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Attitudes toward a Software Process Innovation
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A Case of Re-Invention of
a Requirements Inspection Process

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ABSTRACT

Requirements specification defects are the cause of failure for many software development projects. A large financial services company recently implemented a software requirements inspection process with the assistance of the authors. Subsequently, the process was re-invented by users, and the organization changed the official process to encourage institutionalization. Company representatives questioned the degree of institutionalization, and the authors investigated this issue. A questionnaire was developed by the authors in conjunction with the company. The research is in progress, and to date one round of questionnaires has been administered to eighteen subjects. Results are not consistent with the proposition based on diffusion theory that re-invention has increased favorable perception of the innovation and thus its institutionalization. The proposition that subjects would perceive inspections as beneficial in producing software more quickly and/or of higher quality is also not supported. Possible reasons for these findings and their implications for future research are discussed.

Keywords

Diffusion; Software Process Innovation; Deployment; Re-invention; Sustainability; Institutionalization.

INTRODUCTION

Enormous resources are devoted to software development, with much of the effort being wasted. According to the CHAOS Report (Standish, 1994),

> In the United States, we spend more than $250 billion each year on IT application development…The Standish Group research shows a staggering 31.1% of projects will be canceled before they ever get completed. Further results indicate 52.7% of projects will cost 189% of their original estimates…The lost opportunity costs are not measurable, but could easily be in the trillions of dollars…The Standish Group estimates that in 1995 American companies and government agencies will spend $81 billion for canceled software projects. These same organizations will pay an additional $59 billion for software projects that will be completed, but will exceed their original time estimates.

These results are consistent with earlier and later studies. E.g., a recent study (Hayes, 2004) found that "Only 28% of IT projects succeed these days, down from 34% a year or two ago. Outright failures – IT projects canceled before completion – are up to 18% from 15%. The remaining 51% of IT projects are 'challenged' – seriously late, over budget and lacking expected features."

According to CIO Magazine, "as many as 71 percent of software projects that fail do so because of poor requirements management, making it the single biggest reason for project failure – bigger than bad technology, missed deadlines or change management fiascoes." (Lindquist, 2005) A Carnegie Mellon Software Engineering Institute study states that "authoritative studies have shown that requirements engineering defects cost 10 to 200 times as much to correct once fielded than if they

were detected during requirements development… The total percentage of project budget due to requirements defects is 25 to 40 percent." (Mead, n.d.)

While some progress is being made using methodologies that focus on defect prevention rather than defect removal (e.g., "Clean Room" [Carnegie Mellon, n.d.]), development of quality software will require effective methods for software defect identification and removal for the foreseeable future.

Inspection and other Formal Technical Review (FTR) techniques are preferable to testing for software defect identification and removal since they can be implemented early in the development lifecycle, do not require executable code, and are an effective way to improve the development process. For an organization that has not previously inspected requirements, adding such a process represents a significant software process innovation (SPI).

Diffusion of innovation theory is utilized in this study because it provides insights into the adoption, implementation, and institutionalization processes for innovations, including SPIs. (E.g., Fichman and Kemerer, 1999) This paper reports preliminary results of the examination of one aspect of the deployment and institutionalization of an SPI in a large financial services organization.

THEORY

In the diffusion literature, institutionalization is a measure of "the degree to which an innovation continues to be used after initial efforts to secure adoption is completed." (Rogers, 2003) Institutionalization is positively related to "the degree to which an innovation is re-invented (defined … as the degree to which an innovation is modified by adopters as it diffuses) … When an organization's members change an innovation as they adopt it, they begin to regard it as their own, and are more likely to continue it over time, even when the initial special resources are withdrawn or diminish." (Rogers, 2003)

Perspectives on re-invention vary. Adopters generally view re-invention positively and may even overemphasize the amount of re-invention implemented. (Rice and Rogers, 1980). Rogers (2003) notes that

> At least some implementation problems are likely to be created by individuals or organizations, so adopters of an innovation almost always attempt to make changes in the original innovation to fit their situation better.

> Re-invention can be beneficial to adopters of an innovation. Flexibility in the process of adopting an innovation may reduce mistakes and encourage customization of the innovation to fit it more appropriately to local and/or changing conditions. As a result of re-invention, an innovation may be more appropriate in matching an adopter's preexisting problems and more responsive to new problems that arise during the innovation-decision process.

To the degree that re-invention encourages institutionalization, it is generally considered to be good.

However, research and development agencies generally view re-invention negatively since it may lead to reduced effectiveness. "Some designers of an innovation structure a new idea so that it is particularly difficult to re-invent … Diffusion agencies may also be unfavorable toward re-invention, feeling that they know best as to the form of the innovation that users should adopt." (Rogers, 2003)

In the diffusion of innovation literature, both *perceived usefulness* and *perceived ease of use* of an innovation are found to affect adoption. Probably the most prominent explication of these factors is Davis's Technology Acceptance Model (1989), which as an extension of the Theory of Reasoned Action (TRA) is actually a result of a separate line of study. (Wikipedia, 2006)

This research seeks to measure the degree to which an SPI introduced at the financial organization studied has been institutionalized, the effect of the re-invention of the SPI on institutionalization, and the benefits perceived by users of the SPI.

Propositions

This research reports on the first of a planned series of "snapshots" of the diffusion and institutionalization of a software process innovation. Given the preliminary nature of the research and the relatively small numbers of subjects involved, no formal hypotheses were generated. However, as discussed below, *propositions* were developed.

The organization had long used a less structured review process, and company representatives indicated their belief that IT personnel understood the need for inspections and had a generally favorable view of them. Question #1 measures the attitude of IT personnel toward inspections in general.

1. *Perception of New Inspection Process* – The diffusion literature indicates that adopters who re-invent an innovation generally have a more favorable view of the innovation. Since the current organized review process *as implemented at xxx* is the result of adopter re-invention, it is expected that IT personnel have a more favorable attitude toward the xxx process than toward organized reviews in general. I.e., the mean value for Question #2 (which measures attitude toward the process as implemented at xxx) will indicate a more favorable attitude than the mean value for Question #1 (which indicates the attitude toward organized reviews in general).

2. *Attitude Toward the Need for a Trained, Outside Moderator* – Since the key difference between the original and re-invented processes is the elimination of a trained moderator from outside the team for most inspections, it is expected that the attitude toward the need for a trained, outside moderator (as measured by Question #3) will not be favorable.

3A. *Perception of Inspections as Being Beneficial in Producing Software More Quickly*
3B. *Perception of Inspections as Being Beneficial in Producing Software of Higher Quality*

The Technology Acceptance Model explains acceptance of technology in terms of *perceived usefulness* and *perceived ease of use*, with perceived usefulness being the more important of the two. Two of the major expected benefits of an SPI are (a) the production of software more quickly and (b) the production of software of higher quality. If the new organized review process is viewed favorably, it is expected that the process will be seen as beneficial in producing software more quickly and/or of higher quality (as measured by Questions #9 and #10).

METHOD

Background

In 2003, Bass (then a graduate student in Hungerford's SA&D class) asked Hungerford for advice in implementing a requirements inspection program at the major financial services company where he then worked. This led to some informal consulting during which Hungerford made suggestions and critiqued materials developed by Bass. The new requirements inspection program was instituted at the beginning of 2004. The process developed was fairly strict and implemented some of the more formal structures of the Fagan Inspection, such as independent moderators and formal meetings. Internally, the process was simply called the "Formal Review."

At the beginning of 2005, the review process changed. Less emphasis was placed on the formal elements (moderator, documentation, etc.), and process users were allowed to focus on quickly moving through the process vs. keeping the process elements pure. The intent was to address employee feedback that had stated that the more formal elements were not necessary for most reviews. By this time, Bass had changed employment, and Hungerford was no longer involved.

In mid-2005, the authors contacted the organization looking for a real-world research project. In the ensuing discussions, it was decided that an objective examination of the deployment and institutionalization of the requirements inspection process would be useful to the organization and had the potential to provide data for several studies. (An earlier, related study of the relative effectiveness of the two processes has been reported previously. [Bass and Hungerford, 2006])

Analysis

A questionnaire utilizing a five-point scale (1 = Strongly Agree; 3 = Neutral; 5 = Strongly Agree) was developed by the authors in conjunction with company representatives. To limit the time impact of the questionnaire, the researchers agreed to limit it to ten items, five of which measured attitudes toward specific requirements elements and were thought to be primarily of benefit to the company. The questionnaire was administered by Hungerford with company assistance simultaneously at two locations using videoconferencing equipment to a total of eighteen subjects. Means were calculated for each question for each location and overall. While attitudes at Location #2 were generally more positive, the differences do not appear to be significant.

RESULTS

Proposition 1 – Perception of New Inspection Process

The overall means for Questions #1 and #2 are 4.11 and 3.56 respectively. Both of these values are above the 3.00 neutral-point and would seem to support the company expectation that their IT personnel perceive inspection processes in general and the specific process at the company studied favorably. However, the values do not support Proposition #1 that the mean value for Question #2 would be higher than that for Question #1.

Proposition 2 – Attitude Toward the Need for a Trained, Outside Moderator

The overall mean for Question #3 is 2.83. This is below the 3.00 neutral-point and is consistent with Proposition #2.

Proposition 3A – Perception of Inspections as Being Beneficial in Producing Software More Quickly

The overall mean for Questions #9 is 2.61. This value seems to be significantly below the 3.00 neutral-point and does not appear to support the proposition that inspections are perceived as having positive effects on the speed of software development.

Proposition 3B – Perception of Inspections as Being Beneficial in Producing Software of Higher Quality

The overall mean for Question # 10 is 3.06. This value does not appear to be significantly above the 3.00 neutral-point and does not appear to support the proposition that inspections are perceived as having positive effects on the quality of software developed.

	Mean Response	Location #1	#2	Δ	Overall
Question					
1	Organized reviews are generally a good use of project resources.	4.00	4.22	0.22	4.11
2	Organized reviews as *implemented at xxx* are generally a good use of project resources.	3.50	3.56	0.06	3.53
3	Having a trained moderator from outside the team facilitate the meeting is an important element in making an organized review successful.	2.50	3.00	0.50	2.75
4	Most *requirements specification* documents should have an organized review.	4.25	4.44	0.19	4.33
5	Most *test plan* specifications should have an organized review.	3.88	4.00	0.13	3.93
6	Most *code deliverables* should have an organized review.	3.75	4.00	0.25	3.83
7	Most *deployment/roll-out plans* should have an organized review.	4.13	4.11	-0.01	4.12
8	During the development process, virtually all components (e.g., billing, imaging) of a software system should have an organized review.	3.50	3.56	0.06	3.53
9	In my opinion, the new organized review processes (formal and informal) introduced at xxx since 2004 have helped us to release software more quickly.	2.25	3.00	0.75	2.61
10	In my opinion, the new organized review processes (formal and informal) introduced at xxx since 2004 have helped us to release software that is of higher quality.	3.13	3.13	0.00	3.13
	Overall Mean	3.49	3.70	0.21	3.58
	1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.				

Table 1. Analysis of Questionnaire Responses

DISCUSSION AND CONCLUSION

The results are, with one exception, not consistent with the propositions developed by the authors based on organization representative input and diffusion of innovation theory.

The data are consistent with the proposition that the attitude toward the need for a trained, outside moderator would not be favorable.

A company representative provided one possible explanation for the lower favorable attitude toward the organized review process as implemented at xxx versus the attitude toward organized reviews in general. The financial services company studied is the result of a fairly recent merger. He speculated that the subjects may have answered Question #1 based on their experience with the pre-merger process for their individual company, while Question #2 measured attitudes toward a process that may be perceived as a "compromise" between the two companies. This may necessitate revision of Question #1 and/or Question #2.

If borne out by future data, the finding that the inspection processes are not perceived as being beneficial in speeding up software development and/or improving its quality raises the question of why the subjects generally viewed inspections (including the process as implemented at xxx) favorably. One might speculate that inspections are perceived favorably for educational and/or social reasons – examining this possibility would be an obvious subject for future research.

There are a number of limitations to this study.

This is very preliminary research that is still in progress. It involves relatively small numbers of subjects, and no formal hypotheses were developed.

The study examines the attitudes of a convenience sample of subjects involved in requirements development for one organization. While conversations with organization representatives give no reason to believe these subjects are atypical, without random sampling, generalization to the organization is problematical. Whether the results can be generalized beyond the organization is even more problematical. These are, of course, usual problems with any case-type research.

Finally, this study should be understood as being only the beginning of the second in what is hoped will be a series of case-type studies using a variety of methods.

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