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FOLLOWER HELPING BEHAVIOR IN ENGINEERING DESIGN TEAMS:
THEORETICAL CONSTRUCTS AND PROTOCOL ANALYSES

A Thesis
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science
Mechanical Engineering

by
Jessica A. Plaunt
August 2020

Accepted by:
Dr. Joshua D. Summers, Committee Chair
Dr. Marissa Shuffler
Capt. Richard J. Watkins

ABSTRACT

The purpose of this research is to develop an understanding of followership behaviors in engineering design team situations by studying leadership behaviors. While leadership in engineering design teams has been studied from role, function or behavior, and individual characteristic perspectives, no studies appear to examine (follower) helping behavior in the context of an engineering design team. Understanding this behavior can lead to intervention strategies that might be employed to improve team dynamics and performance. To this end, a theoretical framework of follower behavior is defined based on a review of “helping behavior” from the literature. Characteristics of follower helping behavior include exhibiting citizenship, voluntary, and extra-role behaviors while not upsetting the status-quo. A model is developed that links leadership style, follower character/mindset, social exchange relationships, influence tactics, group dynamics, and follower performance. The central behavior studied here is helping behavior. The literature-based framework reviewed is primarily based on studies employing survey data, with only a single study using observational studies. Therefore, data presented from a previous protocol study is re-examined in search of patterns of conversions of followers to leaders through behavior modeling. In the previous study, eight teams of four graduate engineering students were tasked with generating a function model for a design prompt. These teams were video recorded, and their behaviors coded for seven leadership actions. Of the eight design teams previously studied, there were 325 total leadership behaviors coded. A follower-to-leader transition pattern was defined where a follower in one behavior immediately exhibited leadership behavior in the next coded activity. Of the

activities coded, 131 (40.3%) possible follower helping actions have been identified. These are examined further to determine whether there is a correlation between the initial leadership behavior type and the immediately occurring follower-leader leadership behavior type. Patterns are also sought to determine how often the initial leader also changes to a follower in the subsequent activity, termed a follower-leader. This study shows that there are follower patterns that are found in design activities. Further, these patterns are related back to the (follower) helping behavior model that is derived from the literature, specifically the influence tactics that include: inspirational appeals, consultation, and supplication; as well as social exchange relationships of leader-member exchange (LMX), team-member exchange (TMX), and affect-based trust. Finally, this study provides suggestive evidence of patterns to motivate future systematic study of followership in engineering design.

DEDICATION

This thesis is dedicated to my parents, Kim Davis and Dennis Plaunt, along with my “little” brother Christopher Plaunt. Their response to my wanting to go back to graduate school after 11 years in industry for Mechanical Engineering was, “finally!” My family has always been there to support my efforts. I also wish to dedicate this to my undergraduate physics advisor, Dr. J. Erik Hendrickson, who was always open to conversation whether about school or life, and who had encouraged me to explore the world so I could discover what I wanted from my life. Both he and my previous physics classmate Samantha Falkner were very helpful in aiding me in figuring out how to return to being a student again.

ACKNOWLEDGEMENT

I would like to thank my advisor Dr. Joshua D. Summers who provided a very holistic learning experience for me at Clemson. Without his patience, kindness, and wisdom on when I needed to be pushed – I would have not done a thesis. Through the process of writing this thesis, I have learned much more than I realized I would. Thank you for that.

My experience at Clemson would not have been nearly as enjoyable without being part of the CEDAR lab. After a series of interesting industrial experiences, the CEDAR lab environment reminded me how working around people could be positive and very helpful. I specifically am very thankful to Travis Roberts and Josh Ortiz for their assistance in helping me learn how to use MatLab. That assistance morphed into a friendship with both of them and their respective significant others – an excellent group of friends, no doubt for a very long time to come. Additionally, I appreciated the positive attitude from lab neighbor Brian Davenport and the intermittent guidance from Apurva Patel and Akash Patel, AP #1, and AP #2. Friday lab lunches and other outings would not have been nearly as interesting without the great conversation from Vijay Sreedhara and Shubam Kulkarni.

Last, but not least, I thank Josh Ortiz for his contributions to the Motivation section of 0 as well as both Josh Ortiz and Malena Agyemang for their contributions to the literature review in Chapter Two.

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Chapter One: MOTIVATION: STUDYING LEADERSHIP

Researchers have long struggled to frame the idea of leadership within a single, concise definition. Many have sought patterns in available literature in an effort to formulate a consensus, only to realize that nearly every attempt to define the concept has characterized it in a different way [1–5]. Perhaps it is due to this elusiveness that it has become common practice to describe leadership on the basis of its attributes rather than define it directly [6]. These attributes have been broadly classified as either characteristics of the leader, of the followers, or of the situation [7]. Further, each of these can be viewed either from the standpoint of a leader or that of the follower, since both play an active role in the implementation of leadership [8]. Amorphous though it may be, understanding the nature of leadership carries significant value. This is because of the affect that leadership can have on the organizations and individuals under its influence [9].

Leadership in the context of engineering design teams has been examined in terms of increasing creativity based on the social structure of the design teams [10,11] or in terms of shared leadership [12]. However, the definition of what leadership means in engineering has not reached a consensus [6,13–16].

1.1 Engineering Design Team Leadership Studies

Leadership has been studied in the context of engineering design teams in the mechanical engineering department at Clemson University through both case [15,17] and protocol studies [18,19]. In one case study, it was found through triangulation that team leaders could be recognized by direct observation, team member evaluation, and external

faculty advisors [15]. Self-identification as a leader was found to not align with the other methods. Team members exhibiting leadership behaviors often did not self-identify as the team leader [15]. This study tracked a single team of capstone design students through a single semester project, with one of the researchers embedded in the team as a graduate coach.

A later case study followed student design teams in a capstone project in a less intrusive manner [18]. In this approach, student design teams were given access to an extra prototyping and collaborative space in exchange for being video recorded while they were using the space. These videos were analyzed against a coding scheme to identify leadership behaviors during the sessions. These videos were complemented with videos during the weekly design review sessions held with faculty advisors. It was found that all students exhibited leadership behaviors, with the leadership role switching continually both during meetings and across the semester. The coding scheme required at least one immediate person to be influenced by the originating leadership behavior. This influenced person is defined as a follower.

This same coding scheme for video observations was applied again in replicated design activities [20]. Teams of graduate students were given the task of creating a function model for a given design prompt. The participants were drawn from two pools.

From the first pool, five teams of four students were given the task during a summer workshop on engineering design research. This summer school brought 30 graduate students together for two weeks to learn about design research methods such as controlled user experiments, observational protocol studies, and case study methods. To provide the

students with an opportunity for insight into protocol studies, they were asked to participate in one as a subject.

From a second pool of participants, four teams were formed from a regularly scheduled advanced design methods graduate course. These students were offered extra credit in the course for participating in the experiment. The study is based on similar protocol studies that explored how individuals create function models [21–23].

A function model is how a design problem is decomposed and represented graphically to show the inputs and outputs of a design concept with unique line types utilized to represent how material, energy, and information flow in and out of the design concept [24]. One of these function models is shown in Figure 1.1.

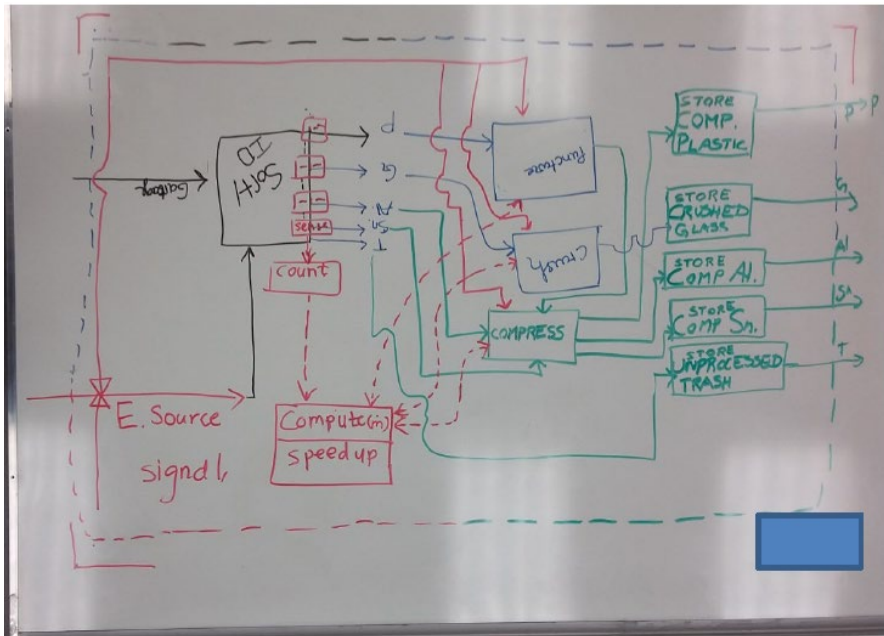


Figure 1.1. Function Model Example [20]

The results from the protocol study showed that, while the design teams began their work on the function models without a formal leadership structure, those individuals who initially exhibited more frequent leadership behaviors continued to do so throughout the exercise [19]. Further, all members in every team exhibited some leadership function during the hour long activity [19]. Thus, all team members served as a leader at some point in the design activity. Some leadership functions, such as empowerment and consideration, were found infrequently throughout the teams, likely attributed to the short duration of the activity and low group familiarity. Just as every team member exhibited leadership behaviors, every member also served in the role as a follower. No detailed analysis was done on this phenomenon, until that presented herein (Chapter Four).

1.2 Followership and Helping Behavior

Followership and more specifically, follower helping behavior, in engineering teams is of interest because it is capable of improving performance from both individuals and groups [25–27]. This is of interest because improved performance from subordinates has a positive impact for the companies the followers work for, in the aggregate the contribute to the success of the organization [28,29]. In engineering, while considering the amount of work which is completed by teams in engineering, collaboration and leadership in engineering teams is vital to the success of most design efforts [30–34]. It follows then that considering leadership should also include a look at followership, and more specifically, helping behavior, in engineering design teams.

Given that followers typically make up 80% of a company [35], and courageous followers have the ability to improve institutional integrity, paired with the study of followership still being in its infancy [29], followership, and followership in engineering design teams is a subject which has many research opportunities to explore.

Chapter Two

FOLLOWER HELPING BEHAVIOR: WHAT IS IT?

Follower helping behavior has not been studied in the context of engineering design, from a review of the literature. Further, the definition of follower behavior that is most common in the broader literature is focused on helping behavior. Several definitions of (follower) helping behavior are found in Table 2.1. These definitions are coded with respect to six characteristics (citizenship, voluntary, extra-roles, obligation, non-status quo upsetting, and structure). Citizenship behavior is also defined as Organizational Citizenship Behavior (OCB) and is a discretionary and often unexpected behavior exhibited by an individual which has a positive contribution towards the goals of the organization. These behaviors are voluntary in that their absence is not a punishable offense. It follows then that they are “extra-role” behaviors, or behaviors completed that are beyond the expectation of a job description [28]. Obligation is generally viewed in the context of exchange, or more specifically social exchange, where follower behaviors are exhibited in the context of an unspoken obligation [36]. The concept of helping behaviors which do not challenge the status-quo are behaviors which are not controversial [37]. The formal structure for this group of literature is referring to a formal corporate structure where there is a defined leader and subordinate [25,26,37–41].

Further, the type of research conducted, and the location of the study are included to highlight research opportunities. Most of the literature pieces reviewed here used data which was collected through surveys (S). One included mixture of survey and standard examinations [26], and a second piece included a mixture of survey and observational data

[27] (M). The research reviewed collected data in Germany (GE), United States (US), China (CH), and an unspecified location (U).

Table 2.1. Determining the Definition of (follower) Helping Behavior

Ref.	Definition of “Follower Helping Behavior”	Citizenship	Voluntary	Extra-Role	Obligation	No Status-Quo Upset	Structure (Formal)	Data Collection Method	Location of Research
[27]	Individual behavior that is discretionary, not directly or explicitly recognized by the formal reward system, and that in aggregate promotes the effective functioning of the organization [28].	X	X					M	US
[38]	A citizenship behavior where coworkers help their peers voluntarily, or act in a way to prevent work-related issues [42]. It is also a discretionary behavior which does not upset the status-quo which can be explained by social exchange in terms of the follower feeling obligated to return favorable treatment from a leader [42,43].	X	X		X	X	X	S	CH
[26]	As one facet of Organizational Citizenship Behavior (OCB), with helping behavior workers can show other workers how to be productive, going above and beyond the call of duty [44].	X	X	X			X	M	U
[25]	One of three facets originating from Organizational Citizenship Behavior (OCB) in that the behavior is helpful	X		X		X	X	S	GE

Ref.	Definition of “Follower Helping Behavior”	Citizenship	Voluntary	Extra-Role	Obligation	No Status-Quo Upset	Structure (Formal)	Data Collection Method	Location of Research
	and beyond expectations which are viewed as extra-role behaviors [28,45].								
[39]	Helping behavior is seen as being based in the theory of social exchange, as it is an obligation, or reciprocal based relationship [36]. It is also defined as a behavior where coworkers help their peers voluntarily, or act in a way to prevent work-related issues [42] and as an extra-role behavior [28], or outside of regular job requirements.		X	X			X	S	US
[40]	Helping behavior is one type of Organizational Citizenship Behavior (OCB) in which the follower would receive exemplary treatment from a servant leader and feel obliged then to return that effort in kind by performing beyond the expectations of their role [28,37,46,47].	X		X	X		X	S	CH
[41]	Helping behavior is defined here as a discretionary, individual, extra-role (beyond expectations) behavior which is done with the intention of benefiting peers or the group as a whole [48]. It originates from the altruism dimension of organizational citizenship behavior [49].	X		X			X	S	US

Interestingly, Table 2.1 illustrates that all the reviewed studies were conducted with survey instruments as the primary research method. This prior research [25–27,38–41]

was conducted in different countries, indicating that this behavior may be trans-cultural.

Finally, for this research, (follower) helping behavior is defined as:

a follower exhibiting voluntary, “extra-role” (beyond expectation) behaviors in a professional setting done without upsetting the status-quo in a formal leadership setting

An example of this behavior might include one co-worker voluntarily helping another co-worker to prevent the possible future occurrence of work-related problems. This behavior is one of the organizational citizenship behaviors (OCB). Other types of OCB include conscientiousness, sportsmanship, courtesy, or civic virtue [28]. OCB is defined here as a discretionary behavior which can easily be taken for granted, is not formally recognized or rewarded, but also supports the effective operating of an organization when the behavior is enacted by a single person in the aggregate [28].

To put helping behavior in the context of the follower, first followership is examined [29,35,50–52]. Secondly, leadership styles and their impact on helping behavior has been the focus of past research [25,26,37–41]. Some of the leadership styles studied include transformational [25,38], transactional [25], servant [40], military [26], and ethical leadership [39]. Further, the impact of leadership influence tactics, such as inspirational appeal, consultation, and supplication have been examined as compared to helping behavior [39,41]. Next, research has considered the leader-follower relationship in terms of the social exchange in terms leader-member exchange (LMX) and affect-based trust [38,40,41]. The follower mindset and its relationship to these considerations has been studied to determine the levels of positive reciprocity belief and prosocial motivation

inherent in the follower [38,40]. The following sections provide a review of this previous research to provide the context of studying follower behavior as it relates to helping behavior. Finally, helping behavior was examined in terms of task interdependence [27].

2.1 Followership Impact on Performance

Followership has been found to have a positive impact on organizational performance through different perspectives. The following sections explore these perspectives on the effective follower, helping behavior impact on performance, and on unit performance in military teams.

2.1.1 The Effective Follower

While many of the subsequent pieces reviewed here discuss the impact of different types of leadership, this piece confirms that leadership is not significant without looking at the impact the leader has on the follower [50]. Examining the follower is justified, as companies tend to spend 80% of their time on 20% of their population – their leaders [35].

In 1987, a bank was performing so poorly, that one department was forced to transfer the responsibility of the leader to the followers as they had recently been trained in self-management. With a combination of self-initiative and self-control, the subordinates were able to lead themselves and meet the goals of the organization [50]. Although the title of “leader” can be a designated one, managers also have follower responsibilities, as they often also report to a boss. Another suggested model is that instead of followers reporting to leaders, leaders and followers work together to achieve a common goal [51]. Another way to view leadership is as a cumulation of followership actions [29].

This suggests that organizational goals can be met when there is a level of fluidity between leadership and followership behaviors in expectations of both designated leaders and followers.

However, with the general focus on leaders and leadership, the role and value found in the follower is often overlooked [50,51]. In examining the effectiveness of a follower, two measures were used: the level of which critical thinking was employed, and the level of passiveness compared to activeness [50]. As shown in Figure 2.1, with these measures, five types of followers were defined: Alienated, Sheep, Survivor, Yes People, and Effective [50].

The “Alienated Follower” is capable of critical thinking, but no longer actively applies it in the workplace. The “Sheep” perform only what is asked of them and do not offer initiative. The “Survivor” is able to withstand change but also approaches tasks very cautiously. The “Yes People” are dependent on leadership for direction and are often favored by bosses as they are active but dependent. Conversely, the “Effective Follower” is an independent thinker who is also active in completing their work duties [50]. The “Effective Follower” is further defined as being effectively self-managing, committed to an objective or person beyond themselves, and are not just credible and honest, but also courageous [50].

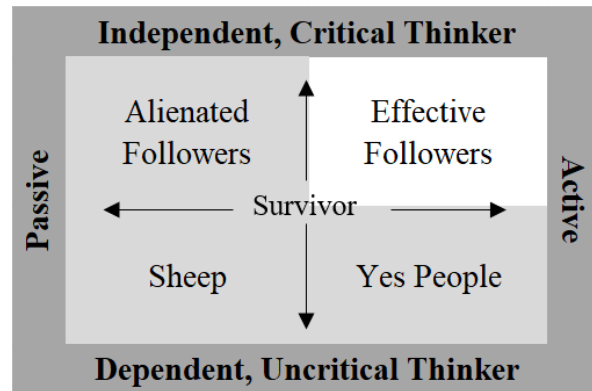


Figure 2.1. Types of Followers [50]

In several interviews, “Effective Followers” who were both in line with organizational goals and comfortable taking risks who proposing solutions along with problems had been able to provide solutions for overlooked problems [50]. More recently, the effective follower has also been called a “Star Follower” who are independent thinkers that are very active and emanate positive energy [that doesn’t overwhelm others] - some regard these star followers as “leaders in disguise” [29]. Even so, one interviewee was perceived unfavorably by mid-level management, but received support from her high-level management [50]. Another trait found in the “Effective Follower” is courage. This trait has them viewed by others as a knowledgeable and trusted resource [50]. The courageous follower also has the opportunity to increase institutional integrity in place of groupthink [29].

However, a courageous effective follower paired with an unethical leader then causes perceived problems for this leader [50]. Another way to look at this: a follower is more in tune with the day to day operations and is in a better position to warn leadership

in order to prevent catastrophes [29]. Unfortunately, this may result in a follower which becomes a whistleblower or decides to leave instead of become complacent to an unethical situation [52].

To encourage followership, several organizational structures are suggested. In smaller groups, no designated leader can encourage all group members to take equal responsibility for the group's success [50]. This work suggests this is the model that engineering design teams take on.

Additionally, in small groups rotating leadership roles can provide valuable insights to the team members. This is because experiencing the role of being leader can be valuable in understanding how to be an effective follower [50]. Assuming that not all members of the team are excellent leaders, a rotating designated leader can teach followers how being a good follower can compensate for ineffective leadership [50].

Delegation and a reward system can also encourage followership in an organization. Delegation empowers the follower to think independently and take responsibility for their decisions [50]. A reward system for good followership can be complicated as this may encourage mixed treatment for effective followers [50]. Effective followers in a reward system may make leaders who rely on the "Sheep" and "Yes People" type of followers uneasy [50]. Additionally, research showed that in a reward based system about half of the time effective followers received substantial awards, whereas the remaining half were punished for exercising their own judgement instead of conforming [50].

2.1.2 Helping Behavior and Group Performance

The impact of task interdependence on group performance paired with helping behavior was examined through a competition for business school students in southeastern United States [27]. Organizational Citizenship Behavior (OCB) was defined as a discretionary behavior from an individual which in the aggregate aid in the success of the organization, but is not an behavior that is expected or formally rewarded [28]. Helping behavior and OCB were used interchangeably. Task interdependence is when members of a group are dependent on their team members to complete their work efforts [53]. Of the two hypothesis investigated, one applies to the effort here: whether or not helping behavior would have a positive effect on group performance, independent of high or low task interdependence environments [27].

The business students were divided into 62 groups of three individuals. Each group was assigned to a low or high task interdependence task prior to their arrival to the competition. The individuals also completed pre- and post-competition surveys, allowing for the amount of preparation completed by the individuals to be accounted for [27]. Groups were scored on speed and accuracy while making attempts at reproducing a card sequence in specified time period. The card sequencing had been adopted for three person teams from a previous experiment [54].

Sixteen graduate students received training and then coded the behaviors exhibited by the different business student teams at a time after the competition was completed [27]. The statistical analysis completed across the high and low task interdependence, speed and accuracy of the group performances, and amount of observed helping behavior revealed a

positive main effect on group performance over both low and high task interdependence. This is shown graphically in Figure 2.2. Future work recommended completing similar studies but in a more complex environment that included both observations over a longer period of time and differing settings. This is suggested to improve the understanding of coworker OCB and group performance [27].

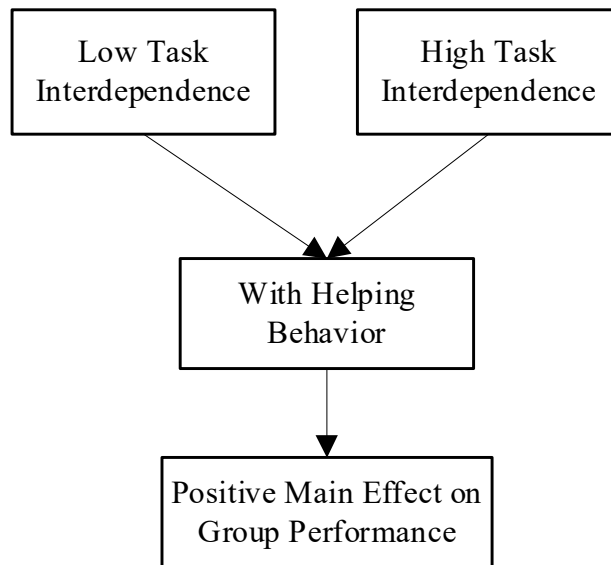


Figure 2.2. Helping Behavior and Group Performance

2.1.3 Unit-Level Helping Behavior and Effectiveness

The impact of unit effectiveness was examined against how much helping behavior the unit reported as being present for 31 military (Army) units with an average of 78 soldiers per unit [26]. The unit-level organizational citizenship behavior (OCB) differs from how it is otherwise described above in Section 2.1.2 as in this instance it is viewed “as the normative level of OCB performed within the unit” [55], not how the individuals each contribute to the whole of the unit in the aggregate. Helping behavior was the facet

of OCB focused on as it was expected for the team to help show each other how to be productive [44]. In this case the measures of productiveness were standard military tests of combat readiness, physical fitness, M16 weapon range scores, and the number of awards earned by the unit [26].

Unit-level helping behavior was also examined against cohesion, leader effectiveness and within-group relationship conflict for impact on the unit-level effectiveness [26]. Essentially, the question was whether high levels of group-level OCB in terms of helping behavior would distinctly improve the unit performance beyond the aforementioned historic Army company factors for success in combat [26,56,57]. Cohesion is where the soldiers establish kinship and connection with their fellow soldiers [26]. Leader effectiveness in the Army unit is effective maintenance of morale while also completing the mission at hand [58]. Relationship conflict is described as differences in personality or values [59,60] which are disruptive to the military unit.

The statistical analysis of the data revealed that unit-level helping behavior did increase the effectiveness of the unit, with improved scores in those units in combat readiness, physical fitness, M16 weapon range scores, and the number of awards earned by the unit. Additionally, when compared against cohesion, leader effectiveness and within-group relationship conflict, unit-level helping behavior showed improved unit-effectiveness for physical fitness, M16 weapon range scores, and the number of awards earned by the unit, but not combat readiness. Effectively, these results demonstrate that the historic approach to unit-level leadership does not replace having helping behavior present in the unit [26]. This is shown graphically in Figure 2.3. Future work was

recommended to examine multilevel relationships in place of only group level relationships and how OCB becomes normative in a group. Lastly, it was suggested this type of a study also be replicated in additional settings to examine the ties between unit-level OCB and how that impacts the effectiveness of said unit [26].

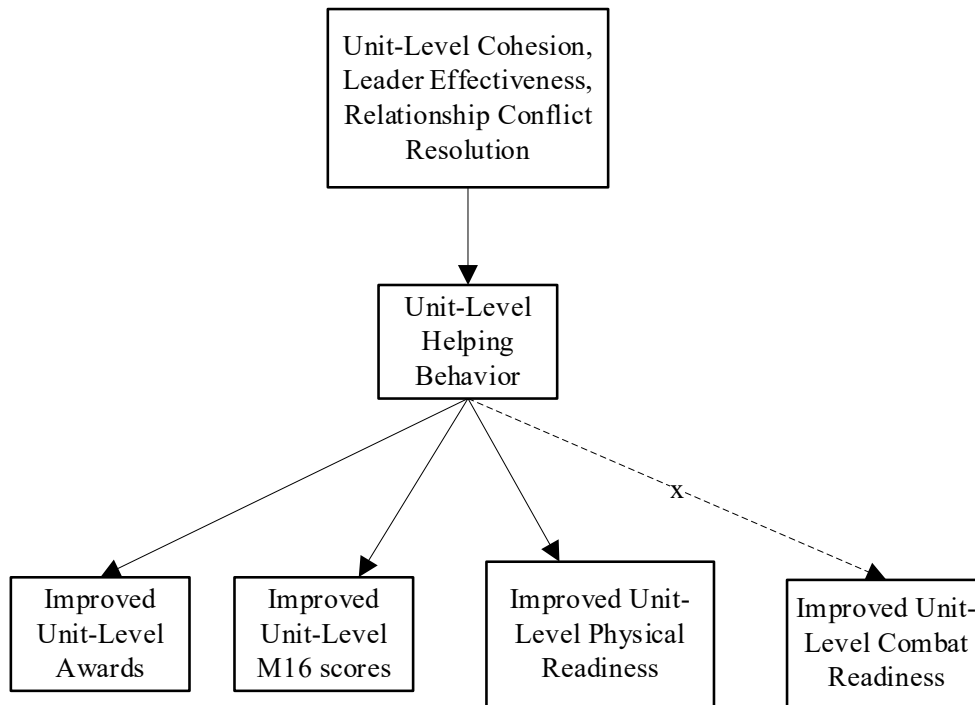


Figure 2.3. Unit-Level Helping Behavior and Effectiveness

2.2 Leadership and Behaviors

This section introduces concepts of leadership, such as transformational, ethical, and servant, and how they relate to various behaviors, such as prosocial, organizational, influence tactics, and positive reciprocity beliefs.

2.2.1 Transformational Leadership and Prosocial Behavior

Transformational leadership and prosocial behavior were examined for their impact on helping behavior on leaders and followers in a typical work setting in China [38]. A transformational leader was described as one who both empowers and considers the needs of their followers [45]. Helping behavior was viewed here as a citizenship behavior where coworkers help their peers voluntarily, or act in a way to prevent work-related issues [42]. It is also a discretionary behavior which can be explained by social exchange in terms of the follower feeling obligated to return favorable treatment from a leader [42,43].

Whether or not follower helping behavior was evoked by the transformational leadership style was dependent two factors with the follower. One was whether the relationship included cognition-based or affect-based trust [38]. Followers with high levels of cognition-based trust feel a lower level of risk paired with a perceived confidence in their leaders' decisions [61–65], whereas followers with affect-based trust feel an obligation to respond in kind to social exchanges with their leaders [36].

The second factor considered was the level of prosocial motivation found inherent in the follower. Prosocial motivation is defined in this context as a heuristic action where followers would place a high regard on the interests of others over themselves [66,67]. A follower with a low level of prosocial motivation was expected to be less likely to exhibit the follower helping behavior without receiving a cue from cognition-based trust that risk is reduced and there is a high likelihood the helping/citizenship behavior would be recognized by their leadership [38].

Surveys were conducted using established test questions for leadership style, affect- and cognition-based trust, prosocial motivation, and follower helping behavior. Transformational leadership was found to promote helping behavior where the follower had a low level of prosocial motivation paired with cognition-based trust. Additionally, transformational leadership was found to promote helping behavior where the follower had a high level of prosocial motivation paired with affect-based trust [38]. These results are shown graphically in Figure 2.4. Future work recommended was further exploration of additional moderators for social exchange to further refine the ways that influence tactics and transformational leadership could be used. It was also suggested the citizenship behaviors such as voicing problems and taking charge be examined, as these behavior challenge the status-quo [38].

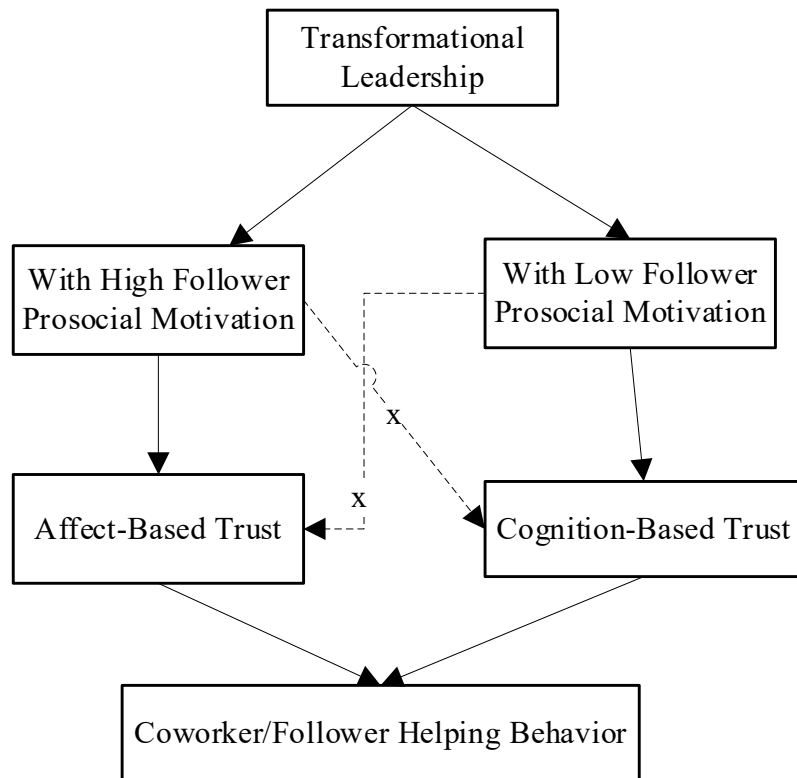


Figure 2.4. Influence of Transformational Leadership, Prosocial Motivation, and Type of Trust on Helping Behavior

2.2.2 Transformational Leadership and Organizational Performance

Additional work has been done to put the importance of follower helping behavior into practical context. Researchers have found that leaders can influence their followers' performance, in part, by fostering and encouraging organizational citizenship behavior (OCB), of which helping behavior is one facet [25]. Organizational Citizenship Behavior has been defined as the behavior exhibited by followers beyond their defined roles [25], and increased expression of this behavior has been positively linked to follower performance [42,68]. Furthermore, OCB has been conceptualized as having three main facets: helping behavior, sportsmanship, and conscientiousness [69]. One of the

hypotheses of this work, then, is that OCB mediates the relationship between leadership, specifically transformational leadership, and worker performance. If this is true, it would seem to indicate that any action taken by a leader which increases helping behavior will likely improve team productivity and enhance the potency of other leadership functions.

To evaluate their claim, the researchers needed to measure the levels of transformational leadership, OCB, and performance exhibited by the subjects. To do this, the team interviewed 91 leaders from 91 companies in a variety of industries located in different parts of Germany. These leaders were of different ages, had different levels of experience, different size teams, and came from an assortment of professional backgrounds [25]. In the survey, transformational leadership was measured using the Multifactor Leadership Questionnaire, which had been translated into German [70,71]. Organizational Citizenship behavior was assessed by means of a tool created by in 1989 [72] and later refined in 1999 [69].

Finally, performance criteria were evaluated based on an adapted seven-point response scale [73]. Analysis of the survey responses indicated that OCB was indeed a mediator between transformational leadership and follower performance to a certain degree. Despite only partial confirmation of the conjecture, the findings serve nevertheless to illustrate that OCB, and helping behavior by extension, has a significant effect on workplace performance. It therefore merits further investigation to better understand the nature of its contribution as well as best practices for the promotion of helping behavior among subordinates. A graphical representation of the conclusion from this research is

shown below in Figure 2.5. Future work recommended was to obtain the independent and dependent variables from unique sources [25].

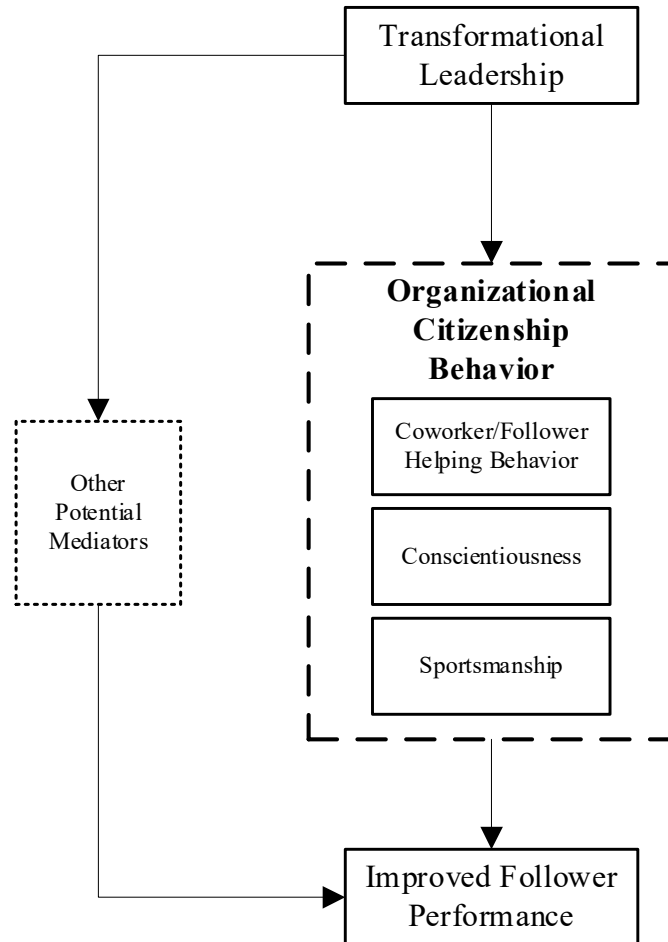


Figure 2.5. Influence of Transformational Leadership on Follower Performance as Mediated by OCB

2.2.3 Ethical Leadership and Influence Tactics

Ethical leadership and influence tactics for their impact on helping behavior and work effort were examined in a formal leadership system in state government agency whose employees were responsible for dealing with disease-related issues in the United States [39]. Ethical leaders are viewed as being trustworthy, caring, and moral who

additionally make just decisions. Ethical leaders also set ethical standards along with a reward and reprimand system to maintain compliance with those expectations [74]. Ethical leadership differs from transformational leadership in that communicate directly with their subordinates individually in order to convey what is expected of them [75,76]. In this way, ethical leadership is transactional [39]. Helping behavior is seen as being based in the theory of social exchange, as it is an obligation, or reciprocal based relationship [36]. Helping behavior is also defined as a citizenship behavior where coworkers help their peers voluntarily, or act in a way to prevent work-related issues [42]” and as an extra-role behavior [28], or outside of regular job requirements. Of the two hypotheses investigated, one applies to the effort here: the perception of highly ethical leadership would positively moderate helping behavior seen in followers when paired with a supplication influence tactic. Supplication is an influence tactic where leaders portray inexperience in a subject area or act helpless with the goal of getting subordinates to help [77].

Surveys were deployed using established test questions to collect data for measuring ethical leadership perceptions, helping behaviors, and supplication. Employees responded to questions on ethical leadership and supplication perceptions. Their formal leaders responded to questions on helping behavior. The survey responses resulted in a sample size of 175 [39]. It was found that there is positive relationship between the supplication influence tactic and helping behavior when perceptions of ethical leadership are high but negative when ethical leadership is low [39]. These results are shown graphically in Figure 2.6. Future work recommended included examining additional influence tactics and that the data collected not be self-collected [39].

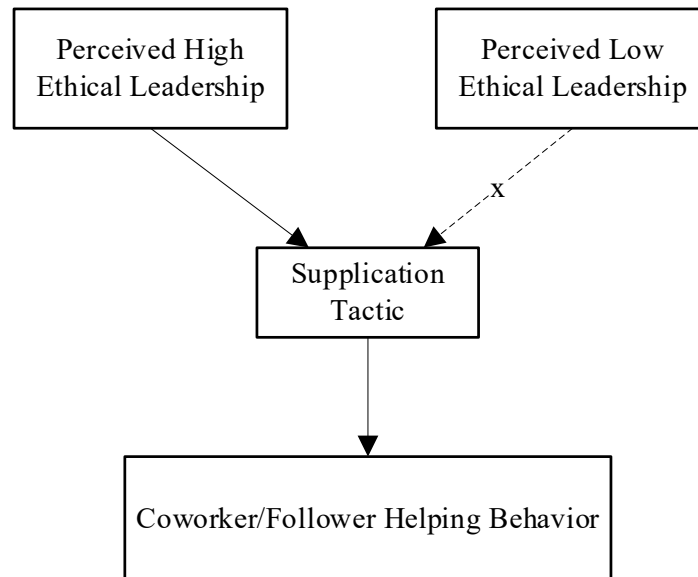


Figure 2.6. Influence of Tactics and Ethical Leadership on Helping Behavior

2.2.4 Servant Leadership and Positive Reciprocity Belief

Servant leadership was compared to its impact on helping behavior with and without the varying levels of positive reciprocity belief, leader-member exchange (LMX) and team-member exchange (TMX) social exchanges in the hospitality industry in China [40]. Social exchange theory was paired with the norm of reciprocity while examining helping behavior. Social exchange is when a rewarding service is completed with the intent that an unspecified act will be provided to the originator in return. With no guarantee that a service provided will be returned, social exchange efforts are completed with the trust that the receiver will “discharge their obligations [36].” The norm of reciprocity involves two requirements: assistance should be repaid in kind, and harm should not come to the provider of the assistance [47]. Helping behavior was then viewed here as one type of Organizational Citizenship Behavior (OCB) in which the follower would receive

exemplary treatment from a servant leader and feel obliged then to return that effort in kind by performing beyond the expectations of their role [28,37,46,47]. Servant leadership is defined here as a leader which sets aside their personal interests over the stakeholders at their organization. They see their position as an opportunity to provide services for where they are and to inspire other servant leaders. This is in place of seeking personal recognition and power [78,79]. Leader-member exchange (LMX) is a social, or reciprocal, exchange between a formal leader and their direct subordinate, originating from the basis of “trust, respect, and obligations [80,81].” Like LMX, Team-member exchange (TMX) is also a social exchange based on reciprocity. However, with TMX, the reciprocity is between peers instead of a formal leader and their subordinate. It is also more specifically based on the exchange of ideas, feedback, and assistance [82].

Survey data was collected from 300 employees to measure servant leadership, positive reciprocity beliefs, LMX, and TMX. Survey data was collected from 80 supervisors on the employees’ helping behavior tendencies. This study found that with servant leadership, LMX and TMX tactics are both positively related to helping behaviors. The study also supports that LMX and TMX can be used to elaborate on the relationship between servant leadership and helping behaviors.

With different magnitudes of positive reciprocity beliefs, it was found that positive reciprocity beliefs (a willingness to reciprocate) strengthened the relationship of TMX and LMX with servant leadership [40]. Lastly, the study found that higher levels of reciprocity beliefs have a positive relationship with helping behaviors from TMX or LMX in servant leadership [40]. These results are shown graphically in Figure 2.7. Future work

recommended was to combine servant leadership, group dynamics, and personality characteristics in order understand the impact of servant leadership in a more complex way [40].

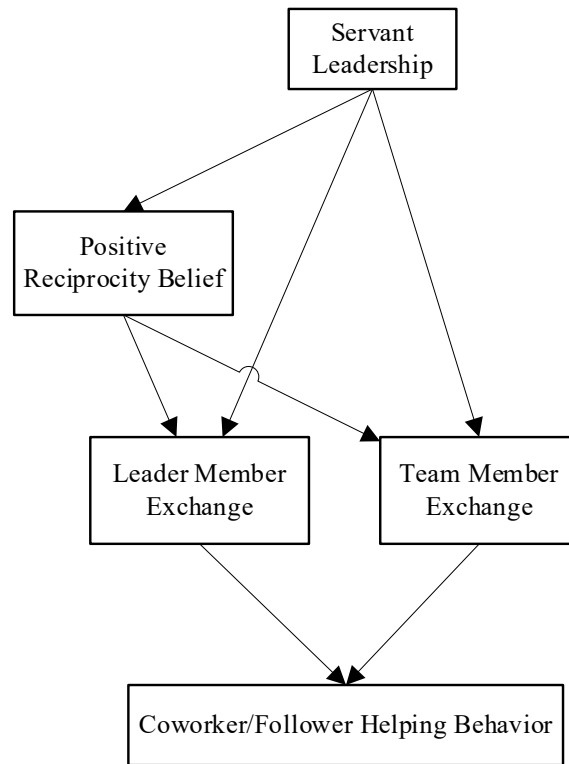


Figure 2.7. Influence of Servant Leadership, Reciprocity Belief, and Exchange Tactics on Helping Behavior

2.3 Influence Tactics in Leadership

Other research completed based on data from a distribution company in the United States has focused on the between link the Leader-Member Exchange (LMX) relationship and the helping behavior displayed by members within an organization [41]. Leader-Member Exchange refers to the actual and perceived reciprocity of respect, loyalty and contribution between a leader and a member of their team [83]. Helping behavior is defined

here as a discretionary, individual, extra-role (beyond expectations) behavior which is done with the intention of benefiting peers or the group as a whole [48]. It originates from the altruism dimension of organizational citizenship behavior [49].

This research posits that the specific tactics leaders use to influence and direct the actions of their team members can affect the helping behavior exhibited by these subordinates in different ways and to varying degrees based on the quality of their LMX relationship. This view brings together the group engagement model, in which leaders facilitate helping behavior by the treatment of members [84], and the Leader-Member Exchange theory, which conceptualizes leadership as a process that is centered on the interactions between leaders and followers [9]. In this case, the influence tactics were applied downwardly, from the leader to the follower [85].

This research looked at five influencing tactics which have been previously related to members' discretionary behavior:

- Inspirational Appeal: when one person inspires another person that they are able to complete a task, or makes a suggestion in line with the other's values which ignites enthusiasm within them [86].
- Consulting: when one person seeks the participation/support of another person in for the planning of an approach or displays a willingness to modify an approach based on the second person's recommendations and apprehensions [86].
- Exchange: when a person requests a favor with a promise to provide a favor at a later date or assures that benefits from a request completed will be shared [86].

- Legitimation: when a person strives for acceptance of a request by stating they have the authority to do so or that the request is in line with policies and/or expectations of the organization [86].
- Pressure: when a person is insistent in making requests or demands, even threats, to persuade a second person to complete their request [86].

Certain influence tactics can be further defined as hard or soft influence tactics. Soft influence tactics are consultative and applied through the use of personal power or the sharing of power [87,88] which include inspirational appeal and consultation. Hard influence tactics are used from an authoritative frame of mind and are used to manipulate followers into compliance or resistance [41,88]. Pressure and legitimation are hard influence tactics [88].

The researchers examined whether there was a significant correlation between their use and the helping behavior displayed by the target member and, further, how that correlation changed in the context of a high- or low-quality LMX relationship. The experimental process involved anonymous surveys of 62 managers and 177 team members at a distribution company, providing data for 177 leader-member pairs [41].

Analysis of the survey data revealed that three of the five influencing tactics shared a statistically significant correlation with both LMX quality and follower helping behavior. For those members perceiving a low-LMX relationship with their leader, inspirational appeals and exchange influencing tactics related negatively to the helping behavior exhibited by the member. However, consultation tactics showed a positive correlation

among the same group of members. In the case of high-LMX relationships, only exchange tactics related positively to member helping behavior while consultation tactics related negatively, and inspirational appeals showed no change in helping behavior [41]. These findings are represented graphically in Figure 2.8.

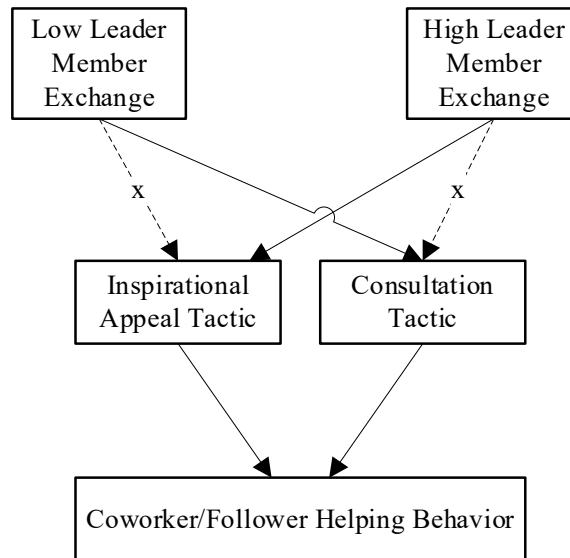


Figure 2.8. Influence of Leader Member Exchange and Varying Leadership Tactics on Helping Behavior

2.4 Summary of Influences and Outcomes of Helping Behavior

From the literature reviewed, helping behavior has been shown to be promoted from transformational [25,38], transactional [25], servant [40], military [26], and ethical leadership [39]. It has also been demonstrated to be promoted by the social exchanges of LMX [40,41], TMX [40], and affect-based trust [38]. Additionally, prosocial motivation [38] and positive reciprocity beliefs [40] have shown to be effective moderators for promoting helping behavior. This review shows there are a myriad of ways that helping behavior can be encouraged both in individuals and at the group level.

The results of helping behavior are clear. As one facet of OCB, helping was shown to partially improve follower performance [25]. Helping behavior was shown to directly improve group performance [27]. Helping behavior was also shown to improve unit-level effectiveness when added to, but not substituted by historic military leadership [26]. The positive results from the research reviewed are shown graphically in Figure 2.9.

By no means do the pieces discussed here claim to display all of the ways that helping behavior can be promoted or the impact it can have on individuals and groups. Instead, the work here shows that helping behavior has been established to be an important factor in how individuals and groups perform, and is worth looking at further in the context of engineering design teams.

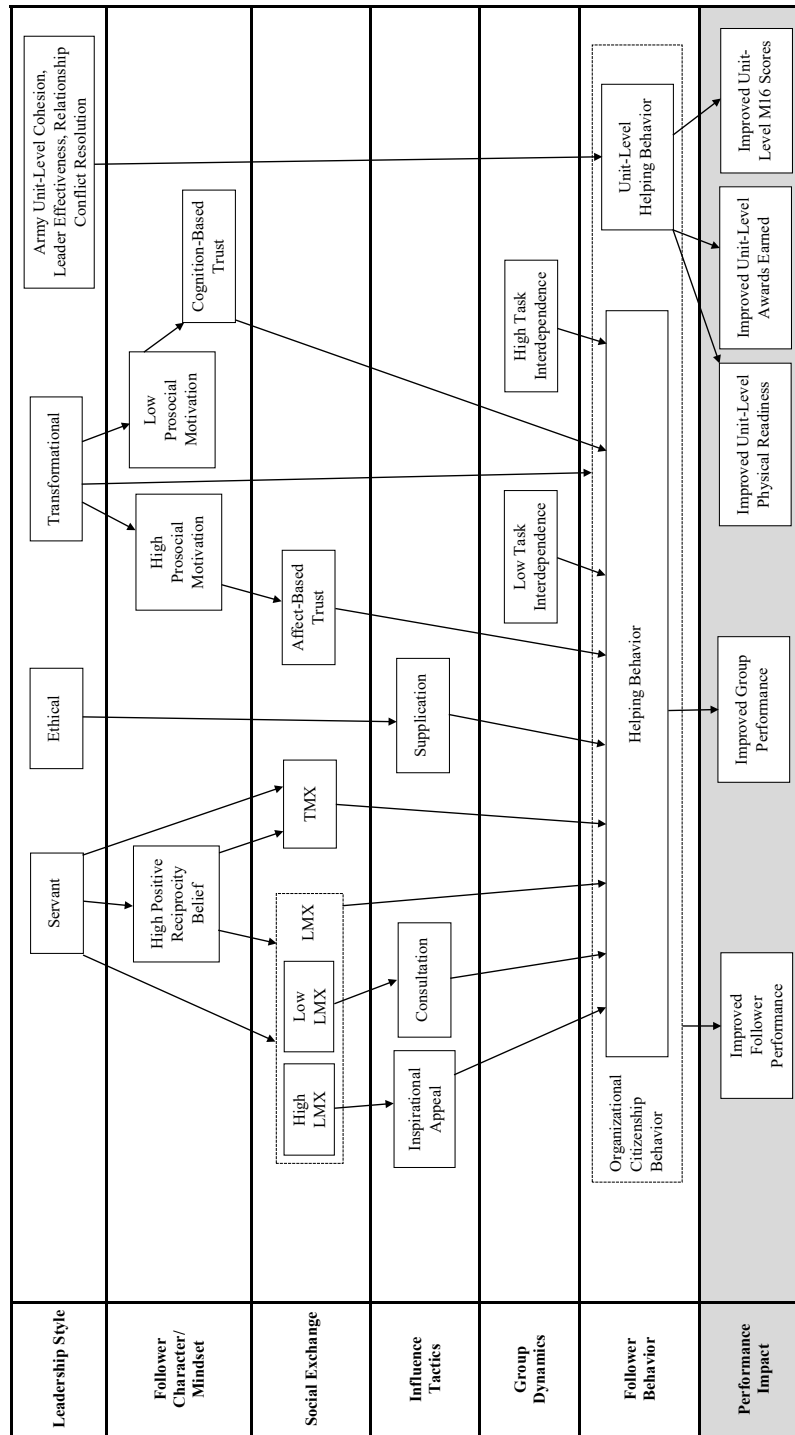


Figure 2.9. Brief Summary of Antecedents and Outcomes of Helping Behavior as One Facet of OCB

Chapter Three
 INFLUENCE TACTICS, SOCIAL EXCHANGE, AND LEADERSHIP BEHAVIORS

With helping behavior as the key follower behavior, it is important to identify the additional influential factors found in the literature: Influence Tactics (inspirational appeals, consultation, supplication) and Social Exchanges (LMX, TMX, affect-based trust). These influence tactics and social exchange relationship characteristics have some similarities with the leadership behaviors identified in the protocol coding scheme of [18,19]. The leadership behaviors from the protocol coding scheme [89] which are also analyzed in Chapter Four are defined in Table 3.1.

Table 3.1. Leadership Behaviors

Leadership Behavior	Acronym	Definition
Sensemaking	(SM)	Identifying and interpreting essential environmental events and communicating this interpretation [90].
Solve Problems	(SPS)	Diagnose and solve any problems that keeps the team from achieving its potential [90].
Structure and Plan	(SP)	Developing an understanding of how best to coordinate team actions and work together to achieve the established goals and expectations [90].
Consideration	(C)	Showing concern and respect for individual team members [90,91].
Train and Develop	(TD)	Identifying deficiencies in team capabilities and providing training and opportunities for the team to enhance its skill set [90].
Perform Team Task	(PT)	Executing an activity or doing a task as a team member [90].
Provide Feedback	(PF)	Providing feedback on performance against established goals and milestones in a formal or informal manner [90].
Monitor and Guide	(MG)	As team is actively involved in work, the team's progress and performance must be monitored to

		Providing feedback on performance against established goals and milestones in a formal or informal manner ensure the team is on target for reaching their goals [90].
Empowerment	(E)	The act of strengthening an individual's beliefs in his or her sense of effectiveness [92].

These leadership behaviors are mapped to the follower helping behavior enablers in Table 3.2, where a lowercase “x” represents a minor relationship, and a capital “X” represents a strong expected relation between the influence tactic or social exchange and the leadership behavior. Each leadership behavior aligns with one or more enabler, though it is clear that there is not a direct correlation. These leadership behaviors will be evaluated using the established protocol [89], rather than developing additional observational protocols for the leader enablers, or follower-leaders.

Table 3.2. Alignment of Theoretical Follower Enablers and Leadership Behaviors

	Influence Tactics			Social Exchange		
	Inspirational Appeal	Consultation	Supplication	Affect-based Trust	LMX	TMX
SM		x		X		x
SPS				X		x
SP			X		x	
C	x			X	X	
TD		X				X
PT						
PF		X		x	x	X
MG						
E	X				x	X

The next two sections discuss how the influence and the social exchange tactics relate to leadership behaviors. These relational mappings will provide a mechanism to review follower behaviors through the prism of coded leadership behaviors in an observational protocol study.

3.1 Influence Tactics and Leadership Behaviors

Influence tactics can be classified as upward, lateral, or downward [85]. A downward influence is one which directionally flows from a designated leader to a subordinate in an attempt from the leader for the subordinate to complete a task; conversely an upward influence directionally flows from the subordinate up to the leader [85]. A lateral influence is one which the initiator and recipient are at the same level in a formal structure, such as manager to manager, or coworker to coworker [93].

Influence tactics can also be classified as hard or soft. Hard influence tactics are used from an authoritative frame of mind and are used to manipulate followers into compliance or resistance [41,88]. Soft influence tactics are consultative and applied through the use of personal power or the sharing of power [87,88].

Inspirational appeal is a soft influence tactic where the one person inspires another person that they are able to complete a task, or makes a suggestion in line with the other's values which ignites enthusiasm within them [86]. This influence tactic is partially related to leadership behavior Consideration (C) and closely related to Empowerment (E). One of the ways Consideration (C) supports the social atmosphere of the team is to ensure all members of the team are treated the same whether they are performing well or poorly [89]. This has the possibility of inspiring followers who are not performing well to perform

better. Empowerment (E), as stated above, strengthens a followers belief in their sense of effectiveness [92], which is very similar to the concept of inspiring a follower that they are capable of completing a task [86].

Consultation is a soft influence tactic where one person seeks the participation/support of another person in the planning of an approach, or displays a willingness to modify an approach based on the second person's recommendations and apprehensions [86]. This influence tactic is partially related to Sensemaking (SM). Consultation is more closely related to Train and Develop (TD) and Provide Feedback (PF). In communicating an interpretation to a team, sensemaking can be considered as a form of consultation. With Train and Develop (TD), technical training and prolonged coaching along with peer coaching may be involved [90]. Training and coaching creates an opportunity for one person to be receiving support, if not direction, from another in their approach. Providing informal feedback would be done as a project progresses, which would also have the possible impact of altering the approach to a task.

Supplication is an influence tactic where leaders portray inexperience in a subject area or act helpless with the goal of getting subordinates to help [77]. This is closely related to Structure and Plan (SP). The leadership behavior of structure and plan involves understanding what the team is capable of accomplishing [90]. With the formal leader acting like they are unaware how to do something, they are likely to figure out exactly what their team is capable of.

3.2 Social Exchange and Leadership Behaviors

Exchange, as it is used here, is in terms of obligation. When one person provides worthwhile acts towards a second person, that person is then obligated to the originator. To fulfill the obligation, the “rewarding service” must be returned in kind [36]. Social exchange, then, is when the rewarding service is completed with the intent that an unspecified act will be provided to them in return. With no guarantee that a service provided will be returned, social exchange efforts are completed with the trust that the receiver will “discharge their obligations [36].”

Affect-based trust is a social exchange where a second person feels an obligation to respond in kind to exchanges with their originating person [36]. There is an emotional tie involved with affect-based trust in that genuine care and concern is expressed in the trust relationship [94,95]. Affect-based trust is partially related to the leadership behavior of Provide Feedback (PF). It is more closely related to the leadership behavior of Sensemaking (SM), Solve Problems (SPS), and Consideration (C). In providing feedback, as mentioned earlier, it can be done through requested performance reviews or peer evaluations [90]. Feedback is expected to be constructive where there is a genuine and caring person providing it. It is also likely to be provided in kind back to the originator where there is an open environment for sharing ideas and feelings. With sensemaking, the leader is aiding the team in understanding internal and external events [90]. It is possible that a team member will inquire about an event which initiates this discussion. This fits closely with the affect-based trust concept of “My leader and I have a sharing relationship. We can both freely share our ideas, feelings, and hopes” [96]. With the leadership behavior

of solving problems, the problems being solved may be related to team tasks or personal – any problem preventing the team from realizing its potential is within the scope of this leadership behavior [90]. As with the example given above, issues between team members are unlikely to be raised to a leader without the trust of knowing genuine care will be exhibited and there is comfort with discussing ideas and feelings. Consideration is a leadership behavior where an environment of concern and respect is created for all team members so that team or project issues can be discussed openly [90]. Consideration is likely another way of describing affect-based trust.

Leader-member exchange (LMX) is a social, or reciprocal, exchange between a formal leader and their direct subordinate, originating from the basis of “trust, respect, and obligations” [80,81]. This social exchange is partially related to Structure and Plan (SP), Provide Feedback (PF), and Empowerment (E). LMX is more closely related to Consideration (C). The structure and plan leadership behavior involves comprehending the capabilities of the individual team members and how they may best be applied best for the team to achieve its goals [90]. In this way, structure and plan involves trust that the subordinate is capable of completing a task, and a form of obligation to do so. Providing feedback could be a form of leader exchange where trust, respect, and obligation are built. Feedback that a subordinate is doing well can be expected to build trust and respect. Empowerment involves providing encouraging words and giving team members the freedom to try new things [90]. In this way, the formal leader is displaying trust and confidence in their subordinate. The leadership behavior consideration clearly involves respect and trust in ensuring all of the team members feel free to raise and discuss issues

[89,90]. Consideration is therefore another way to describe an exchange between a leader and subordinate built on trust and respect.

Like LMX, Team-member exchange (TMX) is also a social exchange based on reciprocity. However, with TMX, the reciprocity is between peers instead of a formal leader and their subordinate. It is also more specifically based on the exchange of ideas, feedback, and assistance [82]. TMX is partially related to the leadership behavior of Sensemaking (SM) and Solve Problems (SPS). TMX is more closely related to Train and Develop (TD), Provide Feedback (PF), and Empowerment (E). With sensemaking, assistance is provided in the form of ensuring all team members have the same understanding of specific events and how those events impact the efforts of the team. In solving problems, problems may need to be solved between team members or from the external environment [90]. To achieve this, ideas will likely be exchanged to resolve the issue(s) at hand. The leadership behavior of train and develop can include peer coaching [90]. Coaching between peers to teach another team member a new skill is a direct form of assistance between team members. Providing feedback can take place formally, or informally. Informal feedback from peers can be done in the form of technical feedback or as a peer evaluation [90]. Empowerment from peers involves providing assistance in stressful situations, whether is the stressful situation is task or personally related [92]. In this way, peers are directly sharing ideas and aiding others to navigate the stressful situations.

Chapter Four

ANALYSIS OF FOLLOWER-LEADER TRANSITION PATTERNS

The literature reviewed did not reveal observational research as a common method in the studies published [25,38–41]. Some of the previous research recommended future work by completing similar studies in a complex environment that includes observations over a long time period and in various settings. This had been suggested to improve the understanding of coworker OCB and group performance [27]. Previous researchers have also suggested that future work should involve data be used which is not self-collected [39]. The impact of follower helping behavior has noticeably not been specifically studied in the context of engineering design teams.

In an engineering design team, while there may be a defined leader, any member of the team may exhibit leader behaviors, as has been demonstrated through a previous protocol study [20]. It can be seen in the data reviewed in Appendix A that each member of the teams exhibited both leadership and followership behaviors. The use of the coded data from this protocol is in response to previous researches suggestions for using data which is not self-collected, and has been collected over a time period longer than a day [27,39].

In considering how (follower) helping behavior applies to an engineering design team, the following definition is suggested:

One type of organizational citizenship behavior where a design team member exhibits “extra-role” (beyond expectation) behaviors, such as voluntarily helping peers on the team with, or preventing the occurrence of design team-related problems. This can be observed as originating

from a leader or a follower behavior. The helping behavior is done without upsetting the status-quo in an informal or formal leadership setting.

To investigate this idea, data has been re-examined of a protocol study completed in 2017 from recorded meetings of eight graduate design teams comprised of four members which created function models [20], an example of which is shown in Figure 4.1. The original teams for the protocol study also included one team of three members. That team is not examined here.



Figure 4.1. Example Design Team

The data in the protocol study was coded and analyzed based on the Clemson Engineering Design Applications and Research (CEDAR) Leadership in Engineering Design Teams Coding Manual last updated in 2018 [89]. The coding manual defined

various leadership behaviors. The data from the eight coded design teams has been preliminarily reviewed for evidence of follower helping behavior. An example of the reviewed coded data for a direct conversion from a follower behavior to a leadership behavior (follower-leader) is shown in Figure 4.2. The complete set of data can be found in Appendix A. The preliminary review has been completed with the following process:

1. Locate a coded leadership function for a member of the design team (Row 3, Person C).
2. Review the directly precedent action for the same design team member (Row 2, Person C).
3. If the action directly before the leadership function was a follower action, flag this activity as a possible follower helping behavior.

Number	Time Recording		Leadership	Individual Behavior Coding			
	Start Time	End Time	Leadership Behavior	Per. A	Per. B	Per. C	Per. D
1	0:01:50	0:01:57	SP	L	F	F	F
2	0:02:10	0:02:18	SM	L	F	F	
3	0:02:45	0:03:00	SM	F		L	
4	0:04:29	0:04:40	SP	L	F	F	F
5	0:04:40	0:05:30	SM	L		F	F
6	0:05:50	0:06:00	SM	L		F	F
7	0:06:10	0:06:18	MG	F		L	
8	0:07:00	0:07:20	SM	L		F	
9	0:09:30	0:09:40	SM	L		F	F
10	0:10:07	0:10:09	C	L		F	

Figure 4.2. Example of Coded Data Reviewed

Of the eight design teams reviewed, there were 325 total leadership behaviors coded. Of the items coded, 131 (40.3%) possible follower helping actions are found.

The leadership behaviors identified in Figure 4.2 are Structure and Plan (SP), Sensemaking (SM), Monitor and Guide (MG), and Consideration (C) [89]. The full list of leadership behaviors reviewed in this analysis and their definitions are located in Table 3.1.

4.1 Coarse Data Analysis

Of the eight design teams under consideration, several sets of data have been extrapolated from the follower-leader transitions and the overall leadership behaviors noted in Figure 4.2. To provide further clarification of the data set being displayed, the three data sets are given both names and colors. The first set of data is the count of leadership behavior which resulted in the follower who then immediately converted to a leader. As an example, this would be the “SM,” or sensemaking behavior seen on line 2 of Figure 4.2. This data set is labeled “Transition Initiator” (F of F → L) and is colored yellow throughout this chapter. The second set of data is the count of leadership behavior that ensued from an immediately previous follower behavior. Continuing with the example shown in Figure 4.2, this would be SM again, but now from line 3. This data set is labeled “Transition Result” (L of F → L) and is colored orange. The third set of data is the total count of leadership behaviors for each team. This gives a total frequency of leadership behaviors seen in the team independent of how they originated. This data set is labeled “Total Leader Behaviors,” and is colored a pale blue.

To complete analysis of the data sets as a group, first it needs to be determined if there are anomalies between the teams. To do this, a vector is created for each team based on the frequency of leadership behaviors noted for each of the three data sets. The vector for the frequency of leadership behaviors which initiated the follower-leader transition is

shown with the yellow data set “Transition Initiator” in Table 4.1. The vector for the frequency of leadership behaviors which resulted from the follower-leader transition is shown with the orange data set “Transition Result” in Table 4.2. The vector for the frequency of the total number of leadership behaviors is blue and displayed in Table 4.3.

With the yellow Transition Initiator data set in Table 4.1, there are nearly double the leadership activities seen in teams B1 and B2. At first glance, this may be tied to the amount of time the teams spent together while meeting. However, Team A1 met for close to 50 minutes and teams B1 and B2 met for just over 50 minutes. It is possible that if the data were examined in quartiles, the frequency patterns would show different results than those shown here. The leadership behaviors which occurred most frequently for the Transition Initiator were Sensemaking (SM) with 44 and Provide Feedback (PF) with 18. These maximum occurring leadership behaviors are shaded green. Conversely, the rows for leadership behaviors which occurred most infrequently are shaded red. The leadership behaviors which occurred most infrequently were Structure and Plan (SP) and Consideration (C), both with 5; as well as Empowerment (E) with 1.

Table 4.1. Frequency of Transition Initiator Behaviors

Initiator	Team A1	Team A2	Team A5	Team A6	Team B1	Team B2	Team B3	Team B4	All/ Combined
SM	2	1	3	4	11	10	5	8	44
SPS	2	4	0	1	2	3	1	0	13
SP	0	0	0	1	0	3	1	0	5
C	2	0	0	0	0	2	0	1	5
TD	0	3	0	2	2	0	0	0	7
PT	1	0	2	1	1	3	2	0	10
PF	1	2	5	0	2	3	3	2	18
MG	0	0	2	4	3	0	0	1	10
E	0	0	0	0	0	0	1	0	1
Total	8	10	12	13	21	24	13	12	113

In the orange data set “Transition Result” in Table 4.2, a similar increase in frequency is noted with teams B1 and B2. In teams B1, B2, and B4, there are a little more than twice the instances of Sensemaking (SM) when compared with the A teams. With the A teams coming together from different locations and backgrounds, perhaps they were more likely to go along with what had been suggested in place of discussing the idea before proceeding. With the B teams all being in the Advanced Design Methods course, ME 8700, at Clemson University, perhaps they had more discussion on how to best proceed, even with their background on the subject being somewhat leveled.

It may have been expected that with more dissimilar backgrounds, more discussion would have taken place at reaching a common understanding instead of less. One idea to consider for understanding why this may be occurring is that some of the ME 8700 class may have also had the undergraduate version of the Design class, ME 4010. Perhaps the

students who were both in the undergraduate and graduate version of the design methods course recall additional facts they had learned previously and are presenting them to the group to consider or have additional discussion from their previous work with function models. It is also possible that the students which continued from being undergraduate students to graduate students had more familiarity with each other and this is another reason why there were more leadership behaviors in the B teams.

In both the yellow Initiator data set and the orange Resultant data set, Sensemaking (SM) and Provide Feedback (PF) have a noticeably higher frequency count over the remaining leadership behaviors seen. This seems to indicate that perhaps similar leadership behaviors result from the follower-leader leadership behavior that induced the follower to leader transition.

In the yellow Initiator data set Empowerment (E), Consideration (C), and Structure and Plan (SP) have the lowest overall frequency count. This partially overlaps with the orange Resultant data set, which also has the lowest frequency seen from Empowerment (E), Consideration (C). This may imply that while these leadership behaviors serve distinct functions in the team operating, they should not be the focus of future studies.

Table 4.2. Frequency of Transition Resultant Behaviors

Resultant	Team A1	Team A2	Team A5	Team A6	Team B1	Team B2	Team B3	Team B4	All/ Combined
SM	0	3	2	4	11	11	4	5	40
SPS	2	3	0	1	2	2	0	0	10
SP	1	1	0	1	0	2	0	2	7
C	0	1	1	0	0	1	1	1	5
TD	0	1	2	3	2	0	0	0	8
PT	2	0	3	1	2	4	3	0	15
PF	3	1	3	1	3	4	4	3	22
MG	0	0	1	2	2	0	0	1	6
E	0	0	0	0	0	0	1	0	1
Total	8	10	12	13	22	24	13	12	114

In the blue data set of total leadership in Table 4.3, Sensemaking (SM) and Provide Feedback (PF) have the highest overall frequency counts. Recall that the full list of leadership behaviors reviewed in this analysis and their definitions are located in Table 3.1. While teams B1 and B2 still have the highest overall count of leadership behaviors, notice that Sensemaking (SM) is the dominant leadership behavior seen, independent of whether or not there is a follower-leader transition taking place. This could imply that sensemaking is more of a moderator than a leadership behavior.

Consistent with the two prior data sets, Consideration (C) and Empowerment (E) remain with the lowest count for leadership behavior frequency out of the coded behaviors seen.

Table 4.3. Frequency of Total Leadership Behaviors

Total Leadership Behaviors	Team A1	Team A2	Team A5	Team A6	Team B1	Team B2	Team B3	Team B4	All/ Combined
SM	7	4	6	10	21	18	12	18	96
SPS	3	8	0	3	3	5	3	0	25
SP	3	2	0	1	1	6	2	4	19
C	2	1	1	0	0	2	1	2	9
TD	2	5	4	5	3	0	1	0	20
PT	4	1	6	3	2	6	5	0	27
PF	6	4	8	5	6	11	10	5	55
MG	0	0	4	9	6	0	0	3	22
E	0	0	0	0	0	0	1	0	1
Total	27	25	29	36	42	48	35	32	273

To equalize the values between the data sets to complete a comparison between the teams, these leadership frequency counts are normalized against the total number of leadership behaviors for each team. The normalized vectors for the leadership behaviors which resulted from the follower-leader transition for the yellow Initiator data set are displayed in Table 4.4. The orange Resultant data set is shown in Table 4.5 and the blue data set of the total leadership behaviors is shown in Table 4.6. With all of these tables, the data being normalized means that the column for each team now adds up to one. This is why a total for each column is no longer shown.

With the yellow Initiator data set displayed in Table 4.4, the normalized data still reflects what was observed in Table 4.1. Sensemaking (SM) and Provide Feedback (PF) remain the largest contributors of leadership behaviors which induce the follower-leader

transition. These rows are again shaded green. It is also observed that the leadership behaviors which contribute the least to the follower-leader transition remain as Empowerment (E), Consideration (C), and Structure and Plan (SP). This confirms that the normalization process of the data has not modified its significance. These rows are again shaded red.

Table 4.4. Normalized Data for Initiator Data Set

Initiator	Team A1	Team A2	Team A5	Team A6	Team B1	Team B2	Team B3	Team B4	Average Team
SM	0.25	0.10	0.25	0.31	0.52	0.42	0.38	0.67	0.39
SPS	0.25	0.40	0.00	0.08	0.10	0.13	0.08	0.00	0.12
SP	0.00	0.00	0.00	0.08	0.00	0.13	0.08	0.00	0.04
C	0.25	0.00	0.00	0.00	0.00	0.08	0.00	0.08	0.04
TD	0.00	0.30	0.00	0.15	0.10	0.00	0.00	0.00	0.06
PT	0.13	0.00	0.17	0.08	0.05	0.13	0.15	0.00	0.09
PF	0.13	0.20	0.42	0.00	0.10	0.13	0.23	0.17	0.16
MG	0.00	0.00	0.17	0.31	0.14	0.00	0.00	0.08	0.09
E	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.01

The orange Resultant data set shown in Table 4.5 follows suit where teams B1 and B2 still contribute a notable amount of the Sensemaking (SM) leadership behaviors, with team B4 not far behind. Sensemaking (SM) and Provide Feedback (PF) remain the largest contributors of leadership behaviors which result from the follower-leader transition. Additionally, Empowerment (E) and Consideration (C) remain as the least likely leadership behavior to result from the follower-leader transition. The normalization of this data set also has not modified its significance.

Table 4.5. Normalized Data for Resultant Data Set

Resultant	Team A1	Team A2	Team A5	Team A6	Team B1	Team B2	Team B3	Team B4	Average Team
SM	0.00	0.30	0.17	0.31	0.50	0.46	0.31	0.42	0.35
SPS	0.25	0.30	0.00	0.08	0.09	0.08	0.00	0.00	0.09
SP	0.13	0.10	0.00	0.08	0.00	0.08	0.00	0.17	0.06
C	0.00	0.10	0.08	0.00	0.00	0.04	0.08	0.08	0.04
TD	0.00	0.10	0.17	0.23	0.09	0.00	0.00	0.00	0.07
PT	0.25	0.00	0.25	0.08	0.09	0.17	0.23	0.00	0.13
PF	0.38	0.10	0.25	0.08	0.14	0.17	0.31	0.25	0.19
MG	0.00	0.00	0.08	0.15	0.09	0.00	0.00	0.08	0.05
E	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.01

As expected, the blue data set of the Total Leadership Behaviors shown in Table 4.6 is also reflective of the patterns first seen in Table 4.3. Sensemaking (SM) and Provide Feedback (PF) have the largest proportion of the leadership behaviors. Teams B1, B2, and B4 remain high contributors to the overall leadership behavior proportions. Consideration (C) and Empowerment (E) remain with the lowest proportion of leadership behavior out of the coded behaviors seen.

Table 4.6. Normalized Data for Total Leadership Data Set

Total Leadership Behaviors	Team A1	Team A2	Team A5	Team A6	Team B1	Team B2	Team B3	Team B4	Average Team
SM	0.26	0.16	0.21	0.28	0.50	0.38	0.34	0.56	0.35
SPS	0.11	0.32	0.00	0.08	0.07	0.10	0.09	0.00	0.09
SP	0.11	0.08	0.00	0.03	0.02	0.13	0.06	0.13	0.07
C	0.07	0.04	0.03	0.00	0.00	0.04	0.03	0.06	0.03
TD	0.07	0.20	0.14	0.14	0.07	0.00	0.03	0.00	0.07
PT	0.15	0.04	0.21	0.08	0.05	0.13	0.14	0.00	0.10
PF	0.22	0.16	0.28	0.14	0.14	0.23	0.29	0.16	0.20
MG	0.00	0.00	0.14	0.25	0.14	0.00	0.00	0.09	0.08
E	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00

4.2 Team Similarity Analysis

To continue with analysis of the data, it needs to be determined that the teams are similar enough to each other to combine the team data into their respective sets. To compare the similarity between these normalized vectors, the cosine distance is calculated per Equation 4.1, where x-values are used for each individual team, and the y-values are the averages for the specified data set.

$$similarity = \frac{\sum_i^n x_i y_i}{\sqrt{\sum_i^n x_i^2} * \sqrt{\sum_i^n y_i^2}} \quad \text{Equation 4.1}$$

This vector cosine normal distance method is used in place of Euclid similarity analysis because the data set considered here are not paired data [97]. This analysis is instead looking at a team against the total average from all the teams. The results of this

are shown below for all three data sets in Table 4.7. The color-coding scheme from Section 4.1 continues here to aid in the understanding of which extrapolated data set the column is representing. The leadership behaviors which induced the follower-leader transition continue to be displayed as yellow and labeled as “Initiator.” The leadership behaviors which resulted from the follower-leader transition remain displayed as orange and labeled as “Resultant.” All of the coded leadership behaviors from each team are shown in the blue column which is also labeled “Total Leadership.”

To interpret the similarity calculation results, the values range from 0 to 1. The closer to 0 the value is, the more dissimilar the team is compared to the average of the teams. The closer to 1 the value is, the more similar the team is compared to the average of the teams. Therefore to interpret Table 4.7: When looking at the Initiator data set, team A2 is most dissimilar to the average of the teams and team B1 is most similar to the average of the teams. For the Resultant data set, team A1 is most unlike the average of the teams and team B2 is most similar to the average of the teams. The teams will be compared against each other in a pairwise comparison below.

Table 4.7: Similarity Analysis of Teams to Average

Team	Initiator	Resultant	Total Leadership
A1	0.778	0.570	0.944
A2	0.535	0.805	0.710
A5	0.774	0.811	0.853
A6	0.791	0.856	0.884
B1	0.961	0.951	0.950
B2	0.951	0.969	0.964
B3	0.945	0.905	0.961
B4	0.922	0.905	0.911

Some of the assumptions involved with this calculation is that the teams were similar upon their formation – not on any other factors such as personality, age, gender, experience, or ethnicity. In creating the A and B teams randomly, the previous protocol study had assumed that their formation was equal. The A and B teams were created from university graduate students. This population is not assumed to be representative of the design engineering population. Additionally, the data input to Equation 4.1 was a frequency of leadership behaviors which was not separated into sequential quartiles. In looking at the original data shown in Appendix A, examining the data in smaller groupings may give a false impression that a leadership behavior is present more or less than it truly is in the aggregate. However, what it may reveal is what leadership behaviors appear at the beginning of the time the team is together versus after they have spent additional time together.

In addition to the numerical data, there is a way to view the data visually through a Pareto chart. The Pareto chart is a modified histogram which displays the bars in descending order, with a line showing the overall total [98]. In this regard, the teams most similar to the average will be on the left-hand side of the graph, and the teams most dissimilar to the average will be on the right-hand side of the graph. The Pareto chart for the first data set, Initiator (yellow), is shown in Figure 4.3. Again, in looking at the follower-leader transition, this data set represents the similarity between teams not of the follower behavior, but the leadership behavior which inspired the follower which immediately converted to a follower-leader. As can also be seen in the numerical data, Team A2 is most unlike the average than the other teams. This could have to do with the

Team A students had not spent a lot of time together prior to participating in the research study and were just more quiet than the other teams because the team members did not know each other that well. It could also be an indicator that Team A2 was the least familiar with function models and did not exhibit a lot of helping behavior, or follower-leader transitions because of the lack of familiarity in the subject. Again, there was no survey done before the protocol study to indicate what the level of knowledge about function models was prior to the team completing the task for the protocol study.

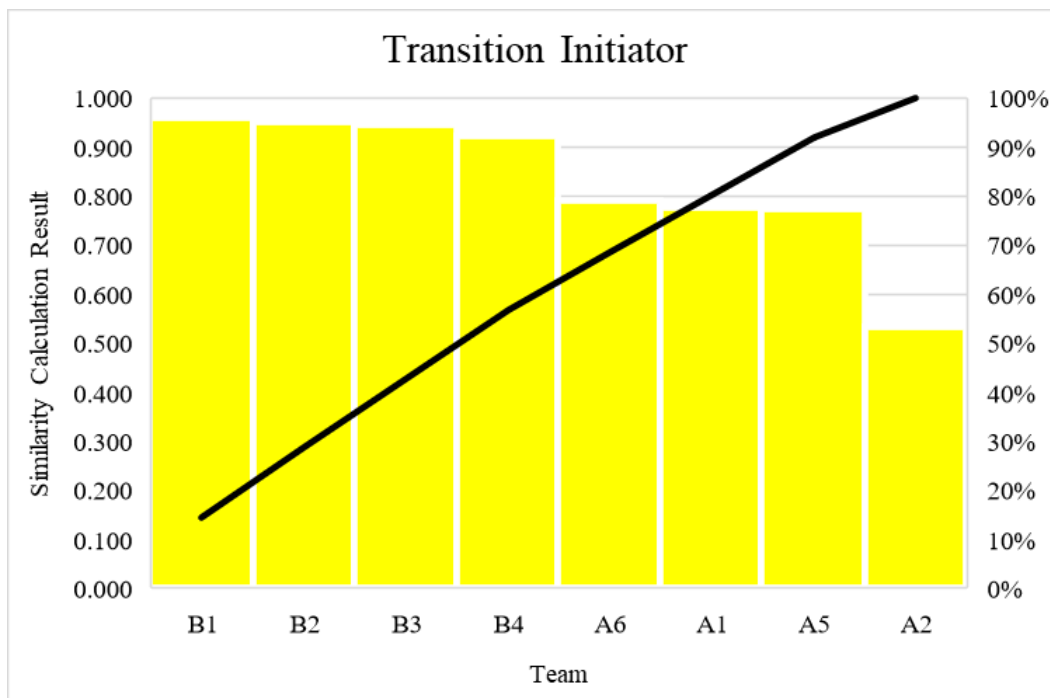


Figure 4.3. Pareto Chart for Initiator Data Set

The Pareto chart for the second set of data, Resultant (orange), is shown in Figure 4.4. As a reminder, this data set represents the similarity between teams to the average of all the teams for the leadership behavior which resulted from the follower-leader transition.

Different than Figure 4.3, Team A2 is more similar to the average of the teams here in the Resultant data set than it was in the yellow Initiator data set. This could indicate that while Team A2 did not initiate many follower-leader transitions, the leadership behaviors that occurred when they did have the follower-leader transitions was reasonably similar to the average of the teams. In looking at just the leadership behaviors resulting from the follower-leader transition, Team A1 is instead most unlike the average of the teams. This indicates that while the leadership behaviors they exhibited to initiate the follower-leader transitions were similar to the other teams, the resulting leadership behavior from the transition was not.

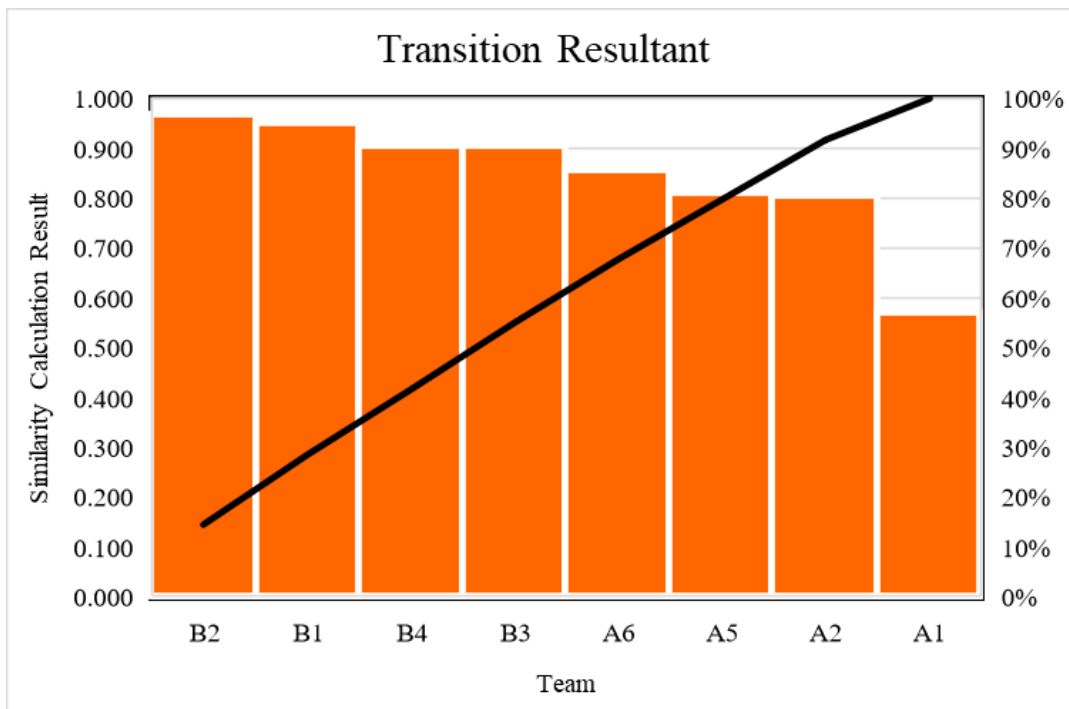


Figure 4.4. Pareto Chart for Resultant Data Set

The Pareto Chart for the remaining data set, Total Leader Behaviors (blue), is shown in Figure 4.5. This data set represents the similarity between all the teams reviewed here with regards to all the observed and coded leadership behaviors recorded for those teams. When considering all the leadership behaviors coded in the teams, Team A2 appears to be most unlike the overall average of the teams. Team A1, which appeared non-similar to the average in Figure 4.4 does not numerically, nor visually, appear to be unlike the team average when all of the leadership behaviors are considered.

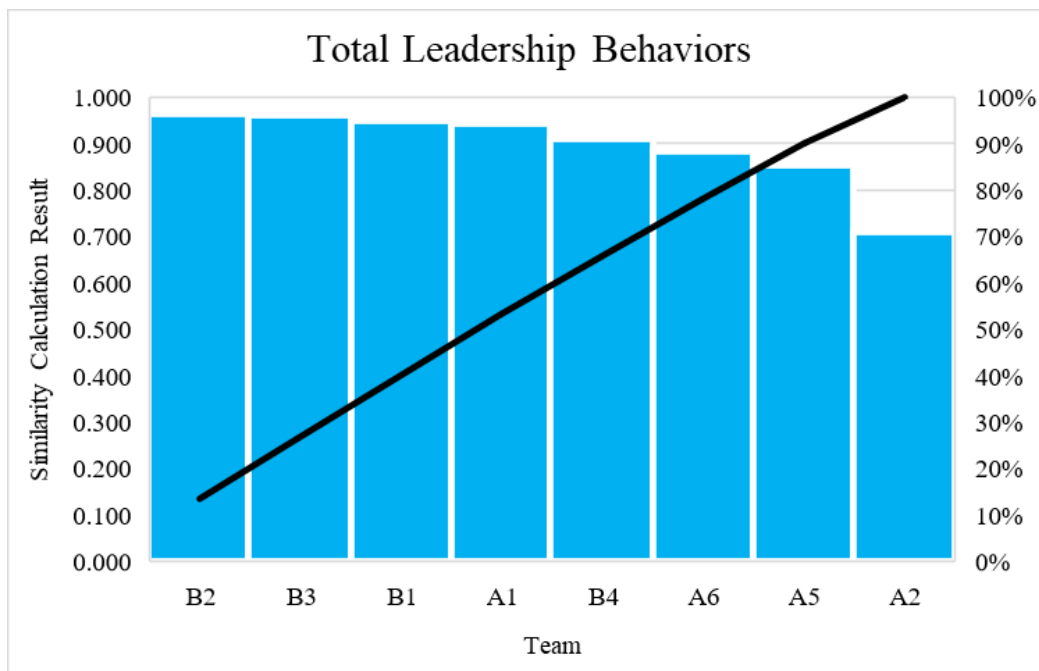


Figure 4.5. Pareto Chart for Total Leader Behaviors Data Set

From the data shown in Table 4.7 and Pareto charts in Figure 4.3 and Figure 4.5, it appears Team A2 is most unsimilar to the other teams. However if looking at the data in Table 4.7 and the Pareto Chart in Figure 4.4, it appears that Team A1 is most unlike the average of the teams. To verify which one of these teams should be removed from the data

set for continued analysis, the minimum and maximum values of similarity of the teams against each other can be examined. This is done again by using Equation 4.1 where instead of looking at the individual team against the average, the values from Table 4.7 are entered into the equation for two teams in the column and row of Table 4.8. For the results here, the minimum values for the given column are shown in red and the maximum values for the given column are shown in green. As an example, when looking at Team A1, Team A1 is most dissimilar to Team A6, and most similar to Team B1. When looking at Team A2, Team A2 is most dissimilar to Team B4 and most similar to Team A1. What was unclear from the similarity data in Table 4.7 and Pareto charts in Figure 4.3, Figure 4.4, and Figure 4.5 was whether Team A1 or Team A2 was most unlike the average of the teams. Now the numerical comparison in Table 4.8 confirms that Team A2 shows as most unlike Teams A5, A6, B1, B2, B3, and B4. This confirms that Team A2 instead of Team A1 has the lowest amount of similarity compared to the average of the other teams, and is therefore removed from the data set for continued analysis.

Table 4.8. Similarity of All Teams

	A1	A2	A5	A6	B1	B2	B3	B4
A1	-	0.59	0.54	0.47	0.65	0.81	0.71	0.64
A2	0.59	-	0.37	0.41	0.44	0.43	0.43	0.26
A5	0.54	0.37	-	0.544	0.66	0.67	0.82	0.66
A6	0.47	0.41	0.54	-	0.84	0.66	0.60	0.69
B1	0.65	0.44	0.66	0.84	-	0.88	0.85	0.95
B2	0.81	0.43	0.67	0.66	0.88	-	0.94	0.89
B3	0.71	0.43	0.82	0.60	0.85	0.94		0.86
B4	0.64	0.26	0.66	0.69	0.95	0.89	0.86	-

4.3 Objective and Research Question

With the numerical confirmation from Table 4.8 of what is seen from the data in Table 4.7 and Pareto charts in Figure 4.3, Figure 4.4, and Figure 4.5, Team A2 is removed from the data set going forward. The remaining teams under consideration are: teams A1, A5, A6, B1, B2, B3, and B4. With reasonable similarity in the remaining seven teams, the data from them is combined to answer the research question of:

How do leadership behaviors impact the follower to leader conversion?

To answer this question, the Transition Initiating and Transition Resultant leadership behaviors are compared to the leadership behaviors which did not lead to a follower-leader transition. For example, in Figure 4.2, such a transition from follower to leader is highlighted between rows 3 and 4 in the coded data. In Table 4.9, the first leadership behavior in this transition is on the row of the table, and the second leadership behavior is located on the column of the table. As an example, a count of one would be added in row “SM” and column “SP” for the conversion from follower to leader between rows 3 and 4. This is done for all seven of the remaining teams, A1, A5, A6, B1, B2, B3, and B4. While Table 4.9 is a summation of this data from the teams remaining under consideration, the counts for the individual teams can be found in Appendix B. Additionally, a column of “null” indicates the number of times the leadership behavior in the row occurs without directly preceding the follower to leader conversion. Notice there is not a row for “null” as the question of interest here is what leadership behaviors are initiating the follower-leader transition. Also, the null column puts the data shown in Table 4.9 in context of how many times that leadership behavior appears versus how many times

it induces the follower-leader transition. For clarity, the zeros in the results are not displayed when insignificant.

As was seen earlier in Section 4.1, Sensemaking (SM) and Provide Feedback (PF) remain the largest contributing leadership behaviors to the follower-leader transition. Perhaps because they are the more common leadership behaviors seen in the teams is why they were also the most likely leadership behaviors to initiate the follower-leader transition. Examples of Sensemaking (SM) seen in the design teams while they were creating function models were bringing in a list of materials, bringing in information from the design prompt to explain how the team should proceed, communicated requirements to the team, organizes order of functions and after communicates that, gets concurrence from team mates. Some examples of Provide Feedback (PF) are asking a question and adjust discussion based on feedback, redirect discussion by bringing up glass cannot be compressed, feedback on sorting assumptions.

Consideration (C) and Empowerment (E) remain the leadership behaviors which contribute the least to the follower-leader transition. With that being said, they do not appear without being involved in the follower-leader transition. So while infrequent, they are possibly significant in the study of helping behavior, or the follower-leader transition. Some examples of Consideration (C) include handing over the dry-erase marker, asking who else would like to participate, asking if anyone else would like to draw. The instance of Empowerment (E) had been one teammate encouraging the other team mates to make changes.

Table 4.9. Impact of Leadership Behaviors on Follower to Leader Conversion

		Transition Resultant										
		SM	SPS	SP	C	TD	PT	PF	MG	E	NULL	All/Comb.
Transition Initiator	SM	24	3	3	4	1		6	2		26	69
	SPS	2	2				3	2			5	14
	SP	1	1				3				8	13
	C	3					1	1			0	5
	TD					3			1		6	10
	PT	1					2	7			6	16
	PF	2	1	1			6	3	2	1	21	37
	MG	5		1		2		1	1		10	20
	E									1	0	1
	Total	38	7	5	4	6	15	20	6	2	82	103

As done earlier, the data from each row of Table 4.9, is normalized by dividing the individual value by the total at the end of the row. For example, row “SM” and column “SM” has a total of 24, which would be divided by the total of the row of 69, which is 0.63, or 63%. The results of doing this are shown as percentages in Table 4.10. For clarity, the zeros in this table have been omitted. Additionally, values of greater than 30% have been shaded light tan, and values of greater than 70% have been shaded a light purple. When normalized, Perform Task (PT) comes in a close third to the total proportion of leadership behaviors seen, with Sensemaking (SM) and Provide Feedback (PF) remaining the two largest contributors. It is noticeable that while Sensemaking consumes 37% of the average leadership behaviors seen, it leads to follower-leader transitions frequently with resulting leadership behaviors of Sensemaking (SM) 63% of the time, Solve Problems (SPS) 43%

of the time, Structure and Plan (SP) 60% of the time, Consideration (C) 100% of the time, and Monitor and Guide (MG) 33% of the time. When looking at percentages higher than 30%, Provide Feedback (PF) also appears to be a significant contributor to the follower-leader transition. It appears as 20% of the average leadership behaviors seen in the teams, but out of this 20%, 40% of the time it leads to Perform Team Task (PT), 33% of the time it leads to Monitor and Guide (MG), and 50% of the time it leads to Empowerment (E). As a reminder again, the definitions of these leadership behaviors are shown in Table 3.1.

Table 4.10. Normalized Collective Leadership Behaviors

		Transition Resultant										
		SM	SPS	SP	C	TD	PT	PF	MG	E	NULL	Average
Transition Initiator	SM	63%	43%	60%	100%	17%		30%	33%		32%	37%
	SPS	5%	29%				20%	10%			6%	8%
	SP	3%	14%				20%				10%	7%
	C	8%					7%	5%			0%	3%
	TD					50%			17%		7%	5%
	PT	3%					13%	35%			7%	19%
	PF	5%	14%	20%			40%	15%	33%	50%	26%	20%
	MG	13%		20%		33%		5%	17%		12%	11%
	E									50%		1%

The column in Table 4.10 for each resulting leadership behavior from the follower-leader transition are examined for similarity to the average of that behavior by implementing Equation 4.1. The results of this calculation are displayed in Table 4.11. What is interesting is that in that up to this point Sensemaking (SM) and Provide Feedback (PF) have been the dominating leadership behaviors observed. What is observed here is that Structure and Plan (SP) has overtaken both sensemaking and provide feedback as being

most similar to the average for the specified leadership behavior. In this case, when the data was normalized through the column instead of the row, or the overall average of the table, the leadership behaviors of Consideration (C) and Empowerment (E) normalized to high values, which was not in line with how often these leadership behaviors appeared. Because of this, the normalized values of Consideration (C) and Empowerment (E) are skewing average. With the average then improperly weighted, the similarity calculation results are out of line with what was expected. With this weighted average, in Table 4.11, Null, Structure and Plan (SP) and Monitor and Guide (MG) are showing as most similar to the average. What was anticipated was seeing Sensemaking (SM) and Provide Feedback (PF) remain as the dominant leadership behaviors they have been throughout the previous analyses. In reviewing the data sets, Structure and Plan (SP) has been either appeared close to the least frequent or in the middle range of the leadership behaviors seen. This is far from a dominating leadership behavior. With the weighted average, Train and Development (TD) and Empowerment (E) are shown as the least similar to the average.

Table 4.11. Similarity Analysis of Modified Combined Teams to Combined Team Average

SM	0.895
SPS	0.863
SP	0.933
C	0.809
TD	0.435
PT	0.519
PF	0.809
MG	0.897
E	0.315
NULL	0.979

4.4 Frequency Analysis

Several interesting patterns and observations may be extracted from the analysis. First, in Table 4.9, it is noteworthy that Consideration (C) only appears in the follower to leader conversion as a leadership behavior when directly preceded by Sensemaking (SM). No other instances of leadership behaviors led to a subsequent consideration behavior. However, there are few (~3%) Consideration behaviors observed in the entire data set.

Secondly, Empowerment (E) appears in the follower to leader conversion as a leadership behavior only twice and only when directly preceded by leadership behaviors of Provide Feedback (PF) and Empowerment (E). Again, Empowerment is a rarely observed behavior (~1%) from the entire data set.

From Table 4.11, one can see that Structure and Plan (SP), Monitor and Guide (MG), and Sensemaking (SM) are the top three dominating leadership behaviors leading to the follower to leader conversion. These are the leadership behaviors which produce follower behaviors which are most likely to lead to subsequent follower-leader transitions.

From Table 4.10, it is seen that Sensemaking dominates as an overall leadership behavior with 37% of the average leadership behaviors. Of these 37% of average occurrences, nearly two thirds (63%) of the SM follower-leader transitions resulted from an initial SM behavior. Of all follower-leader Solving Problems (SPS) behaviors, 43% are a result from Sensemaking. Sixty percent of the Structure and Plan follower-leader behaviors are preceded by Sensemaking. All the instigated Consideration follower-leader behaviors are a result of an initial Sensemaking behavior. Finally, the Monitor and Guide (MG) follower-leader behavior is found following a Sensemaking behavior one third of the

time. Sensemaking plays an important role as both an overall leader behavior, and as the leader behavior that most likely produces follower-leader transitions.

The second leadership behavior that occurs most frequently is Perform Team Task (PT), which accounts for 20% of the total leadership behaviors. Performing Team Task as a leader behavior induces 20% of the Performing Team Task follower-leader transitions. One third of the Monitor and Guide follower-leader transitions are a result of Perform Team Task. Finally, half of the Empowerment follower-leader transitions are a result of Perform Team Task.

The third most frequent leadership behavior is Monitor and Guide (MG). One third of the Train and Development follower-leader transitions resulted from the Monitor and Guide leadership behavior.

However, given that this is contradictory to the other patterns seen in the data, perhaps in determining which leadership behaviors will inspire a follower-leader transition, in this case it is more conclusive to look at the frequency counts instead of the normalized values. At least the way the values have been normalized herein.

4.5 Pattern Analysis

The frequency instead of the similarity of the leadership behaviors is considered for this pattern analysis. This means that the similarity in the context of the leadership behavior sequencing had not been verified for the network diagrams. Figure 4.7 illustrates the directed network for the leadership behaviors that induce the follower-leader transition for teams A1, A5, A6, B1, B2, B3, and B4. Recall that Team A2 was removed from continued use in Section 4.2. If this network were generated for each team individually, they would

not be quite the same as what is seen as the compilation shown in Figure 4.7. An example of the non-normalized leadership behavior sequence frequencies is shown for Team A6 in Figure 4.6. Noticeably, with Team A6, no leadership transitions occur from or lead to Empowerment (E) or Consideration (C). This type of data is available for all the teams in Appendix B.

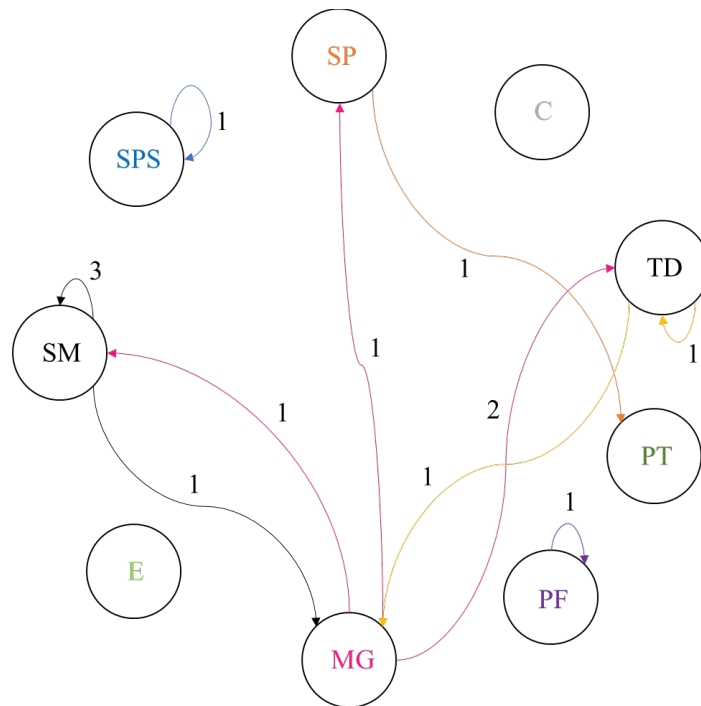


Figure 4.6. Follower-Leader Transition Network – Team A6 Frequency

The graph in Figure 4.7 shows all the relations for the aforementioned teams, independent of frequency. From visual inspection, one can observe the in-node and out-node characteristics to identify leadership behaviors that can serve as primary sources (more out-node) and sinks (more in-node). As an example, Empowerment has two in-node (PF and E) and only one out node (E). Therefore, it can be generally classified as a sink in the leader/follower-leader transition network graph.

With all instances shown in Figure 4.7, the sinks include: TD, PT, E, and SPS; the sources include C and PF. The nodes that are balanced include: SM, SPS, and SP. Counts used to determine the sinks and sources are located in Table 4.12. This network is unweighted. A weighted network would lead to the development of a Markov chain like simulation model for leadership evolution.

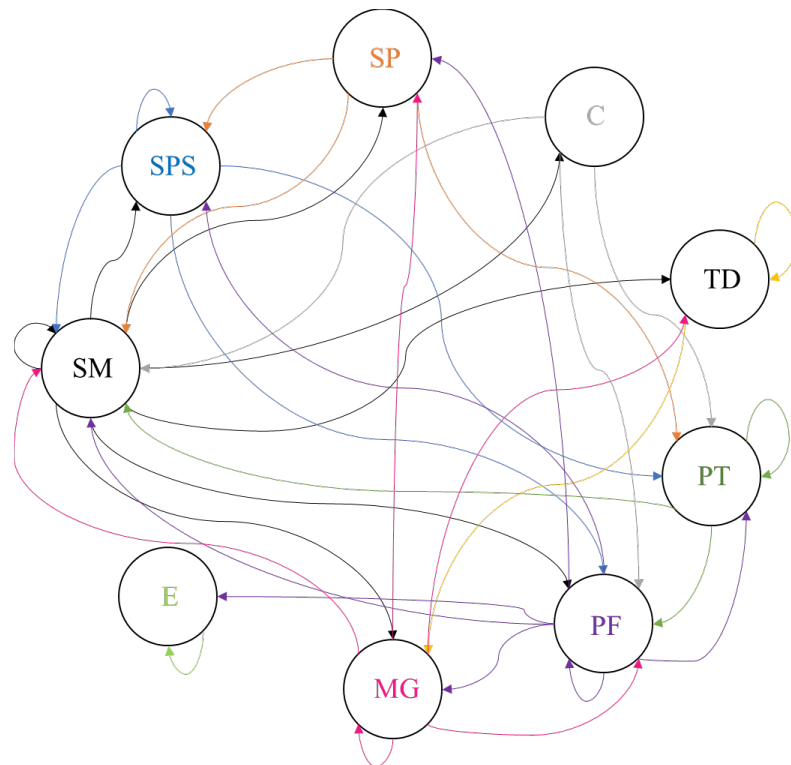


Figure 4.7. Follower-Leader Transition Network

Perhaps viewing the directed network in further detail can provide additional information on the most influential leadership behaviors which create the follower to leader conversions. Figure 4.8 shows values of 30% and higher, while Figure 4.9 shows values of 50% and higher, and Figure 4.10 shows values of 70% and higher.

With Figure 4.8, this is now a weighted network. In addition to labeling the arrows with the normalized percentage values, for every increase in 10%, the weight of the line has also been increased. By reducing the view in the network to 30% or higher, there has been a substantial drop in the number of follower-leader transitions observed in the network. When looking only at ratings of 30% or higher, the number of sinks seen in this network have increased quite a bit and include: SPS, SP, C, TD, MG, and E. The sources include SM and PF. There remains only one balanced node: PT. Again, the counts used to determine the sinks and sources are located in Table 4.12.

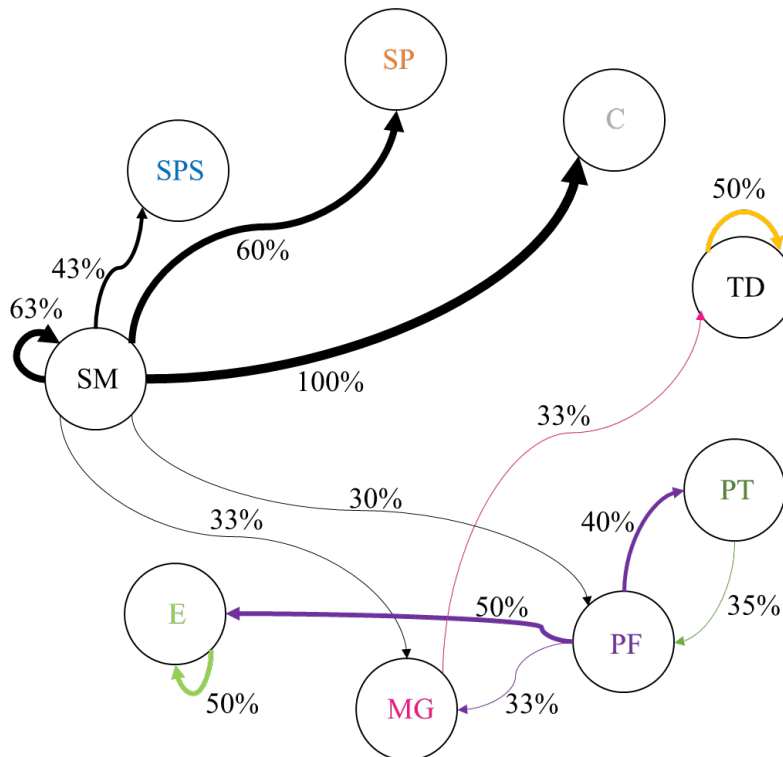


Figure 4.8. Follower-Leader Transition Network, 30% or Higher

By changing the minimum level in the network to 50% in Figure 4.9, there has been another substantial drop in the number of follower-leader transitions observed. Now the

sinks include SM and PF. The sources are SP and C. The balanced nodes are TD and E.

Note that MG and PT have completely dropped off at this level.

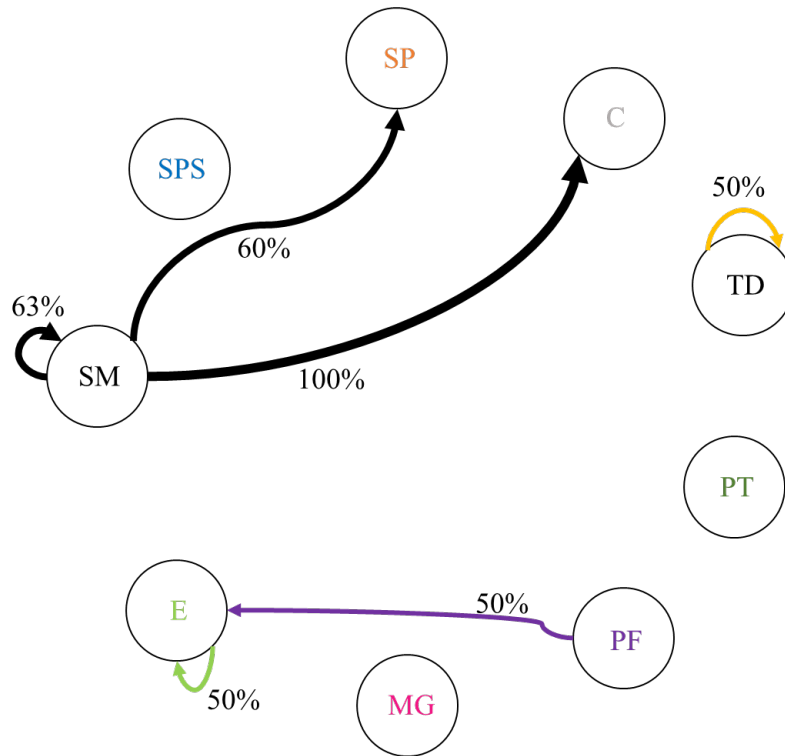


Figure 4.9. Follower-Leader Transition Network, 50% or Higher

In Figure 4.10, now the minimum threshold has been raised to 70% or higher. At this level, only one sink, C, and one source, SM, remain. Sensemaking and consideration appear to be the more robust of the leadership behaviors. Again, the normalization process could be re-examined to verify the accuracy of these values.

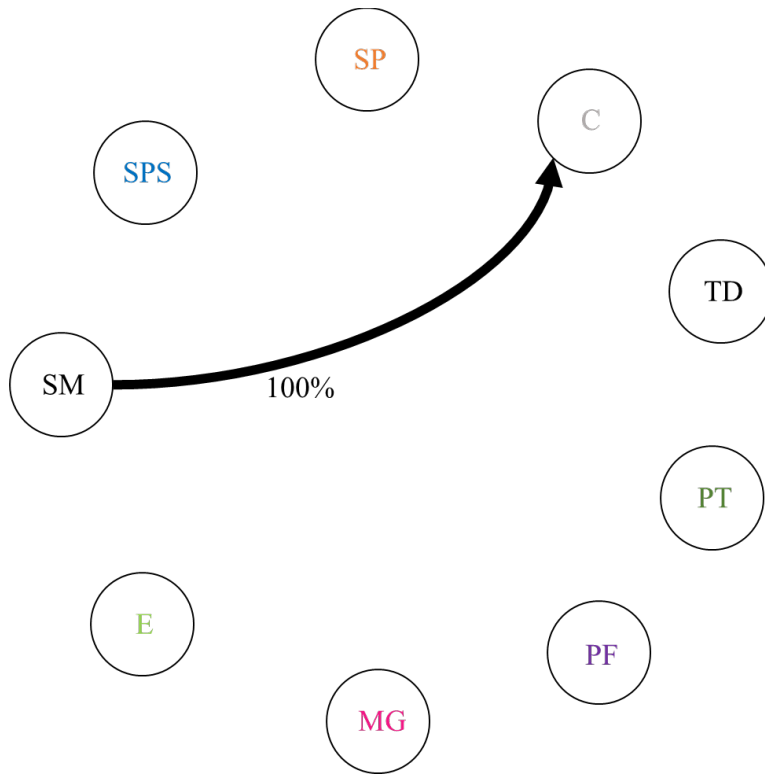


Figure 4.10. Follower-Leader Transition Network, 70% or Higher

To compare the sinks and sources noted in the leadership networks while taking into account the frequency of occurrence, a weighted in/out degree is displayed in and has been calculated from the values listed in Table 4.12. This overall frequency shows Sensemaking (SM) and Provide Feedback (PF) as the two most active leadership behaviors, even though it was Sensemaking (SM) and Consideration (C) that appeared as the two most robust leadership behaviors in the leadership network. This weighted calculation, in comparison to the similarity values calculated for this same set of data do show what was expected. Sensemaking (SM) and Provide Feedback (PF) as the most active leadership behaviors notes. In addition to the expected leadership behaviors of Consideration (C) and

Empowerment (E) being among the least active leadership behaviors coded, Structure and Plan (SP) and Train and Development (TD) also tied with Empowerment (E) as the least occurring leadership behaviors coded.

Table 4.12. Behavior Network Counts

Leadership Behavior	All		30% +		50% +		70% +		Weighted In/Out Degree
	In	Out	In	Out	In	Out	In	Out	
SM	7	7	1	6	1	3	0	1	3.25
SPS	4	4	1	0	0	0	0	0	1.125
SP	3	3	1	0	1	0	0	0	1
C	1	3	1	0	1	0	1	0	0.875
TD	3	2	1	0	1	1	0	0	1
PT	5	3	1	1	0	0	0	0	1.25
PF	6	7	2	3	0	1	0	0	2.375
MG	4	5	2	1	0	0	0	0	1.5
E	2	1	2	1	1	1	0	0	1

One last time, a Pareto chart is shown in Figure 4.11 to show these weighted in/out degree values in a descending order. Not only are Sensemaking (SM) and Provide Feedback the leadership behaviors that are occurring the most frequently, it can be easily seen they are doing so by close to a factor of two from the remaining leadership behaviors. This is again expected to be attributed to nearly double the count of these leadership behaviors attributed to the B teams from the A teams.

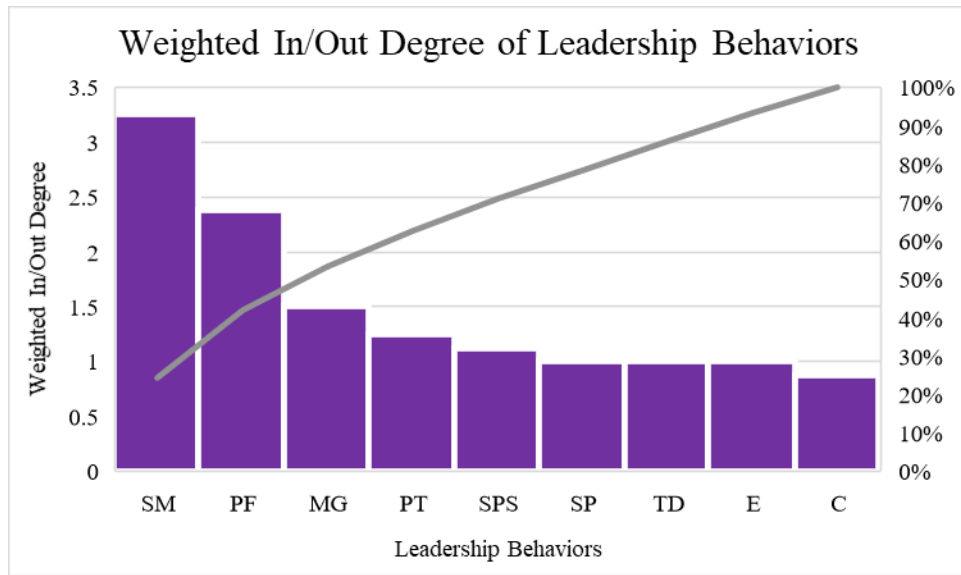


Figure 4.11. Pareto Chart Weighted In/Out Degree of Leadership Behaviors

To best compare the frequency seen in the nodal network charts against the comparison of the theoretical follower enablers and leadership behaviors from Table 3.2, the weighted in/out degree values from Table 4.12 are added to Table 3.2 in Table 4.13. In reviewing Table 4.13, an interesting pattern is observable. The leadership behaviors that are thought to be most linked to follower enabler activities are Provide Feedback (PF), Empowerment (E), Consideration (C), and Sensemaking (SM). This aligns with the what has been seen in most of the data: that while Sensemaking (SM) and Provide Feedback (PF) occur most frequently, Consideration (C) and Empowerment (E) only appear when related to a follower-leader transition. It is not surprising then that Consideration (C) and Empowerment (E) have similar or equal overlap with the influence tactics and social exchange relationships discussed herein. These appear to be the leadership behaviors most likely linked to the follower-leader transition, or follower helping behavior.

Table 4.13. Weighted In/Out Degree and Follower Enablers

Leadership Behaviors	Weighted In/Out Degree	Influence Tactics			Social Exchange		
		Inspirational Appeal	Consultation	Supplication	Affect-based Trust	LMX	TMX
SM	3.25		x		X		x
SPS	1.125				X		x
SP	1			X		x	
C	0.875	x			X	X	
TD	1		X				X
PT	1.25						
PF	2.375		X		x	x	X
MG	1.5						
E	1	X				x	X

Chapter Five CONCLUSIONS AND FUTURE WORK

While follower helping behavior has been studied in business and management primarily, the research reviewed showed results primarily from data gathered by surveys in place of observational data. Helping behavior is of interest because it has been found to improve follower performance in individuals and groups [25–27]. No studies on follower helping behavior specifically within engineering design teams were found. This study begins to close this gap by both studying engineering design teams and by using direct observation studies. This work has also begun to answer the call from other researchers for data to be used which was not self-reported and was collected over a longer time period [27,39]. This preliminary review of the previously completed protocol study [20] showed that 40.3% of the behaviors coded may be further defined as follower-leaders transitions of (follower) helping behavior in the engineering design teams.

5.1 Key Results of Data Analysis

Returning to the research question that was posed in Section 4.3, “*How do leadership behaviors impact the follower to leader conversion*” it is found that some leadership behaviors induce follower-leader transitions more than others. The most significant inducer of the follower-leader behaviors is between Sensemaking and Provide Feedback. Sensemaking (SM) appears a dominating 37% on average to initiate the follower-leader transition. When it does, it leads to Consideration (C) 100%, back to Sensemaking (SM) 63%, Structure and Plan (SP) 60%, Solve Problems (SPS) 43%, and Monitor and Guide (MG) 33% of the time. The Sensemaking (SM) leadership behavior

most aligned with the influence tactic consultation and social exchange relationships of affect-based trust and team-member exchange (TMX). These influence tactics and social exchange relationships are anticipated to be follower helping enablers.

The Provide Feedback (PF) leadership behavior appears 20% on average where it initiates the follower-leader transition. When it does, it leads to Empowerment (E) 50%, Perform Task (PT) 40%, and Monitor and Guide (MG) 33% of the time. The Provide Feedback (PF) leadership behavior most aligned with the influence tactic of consultation, and social exchange relationships of affect-based trust, leader-member exchange (LMX), and team-member exchange (TMX). A controlled study in these enablers might prove enlightening in the study of follower-leader behaviors in engineering design collaboration.

Consideration (C) and Empowerment (E) were also found to be noteworthy leadership behaviors. Consideration (C) appears only 3% on average, but it only appears when it is involved with the follower-leader transition. Consideration (C) notably correlates the influence tactic of inspirational appeal and social exchange relationships of affect-based trust and leader-member exchange.

Empowerment (E) appears 1% on average, but it only appears when it is involved with the follower-leader transition. Empowerment (E) leads back to itself 50% of the time. It is correlated with the influence tactic of inspirational appeal and social exchange relationships of leader-member and team-member exchange.

5.2 Applications of This Work

Understanding the antecedents and outcomes of (follower) helping behavior, researchers, managers, and educators can develop a deeper understanding of teamwork and

collaboration within engineering design teams. This new “view” of design teams may inspire additional ways to increase their efficiency, or uncover additional unexpected relationships between behavior and productivity.

Given the significance seen in the data with providing feedback, an increase in the training of leaders and students should be considered. This training should encompass how to both give and receive feedback. It can be noted also that previous work at Clemson had also noted the importance of providing feedback as a key components for students developing leadership skills [20].

With the amount of time spent studying leadership, leadership should include an understanding of the type of followers. If a manager or leader can properly pair the talents and active/passiveness of a follower to their tasks, would they be more likely to be promoted because of the improved performance of their team? Also, by understanding the type of followers their subordinates are, teams and departments can be better constructed to be the ideal follower types for the leadership type of the leader.

This work has summarized the ways that helping behavior can improve individual and group performance. This can be applied between peers in a professional setting through the further study of the social exchange relationship of team-member exchange. Helping behavior is a function of helping other coworkers, and promoting team-member exchange between peers should also promote the helping behaviors between those peers.

5.3 Limitations of This Work

Many of the limitations of this work have to do with how the data had been collected in the protocol study where the Leadership protocol had been applied. Given that the teams

were formed from student bodies, albeit varying student bodies, the sample here is not assumed to necessarily reflect the true population of design engineers and how they may work in their teams.

Additionally, the formation of the teams was done randomly. This random formation of the teams was assumed to provide an equal distribution of variation between the students over the teams. The background of the students had not been captured. Therefore, the teams had not been purposefully distributed to have similar characteristics.

The leadership coding in the protocol study was done for a design activity that is not typically presented as a collaborative one. This paired with the fact that the teams only met one time may have an impact on what leadership behaviors were observed.

5.4 Future Work

The frequency with which follower-leader transitions were observed in the previously coded data seems to be a strong indication that the previously coded leadership behaviors may be further examined to define the follower-leader transitions noted. This could include a review of the metrics used to quantize (follower) helping behavior in the literature reviewed along with additional literature. These summarized metrics could be used as a starting basis for expanding the definitions of follower-leader transitions in the coding manual. The proposed incorporation of follower helping behavior definitions to the coding manual can be tested on a meeting from a graduate level design team with five members which was recorded the fall of 2019. This recording aligns with a team meeting as part of a semester long project, rather than as a single focused design activity with unfamiliar teammates. With the verification of the follower helping behavior definitions

tested against that recording, the video recordings from the previous protocol study could be reviewed to verify if the follower to leader transitions are indeed follower helping behavior. Doing this could answer the research question of:

Are follower-leader transitions truly follower helping behavior?

The background of a study participant can influence the type of leadership behavior seen. It would be expected that someone who has years of experience working in a technical field would present different leadership behaviors than someone who has not worked outside of academia. It could be expected that someone's age, gender, or personality could also alter what types of leadership behaviors they exhibit. Given that the population of graduate students at Clemson are not just from all over the United States, but from all over the world, a participant's native culture, as in their expectations of leadership/submissiveness are likely to alter the leadership behaviors they exhibit. Capturing these and other characteristics that may change the leadership behaviors the study participants present during a study could answer the research question of:

How does a participant's background impact the type of leadership behaviors they exhibit?

The correlation between the leadership behaviors and the influence tactics and social exchange relationships discussed here also deserve a closer look. Perhaps a mathematical model to determine which influence tactics would be effective given the inputs of the traits inherent in a leader/follower pair of individuals could be developed. Then additional engineering design team meeting protocol studies can be conducted,

considering additional observable metrics such as influence tactics and social exchange relationships. This could find a data-driven response to the research questions of:

How do influence tactics relate to the current leadership behavior codes?

How do social exchange relationships relate to the current leadership behavior codes?

In the previously completed protocol study [19] and case study [17], as well as in this work, Sensemaking (SM) has shown to be a dominating leadership behavior. To complete this work, it is also understood that there are leadership behaviors, and moderators which impact the resulting follower behavior. A closer look at Sensemaking (SM) on its own can answer the question of:

Is Sensemaking (SM) a leadership behavior or is it actually a moderator?

Given the amount of trust involved in social exchange, and the involvement social exchange has in helping behavior, additional work examining the ways and mechanisms that trust is generated and maintained in conjunction with engineering design teams is also warranted. A closer look at the types of trust that exist may aid in answering the research question of:

How do types trust impact follower-leader transitions?

The work done here seems to show that while the leadership behaviors of Consideration (C) and Empowerment (E) appear infrequently, they only do so in the context of the follower to leader transition. It is expected that when teams operate over time, the leadership behavior patterns they exhibit will change. For example, as the team

progresses in completing their task, they may exhibit more Monitor and Guide (MG) and Structure and Plan (SP) leadership behaviors than were observed in a team that only met one time. Additionally, the more the team members get to know each other, will additional instances of Consideration (C) and Empowerment (E) be observed? Conducting a protocol study to observe leadership behaviors over the life of a team paired with survey data capturing how well they know each other as their work progresses could answer the research question of:

Do Consideration (C) and Empowerment (E) increase in frequency the longer the design teams are together?

This work discussed the idea of understanding followership was a key aspect of understanding leadership. Different types of followers and their respective characteristics were discussed. However, does experience on design teams, in a collegiate setting or a professional one change what type of a follower the follower is? Does an active and critically thinking follower become an alienated follower after their suggestions are rejected? Does an active follower become a passive one because they don't feel their work is appreciated? These questions could be investigated to understand:

How does experience level impact follower type?

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APPENDICES

APPENDIX A. ORIGINAL CODED DATA

While the data used in Chapter Four was not explicitly in the dissertation from James Righter [20], the data was provided from him upon request. For clarity, the blank column “Design Activity Coding,” and completed columns “Upper Level Leadership Behaviors,” and “Behavior Observed” have been omitted for all the teams. For the purpose of adding additional clarity for the discussion herein, in Figure 4.2, the phrase “Leadership Function” was modified to “Leadership Behavior.”

Number	Time Recording			Leadership	Individual Behavior Coding			
	Start Time	End Time	Duration	Leadership Function	Per. A	Per. B	Per. C	Per. D
1	0:01:17	0:02:15	0:00:58	SM	L	F	F	
2	0:02:25	0:02:40	0:00:15	SM	F		F	L
3	0:03:45	0:04:00	0:00:15	SM	F			L
4	0:04:05	0:04:33	0:00:28	SM	F	L		
5	0:05:30	0:06:30	0:01:00	TD	F			L
6	0:08:25	0:09:05	0:00:40	TD	F		F	L
7	0:11:35	0:11:45	0:00:10	SP	F		F	L
8	0:13:15	0:13:45	0:00:30	SP	F	F	F	L
9	0:18:20	0:19:00	0:00:40	SM	F	F		L
10	0:19:45	0:19:55	0:00:10	SM	F		F	L
11	0:20:00	0:20:20	0:00:20	SPS	F		L	F
12	0:21:12	0:21:17	0:00:05	SP	L			F
13	0:22:25	0:22:59	0:00:34	C	L		F	F
14	0:24:03	0:24:25	0:00:22	PF	F	F	F	L
15	0:25:25	0:25:30	0:00:05	PF		F		L
16	0:27:45	0:28:45	0:01:00	PF		F		L
17	0:29:55	0:30:20	0:00:25	PT		L		F
18	0:31:58	0:32:10	0:00:12	SM	L			F
19	0:32:14	0:32:40	0:00:26	SPS	F	F	F	L
20	0:35:30	0:36:00	0:00:30	PF		L		F
21	0:39:45	0:40:00	0:00:15	SPS		F	L	F
22	0:41:45	0:45:53	0:04:08	C	L	F	F	F
23	0:42:45	0:44:30	0:01:45	PT	F	L		
24	0:45:02	0:45:50	0:00:48	PT	F	L		F
25	0:46:50	0:47:00	0:00:10	PT		L		F
26	0:47:50	0:48:48	0:00:58	PF	F	F		L
27	0:49:20	0:49:45	0:00:25	PF	F	F		L

Figure A.1. Original Data for Team A1

Number	Time Recording			Leadership	Individual Behavior Coding			
	Start Time	End Time	Duration	Leadership Function	Per. A	Per. B	Per. C	Per. D
1	0:00:45	0:01:08	0:00:23	TD	L	F		
2	0:01:08	0:01:25	0:00:17	C		L	F	
3	0:01:55	0:02:31	0:00:36	TD	F		F	L
4	0:02:40	0:03:06	0:00:26	TD	F		F	L
5	0:04:13	0:04:25	0:00:12	SM	L	F	F	F
6	0:04:30	0:04:50	0:00:20	SM		L		F
7	0:06:17	0:06:45	0:00:28	SM	F	F	L	
8	0:10:25	0:10:45	0:00:20	PF	F	F	L	
9	0:11:20	0:11:30	0:00:10	PF	F	L	T	
10	0:16:50	0:17:26	0:00:36	SP	F	F	F	L
11	0:19:30	0:20:00	0:00:30	SPS	F	F	F	L
12	0:23:00	0:23:10	0:00:10	SPS	L	F	F	F
13	0:24:40	0:25:00	0:00:20	SPS	L		F	F
14	0:25:25	0:25:50	0:00:25	TD		F		L
15	0:28:12	0:28:19	0:00:07	SPS	L	F	F	
16	0:28:20	0:28:29	0:00:09	SM	F	F	L	
17	0:28:55	0:29:05	0:00:10	PF	F			L
18	0:29:30	0:29:33	0:00:03	SPS	F		L	
19	0:29:55	0:30:02	0:00:07	PF	F		F	L
20	0:31:15	0:31:30	0:00:15	SPS	L	F	F	
21	0:32:10	0:32:20	0:00:10	SP	F		L	
22	0:35:10	0:35:35	0:00:25	TD	F		F	L
23	0:36:40	0:36:45	0:00:05	SPS	L	F	F	
24	0:38:52	0:38:57	0:00:05	SPS	F	F		L
25	0:39:19	0:40:20	0:01:01	PT	F			L

Figure A.2. Original Data from Team A2

Number	Time Recording			Leadership	Individual Behavior Coding			
	Start Time	End Time	Duration	Leadership Function	Per. A	Per. B	Per. C	Per. D
1	0:02:20	0:02:45	0:00:25	MG	L	F	F	F
2	0:03:15	0:03:32	0:00:17	MG	L	F	F	
3	0:03:35	0:03:45	0:00:10	SM	F	L		
4	0:03:50	0:04:02	0:00:12	TD	L	F		
5	0:04:38	0:04:46	0:00:08	TD	L	F		
6	0:05:50	0:05:58	0:00:08	TD	L	F	F	
7	0:08:31	0:08:40	0:00:09	sm	L		F	
8	0:08:45	0:08:49	0:00:04	SM		L	F	
9	0:08:50	0:08:59	0:00:09	SM	F		L	
10	0:09:00	0:09:03	0:00:03	C	L	F		
11	0:10:40	0:11:05	0:00:25	SM	L	F	F	
12	0:11:05	0:11:20	0:00:15	SM		F	F	L
13	0:12:25	0:12:34	0:00:09	MG	L	F	F	
14	0:13:56	0:14:30	0:00:34	PT	L	F	F	
15	0:14:45	0:15:08	0:00:23	PT	L	F	F	F
16	0:15:20	0:15:42	0:00:22	PF	F	F		L
17	0:16:14	0:16:37	0:00:23	PT	L	F	F	
18	0:20:10	0:20:45	0:00:35	PT	L	F	F	
19	0:20:48	0:21:15	0:00:27	PF		F	F	L
20	0:21:58	0:22:20	0:00:22	PF	F			L
21	0:23:00	0:23:10	0:00:10	PF	F	L		
22	0:23:20	0:23:35	0:00:15	PT	L		F	
23	0:23:35	0:23:40	0:00:05	PF	F	F		L
24	0:25:45	0:26:45	0:01:00	PT	L	F	F	F
25	0:27:40	0:27:45	0:00:05	PF	F		L	
26	0:28:35	0:28:40	0:00:05	TD	L		F	
27	0:28:55	0:29:00	0:00:05	pf	F	L		
28	0:30:10	0:30:21	0:00:11	MG	L	F		F
29	0:30:30	0:30:38	0:00:08	PF	F	L		

Figure A.3. Original Data for Team A5

Number	Time Recording			Leadership	Individual Behavior Coding			
	Start Time	End Time	Duration	Leadership Function	Per. A	Per. B	Per. C	Per. D
1	0:00:25	0:00:34	0:00:09	MG	L		F	
2	0:00:35	0:01:04	0:00:29	TD	F		L	
3	0:01:08	0:01:26	0:00:18	TD	F		L	F
4	0:01:27	0:01:33	0:00:06	TD	L		F	
5	0:01:36	0:01:39	0:00:03	MG	L	F		
6	0:02:36	0:02:43	0:00:07	MG	L	F	F	F
7	0:02:57	0:03:05	0:00:08	TD	F	L		F
8	0:03:10	0:03:15	0:00:05	MG	L			F
9	0:03:17	0:03:42	0:00:25	SM	F		L	
10	0:04:20	0:04:45	0:00:25	SM	L	F	F	
11	0:05:19	0:05:20	0:00:01	MG	L	F	F	F
12	0:05:26	0:05:29	0:00:03	SM	F		F	L
13	0:05:32	0:05:34	0:00:02	SM	F		L	
14	0:06:28	0:06:32	0:00:04	SM	F		L	F
15	0:08:50	0:08:54	0:00:04	MG	L	F	F	
16	0:10:05	0:10:25	0:00:20	TD	L		F	
17	0:10:25	0:10:34	0:00:09	MG	L	F		
18	0:10:36	0:10:50	0:00:14	SP		L	F	
19	0:10:53	0:11:01	0:00:08	PT		F	L	F
20	0:11:18	0:11:19	0:00:01	PF	L		F	
21	0:11:30	0:11:35	0:00:05	MG	L	F		
22	0:13:02	0:13:18	0:00:16	SM	F		L	
23	0:13:47	0:14:01	0:00:14	SM	L	L	F	
24	0:16:30	0:16:51	0:00:21	SPS	F	F	F	L
25	0:17:53	0:17:59	0:00:06	SPS	L		F	
26	0:18:25	0:18:56	0:00:31	PF	L	F	F	
27	0:19:40	0:19:43	0:00:03	PF	L	F	F	
28	0:20:50	0:20:55	0:00:05	SPS			F	L
29	0:21:58	0:22:02	0:00:04	PT	L		F	
30	0:23:13	0:23:16	0:00:03	MG	L	F	F	
31	0:24:03	0:24:20	0:00:17	SM	L	F		F
32	0:24:28	0:24:39	0:00:11	SM	L	F		
33	0:26:15	0:26:30	0:00:15	PT	L	F		
34	0:27:16	0:27:38	0:00:22	PF	F	L		
35	0:28:41	0:28:51	0:00:10	PF	F	F	L	

Figure A.4. Original Data for Team A6

Number	Time Recording			Leadership	Individual Behavior Coding			
	Start Time	End Time	Duration	Leadership Function	Per. A	Per. B	Per. C	Per. D
1	0:05:20	0:05:25	0:00:05	SP	L	F	F	
2	0:05:36	0:05:40	0:00:04	SM	L	F	F	
3	0:06:01	0:06:03	0:00:02	SM	F	F	L	
4	0:06:05	0:06:10	0:00:05	SM	L	F	F	
5	0:06:52	0:06:56	0:00:04	SM	L	F	F	
6	0:07:10	0:07:12	0:00:02	SM	F	F	F	L
7	0:07:48	0:07:57	0:00:09	SM	L	F	F	
8	0:08:09	0:08:16	0:00:07	SM	L	F	F	
9	0:08:43	0:09:30	0:00:47	TD	L	F	F	
10	0:09:40	0:09:58	0:00:18	TD	F	L	F	
11	0:10:00	0:10:45	0:00:45	TD	L		F	
12	0:12:23	0:12:30	0:00:07	MG	F	L	F	F
13	0:14:35	0:14:45	0:00:10	SM	F	L	F	F
14	0:15:22	0:15:45	0:00:23	SPS	L		F	
15	0:17:20	0:17:37	0:00:17	SM	L	F	F	
16	0:18:06	0:18:25	0:00:19	SM	F	L	F	
17	0:18:40	0:19:40	0:01:00	SM	F	F	L	F
18	0:21:15	0:21:28	0:00:13	SM	L	F	F	
19	0:21:29	0:21:48	0:00:19	SM	F	L	F	
20	0:21:57	0:22:08	0:00:11	SM	L	F	F	
21	0:23:25	0:23:28	0:00:03	MG	L	F	F	
22	0:24:30	0:25:30	0:01:00	PT	L	F	F	
23	0:28:35	0:28:40	0:00:05	PF	F		L	
24	0:29:05	0:29:10	0:00:05	MG	L	F	F	F
25	0:30:45	0:30:48	0:00:03	MG	F		L	
26	0:32:15	0:32:26	0:00:11	SM	L	F	F	
27	0:32:40	0:32:55	0:00:15	SM	L		F	
28	0:33:10	0:33:12	0:00:02	SM	L		F	
29	0:34:24	0:34:26	0:00:02	PF	F	L		
30	0:36:36	0:36:42	0:00:06	MG	F	L	F	
31	0:37:44	0:37:57	0:00:13	SM	L		F	F
32	0:38:40	0:39:05	0:00:25	SM	F	L	F	
33	0:39:45	0:39:52	0:00:07	PF	F	F	L	
34	0:40:35	0:40:38	0:00:03	SPS	L	F		
35	0:41:30	0:41:36	0:00:06	PT	F	L		
36	0:42:41	0:42:45	0:00:04	SM	F	F	L	
37	0:42:51	0:42:55	0:00:04	SM	L		F	
38	0:45:13	0:45:16	0:00:03	SPS	F	L	F	
39	0:46:52	0:46:55	0:00:03	PF		F	L	
40	0:47:00	0:47:05	0:00:05	PF	F	F	L	
41	0:48:35	0:48:39	0:00:04	MG	F		L	
42	0:50:25	0:50:30	0:00:05	PF	F	L		

Figure A.5. Original Data for Team B1

Number	Time Recording			Leadership	Individual Behavior Coding			
	Start Time	End Time	Duration	Leadership Function	Per. A	Per. B	Per. C	Per. D
1	0:00:43	0:00:45	0:00:02	SP	L			F
2	0:01:13	0:01:16	0:00:03	SM	F		L	
3	0:01:26	0:01:33	0:00:07	SM	F			L
4	0:01:43	0:01:57	0:00:14	SM	L			F
5	0:03:20	0:03:30	0:00:10	SM	F			L
6	0:05:12	0:05:18	0:00:06	SP	L			F
7	0:05:35	0:05:40	0:00:05	SM	F			L
8	0:06:35	0:06:40	0:00:05	SM	L			F
9	0:07:00	0:07:02	0:00:02	SPS	F		L	
10	0:07:08	0:07:10	0:00:02	SM	F			L
11	0:07:25	0:07:28	0:00:03	SM	L			F
12	0:07:44	0:07:46	0:00:02	PF	F	F		L
13	0:08:40	0:08:50	0:00:10	SM	L			F
14	0:09:57	0:10:03	0:00:06	SPS	F	L		F
15	0:10:15	0:10:28	0:00:13	SM	F			L
16	0:10:30	0:10:33	0:00:03	C	L			F
17	0:10:58	0:11:45	0:00:47	SM	F			L
18	0:13:09	0:13:13	0:00:04	PF	F	L		F
19	0:13:56	0:13:58	0:00:02	SP	L			F
20	0:14:14	0:14:17	0:00:03	SP	L		F	F
21	0:15:08	0:15:09	0:00:01	SPS	F		L	F
22	0:15:25	0:15:35	0:00:10	PT	F			L
23	0:18:10	0:18:33	0:00:23	PT	F			L
24	0:18:35	0:18:40	0:00:05	SM	L			F
25	0:19:30	0:19:45	0:00:15	SM	F		L	F
26	0:24:50	0:25:00	0:00:10	SM	F			L
27	0:25:44	0:25:46	0:00:02	PF	L	F	L	F
28	0:26:35	0:27:10	0:00:35	SM	L			F
29	0:29:35	0:29:45	0:00:10	SP	L	F		F
30	0:31:15	0:31:19	0:00:04	C	L	F		F
31	0:33:28	0:33:35	0:00:07	SM	F	F		L
32	0:36:10	0:36:15	0:00:05	SP	F	F	L	
33	0:37:58	0:38:10	0:00:12	PT		L	F	
34	0:38:12	0:38:15	0:00:03	PT	F	F	L	
35	0:41:15	0:41:30	0:00:15	SPS	F		F	L
36	0:42:48	0:42:51	0:00:03	SPS	F		L	F
37	0:42:47	0:42:52	0:00:05	SM	F		L	F
38	0:45:15	0:45:38	0:00:23	SM	F	F	L	F
39	0:46:00	0:46:05	0:00:05	PF	F	L		
40	0:46:40	0:47:21	0:00:41	PT	L			F
41	0:48:05	0:48:22	0:00:17	PT	L			F
42	0:48:50	0:48:53	0:00:03	PF	F			L
43	0:50:04	0:50:06	0:00:02	PF	F		L	
44	0:51:20	0:51:25	0:00:05	PF	F		L	
45	0:52:47	0:52:50	0:00:03	PF	F		F	L
46	0:53:00	0:53:06	0:00:06	PF	F			L
47	0:53:26	0:53:28	0:00:02	PF	F			L

Figure A.6. Original Data for Team B2

Number	Time Recording			Leadership	Individual Behavior Coding			
	Start Time	End Time	Duration	Leadership Function	Per. A	Per. B	Per. C	Per. D
1	0:02:01	0:02:21	0:00:20	SM		F	L	
2	0:02:21	0:02:35	0:00:14	SM		L	F	
3	0:02:41	0:02:45	0:00:04	SM		F	F	L
4	0:03:05	0:03:07	0:00:02	C			L	F
5	0:03:16	0:03:17	0:00:01	SM		L		F
6	0:06:12	0:06:18	0:00:06	PF			L	
7	0:07:35	0:07:44	0:00:09	SP	F	F	L	F
8	0:07:50	0:08:12	0:00:22	SM		F	L	
9	0:08:25	0:08:35	0:00:10	PF		F	F	L
10	0:09:20	0:09:32	0:00:12	SM			L	
11	0:09:35	0:09:40	0:00:05	SM	L		F	F
12	0:10:30	0:10:40	0:00:10	SM			F	L
13	0:11:20	0:11:35	0:00:15	SM		F	L	F
14	0:13:16	0:13:20	0:00:04	SPS			L	F
15	0:14:02	0:14:10	0:00:08	SM				
16	0:16:10	0:16:18	0:00:08	SP	F	F	F	L
17	0:19:59	0:20:13	0:00:14	PT		L		F
18	0:20:16	0:20:20	0:00:04	PT		F		L
19	0:23:54	0:24:03	0:00:09	SPS		F	L	F
20	0:24:30	0:24:46	0:00:16	PT		L	F	F
21	0:24:47	0:24:54	0:00:07	PF		F		L
22	0:25:50	0:26:05	0:00:15	SPS	F	F	L	F
23	0:26:05	0:26:14	0:00:09	SM				
24	0:27:48	0:27:55	0:00:07	TD		F	L	
25	0:28:10	0:28:18	0:00:08	PT		F	L	F
26	0:29:15	0:29:43	0:00:28	PT		F	L	
27	0:30:35	0:30:40	0:00:05	SM	L	F	F	F
28	0:33:00	0:33:05	0:00:05	PF			F	L
29	0:33:40	0:33:43	0:00:03	PF			F	L
30	0:35:02	0:35:06	0:00:04	PF			F	L
31	0:40:03	0:40:07	0:00:04	E		F	L	
32	0:40:36	0:40:42	0:00:06	PF		L	F	
33	0:40:43	0:40:46	0:00:03	PF	L		F	
34	0:46:02	0:46:03	0:00:01	PF		F	L	
35	0:46:22	0:46:25	0:00:03	PF	L	F		

Figure A.7. Original Data for Team B3

Number	Time Recording		Leadership	Individual Behavior Coding			
	Start Time	End Time	Leadership Behavior	Per. A	Per. B	Per. C	Per. D
1	0:01:50	0:01:57	SP	L	F	F	F
2	0:02:10	0:02:18	SM	L	F	F	
3	0:02:45	0:03:00	SM	F		L	
4	0:04:29	0:04:40	SP	L	F	F	F
5	0:04:40	0:05:30	SM	L		F	F
6	0:05:50	0:06:00	SM	L		F	F
7	0:06:10	0:06:18	MG	F		L	
8	0:07:00	0:07:20	SM	L		F	
9	0:09:30	0:09:40	SM	L		F	F
10	0:10:07	0:10:09	C	L		F	
11	0:10:30	0:11:00	SM	F	F	L	F
12	0:11:50	0:11:55	SP	L		F	F
13	0:12:35	0:12:55	SM	L		F	F
14	0:12:55	0:13:10	SM	F		F	L
15	0:14:00	0:14:30	SM	L		F	F
16	0:15:15	0:15:18	MG	L			F
17	0:15:29	0:15:55	SM	L		F	F
18	0:17:00	0:17:02	SM	F	L		
19	0:18:40	0:18:45	C	L	F	F	
20	0:19:00	0:19:10	SM	L	F	F	F
21	0:19:30	0:19:38	PF	F			L
22	0:21:25	0:21:37	PF	L		F	F
23	0:22:02	0:22:10	PF			F	L
24	0:22:36	0:22:43	SM	L		F	
25	0:24:10	0:24:30	SM			F	L
26	0:29:35	0:29:50	SP	L		F	F
27	0:30:25	0:30:30	PF	L		F	
28	0:33:40	0:33:50	PF	L		F	
29	0:34:32	0:34:44	SM	L		F	
30	0:35:10	0:35:16	SM	L		F	
31	0:35:29	0:35:39	SM	L		F	
32	0:37:49	0:37:55	MG	L		F	F

Figure A.8. Original Data for Team B4

APPENDIX B. TEAM DATA FOR IMPACT OF LEADERSHIP BEHAVIORS ON FOLLOWER TO LEADER CONVERSION

Table B.5.1: Team A1 Impact of Leadership Behaviors on Follower to Leader Conversion

		Transition Resultant									NULL	All/ Combined
Team A1	SM	SPS	SP	C	TD	PT	PF	MG	E			
Transition Initiator	SM		2								5	7
	SPS			1				1			1	3
	SP										2	2
	C						1	1				2
	TD										2	2
	PT							1			1	2
	PF						1				2	3
	MG											0
	E											0
Total	0	2	1	0	0	2	3	0	0	13	21	

Table B.5.2: Team A5 Impact of Leadership Behaviors on Follower to Leader Conversion

		Transition Resultant									NULL	All/ Combined
Team A5	SM	SPS	SP	C	TD	PT	PF	MG	E			
Transition Initiator	SM	1			1	1					3	6
	SPS											0
	SP											0
	C											0
	TD										2	2
	PT							2			2	4
	PF						4		1		2	7
	MG	1						1			2	4
	E											0
Total	2	0	0	1	1	4	3	1	0	11	23	

Table B.5.3: Team A6 Impact of Leadership Behaviors on Follower to Leader Conversion

		Transition Resultant									NULL	All/ Combined
Team A6	SM	SPS	SP	C	TD	PT	PF	MG	E			
Transition Initiator	SM	3						1		2	6	
	SPS		1							1	2	
	SP						1				1	
	C										0	
	TD					1			1	1	3	
	PT									1	1	
	PF							1		4	5	
	MG	1		1		2				3	7	
	E										0	
	Total	4	1	1	0	3	1	1	2	0	12	25

Table B.5.4: Team B1 Impact of Leadership Behaviors on Follower to Leader Conversion

		Transition Resultant									NULL	All/ Combined
Team B1	SM	SPS	SP	C	TD	PT	PF	MG	E			
Transition Initiator	SM	9	1				1			4	15	
	SPS						1	1			2	
	SP									1	1	
	C										0	
	TD					1					1	
	PT							1			1	
	PF		1						1	3	5	
	MG	2							1	3	6	
	E										0	
	Total	11	2	0	0	1	1	3	2	0	11	31

Table B.5.5: Team B2 Impact of Leadership Behaviors on Follower to Leader Conversion

		Transition Resultant									All/ Combined	
Team B2	SM	SPS	SP	C	TD	PT	PF	MG	E	NULL		
Transition Initiator	SM	5		1	1			3			3	13
	SPS	1	1				1				1	4
	SP	1	1				1				2	5
	C	2										2
	TD											0
	PT	1					1	1				3
	PF	1		1			1				5	8
	MG											0
	E											0
	Total	11	2	2	1	0	4	4	0	0	11	35

Table B.5.6: Team B3 Impact of Leadership Behaviors on Follower to Leader Conversion

		Transition Resultant									All/ Combined	
Team B3	SM	SPS	SP	C	TD	PT	PF	MG	E	NULL		
Transition Initiator	SM	3			1			1			2	7
	SPS						1				2	3
	SP						1				1	2
	C											0
	TD										1	1
	PT						1	1			2	4
	PF	1						1		1	3	6
	MG											0
	E							1				1
	Total	4	0	0	1	0	3	4	0	1	11	24

Table B.7: Team B4 Impact of Leadership Behaviors on Follower to Leader Conversion

		Transition Resultant									NULL	All/ Combined
Team B4	SM	SPS	SP	C	TD	PT	PF	MG	E			
Transition Initiator	SM	3		2	1			1	1		8	16
	SPS											0
	SP										2	2
	C	1										1
	TD											0
	PT											0
	PF							2			2	4
	MG	1									2	3
	E											0
Total	5	0	2	1	0	0	3	1	0	14	26	