Technical Leadership in Systems Engineering

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Leadership is an important but often overlooked component of technical projects and programs. It addresses the performance of people: their behaviors, their ability to think individually and collectively, and their motivation and energy. Technical leadership in systems engineering creates the environmental conditions conducive to good performance: support of shared understanding, innovation, problem solving, resilience and learning. Leadership is thus complementary to management, which directs specific activities to deliver outputs. A systems engineering leader may lead a team of systems engineers for a project or program, or may be the only systems engineer in a team of diverse members involved in project or program (e.g. other engineers, IT personnel, service providers). There are various models and styles of leadership and key to success is matching leadership to the needs of a situation. '''Models''' of leadership describe the mechanisms by which leadership arises and operates (e.g. situationally-driven or caused by a charismatic individual). '''Styles''' of leadership describe the manner in which a leader (or a leadership team) leads (e.g. task-focused or people-focused; autocratic, democratic or "laissez-faire" (Lewin et al., 1939)).

There is a vast amount of literature addressing leadership issues from multiple points of view, including philosophical, psychological and emotional considerations (Yukl, 2012). This article highlights key aspects of leadership theory to help systems engineers understand how they may influence the success of their team and organization. Leadership theory provides the basic building blocks for adapting leadership behaviors

at work. The pragmatic aspects of leading team members involved in systems engineering are summarized in section 1.11. This section highlights the need to use different approaches to leadership across the systems engineering context, and it is therefore important be able to understand and adopt the leadership behaviors discussed in the preceding sections, as judged appropriate. Related knowledge areas and articles are in the Part 5 Knowledge Area Part 5 Enabling Systems Engineering and the Part 6 Knowledge Area Systems Engineering and Project Management.

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Attributes of Effective Leaders

Traditional Attitudes to Technical Leadership

The need for leadership in an engineering environment has not been widely emphasized or understood. Traditional academic engineering curricula do not cover the development of leadership skills, and industry professionals tend to be task-oriented, with project leaders perceived in terms of power and authority (Toor and Ofori, 2008). In many cases, technical organizations focus on management rather than leadership. "Managers are people who do things right while leaders are people who do the right thing" (Bennis and Nanus, 1985). Doing the right thing is not only about identifying the right approach in the first place; it is also about taking responsibility for understanding and challenging the progression of a project or program in a continuous manner. It is now recognized that leadership is a critical component of successful projects and programs, and that technical leadership is likely to be a distributed responsibility.

Great Man Theories: Traits and Charisma Models of Leadership

Early concepts of leadership were driven by views of leaders as heroic figures, with particular qualities that made them different to other people. The notion of "charisma" was used to describe the ability to charm and influence followers. Numerous studies have been conducted to try and define the particular personality traits that made someone a born leader. The findings are not clear-cut, partly because there are many different models of personality which produce different results (Hippocrates first identified 4 personality dimensions in the 5th Century BC, and many different conceptualizations have been devised since then). Personality tests should be used with great caution because each test has been developed for specific purposes and contexts, and is only valid within those parameters. For tests to be valid they must undergo a strict set of tests with extensive data sets, and then they must be used exactly as specified by the validation process. The current best consensus of evidence is that there are 5 main dimensions of personality: '''Extraversion''' (talkative, sociable); '''Agreeableness''' (good natured, co-operative); '''Conscientiousness'''

(responsible, tidy); '''Neuroticism''' (general level of anxiety or composure); and '''Openness''' (to new experiences). This 5-Factor model has good validity across literate populations, but even this model may not be universal (Gurven at al., 2013). There is some evidence that extraversion is associated with leadership roles, but this is not always a predictor of success, and may reflect a cultural stereotype which leads to people who behave like leaders being more likely to get leadership roles. Different contexts will change the value of extraversion (and other traits) in a leader. (See Judge et al. (2002) for a meta-analysis of the literature).

In business settings, the Myers-Briggs Type Indicator (MBTI) personality test is often used as part of guided discussions to assist with self-development (although it lacks the important personality dimension of 'neuroticism'). People can use their MBTI profiles to help them use their strengths more effectively. Occasionally, MBTI is misused as a basis for selection, especially for leadership roles. The evidence indicates this is not justified (National Research Council, 1991).

Transactional and Transformational Leadership Styles

Certain behaviors have been associated with successful leadership. These behaviors arise from the style of leadership and particularly the attention paid to the task compared to team relationships. Such differences are described as transactional and transformational styles (Burns, 1978). Transactional leadership is closely allied to management, focused on defined task outputs and incentivizing people to follow directions by rewarding and punishing.

Transformational leadership is concerned with achieving outcomes through the development of the people (team building), building trust, developing a shared vision, motivation, cultivating relationships and sharing knowledge. Both types of leadership have value, but transformational leadership is needed for developing the culture of an organization, and for ensuring qualities such as safety, adaptability, learning and improvement. It is usually considered the most valuable form of leadership.

Understanding that different styles have value for different situations provides the basis for leadership models that recognize the interactions between style and situation. Fiedler's Contingency Model, Hersey et al.'s

Situational Model and House's Path-Goal Theory (all described below) provide useful variations on this approach.

Contingency Model of leadership

Fielder's Contingency Model (1964) states that there is no one best style of leadership. Effectiveness is about the match between leadership style (defined as task or relationship-oriented) and situation (defined by: the degree to which the leader is supported by the group; the degree to which the task is clearly structured; and the degree to which the leader can reward and punish team members). Fiedler devised a way of assessing leaders' styles by measuring their attitude to their 'least preferred co-worker' or LPC. In general terms, leaders who are more negative about their LPC are task-oriented and focus on organizing. Leaders who are more positive towards their LPCs are more able to avoid conflict, promote innovation and learning and are better at making complex decisions. In moderate situations (not extreme in any of the three situation dimensions), the more positive, relationship-oriented leaders appear to be more successful (Valle & Avella, 2003). This contingency model of leadership was found to predict leadership style in an information systems engineering environment, where leadership functions were distributed across technical experts and the end-user (Franz, 1985).

Situational Theory

Situational Theory offers a model of leadership in which any individual leader adapts his or her style according to the needs of the situation. For example, they can learn to change from being task-focused to being relationship focused. They may also adapt according to their own changing status. Hersey, Blanchard and Johnson (2001) describe four modes that leaders can adapt between, according to the nature of the members of the team or organization: delegating, supporting, coaching, and directing. In this situational model, leadership is a learned skill based on understanding context and self-awareness.

Path-Goal Model

The Path-Goal Theory describes the leader's role as helping followers to develop behaviors that allow them to achieve their goals (House and Mitchell, 1974).

Leaders are facilitators for others' achievements, e.g. providing resources, associations, knowledge and support. Leaders are members of a community of practice united in a common enterprise and sharing a common culture: history, values, ways of doing things, and ways of talking (Drath and Palus, 1994). In technical leadership, this means helping technical followers to perform effectively in their tasks, and in systems engineering this means facilitating pathways of communication between different areas, encouraging attitudes and behaviors that promote integrated perspectives.

Authentic Leadership

Somewhat in contrast to the principle of leading by adapting style, and thus in effect "acting the part", research on leaders being "authentic" evaluates the effectiveness of staying true to one's own natural style. Successful authentic leaders are described as positive, leading from the heart, concerned with ethics, building on trust, motivating people to achieve challenging tasks. According to the authentic leadership literature (e.g., Gardner et al., 2011; Walumbwa et al., 2008), authentic leaders display four types of behaviors. These include balanced processing (taking evidence from all sides), internalized moral perspective (driven more by morality than external pressures), relational transparency (openly sharing thoughts and feelings), and self-awareness (understanding of self and how others view them) (Gardner et al., 2011). These behaviors are likely to lead to a team having trust in the leader, which will be important in a technical context where safely achieving the right outcome= in a complex situation is paramount.

Allied to authentic leadership in terms of behaviors is the concept of Servant Leadership, described as having seven key practices: self-awareness; listening; inverting the pyramid (leadership hierarchy); developing your colleagues; coaching, not controlling; unleashing the energy and intelligence of others; and foresight. Keith (2012), and Sipe and Frick (2009) have a similar list: servant leaders are individuals of character, put people first, are skilled communicators, are compassionate collaborators, use foresight, are systems thinkers, and exercise moral authority.

The servant leadership elements of Empowerment, Standing Back / Sharing Credit, Courage / Risk Taking, Humility, Authenticity, and Stewardship were shown to have a statistically significant correlation with

innovation output from engineering teams when applied at a frontline team leadership level (McCleave and Capella, 2015).

Complexity Leadership and the Leadership Process

Authentic and servant leadership styles place a leader in the role of a facilitator, rather than a director; someone who can leverage the capabilities of the team and create synergistic benefits. This perspective is taken a step further in the model of leadership that comes from complexity theory.

Complexity Leadership describes leadership as promoting emergent adaptive outcomes from organizations (such as learning and innovation). Organizations are considered to be complex adaptive systems and leadership can take three forms: administrative, adaptive and enabling. Each form will vary itself according to its locus in an organizational hierarchy. The complex adaptive functions provide the adaptive capability while the bureaucratic functions provide the coordinating structures. Leadership should disentangle these two types of functions in a way that enhances the effectiveness of the organization (Marion & Uhl-Bien, 2001). In this model, leadership is mostly about developing interactions.

Complexity leadership is differentiated from leaders as individuals, because in some cases leadership is about a function rather than a person. In a technical situation such as a Systems Engineering team, this will be an important consideration, as different people will have technical expertise and will be required to provide leadership in areas such as understanding, challenging and communicating. Systems engineering teams consist of members from diverse disciplines with diverse interests. Silos of self-interest must be broken down (or at least effective communication among silos must be established and a balance between global system concerns and provincial disciplinary interests must be maintained.)

Manz and Sims (1989) also see leadership as a process, but they focus on self-leadership within each individual more than the behaviors and actions of a few select people designated as formal leaders in an organization. With this perspective, most people have some contribution to leadership.

Followership

Equally important is the concept of followership. A leader can only lead with effective followers. In technical situations, where a distributed process of leadership may be needed, this is especially important. The study of followership is much less developed than that of leadership, although they are two sides of the same coin. Uhl-Bien et al. (2014) have conducted a review of the literature to date and identify two theoretical frameworks for understanding followership: a role-based approach and a process approach. They warn against too much focus on a leader role and not enough on the leadership process, and suggest that understanding followership can help with:

- Recognizing the importance of follower roles, following behaviors, and the leadership process
- Understanding leadership processes and its outcomes as a function of leaders and followers
- Identifying effective followership behaviors
- Embedding context in the leadership process
- Recognizing that leadership can flow in all directions
- Understanding why and how managers are not always able to co-construct leadership with their subordinates
- Developing followership

This perspective is supportive of a distributed leadership function and is helpful for supporting people who have leadership roles as a consequence of their technical knowledge rather than their desire to lead or comfort with doing so.

Associated with followership development is the nature of motivation within the individuals that the leader wishes to influence. The term "motivation" has been used to describe a range of possible causes of behavior, and no single theory can explain all situations. A useful distinction, however, is the difference between "intrinsic" and "extrinsic" motivation. The former relates to factors arising from emotions, ambitions, expectations and other internal states of an individual, and tends to be the focus of transformational leaders (see section 1.3). The latter relates to factors arising from external factors such as threats, rewards, and social pressure, and tends to be the focus of transactional leaders (also in section 1.3). It is important to recognize that there are cultural and professional differences in the strength of internal and external causes of motivation. One famous

model of motivation by Maslow (1943), the "Hierarchy of Needs", is useful to assess a range of potential factors, but does not have scientific validity and is based on a rather narrow Western 20th Century perspective. For example, it does not explain why people are willing to undergo physical hardship to conquer higher level challenges; or why some cultures are collectivist while others are individualistic. (A useful review of these culture differences can be found in Triandis et al., 1988).

A more actionable approach to motivation emphasizes an individual's mental model of what is important (valence), what their own role is in achieving it (instrumentality), and how able they are to achieve it (expectancy). This was first described by Vroom (1964) and has led to the concept of 'empowering' individuals (e.g. Conger and Kanungo, 1988). The Path-Goal model of leadership (section 1.6) aims to facilitate performance by addressing these aspects of motivation. This approach to motivation, called Expectancy Theory, can help leaders understand how to motivate employees through challenge and self-belief (Isaac, Zerbe, and Pitt, (2001).

An attempt to understand motivation at the organizational level has led to the concept of "organizational energy" (Cole, Bruch and Vogel, 2005). According to the existing overall energy type in an organization, a leader should adopt a different motivational strategy to achieve the optimum "productive" energy, which is described as high intensity and positive. A resignative energy (low intensity, negative) requires the development of a vision, empowerment and challenge. A corrosive energy (high intensity, negative) requires better communication and the development of trust. A comfortable energy (low intensity, positive) requires the identification of an external threat.

Competencies

Leadership competencies are the knowledge and skills required by individuals and teams for making leadership effective. Sometimes traits and other individual differences are added to skills and knowledge to create a "Competency Framework" for the leadership characteristics needed for a role. Communication, managing staff by supporting and providing feedback, and emotional competence are often featured in these frameworks. It is important to distinguish between those characteristics that are learned and those that are based on traits. Learned competencies can be enhanced

through personal development; innate individual differences could be acquired for a role through personnel selection (although selection based on personality is not recommended: see section 1.2). As indicated above, leadership depends on many behaviors, including matching style to situations, effective followership, and individual leadership.

A number of roles will be required in a team, and ideally these may be distributed to individuals with the apposite competencies. Emotional competence has been the focus of much recent research and some studies show a strong correlation with effective leadership (e.g. Cavallo and Brienza, 2006, who used the Emotional Competence Inventory©).

Daniel Goleman has extended and publicized the concept of emotional intelligence (an innate characteristic) and the competencies (skills that can be learned) that put it into practice. He describes how emotional aptitudes can preserve relationships, protect our health and improve our success at work (Goleman, 1998).

Goleman differentiates 5 main categories of competence. The first three are about self-management and the last two are about being effective in relationships.

1. Self-awareness: accurate self-assessment, emotional awareness and self-confidence
2. Self-regulation: innovation, adaptability, conscientiousness, trustworthiness and self-control
3. Motivation: optimism, commitment, initiative and achievement, drive
4. Empathy: developing others, service orientation, political awareness, diversity, active listening and understanding others
5. Social skills: communication, influence, conflict management, leadership, bond building, collaboration, cooperation and team capabilities

Emotional Intelligence is most associated with transformational and situational leadership.

Communication skills are also highlighted in most leader competency frameworks. These skills are about communicating to other people and listening and being communicated to by other people. Some skills are about engagement, others about sharing understanding. In particular, avoiding hidden assumptions and understanding others' perspectives are important.

Communication can take place in many ways, especially with the help of IT and social media. Each mode of communication has advantages and disadvantages. Consideration should be given to how important it is to have face-to-face communication (usually better, but especially for complex matters and when emotions are involved). Although this takes more time and effort, it will often save time and effort in the long term by reducing misunderstandings and negative emotions. Nikoi (2014) presents a collection of studies that investigated the way in which communication works across media and teams.

Communication may be synchronous or asynchronous, broadcast or individual, dialogue or one-way. Bowman (2004) has a useful summary of the advantages and disadvantages of different communication channels.

Some competencies that are often associated in the literature with good leadership are listed in Table 1. The relevance of these will depend on the style and the situation/context.

Some commonly cited attributes of effective leaders are listed in Table 1 below.

Table 1. Attributes of Effective Leaders (Fairley 2009).
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Listening carefully	Maintaining enthusiasm
Delegating authority	Saying "thank you"
Facilitating teamwork	Praising team for achievements
Coordinating work activities	Accepting responsibility for shortcomings
Facilitating communication	Coaching and training
Making timely decisions	Indoctrinating newly assigned personnel
Involving appropriate stakeholders	Reconciling differences and resolving conflicts
Speaking with individual team members on a frequent basis	Helping team members develop career paths and achieve professional goals
Working effectively with the project/program manager and external stakeholders	Reassigning, transferring, and terminating personnel as necessary

Characteristics that result in effective leadership of systems engineering activities include behavioral attributes, leadership style, and communication style. In addition, a team leader for a systems engineering project

or program has management responsibilities that include, but are not limited to: developing and maintaining the systems engineering plan, and establishing and overseeing the relationships between the project/program manager and project/program management personnel.

Implications for technical leadership in systems engineering

Leadership can have a significant impact on engineering performance (Kolb, 1995) and resilience (Flin, 2006). The models and styles of leadership described above emphasize the power of social skills: the ability to relate to and connect with other people. This appears to be particularly true for the sorts of situations that system engineering leaders are likely to find themselves in: working on complex problems with other professionals who are willing to follow but need to be confident in the leader's technical skill and trustworthiness. The technical leader should possess not only essential technical knowledge but should also have positive values, high levels of ethics, morality, leadership from the heart, personal capabilities, out-of-the-box thinking, interpersonal skills, etc. (Lloyd-Walker and Walker, 2011).

In a systems engineering context it is useful to recognize that different leadership functions may be distributed across a team. Some leadership functions will be knowledge focused, but it may be necessary to have a 'facilitator' (complexity) leader to ensure that the team follows the most appropriate leadership at any time. Each organization will have particular leadership requirements, which should be articulated in a behavioral framework in order to identify the most effective leadership styles and competencies, and where and how they should be applied.

Leadership capability for systems engineers should therefore be seen as a distributed capability to be developed across engineers. NASA takes a systems approach to developing leadership in their Systems Engineering Leadership Development Program (SELDP). They define technical leadership as the 'art' of systems engineering. Technical leadership includes broad technical domain knowledge, engineering instinct, problem solving, creativity, and the leadership and communication skills needed to develop new missions and systems. It focuses on systems design and technical integrity throughout the life cycle. A system's complexity

and the severity of its constraints drive the need for systems engineering leadership (Williams and Reyes, 2012).

Selecting leaders by promoting the best technical performers or the most ambitious candidates is not an effective way of ensuring good leadership in an organization or program. For this reason, companies such as General Electric, Motorola, Toyota, Unilever, Raytheon, and Northrop Grumman use internal leadership academies to develop their leadership capability according to their needs (Daniels, 2009). A role model approach may be effective only if the appropriate role model is paired with a candidate, with good leadership characteristics that are valid for the situation (Yukl, 2012).

More effective approaches would involve developing competencies that can be learned through example, experience and reflection. The most effective methods will depend on the competencies needed, the type of organization, and the opportunities. They could include coaching, mentoring, shadowing, 'assistant-to' trial periods, and career management to provide experience (e.g. Fast-track).

There must also be an element of self-development: systems engineers should recognize the impact that people (or 'soft') issues have on the performance of a technical team and organization and learn how to adjust their own behavior and facilitate the behavior of others.

Behavioral Attributes

Behavioral attributes are habitual patterns of behavior, thought, and emotion that remain stable over time (Yukl 2013). Positive behavioral attributes enable a systems engineering leader to communicate effectively and to make sound decisions, while also taking into consideration the concerns of all stakeholders. Desirable behavioral attributes for a systems engineering leader include characteristics such as (Fairley 2009):

- Aptitude - This is exhibited by the ability to effectively lead a team. Leadership aptitude is not the same as knowledge or skill but rather is indicative of the ability (either intuitive or learned) to influence others. Leadership aptitude is sometimes referred to as charisma or as an engaging style.
- Initiative - This is exhibited by enthusiastically starting

and following through on every leadership activity.

- Enthusiasm - This is exhibited by expressing and communicating a positive, yet realistic attitude concerning the project, product, and stakeholders.
- Communication Skills - These are exhibited by expressing concepts, thoughts, and ideas in a clear and concise manner, in oral and written forms, while interacting with colleagues, team members, managers, project stakeholders, and others.
- Team Participation - This is exhibited by working enthusiastically with team members and others when collaborating on shared work activities.
- Negotiation - This is the ability to reconcile differing points of view and achieve consensus decisions that are satisfactory to the involved stakeholders.
- Goal Orientation – This involves setting challenging but not impossible goals for oneself, team members, and teams.
- Trustworthiness - This is demonstrated over time by exhibiting ethical behavior, honesty, integrity, and dependability in taking actions and making decisions that affect others.

Weakness, on the other hand, is one example of a behavioral attribute that may limit the effectiveness of a systems engineering team leader.

Personality Traits

The concept of "personality traits" was initially introduced in the early 1900's by Carl Jung, who published a theory of personality based on three continuums: introversion-extroversion, sensing-intuiting, and thinking-feeling. According to Jung, each individual has a dominant style which includes an element from each of the three continuums. Jung also emphasized that individuals vary their personality traits in the context of different situations; however, an individual's dominant style is the preferred one, as it is the least stressful for the individual to express and it is also the style that an individual will resort to when under stress (Jung 1971). The Myers-Briggs Type Indicator (MBTI), developed by Katherine Briggs and her daughter Isabel Myers, includes Jung's three continuums, plus a fourth continuum of judging-perceiving. These four dimensions characterize 16 personality styles for individuals designated by letters, such as ISTP (Introverted,

Sensing, Thinking, and Perceiving). An individual's personality type indicator is determined through the answers the person has provided on a questionnaire (Myers 1995) combined with the individual's self-assessment which is done one to one with a qualified practitioner or in a group setting. MBTI profiles are widely used by coaches and counselors to help individuals assess how their personality type will affect how they might react in a particular profession and make suggestions about which professions might suit their individual preferences. It should never be used to decide which profession would be "most comfortable and effective" as the MBTI measures preference not ability. The MBTI has also been applied to group dynamics and leadership styles. Most studies indicate that groups perform better when a mixture of personality styles work together to provide different perspectives. Some researchers claim that there is evidence that suggests that leadership styles are most closely related to an individual's position on the judging-perceiving scale of the MBTI profile (Hammer 2001). Those on the judging side of the scale are more likely to be "by the book" managers, while those on the perceiving side of the scale are most likely to be "people-oriented" leaders. "Judging" in the MBTI model does not mean judgmental; rather, a judging preference indicates a quantitative orientation and a perceiving preference indicates a qualitative orientation. The MBTI has its detractors (Nowack 1996); however, MBTI personality styles can provide insight into effective and ineffective modes of interaction and communication among team members and team leaders. For example, an individual with a strongly Introverted, Thinking, Sensing, and Judging personality index (ITSJ) may have difficulty interacting with an individual who has a strongly Extroverted, Intuiting, Feeling, Perceiving personality index (ENFP).

Leadership Styles and Communication Styles

There is a vast amount of literature pertaining to leadership styles and there are many models of leadership. Most of these leadership models are based on some variant of Jung's psychological types. One of the models, the Wilson Social Styles, integrates leadership styles and communication styles (Wilson 2004). The Wilson model characterizes four kinds of leadership styles:

- Driver leadership style - This is exhibited when a

leader focuses on the work to be accomplished and on specifying how others must do their jobs.

- Analytical-style leadership - This emphasizes collecting, analyzing, and sharing data and information. An

analytical leader asks others for their opinions and recommendations to gather information.

- Amiable leadership style – This is characterized by emphasis on personal interactions and on asking others

for their opinions and recommendations.

- Expressive leadership style – Like the amiable style, this also focuses on personal relationships, but an

expressive leader tells others rather than asking for opinions and recommendations. When taken to extremes, each of these styles can result in weakness of leadership. By focusing too intently on the work, "drivers" can provide too much or too little guidance and direction. Too little guidance occurs when the individual is preoccupied with her or his personal work, while too much guidance results in micromanagement, which limits the personal discretion for team members. Drivers may also be insensitive to interpersonal relationships with team members and others. Analytical leaders may provide too much information or may fail to provide information that is obvious to them, but not their team members. They do not like to discuss things they already know or that are irrelevant to the task at hand. Like driver-style leaders, they may be insensitive to interpersonal relationships with other individuals. Amiable leaders focus on interpersonal relationships in order to get the job done. They may exhibit a dislike of those who fail to interact with them on a personal level and may show little concern for those who show little personal interest in them. Expressive leaders also focus on interpersonal relationships. In the extreme, an expressive leader may be more interested in stating their opinions than in listening to others. Additionally, they may play favorites and ignore those who are not favorites. While these characterizations are gross oversimplifications, they serve to illustrate leadership styles that may be exhibited by systems engineering team leaders. Effective team leaders are able to vary their leadership style to accommodate the particular

context and the needs of their constituencies without going to extremes; but as emphasized by Jung, each individual has a preferred comfort zone that is least stressful and to which an individual will resort during times of added pressure.

Communication Styles

An additional characterization of the Wilson model is the preferred style of communication for different leadership styles, which is illustrated by the dimensions of assertiveness and responsiveness.
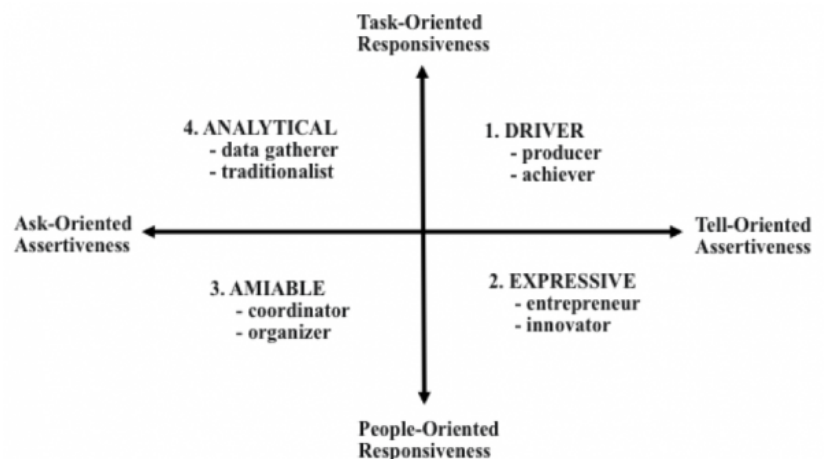

Figure 1. Dimensions of Communication Styles (Fairley 2009). Reprinted with permission of the IEEE Computer Society. All other rights are reserved by the copyright owner.

Task-oriented assertiveness is exhibited in a communication style that emphasizes the work to be done rather than the people who will do the work, while the people-oriented communication style addresses personnel issues first and tasks secondly. A tell-oriented communication style involves telling rather than asking, while an ask-oriented assertiveness emphasizes asking over telling. Movies, plays, and novels often include caricatures of extremes in the assertiveness and responsiveness dimensions of Wilson communication styles. An individual's communication style may fall anywhere within the continuums of assertiveness and responsiveness, from extremes to more moderate styles and may vary considering the situation. Examples include:

- Driver communication style exhibits task-oriented responsiveness and tell-oriented assertiveness.
- Expressive communication style shares tell-oriented assertiveness with the driver style but favors people-oriented responsiveness.

- Amiable communication style involves asking rather than telling (as does the analytical style) and emphasizes people relationships over task orientation (as does the expressive style).
- Analytical communication style exhibits task-oriented responsiveness and ask-oriented assertiveness.

The most comfortable communication occurs when individuals share the same communication styles or share adjacent quadrants in Figure 1. Difficult communication may occur when individuals are in diagonal quadrants; for example, communication between an extreme amiable style and an extreme driver style. Technical leaders and others can improve communications by being aware of different communication styles (both their own and others) and by modifying their communication style to accommodate the communication styles of others.

Management Responsibilities

Leading a systems engineering team involves communicating, coordinating, providing guidance, and maintaining progress and morale. Managing a project, according to the PMBOK® Guide (PMBOK 2013), involves application of the five process groups of project management: initiating, planning, executing, monitoring and controlling, and closing. Colloquially, systems engineering project/program management is concerned with making and updating plans and estimates, providing resources, collecting and analyzing product and process data, working with the technical leader to control work processes and work products, as well as managing the overall schedule and budget. Good engineering managers are not necessarily good technical leaders and good technical leaders are not necessarily good engineering managers; the expression of different personality traits and skill sets is required. Those who are effective as both managers and leaders have both analytical and interpersonal skills, although their comfort zone may be in one of managing or leading. Two management issues that are typically the responsibility of a systems engineering team leader are:

- Establishing and maintaining the division of responsibility among him or herself, the systems engineering team leader, and the project/program manager.
- Developing, implementing, and maintaining the

systems engineering plan (SEP).

Relationships between systems engineering and project management are addressed in the Part 6 Knowledge Area (KA) of the SEBoK, Systems Engineering and Project Management. Also see the Part 5 Knowledge Area Enabling Teams for a discussion of the relationships between a project/program manager and a systems engineering technical leader.

The System Engineering Plan (SEP) is, or should be, the highest-level plan for managing the Systems Engineering effort and the technical aspects of a project or program. It defines how a project will be organized and conducted in terms of both performing and controlling the Systems Engineering activities needed to address a project's system requirements and technical content. It can have a number of secondary technical plans that provide details on specific technical areas and supporting processes, procedures, tools. Also, see the Planning article in Part 3, which includes a section on Systems Engineering Planning Process Overview.

In United States DoD acquisition programs, the System Engineering Plan (SEP) is a Government produced document which assists in the development, communication, and management of the overall systems engineering (SE) approach that guides all technical activities of the program. It provides direction to developers for program execution. The developer uses the SEP as guidance for producing the System Engineering Management Plan (SEMP), which is a separate document and usually a contract deliverable that aligns with the SEP. As the SEP is a Government produced and maintained document and the SEMP is a developer/contractor developed and maintained document, the SEMP is typically a standalone, coordinated document.

The following SEP outline from (ODASD 2011) serves as an example.

1. **Introduction – Purpose and Update Plan**
2. **Program Technical Requirements**
   1. Architectures and Interface Control
   2. Technical Certifications
3. **Engineering Resources and Management**
   1. Technical Schedule and Schedule Risk Assessment
   2. Engineering Resources and Cost/Schedule Reporting

3. Engineering and Integration Risk Management
       4. Technical Organization
       5. Relationships with External Technical Organizations
       6. Technical Performance Measures and Metrics
   4. **Technical Activities and Products**
       1. Results of Previous Phase SE Activities
       2. Planned SE Activities for the Next Phase
       3. Requirements Development and Change Process
       4. Technical Reviews
       5. Configuration and Change Management Process
       6. Design Considerations
       7. Engineering Tools
   5. **Annex A – Acronyms**

SEP templates are often tailored to meet the needs of individual projects or programs by adding needed elements and modifying or deleting other elements. A systems engineering team leader typically works with other team members, the project/program manager (or management team), and other stakeholders to develop the SEP and maintain currency of the plan as a project evolves. Some organizations provide one or more SEP templates and offer guidance for developing and maintaining an SEP. Some organizations have a functional group that can provide assistance in developing the SEP.

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