engineers were asked the number of engineers that they managed. Again, depending on the level of leadership and the type of organization, this number could range. The average number of engineers that the managers supervise is 15, lowest is 0, maximum is 250, median is 2, and standard deviation is 48.06. Depending on the level of leadership, there is a possibility that the managers could manage other managers. For this study, 11 of the managers supervise other managers, while 16 of the managers do not supervise other managers. According to the data received, the average number of managers that the participants supervise is 5, minimum is 0, maximum is 45, median is 0, and standard deviation is 11.89.To gain an understanding of how the managers were prepared to be managers, they were asked about the training they received both within their organizations and external to their organizations. The training was broken into three areas for engineering managers, non-engineering managers, and others as represented in Tables 2-4 in Annexure, respectively.

6. CASE STUDY 1

This section provides an overview of the qualitative responses that were required in the case study. The participants were given the following instructions: Describe a situation or problem that you have experienced in your time as a manager. It can be a recurring situation or a onetime occurrence with your subordinates, peers, or manager. Who are the important people involved and what is your relationship to them? Feel free to use generic names (i.e. "Employee A", "John Doe"). Again, this case study is open-ended and there were a variety of situations that were discussed. There was some overlap as several managers were experiencing similar situations with employees such as underperformance, undervalue of management, personal problems affecting work performance, insubordination, working with other employees, and training colleagues.

6.1 Cause of the Problem

In this section, the managers were asked what they thought was the cause of the problem and who or what is primarily responsible for causing the problem. There was a range of responses to answer this question; however, many managers made comments regarding that employees were not familiar with job duties stemming from not being adequately trained or transitioned. The managers who experienced insubordination believed the cause was due to company cultures and faulty organization reporting.

6.2 Goals

In this section, the managers were asked to describe the goals/objectives of the people involved and inquired how certain they were of this. The common themes in the responses were that the goal of the manager is to get the job done, delegate tasks, and find out what the problem is. Many of the managers had the goal of having a successful team and smooth running organization.

6.3 Strategy

In this section, the managers were asked what would be their strategy for obtaining the goals that were listed in the previous section. Strategies included face-to-face meetings with the employees, additional training, and transparency to their teams, feedback, listening, involving human resources, and redistributing workloads.

6.4 Scenario

The scenario section is where the private thoughts and feelings are captured along with the public dialogue. The scorers scored the dialogue only of the manager based on the instructions in the scoring packet. The final tally only calculated whether the manager operated in Model 1 Theory-In-Use or Model II Theory-In-Use. Scorer 1 and Scorer 2 had an overall 80.77% scoring agreement among

the scored cases. Scorer 1 and Scorer 3 had an overall 88.46% scoring agreement. Scorer 2 and Scorer 3 had 80.77% . Because there was only the choice between Model I and Model II behavior, there was either 0% agreement or 100% agreement. The total average of scorer agreement is 83.33%. A tabular view of the managers and how they measured is shown in Table 5. Eight of the engineering managers operated in Model I Theory-In-Use, five non-engineering managers operated in Model I Theory-In-Use, and six of the managers classified as "other" operated in Model I Theory-In-Use. Only one engineering manager operated in Model II, three non-engineering managers operated in Model II Theory-In-Use, and three of the other managers operated in Model II Theory-In-Use.

7. CASE STUDY 2

This section takes an overview of the qualitative responses that were required in the case study. The participants were given the following instructions: Describe a situation or problem that you have experienced in your time as a manager. It can be a recurring situation or a onetime occurrence with your subordinates, peers, or manager. Who are the important people involved and what is your relationship to them? Feel free to use generic names (i.e. "Employee A", "John Doe"). Again, this case study is open-ended and there were a variety of situations that were discussed. There was some overlap as several managers were experiencing similar situations with employees such as underperformance, undervalue of management, personal problems affecting work performance, insubordination, working with other employees, and training colleagues.

7.1 Cause of the Problem

In this section, the managers were asked what they thought was the cause of the problem and who or what is primarily responsible for causing the problem which is similar to Case 1. There was a range of responses to answer this question. Many managers made comments regarding employees not familiar with job duties resulting from not being adequately trained or transitioned. The managers who experienced insubordination believed the cause was due to company cultures and faulty organization reporting.

7.2 Goals

In this section, the managers were asked to describe the goals/objectives of the people involved and inquired how certain they were of this. The common themes in the responses were that the goal of the manager is to get the job done, delegate tasks, and find out what the problem is. Many of the managers had a goal to have a successful team and smooth running organization which was similar to the responses in Case 1.

7.3 Strategy

In this section, the managers were asked what would be their strategy for obtaining the goals that were listed in the previous section. Again, the responses were very similar to case 1 in that they mentioned that strategies included face-to-face meetings with the employees, additional training, maintain a level of transparency to their teams, compile feedback, listen more, involve human resources, and redistribute workloads.

7.4 Scenario

The scenario section is where the private thoughts and feelings are captured along with the public dialogue. The scorers scored the dialogue only of the manager based on the instructions per the scoring packet. The final tally only calculated whether the manager operated in Model 1 Theory-In-Use or Model II Theory-In-Use. Once the case studies were scored completely, the inter-rater reliability was calculated. Scorer 1 and Scorer 2 had an overall 80.77% scoring agreement among the scored cases. Scorer 1 and Scorer 3 had an overall 88.46% scoring agreement. Scorer 2 and Scorer 3 had 88.46% scoring agreement. The total average of scorer agreement is 84.62%. A tabular view of the managers and how they measured is shown in Table 6. Eight of the engineering managers operated in Model I Theory-In-Use, five non-engineering managers operated in Model I Theory-In-Use, and six of the managers classified as "other" operated in Model I Theory-In-Use. Only one engineering manager operated in Model II, three non-engineering managers operated in Model II Theory-In-Use, and three of the other managers operated in Model II Theory-In-Use.

8. ADDITIONAL ANALYSIS

Many inferences can be drawn from examining the demographics and correlating data for each of the manager participants. The age demographics were analyzed to determine which generations operated more in Model I Theory-In-Use or Model 2 Theory-In-Use. The 27 participants were categorized as Baby Boomers, Generation X, and Generation Y. The Baby Boomers are the managers that were born between 1946 and 1963 and the Generation X are the managers that were born from between 1964 and 1980. The Generation Y managers, also known as millennials, are all those born after 1980. After grouping, there were a total of 11 managers that would be classified as Baby Boomers, 15 managers classified as Generation X, and 1 manager classified as Generation Y. According to Case Study 1, there were 5 Baby Boomers that operated with a Model I Theory-In-Use and 6 that operated with a Model II Theory-In-Use. For Case Study 2, 7 operated with Model I Theory-In-Use, while only 3 operated with Model II Theory-In-Use. For the Generation X managers, there were 8 managers that operated in Model I Theory-In-Use behavior and 6 that operated in Model II Theory-In-Use behavior for Case Study 1. For Case Study 2, 11 of the Generation X managers operated in Model I Theory-In-Use, while only 4 operated in Model II Theory-In-Use. For the Generation Y manager, this manager operated in Model I Theory-In-Use for both cases. Examining the behaviors according to gender can also lend

some additional information in how defensive routines are prevalent. In Case Study 1, there were 5 males who operated in Model I and 5 who operated in Model II. In Case Study 2, there were 7 males who operated in Model I and 2 who operated in Model II. In Case Study 1, there were 9 females who operated in Model I and 7 who operated in Model II. In Case Study 2, there were 12 females who operated in Model I and 5 who operated in Model II. An interesting finding was that managers switched from Model I to Model II behavior in the two cases. There were 11 managers whose Theory-In-Use changed in the second case. There were 3 managers who changed from Model I to Model II, whereas there were 8 that changed from Model II to Model I. There is a possibility that second case, which is a case from their own personal experience, triggered a stronger reaction because the manager may be more passionate about that particular situation.

9. CONCLUSION

Understanding how engineering managers behave when put in certain situations can be beneficial to an organization. This information can allow organizations to develop training and coaching methods to reduce undesired behaviors in their managers. The purpose of this study was to use the scoring method to determine whether defensive routines are more prevalent in engineering managers than non-engineering managers. Based on the results of the scoring, defensive routines are more prevalent in engineering managers. As shown in Tables 5 and 6, more engineering managers operated in Model I Theory-In-Use than non-engineering managers. Therefore, in revisiting the original hypotheses, we would fail to reject the hypothesis that defensive routines are more prevalent in engineering managers than non-engineering managers. We would fail to reject this hypothesis because according to the results, engineering managers illustrated more defensive routines than non-engineering managers.

10. FUTURE WORK

This study explored a different arena in terms of engineering managers. To date there has not been a comparison study performed of engineering managers against other types of managers. This study used methods to see if there was a difference in engineering managers versus non-engineering managers and the data shows that there is. This opens the door to several actions of future work. Intervention methods could be developed specifically for engineering managers to help bring awareness to their behaviors and how to improve upon them. In addition, training curriculum could be developed for organizations and universities to bring awareness to this area as well. The literature illustrates that there is a clear gap in the training of engineering students that prepares them for entry into the organizational environments. There could be more research performed in analyzing the personality traits of the managers. As mentioned in a previous section, the Big Five Survey is an instrument that could be used to capture this data. In order to collect this data at a later time, a plan would need to be put into place. The biggest challenge would be for the managers to find time to complete the survey. The approach would be to obtain the additional information on their personality traits. Lastly, because this was a qualitative study, statistical analysis was not conducted on the dialogues of the case studies. Therefore, future work could develop statistical tools to further validate the scoring method used.

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ANNEXURE

Table 1: This table shows a summary of the demographics of the participants.

Age	Yrs of Management	Individuals Managed	Engineers Managed	Managers Managed	Undergraduate Degrees	Advanced Degrees
26-35 yrs, (8)	0-9 yrs, (9)	0-24, (18)	0-9, (20)	0-9, (22)	Biology, (1)	Accounting, (1)
36-45 yrs, (7)	10-19 yrs, (9)	25-49, (6)	10-19, (3)	10-19, (2)	Business, (7)	Business Administration, (10)
46-55 yrs, (7)	20-29 yrs, (7)	50-74, (1)	20-29, (1)	20-29, (1)	Computer Science, (3)	Engineering Management, (3)
56-65 yrs, (4)	30+ yrs, (2)	75+, (2)	30+, (3)	30+, (2)	Electrical Engineering, (5)	English, (1)
					General Engineering, (1)	Industrial Hygiene, (1)
					Industrial Engineering, (3)	Information Management, (1)
					Marketing, (1)	Management Information Systems, (1)
					Mathematics, (1)	None, (8)
					Mechanical Engineering, (1)	Physics, (1)
					Management Information Systems, (1)	Telecommunications Management, (1)

					Physics, (1)	

Table 2: Training completed by engineering managers

Engineering Managers		
Management within the Law	Team Basics	Objectives and Deadlines
Company Policy	Communication	Excelling as a Manager or Supervisor
Conflict Resolution	Legal Issues for Managers	Transition to management
Project Management	General Leadership	Leadership Development
First Line Leadership	Coping with Difficult People	ATT Leadership Training
Managing from the Middle	Myers-Briggs	GE Leadership Training
Delegating	Invest in your Career	Senior Leadership Training
Coaching Others	Earned Value Management Systems	Executive Program I
Setting Expectations	Value Engineering	Executive Program II
Time Management	Essentials of Communicating with Diplomacy and Professionalism	Executive Program III
Managing Multiple Projects		

Table 3: Training completed by non-engineering managers

Non-Engineering Managers	
Lean Six Sigma Greenbelt	Healthcare Management and Administration
Middle Management Training	Sexual Harassment
General management training	Crucial Conversation
Human Resources	Infantry Officer Basic Course
Connections Training	Infantry Officer Advanced Course
Workplace violence	Combined Arms and Services Staff School
Harassment Policy Training	Command and General Staff College
Information sharing	Introduction to management
Management development 12 week program	Speaking and Presentation Skills

Table 4: Training completed by other managers

Others	
Well-managed Health Care Organizations	Senior Leadership Training
Ethics	Executive Program I
Human Resources	Executive Program II
Governance	Executive Program III
Project Management	Transition to management
Conflict & Acquisition Training	Management Development
Conflict Management	University Executive Program

Table 5: Managers scoring in terms of Model I and Model II Theory-In-Use.

	Engineering Managers	Non-Engineering Managers	Others
Model I	6	5	3
Model II	3	4	5

Table 6: Managers scoring in terms of Model I and Model II Theory-In-Use.

	Engineering Managers	Non-Engineering Managers	Others
Model I	8	5	6
Model II	1	3	3