MOTIVATION AND LEADERSHIP AMONG ENGINEERS IN A UNITED STATES ARMY RESEARCH AND DEVELOPMENT CENTER

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Abstract

In the last few years, hiring freezes, downsizing, and outsourcing have significantly reduced the number of workers in the Defense Department's acquisition operations. These changes have created concerns about the effects on the morale and motivation of the acquisition technical workers.

This paper describes a 2003 research study to explore the intrinsic motivational factors and the preferred leadership styles among approximately 1500 Team Leaders and engineers in a U. S. Army government research and development (R&D) center in the United States. This study attempted to determine the preferred motivational factors and preferred leadership styles of these engineers.

Introduction

During the summer of 2002, the U. S. Government Office of Personnel Management conducted the Federal Human Capital Survey to assess the presence and extent of conditions that characterized high performance organizations (*What Do Federal Employees Say?,* 2003). More than 70% of the respondents to the Federal Human Capital Survey did not perceive their leaders as effective in motivating them or giving them the opportunity to grow and develop (*What Do Federal Employees Say?,* 2003). Only 36% agreed that their leaders generated high levels of motivation and commitment. Almost 9% of the respondents to the survey were civilian members of the Department of the Army. Some of the civilians were members of the Army Acquisition Corps (AAC) which has the responsibility of developing weapon systems for the Army.

The Department of Defense (DOD) is a major part of the Federal Government, and one critical element of the DOD workforce is the AAC. This acquisition corps includes defense workers who have acquisition and procurement responsibilities, from purchasers to physicists (Cahlink, 2001). A portion of this AAC is the engineers and scientists who oversee research and development support contracts. Over the past decade, hiring freezes, downsizing, and outsourcing have all but eliminated young workers in the DOD's acquisition operations (Cahlink, 2001).

Research Background

The top leadership of a U. S. Government Research and Development (R&D) laboratory has concerns about the effect of this stagnant growth environment on the morale and motivation of the R&D engineers and scientists (Tamosaitis & Schwenker, 2002).

The efficiency and effectiveness of the R&D engineers are critical to the success of the government laboratory. To achieve efficient and effective R&D performance, Engineering Managers will be required to recognize and deal with the organizational factors that influence the motivation of technical personnel (Hoyt & Gerloff, 1999). Engineers seem to be most efficient and effective when they are properly motivated. Motivation poses significant issues for Engineering Managers charged with the responsibility of effective utilization and motivation of these personnel. Therefore, leadership of engineers in this environment is a significant challenge (Hoyt & Gerloff, 1999).

The unique feature of a government civilian R&D environment is that the Team Leader has task authority but not administrative authority for the team members. The Team Leader is responsible for dividing the assignments among the team members and ensuring that the work is performed. If the work is not done, the Team Leader is the individual that upper management holds accountable. However, personnel functions are performed at a higher management level than that of the Team Leader. As a result of this lack of personnel responsibility, the Team Leader has no real authority over the team. This Team Leader has input into the yearly performance evaluations and determines the engineers' work assignments but cannot really discipline them.

The Team Leader does not have the power to fire, promote, or financially reward his or her team members. In this type of environment, the Team Leader cannot lead by fear or power, since he or she has no real power and cannot make a significant difference in personnel matters. The only way he or she can ensure that the work is accomplished is to create an environment supportive of the intrinsic motivators of the team members. Through this supportive environment, the team leader hopes to influence the team to accomplish team goals. When properly motivated, engineers tend to be *results oriented* problem solvers capable of expending high

levels of effort and innovation to complete a project (Hoyt & Gerloff, 1999).

Research Study

In this research study, the sample population was the engineers and scientists employed by a U. S. Army Research, Development, and Engineering Center. These engineers and scientists are civil service employees of the Federal Government. The total population for this study was approximately 1500 individuals.

In a recent study performed at a U.S. Government research laboratory, it was determined that Herzberg's motivation-hygiene factor theory generally applied to this environment (Leach & Westbrook, 2000). In Herzberg's 1959 study, the motivators reflected opportunity for achievement, recognition of achievement, the work itself, responsibility, and potential for advancement (Herzberg et al., 1959). This study used Herzberg's motivation-hygiene factor theory as a framework to determine the most important motivating and job satisfaction (hygiene) factors in this research and development environment.

This study, like the 1959 Herzberg motivation study, addressed factors that motivate engineers. Maidani (1991) made a comparative study of Herzberg's theory in public sector and private-sector jobs. For employees in public and private sectors, Maidani (1991) indicated that the motivation to work tended to emphasize intrinsic motivating factors. The intrinsic motivators include: (a) achievement, (b) recognition, (c) the work itself, (d) responsibilities, and (e) advancement (Herzberg, 1959).

The preferred leadership styles are the characteristic skills defined by the following models: (a) Great Man, (b) Group, (c) Trait, (d) Contingency, (e) Transactional, and (f) Transformational leadership as defined by Bass (1991), Kouzes & Posner (2002), Rost (1993), and Wren (1995). Rost (1993) defined the first four leadership styles as examples of modern industrial theories of leadership. Kouzes & Posner (2002) defined the last two leadership styles as applicable to the post-industrial environment.

Methodology

This research study used an Internet survey instrument. Each participant was asked a set of questions. The survey used a five-point Likert-type scale: 1 is not important to 5 is very important. Each question had five distinct response choices and the options were balanced, with the choices being strongly disagree, disagree, neutral, agree, and strongly agree.

The first set of questions in the survey concerned intrinsic motivation. Questions 1 through 15 were the motivation questions. There were three questions for each of the five motivational factors, for a total of 15 questions. These motivation questions assessed the importance of each of the five following factors to the participant in the performance of his or her job: (a) Potential for Achievement, (b) Potential for Recognition, (c) Work that I enjoy, (d) Having a Responsible Position, and (e) Possibility for Advancement.

Questions 16 through 33 were used to define the preferred leadership styles for engineers working in government service. The survey asked each respondent to answer the survey as if he or she were the manager or Team Leader of his or her group. There were three questions for each of the six leadership styles, for a total of 18 questions. The questions for each of the leadership styles asked the respondents to specify which leadership characteristic would motivate their team of engineers most effectively in their daily job assignments. Preferred leadership style questions were based on the following leadership models: (a) Great Man, (b) Group, (c) Trait, (d) Contingency, (e) Transactional, and (e) Transformational leadership as defined by Bass (1991), Kouzes & Posner (2002), Rost (1993), and Wren (1995). The key for linking questions 16 through 33 to a leadership style is in Appendix C.

In the process of developing the survey instrument, the researcher reviewed the literature and developed questions that would measure the intrinsic motivational factors and the preferred leadership styles using a simple Likert-type scale (Creswell, 2002). Through this process, the 33 questions (see Appendix B) reflected reliable and valid measures of the motivation factors and leadership models (Bickman & Rog, 1998). The survey form consisted of two parts: (a) the 33 question Internet survey with the motivation and leadership questions, and (b) the two open-ended questions that were designed to generate additional comments at the end of the survey, with one question for motivation and one for leadership.

The sampling design for this research study was a convenience sampling (Bickman & Rog, 1998). This approach was used for convenience since the entire population was available for the survey.

The survey instrument was an Internet-driven computer interactive model. The model was loaded onto an official Army web site. The engineers were sent an email with a link to the survey. The email explained the purpose of the survey and asked for each engineer to go to the link and take the survey. As each respondent completed the survey and closed the web site application, the model automatically tabulated the results of the survey.

In addition to the motivation and leadership questions, demographics data was collected from each

participant: (a) gender, (b) age range, (c) highest level of education completed, (d) race/ethnicity, and (e) job position category.

Results

The survey was emailed on August 20, 2003, and was completed by September 5, 2003. There were a total of 363 responses of a population of approximately 1500 engineers. There were a total of 113 incomplete survey responses. When the incomplete survey responses were discarded, a total of 250 complete surveys remained. Therefore, this study was based on the 250 complete survey questionnaires, which represents 16.7 % of the population. The 250 surveyed respondents represent the entire population for the analysis of this study. Therefore, 16.7% of the population is the sample that will represent the entire population.

Of the respondents, 200 identified themselves as male and 48 identified themselves as female. Two individuals did not indicate their gender.

There were three respondents in the 18-22 age range, 12 respondents in the 23-29 age range, 56 respondents in the 30-39 age range, 105 respondents in the 40-49 age range, 62 respondents in the 50-59 age range, and 11 respondents in the 60 plus age range.

There were 11 respondents who indicated they had some college. There were 65 respondents who indicated they had a Bachelors degree, and 67 who indicated they had completed some graduate work. The most common education demographic was Masters level degree, which included 94 individuals. Finally, 13 individuals indicated they had a Doctorate level degree.

There were 222 respondents who identified themselves as White. Next, 13 individuals identified themselves as Black. Native Alaskan or American Indian was indicated by six individuals and Asian was indicated by six individuals. There were two individuals who identified themselves as Hispanic, Latino, or of Spanish origins.

The engineers were given a period of two weeks in which to complete the survey. At the conclusion of this time period, the researcher downloaded the tabulated results into a spreadsheet program for statistical analysis. The mean and variance of the data were calculated from the spreadsheet using statistical software (Levine et al., 2002).

Exhibit 1. Motivation Overall Means

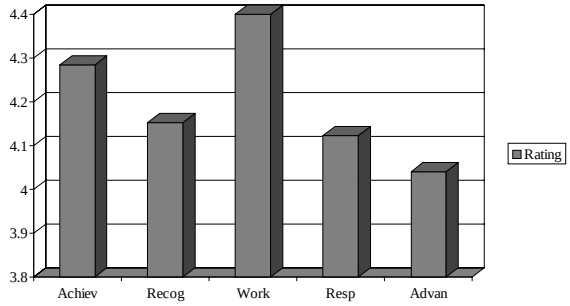


Exhibit 1 shows the overall means of the motivators. The mean response for achievement as a motivator for all survey respondents was 4.28 with a standard deviation of 0.66. The mean for recognition was 4.15 with a standard deviation of 0.74. The mean for work was 4.40 with a standard deviation of 0.67. The mean for responsibility was 4.12 with a standard deviation of 0.70, and the mean for advancement was 4.04 with a standard deviation of 0.97. The mean motivation rating for all survey respondents is ordered from highest to lowest as (a) work, (b) achievement, (c) recognition, (d) responsibility, and (e) advancement. Work had the highest overall motivation mean and advancement had the lowest.

Exhibit 2. Leadership Overall Means

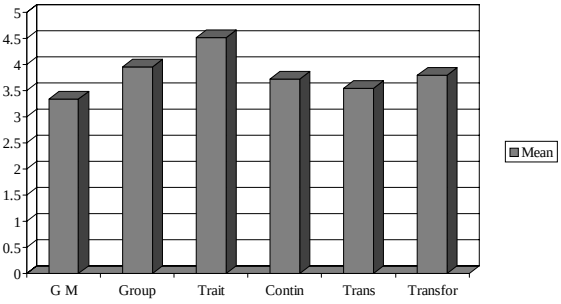
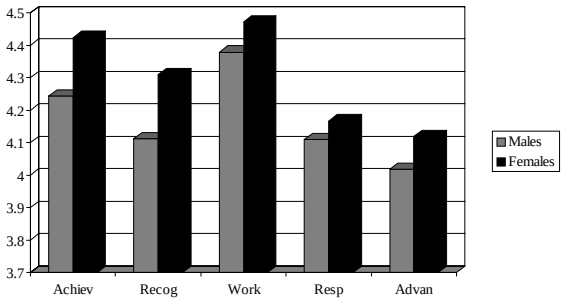


Exhibit 2 illustrates the overall means for leadership styles. The mean response for Great Man leadership was 3.34 with a standard deviation of 0.74. The mean for Group leadership was 3.95 with a standard deviation of 0.69. The mean for Trait leadership was 4.52 with a standard deviation of 0.63, and the mean for Contingency leadership was 3.72 with a standard deviation of 0.69. Transactional leadership had a mean of 3.55 with a standard deviation of 0.65, and Transformational leadership had a mean of 3.80 with a standard deviation of 0.69. The

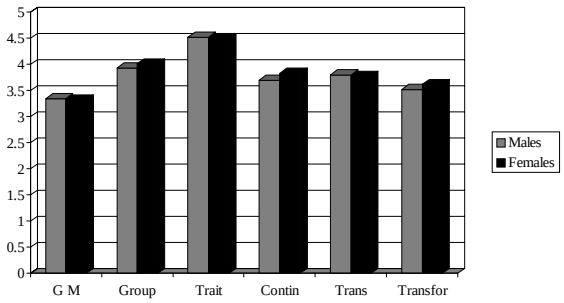
mean leadership rating for all survey respondents is ordered from highest to lowest as (a) Trait, (b) Group, (c) Transformational, (d) Contingency, (e) Transactional, and (f) the Great Man leadership. Trait leadership had the highest overall mean for leadership and the Great Man Leadership had the lowest mean.

Exhibit 3. Motivation Means by Gender



The mean response for the motivators when separated by gender is shown in Exhibit 3. For males the mean for achievement as a motivator was 4.24 while for females the mean was 4.42. The mean for recognition was 4.11 for males and 4.31 for females. The mean for work was 4.38 for males and 4.47 for females. The mean for responsibility was 4.11 for males and 4.17 for females. Finally, the mean for advancement was 4.02 for males and 4.12 for females. For both males and females, work had the highest overall motivation mean and advancement had the lowest overall mean.

Exhibit 4. Leadership Means by Gender



The mean response for the leadership models, when separated by gender, is shown in Exhibit 4. For males the mean average for Great Man leadership was 3.34, while for females the mean was 3.31. The mean for Group Leadership was 3.94 for males and 4.01 for females. The mean for Trait leadership was 4.52 for males and 4.50 for females. For Contingency leadership the mean for males was 3.69 while the mean for females was 3.83. Transactional leadership had a mean of 3.52 for males and 3.62 for females, while Transformational leadership had a mean of 3.80 for males and 3.78 for females. For both males and females, Trait leadership had the highest overall mean for leadership and Great Man leadership had the lowest mean.

Exhibit 5. Motivation Means by Age

	Achv	Recg	Work	Resp	Advn
<30	4.20	4.24	4.36	3.85	4.11
30-39	4.31	4.11	4.44	4.14	4.23
40-49	4.30	4.16	4.39	4.16	4.12
50-59	4.28	4.19	4.38	4.12	3.91
60+	4.15	4.18	4.49	4.09	3.21

Exhibit 5 summarizes the motivation means by age categories. Work as a motivator was the highest mean in all age categories. All engineers, regardless of age, selected the work itself as the highest motivator. For respondents under 30 and over 60, recognition had the second highest mean. For respondents between 31 and 60, achievement was the second highest mean. This makes intuitive sense since these are the years when most of the respondents are in the middle of their careers.

For respondents under 30 and over 60, the lowest rated motivator was responsibility. Recognition was the lowest rated for ages 31 to 39. For respondents between 40 and 59, advancement had the lowest mean rating. This shows that most engineers between 40 and 59 do not value advancement. Work appears to be their highest rated motivator.

Exhibit 6. Leadership Means by Age

	Trnf	Tran	Grp	Cont	GM	Trait
<30	3.62	3.84	4.04	3.53	3.56	4.49
30-39	3.83	3.57	3.93	3.65	3.42	4.57
40-49	3.80	3.52	3.99	3.81	3.30	4.55
50-59	3.82	3.52	3.92	3.73	3.30	4.44
60+	3.88	3.58	3.91	3.67	3.21	4.58

Exhibit 6 summarizes the leadership means by age categories. Trait leadership preference was the highest mean in all age categories. All engineers, regardless of age, selected Trait leadership as the highest rated leadership style. Interestingly, all age categories agreed on the second highest rated leadership style, Group leadership. These results indicate that the respondents prefer Trait and Group leadership.

The lowest rated leadership category was the Great Man style. Contingency was lower for the respondents under 30, but the mean average was very close to Great Man. Therefore, for most age groups, the Trait style was the most popular and the Great Man style the least popular.

Exhibit 7. Motivation means by Education

	Achv	Recg	Work	Resp	Advn
Coll	4.39	4.30	4.40	4.15	4.03
BS	4.32	4.09	4.36	4.15	3.95
Grad	4.28	4.18	4.40	4.13	4.23
MS	4.28	4.16	4.42	4.12	4.04
PHD	4.05	4.13	4.49	3.90	3.54

Exhibit 7 summarizes the motivation means by education categories. Work as a motivator was the highest mean in all education categories. All engineers, regardless of education, selected the work itself as the highest motivator. For respondents with some college, achievement tied the work mean. For respondents with any type of college degree, achievement was the second highest rated mean. An interesting observation is that the mean average increased as the education level increased. This would seem to indicate that the more educated an engineer becomes, the higher is his or her preference for his or her work as a motivator.

For the respondents with a Bachelors degree or some college, the lowest rated motivator was advancement. For respondents with some graduate work, responsibility was the lowest rated. For respondents with a Masters or Doctorate degree, advancement was the lowest rated mean. This shows that most highly educated engineers do not value advancement.

Exhibit 8. Leadership Means by Education

	Trnf	Tran	Grp	Cont	GM	Trait
Col	3.85	3.91	4.21	3.85	3.52	4.30
BS	3.84	3.59	3.97	3.64	3.44	4.42
Grd	3.78	3.56	3.94	3.73	3.40	4.56
MS	3.81	3.51	3.94	3.76	3.23	4.58
DR	3.50	3.21	3.82	3.74	3.12	4.54

Exhibit 8 summarizes the leadership means by education categories. Trait leadership preference was the highest mean in all education categories. All engineers, regardless of education level, preferred Trait leadership. Interestingly, all education level categories agreed on the second highest rated leadership style, Group leadership. These results indicate that the respondents prefer Trait and Group leadership independent of their education level.

The lowest rated leadership category was the Great Man style. Great Man was the lowest in all education categories. Therefore, for any level of education, the Trait style was the most popular and the Great Man style the least popular.

Exhibit 9. Motivation means by Position

	Achv	Recg	Work	Resp	Advn
EMP	4.27	4.09	4.38	4.06	4.01
TL	4.32	4.28	4.51	4.26	4.11
SUPV	4.40	4.31	4.29	4.17	4.05
MGR	4.00	4.00	4.33	4.24	4.14

Exhibit 9 summarizes the motivation means by position categories. Work as a motivator was the highest mean for Employees, Team Leaders, and Managers. Supervisors selected achievement as the highest motivator. For Employees and Team Leaders, achievement had the second highest mean. For Supervisors, recognition had the second highest mean. Finally, for Managers, responsibility had the second highest mean.

The lowest rated motivator for Employees, Team Leaders, and Supervisors was advancement.

Recognition was the lowest rated for Managers. There is a greater variation of means as categorized by position than for any of the other demographics.

Exhibit 10. Leadership means by Position

	Trnf	Tran	Grp	Cont	GM	Trait
EM	3.75	3.58	3.93	3.65	3.29	4.47
TL	3.85	3.58	4.00	3.90	3.57	4.63
SUP	3.99	3.40	4.04	3.83	3.26	4.68
MG	3.91	3.05	3.95	3.62	2.81	4.38

Exhibit 10 summarizes the leadership means by position categories. Trait leadership had the highest mean in all position categories. All categories of engineers, regardless of position, selected Trait leadership as the highest rated leadership style. Interestingly, all position level respondents agreed on the second highest rated leadership style. Group leadership had the second highest mean for all respondents. These results indicate that the respondents prefer Trait and Group leadership independent of position.

The lowest rated leadership category was the Great Man style. Great Man was the lowest in all position categories. Therefore, for any level of position, the Trait style was the most popular and the Great Man style the least popular.

Comparison of Motivation Survey to Herzberg's Survey

This section will compare the motivator rankings of the Herzberg et al. (1959) original survey with the results of this survey. In the original survey by Herzberg et al. (1959, p. 60), the rank order of the motivators was:

Achievement
Recognition
Work itself
Responsibility
Advancement

Herzberg's (1959) original study was conducted in a different manner than this survey. The original study was conducted by interviewers. The interviewers asked questions of the participants about what work experiences motivated or did not motivate them. Some of the interviewers asked follow-up questions depending on the responses to the first question. Herzberg (1959) called this a sequence. If the first answer described a high experience, the interviewer followed-up with a question about a low experience, etc. The average number of sequences per respondent was 2.4. This survey did not ask any follow-up questions. However, each respondent was asked to provide comments to follow-up on the survey questions.

The rank order of this research study survey was similar except for work itself:

Work itself
Achievement
Recognition
Responsibility
Advancement

The greatest difference in the study motivation rankings is that work itself was the top rated motivator in this study (2003); however, it was only number three in the original study (Herzberg, 1959). The other motivators are in the same order as in the Herzberg et al. study (1959). It appears that the higher ranking of *work itself* in the 2003 study is due to the unique culture of a government civil service environment. Many workers in the civil service value the security of government jobs. This culture does not have the employee turnover and rapid change which exists in American corporations and businesses. Therefore, the culture is similar to that of an earlier era like the 1950s. The jobs in this culture are primarily research positions, which appear to attract engineers who prefer the security and stability of this type of culture and who are primarily motivated by the research work itself.

Analysis

A statistical analysis of the data form this study revealed the means as summarized in Exhibits 1and 2. Exhibit 1 has the overall means for the five motivational theories and exhibit 2 has the overall means for the six theories of leadership. The mean motivation rating for all survey respondents was ordered from highest to lowest as Work, Achievement, Recognition, Responsibility, and Advancement. Work had the highest overall motivation mean and advancement had the lowest.

The mean leadership rating for all survey respondents was ordered from highest to lowest as Trait, Group, Transformation, Contingency, Transactional, and the Great man Theory. Trait leadership had the highest overall mean and the Great Man Theory of leadership had the lowest.

The data was also analyzed for observed differences by demographics. For males and females, work had the highest motivation mean and advancement had the lowest mean. For males and females, Trait leadership had the highest mean for leadership and the Great Man Theory of leadership had the lowest mean.

All categories of engineers, regardless of age, selected the work itself as the highest motivator. For the respondents under 30 and over 60, recognition had the second highest mean. For respondents between 31 and 60, achievement was the second highest rated mean. This makes intuitive sense since these are the years when most of the respondents are in the middle of their careers. In the questions about leadership, all engineers, regardless of age, selected Trait leadership as the highest rated leadership style. Interestingly, all age categories agreed on the second highest rated leadership style. Group leadership had the second highest mean for all respondents. These results indicate that the respondents prefer Trait and Group leadership.

All categories of engineers, regardless of education level, selected the work itself as the highest motivator. For the respondents with some college, achievement tied the work mean. For respondents with any type of college degree, achievement was the second highest rated mean. An interesting observation is that the mean average increased as the education level increased. This would seem to indicate that the more educated an engineer becomes, the higher is his or her preference for the work he or she is doing as a motivator.

All categories of engineers, regardless of education level, selected Trait leadership as the highest rated leadership style. Interestingly, all education level age categories agreed on the second highest rated leadership style. Group leadership had the second highest mean. These results indicate that the respondents prefer Trait and Group leadership independent of education level.

The motivation and leadership means were also analyzed by position categories. Work as a motivator is the highest mean for Employees, Team Leaders, and Managers. Supervisors selected achievement as the highest motivator. For Employees and Team Leaders, achievement had the second highest mean. For Supervisors, recognition had the second highest mean. Finally, for Managers, responsibility had the second highest mean.

The lowest rated motivator for Employees, Team leaders, and Supervisors was advancement. Recognition was the lowest rated for Managers. There is a greater variety of means as categorized by position than for any of the other demographics.

Trait leadership preference is the highest mean in all position categories. All engineers, regardless of position, selected Trait leadership as the highest rated leadership style. Interestingly, all position level respondents agreed on the second highest rated leadership style. Group leadership had the second highest mean. These results indicate that the respondents prefer trait and group leadership independent of position.

The lowest rated leadership category was the Great Man style. Great Man was the lowest in all position categories. Therefore, for any level of position, the Trait style was the most popular and the Great Man style the least popular.

Significance of this Study for Leadership

This study revealed a preference of engineers for work as a motivator and Trait Leadership as the preferred leadership style. Both of these qualities are the highest rated and are statistically preferable to the other factors. There is an intuitive observation that if engineers are motivated by the work itself, they would prefer a leader who assigns them their work and to leave them alone to do the work. Engineers prefer a leader who has the qualities of honesty, straightforwardness, and a *hands-off* attitude about management. Any manager with these qualities would be perceived as a *good leader* and would allow the engineer to concentrate on his or her work.

Engineers tend to be somewhat individualistic (Hoyt & Gerloff, 1999). They tend to favor autonomous, challenging, and meaningful assignments. The survey results are consistent with these characteristics of engineers. Engineers are known for having a desire for challenging work and for preferring to be left alone to do this work. As a result, these engineers would prefer a leader with the traits that would allow them to concentrate on the *work itself*. They would prefer a leader who has the traits that are most conducive to allowing them to concentrate on their work.

The Team Leader for engineers will be most successful if he or she lead according to these concepts. In the Introduction, it was noted that one unique feature of a government civilian R&D environment is that the Team Leader has task authority but not administrative authority for the team members. The Team Leader has to ensure that the work is accomplished by creating an environment supportive of the intrinsic motivators of the team members. In this study, the primary intrinsic motivator was the work itself. Thus, the Team Leader will be most successful if he or she matches the engineers with the right work assignments to create workers who are enthusiastic about their tasks. The Team Leader needs to ensure that the environment for the team is such that the engineers can concentrate on their work assignments.

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