Evolving Distributed Project Management

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Industries in general can benefit from analyzing how the defense industry is changing to effectively meet the challenges of new drivers and enablers of complex, distributed project management.

The ever-increasing growth and complexity of software-intensive systems that has occurred over the last 20 years and the ensuing rise in geographically distributed projects are trends that are here to stay. Leading the charge into large, complex, dispersed systems is the government defense contracting industry. Government defense organizations have a critical need (further supported by the war on terror), the ability to make long-term investments based on the public interest, and a culture adapted to embracing distributed work (war fighting has always been a distributed project).

The Systems and Software Consortium, with a membership comprising most of the largest defense contractors, has a unique view into evolving initiatives both in and among its member companies. Here, we describe an array of drivers, constraints, and enablers that are leading organizations to invest in real-time project management information systems. These systems must evolve to support increased decision velocity and cohesiveness in today's increasingly distributed world.

How we got to where we are today

Advances in technology, the growing need for larger and more complex software-intensive systems, the customer's desire to place more risk with the developer, and the need for companies to be more competitive in the marketplace are the principal forces driving project development teams to become increasingly dispersed. Project management is a discipline that surely existed from the beginning of our civilization. Slowly through the millennia, and more rapidly within the last century, an immense body of management knowledge has arisen. A glimpse at project management's history shows that while these practices have served us well, incremental improvements are not enough to respond to today's challenges.

Project management past

In the 1970s and early 1980s, achieving effective software project management became recognized as a significant issue. Projects were often delivered late and over budget and didn't meet requirements and expectations. Thought leaders like Winston Royce, Frederick Brooks,

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Responding to the "Software Crisis"

Several initiatives have been taken to address the "software crisis." As one of the field's old timers, I was fortunate to be part of a number of these, including

- the US Department of Defense's formation of the Software Engineering Institute;
- industry's formation of the Software Productivity Consortium (now the Software and Systems Consortium);
- education programs including the development of the Defense Systems Management College program on the Management of Software Acquisition and George Mason University's graduate software engineering program;
- the development of improved acquisition standards, such as DoD acquisition standards 2167 and 2168;
- DoD's Software Technology for Adaptable, Reliability Systems (STARS) program, which established the foundations for integrated tool environments; and
- the industry's movement toward systematic process improvement.

—*K.N.*

Arthur Pyster, Richard Thayer, Richard Fairley, and Barry Boehm helped chart new directions in software project management. In those days, only a few complex systems existed, and the project development team was much more centralized than today.

As we approached the 1980s and our knowledge and sophistication with software development grew, the number of complex systems began to increase dramatically, and the problems associated with ineffective project management became more acute. Senior managers coined the term "software crisis" to focus attention on providing solutions to this problem; numerous government and industry initiatives were developed in response (see the sidebar, "Responding to the 'Software Crisis'"). Collectively, these initiatives embodied a four-pronged technical and management attack: standardize the process, standardize the product, standardize the support environment, and professionalize the workforce.[1]

In the mid 1980s, the Software Engineering Institute's Capability Maturity Model (CMM) began to take shape. This framework has enabled many organizations to adopt the processes, methods, and tools of effective project management. Product-line management techniques, increased graduate-level education in software and systems engineering management, and the development of such standards as the Project Management Institute's *Guide to the Project Management Body of Knowledge* (PMBOK) also emerged in response to the software crisis.

Project management present

Managing a large, software-intensive system is a complex and intrinsically difficult task. The system is complex and can involve hundreds of staff years of skilled effort, large budgets, and potentially thousands of activities. Many perspectives attest to the facts that the delivery of complex systems on time, within cost, and meeting customer requirements is a significant problem, and that the number of complex systems is increasing (see the sidebar "Keeping Up or Falling Behind?"). This situation doesn't bode well for our ability to improve project management's effectiveness.

The project management discipline is certainly better off today than it was 20 years ago. However, while companies were responding internally, customer behavior, industry structure, and the competitive environment began changing externally at an accelerated rate. The net effect, as evidenced by the data we present here, has been to push the limits to which organizations can effectively manage projects in today's environment. This effect, coupled with the increasing rate of technological change, makes it clear that the current initiatives are not enough.

The drivers

Project managers must adapt to a new set of *drivers*, the changes in the acquisition environment and in the acquisition risk/reward model for industry, and a new set of *enablers* for geographically distributed projects.

The impact of recent federal legislation

Major US Department of Defense (DoD) and other federal legislation has significantly influenced today's acquisition environment (see the sidebar, "Recent Legislation Impacting IT Projects"). Look closely at the legislation's language. Words such as *results*, *streamlining*, *reform*, *reduction*, *improvement*, and *elimination* indicate the acquisition community's changing culture and future direction.

This legislation has influenced government agencies to approach acquiring and procuring complex systems in a fundamentally different way. It has enabled them to say, "I am not going

Keeping Up or Falling Behind?

Many perspectives attest to the facts that the delivery of complex systems on time, within cost, and meeting customer requirements is a significant problem, and the number of complex systems is increasing.

For example, *Winning with Software, An Executive Strategy* describes increasing complexity in terms of the growth of software in military aircraft (see table A).[1]

In addition, The CHAOS report quantifies our poor ability to keep pace with complexity:[2]

- Success rates are improving but are still dismal at 34 percent.
- 15 percent of projects are outright failures.
- A staggering 51 percent are significantly "challenged" (late, over budget, or lacking in anticipated capabilities).
- The level of complexity on IT projects is rising faster than our ability to effectively manage it.[3]

And, finally, 2004 US General Accounting Office report determined the following:[4]

- Software-intensive weapon acquisitions are increasingly critical.
- Current project management practices are insufficient to meet the challenge.

Table A

Software complexity in military aircraft

Year	Aircraft	Percent of pilot's functions supported by software
1960	F-4	8
1982	F-16	45
2000	F-22	80

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to tell you my requirements. I'm going to tell you the objective capabilities I want. I am willing to do business with you in different sorts of ways, and if you want to do business with me, you need to play by these new rules." The government customer has taken on a new industrial awareness and commitment to achieve a business advantage that is beyond a traditional process-improvement mindset. There is an expanded customer emphasis on improvements across the total life cycle, particularly in earlier phases, and a broader perspective on assessing the return on investment from an enterprise performance perspective. The emphasis has shifted from simply building IT systems to the more encompassing goal of providing business value.

The changing acquisition environment

Changes in the acquisition environment—in particular the growing need for larger teams with a wide range of specialized expertise—are rapidly driving industry to a distributed project management environment with new rules of engagement. Table 1, adapted from James A. Kane's presentation at SSCI's members-only event ("11th Annual Executive Round Table: Building Business Value," 21–22 Sept. 2004), frames the business and operational environment we can expect over the next several years.

To top off all of this increased complexity, the shift in the acquisition environment isn't simply in one direction (as in the shift from requirements to capabilities); industry must respond to both sides of the driver equations and do it at a much faster pace to remain competitive.

Changes in the risk/reward model

These changes in legislation and in the mar

Recent Legislation Impacting IT Projects

1990—Chief Financial Officers Act
1993—Government Performance and Results Act
1994—Federal Acquisition Streamlining Act
1994—Government Management Reform Act
1995—Paperwork Reduction Act
1996—Federal Acquisition Reform Act
1996—Clinger/Cohen Information Technology Management Reform Act
1996—Federal Financial Management Improvement Act
1998—Government Paperwork Elimination Act
1998—Federal Activities Inventory Reform Act
2002—Homeland Security Act
2002—E-Government Act (includes Federal Information Security Management Act)

Table 1

Complexity drivers in the acquisition environment

Complexity driver	Explanation	Examples	Implication
Increasing problem complexity. The customer acquisition model is shifting its focus from *requirements* to *objective capability* statements.	In the 1980s, customers typically framed acquisitions in terms of requirements. Now customers often state their needs in terms of capabilities, placing the burden of figuring out the requirements on industry.	The Missile Defense Agency initiative has specified a set of deliverable capabilities due at designated points in the project life cycle.	Project managers must secure the required expertise to address the full scope of issues, which often translates into larger teams frequently augmented through strategic partnerships.
Increasing solution complexity. Customer emphasis is shifting from the *platform* to the *enterprise*.	Software-intensive systems acquisition was much easier when customers acquired platforms, such as a specific aircraft, to be added to their existing portfolios. Today customers frame their requirements in terms of their enterprise needs.	The enterprise is often codified in terms of its enterprise architecture, a systematic description of not only the pieces of the enterprise portfolio of systems but also the complex interrelationships between them. Examples include the Office of Management and Budget's Federal Enterprise Architecture and the DoD Architecture Framework.	With increased emphasis on providing fully integrated systems, project managers must understand their customer's business in much greater depth to address "systems of systems" interface considerations. This increases the need for larger teams with more specialized solution expertise.
Increasing technical complexity. Challenges related to interoperability and interconnectedness have shifted from integrating stand-alone black boxes to integrating across the layers and stacks of the communications/network architecture.	In the 1980s, project managers were concerned about what they needed to integrate their boxes (distinct packages of requirements) with other boxes. In the new world of network centricity, a supplier still needs to integrate the boxes but at multiple infrastructure, transport, and application levels.	Defense Advanced Research Projects Agency's request for proposal for Innovative Information Exploitation Technology and Systems. Even as DoD builds a massive information grid, a new generation of software and sensors is needed to fulfill the promise of network-centricity. Competing firms will need to integrate their systems into the global information grid.	More than ever, the project team must be extremely knowledgeable about the complexities of how their software-intensive products fit into current and future architectures.
Increasing compliance complexity. The application of standards is shifting from *proprietary* to *open standards*.	In the past, industries have leveraged proprietary standards to gain competitive advantage. In today's world of strategic teaming and integration, there is much greater emphasis on interoperability. Also, the number of open standards to comply with is growing.	Rockwell Collins supplies communication products to both commercial and government clients. As part of their project management strategy to reduce costs, they try to minimize the differences in products that satisfy different clients through increased reliance on open standards.	Through compliance with open standards, forward-thinking organizations have developed a new competitive advantage. One difficulty these organizations must face is determining which standards to support.
Increasing team complexity. Project execution is shifting from the *dominant prime* contractor to *strategic teaming* and *mergers and acquisitions*.	More and more, organizations are turning to strategic partnerships and mergers and acquisitions to meet these shifting customer demands. Competing organizations want to ensure the best technologies are being brought to bear across the acquisition life cycle, even if the source of that technology rests outside the current company.	The Army's Future Combat Systems, where the DoD has elevated its requirement for sensors to help fend off rocket-propelled grenades and improvised explosive devices. The technologies to deal with these opportunities will come from diverse sources.	The project manager will face more supplier management and mergers and acquisitions issues. Techniques for managing these diverse relationships must be matched to the organization's differentiating features, such as its size, resources, and process maturity.

ketplace have changed the risk/reward model for industry (see figure 1). Historically, industry and government-contracting organizations accepted certain risk/reward trade-offs as rep resented toward the left side of the graph. In general, industry accepts a higher risk/reward position (point "a" in the figure) than government (point "b"). For example, industry typically prefers the guaranteed profit of "cost plus fixed fee" contracts, while the govern-

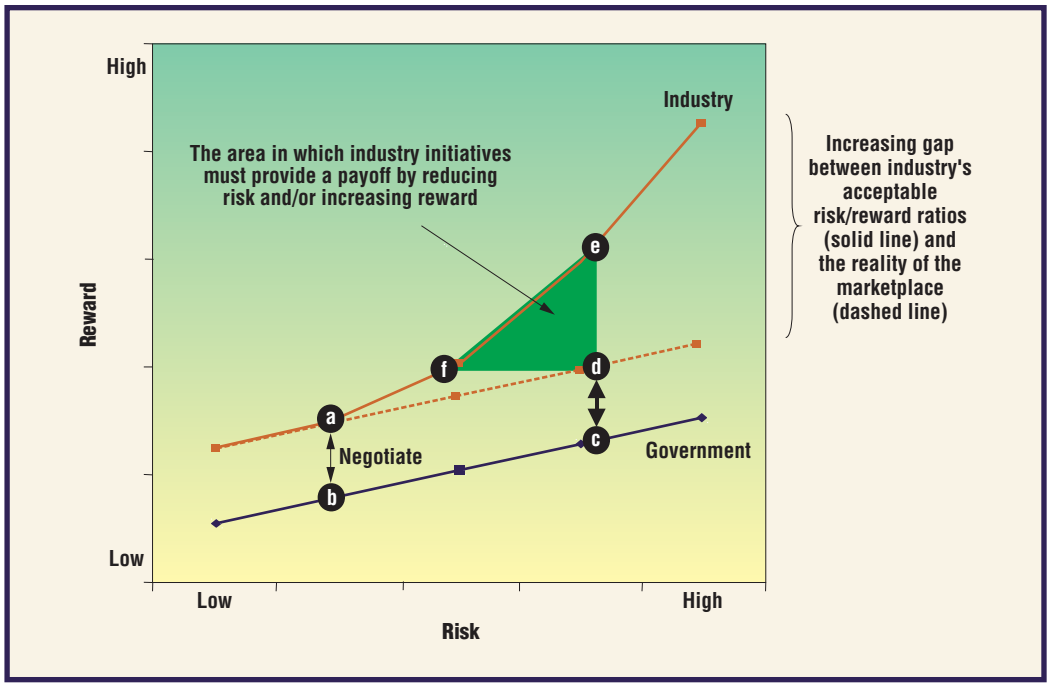

Figure 1. The risk/reward model. Acquisition changes based on previous legislation have introduced new levels of risk. Points "a" though "f" represent risk/reward trade-offs. (figure courtesy of the Systems and Software Consortium)

ment prefers "cost plus award fee"—where part of the contract payment depends on performance. Usually, the two sides negotiate to the satisfaction of both parties.

Industry today must consider much riskier acquisitions, but with the potential for greater reward (point "c"). Yet, not enough risk has shifted out or reward shifted in (to approach point "d") for industry to satisfactorily negotiate the gap. Industry must find some way to either secure a greater reward (point "e") through innovation or minimize the risk (point "f") through systematic process improvement. It is in this green space in the figure that industry must apply process improvements, better software engineering, and better systems engineering. In short, industry must employ better project management, either to yield greater predictability and greater certainty, thereby reducing risks, or to secure productivity gains that enable them to capture the reward differential they seek.

The green space defines a new opportunity area for distributed project management, dependent on effective communications and information brokerage.

Promise, problems, and challenge of leveraging distributed work

Geographically distributed projects let managers compress schedules by employing larger workforces than could fit in a single location (collaboration on any shore), using time zone differences to increase the number of productive work hours in a day (around-the-clock operations), and securing scarce resources such as knowledge experts and other specialized resources no matter where they reside (zero geography staffing).

However, these benefits come with increased risks because of the lack of face-to-face communication, in particular, the potential loss of trust, collaboration, and communication richness. Erran Carmel argues that teams of software engineers need at least a minimum amount of face-to-face meetings to be effective.[2] The agile and Extreme Programming movements suggest ways to increase communication such as *pair programming*, in which programmers share desks so they can see each other to efficiently understand the subtleties of design and debugging. Research on managers engaging in complex information processing that requires rich information and frequent feedback indicates that the more complex the organizational phenomena, the richer the communication must be for the manager to process it effectively. The established trend toward customers placing more risk with the developer means failures at this level will inevitably impact the developers' bottom line and eventually the company's long-term survivability.

The evolution toward distributed project management drives the need for improved processes, methods, and tools to input and share common data.

To successfully manage complex projects, project management practices must evolve to work in a distributed world, focusing simultaneously on people, processes, and technology. According to the CHAOS report,[3]

> *Most project management techniques were designed for co-located teams. Those techniques may prove ineffective in global, multi-site organizations. … CIOs understand that managing a virtual project workforce is not technology dependent. From email to cell phones and pagers, communications abound. Again, people and processes are at the heart of project management, not tools and technology. … Building virtual teams with a minimum of face time, clearly defining work, measuring cybernetic worker productivity and managing employee communications across time zones are major management priorities.*

Yet, managing a virtual project workforce is not technology independent, either. Thomas Malone describes how historically, the high cost of communication prompted organizations' evolution from small, decentralized firms to large, centralized hierarchies to gain efficiencies.[4] The rapidly shrinking cost of communication brought about by the rise of the Internet is causing the pendulum to swing away from centralization, resulting in the rise of decentralized, networked organizations. As a result, project managers seek communication systems that combinatorially support data, voice, video, and virtual presence, and these tools are available today.

But technology by itself is not a solution—it is simply an enabler. Technological advances in communication are enabling profound changes in organizations and management—changes that simply were not possible before.

As we move forward, many additional issues must be resolved before we can take full advantage of the promise of distributed work. Resolved issues have the capacity to become enablers, while unresolved issues act as constraints.

Insights from Consortium research

The not-for-profit membership model of the Systems and Software Consortium (formerly the Software Productivity Consortium) enables a unique perspective on complex systems through its ongoing research and consulting across a variety of organizations. Consortium members include the top contractors to the federal government and the top technology implementers that are transforming how business is done. Working in partnership with these members, the Consortium recognizes the growing use of distributed teams and their unique needs in specialty areas such as process improvement, engineering, measurement, verification and validation, and project management.

The Consortium's research in distributed work began in 2000 and has continued since then with a focus on tools, processes, measurement, and culture. In early 2003, a structured survey of Consortium members identified six issues of primary concern in distributed development (see table 2). The Consortium's ongoing work aims to resolve these issues.

Also in 2002, the Consortium formed a subsidiary organization, the Telework Consortium, funded with federal grants and supported by numerous high-profile and innovative technology partners. Its mission is to demonstrate how advanced tools and technologies for communications can be used as a substitute for transportation. Ongoing executive briefings and a varied list of pilot projects continue to provide the Consortium with insight into the requirements and realities of working in a distributed manner. Table 2 also includes lessons from the Telework Consortium.

Enablers

Through the lens of this research, we can begin to build a vision for project management in the future. The evolution toward distributed project management drives the need for improved processes, methods, and tools to input and share common data (such as technical, financial, project, and communication). The need applies across the project life cycle (for example, R&D, concept exploration, demonstration, engineering, production, support, and disposal) and among all or selected elements of the team (primes, subcontractors, vendors, customers, oversight agencies, and so on). In our global economy, there's a growing need to decrease the time it takes to make an informed decision, to improve the team's "decision velocity." Also, despite being geographically separated, the participants must be highly visible to each other (the concept of

Table 2

Top issues in distributed development*

Issue	Potential enablers	Current constraints
Strategic: Difficulty leveraging available resources.	■ Understanding common issues on distributed projects so that stakeholders can anticipate and manage risks. ■ Knowledge management systems, especially expertise management systems.	■ Best practices are often deemed proprietary. ■ Time consuming to implement and maintain.
Project and process management: Difficulty synchronizing work between distributed sites.	■ Integrated quality frameworks help define synchronization points between work teams. ■ Shared workspaces for storing files in centralized, accessible locations paired with workflow capabilities can increase efficiency for distributed teams. ■ Engineering tool vendors are beginning to release distributed versions.	■ Complex projects often involve organizations at various maturity levels, making it difficult to implement a standard process across the project. Even organizations at the same maturity level might implement processes in incompatible ways. Different organizations might subscribe to different quality frameworks all together. ■ A wide range of choices, each with different user interfaces that might require familiarity training, can be costly and time consuming to set up and maintain. ■ Still need to integrate these into a real-time project management reporting system.
Communication: Lack of effective communication mechanisms.	■ Asynchronous collaboration tools (email, electronic bulletin boards, voicemail, search agents and change alerts, and so on). ■ Real-time collaboration tools, including virtual presence. ■ Standardized, simplified display of information to combat information overload.	■ Loss of communication richness increases the risk of miscommunication. ■ Lack of bandwidth, robust security, and inexpensive appliances (though these issues are becoming less of a challenge). ■ Agreement required between partnering organizations and with customer—each have their respective informational requirements.
Cultural: Conflicting behaviors, processes, and technologies.	■ Targeted training for managers and employees on distributed projects. ■ Advances in process, methods, and tools.	■ Hard to quantitatively justify investments in soft skills. ■ Adaptation is difficult because managers might not mind change, but they mind being changed. It is a very conservative, risk-adverse environment.
Technical: Incompatible data formats and exchanges.	■ XML Web Services for data exchange. ■ Standards for real-time collaboration are converging.	■ Lack of industry-wide standard schema for software-intensive development projects. ■ Leading standards are still being defined.
Security: Ensuring electronic transmissions' confidentiality and privacy.	■ Emerging standards for secure messaging, including role-based security and encryption technologies.	■ Numerous competing standards are evolving simultaneously. Current offerings can be expensive to administer, inconvenient to use, and incompatible. No solution is fail-safe, leading to difficulty establishing appropriate limits for sharing of intellectual property across organizational boundaries.

** These issues were identified through guided interviews with lead engineering managers of approximately 75 percent of SSCI member companies, January–March 2003. The organizations' combined annual revenue is well over US$100 billion.*

virtual presence) to maintain trust for discussion, deliberation, and negotiation. These needs, in turn, require a renewed focus on the enablers of successful project management in a distributed world.

Tools and technologies

The rise of the Internet as a ubiquitous connection between distributed locations and the quickly maturing marketplace of collaborative tools are essential ingredients for complex

Organizations are now beginning to leverage real-time collaboration tools to bridge the soft skills gap for distributed teams.

project success. Software vendors already have released Web-enabled versions of many familiar project management tools, enabling specialized tasks such as tracking requirements, schedules, and budgets to be distributed to multiple sites and scaled for multiple users. Software engineering tool suites are beginning to follow suit. Similarly, more organizations are employing Web-based repositories, such as project Web sites, portals, and workspaces, for intelligently sharing and storing files both within and across corporate firewalls.

Those structured collaboration tools, often enhanced with workflow functionality, are instrumental for enabling the project management hard skills previously mentioned—such as budgeting, scheduling, and tracking requirements—on complex projects. However, they fall short for enabling the increasingly critical soft skills such as defining the business value, clarifying the vision, determining requirements, providing direction, building teams, resolving issues, and mitigating risk. Research on virtual teams treats this lack of support as a preexisting constraint, recommending face-to-face meetings as often as possible and at critical points in the project to augment email and telephone communications.[2,5]

Organizations are now beginning to leverage real-time collaboration tools to bridge the soft skills gap for distributed teams. Tools such as instant messaging, Web conferencing, whiteboards, and desktop videoconferencing provide substantially different communication possibilities than the familiar telephone, email, and face-to-face options. Tools for unstructured collaboration can enhance communication by enabling more frequent collaboration between distant coworkers. In contrast to early incarnations of unstructured tools (for example, expensive, room-based videoconferencing systems), these inexpensive desktop tools are designed for frequent, ad hoc use. Telework Consortium pilots indicate that these characteristics can lead to increased communications and trust, thereby facilitating quick decisions and enhanced team cohesiveness.

Looking across the IT industry, organizations with multiple locations and trading partners are rolling out integrated digital environments for secure sharing of files and databases, leveraging technologies from Electronic Data Interchange to Web Services. Workflow functionality is enabling great leaps forward in productivity by minimizing lag time between tasks. Communication and collaboration tools are maturing rapidly, and despite the lack of interoperability, single-vendor applications are functional and stable enough to support distributed work in standardized environments. The emerging move toward contextual collaboration promises to bring these communication tools to our fingertips by linking them within the familiar applications we "live in." Security concerns and limited network capacity still limit the use of advanced tools such as desktop videoconferencing in some work environments, but progress is accelerating on these fronts as well.

Based on ongoing research at the Consortium, it's clear that the technology is available to support distributed project management needs, despite the fact that incompatible data formats and exchanges remain a challenge. A remaining issue for the project manager is how to make effective trade-offs among the alternatives.

The recent history of knowledge-management projects demonstrates that relying on the "if you build it they will come" principle merely leads to the creation of hugely expensive and disappointingly empty repositories.

Reevaluating processes and procedures

Organizations must reassess existing processes for use in a distributed work environment. Some will be inappropriate, controlling, or confining, while others will require more formalization to be effective. Telework Consortium pilots with small distributed teams show that each organization must approach the shift to distributed work with a mind open to identifying process improvements customized to its business environment.[6] For example, when a four-person magazine staff began teleworking, they quickly recognized the inefficiency of reviewing articles by passing hand-edited paper copies to each of the three editors in turn and then to the art director for incorporating changes. The electronic-editing software and related processes they implemented shortened the review process by letting the editors accomplish their tasks in parallel—shrinking the time for this step by a factor of three and increasing quality at the same time. The new solution was so successful that they're considering it for use across their parent organization. This solution was always

available to them, but they never considered it before they moved to a distributed environment. We believe that the strategic advantage from distributed work will stem from implementing streamlined processes and procedures such as this.

Process improvement models such as CMM Integration were originally developed for use in a single organization. The model enumerates practices in areas of concern to the development process. Each organization interprets these requirements for its own environment, mapping the practices to its own processes based on business goals. The model mandates that standard processes be established throughout the organization. And, although each project has the option to tailor these for its unique needs, certain aspects may be mandated across all projects. These mandates let the organization create a baseline for reporting and analysis and ultimately for measuring new initiatives' success. Adherence to a single framework also enables the business to implement common, shared processes across all of its business units, allowing personnel to work across different business units with minimal need for training.

But compliance to a single standard within the organization isn't enough in our increasingly distributed world; suppliers and business partners must be a part of the process as well. For example, on DD(X), the US Navy's 21st century surface combatant ship, the Consortium is working through Raytheon to ensure that software suppliers achieve a minimum CMMI Level 3 rating. This rating enables them to leverage advanced, integrated processes across the various organizations involved.

Whether in a single organization or across several working in partnership, project and process management issues associated with defining integration and synchronization points are still an issue for many distributed teams. Furthermore, security issues associated with ensuring electronic transmission confidentiality and privacy must be addressed partly through processes and procedures and partly through applying technologies within an integrated solution.

People and cultural change

In most cases, the rate-limiting variable for success in distributed project management is the human element of the project team. This variable is difficult to address because it deals with cultural changes in the areas of conflicting behaviors, processes, and technologies.

For example, distributed project management requires new human interaction skills that shift the emphasis from project management to project leadership. The manager must give up the role of benevolent dictator in a top-down hierarchical structure and develop new skills as an orchestrator of interconnected relationships. Negotiation is a core competency for the new project manager who must balance the needs of an increasingly large and diverse set of stakeholders. Valerie Lynne Herzog recommends that project managers employ 15 specific activities to increase communication and build trust in a team.[7] Management by walking or flying around must give way to management by results. Watts Humphrey recommends several leadership activities in his Team Software Process, including ways to build trust, increase teamwork, and motivate teams.[8] Looking across the range of management activities that rely heavily on soft skills, it's easy to understand why cultural change is needed to manage distributed work adequately.

Work must be done to move the current project management culture to a new way of thinking. Initiatives are ongoing at the Consortium, the Defense Systems Management College (Defense Acquisition University),[9] and other organizations to support this transition.[10]

Maturing the new culture

The availability of enabling tools, reevaluation of processes and procedures, and individual adoption of new skills for distributed work are essential, but taken individually, they're not sufficient to change a workforce's habits. Senior management support for coordinated, complimentary change initiatives across all three aspects of the organization is essential to fully embrace distributed work's competitive advantages.

One way to begin addressing the challenge is to develop a prototype and demonstration center where key practitioners and project managers can evaluate hardware and software alternatives, assess current approaches, and make suggestions on how to architect an integrated solution for their environment.[11] Consortium support includes a collaboration tool database, which contains evaluation data to support tool selection, and displays of hardware and soft-

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ware collaboration solutions connected to different communication mechanisms.

Another effective way to assist the project manager is by organizing a pilot that provides a set of capabilities tailored to the project's specific needs. The Telework Consortium's pilots with distributed teams have achieved promising results by leveraging advanced virtual-presence tools. The goal of these experiments is to approximate colocated interactions as closely as possible through using integrated data, voice, and video communication, available frequently and spontaneously. To date, pilot results support the hypothesis that these tools can help minimize the impact of cultural changes and overcome the need to apply heavy processes when transitioning to a distributed work environment.

Today's market environment is changing in several significant ways. The key drivers causing these changes are apt to stay relevant for some time, pushing organizations to leverage distributed work. In response, the project manager, to manage and grow projects effectively, must look for mechanisms that provide integrated communications and information-sharing systems. Effective systems will incorporate not only technological advances, but also the complementary efforts required to evolve processes and culture for success in a distributed environment. By taking this action, project managers will enhance enterprise performance by reducing risks and increasing the velocity by which effective decisions can be made.

As the processes, tools, and technologies to support distributed work mature, more organizations are applying them to support their increasingly complex systems and software development projects. A growing body of academic research and case studies describe successful distributed projects' issues and considerations and show how they are managing risks. By coupling existing research with the lessons from complex programs in the defense industry, the Consortium intends to place its member companies ahead of the curve in the area of distributed project management.

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