Requirements Engineering Process Selection
at Hewlett-Packard

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Abstract

The requirements engineering (RE) processes used at Hewlett-Packard (HP) are many and varied. They range from informal to formal on projects that are short, agile, and at internet-speed as well as long and methodical ones. Typically, the RE approach is influenced by business drivers as well as constraints or attributes of the project. Some of the major attributes that affect HP's RE selection process include: level of understanding of the user's domain/needs, project size and complexity, schedule, resources, cost, quality expectations, project personnel expertise, development model (in-house versus outsourced), tolerance for requirements volatility, cost of requirements changes during development and after release, and the speed at which changes can be applied to the product after release. Attributes of the RE approach for two HP projects are examined in this paper. The first project is agile with an internet-speed release schedule. It is based on experience with the web site and consumer award-winning eServices hpshopping.com organization. The other project is large, complex, and makes use of outsourced development. It is based on experience with the development of an HP worldwide (WW) IT customer communications system that cuts across all of HP's businesses. Many different RE processes are used at HP. The most effective ones are those customized to closely fit the business drivers and project attributes.

1. Introduction

A variety of Requirements Engineering (RE) processes are practiced across Hewlett-Packard (HP). The process selection is based on many factors. Some drive the business while others may be thought of as constraints or attributes of the project. This report highlights two HP projects. The hpshopping.com project is agile with an internet-speed release schedule; the Customer Communications System project is a world-wide (WW) IT system that is large, complex, and makes use of outsourced development. For each of these projects this paper provides:

- a brief description of the project objectives,
- an outline of the front-end of the RE approach used,
- the primary business driver(s) influencing the selection of the RE approach,
- the key RE process success factors and their effect.

2. hpshopping.com

hpshopping.com is an eServices business that simultaneously develops major projects to support the selling of multiple HP product lines while supporting a 24/7 web-based online store. Quarterly business cycles include major project planning, development, and release. Defect fixing, minor enhancements, emergencies, sustaining IT infrastructure changes, and content are managed through other separate release processes tuned for their respective business purpose.

The approach to the RE process consists of creating multiple project proposals with their associated business requirements from several different HP product lines. Inside hpshopping.com, there is a small, co-located team who represent the different product lines that use the storefront's eServices. These individuals submit the requirements from the product lines that they serve to a program management office (PMO) business analyst. The business analysts who collect these proposals are well-steeped in the technical architecture and design of the system. Their intimate system knowledge enables them to quickly translate the business requirements from the product lines into a set of functional and non-functional requirements that are achievable in the quarterly business cycle. High-level requirements are documented in a simple product data sheet template. Depending on the size of the project, subsequent refinements of the requirements are documented to the appropriate degree (as determined by the

project manager) in slide sets, spreadsheets, and simple documents. Formal RE tools are not used or needed. These sets of requirements are grouped into projects and then presented as a portfolio of project proposals to the PMO decision makers. That team further prioritizes the project proposals as well as the requirements that constitute each project. They then conclude with a final go/no-go decision on the portfolio they have reviewed and/or modified. The projects then enter the PMO execution phase or what is more commonly referred to as the development lifecycle. Interestingly the first phase of the development lifecycle is a requirement's "analysis phase" where the Information Technology (IT) team leads a refinement of the requirements definition and further qualification of the technical feasibility and scope. For the large projects, this is when more complete requirements documents are produced. See Figure 1.
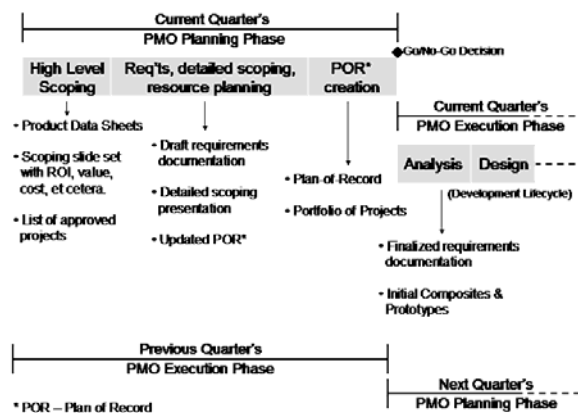

Figure 1. hpshopping.com requirements process

This differs from traditional models in that there is essentially a second requirements phase before design begins; however, the go/no-go management decision has already been made as part of the entry criteria --- not the exit criteria of what is essentially a traditional waterfall development model. This decision process accelerates the project by solidifying the team around a common objective early on and avoiding "analysis paralysis".

Figure 1 also shows that requirements planning and their "execution" or development occur in parallel. The set of requirements from the previous quarter's PMO planning phase is being actively developed while the requirements for the next quarter's development are being identified. So as the current PMO planning phase ends, the same people begin the planning process all over again for the next phase. This enables the cross-functional requirements development team to become very good at this process.

A difficult part of RE is knowing when to stop gathering requirements and deciding what's-in and what's-out of the specification. With that said, there is a change control process in place to handle requirements that have been under scoped (that is, under estimated in resources or time needed to develop) or for some other reason need to be adjusted. However, this is considered a formal change to the baseline of approved requirements. At HP, this process closely aligns with the classic definition of Requirements Management (RM) in that the set of project requirements is changed and agreed upon by development and the customer, who in this case is one of the product line businesses. Note that explicitly distinguishing the RM process from the more encompassing RE process is typically not done at HP. That is because it is generally not recognized as providing value in the product generation process. Requirements that did not make the current Plan-of-Record (POR) are added to a list of backlogged requirements along with any new requirements that emerge during development. This backlog of requirements is then reviewed and reconsidered during the next planning phase.

Uncertainty in the development time estimates caused by inadequate requirements specificity is explicitly recognized as something that does exist but decreases in range over time. After the "high level scoping" of the requirements in the PMO Planning Phase (see Figure 1), the schedule estimate is targeted to be within a tolerance of plus or minus 7% of each individual project's development schedule. At the start of the analysis phase in development, that schedule and resource estimate has been reduced to an uncertainty range of plus or minus 3%. See figure 2.
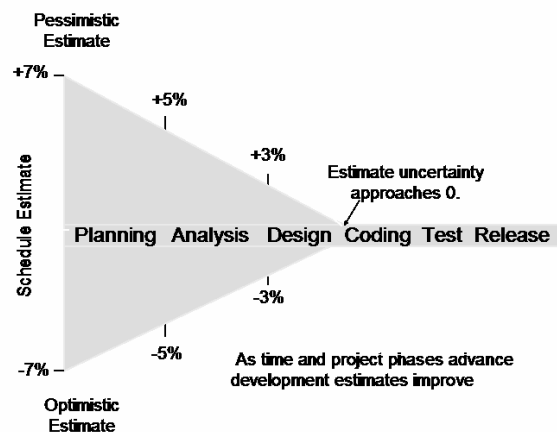

Figure 2. hpshopping.com estimation tolerances

During analysis phase, composites and prototypes are created by IT and validated by the business clients. Composites are simply paper mockups of an interface

intended to check for requirements compliance to the client's real needs. Prototypes are working code and are NOT thrown away. They are integrated into the actual system. These tools are used to hone the estimate even sharper. At the end of design, a final estimate is made that is integrated into the overall portfolio schedule. The team will strive to meet that schedule by possibly adjusting resources and scope.

The primary business driver for this RE approach is the demand for frequent new project releases. This is due to an extremely competitive business environment with a continuous stream of new product releases and promotions by the client businesses. Additionally, new functions, evolving technologies, and changing system infrastructure are constantly needed to support the online store business itself. They are virtually modifying the plane while in flight.

Key RE process success factors include:

- small, close-knit, geographically-close teams that have easy physical access to their business clients. This affords IT the means to develop a deep understanding of the requirements and an efficient environment to iteratively clarify them when even the client may not know exactly what they want,
- prototypes to validate requirements and their direct integration into the system to save time,
- decisions on a portfolio of projects optimizing the flexibility to manage resources to accommodate under estimation or changing requirements,
- short but full development cycles that provide continuous, repetitive practice and improvement of requirements process skills. The capabilities of essentially the same individuals and teams are enhanced since the next quarter's requirements planning begins as the current quarter's ends,
- teaming of a business representative and a business analyst who switch roles as the "lead" between the initial requirements definition phase of PMO planning and the deeper requirements analysis phase of PMO execution. This aids a shared understanding and ownership of the result,
- firm, quick, and early management decisions providing project team acceptance or minimal dissent in the initial estimation and content of the projects allowing everyone to just move on and focus on the task at hand,
- a web infrastructure that enables essentially instantaneous changes in production in emergencies although this is rarely used. Risk is reduced by this fast, low-cost means to fix a "non-optimal" requirements decision. This makes quick, early decisions a frequently-used, safe process tool,
- relatively light RE process and documentation tailored to a project's size and complexity,

- informal, generally undocumented traceability of the requirements. This is efficient for these fast-cycle projects as the projects are usually done by the time one might need to refresh their memory of the derivation of a requirement or feature. In this type of business, formal traceability has a small return on investment for classic usages such as change impact analysis, test case generation, safety-critical certifications, etc.,
- generally, a relatively small set of requirements per project such that most projects can be implemented by two developers in two to four months.

3. Customer Communications System

An essential objective of this WW IT project was to specify and develop a system capable of managing information and interactions with customers at all touchpoints (web, point-of-sale, call center support, etc.) that engenders trust, friendliness, and the customer's desired level of familiarity by HP.

The RE front-end acquisition process sprang forward from a small, high-performance team intimately familiar with both positive and negative customer interactions at a multitude of touchpoints. A full set of "vignettes" was created after many interviews with a variety of customers and HP front-line customer contact personnel. These vignettes portrayed desirable customer interaction scenarios and the customer experience as the customer interacted with the system and/or HP personnel used the system.
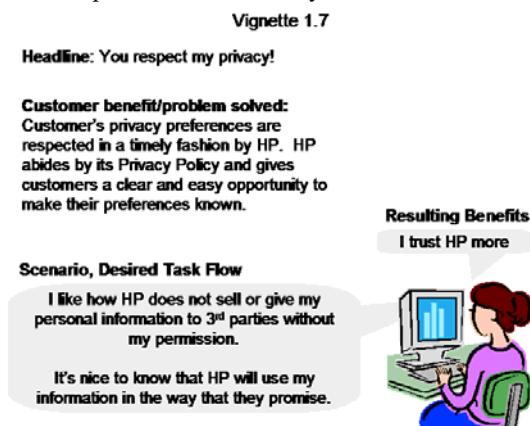

Figure 3. A customer communications system vignette

A key aspect of these vignettes was the documented "inner dialogue" of customers and HP personnel. The vignette in Figure 3 enabled a better understanding of the customer scenario, the customer experience, the benefit and the needed capability in the context of cus-

tomer privacy. However, the vignettes were not restricted to just business policies or external customers. They also addressed internal HP users. For example, another user scenario illustrated the need for an internal HP user to easily migrate data from legacy systems with speed and simplicity to a centralized repository. Again, the scenario described the customer scenario, the customer experience, the benefit, and the system capability but from the internal user's perspective.

These were validated by a meaningful sampling of customers to ensure the essence of the requirements or needs was captured. These vignette scenarios were then converted into customer and business requirements (customer, HP, system) that were entered into an RE database tool. The linkage (one-to-many) between the vignette and the satisfying business requirements was maintained. Next, a team including an end user representative, a technical internal HP IT project manager, and several RE experts derived functional and qualitative requirements from them. They also were entered into the database. Backward and forward pointers were recorded to maintain traceability through the system. This set of requirements was then used as the backbone for the creation of an RFI (Request for Information) document to solicit scope, schedule, and cost estimates to develop this system from interested third party vendors.

The RE team consciously avoided crafting or rejecting requirements based on existing legacy systems. Constraints imposed by those systems were to be considered later. Meanwhile a set of requirements that reflected the ideal system was defined which rewarded creativity and innovation by third parties.

A primary business driver for this RE approach was the cost of outsourcing. It reinforced the goal for early, accurate, relatively stable, complete, and high-quality requirements. The need for thorough documentation and traceability was evident given the relatively long development cycle and that the outsourced developers were not involved with the development and documentation of the requirements. The ill-consequences from inaccurate, vague, or incomplete requirements are costly and obvious. The use of outsourced developers to develop the system is a key differentiator from the previously described project. The contrast is magnified even further given that the hpshopping.com projects were typically developed on the same floor of the same building.

Key RE process success factors include:

- creating clear, complete vignettes with inner dialogue of customers and HP personnel,
- using vignettes to easily communicate value-added capabilities related to requirements to the stakeholders including management and sponsors,

- focusing on customer experience versus the more traditional problem/feature focus,
- providing full traceability from vignette-to-requirement-to-capability-to-feature in order to support deeper understanding of the requirements and dependencies when scoped,
- using the requirements to drive the RFI process and IT system architecture work,
- dedicating a cross-functional team (system, world-wide headquarters, international regions, and external consultants) to the project throughout the entire RE process,
- using top performers for an important and relatively expensive project.

4. Conclusion

This industry experience report documented some of the attributes of an agile, lightweight, and internet-speed eServices project and that of a Customer Communications System project that was large, complex, and planned to be outsourced. Table 1 shows a summary of some of the key attributes of these projects.

Table 1. RE project attributes

	hpshopping.com	Customer Communications System
Business Objective	Deliver projects defined by HP product lines to web storefront	Develop a system to manage HP/customer information and interactions
Primary Business and Project Attributes	• Fast-cycle time • Web-based • Close client proximity • Analyst knows client domain • Small sets of requirements	• Development time relatively long • WW clients and analysts • Outsourcing used in development • Large, complex requirements
RE Process Attributes	• Prototypes used for refinement • RE of portfolio of projects • Short, repeated RE cycles done by the same team	• Vignettes used to capture "inner dialogue" • Vignettes used to communicate requirements • Focus on customer experience

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• Close teaming of IT analyst and client rep • Quick, early decisions on requirements; refined later • Light RE process and documentation • Implicit traceability	• Tool used for RE documentation and traceability • Dedicated WW RE cross-functional team • Architecture and RFI process driven by RE results • Use of top performers

The RE approaches were different and based on the differing project's business drivers and project attributes. The hpshopping.com project relied primarily on early requirements engineering decision-making during the planning phase, strong cross-functional teaming with leadership role switching, decision-making based on a portfolio of project requirements not just a single project, prototyping to validate and accelerate development, and easily accessible local end user business representatives. Emphasis was placed on greater speed and quantity of project releases that were implemented to the requirements rather than a slower, more methodical, heavy-duty requirements engineering process and documentation.

The Customer Communications System project relied on a small team of top performers who knew the domain very well, a dedicated WW cross-functional team, in-depth interviews with a large set of customers, the creation of vignettes to reflect inner dialogue to provide additional understanding and easy communication, and the use of a tool to create and maintain documentation as well as provide full traceability into a large system definition.

A key learning from these and other projects at HP is that countless variations in projects discourage widespread standardization and adoption of any single, rigid RE process. Rather there is a fundamental meta-process that incorporates close teamwork; locally standardized requirements gathering and documentation among individual project teams; and an efficient, fast-turnaround change management process. From there, the RE process is tailored to best fit the business needs and project attributes.