

Process Transition International, Inc.

Senior Management Actions Critical for Successful Software Process Improvement

Cindi Wise

Process Transition International, Inc.

Abstract

The role of the senior manager often determines whether an organization succeeds or fails at a systematic effort to improve its software process. At the outset of such an effort, senior managers often ask the improvement team: "What do you need from me?" The paper provides an answer to this question based on the author's field experience, interviews with SEPG members, and a review of the literature.

1. BACKGROUND

Being successful at software process improvement (SPI) is critical to organizations wanting to improve the quality and delivery schedules of their software products. A popular approach to SPI, promoted by the SEI, includes two primary components. (The Software Engineering Institute (SEI) is a federally funded research and development center that has a mission to provide leadership in advancing the state of the practice of software engineering to improve the quality of systems that depend on software.) The first component is a software process maturity framework, referred to as the Capability Maturity Model (CMM), that provides the roadmap for software process improvement. The maturity framework, describes a 5-level evolutionary path from an ad hoc, chaotic software process to one that is defined and measured, providing the basis for continuous improvement. The second component includes software process assessment and evaluation methods that enable an organization to appraise and characterize their current practice and identify the issues most critical for improving their quality and productivity.

Based on the 1993 update of the Process Maturity Profile of the Software Community, published by the SEI, the overall community profile has remain unchanged. The source of the data for the profile are results of software process assessments reported to the SEI. The profile shows 75% of organizations are at the initial (1) level of maturity, 16% at the repeatable (2) level, and 8% at the defined (3) level. Whereas this data indicates some organizations have been successful at software process improvement, there are many that have not yet succeeded in achieving a higher level of software process maturity. There are even organizations that fail to take any action after conducting a software process assessment.

In "Managing the Software Process" Watts Humphrey, discusses the basic principles of software process change, including the importance of Senior management leadership in the effort. Senior management must believe software process improvement is both achievable and necessary and insist on performance (Humphrey, 1989). The importance of Senior management in software process improvement was also stressed in a technical report published in 1994 by the SEI on the

Benefits of CMM-Based Software Process Improvement (Herbsleb et al., 1994). In this report, case studies of software process improvement were done for five organizations. Four of the five organizations (Bull HN, Hughes Aircraft, Schlumberger, and Oklahoma City Air Logistics Center) mentioned as a lessons learned, how critical it is to have support of Senior and middle management to succeed.

Based on my experience in both managing groups responsible for improving the productivity and quality within software development, and in assisting numerous organizations with their SPI efforts, I have come to believe the most important factor for success is the role that Senior management assumes in these initiatives. In my own experiences, initially, the challenge was to get management to assign resources to focus on SPI. The SEI advocates a software engineering process group (SEPG) be established, with dedicated resources, to act as the focal point for process improvement. According to Fowler (Fowler & Rifkin, 1990), the size of this group is typically 1-3% of the development staff and is composed of line practitioners that facilitate the process improvement efforts. When I would advise Senior management on how to proceed with SPI, I informed them to assess their current practice, identify priority issues, and assign resources dedicated to SPI. I also stressed their role in sponsoring the SPI effort. It did seem like a major victory when management actually staffed an SEPG.

Although critical for success, it does not appear to be enough for Senior management to just assign dedicated resources, which I will refer to as an SEPG, to work on improvement. While the SEPG assumes the major role in facilitating the development of improved processes, the improvements cannot be institutionalized unless adopted by the software engineers and managers. The SEPG also needs individuals that are actively involved in project work to assist in the improvement effort. This involvement is crucial because these individuals deal day-to-day with the issues and are the best source for the solutions and also are needed to successfully transition improved processes into their projects. The problem arises in that software managers and engineers are typically operating within tightly constrained schedules for delivering a software product. Whereas the software engineers may be excited and willing to work on software process improvement, middle management has to find some way of freeing up individuals to work on and implement the improvements without recasting the schedules for delivering the product. When push comes to shove, the product work wins out and the process improvement often dies. Middle management is not intentionally sabotaging the improvement work but has not had Senior management clearly communicate the importance of software process improvement, express their understanding of the impact on product work, or provide adequate follow-up to ensure the improvements are progressing as planned.

During an assessment for an organization that I was coaching, the assessment team was asked by the Senior manager in a meeting after the Findings briefing, “What do you need from me?” This Senior manager had already funded the assessment, staffed an SEPG, and expressed publicly his commitment to the effort. Beyond what he had already done, the team was not prepared to provide specific guidance to the Senior manager. It was at this point that I decided, in conjunction with working on my master’s thesis, to conduct an exploratory study designed to answer the question: ***What Senior management actions are critical for being successful at software process improvement?***

2. STUDY APPROACH

The study began with a review of literature on management practices in software process improvement, process innovation, particularly technological, quality management, and technology transition. Most of the sources pertained to management's role in process innovation. Process innovation, in the literature, is defined as a change in the way a product is made or a service is provided (Tushman & Nadler, 1986). Based on this definition, software process improvement is a form of process innovation. Therefore, I use the two interchangeably within the paper. Where a particular reference was speaking solely about radical innovations, or totally new ways of producing products or services, I have used my judgment in determining whether the management practice being described also applied to process improvement.

From the literature, I categorized seven areas of action for Senior management to take to be successful at SPI. A structured interview guide was developed to ask questions to determine whether action was taken by Senior management in each of the seven areas. The structured interview was administered to individuals that were members of the SEPG in organizations undertaking SPI. SEPG members were asked for their perceptions of what action Senior Management was taking to either support or undermine their process improvement efforts.

As of this time, I have included eight organizations in the study with one SEPG member from each organization being interviewed. I am performing more analysis and I discuss here the preliminary results.

Three of the organizations were classified as being successful, they had succeeded in being appraised at a higher level of maturity from where they initially started. Of these three organizations, 1 is an in-house organization, 1 is military, and the third is 50/50 defense contractor/commercial organization. The size of the software engineering organizations involved in the SPI effort ranged from 250 - 450 engineers.

Two of the organizations have been classified as unsuccessful because they either abandoned the SPI program or they had not completed an action plan within a year and a half of conducting an assessment. Both of these are commercial organizations with sizes ranging from 150 - 750.

Three of the organizations do not meet the criteria for either the successful or unsuccessful category. Two of these latter organizations are commercial and the third is a defense contractor with sizes of the software engineering organization ranging from 50 - 200 software engineers.

The study is limited due to the small sample size. It also only represents the perceptions from one point of view within an organization, specifically those of an SEPG member. For further research, it may be beneficial to have multiple interview sources from an organization, including Senior management. The design of the study did not take into account various business factors such as financial condition of the organization and turnover in the position of Senior management. These factors may have a significant impact on the actions taken by Senior management and should be addressed in further research.

3. DESCRIPTION OF SENIOR MANAGEMENT ACTIONS

Based on a review of the literature, I have arrived at seven actions that Senior management should be taking to be successful at software process improvement (SPI). These actions are summarized in Figure 1.

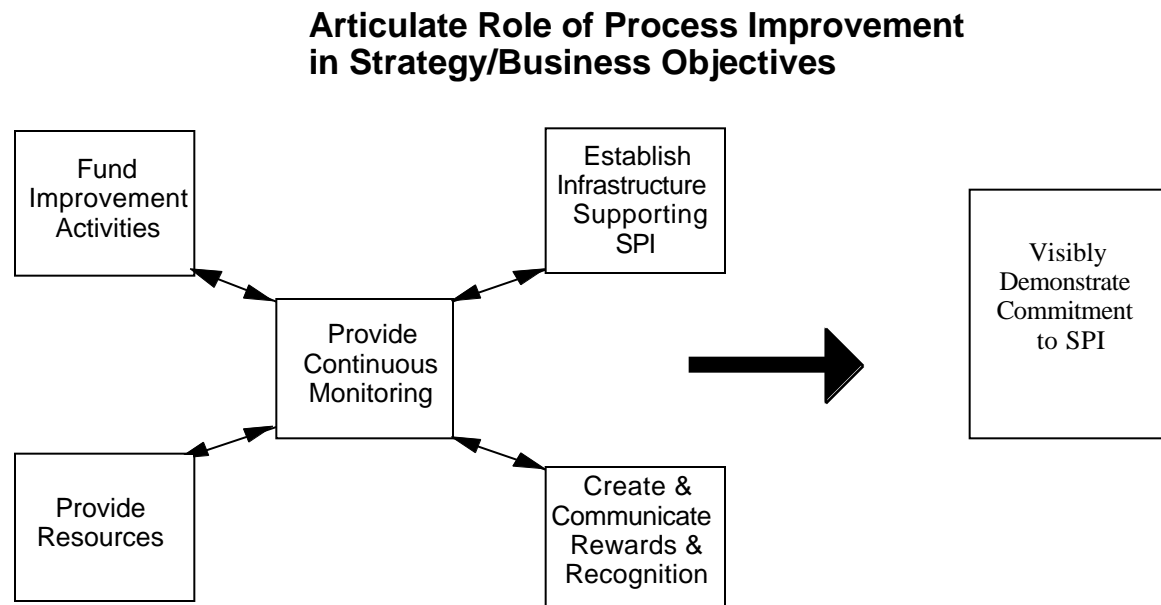


Figure 1 Senior Management Actions Contributing to Successful Process Improvement

The first action is for top management to send a clear signal of why software process improvement is important by *articulating the role of SPI in terms of the organization's strategy and business plans/objectives*. According to Dutton (1992) by conveying the importance of SPI in such a high visibility arena, it adds significant weight to informal claims that SPI is important.

By being explicit about the organization's strategy and how SPI will contribute to achieving it, Senior Management is communicating the importance of both short-term management and the long-term investment of process improvement (Tushman & Nadler, 1986). In a study of 12 IS directors planning for new systems development environments, it was found that providing this long-term business-based context enabled the executives to understand the real benefits of the future environment (Rockart & Hofman, 1992). The same appears to be true for the plans for SPI. Without understanding the benefits to be achieved by the program, Senior Management can only see the cost side of this often expensive initiative. It seems certain that focusing on costs without the corresponding benefits will make it difficult to provide sustained support for the improvement program.

Another reason why it is important to align SPI with the organization strategy is to eliminate any ambiguity in the minds of individuals within the organization regarding the role of SPI. If the role is uncertain or ambiguous, individuals will attempt to preserve the status quo, rather than contribute to the improvement program (Howell & Higgins, 1990).

Lastly, the goal of SPI is not just to identify and develop process improvements, but to have the improved processes be successfully transitioned into ongoing organizational practice. Improvements that are aligned with strategic objectives, will have an easier time of being adopted. The projects that will be expected to adopt the practices will to some degree have already been prepared to accept the improvements (Kanter, 1988).

The second action is for Senior management to *provide and sustain funding for SPI*. Senior management is faced with the difficult task of providing for the work to be done to meet short-term commitments while still providing the foundation for innovation and change, thus preparing for tomorrow (Rockart & Hofman, 1992). This short-term versus long-run trade-off has to be made as far as where to budget and allocate funds. (Galbraith, 1982)

The next decision is whether to provide for special improvement funds or to allocate the funds within the various line budgets. The problem with allocating funds within the line budgets is that the improvement activities will have to compete directly with the software project activities of developing and delivering a product. In a study comparing innovation successes and failures, high innovating companies set aside separate funds in support of innovation, not placing them within already constrained line budgets (Delbecq & Mills, 1985). The study also indicated that the separate funds were for real innovation, while funds for changes within tradition had to be funded within the line budgets. I surmise that the magnitude of the change required to move from the initial level of software process maturity to the repeatable level, or from the repeatable level to the defined level, constitutes major organizational changes that are not consistent with tradition. My conclusion is that having funds set aside specifically for SPI would contribute to the program's success.

The third action is closely tied to funding and involves *providing and sustaining resources for SPI*. Galbraith (1982) identifies the role of senior management as being the "orchestrator" in designing the innovating organization. This means that senior management must be involved in making decisions regarding who will fill key roles, where the staffing should come from for the effort and where they should be located, and how differentiated from the rest of the organization the effort should be.

While at the SEI, it was common after a software process assessment with an organization, to recommend that a software engineering process group (SEPG) be established. This recommendation was made to address the staffing issue for SPI, requiring that dedicated resources be established to act as the focal point for process improvement. This is similar to the organizational unit that Galbraith refers to as "reservations," which provide for dedicated resources to be assigned to the innovation effort (Galbraith, 1982) Senior management should be involved in making decisions regarding the staffing of an SEPG. In addition to how it should be funded noted previously, they should look at where this group should be located. In some organizations it reports through line management, while in others it is considered a staff function, such as tool support, and in others it may be part of the quality department. In the study by Delbecq (Delbecq & Mills, 1985) of high and low innovating companies, innovation failures were characterized by resources being obtained through the line managers and having to work on SPI over and above their current activities.

A major consideration for Senior management relating to resources is how differentiated to make the SPI effort. This relates to how separated the SPI effort is from the day-to-day

functions of the software project. Whereas it may be easier to develop new processes in isolation from the projects, it will likely be difficult to transfer the new processes into use within the projects (Galbraith, 1982). In my experience, I have seen organizations establish an SEPG and expect them to develop the procedures required to satisfy a higher level of process maturity and then transition these procedures back to the line organization. In these situations, the SEPG has encountered resistance, particularly from middle management, who are already operating within tight schedule constraints, and see the process changes as hampering their ability to meet their preexisting deadlines. A consideration is to augment the SEPG by using part-time resources from the projects in developing the process improvements (Fowler & Rifkin, 1990). Members of the projects can be assigned to work with the SEPG in developing a new process and then when it is developed, help transfer the process back to their projects. The resources could physically be reassigned to the SEPG temporarily, or work part-time on the process improvement effort while still carrying out their project responsibilities.

The fourth action relates to Senior management ***creating and communicating rewards and recognition to encourage contribution to the SPI efforts***. Individuals within the organization need to see the benefits of contributing to process improvement and also that there will be consequences of not participating in the effort (Tushman & Nadler, 1986).

Individuals will consider what is referred to by Rogers (1983) as the defacto reward structure. If management consistently only measures and rewards task performance on projects, the message sent to individuals in the organization is that it is not beneficial to contribute to SPI, and then SPI will suffer. In a case study of implementing structured software (SSA) methodologies (Leonard-Barton, 1987), the programmers that did not feel they were “rewarded for the quality (versus quantity) of the product” were unlikely to use the methodology even though it was encouraged by management. Senior Management must decide how to reward and recognize SPI contributions. This may take the form of tying salary increases and promotions to SPI accomplishments. (Tushman & Nadler, 1986)

Many of the process improvements that must be made to reach higher levels of process maturity cross functional boundaries. For example, establishing an effective commitment process, which is a required to satisfy level 2 requires coordination of all functions throughout the software development process. Addressing this problem will require individuals from the various functions to coordinate and collaborate with the other functions to develop a solution. Therefore, rewards should be provided not just for contributions within functional boundaries, but also to legitimize contribution to these group efforts (Bush & Frohman, 1991; Johnson & Frohman, 1989).

The reward system also needs to provide incentive for middle managers to contribute and support SPI. Middle management is in essence the gatekeeper for the process improvements and can either encourage and sponsor the SPI effort or impede its success (Leonard-Barton, 1987). Senior management may decide to offer special incentives such as bonuses to encourage middle management to contribute to SPI.

Formal rewards as mentioned above can be combined with less formal recognition and rewards. (Tushman & Nadler, 1986) These informal rewards can take many forms such as special awards, recognition in company newsletters, being able to attend conferences, and being

allowed to contribute to other process improvement efforts. The purpose is to communicate that process improvement is important to the organization and to stimulate involvement.

The fifth action requires that Senior management ensures organizational processes that support being successful at SPI are established. This involves ***establishing an infrastructure that motivates and prepares individuals to participate in the SPI effort***, encouraging collaboration and problem-solving throughout the organization. Tushman (1986) identifies the following elements of formal organizational arrangements that provide structures, systems, and procedures which direct and motivate behavior.

Formal linking mechanisms must be developed to connect disparate functions and enable improvements to be developed for the organization, not just within functional boundaries. (Tushman & Nadler, 1986) Examples of linking mechanism that can be established are task forces and cross-functional teams.

By designing jobs and career paths that enable individuals to have experience in many functions allows them to have a more balanced view of the organization, and not just the narrow focus of a particular functional area. In a study conducted of 25 champions of successful information-technology innovations (Howell & Higgins, 1990), the champions indicated that by having management provide job autonomy and diverse career experiences, they were more successful at innovations. The diverse job experience also enabled them to develop networks and collaborate with others.

Establishing joint-problem solving teams, such as the cross-functional team noted above, can act to maximize ownership and the coupling between the various functions (Tushman & Nadler, 1986). These teams can establish their priorities and plans for developing a new process, and then evaluate their own successes and failures. Some organizations have also expanded their appraisal systems to include peer assessments from within and outside the functional group (Bush & Frohman, 1991). The team approach can also facilitate the transfer of the new processes back into their own organization and help to reduce the “not-invented-here” syndrome.

Lastly, individuals need to receive training in areas such as problem-solving, team building, and conflict resolution to prepare them to work as a team in contributing to SPI. This training should be geared to all levels within the organization.

Providing continuous monitoring of the SPI activities is the sixth action of Senior management. This action emphasizes the sustained role of senior management in SPI. Senior management must monitor the SPI effort providing guidance and direction and making adjustments where necessary in the funding, resources, rewards and recognition and the infrastructure. The monitoring includes meeting regularly and both providing and receiving feedback on the improvements. According to Friedlander and Scott (1981), when a change team had a great deal of two-way communication with top management on their projects, the changes were more likely to be implemented. There are often also conflicting demands on the resources for SPI. Senior management’s role is to protect both the improvements and the team. In a study of seven innovations (Schroeder et al., 1986), higher management had to “run interference” for the innovations, in addition to providing the resources.

Taking action in the areas discussed above contributes to satisfying the last action of ***visibly demonstrating commitment to SPI***. Senior management must send a clear message through their behavior, actions, and statements that process improvement is important. In the study of

25 champions of technological innovation (Howell & Higgins, 1990), the champions noted that a critical factor for successful innovation is that top managers backed up their words with action. This requires senior management to express enthusiasm for SPI, communicate strong expectations, and to believe in, and promote its benefits.

4. PRELIMINARY INTERVIEW RESULTS

The preliminary results of the interviews are summarized by action area.

4.1 ARTICULATE ROLE OF SPI IN STRATEGY/BUSINESS OBJECTIVES

Two of the three successful organizations linked process improvement to the organization's strategy and/or business objectives. This was not done in either of the unsuccessful organizations. I find the most interesting result to be that SEPG members in 2 of the 3 not classified organizations, when asked what action they would like to see Senior Management take, indicated the action of visibly tying the role of SPI to the organization's business plans and objectives in order to elevate the importance of SPI. The third not classified organization was in the process of trying to accomplish this.

4.2 PROVIDE FUNDING

All three of the successful organizations funded SPI through central improvement funds separate from the line budgets. The funding provided was based on SPI plans and was either sustained at the same level or increased. In one of the unsuccessful organizations, SPI was funded through line budgets and charges to SPI were not tracked, and eventually, there were no resources assigned to work on SPI. It was noted by one of the successful organizations, that having the funding come out of a central source was a key to their success. It was then possible to track what was being spent on SPI and prepare cost and schedule variances.

4.3 PROVIDE RESOURCES

All of the organizations appeared to recognize the importance of using cross-functional teams to contribute to SPI. In the successful organizations, the resources assigned to SPI increased over time, while in the unsuccessful organizations, the resources in one case stayed the same and in the other case decreased. In the successful organizations, both full-time and part-time resources were used for SPI, with the part-time resources coming from the projects. The full-time and part-time resources from the projects were funded through the central improvement fund. Senior management participated in providing guidance pertaining to resources, specifically where there should be representation for particular working groups, and also who would be best to participate. In these successful organizations, the SEPG found it was a constant challenge to share resources with the projects and get the people they needed to work on SPI. If it was a challenge in organizations with strong Senior management sponsorship, It seems it would be an extremely difficult task with little sponsorship.

4.4 CREATE AND COMMUNICATE REWARDS AND RECOGNITION

In two of the successful organizations, contribution to process improvement was included as part of the annual performance review system. Recognition was provided by all of the successful organizations in a number of ways such as hosting special events for achievements, quality awards, opportunity to attend conferences, and recognition in newsletters. When asked specifically about what Senior management did to encourage middle management to participate in SPI, it was indicated that Senior management communicated the importance of SPI to their direct reports and actively recruited them to be involved in the effort in a leadership role. Middle management then recruited individuals from their staffs to contribute to SPI. The cascading sponsorship sent the message to the organization that it was beneficial to participate in SPI. In terms of the “defacto reward structure” discussed previously, individuals in the organizations saw that good people were being assigned to work on SPI, and that these people in turn were the ones getting promoted. This strongly contributed to the desire to be involved in SPI. In the unsuccessful organizations, there were no rewards or recognition provided for SPI efforts.

4.5 ESTABLISH INFRASTRUCTURE SUPPORTING SPI

All of the successful organizations used a working group approach with diverse representation from part-time resources across the organization. The only organization to have a formal program for job-rotation was one of the not classified organizations. It was indicated that the program helped to improve the understanding of and communication with other functions, and also served as a form of training for the staff. As far as education, the comment was made in the interview of one of the successful organizations that having management and those involved in SPI receive training in “managing change” would have helped them be better prepared to deal with broader transition issues, particularly the human side of technology transition.

4.6 PROVIDE CONTINUOUS MONITORING

Each of the three successful organizations had Senior Management actively participating in a Steering Committee providing guidance and direction for the SPI program. In each case, the Senior manager responsible for the software organization chaired the steering committee which also included representation from their staff. This committee met monthly and sometimes weekly. Where the organization had a General Manager, they were involved in reviews of SPI progress in one case quarterly, and the other semi-annually. There was no monitoring of the SPI efforts in the unsuccessful organizations.

It was stressed by each of the SEPG members in the successful organizations that the project goals remained the top priority. Senior management was involved in providing the balance between the project and SPI, helping to determine how to meet the project’s short-term needs while ensuring progress towards SPI.

5. INTERIM CONCLUSIONS

Based on the interviews held-to-date, the results suggest the two areas that distinguish organizations successful and unsuccessful at SPI are those of continuous monitoring and rewards and recognition. In the successful organizations, Senior management provides continuous

monitoring of SPI and is actively involved in the SPI effort by meeting regularly, providing and receiving feedback on the improvements, and balancing the short-term project needs with the need to contribute to SPI. As far as rewards and recognition, in the successful organizations, Senior management sends a clear signal to individuals within the organization that it is beneficial to contribute to process improvement. This is accomplished through formal and informal rewards and recognition such as tying process improvement accomplishments to the annual goal setting and performance appraisal systems and by providing various forms of recognition such as hosting special events, giving quality awards, and recognizing efforts in newsletters. The most significant factor was the relationship individuals saw between SPI and the defacto reward structure. Having cascading sponsorship through all management levels, individuals knew that by contributing to SPI, they were working on something that was important to their boss and to their boss's boss. They also saw that the same "good" people that were being recruited to work on SPI were also the ones that were getting promoted. Two areas that did not necessarily distinguish successful and unsuccessful organizations, but appeared to contribute to success included articulating the role of SPI in terms of the organization's strategy and business objectives and also funding the process improvement effort through central improvement funds. By taking action in the areas noted above, there was a third area of distinction between the successful and unsuccessful organizations. In the organizations that were successful at software process improvement, Senior management visibly demonstrated their commitment to SPI by backing up their words with action.

REFERENCES

- Bush, Jr., J.B. & Frohman, A.L. 1991, "Communication in a Network Organization," *Organizational Dynamics*, vol 20, pp. 23-26.
- Delbecq, A.L. & Mills, P.K. 1985, "Managerial Practices That Enhance Innovation," *Organizational Dynamics*, vol 14, pp 24-34.
- Dutton, J.E. 1992, "The Making of Organizational Opportunities," *Research in Organizational Behavior*, vol 15, pp 195-226.
- Fowler, P. & Rifkin, S. 1990, *Software Engineering Process Group Guide*, Technical Report CMU/SEI-90-TR-24, Software Engineering Institute.
- Friedlander, F. & Scott, B. 1981, "The use of task groups and task forces in organizational change." In C. Cooper & R. Payne (Eds.), *Groups at work* (pp. 191-217), New York: John Wiley & Sons.
- Galbraith, J.R. 1982, "Designing the Innovating Organization," *Organizational Dynamics*, Winter, pp. 5-25.
- Herbsleb, J., Carleton, A., Rozum, J., Siegel, J., Zubrow, D. 1994, *Benefits of CMM-Based Software Process Improvement: Initial Results*, CMU/SEI-94-TR-013, Software Engineering Institute.
- Howell, J.M. & Higgins, C.A. 1990, "Champions of Change: Identifying, Understanding, and Supporting Champions of Technological Innovations," *Organizational Dynamics*, vol 19, pp. 40-55.

- Humphrey, W. S 1989, *Managing the Software Process*, Addison-Wesley Publishing Company, New York.
- Johnson, L.W. & Frohman, A.L. 1989, "Identifying and Closing the Gap in the Middle of Organizations," *The Academy of Management Executive*, vol. III, No 2, pp. 107-114
- Kanter, R.M. 1988, "When a Thousand Flowers Bloom: Structural, Collective, and Social Conditions for Innovation in Organization," *Research in Organizational Behavior*, vol 10, pp. 169-211.
- Leonard-Barton, D. 1987, "Implementing Structured Software Methodologies: A Case of Innovation in Process Technology," *Interfaces*, Vol 17, pp. 6-17.
- Rogers, Everett M. 1983, *Diffusion of Innovation*, The Free Press, New York.
- Rockart, J.F. & Hofman, J.D. 1992, "Systems Delivery: Evolving New Strategies," *Sloan Management Review*, Summer, pp. 21-31.
- Schroeder, R., Van de Ven, A., Scudder, G., & Polley, D. 1986, Observations leading to a process model of innovation: Discussion Paper No. 48, Strategic Management Research Center, University of Minnesota.
- Tushman, M. & Nadler, D. 1986, "Organizing for Innovation," *California Management Review*, Vol XXVIII, No 3, pp. 74-92.