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A Rare and Valued Asset: Developing Leaders for Research, Scientific, Technology, and Engineering Organizations

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Abstract (Document Summary)

Leadership is an area of intense interest and need, particularly among scientific, technology, engineering, and mathematics (STEM) organizations. STEM leaders face cultural challenges different from those of mainstream businesses and have developmental needs not adequately addressed in the organizational literature. This article summarizes the current design for a mainstream leadership development program, focuses on the unique needs of STEM organizations and their leaders, and recommends five design elements for a STEM leadership development program. [PUBLICATION ABSTRACT]

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[Headnote]
Abstract
Leadership is an area of intense interest and need, particularly among scientific, technology, engineering, and mathematics (STEM) organizations. STEM leaders face cultural challenges different from those of mainstream businesses and have developmental needs not adequately addressed in the organizational literature. This article summarizes the current design for a mainstream leadership development program, focuses on the unique needs of STEM organizations and their leaders, and recommends five design elements for a STEM leadership development program.

Introduction

Leadership development is a foremost topic in the business literature and one of the most prolific and fastest-growing areas of interest in organization development (Piotrowski & Armstrong, 2005; Sharkey, 1999). Yet there remains an acute need to develop leaders. Survey results from over 500 senior learning professionals (that is, those within training and development and human resources) indicate that leadership and development are among the top training priorities among U.S. profit, nonprofit, and government organizations, with the need for experienced managers increasingly recognized as urgent (Hall, 2005). Even so, according to the U.S. Conference Board, businesses report a significant decline of confidence in their leadership strength, down from a high of 50% in 1997 to about 33% in 2001 (Barrett & Beeson, 2002). Ironically, although leadership development is seen as a good idea, according to a recent survey of Fortune 100 level businesses, only 44% had formal welldefined, well-structured systems for developing highpotential employees (Giber, Carter, & Goldsmith, 2000).

Professionals in science, technology, engineering, and mathematics (STEM) who find themselves in positions of management have unique leadership development needs not fully addressed in organizational literature. Similarly, STEM environments are different than those of mainstream businesses and are "are long over due for leadership skills building and training in basic business acumen" (Hall, 2005, p. 24).

The premise of this article is that STEM organizations require specially designed leadership development programs so that these professionals can optimally contribute to the organization. STEM organizations include scientific institutes, universities, and pharmaceutical and software development organizations. This article offers recommendations for leadership program design elements to meet the unique needs of these groups. The authors explore what is already known about general leadership development program design, describe the needs of STEM organizations and the characteristics of their new leaders, and conclude with five design elements essential to the success of a STEM leadership development program.

Background

Regardless of the organizational environment and despite stylistic differences and variations among curricula, most authors agree on the core purposes and best practices for leadership development programs (LDPs). A review of organization development literature from the past decade shows that LDPs typically include (a) formal classroom training, (b) real-world and real-time application, (c) reflection (an inward and outward focus on self, others, and the whole system), (d) 360-feedback tools with coaching, and (e) the participation and support of senior management for content expertise and mentoring.

Organizations choose LDPs based on various organizational development considerations, including leveraging favorable cultural effectiveness and transformation. The major goals are to create a more competitive advantage, foster greater adaptability, and fortify performance capacity (Fulmer, 1997; Fulmer, Gibbs, & Goldsmith, 2000; Fulmer & Vicere, 1996; Vicere, Taylor, & Freeman, 1994). Additionally, LDPs serve the aims of succession, building bench strength (Tyrrell & Swain, 2000) and retention (Pernick, 2001). Organizations invest in LDPs because they believe that homegrown leaders will fortify their organizational cultures and reinforce both their strategic agendas (Pernick, 2001) and strategic advantages (Fulmer et al.; Giber, Carter, & Goldsmith, 2000). They are also leveraging knowledge and learning as an important sustainable competitive advantage (Vicere et al., 1994).

Organizations with active LDPs have moved rapidly away from the perception that leadership development is exclusively the executive domain and are extending their reach into all levels of management (Fulmer & Vicere, 1996; Fulmer, 1997; Fulmer et al., 2000; Vicere, Taylor, & Freeman, 1994). Typically education and training are delivered by a variety of external and internal sources. Specific program content may be either the standardized off-the-shelf variety or customized to the specific needs of the individual participants and/or the organization as a

whole (Fulmer & Vicere).

Quality LDPs include several key personality profiles that indicate developmental opportunities, strengths, and weaknesses. Psychometric-based assessments, when properly applied, are particularly effective for leaders' transformations and behavioral changes. Chief among them is the Myers-Briggs Type Indicator (de Charon, 2003; Michael, 2003). Internal 360 degree instruments that capture the key behavioral success indicators are especially useful when combined with feedback and coaching. Additionally, good LDPs also combine formal and experiential learning opportunities that result in sustained and valued change for both the individual and the organization (Fulmer, 1997; Fulmer & Vicere, 1996; Vicere, Taylor, & Freeman, 1994). Sufficient critical reflection by the participant is particularly relevant to the success of an LDP (Densten & Gray, 2001). This is often accomplished through mentorship or external coaching (de Charon; Fulmer et al., 2000; Giber et al., 2000).

Evaluating program results on a regular basis is essential to assuring that the program is working and that the organization's investment dollars are being well spent (Dalton & Hollenbeck, 1996; Fulmer et al., 2000; Pernick, 2001; Sirianni & Frey, 2001). Leadership development can effectively provoke cultural change, especially when joined with other levers, such as recognition and managerial support (Hyde & Patterson, 2002; Sharkey, 1999; Sirianni & Frey, 2001). However, money is unwisely spent by the organization that invests in an LDP yet remains resistant to continuous learning and development (Sharkey).

Leadership Development Programs in STEM Organizations

With the exception of a study by Parke-Davis, there is little discussion in the literature about the singularity of STEM cultures and their leaders. The pharmaceutical research and development division at Parke-Davis created a program to develop leadership effectiveness of its scientific management staff who were engaged in leading and managing other scientists. Generally, scientists at Parke-Davis lacked formal training and had little interest in managing. Among them, leadership talent was recognized as "a scarce and highly-valued asset" (Jones, Simonetti, & Vielhaber-Hermon, 2000, p. 2). Previous training and development efforts emphasized developing skills and techniques but were fragmented, leaving little room for a shared, collegial experience integral to collaboration and teamwork. However, in Parke-Davis' second attempt, as with the other bestpractice models, leadership competencies were identified, and the program was customized and delivered in concert with an integrated learning model emphasizing real-world applications. Shared experience was a vital part of the program.

Key improvements found among the participants included personal transformation, valuable organization contributions, communication, team-building, and problem-solving skills. The program debunked the notion that "scientists are a breed apart, to be left alone to get on with the arcane work in laboratories far from the center of corporate power" ("Making Scientists Into Leaders," 2001, p. 5). Rather, Parke-Davis discovered that it is incumbent upon organizations to make maximum use of all their talent in order to thrive and grow in turbulent times (Jones et al., 2000).

In contrast, U.S. federal leadership development programs, nine altogether, including the U.S. Department of Agriculture's Graduate School's New Leader Program, are stand-alone centers that function apart from the participants' own organizations (Silverman & Miranda, 1997). Although some of the federal programs involve internships, there is much less opportunity for integration of real-world experiences that foster working and learning with others within the organization. Examples of other successful STEM leadership development programs are Space Systems Loral and AstraZeneca. Space Systems Loral's program for recent college graduate hires included a mentor relationship and relied upon executive sponsorship. The purposes of the program included retention, technical skills training, and leadership development (Barbian, 2000). Astra and Zeneca merged in 1999, forming AstraZeneca, one of the top five pharmaceutical companies in the world. To advance cultural integration between the then-merging organizations, it leveraged its newly created actionlearning-based leadership development program with other merger activities. Involving its top 200 executives, the program achieved a whole-systems, futureoriented, and vision-driven perspective that embraces and utilizes differences among various members of its workforce-professionally, racially, and by company history and affiliation (Hyde & Paterson, 2002).

Universities often underutilize the strategic advantage offered by their own potential leaders while facing many unique challenges that call for leadership at all levels among faculty, staff, deans, departmental chairs, provosts, chancellors, presidents, and students (Armstrong, Blake, & Piotrowski, 2000). Brown's (2001) case study at the University of Saskatchewan found that most department heads had not initially aspired to serve in leadership roles. Preexisting tensions between academicians and management had contributed negatively to attitudes toward formal leadership roles. To close perceptual gaps and build productive relationships, an LDP was created involving participants from both administration and academics. The program embraced a shared pursuit of learning and

development, diminishing much of the preexisting negativism and instilling a spirit of collaboration and an appreciation for leadership.

New Leaders Within STEM Organizations

The STEM organization comprises leaders that are, in many respects, unique from those found in most other kinds of organizations. In consulting assignments, the authors conducted field experience while designing leadership development programs at the University of Nebraska Institute of Agriculture and Natural Resources, the University of Colorado, the University Corporation for Atmospheric Research, and the National Center for Atmospheric Research. In addition, we coached individual research scientists, university faculty, and engineering managers. In all, our organization development initiatives involved over 400 LDP participants across these and several other private scientific and engineering STEM organizations. Our conclusions support Brown's findings; that is,

1. Highly educated in their specific areas of expertise, most leaders initially express negativity and reluctance about managing and leading. They view it only as a necessity to furthering their research or technical aspirations or organizational advancement.

2. Most STEM professionals eventually discover opportunities for creative leadership and want to make a difference in the lives of others and their organizations. They realize that leadership competencies are transferable to their individual research and to their research teams. They find their skills to be a service to their organizations and the broader communities, as well as their personal lives.

3. The best source of help and support is another leader with a similar background. The two leaders together can create and strengthen collegial relationships with counterparts across departments while sharing challenges and best practices.

4. Many express the view that balancing their work and personal lives and balancing their new roles with their research and technical interests create additional pressures. Particularly in the scientific realm, the reward system has traditionally rein forced research and publishing over leading and managing others. However, this is changing because of the greater emphasis on interdisciplinary science, the needs of the organization's constituents, competitive forces, and advantages of interdepartmental collaboration.

5. Leaders in STEM organizations find relational challenges the most difficult to handle. Chief among these are concerns over personal conflicts and keeping others motivated and oriented toward developing solutions.

6. Leadership succession and transition planning suffer as management and leadership efforts go underrecognized and under-rewarded.

A striking example of the sixth point is cited in the investigation report for the Columbia space shuttle accident, which found that the organizational causes of the 2003 loss of the shuttle and its seven-member crew were rooted in the program's history and culture. The Gehman Report documented barriers to effective communication, lack of integrated management, and a shadow chain of command that operated outside the organization's rules (Columbia Accident Investigation Board, 2003). Among the recommendations was that, "NASA should implement an agency-wide strategy for leadership and management training that provides a more consistent and integrated approach to career development. Strategy should identify the management and leadership skills, abilities, and experiences required for each level of advancement" (p. 223).

Culture Is Key

The matter of culture has much to bear on the design, nature, and intended outcomes of a leadership development program. Emerging as the frame of reference for every leader in any organization, culture is intimately tied to and shaped by the leaders within. It offers guidelines for creating meaning from behavior, sets the pattern for how people function and relate to one another, determines standards of effectiveness, and provides order and structure for activity (Schnieder, 1994).

The STEM culture values competence above all other considerations among these kinds of organizations, which include accounting firms, think tanks, engineering, high-technology companies, universities, and scientific foundations. Professionals find that the STEM culture reinforces their calling to achieve mastery and allows them to

contribute to an inspired vision. Although somewhat true for other cultures, it is particularly true in these competency-based cultures where hiring and promotion are based upon demonstrated achievement. Graduate degrees and professional recognition carry great weight, and technical mastery is vitally important. As a result of constant "stretching," STEM professionals are more intense, act with more urgency, and have greater difficulty feeling satisfied with their accomplishments than do those in other cultures. Careful planners, they value information and exercise exceptional rigor and rationale for their decisions (Schnieder, 1994).

Five Design Elements for Success

The following five design elements address the STEM professional's unique needs and are essential to effective program design.

1. Define Organization-Specific Leadership Competencies

Leadership competencies and a leadership model must foster best practices. These should take into consideration the STEM professional's need for both a clear and engaging vision that provides a challenge and rationale for developing new products, services, and opportunities. Technical mastery is vitally important to the STEM professional. The combination of exploring new possibilities and extensive rational argument distinguishes this culture. High value is placed on conceptual systemization-a spawning ground for ingenuity and invention (Schnieder, 1994). Therefore, the LDP must include problem-solving, project planning, and action-learning models that engage the professional's need to solve or improve upon that which is novel and unique. It is important to create explicit objective measures of success relative to a standard of organizational excellence to keep the professional both striving and satisfied, which in turn adds value to the organization.

2. Apply Selection Criteria

It is vitally important to enroll participants into the LDP who will have the greatest likelihood of maximizing the return on the organization's investment. Organizational considerations should include overall corporate direction, strategy, goals, and need for leadership succession. Criteria for the individual include desire, confidence, assertiveness, readiness, self-awareness, energy, and experience.

As noted, in the scientific and scholarly realm, the reward system predominantly reinforces research and publishing over leading and managing. For those in engineering, learning and practicing mechanical, nonhuman systems-related principles are the primary focus. Aside from leading a team of a few members for a single purpose project or research grant, it is uncommon for STEM professionals to anticipate broader realms of management and leadership responsibilities as part of their careers. A clear, fair, simple process is needed to communicate the purpose and scope of the LDP, as well as for selecting and notifying the applicants. In addition to having the desire to further their professional development, participants must demonstrate the capability to balance work and life, have longevity with the company, fulfill qualifications such as tenure, and desire to build cross-functional relationships and pursue leadership goals. The nomination process must reveal whether these individuals posses key desirable traits, including:

* Sense of purpose;

* Desire to make an impact;

* Assertiveness;

* Receptivity to feedback;

* Long-range view of the organization and its purpose;

* Ability to engage others in a compelling vision;

* Propensity to architect operational systems and design effective strategies;

* Demonstrated need for continuous learning, for rigorous processes, and for producing substantive information;

* Internal motivation for competency;

* Some success with and an orientation toward working with others.

3. Create Learning Partnerships with Relevant Activities

Real-world developmental activities or, action-learning groups, reinforce informed change. Although it is certainly true that an action-learning component contributes substantially to instilling collégial partnerships among the participants in mainstream programs, it is particularly necessary to the STEM leadership development program.

More often than not, the engineer, scientist, or scholar will show much greater commitment and loyalty to his or her own professional interests than to the needs of the organization. However, the days of the solitary researcher, scientist, or engineer pursuing her or his own curiosity are quickly eroding and being replaced by team participation. Interdisciplinary lines of demarcation are fast eroding. Individual contributor roles are less common, whereas joint appointments and working collaboratively within matrix reporting systems across departments and disciplines are fast becoming the norm. A participant can, and does, find that collaborative leadership improves their creativity and ingenuity and provides focus and relevancy for professionals' working together. The role of the LDP is to create platforms for collaborative relationships while framing responsibilities in a light that illuminates the contribution of individual achievement and excellence. One prime arena is the action-learning team with an organizationally relevant shared purpose and task and an agreement to formally present its findings to senior management at the conclusion of the program.

While often overlooked, it is advisable to place emphasis on the human dynamics that emerge within the action-learning team so as to inform the members of the personal and relational developments. Team development models such as Tuckman's Five Stages of a Team are particularly useful for redirecting attention to the team's processes. The DIET model, a proposed form of action research, blends the human systems' side of teams with the rigor of empirical data analysis (Cady & Caster, 2000). Nontraditional, more humanistic change methodologies such as appreciative inquiry can be incorporated into the STEM organizational system to offer a balanced learning experience and effective model for program participants.

4. Involve Organizational Leaders and Peers

A leadership development initiative is only as good as those sponsoring it. Best-practice organizations involve executive sponsorship in the form of program design, instruction, and mentorship. Senior management must drive the need for and support the establishment of a formal LDP. A clear vision and continued involvement by senior level staff are essential to success and continuation. Senior staff may support the program in a number of ways: (a) financially; (b) as subject matter experts teaching within a program; (c) as mentors; and (d) for executive development, as participants themselves, to lend credibility and place emphasis on the importance of the program.

As discussed earlier, given that the best source of help and support to the leader-professional is another leader of similar background and orientation, those already serving in a formal leadership role serve as excellent resources, mentors, and models for those just taking on the role. Peers should also contribute to the program design and implementation. Advisory panels are typically composed of representatives from administration, human resources, training and development, external consultants, and universities. An essential ingredient to the STEM LDP is peers from among the ranks of fellow professionals, most notably, those who have already completed the program. This brings a unique, first-hand perspective that contributes to peer engagement and overall collegiality. These peers serve as representatives from among the participant group who not only understand the developmental needs, experiences, and challenges of the participants, but also model leadership as well-positive proof of what the program is about.

5. Customize Participant Support Structure to Match Needs

An LDP experience can cause pressures involving work/life balance as well as the challenge of balancing new leadership roles with individual research and technical interests (see Lambert et al., this issue). Coaching is an excellent resource for fostering the critical reflection needed to integrate and balance these potentially unsettling demands of transition and change, however rewarding the demands may be (Ryan, Brutus, Greguras, & Hakel, 2000). The capacity to reflect can be developed. When tied directly to personal experience, it provides a process for leaders to deepen their understanding and maximize their effectiveness through the interpretation of their experience from a leadership perspective (Densten & Gray, 2001). As a reciprocal relationship, the capacity to

reflect also extends participants' abilities to listen intently to others, thus fostering a key leadership attribute (Kouzes & Posner, 2002).

High-functioning mentor relationships not only reinforce the collegial experience but foster continued learning by promoting accountability, inspiring reflection, sharing feedback, and contributing to and building upon the organization's knowledge and collective positive history. For the participant, this occurs during the program as a protégé, as well as beyond, when serving as an alumni mentor. When integrated into an action-learning team, mentoring contributes the trust and recall of the positive history needed for organizational growth.

Managers throughout the organization should also be engaged at the onset to support the participants' learning, thus providing mentorship and creating an environment for success and advancement for their employees. An individual development plan provides a structure for the desired learning, the competencies addressed, the actions that will be taken, target completion dates, and measurable success indicators. These plans are reviewed in triad meetings involving the participant, the manager, and the participant's coach; this allows the manager an opportunity to fine-tune the plan and offer ongoing support for the individual.

Summary

Our experience with design, delivery, leading, and participating in leadership development programs within STEM organizations supports and extends the six findings noted by Brown (2001). In addition, we recommend these five additional and essential components for LDPs, specifically designed for STEM organizations:

1. Define organization-specific leadership competencies;

2. Apply appropriate selection criteria;

3. Create learning partnerships with relevant activities;

4. Involve organizational leaders and peers;

5. Customize participant support structure to match needs.

Although defining organization-specific leadership competencies is likely a good idea for any program, it is especially important within a STEM organization because it shifts the emphasis on the primary role from technical applications to leading others. Likewise, all programs need appropriate selection criteria, as pointed out in recommendation 2. However, we suggest that these specific traits be particularly emphasized as qualifying criteria for participants within a STEM organization leadership development program:

* Sense of purpose;

* Confidence in making an impact;

* Assertiveness;

* Receptivity to feedback;

* Long-range view of the organization;

* Ability to engage others in a compelling vision;

* Propensity to architect operational systems and design effective strategies;

* Strong need for continuous learning, for rigorous processes, and for the production of substantive information;

* Internal motivation for competency;

* Orientation toward working with others.

Although these traits are indicative of leadership effectiveness, they are often not highly valued in a typical STEM environment that tends to reward subject knowledge and technical mastery over working within human systems. Similarly, the third point, creating learning partnerships, is sound advice for any LDP, yet it is critical to the success of programs in STEM organizations because it balances the polarity between individual and team-based endeavors in an era of increasing need to integrate science and technology. It is also important for the success of an LDP program to involve organizational leaders and peers. Lastly, as stated in the last recommendation, LDP participants in STEM organizations require unique encouragement and support throughout the program in order to balance and integrate professional and personal changes.

Applying these five strategies will help ensure that a leadership development program within a STEM organization produces maximum results. Participants will be positioned to succeed, will understand the goal of the LDP, and will have the support they need to learn and grow and exercise their new leadership skills. Moreover, participants will have addressed their uniqueness as technical professionals as they grow accustomed to and embrace their new roles as leaders, all of which results in a long-term strategic competitive advantage to the organization.

[Sidebar]
Leadership is an area of intense interest and need, particularly among scientific, technology, engineering, and mathematics (STEM) organizations.

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... according to a recent survey of Fortune 100 level businesses, only 44% had formal well-defined, well-structured systems for developing high-potential employees.

[Sidebar]
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[Sidebar]
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[Sidebar]
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[Photograph]

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