A Multiple Case Study of Innovation

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This study aims to explore how leadership and contextual factors influence innovation in R&D teams in national laboratories, using the approach of multiple case studies. This paper provides some preliminary findings from two highly innovative teams residing in two national laboratories in the US. The preliminary results suggested several common characteristics regarding leadership, social capital, and learning culture. Implications for HRD are drawn.

Keywords: Innovation, Leadership, Social Capital

Innovation is the cornerstone of development. Starting from Schumpeter (1942), the role of innovation in precipitating social and economic development has been established. Researchers and practitioners have been spending extraordinary amounts of energy in unearthing the mechanisms that foster innovation. Leaders of R&D teams have attracted particular attention because of their direct influence on leading, organizing, rallying, and managing the operations of innovative tasks in research teams. However, whether there is a universal set of leader characteristics that fit best with the task of leading innovation is contested (Nippa, 2006). Considering contextual factors of the team would add an important dimension to the leadership-innovation linkage. Contextual factors such as social capital and team learning culture exert significant influence on innovation. The purpose of this study is to investigate what characteristics of leadership, social capital, and team learning culture are perceived to influence scientific and technological innovation in R&D teams.

Leadership is one of the growth areas in HRD and this study will provide substantial insights into the mechanisms of how leaders influence their environment and the innovative outcomes of their teams. The findings could be used for curriculum design, performance metrics, OD strategy, and will inform the features of high performing teams and cultures that need to be retained and fostered at national research laboratories.

Research Questions

The overall purpose of this study is to investigate what characteristics of leadership, social capital, and team learning culture influence innovation in R&D teams in national laboratories. Some specific research questions are:

1. What kind of leadership characteristics do highly innovative teams possess?
2. What are some social network characteristics of the teams?
3. How much trust is there in these teams?
4. What kind of learning culture is there in these teams?

Rationale and Background

A number of studies have examined innovation, social capital, and organizational learning culture separately. However, there has not been a study that explicitly examined the dynamic relationship among leadership style, social network, organizational learning, and innovation. This study will add an importance piece of literature to the existing body of knowledge by integrating personal and contextual factors.

Van de Ven and Angle (1989) defined innovation as the "generation, acceptance, and implementation of new ideas, processes, products, or services" (p.20). Innovation is believed to be vital to organizational, national, and regional success (van der Panne, van Beers, & Kleinknecht, 2003). Traditional innovation studies did not put much emphasis on leadership, maybe due to the autonomous nature of innovation work and the attribution of innovation to individuals (Jung, 2001; Mumford, Scott, Gaddis, & Strange, 2002). As innovation is perceived as more of an integration of diverse knowledge and resources, the leader's role in innovation has been elevated. However, limited studies have been conducted to investigate how leadership influences innovation outcomes (Tidd, Bessant, & Pavitt,

2001). There is a special dearth of research in leadership in R&D teams (Nippa, 2006). Research teams are made up of high-level knowledge workers -- scientists and engineers. Their work involves a large amount of autonomy and self-management, as what Reich (1994) called symbolic-analytic services, services that cannot be codified and controlled and services upon which the organization is dependent for competitive advantage. Leading high-level knowledge workers may entail a different approach from leading, for example, a sales team. Do scientists defy leadership? Do leaders lead with their technical expertise or some other leadership qualities or both? What characteristics do successful research team leaders have? Further, Nippa (2006) doubted the stream of research trying to find the perfect R&D leader. Contextual factors and their dynamic relations with leadership seem to be neglected (Nippa, 2006). This study introduces two contextual factors, social capital and organizational learning culture, and examines how they come into play with leadership in influencing innovation.

Social capital is "the sum of the actual and potential resources embedded within, available through, and derived from the network of relations possessed by an individual or social unit" (Nahapiet & Ghoshal, 1998, p.243). According to Nahapiet & Ghoshal (1998), social capital encompasses three distinct dimensions, the structural dimension that captures the characteristics of an actor's social network (such as size and strength of one's social relations), the relational dimension that involves beliefs and norms that bind people together in a social network (such as trust and respect), and the cognitive dimension with shared representation, interpretation, and systems of meaning among people in the same social network (such as shared vision). A number of empirical studies on how innovation is related to social capital have been conducted. Zheng's (2006) review of the social capital-innovation link revealed that separate studies suggested that a larger network size (Ahuja, 2000; Smith, Collins, & Clark, 2005), a higher level of diversity and stronger relations an actor has in its network (Smith et al. 2005; Perry-Smith, 2006), more diverse bodies of knowledge the actor is exposed to (Burt, 2004), and a higher level of trust tend to lead to increased innovativeness, until maintaining the network overweighs its benefits (McFadyen & Cannella, 2004). These conclusions have been made through different studies on different components of social capital. What has been missing is pooling the different components of social capital, as mentioned above, into one study and examining whether they still stand true in the vicinity of each other.

The other environmental factor is organizational learning culture. Organizational learning has been receiving increasing attention in the HRD literature. It directly impacts innovation in that innovation is perceived as a process of generating, developing, and implementing new knowledge for the purpose of problem-solving (Kanter, 1988). Organizational learning is believed to promote innovation because organizational learning enables an organization to anticipate and adapt to the dynamics of a changing environment, to facilitate open exchange of information and ideas, and to encourage creativity, risk-taking, and experimentation (Bates & Khasawneh, 2005). A learning culture consists of several dimensions: creating continuous learning opportunities, promoting inquiry and dialogue, encouraging collaboration and team learning, creating systems to capture and share learning, empowering people toward a collective vision, connecting the organization to its environment, and providing strategic leadership for learning (Watkins & Marsick, 2003). However, questions remain such as how different dimensions of a learning culture contribute to innovation respectively in the context of R&D teams, and what specific leadership characteristics and practices promote a learning culture.

This study targets to address the above-mentioned questions in literature regarding the mechanism through which leadership, social capital, and organizational learning culture exercise joint impact on the team's innovative outcomes.

Research Setting

The research setting in this study is US national laboratories. National labs originated in the Manhattan Project during the World War II (Jaffe & Lerner, 2001). Most of them are owned by the government, and operated by contractors including a mix of universities and private firms, with the intention of shielding them from political pressures (Jaffe & Lerner, 2001). These labs represent the most comprehensive research system of its kind in the world (Office of Science, 2006). They conduct research and development that are of national interest (Office of Science, 2002). However, despite fact that national laboratories carry out mission critical research for the whole nation, little research has been done in national laboratories.

Scientific and technological innovation is a key mission of national labs. Because of their unique institutional type, workforce, political pressure, and structure, studying social dynamics of innovation in these labs may provide unique contributions to existing literature. On the practical front, better understanding of the innovation-inducing mechanisms in national laboratories could help improve the innovation success rates.

Research Methods

A multiple case study design was adopted for the whole study. The reason is that little research is done on research teams in national laboratories. A case study allows us to examine and understand the dynamics and environmental complexities where the teams reside. As the geographical, functional, and academic fields in which the various teams work are all different, a range of variables may come into play. Multiple cases permit replication and extension among individual cases that could eliminate chance associations and provide more rigorous findings (Eisenhardt, 1991). A multiple case study was thus determined to be appropriate for the purpose and the setting of this study.

Highly innovative teams in several national labs are included in the study in order to detect common factors or relations related to leadership, social capital, and learning culture that are perceived to be contributive to team innovation. Top managers from four national labs are approached and requested to provide names of 1-2 highly innovative teams, regardless of their task areas. A total of 4 highly innovative teams are targeted. The current paper reports findings from two cases where data collection has been completed.

Mixed methods were used to collect data on leadership style, social capital, and learning culture. The qualitative part of the study involves semi-structured interviews, written and electronic document analysis, and non-participant observations. The quantitative part of the study involves a survey, whose purpose is to quantitatively cross validate findings from qualitative sources, as well as allowing more accurate comparison across teams.

Each team leader was interviewed. A proportion of team members with different job functions (scientific, technical, and administrative) within each team were interviewed, each interview lasting from 30 minutes to 90 minutes. Interview questions were generated based on the three research questions. Written documents were obtained from the team or from publicly available sources. The collected information describes team history, team performance, team structure, documented team connections with other groups or organizations, publications and patents, aggregate educational levels, professional tenure, team tenure, and organizational tenure of team leaders and team members. Observations of team meetings were conducted whenever possible. The observations focused on understanding social interactions, team routines, and leadership styles. Qualitative data were analyzed by the two researchers independently using HyperResearch, after which several discussions were conducted to reach consensus.

After the interviews, a survey questionnaire was distributed to all the team leaders and members. A web-based survey instrument was used to collect data on the variables of this study: leadership style (transformational leadership), social capital (including network size, network range, network strength, and trust), and organizational learning culture. Control variables included existing knowledge of the team (an aggregate of their educational level, length of time in their field, and length of time in their teams), length of the time the leaders have been in the leadership positions, size of the team, age of the team, and the disciplinary fields the team is engaged in.

As this study is ongoing, by the time this paper is due, we have analyzed qualitative data from two teams in two national laboratories. The following reports preliminary findings based on the qualitative data from the two teams.

Preliminary Findings

Background of the Teams

Team A resides in a national lab that is located in the west coast region. The lab is a nuclear weapons laboratory which is also missioned to provide technical solutions to key energy, environment, infrastructure, and health security problems. It is primarily operated by an academic institution that has 8,500 employees, 55% of which have advanced degrees (75% of the science and engineering staff hold advanced degrees). There are 29 employees in Team A, out of which 25% are female, 62% hold advanced degrees, with an average age of 38. The team's task area crosses several disciplines, including physics, geophysics, nuclear engineering, electronic engineering, mechanical engineering, , toxicology, earth sciences, geochemistry, analytical chemistry, chemistry, nuclear chemistry, applied mechanics, forestry, and biological sciences. Three leaders (the current director and deputy director and founding director) and 11 team members were interviewed.

Team B resides in a national lab that is quite different from Team A's. Team B's lab is located in the Midwest region. The lab is missioned to advance understanding of high energy physics. It has 2,100 employees, 40% of which are women. Team B has 38 employees, out of which there is only one female. Team B is hierarchically organized into three groups, one of which is headed by the team leader. These three groups are relatively independent and responsible for providing different areas of technological support to other units of the lab that ensure smooth operationalization of the accelerators. In this team, there is only one scientific staff who is on the team only for a short period of time, and the remaining are technological and engineering staff who are not clearly differentiated based on their job titles. Three people were interviewed, the director, a group leader, and a member.

Leadership

Common leadership characteristics can be roughly divided into the internal aspect and the external aspect. The internal aspect captures how leaders interact with their team members, and the external aspect captures how they interface between their teams and their external environment.

Internally, two prominent leadership characteristics were identified. First, team members consistently used "hands off" to describe their leaders' style. The current leader of Team A used the Japanese university style where directors set research agenda for everyone as a contrary example of his style. He went on to explain that his "philosophy, particularly within a scientific organization, is to create and maintain an environment, so that individuals can be successful, and have the ability to contribute to the success of the overall organization". This characteristic is strongly reflected in the team culture which is, as described by his members, "where you were allowed to run with things", and "everybody does the same things. Post-doc's are expected that they will do certain things-bringing in money and trying to get those collaborations as well. It is just everybody does the same thing. They all take care of it; they all watch over it; they all have good ideas about it". Team B leader set his style against micro-management, or in his word, "baby-sitting", and explained that he lets his group leaders work autonomously and gives everyone the freedom to innovate, which was echoed by his members, for example, "you're given the freedom to do your job in the best way you know how to do your job". This hands-off style comes from both leaders' keen awareness of the unique technical expertise of their team members and the limitation of their own technical competence to know everything in highly technical fields.

The second characteristic of leadership internal to the team is the ability to explain the vision or priorities to team members. For example, Team A leader recalled an event where he started an initiative and said "it was my nudging that made that happen but I had to enlist the scientists that were willing to get excited about it and have the same vision that this was important scientifically, and important to the future of the organization". He continued to explain that "we have all these different activities and a multitude of sponsors. So organizationally, I have to keep this organization intact and operating in such a way that allows those things to happen and also help steer the organization towards activities that are appropriate for a national lab". Team B leader said that his members "understand the priority. And sometimes the priorities aren't clear. I try to make it as clear as possible for people in the group". This characteristic complements the hands-off practice, because it creates synergy while individuals who follow their own interests may diverge in many different ways. It is easy for people to stray off team vision, and so it is important to keep them focused on mission-critical areas. Both leaders do so by explaining the vision and helping people realize how things fit in the bigger scheme. This characteristic partly corresponds with the idealized influence of the concept of transformational leadership, where the leader envisions a desirable future, articulate how it can be reached, set an example to be followed, and shows determination and confidence (Bass, 1999).

External to the team but inside the lab, both leaders mentioned that they serve as a buffer between their team and the lab, as they try to "protect their staff" and keep off obstacles that come from the lab, such as increasing bureaucracy from lab management. Every interviewee expressed frustrations about the fact that there has been an increasing amount of lab oversight in recent years because of some safety breaches in one of the labs. Leaders from both teams serve as a buffer between the lab and their team, so as to mitigate obstacles that may interfere with the work of their team members.

External to the lab, leaders from both teams spend efforts in promoting their teams. Team A leader called this "missionary work", and Team B called this PR. Both leaders also mentioned their efforts to help connect their people to outside links because they have networks that their team members may not have on their own. In particular, the founding leader for Team A who worked in prominent positions in the federal government and the military was able to spread the word about Team A because he "moves in a different world" so he could do some "rain-making".

An interesting finding is that neither of the team leaders assumes a technical leader role. Although they both have technical knowledge of all the activities in their teams, they do not assume a leading role in all of their scientific and technical endeavors. Team A leader said "I'm not an expert… All these people are experts…So my challenge is to make sure that that person is recognized and has opportunities to be successful". Team B leader expressed a similar idea that he leads one group and leaves the other two groups to his group leaders. This characteristic does not lend itself well to the intellectual stimulation dimension of transformational leadership where the leader helps followers become more innovative and creative. This is probably due to the complexity of the scientific and technical work both teams engage in. Their leaders cannot possibly become a direct source of scientific or technical inspiration. Their role is more indirect in creating an environment where creative work and innovation are encouraged and grown.

One of our new findings regarding leadership characteristics is that leadership entails both internal and external aspects. Ideas such as transformational leadership only capture the leader practices and characteristics that are demonstrated within a unit. Our findings suggest that there are aspects of leadership that capture leader practices outside a unit which can benefit innovation. Both internal and external aspects of leadership should be taken into

consideration in order to understand how leaders influence innovation in a holistic way. Second, in comparing our findings with existing literature that examines leadership practices inside a unit, we found that some of our findings corresponded with some components of transformational leadership and some findings beyond it. Transformational leadership includes idealized influence, intellectual stimulation, and individualized consideration (Bass, 1999). Idealized influence refers to the leader's ability to articulate a desirable vision, demonstrate commitment to that vision, and speak about the vision with confidence and enthusiasm (Bass, 1999). Team A leaders' practice of steering research efforts toward lab's mission areas, explaining his vision, getting people excited, and obtaining their acceptance of the vision falls into this dimension. Leader B does this too when he "makes priorities clear to people", and helps "people understand how things fit into the bigger picture". In terms of intellectual stimulation where the leader helps with idea generation did not have a close match in our study. Although there was the common encouragement of risk-taking, leaders did not claim or practice technical leadership or contributed directly to idea generation. It is done in a more indirect way. In terms of individual consideration, team A leaders address individual development needs. Their leadership philosophy is to "pay attention to individuals and make them successful". Leader B did not particularly demonstrate that in his leadership practices. A group leader in Team B mentioned that although individual accomplishment is acknowledged, team performance is stressed more. Although there is demonstrated correlation among the three dimensions of transformational leadership, the correlations may not hold true in our case. We further ask whether all three components of transformational leadership are essential to team innovation success. If yes, whether different dimensions are exhibited to different degrees across the innovative teams? Further, some facets of leadership that are not covered in transformational leadership came up. The hands-off leadership style is not covered by transformational leadership but is essential in the teams because of the technical limitations of any individual to accomplish any projects alone. Our findings also suggested that the leader's act of helping members forge social ties, buffering between their organizations and their teams, as well as promoting their teams and enhancing external influence of their teams also play significant roles in their team innovation.

Social Capital

Existing literature suggested that network size, network strength, structural holes, and trust have a significant influence on innovation. Our findings are consistent with existing literature, and added to existing literature by providing clues as to how social capital is established as well as explored how leadership influences social capital.

Both teams have a wide external network. Team A's leader claimed that "very little of the work was wholly conceived, wholly executed here. In fact it's just the opposite. We're often enabling and leveraging work else where". They recognize that "there are more smart people outside this fence than inside". For Team B, because of their supportive function to other units in their lab, a substantial percentage of their time is spent working with other units. For example, their leader spends half his time working with another unit, and a technician spends half of his time working with different units in the lab. Their team leader claimed that he probably knows people in every national lab in the world. This finding runs along the same line as Smith et al. (2005) who concluded that a larger network size is positively associated with top management team's innovativeness in organizations.

Literature suggested that internal cohesion is beneficial to innovation (Perry-Smith, 2006). Both teams have a high level of trust which is described as fundamental to the team/organization sub-unit culture. In Team A, several interviewees used friendship to describe their relationships with each other. Their closeness is displayed in acts such as running each other's experiments and engaging in open and unflinchingly harsh discussion of each other's work without hard feelings. An interviewee described that as "harassing each other in a friendly way". An interviewee summarized that "you have to have rhinoceros's skin to work here or otherwise you'd go home crying every night. And there's a lot of teasing, and a lot of practical jokes and that sort of thing, but any disturbance of the atmosphere is not really very long lived. It's not a huggy touchy feely kinda place, but people can disagree". As a result, the ideas or proposals they deliver outside the team has already gone through a rigorous peer review process and tend to be better ideas than they could have been without rigorous internal discussions. Team A has an all-team meeting every Monday morning that has become a signature event that is viewed unanimously by all interviewees as contributing to innovation and trust. At Monday morning meetings, people share with each other what they are working on, challenge each others' ideas, provide input, and give out their creative ideas that can be used by others. In team B, there is a strong sense of common goal – making the accelerators work and "stay at the top of the game", which is echoed by every interviewee. This common goal exerts a strong bond among team members. Several interviewees described their team as a family. Their team is also described as a commune, with common goals and "a common drive to make things work". It is also characterized with a high level of trust. The leader said that "There is always a lot of finger-pointing like I think that is your fault, no I think that is your fault. But the bottom line is everyone pitches in no matter what it is to get things running".

Outside their teams, both leaders enjoy close ties with lab management. Team A leader is "well trusted and respected in the lab that he would be able to know first when the lab changes rules". Team B leader also enjoys a

close relationship with directors of the lab. He is "pretty chummy with the director these days and on a first name basis" and he makes sure that he knows exactly what is coming down from the director level. Their positions in the lab could contribute to obtaining resources and people for their innovative efforts.

Channels to help establish networks seem to be the similar for both groups. Conference and workshop attendance provides them exposure to other people or teams working on similar problems. Publications help to establish credibility and attract attention from people who need their expertise or who are interested in collaborating with them. Involvement in collaborative projects helps them establish reputation and gain social contacts too. Involving in committees is another channel of staying connected with professional contacts. Team B leader teaches courses in universities that helped him establish more contacts.

Our findings suggested that leaders influence the network of their team members, which matches what literature suggested. For example, Bono and Anderson (2005) found that leaders who exhibit transformational behaviors tend to help their employees establish more central positions in organizational networks. Our findings suggested that leaders' influence on members' networks takes two forms, direct and indirect. The direct form includes leaders' intentional help in connecting members with outside contacts. Indirectly, leaders assign "beefy" tasks to young members and as they acquire new skills and responsibilities, they open up their own channels of establishing professional contacts.

Organizational Learning Culture

Organizational learning is prevalent and continuous in both teams. In Team A, since research occurs in a diversity of academic fields, anyone entering the team needs to learn new things and expand their knowledge, skills, and capabilities continuously. Both the current leader and the founding leader of Team A stressed that a critical criterion for hiring new members is the willingness and ability to cross disciplinary boundaries, which can be translated into the ability to learn. Continuous learning is essential and has been consistently practiced, especially in the form of informal learning happening among team members, such as at Monday morning meetings. The same continuous learning happens in Team B, because the accelerators they work with are complex and need team work. Further, new problems come up from other units of the lab and they are given constant requests to accomplish technical breakthroughs. Both teams mentioned abundant formal learning opportunities, such as workshops, conferences, and presentations, as well as tuition reimbursement programs.

Besides continuous learning through informal and formal learning opportunities, our findings suggested that a dissatisfied attitude toward status quo is critical. An interviewee of Team A commented that the team "was populated by a lot of unreasonable people. And unreasonable people make things happen… some of the unreasonable people have left and we've hired perhaps more reasonable people…But I don't know if it's gotten a better scientific product, people are a lot more reasonable and I don't think they make as much progress because of it…you really want someone to push something to come what may - that's where the real breakthroughs are made, reasonable people don't make progress". A similar comment is made by Team B leader, "I am a real pest, a real pest because I take it personally…I am going to make sure it gets done and I'm a pest".

Another attitude that contributed to learning in one of the teams is the emphasis on equality. Team A does not have a clear division of labor, as it is a "PI-driven organization" in that they have "no major programs, and rely quite heavily on the individuals to develop leadership in their particular area, and they are ultimately responsible for the success of their projects and programs for the team". Team members run each other's experiments, take in the same information, anyone could talk to their team leader directly, and nobody is hired to support other people-they support each other. It was said in Team A that "nobody builds little kingdoms" and that "we all pull up our pants the same and we all do everything…if anyone treats someone else like they are better than they are, they can go out the back door, because they are not going to be in the group". This equal environment proves conducive to the informal and challenging conversations they constantly engage in with each other. The equality issue appears slightly in Team B where both engineering staff and technical staff are expected to innovate. There are turfs and issues associated with turfs in Team B. However, it seems that as Team B works more with outside units than within, internal turfs did not cause significant barriers in their innovativeness.

Another innovation-inducing value is the encouragement of divergent thinking and risk-taking. Team leader A believes that "innovation comes bottom up. It comes from individuals; it doesn't come from having a committee decide what the next breakthrough is gonna be". Risk-taking in Team A is translated into habits such as "people can throw up ideas and they will be rigorously challenged within the group, and sometimes quite brutally, and people realize that it's not a personal attack". Team B leader also stands firm on risk-taking. Risk-taking behavior in this team includes assigning tasks to young members and entrusting them with a lot of responsibilities from the beginning, so that they get substantial training in "the development of tools, how to develop software, what's available, what's not, how to do your work…Then you have to learn what has already been done; you don't want to repeat doing something, we have to learn what you can do and what your contribution can be".

In our study, both teams are heavily involved in learning new things, because of the complexity of work tasks. The major drive for learning is different, though. For team A where a vast diversity of disciplinary areas are involved, team members' motivation to learn is to be able to apply their technology in new areas and solve new problems. It's more self-directed. For team B where their function is primarily supporting other units, the new problems and quest from other units keep them on edge and prod them to find new solutions. Whether the different drive for learning would influence learning culture would be worth further attention. From the social network perspective, who the team interacts with and what the sources of new learning are would influence the learning culture. On the flip side, what kind of learning culture a team nurtures would inevitably influence where they spend the efforts to build networks to access more knowledge. In our survey questionnaire, learning organization culture will be measured and we can further examine whether different teams have different emphasis or focus on learning, how social capital relates to learning culture, and whether the difference would make innovative outcomes diverge.

Our findings also suggested that the leader serves as an influencer and gate-keeper of organizational learning. Leaders are the major influencer of culture, and they are major influencers of the organizational learning climate (Schein, 1990). They are also gate-keepers of learning. They can direct where people focus their learning, such as Team A leader steering research toward mission-critical areas of the lab. They can also gate keep learning, as in Team B where the leader has the authority to approve or disapprove formal learning requests from his members.

Conclusions and Discussions

The preliminary findings lead to tentative answers to the research questions. First, leadership characteristics that the two highly innovative teams share are hands-off, spreading the vision, recruiting based on intellectual flexibility, buffering between the team and the lab, promotion of the team to the outside world, and helping with network building of the team. Second, the team enjoys extensive external networks, strong cohesion inside the teams, and close ties with lab management. Social network was established mainly through participating in projects as well as drawing attention by publications and achievements. Leaders have a prominent role in the establishment of their team's social network in that they help team members connect with people and resources that may not be accessible otherwise. Third, organizational learning culture in the team encompasses continuous learning, a sense of dissatisfaction with status quo, equality among team members, and encouragement of risk-raking. Leaders have an influence on the social network of their members and on the learning culture.

The preliminary findings also raised several interesting questions for further exploration and HRD practice. First, leadership displays itself in ways both internally and externally, which encompasses more than prominent leadership models such as transformational leadership. Transformational leadership only addressed the leader characteristics within their work unit. The external aspects of leader characteristics may also hold true across situations. Do internal and external leadership characteristics need to coexist in order to foster innovation? HRD practitioners need to focus their leadership programs for R&D leaders not only on the transformational aspects but also on how leaders represent their members outside their teams. Second, existing research demonstrated that transformational leadership favorably influences creativity and innovation (Bass, 1999; Jung 2001). Our findings suggested that the three qualities of transformational leadership may not go hand in hand in innovative research teams in national labs. The intellectual stimulation may be demonstrated differently in R&D teams because of the complex nature of scientific innovation. Leaders may not assume the function of intellectual stimulation because of the limitation of their technical expertise. The extent of intellectual stimulation decreases as the diversity of task areas of the team increases and as such, leadership coaching and feedback for development purposes may need to be adjusted. For HRD practitioners, R&D leaders need to be developed to focus more on the social side of things rather than the technical side. Third, another intuition we have is that there seems to be a balance between individualized considerations versus team recognition. For Team A where there is more scientific work than technical work, there seems to be more individual considerations than group orientation. Supposed in a more technically oriented team, such individual consideration may not appear to be true because of the need for people to work closely together and be recognized for their group accomplishment. This means that the nature of the tasks a team engages in, especially the intensity of focus on scientific versus technological work, may moderate leadership styles. Applied to HRD practice, this may have important implications for performance management system focus. Fourth, are all the characters we identified by far essential to innovative teams and can they serve to differentiate team leaders from innovative and average teams? Further, the preliminary findings captured qualitative characteristics of social network and learning culture. How much do the characteristics exist in highly innovative and average teams quantitatively? Would they be able to set innovative teams apart from average teams? Future steps of our research will focus on answering these questions.

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