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Technical Reviews: A Product Adoption Process

Gruia-Catalin Roman

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Complete Abstract:

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TECHNICAL REVIEWS:
A PRODUCT ADOPTION PROCESS

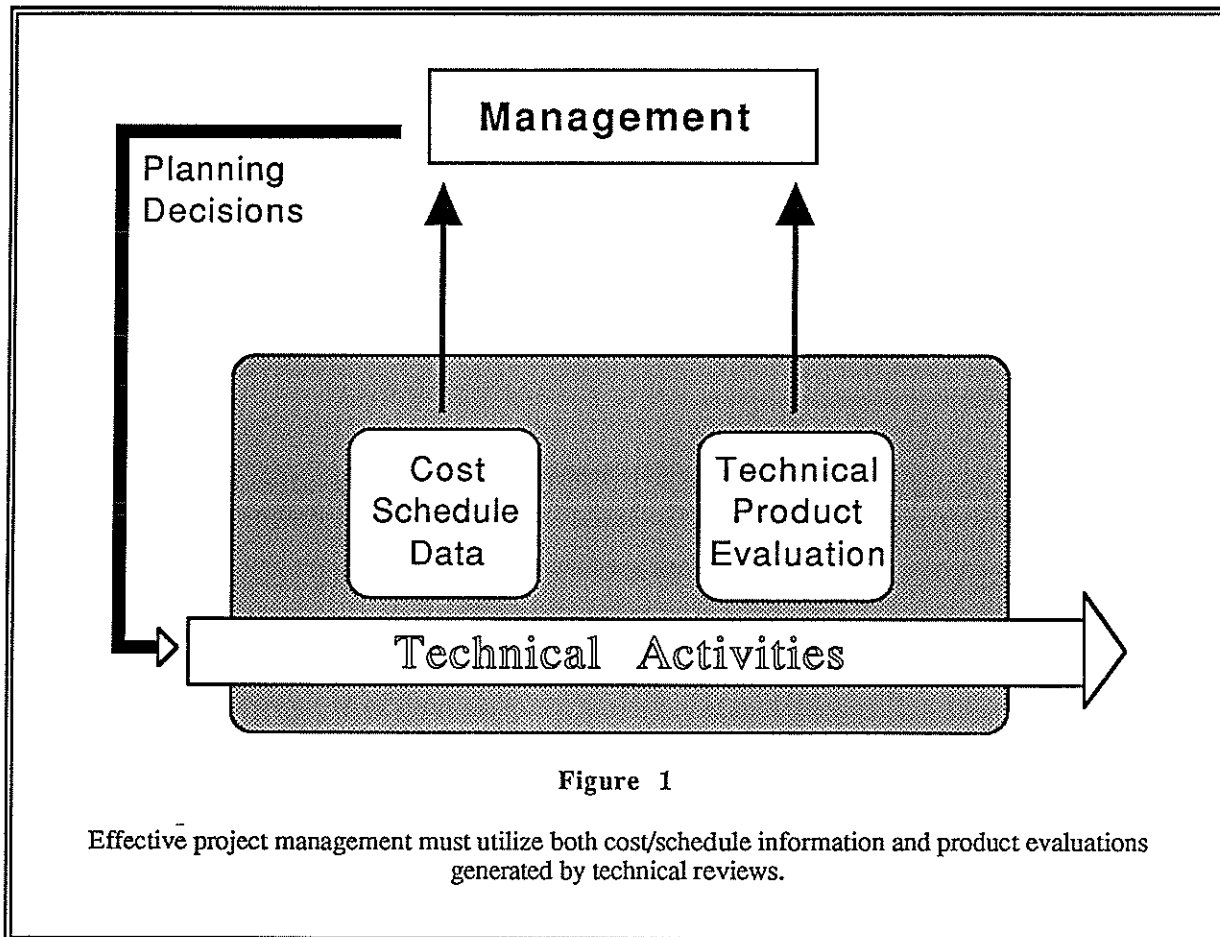Gruia-Catalin Roman

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Abstract

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1. Introduction

Technical reviews are an integral part of the software development process for any company concerned with software quality. (The interested reader may use [2] as a starting point for a survey on the field.) This is due to a wide spread consensus that software development is a long and error-prone process. Since intermediate products are indicative of the quality of the resulting software, their review contributes to a better understanding, planning, and refinement of the development process and ensures the quality of the end-product. Review techniques vary from one company to another and different authors advocate diverse approaches [3, 4, 5]. This paper is neither a survey nor a comparative study of existing approaches but an attempt to reexamine the technical review process from a new perspective, the corporate culture. It is the contention of this paper that technically sound methods are effective only in a climate where (1) reviews are an integral part of the local culture and (2) there is a clear understanding of the kinds of technical and organizational needs the various reviews are intended and able to satisfy.

Figure 1

Effective project management must utilize both cost/schedule information and product evaluations generated by technical reviews.

The presentation starts with a discussion of corporate objectives and technical arguments that led to the integration of technical reviews into software development methodologies. Next, I propose a taxonomy

of review techniques (very similar to that described in [5]) and characterize them with respect to the style in which they are conducted, the purpose they serve, and the mechanism that triggers their execution. I also put forth the notion that, culturally, the reviews must serve as a vehicle for transforming the product of a single individual into a corporate product. It is this process of broadening both the authorship and the responsibility for the product from an individual to a team and, eventually, to a corporation, that I choose to call *product adoption*. A more detailed illustration of the product adoption process and its significance is offered by examining the mechanics of performing a walkthrough.

2. Review Objectives

Quality assurance, measurement and evaluation, project control, and cost effectiveness are the primary objectives of any technical review program. Quality assurance is accomplished by the fact that, as shown in [1] and elsewhere, early error detection leads to easier and less costly corrective actions. Systematic reviews make improvements of the intermediate products possible and allow for dynamic streamlining of the software development process. Measurement and evaluation are essential to both effective project control and accurate planning. Project control requires the availability of up-to-date reliable objective data about the software development dynamics. Planning is based on historical data and presupposes that the software dynamics may be quantified and reproduced from one project to the next. Unfortunately, cost and schedule information, although highly objective in nature, is inadequate, as it simply obscures both the causes of and the remedies for poor performance. Reviews, on the other hand, offer the necessary technical insights. (See Figure 1.) Moreover, reviews can assure a cost effective software development porcess when treated as an investment which, like any other kind of investment, is appropriately timed and sized.

It is interesting to observe, however, that reviews also serve other purposes which, while less technical and less tangible in nature, are equally important for a corporation. First, reviews are a training ground for the technical staff and a way of building corporate expertise. Second, they ensure project continuity and visibility. Individual projects become less dependent upon particular team members as information about the design rationale and approach is disseminated throughout the team. Technical achievements receive exposure within the corporate community. Company standards are reenforced. Third, reviews can help motivate the participants and encourage better performance. Of course, the wrong motivation can undermine the entire review process and devaluate any benefits one expects to draw from it.

3. Review Process

Motivation has a lot to do with the sociological role played by the review. Successful technical reviews are most often associated with a strong sense of personal responsibility, commitment, and advocacy for the organization and its products. In order to foster these positive attitudes among the

participants, one must first understand the complex relationship among the various kinds of reviews, the participants, and the products being reviewed. In this section I put forth two hypothesis and the evidence supporting them. First, I claim that the relationship between reviewers and the products being reviewed can be characterized as a *product adoption process*. Second, I claim that popular review techniques naturally evolved toward satisfying particular needs of this process by which individual products are gradually transfigured into corporate products. Moreover, I believe that failures in the review process are most often the direct consequence of attempts to employ the reviews in a manner that undermines the product adoption process.

To support these claims, I propose to examine, from this product adoption perspective, various kinds of reviews employed today. The taxonomy used here enjoys relatively broad acceptance although, the exact definitions and nomenclature varies from one author to another. Reviews are divided into five classes:

(1) Working session
(2) Walkthrough
(3) Inspection
(4) Project review
(5) Audit

The distinctions between these classes is based on the style used to conduct the review, their explicit technical objectives, and the events that trigger the start of the review. Tables 1 through 5 summarize the general characteristics of each class. The remainder of this section discusses the sociological and motivational contribution of each class of reviews.

Working session. It is the most informal kind of review. Its goal is to develop ideas on how to attack a new task or on how to solve a difficult problem. The session requires little prior preparation, no formal records are kept, and, by design, the expectations regarding the outcome are very modest. Working sessions save time and money by taking advantage of existing expertise within the organization. They also represent the first step along the product adoption path by preparing potential reviewers for the emergence of a new product. Expectations are generated and a gradual understanding of the product is nurtured. These are important benefits. Potential judgment errors and conflicts with other parties may be averted before expending a great deal of effort. Also, prior familiarity with the product's scope and approach helps save preparation time for later, more formal reviews.

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┌─────────────────────────────────────────────────────────────────────┐
│                          WORKING  SESSION                            │
│                                                                     │
│   STYLE            -    informal                                    │
│                                                                     │
│   PURPOSE          -    develop ideas                               │
│                    -    evaluate directions                         │
│                    -    build expectations                          │
│                    -    provide problem solving assistance          │
│                    -    track project activities                    │
│                                                                     │
│   TRIGGER          -    task initiation                             │
│                    -    problem identification                      │
│                                                                     │
│   BENEFITS         -    saves work                                  │
│                    -    exploits existing expertise                 │
│                    -    builds gradual understanding                │
│                                                                     │
│                            Table 1                                  │
└─────────────────────────────────────────────────────────────────────┘
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Walkthrough. It is a semi-formal review whose goal is to identify potential problems in products that are ready to be placed under configuration management. The presentation is led by the author. The product (design, specification, plan, code, etc.) is examined systematically and in every detail. In order to reach definitive conclusions, the product under scrutiny must be complete and self-contained. The focal point of the walkthrough is the product and not the authors. (Ego-less programming, an old coin phrase associated with code walkthroughs, was meant to emphasize precisely this philosophy.) For this reason, the participation of managers and of outsiders to the project needs to be controlled carefully. But there is something more subtle that takes place in a walkthrough that is well performed. The authorship and the great responsibility that comes with it are expanded to include the reviewers and the project membership, to the extent that reviewers represent the interests of the project as a whole.

The extension of authorship and responsibility is the essence of the product adoption process. When it does not take place, the walkthrough becomes ineffective. Authors relinquish their responsibility as soon as the review passes and reviewers perform a superficial job. Moreover, in the very likely case that product faults are uncovered at a later date both groups are ready to place the blame on each other. If, however, the walkthrough is able to transfigure the individual product into a team product this abrogation of responsibility can not take place. Culturally, this requires all members of the team to understand that the outside world measures them, not by their individual performance, but by the results of the team as a whole. At the same time, managers must understand that a team is more like a tapestry in which colors blend and complement each other and not a machine shop with interchangeable parts. In this context, the walkthrough is not only a quality assurance instrument but a facilitator of team formation and growth.

WALKTHROUGH

STYLE   -   semi-formal
                 -   presentation by the author

PURPOSE   -   evaluate completed products or self-contained parts
                 -   identify problem areas
                 -   generate action items
                 -   verify adherence to standards
                 -   define configuration management entry point
                 -   transfigure an individual product into a team product

TRIGGER   -   completion of a self-contained portion of a deliverable item

BENEFITS   -   quality assurance
                 -   team growth
                 -   project cohesiveness
                 -   insurance policy against personnel turnover

Table 2

INSPECTION

STYLE   -   formal
                 -   analysis led by reviewer

PURPOSE   -   evaluate critical products in depth
                 -   perform independent evaluation
                 -   collect useful historical information
                 -   maintain developer involvement across life-cycle phases
                 -   develop and reward review expertise
                 -   promote usage of standard checklists and procedures

TRIGGER   -   completion of a critical deliverable item

BENEFITS   -   increased error detection rates
                 -   increased review productivity
                 -   strict quality assurance

Table 3

Inspection. Although similar in many respects to the walkthrough, the inspection is characterized by greater formality and by lack of author participation. The idea is that the product should stand on its own without the extra information that an author would provide during the review, information which might nor make its way into the technical documentation of the product. Without doubt, an inspection is a stricter and more expensive quality assurance process. The lack of author participation leads

to independent evaluation by personnel specialized in performing technical reviews. A new career path is open to individuals that have highly developed analytical skills. These are all positive aspects which made inspections attractive to some corporations. One may question, however, whether the reviewer participating in an inspection can adopt the product or may be prevented from doing so by the procedural and administrative distance maintained between the author and the reviewer. There are two ways of addressing this problem.

First, if inspections are used in addition to the walkthrough, they should be treated as a product adoption by some organizational entity higher in the corporate hierarchy. This justifies the distance between reviewers and authors without fostering antagonism. The effort to review the product prior to endorsement demonstrates a sense of responsibility. The acceptance of the product leads to shared authorship. Second, if the inspection is employed in place of the walkthrough, great care must be taken not to lose the team growth and allegiance made possible by the walkthrough process. This is particularly important when the inspection is performed by an organization at the same level in the corporate hierarchy. A sense of partnership must be instilled by bringing together the authors and reviewers after each inspection. This leads to the development of mutual trust and understanding. Such meetings also bring the two cultures closer to each other and enhance both individual and corporate technical expertise.

PROJECT REVIEW

STYLE	-	formal
	-	presentation by lead engineers
PURPOSE	-	corporate/customer approval
	-	combined product/team evaluation
	-	assessment of corporate level implications
	-	customer participation
TRIGGER	-	completion of a software development phase
BENEFITS	-	corporate/customer commitment
	-	project/team visibility
	-	definition of corporate expectations

Table 4

Project review. It takes place upon completion of a major team product and is an important event in the life of the project. It is the point at which the product is adopted by the corporation (and/or by the customer). It is also the first review where the performance of the team is being evaluated. All other reviews focused on the product and not on people. The project review presents the team with the unique opportunity to gain visibility for itself and for its products. It is also an opportunity for higher

management to examine the corporate implications of the product and to commit the resources needed to continue the work. The product changes from a team product into a corporate one. This is actually the primary objective of the project review. Any notion that project reviews can serve as a cost effective quality assurance mechanism is highly questionable. Moreover, the discovery of detail technical problems in a project review is unlikely, because of the high level of the presentation, and undesirable, because it clearly demonstrates poor team performance.

AUDIT

STYLE
- very formal
- investigation by external agent

PURPOSE
- external review having contractual implications
- evaluation from an external perspective
- evaluation of a narrow set of issues
- independent evaluation
- expert participation

TRIGGER
- external decisions, contractual agreements

BENEFITS
- enhanced customer responsibility
- customer confidence and cooperation

Table 5

Audit. It is a very formal, narrowly-focused review by an external agent. More often than not, the audit has legal and/or contractual implications. The trigger event may be a prior contractual obligation or an external decision outside the control of the project. Various certification activities typical of government contracts are instances of this category of reviews. While treated as a quality assurance measure by the external agent, under no circumstances should the authors view it in the same light. Aside from being a very expensive strategy, a bad audit can destroy the corporate image and diminish the chances for future business opportunities. If successful, however, the audit serves as an important last step in the product adoption process, it brings the organization represented by the external agent (typically the customer) into a form of joint authorship.

Of all the reviews examined above, the walkthrough is the only one where authorship is extended form an individual to a group, the team. All other reviews broaden the authorship form one organizational unit to another, typically higher in the corporate hierarchy. For this reason I feel that the walkthrough is the key to a successful technical review process in any organization. Organizations are made of people, and

if the transfer of authorship from the individual to the team fails, the entire organization rests on a shifting sand of dissatisfaction and turnovers. Moreover, organizations must build their strategies for success around teams rather than individuals. Teams have a longer life span than an individual's tenure with one organization. Teams can actually take advantage of skill variability among individuals and can ensure continuity along the interlocked phases involved in the development of a single product.

4. Walkthrough Mechanics

Since the walkthrough is both a key quality assurance mechanism and a vehicle by which individuals come together and become a team, it deserves a closer look. The typical walkthrough involves six steps:

(1) Product readiness determination

(2) Planning the review

(3) Preparation for the review

(4) Conduct of the review

(5) Generation of reports

(6) Follow-up on action items

This section examines each step with the intent of highlighting those factors that contribute to an effective walkthrough, effective from both the quality assurance and the product adoption perspective. For the remainder of this section the terms walkthrough and review are interchangeble.

Product readiness. Tentative, incomplete, and marginal products undermine the review process. Review costs are increased because the product must be brought up for review more times than necessary. Review effectiveness is decreased because many errors pass undetected. Moreover, reviewers' frustration with tedious work that has to be repeated and the authors' feelings of having been misunderstood lead to stress, low morale, and friction—a situation not conducive to team cohesion and growth. A product subject to review should be self-contained and in final format. The reviewers should not be asked to trust changes being planned or be permitted to make assumptions about pieces that are not there. Although, there is no need to ask for excessive refinent of a document that may have to undergo extensive revisions, it is important to acknowledge the fact that most documents are written once and read many times (by reviewers, designers, users, etc.). Therefore, a document should be written with the reader in mind, i.e., it must be easy to read and it must be organized in such a manner as to reduce search time. Only when the product is deemed ready for review can planning start.

Planning. Reviews must be treated as an investment. To achieve cost-effectiveness, a review must be properly timed and must have available adequate resources. This responsibility falls on the shoulders of the person in charge of the review, the chairperson or moderator who must select what will be reviewed, schedule the review, identify the participants and their roles, and define the objectives and the scope of the review. Since large products are difficult to review and long sessions are ineffective, the product selected for each review must be small enough to facilitate a thorough examination within a small span of time. Alternatively, only a small set of issues (e.g., functionality, timing, or reliability) relating to the product are evaluated in each session. Additional savings in review time can be achieved by ensuring that one product review defines the context for the next and that each product subjected to the review maintains functional visibility. This latter requirement means that a product should be related directly to some externally visible function of the system. In this manner, the role it plays in the overall system may be readily understood without appealing to unnecessary internal details.

Scheduling of reviews is a non-trivial optimization problem. From the point of view of an individual product, reviews should follow closely the completion of the product and sufficient time must be made available for review preparation and rework. Since the outcome of a review is unpredictable, building adequate review time into the schedule is not easy. The problem is further complicated by the need to maximize review effectiveness at team level. This means that the order in which various individual reviews take place and the selection of reviewers is not arbitrary. The same carefully phased approach used to plan software development in general must be employed in scheduling the reviews. Each review must prepare the next. Each must take a piece of some product and make it understood by an increasingly larger segment of the project team without having the whole team participate in each review.

Effective reviews require small teams (three to five participants) that exhibit a diversity of backgrounds and good prior understanding of the product requirements and context. The choice of participants must balance out the desire for continuity and the advantages of bringing in people having a fresh perspective. A team familiar with the product may speed up the review but may also perpetuate significant technical omissions or misunderstanding. Changes in the composition of the team can slow down the review somewhat but lead to better scrutiny and, above all, serve to strengthen team stability in the face of personnel changes. In other words, the selection of reviewers must balance the short term interest in a speedy review against the long term interest in building up the team. To achieve the latter, one needs to pay attention to two other important issues. First, external participation must be carefully controlled since outsiders require considerably more explanations and may heighten tensions among reviewers. Second one must adhere strictly to a philosophy that states that the subject of the review is a team product and not the output of a particular individual.

Each participant in the review may be assigned one or more functional roles. The typical roles employed in a walkthrough are those of moderator, recorder, reviewer, author, and observer. The moderator is responsible for planning and leading the review and for monitoring the follow-up activities. As part of the planning, the monitor must define a review agenda which ought to include most of the following items:

- objectives of the review
- scope of the review
- participants and their assigned roles
- contents of the review package
- list of other relevant documents not included in the review package
- status of pending action items
- standard review checklists
- time and place of the review

The agenda should be distributed to the participants sufficiently ahead of time so as to ensure proper preparation for the review.

Preparation. Most preparatory activities are carried out by the author and the reviewers with the recorder and the observers having little or no responsibilities at this time. The reviewer must perform an individual review, must annotate the product with questions, issues, and occasional suggested corrections, and must prepare a list of items that need to be considered during the review. This list is a personal plan of action and need not be distributed to any other participants. In parallel, the author is concerned with developing a presentation strategy and any presentation aids that might be required, e.g., selected diagrams, simple examples, processing scenarios used to illustrate the workings of some program. Excessive investment in presentation materials is counter productive since the objective of the review is to assess and adopt a particular product and not the presentation materials. However, the author must give careful consideration to the presentation strategy. The order and the manner in which the product is covered affects the speed and the accuracy of the review. The reason for having the author present the product in the first place is to reduce the review time by a staged introduction of concepts and explanations.

Conducting the review. The walkthrough objectives have always included understanding the product and detecting errors. If, however, one adds to these the reviewers' obligation to assume responsibility for the product and the team obligation to assume collective authorship, a new kind of attitude toward reviews must prevail. The review process must become an integral part of the corporate culture. All products must be reviewed. All personnel must participate. Quality reviews must be an explicit corporate objective. One measure of the degree to which this has been accomplished is the

emergence of a unified review style as a reflection of a common cultural exposure and interest in the review process.

The style is most evident in the leadership exhibited by the moderator. Since the quality of the group interactions is the key to a successful review, the moderator must both facilitate and control them with great skill and finesse. The discussion must be kept highly focused so as to ensure both progress and relevance. A presentation strategy preagreed between the author and the moderator should be followed. Attempts to seek out solutions to uncovered errors should be discouraged. Redundant discussions should be inhibited and apparent consensus should be made evident. Superficiality should be avoided by seeking to extricate the underlying issues and by judicious application of the principle of separation of concerns. Everyone must be allowed and must be encouraged to participate in the discussions in a meaningful way.

The author is the second most important member of the review team. The presentation of the material has a great bearing on the efficiency and thoroughness of the review. If the author assumes too much on the part of the audience, the review can easily get tangled into a barrage of questions and side issues. The contextual information must be carefully introduced so as to build the desired set of expectations on the part of the audience, a mental map to help them navigate at ease through the material had they read it or not. Static structure should always be explained before dynamic behavior as a way of fixing in the mind of the audience a set of clear and stable landmarks. A finely tuned repertoire of predefined processing scenarios should be used in order to provide good coverage of a potentially large and diverse set of possible behaviors.

Finally, the recorder's responsibility is to ensure accurate tracking of the items discussed during the review and their status. The recording process performs an important support role by ensuring complete coverage of the product under review, by furnishing the raw data needed to summarize the review results and conclusions, and by logging the action items agreed upon by the reviewers.

Report generation. The recorder's notes form the basis for generating a number of walkthrough reports including:

- review summary
- error list
- action item list
- error statistics

The review summary is destined for use by the management. Typically, this report contains the review agenda, the disposition (pass or fail), rework plans, estimated level of effort for the rework activities, project

level implications directly relating to the disposition of the review and/or uncovered during the review, and observed error patterns that might reveal some systemic weakness.

The list of errors uncovered by the walkthrough and the action items decided upon during the review are intended for use in the every day workings of the project. The error list is helpful only if it contains sufficient information to support subsequent statistical analysis. The logged information shuld include the error location, source, probable cause, type (according to some standard taxonomy), class (missing , wrong, or extraneous item), and severity. The action item list, on the other hand, must be precise enough so as to ensure strict controls over the rework process. In addition to listing the error and planned corrective action, the list must identify the individual responsible for carrying out the correction, the estimated schedule, the estimated level of effort, and the individual or process required to certify that the correction has been carried out properly. For many errors it not necessary to subject the product to a complete new review or to involve all the reviewers in the certification process. Nevertheless, someone must bear this responsibility on behalf of the review team.

Follow-up. The follow-up activities are of three types: rework in accordance with the specified action item list; certification of completed action items; and measurement and evaluation. This last activity is based on statistical analysis of the accumulated error lists for the entire project. The statistical trends provide the project team an objective and impersonal self-assessment tool consistent with the notion of strengthening the team without singling out the individuals. From such statistical data and comparisons with other historical data for the same or other teams one can assess the effectiveness of the software development methodology and of the review process and can estimate the expected quality built into the team products. Ultimately, one can obtain a measure of team performance and thus provide a strong incentive for self-improvement.

5. Conclusions

In this paper we have examined the notion that technical reviews can be perceived as a product adoption process through which individual products are gradually transformed into corporate ones. This idea defines a functionalist perspective on reviews, one that is broader in scope than the traditional view held by many that reviews are mostly a quality assurance instrument. Moreover, product adoption is able to explain why certain reviews tend to assume particular characteristics, allows for a more judicious allocation of review resources, and averts unwarranted expectations. Finally, in my experience on projects where these ideas have been put to practice team members seem to feel more positive and more enlightened about the role of reviews in the life of the project.

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