Managing a Project's Legacy: Implications for Organizations and Project Management

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Abstract — Organizations that rely on projects to implement their products must find effective mechanisms for propagating lessons learned on one project throughout the organization. A broad view of what constitutes a project's "legacy" is presented that includes not just the design products and leftover parts, but new processes, relationships, technology, skills, planning data, and performance metrics. Based on research evaluating knowledge reuse in innovative contexts, this paper presents an approach to project legacy management that focuses on collecting and using legacy knowledge to promote organizational learning and effective reuse, while addressing factors of post-project responsibility, information obsolescence, and the importance of ancillary contextual information.

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1. INTRODUCTION

A project is defined as "*...a temporary endeavor undertaken to create a unique product or service*" [13, p.4]. The project team that implements the project can be characterized as time-limited, produces a one-time output, consists of tasks that are non-repetitive in nature and involve considerable application of knowledge, judgment, and expertise, and frequently draw members from different disciplines and functional units [6]. While there are many types of projects, for this paper, we refer specifically to new product development and R&D type projects, where the goal is to create a specific product or technology.

The use of projects for new product development has proven beneficial in a variety of industries because they allow resources to be focused on achieving a goal and are an efficient way to bring the necessary expertise to bear on a specific problem. This focus on meeting project goals, however, does not lend itself to supporting additional tasks that provide a long-term benefit to the organization (e.g., transfer of best practices), but no immediate benefit to the project itself.

In an organization such as the Jet Propulsion Laboratory (JPL) which sets its mission as "...achieving that which no one has done before" [17, p.11], each project is expected to accomplish something new and significant. There is, therefore, an ever-expanding base of knowledge produced by these projects that, in theory, is available for future projects to build upon. Unfortunately, a gap exists between the act of creating this new knowledge, which is necessary for the project to accomplish its goals, and the act of capturing this knowledge for the explicit purpose of future reuse, which is important for the organization.

This paper explores a process for managing a project's contributions to its home organization's knowledge, which we refer to as the *project legacy*. It first applies current research on innovation and critical factors important for knowledge reuse to describe the importance of legacy knowledge. Second, it provides a broad description of what constitutes a project legacy. It then describes a "legacy process" that occurs throughout – and after – the project's lifetime. Finally, it ends with a discussion on the implications for the organization and project management.

2. REUSE

The ability of a firm to generate new combinations of existing knowledge is described as "combinative capabilities" [9]. Such a capability is a strategically significant resource to a competitive organization [8] and can result in decreases in cost and development time, and improved product performance. Projects both make use

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of previous knowledge (reuse) and generate new knowledge (the "project legacy"). The ability of a project to effectively reuse knowledge will depend in part on the quality of the knowledge captured from previous projects.

We define *reuse* as the process by which an entity is able to locate and use shared knowledge [2]. We adopt a broad definition of knowledge consistent with prior research [5,8] to include explicit knowledge such as drawings, analytic results, and scientific journals, as well as tacit knowledge such as insights, intuition, and implied assumptions [9,12,18]. Therefore, for the purposes of this paper, "knowledge" is broadly defined to cover the full scope of materials and information that constitutes a project's potential legacy.

From a research and development (R&D) perspective, successful reuse for innovation is the successful exploitation of ideas to create a new, useful offering of product or service [4]. Majchrzak, Cooper, & Neece [10] have described a six stage process by which reuse for innovation occurs:

1. Define Problem
2. Develop and Evaluate Conceptual Approach
3. Search for Reusable Ideas
4. Briefly Evaluate Ideas including deciding not to invent
5. Conduct In-depth Analysis of Ideas
6. Finalize Selected Ideas into Solution

This reuse process features three levels of search and analysis behavior needed for reuse to occur: (1) scanning the environment to become aware of possible ideas (the Scan level); (2) conducting brief evaluations of ideas to determine if the idea is worth pursuing (the Brief Evaluation level); and (3) conducting in-depth analysis of ideas (the In-depth Analysis level).

Majchrzak, et al. [10] also found that an important factor influencing knowledge reuse is the availability of meta-knowledge on the idea being considered for reuse. Meta-knowledge is "knowledge about the knowledge" such as who generated it, how credible it is, or where to find it. Reusers use this meta-knowledge in two ways. When they first become aware of an idea, they want only to know that the meta-knowledge on the idea exists. For example, at the brief evaluation level, reusers want to know, for each idea, whether an adapter exists; a person they trust recommends the source and adapter; prototypes, models and data exist; and the source (or source surrogate) is available for questions. Simply knowing that this meta-knowledge exists is sufficient at this level.

During the final level of search and analysis, when reusers conduct in-depth analyses of the knowledge, they return to the meta-knowledge. At this point, the meta-knowledge must do more than simply exist – it must be accessible, actionable, and adaptable. For example, models and data are experimented with and modified and persons capable of adapting the knowledge (e.g., a specific laboratory or company) are engaged in an interactive process of proposed adaptations. This process of manipulating the meta-knowledge allows the reusers to more clearly determine which assumptions, constraints, and adaptations would help (or inhibit) the potentially reusable idea to meet the problem needs.

The absence of meta-knowledge creates a barrier to reuse [10]. This suggests that meta-knowledge can be constructed and presented in such a way that it facilitates reuse. For example, meta-knowledge that quickly communicates credibility, relevance, and adaptability would provide potential reusers with the ability to assess if the knowledge might be applicable to their particular problem, and the conditions and constraints on its potential applications. By understanding the context in which and for which the knowledge was created, reusers can compare the original domain to their own on multiple dimensions of importance to them (e.g., the thermal, vibration, atmospheric pressure, radiation conditions in the target environment; desired life expectancy; fidelity of measurements).

Reuse for innovation requires that knowledge and products be adapted, integrated, recombined, or otherwise altered to meet new requirements, contexts, and goals. Since a project's legacy can be valued based on its potential for reuse, it is clear that additional effort, beyond that expended in the original creation process, is needed to facilitate the reuse process. The next section provides a description of the multiple components of a project legacy.

3. What is a Project's Legacy?

At the end of its existence, a successful project will have generated the specific product it was tasked to create, the ancillary documentation used to create the product, and it will have increased the experience of the project team members. Many projects, however, will have created significantly more. The following describes three broad categories that constitute a project's legacy: the product legacy, the process legacy, and the people legacy.

Product Legacy

The product legacy consists of the actual product(s) produced by the project and any artifacts created as a by-product [3]. The product legacy therefore includes prototypes, models, simulations, spare units, components, or parts, test equipment, special fabrication equipment, designs, specifications, and myriad other physical or virtual manifestations of the product. It also includes boundary objects [16] such as marketing videos, educational material, and websites, produced to communicate about the product to various stakeholder groups (e.g., sponsors, customers, the general public).

The project produces these items in the normal course of doing business, since they are needed in order for the project to succeed. The electronic versions can be captured in on-line documentation or project data management type systems. The physical products may be captured as part of an organizational hardware management system, or may reside in an ad hoc manner with individual project team members, in which case they are available for future use, or they may be surplused to reduce inventory costs.

Process Legacy

The process legacy consists of new learning, understanding or capabilities that improve an organization's ability to conduct future projects. While the product legacy is most likely to impact the design of future products, the process legacy is more likely to impact *how* the product is developed.

The process legacy may include a new process for screening parts, a new method of contracting, a way of working with a new technology, or a validated way of responding to new regulations. The process legacy can be characterized by "how to" information. It can also include the collection of data that improves processes, such as cost, schedule, or risk data that feeds into organizational models; trend data that indicate needs for upgrading tools or facilities; test data that characterize reliability, performance, or other factors for tools, parts, components, or manufacturing lines; or documentation templates and examples that can be adopted by other projects. Finally, the process legacy may include new or improved tools, facilities, or infrastructure that become available for future use, for example, when one project builds a new test chamber that then becomes an organizational resource. The process legacy resides in the formal organizational procedures and the infrastructure that supports product development.

People Legacy

The people legacy consists of new relationships or tacit knowledge that resides primarily in individual project team members. While the process legacy represents the part of the work that can be encoded as a new procedure or an update to a manual, the people legacy represents the part that can't be written down, but is essential for making use of the new process knowledge. For example, a project may build a new test facility and develop a series of procedures for how to use it. What doesn't necessarily get documented is, for example, the understanding of how to use the facility under different conditions, what constraints interact and in what ways, what represents a "good" use of the facility, or idiosyncrasies in how it operates that may compromise the test. Unless additional effort is expended, this "knowledge" will reside only in the personal experiences of the individual team members.

A second type of people legacy is the establishment of new working relationships. These can be internal to the organization, where departments that normally don't work together form a partnership as is seen in cross-functional teams [e.g., 15]. It can also occur external to the organization in the form of subcontracting, partnering, sponsoring, or new customer or stakeholder relationships. These relationships serve to expand the organization's social network [e.g., 14], providing access to valuable skills or capabilities not available internal to the company. They also represent an investment in team development that can pay off by shortening the "forming, storming, norming, performing" process [19] since teams reformulated from members with prior experience together.

The final type of people legacy is the development of positive social capital within the project team. Social capital is defined as "...the goodwill available to individuals or groups. Its source lies in the structure and content of the actor's social relations. Its effects from the information, influence, and solidarity it makes available to the actor" [1, p.23]. Adler & Kwon [1, p.17] identify multiple positive effects, which include facilitating inter-unit resource exchange and product innovation [7], and the creation of intellectual capital [11]. The social capital developed on one project is what enables the rapid formulation of a new team (when members have positive, previous working relationships), and the ability to call on past colleagues for help on future projects (e.g., staffing recommendations, as peer reviewers, specialized expertise). Shared experiences on a project team engender both an awareness of individual experience and expertise and the positive feelings that allow one person to call on another even when there's no formal relationship between them.

Summary

As depicted in Figure 1, the product, process, and people legacies are generated as a by product of the primary effort by the project to produce a product. The successful development of the product is the purpose of the project, and it therefore benefits by completing the effort. Individual team members also benefit. The experience base gained through the project resides in the individual team members, thereby making them more valuable to the organization. The positive social capital exchanged between team members increases individuals' personal networks, which may provide improved access to future project work. Finally, they benefit by being associated with a project success.

The potential benefit to the organization may be derived from all three legacies and is centered on the organization's ability to perform future project work. The product legacy provides designs, hardware, and a basis for incremental improvement activities. The process legacy contributes to the organization's ability to improve its ability to produce future products (e.g., effectiveness, quality, efficiency, reliability). Finally, the people legacy provides both improved relationships (such as with an external partner), a greater experience base, and an improved ability to assemble future teams more rapidly based on interpersonal relationships developed within the project team. It's important to note that project legacies can be contributed by non-completed or failed projects, in addition to successful ones.

The organizational benefits are qualified as being "potential" benefits, because their mere existence is not

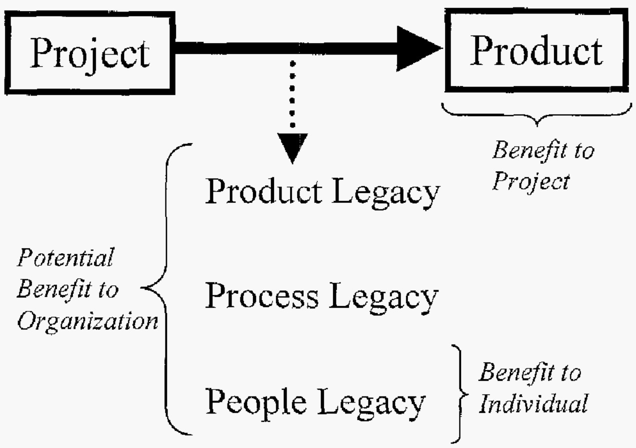


Figure 1 – Project Legacy

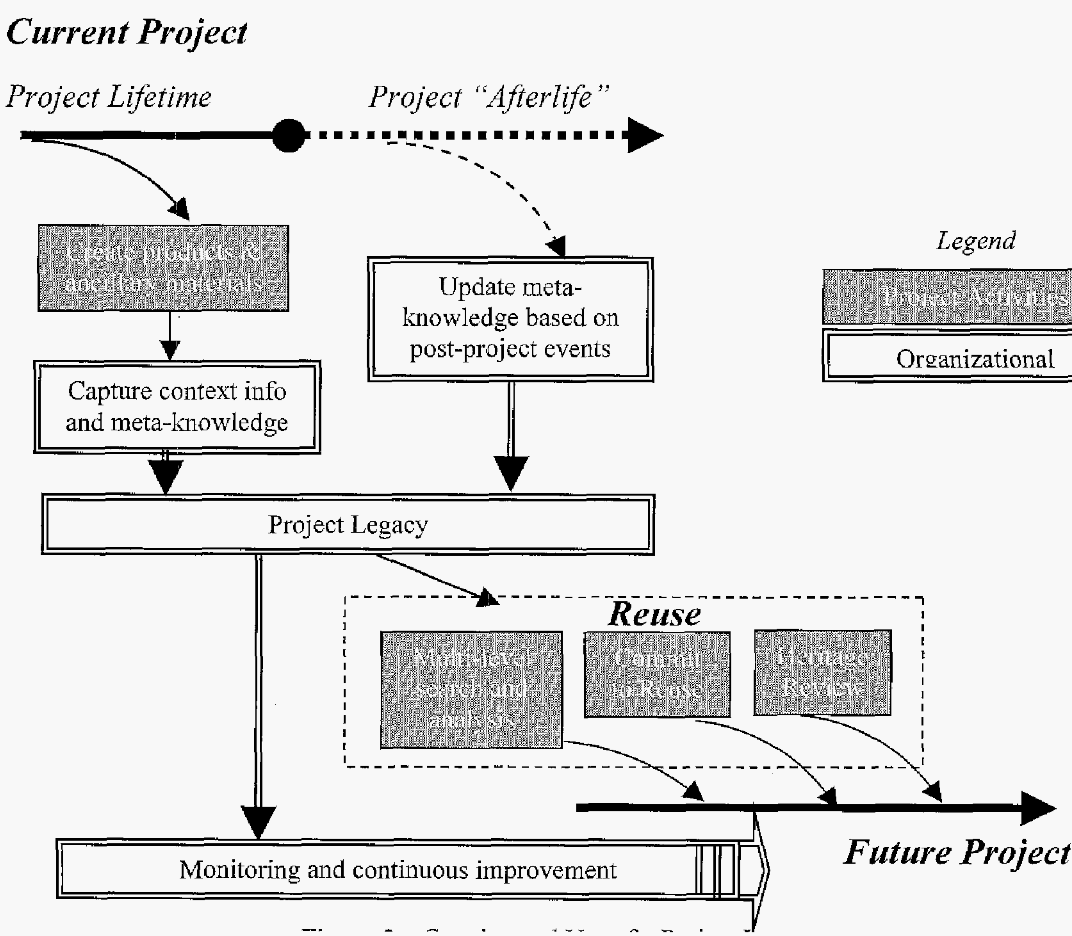
sufficient to ensure that the organization can take advantage of them. The next section takes a process look at developing, managing, and using project legacies

4. Process Perspective

In an environment characterized by limited budgets, schedule pressure, and increased competition, the focus of a project team is to produce the best possible product as quickly and as inexpensively as possible. In the pursuit of these goals, activities of minimal benefit to the team but potential benefit to the organization are unlikely to occur. Preserving the project legacy is often limited to activities such as archiving project documents on a CD-ROM, returning leftover materials to the organization (if such a facility exists), and possibly conducting a "lessons learned review" which tends to focus on bad things that happened and things not to do again. While these activities are somewhat valuable, they are not designed or conducted in a way to facilitate reuse.

There are three primary players in a Legacy Process: the current project (whose legacy is being generated), the organization, and a future project (which in theory can benefit from the current project's legacy). The interplay of these three players is illustrated in Figure 2.

The current project's responsibility is to create its product(s), and to capture knowledge necessary to support its activities. The knowledge and products are generated throughout the project, such that the legacy grows throughout this finite lifetime of the project. The project may "end" over a period of time as people roll off and funding ramps down, but eventually it ceases to exist as a project. There is, however, a sort of "afterlife" that can be



associated with projects. Even though the project doesn't exist as a funded, active entity, the project team members may continue to work in the organization, and the products developed may take on lives of their own as they are used, modified, or as experience is gained in the operation and use of them.

At the receiving end of the Legacy Process is the future project that has the potential to reuse the original project's legacy. In order for this reuse to happen, the future project must first be aware that the previous project existed, and have a feeling for how the knowledge gained on the previous project might apply to the new one. As discussed in the previous section, this involves searching and analysis at multiple levels by the new project personnel. In an organization with a relatively stable population, the reuse process will most likely involve contacting former project members to gather the desired information.

For example, a Mars science instrument developed for one project was placed in storage after the larger project was canceled. Under separate R&D funding, some of the technologies used on the original instrument were updated and improved. When a NASA Announcement of Opportunity was issued that contained requirements that could be partially met by the instrument, proposal teams contacted previous project members to gain information on the instrument. Although the project documentation was available in an on-line repository, the proposal team members chose to make direct contact rather than attempting to retrieve the information from the repository. This proved to be a worthwhile approach because project members had kept up with the technology developments and were able to provide information on not only the original instrument, but also on recommended paths for improving it based on newer technology.

Should one of these proposals including the aforementioned instrument be selected for implementation, the team will be required to conduct what is called a "Heritage Review." In a heritage review, the team members are required to provide justification for their choice of hardware from the perspectives such as what is physically available, the results of previously conducted tests, expected performance, status, and the pedigree of the materials (e.g., Were materials handled in a way that preserves their ability to be used in space vs. being exposed to potential contaminants?). Since this type of information would be extremely difficult to extract from existing documentation, if it even exists, significant iteration between past and future project team members could be expected, and relies on the goodwill and memories of the individuals involved.

The third party in the Legacy Process is the organization, whose role is depicted in Figure 2 as facilitating the creation, maintenance, and use of the project legacy. As indicated previously, the availability of context information and meta-knowledge facilitates reuse. However, since its value to the originator is questionable, it is highly likely that this information will not be generated during the normal activities of the project team. For what is captured, there are costs associated with storage and providing access. Projects may be willing to provide a small amount of funding to cover the difference

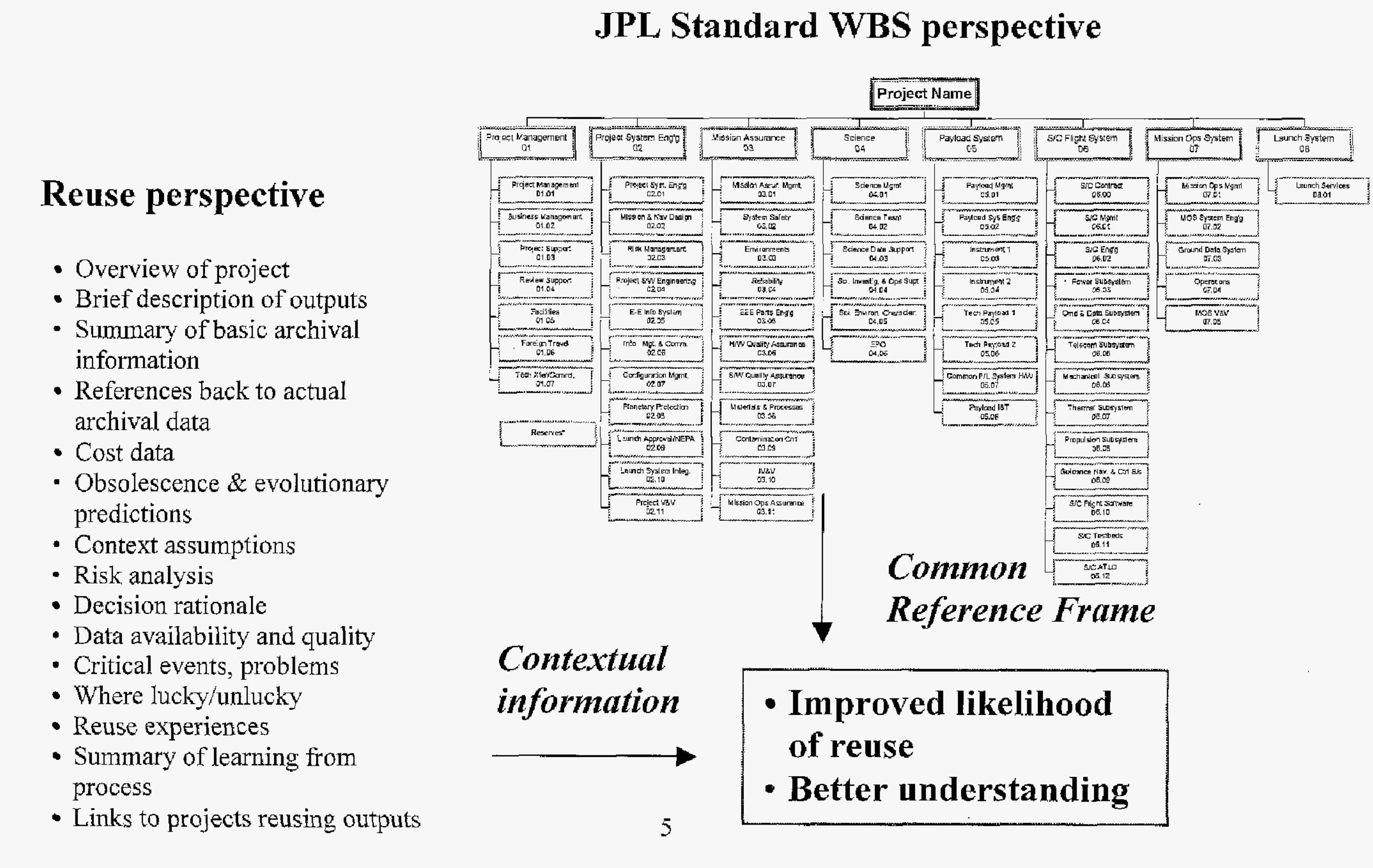


Figure 3 – Structuring Project Legacy Information

between the level of storage and access they require and that needed to support organization-wide access, but that cannot be assumed. Once the project ends, there is no funding to provide storage and access support, nor is there project funding to support updating legacy information based on post-project events. Therefore the role of the organization is two-fold: to provide support for the development of meta-knowledge and continuing maintenance and access during the "afterlife" of the project.

In addition to the project-to-project facilitation role, the organization can also be seen as a user of project legacy information in support of organization activities. For example, the actual costs incurred by projects represent data that could be used in organizational cost models. Similarly, decision rationales which indicate that multiple projects wanted to use a particular technology, a given type of facility, or a new design tool package, but were unable to could provide valuable input to resource investment decisions.

As the holder of project legacies from multiple projects, the organization needs a structure for capturing legacy content that enables efficient comparisons across projects. One approach is to leverage the Work Breakdown Structure (WBS) used by the organization. At the Jet Propulsion Laboratory, a standardized WBS has been developed for use across a wide variety of projects. Structuring legacy information according to this standardized WBS provides a common reference framework for comparing information from multiple projects.

This structure, however, represents only part of the picture. A second perspective is to structure legacy information from the reuse perspective. Features such as an overview of the project, brief description of outputs and archival resources, obsolescence and evolutionary path predictions, risk analyses, decision rational, critical events and problems, represent a variety of ways in which to capture contextual information that can be used to interpret the project legacy. All three parties benefit if the organization standardizes the legacy knowledge capture process and meta-knowledge: it becomes easier for the project to generate, easier for new projects to access, and easier for the organization to manage.

Figure 3 depicts an integration of the common reference frame (e.g. based on the WBS) and the contextual information to create an overall structure that provides flexible access. This integrated structure improves the likelihood of reuse and enables a better understanding of legacy information.

5. Implications

This paper advocates expanding project and organizational practices to promote reuse for innovation. It proposes a broad definition of "legacy" that extends far beyond the common hardware and lessons learned approaches. In addition to details such as what contextual information is important and how to capture it, the use of standards (e.g., stating explicitly what year dollars are used in cost data), or when to declare content obsolete, organizations face a number of significant issues, for example:

1. The legacy process needs to match the needs and strategy of the specific organization. What constitutes a valuable legacy may vary depending on the degree of risk an institution accepts, the type of product being produced, the proposed market or sponsor for the work, and the importance of innovation. Adopting a legacy process approach therefore requires the organization to explicitly match the type of reuse they want to their strategy. For example, in an organization striving for repeatable performance with little variation between products and a continuous improvement strategy, standardized templates, tools, and processes may be critical, but contextual data may not be as important because there is little variation in context. For organizations engaged in radical innovation, however, standardization may only be possible at high levels of abstraction and contextual information is highly critical.

2. For a legacy process to succeed, the organization must dedicate resources to facilitating the process. While some resources can be allocated by requiring projects to include funding for legacy activities, this approach leaves the organization vulnerable to the dynamic priorities of the individual projects. Even if projects do assume more of the responsibility, the organization still must address the post-project life of the legacy, which includes providing long term storage and retrieval functions, as well as funding to support periodic updates to the legacy materials. Organizations will need to carefully weigh the costs and benefits to identify a suitable level of effort and structure appropriate for their needs.

3. If relying solely on the people to propagate the legacy, the organization needs to (a) provide tools that help them manage info as they move from project-to-project; (b) understand impact of this on risk (e.g., people forget over time; a different characterization of what constitutes a critical employee); and (c) put in place resources to give people time to do this. As people are rolling off of one project, their primary concern is finding a position on their next project. They do not have the luxury of reflecting on the effort just completed to internalize their individual learning or to assess contextual information. Unless organizations specifically provide support for these activities, they will not happen. Since reflection is a critical part of learning processes, the organization will therefore lose a prime opportunity to learn from recent experiences.

By addressing these issues, organizations will position themselves in a way that best meets their legacy process needs. We believe this will enable them to capitalize on the experiences and expertise in their organizations and provide valuable resources in support of innovation and reuse.

6. Conclusions

Organizations that rely on projects to implement their products could benefit from using a legacy process for propagating lessons learned on one project throughout the organization, promoting reuse, and providing the visibility needed to monitor multi-project effectiveness. This paper established the concept of a legacy process in the context of an R&D organization whose primary goal is innovation. It developed a case for expanding the role of the organization in this process and tying it to strategic goals.

While a legacy process has the potential to contribute to improved project and organizational performance, doing so has not been thoroughly evaluated with regard to the costs of implementing a legacy process, nor have the potential benefits been quantified. This approach has not been applied in practice, so there are no findings relative to the impact on actual project performance. The value of this work then is in defining project legacy to incorporate product, process and people components, and in opening a discussion on the implications for organizations.

There are many open issues in implementing a legacy process. First, what constitutes reuse and reusable knowledge may differ from organization to organization. The legacy concepts defined in this paper were developed specifically to support the needs of a specific R&D organization. The generalizability of these concepts and how they would apply across domains less concerned with innovation is an open question.

Second, it is hard to predict with certainty what type of information has future reuse value. Since there are costs associated with the capture and maintenance of legacy knowledge, it is important to develop a strategy for what to capture, enhance, and maintain. While current research [e.g., 10] is beginning to address these issues, there is currently little empirical or theoretical guidance on how to predict future relevance.

Finally, the emphasis in this paper has been on the positive aspects of legacy. It is also likely, however, that there are negative aspects to what was learned or experienced on any given project. For example, the people legacy focuses on the development of new and productive relationships. It is possible, however, that a project could result in an extremely bad experience for the parties involved which would make future interactions much more difficult. How to capture this aspect of a legacy could prove to be an extremely sensitive, difficult effort.

In conclusion, we feel that there are many benefits to be gained by adopting a legacy approach. However, there are a number of issues that remain open. Greater understanding of the costs and benefits of this approach will be obtained through empirical testing of these concepts in actual organizations, as well as additional research into the identified areas.

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