Integrating into the Canadian Engineering Workforce: A Team Based Perspective for "Rookie" Engineers

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After toiling for four or more arduous years as undergraduate engineering students in Canadian universities, many newly minted "engineers" find it difficult to seamlessly and effectively integrate into the Canadian engineering workforce. Unfortunately, the reasons for this sometimes become painfully obvious only years later after rookie engineers have individually learned from the 'school of hard knocks'. The purpose of this article is to provide rookie engineers with both an understanding of the dynamic project team environment in Canadian organizations as well as a blueprint for setting in motion a plan for a successful, rewarding and fulfilling engineering career. Although the target audience for this article is mainly newly graduated engineering students, seasoned engineers in both technical staff and engineering management positions will also benefit from this reading by developing a deeper understanding of engineering project team based processes.

Après au moins quatre pénibles années d'études dans les universités canadiennes, nombreux sont les ingénieurs débutants qui ont du mal à intégrer sans heurt le marché du travail canadien. Malheureusement, ce n'est souvent qu'après des années d'apprentissage à la dure école de la vie qu'ils finissent par comprendre pourquoi ils faisaient fausse route et par avoir des regrets. Cet article vise donc à faire connaître aux ingénieurs débutants, d'une part, le concept de l'équipe de projet mis en application dans les organismes canadiens et, d'autre part, à leur expliquer comment planifier une carrière à la fois réussie, valorisante et enrichissante. Bien que cet article s'adresse plus précisément aux nouveaux diplômés, les ingénieurs aguerris qui assument des responsabilités de gestion ou qui exercent des fonctions à caractère technique pourront, à sa lecture, avoir une meilleure idée de ce qu'est le concept d'équipe de projet.

1. Introduction

Armed with your new diploma in hand you have landed your first full-time engineering position with a Canadian firm. After having invested what now seems to be an eternity in your formal engineering education, you feel you are ready to test your metal. You quickly realize however that the dynamics of the organization you are with are far more different then anything you have been accustomed to in the past. Although you view yourself as flexible, experiential and someone who is not resistant to change, you are at a loss to understand the rules of the new game. Buzzwords such as "networked organization", "knowledge management", "smartsizing", and "virtual teams" are common, yet you are unsure of how they relate to your potential future success. For that matter, you are not even sure if this is something that you can ask your direct supervisor or manager.

The scenario above may seem somewhat exaggerated but in reality there is a degree of truth to it. Canadian business, government and research organizations employing engineering professionals are facing increasingly dynamic environments as they approach the new millennium. New technologies are being developed at an impressive rate, competition is fierce due to globalization, and customers are increasingly demanding higher quality, higher value, lower cost products that are developed in less time (e.g., [3]). To adapt to external changes, Canadian organizations are developing new organizational structures and processes together with investigating novel applications of leveraging Information Technology capabilities. What is missing in many organizations however is a human resources policy that includes a specific component focusing on the effective and seamless integration of new engineering graduates. One significant bottom line opportunity cost of not formally including such a component is lower retention rates among new engineering hires.

The purpose of this article is to investigate the factors that contribute to the effective and seamless integration of rookie engineers into the Canadian engineering workforce. Emphasis is placed both on analyzing this problem from the perspective of rookie engineers in Canadian professional services firms and on providing rookie engineers with prescriptions to more proactively manage their engineering careers. The descriptive model presented in this article emphasizes the antecedents relevant for team effectiveness. Rookie engineers who are able to internalize and action this model will likely be better positioned to effectively and seamlessly integrate into their respective organizations. Additionally, the model affords seasoned engineers with an opportunity to develop a deeper understanding of engineering project team based processes. Finally, the normative statements, although directed to rookie engineers, can also be generalized to seasoned engineers to assist them with career development.

2. Background and Project Team Descriptive Model

2.1 Background

The famous Chinese philosopher Confucius once said, "the essence of knowledge is, having it, to apply it." You may rightfully ask what does this have to do with Engineering? This is a fair question and the answer in reality is quite a lot! Engineering is clearly different from Basic Science whereby the latter emphasizes the understanding and explanation of natural phenomena. Engineering on the other hand is a problem solving intensive profession in which specialized knowledge combined with analysis and synthesis of a problem situation result in a recommended solution (usually with tangible benefits). Although the modus operandi of Engineering has not changed much in the past half century, organizations are now increasingly reliant on an organizational structure known commonly as teams to identify, define and implement solutions to various 'problems'. The term problem is used generically in this article and refers to tasks ranging from developing sophisticated encryption algorithms to designing and manufacturing hardware platform products.

Survival is a basic objective of all organizations and is predicated on the attainment of specific organizational goals. The notion of team based work, where people work together and rely on each other, is increasingly prevalent in organizations as the vehicle for achieving organizational goals. Intuitively the benefits of team based designs should be obvious. Not surprisingly, field research has even demonstrated that many organizations have achieved impressive results which can at least partially be attributable to team based work [1]. This section develops a descriptive model of intra project team based processes. The model, which can be used to better understand the drivers and situational variables affecting team effectiveness, is derived from a synthesis of existing project team literature, anecdotal evidence and numerous personal experiences with project teams. Before the model is presented, Figure 1 provides a backdrop for understanding the importance of team effectiveness.

Figure 1 is a conceptual task based model of team effectiveness on 'project success'. Problem solving task is the predictor (or independent)

variable and project outcomes/results is the criterion (or dependent) variable; team effectiveness is the moderating variable and direct relationships are depicted by a solid line whereas indirect relationships are depicted by a dashed line. The basic idea behind the model is that when two variables – predictor and moderator - interact, the impact of the predictor on the criterion is dependent on the level of the moderating variable. In Figure 1, team effectiveness is viewed as the primary moderating variable influencing the relationship between problem solving task and project outcomes/results. In the case of a positive moderating relationship (which is implied in this article), the model suggests that high levels of team effectiveness are critical for difficult and complex problem solving tasks in order to bring about desired (i.e., positive) project outcomes/results. The construct "team effectiveness" is used in this article to refer to teams whereby members are able to naturally and seamlessly cooperate and collaborate, while at the same time keeping in check issues of power, control and coercion. One example of team effectiveness that we can all appreciate is the case of a hospital emergency room transplant operating team performing a complex, lifesaving organ transplant operation on a frail young child.

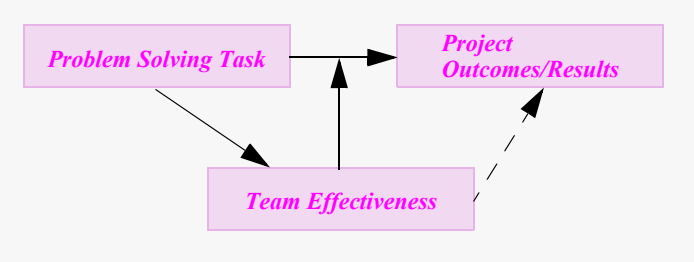

Figure 1: Importance of Team Effectiveness

So what does this have to do with me the reader? you ask. Excellent question which now brings us to the crux of this article - the drivers and situational variables affecting team effectiveness and the career instruments that can assist an individual with career management. The savvy individual who is able to internalize intra project team based processes and leverages team effectiveness will be kilometers ahead of the pact. This is especially important for the ambitious rookie engineer interested in a flying start from the starting blocks.

2.2 Project Team Descriptive Model

New engineering graduates are familiar with the notion of co-located (or proximate) team based work. What is foreign however is knowledge of a promising new emerging organizational structure known as the "virtual team" [4]. Virtual teams are designed to make firms more strategically flexible and effective in dynamic environments. They include groups of geographically and/or organizationally dispersed collaborators that are brought together for a specific purpose, and whose members' primary mode of interaction is through communications related Information Technology. Some important characteristics of virtual teams are: (i) team members rarely meet face-to-face; (ii) membership is often fluid and is contingent on changing task requirements; and (iii) they may be established either as temporary structures to accomplish a specific task or as permanent structures to address ongoing issues.

Figure 2 is a descriptive model of intra project team based drivers and situational variables affecting team effectiveness. The descriptive model is generic in that it encompasses both virtual teams and physically co-located teams. However, for the purpose of this article, the model is discussed in the context of virtual teams for reasons already cited. It is important to note that for the sake of clarity, only direct relationships are shown in the descriptive model.

If project team members in virtual teams rarely meet, how can they feel part of the team and moreover, how can they trust one another? Developing a deeper understanding of the role of trust and cohesiveness among project team members is as important as understanding the activities that facilitate trust and cohesiveness. Very simply the descriptive model suggests that project team member trust, cohesiveness, communication and idea sharing directly influence team effectiveness and are moderated by Information Technology. Proximate refers to the situation where project team members are near (or physically co- located) and is not the case for virtual teams. Virtual team members need to be able to trust and depend on one another in order to function, cooperate and accomplish team goals. In fact, trust is especially important in a virtual team environment where the negative impact of physical distance may easily lead to psychological distance. Moreover, the importance of trust cannot be overstated as it enables cooperative behavior which is necessary for virtual teams to be effective. When team members trust one another, they are more likely to share ideas, information and opinions. On the other hand, distrust leads to information hoarding and consequently does not contribute positively to team effectiveness.

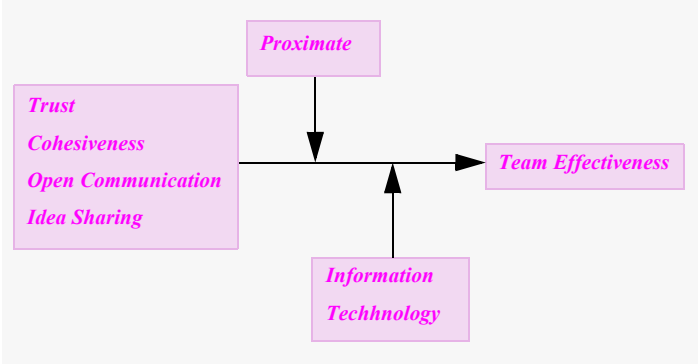

Figure 2: Project Team Descriptive Model

Cohesiveness (or connectedness) refers to the feeling of team members' attachment to the group and is an important group dynamic variable that contributes to effectiveness [2]. Cohesiveness in virtual teams is difficult to maximize since it is easy for physically isolated project team members to feel alienated from the team. With strong team member attachment to the group, cooperation and free flow information exchange are natural outcomes that support the realization of team goals.

Open communication and idea sharing are not merely consequences of team trust and cohesiveness. They are in fact necessary prerequisites that support the development of both project team member trust and cohesiveness. Consider the case of a distributed software development team that must develop a customer relationship management application to support multilingual requirements. As you can quite imagine, this difficult and complex task would be impossible if there were an absence of trust among team members as well as a sense of project team member isolation. Open communication and sharing of ideas among team members who might otherwise chose not to do so, fosters the development of trust and cohesiveness.

Communications related IT such as electronic mail, collaborative and document management applications, and desktop video conferencing systems play a crucial role in enabling open communication and idea sharing in a virtual team. Newly graduated engineers are unquestionably technology literate. What is unfamiliar to most if not all rookie engineers is the growing organizational reliance on advanced IT to provide the infrastructure for distributed personnel to become 'connected' for project team based work. Electronic mail is perhaps the most common form of digital communication. Electronic mail systems facilitate the transmission, receipt and storage of written correspondence, messages and text based information. Although characterized as an asynchronous, point-to- point mode of communication, electronic mail systems are a highly efficient, basic and necessary communications channel through which virtual team members communicate and interact.

Collaborative and document management software applications are increasingly used by distributed personnel to accomplish team based

tasks. This class of communications related IT enhances team member interaction, increases individual team member and total team productivity, and encourages team empowerment. With virtual teams becoming more common, the importance of collaborative and document management software applications will increase. This is because organizations will seek to exploit the benefits of facilitated teamwork, evident in the more traditional co-located work environments, and hope to realize them in the virtual team environment.

Desktop video conferencing systems promise to continue to improve the effectiveness of virtual teams. These systems allow multiple distributed team members to share audio, video, information and software applications simultaneously. While the base technology in these systems is not altogether new, desktop video conferencing overcomes much of the cost and inconvenience associated with older video conferencing systems that required specialized hardware and dedicated meeting rooms.

There is little doubt that desktop video conferencing systems hold the greatest promise to enhance virtual team member interaction because they reintroduce many of the nonverbal social cues present in face-to-face communications. Geographic distribution is a constraint imposed on virtual teams. To overcome this constraint, it is quite likely that desktop video conferencing systems will increasingly be dependent upon by organizations to enable virtual teams to operate in more complex environments.

3. Career Instruments

Organizations seek to attract and retain individuals who can add the greatest value to the firm. For the rookie engineer who is enthusiastically employed, what this means is that the organization you are with has already expended significant resources with the expectation that their hiring decision will reap substantial future business benefits to the firm. The fundamental question that this section seeks to answer is: what are the career instruments that can assist an individual both in the near term as well as with long term career development? Although the context of the discussion on career instruments is a professional services firm, the content is applicable to all in the engineering profession.

The four key career instruments relevant for near term and long term career development are:

- profession specialization
- mentoring
- market valued skills
- professional society memberships

Professional services firms have distinct intra-firm, competency based professions. The decision of selecting a profession specialization track is not simple and is even more difficult for rookie engineers. Selecting a profession in which to specialize establishes focus and clarity of vision of where one wants to be. The primary advantage of making this decision early in ones career is that it subsequently forms the centerpiece of ones career development program. Additionally, selecting a profession specialization early provides the opportunity to participate in discussions with like-minded individuals through both formal and informal networks.

Mentoring is a system of pairing an experienced person with a lesser experienced one, for the purpose of having the lesser experienced person grow and develop the required competencies. The essence of mentoring is for the mentor to advise, teach, guide, coach, encourage and motivate the mentee. Mentoring relationships focus on mutual understanding, mutual respect and trust and may even span the career lifespan of an individual. Establishing a mentoring relationship has significant obvious advantages to all involved. For the mentee, establishing a mentoring relationship soon after entering the engineering workforce assists in the transition from academe to industry and in potentially improving the rookie engineers performance and contribution in the all important first project.

Developing a skills plan to gain market valued skills (in specific technologies, tools, processes, roles) is important not only for developing required competencies but also for maintaining career resiliency. Demonstrating proficiency of specific skills enables one to develop credibility among his or her peers. Putting in place an annual skills development plan with checkpoints to ensure attainment of desired skills is important for the rookie engineer to chart progress in his or her profession.

Participation in professional societies such as IEEE, ACM and INFORMS is not only necessary for maintaining technically current in specific skills but also for keeping up to date on the latest industry trends. The often overlooked benefits of professional society memberships can most certainly go a long way in fostering career growth and enhancement. At a minimum, membership in professional societies as well as participation in conferences affords the rookie engineer with the opportunity to develop meaningful inter- organizational relationships with other professionals.

4. Conclusions

4.1 Implications for Engineering Professionals

The currency of success in industry is radically different from academe. The underlying premise of this article is that through a heightened, advanced awareness of the dynamic project team environment in industry, rookie engineers will be able to effectively and seamlessly integrate into the Canadian engineering workforce. Establishing the importance of team effectiveness, the prevalence of teaming and the drivers and situational variables affecting the effectiveness of virtual teams has positive implications for rookie and seasoned engineers alike. For one, internalization of intra project team based processes will enable rookie engineers to more effectively operate in a virtual team environment. Second, through a deeper understanding of the role of advanced IT as an enabler to foster and reinforce intra project team member trust and cohesion, rookie engineers will be able to enhance their contribution to total team effectiveness. Third, by combining a deeper understanding of the project team descriptive model with the career instruments as tools for career development, rookie engineers will be able to positively influence their performance in virtual teams.

The career instruments alone essentially form the blueprint for navigating the career development maze. Through participation in mentoring, acquisition and development of market valued skills and enrollment in professional societies, all under the auspices of a profession specialization, rookie and seasoned engineers will be able to increase their individual value to the firm. Every professional services organization attaches progressively higher levels of value to cognitive skills (know what), advanced skills (know how) and system understanding skills (know why). Formulating a career development plan that includes the career instruments will go a long way to increase an individuals long term value to his/her firm.

4.2 Implications for Researchers

There are a number of exciting research avenues that can be pursued in the area of engineering project based teams. The descriptive model presented in this article can be empirically tested to illuminate the strength of intra project team based drivers and situational variables affecting team effectiveness (both for virtual and co-located teams). Developing a deeper understanding of the complex interplay between individual team members in virtual teams can help to better define the appropriate set of communications related IT that should be deployed in order for virtual teams to achieve enhanced results. A complex study can also be undertaken to establish and quantify the productivity and competitive benefits, to Canadian firms, of the effective and seamless integration of skilled resources. This avenue of research could potentially be especially important since specific research into the effective and seamless integration of rookie engineers into the Canadian engineering workforce is not well developed. Finally, given the growing skills shortage of technical professionals and the high attrition rate among new hires, the need for additional research to combat the retention problem in technical organizations cannot be overstated.

5. Legend

ACM - Association of Computing Machinery.

INFORMS - Institute for Operations Research and Management Sciences.

6. References

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About the Author

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Karim's current research interests include knowledge mining, representation and management; processes for effective data mining; informatics; data quality; and technology and innovation management. His research work has appeared in IEEE Transactions in Engineering Management and R&D Management. Karim is a member of ACM, the Academy of Management, IEEE, and INFORMS.

GOLD - Younger Members' Column

GOLD Affinity Group

This is the first column in hopefully a new series of columns on issues concerning younger IEEE members - those who are loosely termed as "Graduates Of the Last Decade" or GOLD. The GOLD program is in its infancy. One of its primary aims is to help the younger engineer to transition from a university or college environment to the workplace. One of the main ways in which it accomplishes this is by the establishment of GOLD affinity groups within IEEE sections worldwide. GOLD groups have been granted a similar status to society technology chapters; however, rather than regroup members with an interest in technology, they regroup members who are making the transition from being students to being information workers. There is funding to initiate a GOLD group and I urge you to take advantage of it. In Canada, at printing time two GOLD groups were in the process of being formed.

Professional Development Conference

GOLD activities also strongly focus on professional development. This is why I would like to tell you a few words about the Professional Development Conference 1999: Entering the New Millennium, which will be held in Dallas over Labor Day weekend (Sept. 3-6, 1999). First, two of the six tracks of sessions will be dedicated to the professional needs and interests of GOLD engineers and technologists. Sessions will address basic career issues, with special emphasis on their impact on recent entrants into the profession. There were sessions on how to start a business, how to make an effective presentation, negotiation skills, addressing conflict resolution, management of technology, etc. Most sessions are arranged in a workshop format to allow for a maximum of interaction between the facilitator and the audience. Presenters come from companies and organizations like IBM, Texas Instruments, Lawrence Livermore National Laboratory, Lockheed Martin Mission Systems, Chase Global Mutual Fund Group, as well as several smaller consulting firms. Last year, I found this event to be very useful for indicating what I needed to focus on. The workshop format allows limited participation and exploration of many skills people usually take for granted. I particularly encourage GOLD members to take part in a four hour pre-conference GOLD Leaders Workshop, which will focus on integrating various communication skills. This is a somewhat shorter version of a very successful leadership workshop facilitated by Ray Findlay that was conducted in Hamilton in late May. Of course, GOLD sessions are open to all attendees, and GOLD attendees are free to attend sessions in the other tracks. There is up $500 US in funding if you are endorsed by your section or technical society. There is only one grant per section or technical society available. Contact me at e-mail: s.wesolkowski@ieee.org) if you are interested.

Who should attend? IEEE members and others interested in improving their non-technical, career-related skills will find the Professional Development Conference very useful. Many companies have sent employees to this event to upgrade their skills. Recent graduates will have an opportunity to develop essential professional skills not covered in their college courses. Engineers in the early stages of their careers will find a wealth of information to help them progress professionally in a planned and orderly fashion. Do not hesitate to contact me for more information:

Web links

GOLD Program: http://www.ieee.org/organizations/rab/gold/
Conference: http://www.ieeeusa.org/PRODEVCON/
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