Powering the Project Enterprise Into The 21st Century

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Abstract

The Project Management Institute (PMI) defines an entire body of knowledge (PMBOK®) as a call for integration of all aspects of a project to allow total control of such efforts. This paper expands upon this position, and proposes that project-oriented businesses now need to think beyond individual projects, and view all business activities involving all participants as one unified enterprise, the Project Enterprise. This unified view demands that key stakeholders, owner companies and contractors in particular, must deploy an integrated information technology (IT) platform capable of orchestrating the project enterprise.

Practical requirements for such a platform are developed in this paper, building on concepts articulated within the PMBOK®, and by Rahbar (2000) who argues for the critical need of a comprehensive Web-enabled system for project control.

It is further recognized that large, complex, engineered projects are the venue for many independent companies bounded by the rules of their individual contracts. Therefore, the requirement analyses and implementation issues presented here examine needs well beyond just project control. These requirements are the basis for a comprehensive project enterprise IT platform (Orchestra™) that has recently been deployed in the marketplace.

Issues Confronting the Project World today

Key challenges facing project-oriented businesses today are long delivery times, high costs, high risks, constant change, scattered project knowledge, and the need to deliver superior quality. Data compiled by Winch (1997) indicate that on average, time overruns on projects vary from 11-17%. Similarly, cost overruns range from 14% to as high as 88%.

The Construction Industry Institute (CII; cited in Rahbar, 2000) also reports that only a third of all projects are built to original plans. These situations are compounded by the fact that in today's world, most projects involve companies from various parts of the world, possibly in remote locations. A project conceived, designed, built and operated by one company in the same geographical region, country, or locality, is a rare exception.

Challenges faced by project-oriented businesses cannot be effectively addressed by piecemeal solutions. A fresh perspective that can help transform the industry

is required. Production oriented industries went through such a transformation phase 20 years ago, when they went from a “Company” to an “Enterprise” world view by allowing unifying information management tools to implement the governance of the Product Enterprise economic system.

These tools include Supply Chain Management (SCM) and Enterprise or Manufacturing Resource planning (ERP/MRP) software. The key enabler in this industry was the digitization of the Bill of Material and shop floor processes. This allowed information for the production environment to be represented as a data model, and for it to be used in conjunction with accounting and financial information to create an integrated enterprise-wide resource-planning tool.

We propose that now is the time to treat “The Project” as a business in its own right, with the need for unified governance and recognition of the responsibilities to the project “shareholder” - the owner. We use the term “Project Enterprise” to refer to this new business.

In this paper, we introduce the project enterprise and discuss the practical implementation of an integrated IT platform to support its unique needs. This platform is founded on concepts compiled in the Project Management Book of Knowledge (PMBOK®; PMI, 2000) and by leading proponents of a Web-enabled foundation for project control (e.g., Rahbar, 2000).

Introducing the Project Enterprise

Project enterprises are temporary economic, business entities that come together to conceive, design, construct and manage large complex custom engineered projects that build infrastructure to supply one or more products to a marketplace. In an idealized sense, such entities are fluid, highly networked, goal-driven, self-organizing systems consisting of multiple players, who are either associated with collaborating corporations or participate as free agents.

Typical stakeholders would include project owners, contractors or EPC's (engineering, procurement and construction companies) and vendors. The mission of a project enterprise is ultimately to fulfill requirements defined by the owner within a specified time period.

The project enterprise is thus very different from the traditional view of a project, which provides only a limited perspective of the entire enterprise. It is also different from a recently coined term, enterprise project management, which focuses on all projects within a *single* organization (e.g., LeRouge, 1999; Vandersluis, 2000), and therefore falls between traditional project management on the one hand, and project enterprise management on the other. Table 1 summarizes key differences between traditional project management and project enterprise management.

Table 1. A comparison of traditional project management versus project enterprise management.

Attribute	Traditional Project Management	Project Enterprise Management
Organization	Internal and Local	External and Distributed
Participants	Relatively uniform teams	Diverse teams driven by needs of the phase within the project lifecycle
Orientation	Tasks and Processes	Deliverables and Results
Focus	Planning, Scheduling and Cost Controls	Organizational Interactions and Knowledge Management
Scope Plans	Fixed, but subject to frequent scope revisions	Fluid, with the recognition that requirements evolve over time
Collaboration	Sequential depending on organizational structure	Contextual and Real-time
Business Structure	Self-sufficient and isolated	Inter-dependent and integrated
Change Attitude	Resistant	Recognized
Decision-Making	Single Project Leader	Distributed leadership
Execution Speed	Low-to-moderate	High

The reasons for abstracting “The Project” as an external business entity are simple. Large complex projects require multiple companies to participate in different roles during different phases within the entire project life cycle. The project life cycle in this context occurs from the initial concept phase at the owner's end, to detailed development and procurement phases under the stewardship of prime contractors, and through construction and commissioning. Therefore, the Project Enterprise is really a transient cross-organizational project oriented business entity.

Currently, participating companies manage phases within the overall life cycle as a series of independent (external or internal) projects. This often results in increased delays, with associated cost implications, because information generated in one or more independent projects must be re-worked for use elsewhere. Considerable effort is required simply to communicate information across inter- and intra-organizational boundaries in a manner that preserves relevant context. There are also obvious impacts on the ability of participating companies to take advantage of cost and time savings that may be offered by e-business opportunities.

Further, effective risk management is also not facilitated because identified risks may be buried in documents generated within an isolated project. Alternately, risks may be propagated across the landscape of participating companies in such a manner that appropriate mitigation strategies are developed without a full understanding of implications across the enterprise.

Additionally, many companies do not effectively use knowledge gained during various projects, because a comprehensive and searchable information base to support organizational learning and knowledge re-use is scattered, isolated, incomplete, and/or unstructured. Finally, evolving requirements demand continual attention to scope management, with contractual implications, across multiple projects that are independently managed.

All of these issues can be addressed effectively only if key project stakeholders move beyond a focus on individual projects, and adopt a more holistic, encompassing systems view, i.e., The Project Enterprise. Adoption of this view requires a focus on managing organizational interactions and the development of a structured knowledge base that has increasing value as the enterprise evolves, into operations, and over the long term as a strategic tool for future enterprises.

Differences between the Project Enterprise and the Product Enterprise

Project enterprises precede product enterprises. Further, the former enterprise is driven by requirements and objectives, whereas demand forecasts and market forces drive the latter. Change and risks are ever-present realities in the project enterprise because requirements evolve on a continual basis. The entire enterprise has to act with agility at all times as if it were one entity despite its fluid state and the combination of participating companies (owner, contractors and vendors). It is also necessary to explicitly define and manage common interfaces among these companies.

Traditional product enterprise solutions (SCM, and ERP/MRP solutions), which are designed to handle cyclical supply-demand situations, cannot be deployed to meet the needs of all stakeholders in a project enterprise. Instead, project enterprise IT solutions must be designed from the ground up to support the needs of highly complex engineering design, contractual, procurement and other processes involving multiple companies in a dynamically changing supply chain.

Information Technology Requirements of the Project Enterprise

The Project Management Institute (PMI), an organization focused on bringing together best practices related to the project world, has recently synthesized concepts about this complex field into a comprehensive publication entitled the Project Management Book of Knowledge (PMBOK®; PMI, 2000). The PMBOK® embodies nine key knowledge areas and associated processes (Fig. 1). Although the principal focus of the PMBOK® is on (traditional) project management, these knowledge areas and associated processes are generic enough for extrapolation into the realm of the project enterprise. The more critical issue is the need for an IT platform to fully support the enterprise.

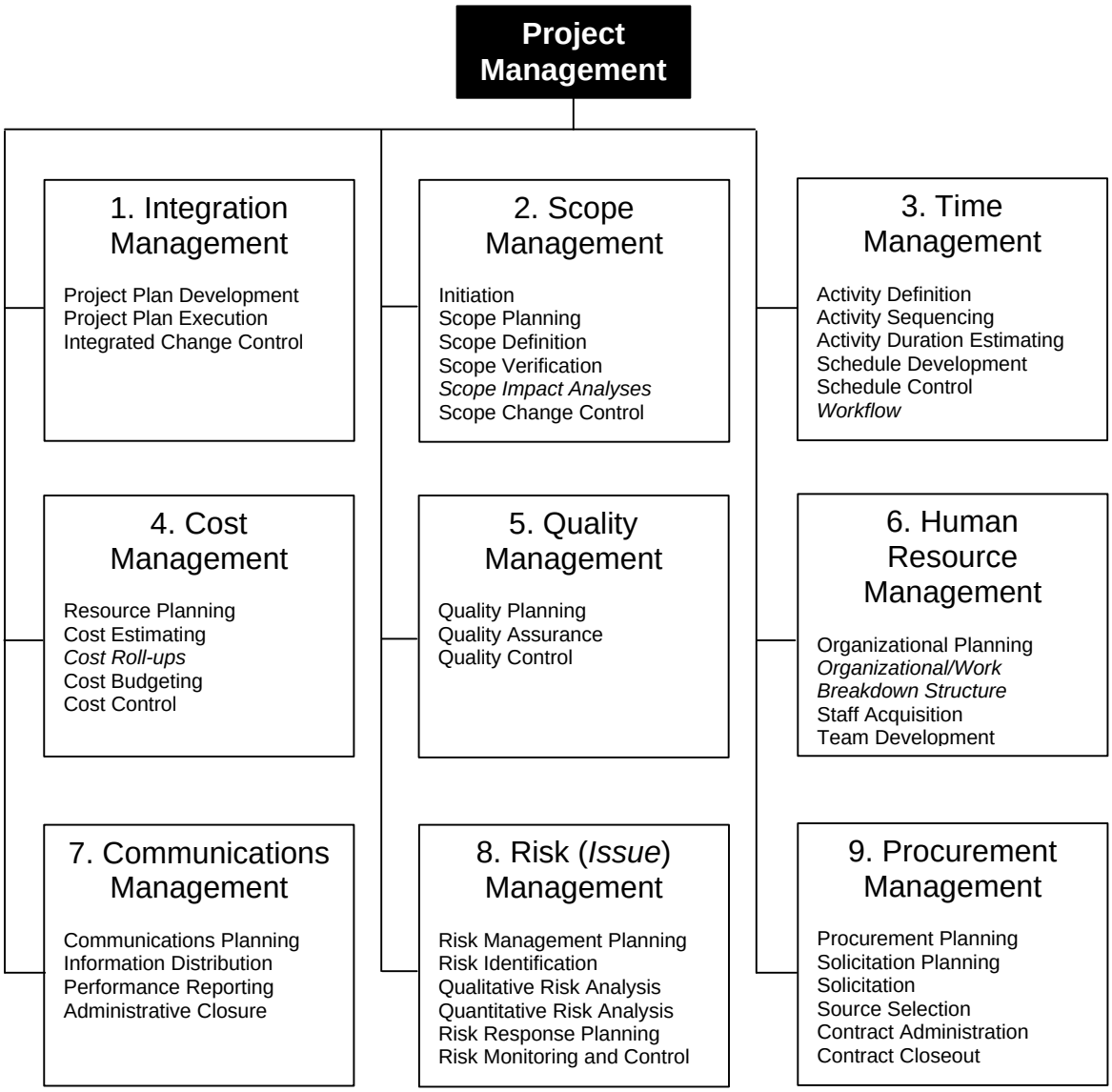

Figure 1. Knowledge areas and processes for a traditional project management scenario adapted from the PMBOK®. Italicized items represent elements that have been added by the present authors. Source: PMI, 2000.

An IT-driven stream that has been occurring in parallel with development of the PMBOK® has resulted in a range of project management offerings in the marketplace. Interestingly, however, most technology vendors have not taken advantage of the impressive body of knowledge that the PMI and other project-related companies have synthesized. Even solutions that extend across individual companies have largely focused on providing Web-enabled document sharing tools coupled with e-mail alerting, notification and scheduling features. These efforts have essentially resulted in additional island solutions that remain

disconnected from the business realities of the project enterprise, and offer little value from the perspective of creating a long-term knowledge base.

Rahbar (2000) laid out a prototype project controls framework intended for deployment over the Web. This framework mirrors many of the concepts captured within the PMBOK® and additionally depicts a range of data flows in the traditional project controls environment (Fig. 2). Rahbar (2000) also discusses the need to integrate such a framework with existing databases and related software applications as a means to provide the entire project team with relevant information and status indicators on an as-needed basis.

An IT platform to power the project enterprise into the 21st Century requires appropriate representation of the PMBOK® and data flow concepts captured by authors like Rahbar (2000). The three fundamental requirements of such an IT platform are the following:

1. Project enterprise structuring;
2. Context-sensitive knowledge representation; and
3. An open, extensible, and scaleable architecture.

Project Enterprise Structuring

Requirement-Response-Linkage Triad: Requirements constitute the driving force behind any project enterprise. The term “requirements” is used in this context to describe formal objectives flowing down from the owner. In a typical project setting where document-based work efforts occurs sequentially, requirements are often specified in large isolated chunks of information that are rarely organized in a systematic manner. This impedes downstream activities from occurring efficiently.

Effective project structuring requires the ability to represent requirements in a hierarchical manner (proceeding from high-level, more abstract elements to lower-level, more specific ones). These requirements may include specifications, tasks, milestones, deliverables or procured items. Requirements structured in this manner provide the foundation for allocating work to relevant project companies and their personnel, describing each element along a number of dimensions, and establishing workflow processes.

A similar structure is also required for the response view of the enterprise, which is the approach that articulates how requirements will be met. Once requirements and associated responses are structured in a project enterprise platform, there is the need for a *linkage* tool that maps one or more responses to a certain requirement.

Such linkage capabilities provide support for assessing compliance of the response(s) with requirements (for red team analysis or during bid responses that are evaluated by an owner), facilitate the automation of evaluation procedures (such as bid tab evaluation), enable the project owner to trace project

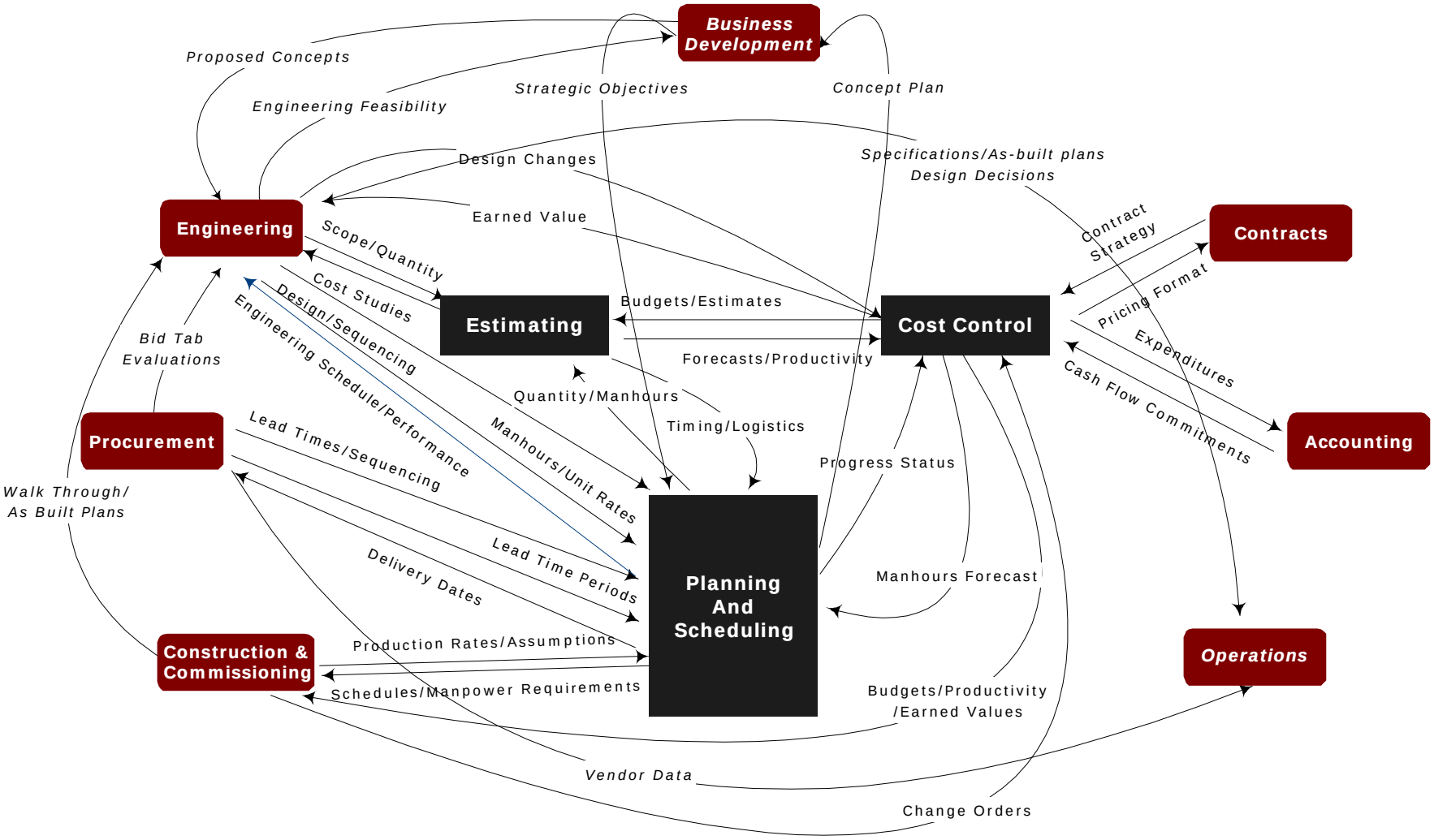

Figure 2. Project control information flow pathways adapted from Rahbar (2000). Italicized items represent business units and information flow items that have been added by the present authors to extend the life cycle of the project from concept to completion, and into operations.

history through different phases, and allow impact analyses along multiple dimensions (e.g., scope control, risk identification and mitigation, work progress, etc.) for effective change management.

It is also important to recognize that the requirement-response-linkage triad is a dynamic structure, which evolves over time as the enterprise proceeds from concept to completion. Typical enterprises would be organized as a series of phases with associated requirements and responses that are mapped depending on the context. Further, as an enterprise proceeds through time, a project response for one phase will become the foundation for a set of requirements for the next.

A classic example of this scenario is when a scope of work negotiated between the owner and one or more contractors' forms the basis of a set of requirements, for which the associated set of response would be a dynamic project execution plan. This pattern of data flow (from the response to the requirements side) over the project enterprise lifecycle is captured in Table 2. Clearly, any enterprise IT platform must support the entire lifecycle of the "project" (from concept to completion, and operations) as well as concurrent activities. For instance, the project execution and procurement activities will likely occur in parallel. Clearly, it is this ability of an enterprise platform to drive project phases into a concurrent mode that will most benefit owner companies in terms of reducing time to the first stream of revenues.

Table 2. Typical phases in a complex engineering project with relevant players, and associated requirement and response views. The arrows show data flows from the response view of one phase to the requirements view of one or more subsequent phases.

Phase	Typical Stakeholders	Requirement View	Response View
Concept Development	Owner	Internal (Business Requirements)	Engineering Feasibility Analysis
FEED (Front-End Engineering Design)	Owner/FEED Contractor	Front-End Engineering Requirements	Preliminary Engineering Design
ITB (Invitation to Bid)	Owner/EPC	Bid/RFP Requirements	Detailed Proposal Response
Project Execution	EPC/Owner	Scope of Work	Project Execution Plan/Detailed Engineering
Procurement	EPC/Vendor	Component Specifications	Component Design/Delivery
Construction & Commissioning	EPC/Vendor/Owner	Construction Specifications	Construction Contract/ Execution Plan
Operations	Owner	Maintenance Requirements	Maintenance Management

It is important to note that each phase within a project enterprise listed in Table 2 would have a unique linkage map relating one or more responses to a relevant requirement. Data flow into the operations phase is not shown because the assumption is that it inherits the entire knowledge base developed from concept to commissioning, and expands upon it for use in future projects.

Data-Centricity: Apart from data flow between project phases, changes to the requirement-response-linkage triad may also occur within discrete phases of the project enterprise as new needs emerge. The implications of these observations are that any IT platform designed to support the project enterprise must be *data-centric*, rather than *document-centric*. In data-centric systems, raw data are separated from their representational schemes. Multiple views of the underlying data (including documents) can be created by assigning various forms to the same data. Data-centricity, therefore, incorporates document-centricity and enhances it by allowing different representations of the same data. A major advantage of data-centric solutions is that data manipulated in one place can automatically be updated in all other places.

Traditional, document-based approaches promote sequential processes, cause considerable re-work, tend to bury critical information, and limit the ability of companies to adapt quickly to new business needs. A data-centric platform, on the other hand, inherently supports concurrent work, supports multiple and customizable views of underlying data elements, allows monitoring of relevant information to trigger workflow and alerting processes, and ensures that participating companies/personnel can rapidly respond to emerging or changing needs.

Equally importantly, data-centric representation of project knowledge automatically creates data liquidity for projects making it far easier for the staff and participating companies to transmit data into e-business transactions such as those in e-marketplaces and e-procurement engines. The use of a generic framework, which supports a hierarchical structure to represent project requirements and responses, allows enterprises to treat major systems and sub-systems as objects that can easily be transplanted from one project enterprise to another like building blocks.

This is a major step towards the standardization of processes and uniform application of best practices within participating companies. In the same manner that standardization was only possible after the manufacturing industry turned towards a component-based approach, data structures in the project enterprise IT platform will become the building blocks from which complex projects in the future can be easily assembled. Such an adaptive, reusable approach to future project enterprises has significant cost, time and quality implications.

Organizational relationships: In addition to supporting effective representation of the requirement-response-linkage triad and inter- or intra-phase data flows, a project enterprise IT platform must allow *organizational relationships* to be

appropriately represented and *proprietary knowledge* to be securely managed. Of particular interest to owner companies in this regard is the need to maintain control over distributed work elements during all phases of the project life, to provide access to corporate guidelines and policies only to its own employees, to provide intelligent search and data mining tools, and to manage common interfaces among project components that are designed, delivered and built by different companies.

In terms of the latter requirement, detailed engineering activities involving one owner and four contractors may have as many as 15 organizational interfaces that must be managed to ensure progress towards enterprise requirements. These contractors are often competitors in other contexts and therefore have an interest in exposing information selectively, and on an "as-needed" basis. Consequently, access to relevant information must be provided on a secure, "as-needed" and flexible basis taking into account both organizational relationships as well as individual work responsibilities.

The enterprise IT solution must thus allow organizational relationships to be mapped into the project structure relieving costly overhead in managing transmittals. Moreover, the project information itself carries that relationship with it, which means that data mining activities in the future will not compromise ownership and access issues. The ability to represent enterprise relationships and work efforts in a flexible but robust IT architecture is thus critical in terms of rapidly adapting to a new phase within an existing project enterprise, or for deploying entirely new enterprises.

Context-sensitive Knowledge Representation

As previously discussed, the PMBOK® recognizes nine knowledge areas and associated processes (Fig. 1). In a data-centric environment, it is possible to further enhance the value of such knowledge attributes by using them to represent *each project element* in a context-sensitive manner. In other words, each project element (on the requirement and response sides) would be represented by relevant attributes in a data schema that constitutes the entire body of knowledge for that element. The PMBOK® knowledge representation scheme was intended as an overarching framework for project management. At the level of individual work elements, knowledge attributes indicated in Figure 3 are more appropriate. Relationships to the PMBOK® for each of these attributes are also shown, within parentheses, in this figure.

Clearly, content for each of these attributes may not be required for all project enterprise elements; that determination is best left to responsible users. The benefits of such a data schema include the ability to:

- Support all communications in a contextual manner;
- Effectively manage work assignments and workflow;
- Allocate relevant engineering/contractual specifications and datasheets;
- Handle budgets, job costs and actuals at an elemental level;

- Identify and mitigate risks and issues; and
- Provide support for information captured in documents such as engineering drawings.

These knowledge attributes are discussed in further detail below.

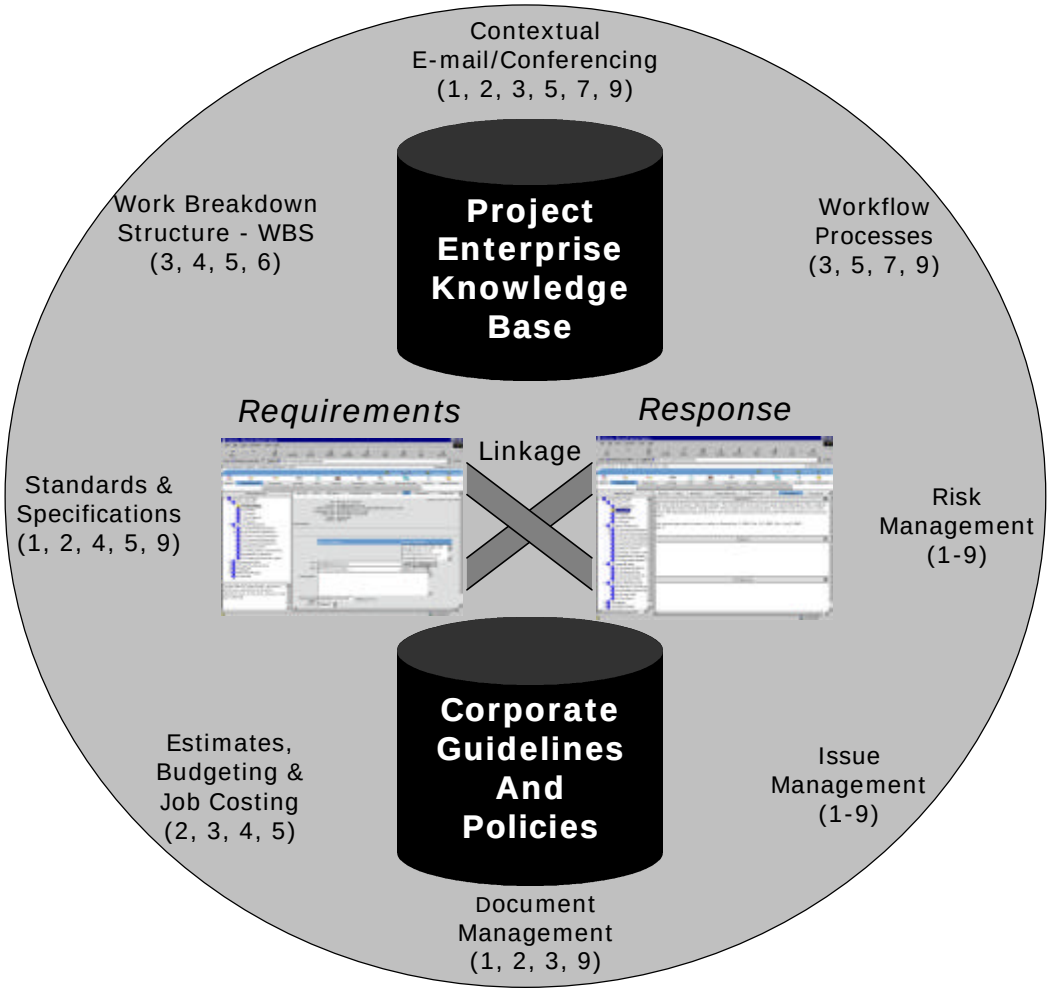

Figure 3. Attributes required for context-sensitive knowledge representation in a project enterprise. Relationships between each attribute and relevant knowledge areas in the PMBOK® (see also Fig. 1) are also shown. The requirements-response-linkage structure reinforces the notion of a contextual "body of knowledge" for each work element within the enterprise.

Contextual E-mail and Conferencing

E-mail communications, which are ubiquitous today, were designed for person-to-person correspondence. Such tools are so commonly and frequently used in today's work environment, that they are actually a significant contributor to information and work overload (Jensen, 1999). This is partly due to the voluminous quantity of e-mail messages, and partly due to the fact that e-mails are not automatically filed according to context.

The “subject” of an e-mail is the specific topic covered in that message. It is not the context to which that e-mail belongs. For example, a subject marked “Design Change Request” may relate to the flange on a pipe in one context, and to the internals of a methanol-cracking tower in another. The fact that multiple contexts and subjects may be buried within the e-mail only complicates matters further.

Context switching is a very expensive and wasteful exercise, and forces each e-mail recipient to maintain separate filing systems (folders) simply to keep track of communications. Access to these systems must be provided to members of the project who have a need-to-know requirement. This requirement cannot be easily supported by current e-mail systems. All of these situations can cause information to be overlooked, lost, improperly filed, or simply ignored.

As the number of project enterprises within which such members participate increases, there is an exponential rise in e-communications that need to be systematically organized. Another key issue is that enterprise team members typically do not have access to the relevant body of knowledge for the work element(s) in question leading either to poor or incorrect responses, with obvious implications for costs, time, and work quality.

It is therefore our position that e-mail communications for the project enterprise should be context-to-context rather than person-to-person. Person-to-person e-mail should be used only for confidential personal communication that both author and recipient have no desire to share with anyone else. As an analogy, communications between members in a physical project office are usually conducted either within a fixed context or between two contexts.

An example of a context-to-context communication would be a procurement officer communicating issues about a pipe flange with the fabrication unit of a piping vendor. Similarly, an engineer and the procurement officer may communicate specifications of that pipe flange within the same context for the same project. The fact that different people may have fulfilled the role of the procurement officer or the engineer is not relevant so long as all personnel authorized to see the communications were able to see it.

In other words, communications to individual project members should not necessarily be based on the fact that they are addressed in an e-mail message. Instead, they should be based on the relevance to work responsibilities and

occur within the context in question. This also implies that contextual e-mail messages can also be automatically triggered by workflow alerting engines. E-mail exchanges in a contextual system would also take the form of threaded discussions to further preserve context. Such a system would obviate the need for separate e-mail organizing systems, and create a self-organized decision trail for future reference freeing up considerable time for more productive work.

Conferences and instant messaging are to be treated in much the same way. This simple yet powerful concept will allow companies to become more event driven and concurrent.

Work Breakdown Structure (WBS)

Planning and managing the WBS for a complex project enterprise is one of the biggest challenges for team leaders today. In part, this is because software systems used for resource allocation (e.g., traditional project management software) are typically independent of the content in work elements that drive the allocation process. If the WBS is made part of the body of knowledge that describes requirement or response work elements, orchestration of work efforts becomes more efficient.

Many project management software tools have excellent tools for managing resources once work assignments are decided; therefore, an implicit requirement of the enterprise IT platform is that it should interface with such tools. When this is supported, adoption of the new technology is facilitated because it builds upon practices that team members have become accustomed to.

Workflow Processes

The term “workflow” is used in this context to describe relationships of various work elements (specifications, milestones, deliverables or tasks) in a project enterprise. The enterprise IT platform must provide support for defining dependencies among work elements to create the network of activities that must be orchestrated to ensure that milestones and deliverables are successfully attained. Creating such dependencies at the context of each work element ensures that relevant team members know exactly what is to be accomplished and when. As previously indicated, because electronic communications are also tagged to the context, automated procedures can be instantiated to remind team members about critical workflow events.

Standards and Specifications

A major component of engineering projects, and one that is usually handled as an island set of activities, involves systems (or process) engineering and contractual activities. These include industry- or company-defined standards and specifications, datasheets, and information pertaining to inputs, outputs and interfaces (e.g., such as those specified for process flow and piping & instrumentation diagrams). Similarly, contractual information involves extensive use of standardized contract vehicles, specifications, and administrative clauses.

Representing all of these types of information as data-driven templates within the context of relevant work elements immediately adds rich data warehousing and mining capabilities to the project enterprise platform. For instance, “smart” datasheets implemented as standardized XML templates allow equipment or component purchasers to add live data that can be queried, analyzed and responded to by relevant suppliers. These data can also serve as addressable information for use in engineering calculations. Bid tab evaluation processes to assess supplier responses are also easily automated and simplified with obvious time and cost savings. Further, packaging specifications and smart datasheets with contractual information allows project components to be seamlessly interchanged with e-procurement and e-marketplace engines with little, if any, re-work effort. The time and cost benefits of such functionality are obvious.

Project Estimates, Budgeting, and Job Costing

During the front-end development as well as execution of a project, estimation and budgeting tools are an integral part of the project enterprise solution. Until scope definition is complete, or individual contracts have been awarded, estimation tools and historical data (from back-end financial systems) must be made available for participants who bid on segments of the overall scope of work. After awards have been made, estimation tools must be replaced by a budgeting process that allows base-lined allocation of resources for scope execution. During actual execution, the process transitions to a job costing mode where the emphasis is on capturing “actuals” pertaining to the use of material and labor resources, accounts receivable and deliverables.

The project enterprise structure must be segmented to allow management by designated authorities. Since these responsibilities may lie in multiple companies within the overall project enterprise, access to back-end financial systems must obviously be restricted from the front-end enterprise platform. This is because sensitive cost estimates and internal estimation tools should be accessible only to designated personnel from relevant companies. At present, each company maintains independent financial and accounting systems that capture transactions and maintain historical data, which are used for estimation purposes. Integration to these systems in a secure manner is a desirable long-term goal.

The budgeting process uses data from the estimating process and from accounting systems to maintain correlation between work elements and accounting budgets assigned to them. This process will also require integration with back-end accounting and financial systems if true seamless behavior is to be maintained. Note however, that scope elements would be tied only to the accounting system of the company responsible for that portion of the overall scope.

Budget interfaces between companies participating in the project would be derived from the contractual elements and the underlying smart contract sheets (which are analogous to engineering datasheets previously discussed in the

section on *Standards and Specifications*). This is because the budgeted cost of procured items is defined within the terms of the corresponding contract.

A very complex issue that needs to be addressed in this context is the fact that budgeted costs have a time dimension tied to events that may differ according to contract types. For example, in certain contracts, payments are tied to milestone events, whereas other contracts involve payments that are made on the basis of monthly estimates. Certain contracts may even involve payments that occur only upon delivery of complete systems. Most contracts also have complex holdback terms, and contingencies that need to be addressed. Therefore, the budgeting process must be capable of integrating all of these commitments and layering them into associated work elements (i.e., the WBS), which are bounded by individual contracts.

During execution, the project enterprise IT solution must support structured data interchanges (e.g., need dates and specifications) with relevant procurement systems. These may include back-end financial systems, supply chain solutions deployed by individual companies, or e-market/e-procurement engines.

The ability to compute and present actual costs incurred needs to be supported in real time if at all possible. This is important because real time data offer the only mechanism to truly tighten the project control loop. For example, labor costs in project budgets are usually captured at the employee's organization. Rather than re-keying these data, the long-term approach should focus on allowing linkages to back-end accounting systems. Until such systems integration tools are in place, direct entry may be required.

Material purchases, component delivery and contract milestone payments also need to be captured from accounting and financial software systems. Material delivery tickets and inspection certificates would also need to be posted and interpreted by the project enterprise IT solution. Likewise, labor resource projections, need dates, and scheduled dates must also be posted by the project enterprise solution to back-end accounting and order processing systems in order to completely close procurement and work progress loops.

It is conceivable that if back-end systems do not grow their internal capabilities to make such integration easy and dynamically configurable, project enterprise solutions will end up with the burden of supporting these transactions as well.

Risk and Issue Management

Identification and mitigation of risks and issues are critical dimensions of effective project management. A number of tools are available to identify risks and issues in traditional project management offerings. However, these tools are either not integrated into a common management platform, or provide only a document-based approach for identifying risks and issues; in both instances, there is little connection with the context of the work element for which the risks and issues have been identified.

All of these situations typically result in risks and issues not being proactively addressed. In certain instances, identified risks or issues may remain buried within documents without opportunity for timely action.

Providing tools for effectively managing risks and issues within the context of relevant work elements is again a critical requirement of any project enterprise IT platform. This is because the amount of information generated over the life of such efforts is large and impacts of risks and issues that are not adequately addressed can be significant. Consequently, a certain degree of automation is required to ensure that risks/issues are both identified and addressed in a timely manner. Further, risk management tools must also support continual assessment of the present value of estimated risk. All of these requirements can again be accomplished only within a data-centric enterprise platform.

Other requirements with regard to risk and issue management include additional security considerations (for sensitive items), the ability to assign priority levels, assessment of the likelihood of occurrence, mitigation strategies, impacts of such strategies for other work elements, and traceability aspects over the enterprise lifecycle.

Document Management

We have previously discussed limitations of purely document-centric approaches within the context of project enterprise management. In many situations, however, documents (particularly engineering visualization and design drawings) are important sources of knowledge. Their benefits can be best realized in an enterprise IT platform by designating a document management component within the context of each work element. This prevents the proliferation of documents across the enterprise space, at the same time ensuring judicious use of the content captured in them. Typical document repository features (e.g., version control with rollback features, mark-up capabilities, and viewing support for multiple file formats) should be provided with such functionality. An alternative may be to link the enterprise IT platform to more extensive document management solutions that may already be place in a corporation while retaining the context-sensitivity of the document repository.

Open, Extensible, and Scaleable IT Architecture

In principle, project enterprise IT solutions should be capable of supporting the enterprise team instantly, out-of-the-box, and with minimum training. They should also be completely capable of delivering functionality derived from integration with other business applications. The solution needs to be scaleable, and its interfaces to the outside world open and inter-operable.

For predominantly project-oriented companies, internally hosted enterprise solutions are very sensible. For companies who need to access the project enterprise platform less frequently, Application Service Provider (ASP) implementations in which relevant applications are rented offer a powerful and

cost-effective deployment pathway. A combination of the ASP model with relevant databases hosted within the IT infrastructure of the Lead Company is yet another alternative that offers advantages of both the enterprise as well as pure ASP solutions.

A project enterprise IT platform deployed by large owners and contractors will typically require integration pathways with legacy or in-house systems that may already be in place. This is to reduce data re-keying that may otherwise be required. Access to such resources would, of course, only be available on a secure basis to members belonging to this company. Other project participants (e.g., EPC's) would typically be given access only to the direct functionality of the IT platform, and not to other internal networked resources. They would also participate only during relevant phases of the project lifecycle (not beyond it). Such entities would need to deploy their own enterprise IT solution if they desire to build a structured knowledge base for use in other ventures.

Integration pathways may include unidirectional or bi-directional data flow, on a real-time or event-driven basis, to one or more specialized software applications serving the needs of different business units. These units may include business development, contracts, engineering, finance and accounting, procurement, construction and commissioning, and operations.

The Orchestra™ Project Enterprise Platform

PointCross has deployed a unique IT platform (Orchestra™ Version 2.3), with an Internet-based suite of integrated business applications explicitly designed to meet the requirements of the project enterprise. These applications allow participants (owners, contractors, and/or vendors) in a dynamic project enterprise to collaborate in real-time by the use of a clear, logically structured data-centric environment that is tied via integration pathways into existing information infrastructures (Fig. 4). Orchestra™ provides support for all phases of a typical engineering/construction project lifecycle: concept to bid, front-end engineering design, invitation to bid (ITB), preparation of bids, evaluation of bids, detailed engineering, construction and commissioning, execution, and operations.

Orchestra™ is currently being offered as the project enterprise IT platform to several Producers, Owners and EPC's in the Energy vertical market. Earlier, prototype versions of the software have also been successfully used to develop bid responses and execute contracts for projects in the defense, telecommunications, environmental, and road transportation sectors.

Conclusions

The project enterprise is an economic and business entity with unique characteristics stemming from a requirement-driven orientation that is in continual flux over its life cycle. The complexity of this entity and its need to be constantly agile cannot be managed by the use of simple-minded collaborative or piecemeal applications within individual firms. Instead, unique characteristics of the project enterprise demand a set of fundamental requirements for a

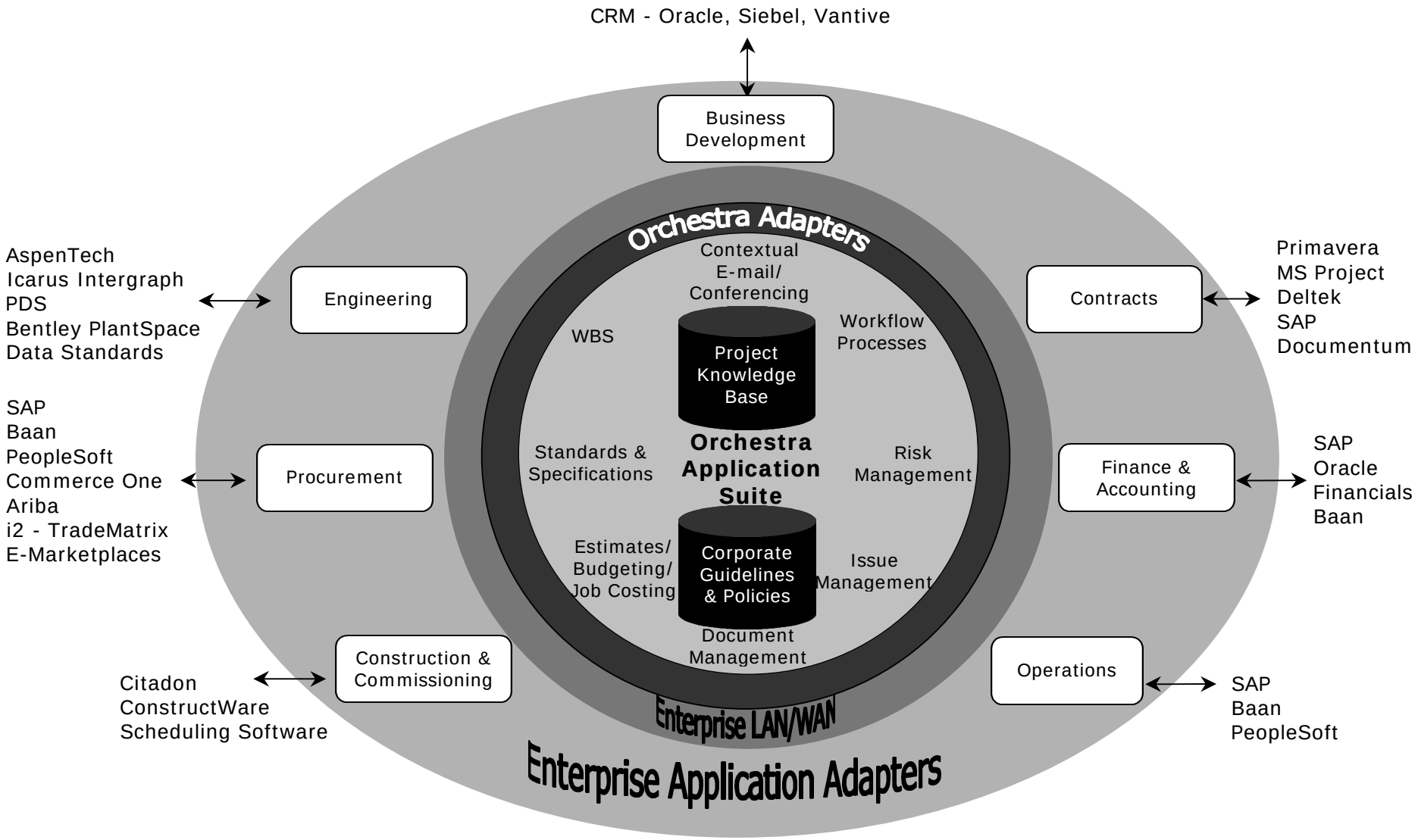

Figure 4. The Orchestra application suite with integration pathways into software solutions that service other needs of various business units. Integration occurs via the use of specialized adapters at the Orchestra™ end, and enterprise application adapters for different commercial software applications. Only typical examples of such applications are illustrated.

comprehensive IT platform that must be explicitly designed to service this new enterprise. Previous work by the PMI and authors such as Rahbar (2000) implicitly point to three core requirements for such a platform: project enterprise structuring, context-sensitive knowledge representation, and an open, extensible, and scaleable architecture.

PointCross has expanded upon these core requirements, and designed a robust IT solution that provides all of the functionality to effectively orchestrate the entire project enterprise, from concept to completion, as well as operations.

The onus is now on the management of project-oriented businesses to embrace the new reality of the project enterprise, and to deploy a robust IT solution to support it. As Rahbar (2000) has pointed out, the time to capitalize on the benefits of such solutions is now. The risks and costs of not adopting them (in terms of negative impacts on productivity, innovation and competitive advantages) are high.

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