Maximizing your Process Improvement ROI through Harmonization

Jeannine Siviy, Pat Kirwan, John Morley, and Lisa Marino

March 2008

This white paper is an executive overview of the business value in harmonizing process improvement efforts when multiple improvement technologies, models and standards are in use. It proceeds with an overview of a harmonization approach that reaches from strategy to tactics and connects enterprise and discipline specific improvement.

Software Engineering Institute | Carnegie Mellon

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
MAR 2008		**00-00-2008 to 00-00-2008**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Maximizing your Process Improvement ROI through Harmonization	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Carnegie Mellon University ,Software Engineering Institute (SEI),Pittsburgh,PA,15213**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**16**	

This work is sponsored by the U.S. Department of Defense.

The Software Engineering Institute is a federally funded research and development center sponsored by the U.S. Department of Defense.

This work was created in the performance of Federal Government Contract Number FA8721-05-C-003 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center. The Government of the United States has a royalty-free government-purpose license to use, duplicate, or disclose the work, in whole or in part and in any manner, and to have or permit others to do so, for government purposes pursuant to the copyright license under the clause at 252.227-7013.

For information about purchasing paper copies of SEI reports, please visit the publications portion of our Web site (http://www.sei.cmu.edu/publications/pubweb.html).

Acknowledgments

We would like to thank Lynn Penn and Lockheed Martin IS&GS for sponsoring preliminary research activities on process improvement in multimodel environments. Through this sponsorship, these white papers were written.

We would also like to acknowledge:

- Alan Lawson, Visiting Scientist at the SEI, who provided key inputs to our discussion of the value proposition from both technical and business viewpoints.
- Dr. Urs Andelfinger, Dr. Hans Sassenburg, and Andre Heijstek, Visiting Scientists at the SEI in Europe, who made important contributions to the concepts presented here.

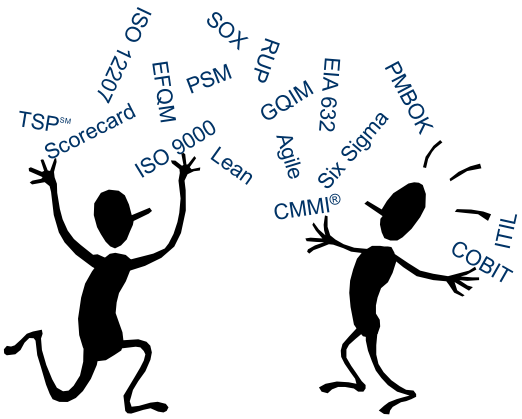
About this paper

This white paper is an executive overview of the business value in harmonizing process improvement efforts when multiple improvement technologies, models and standards are in use. It proceeds with an overview of a harmonization approach that reaches from strategy to tactics and connects enterprise and discipline specific improvement. It is written primarily for executives and managers. For more technical details, there is a five-part white paper series that further examines problems with multimodel environments and the current process improvement approaches such organizations need to consider:

- The 1st white paper addresses the benefits of a harmonized approach when implementing more than one improvement model, standard, or other technology and provides a high-level description and underlying paradigms of a reasoning framework for technology harmonization.
- The 2nd white paper examines the approaches needed in technology selection including a strategic taxonomy, the decision authorities associated with that selection at all levels in the organization, and considerations for thoughtful sequencing of implementation in alignment with the organizations' mission, goals and objectives.
- The 3rd white paper examines technology composition in relation to the concepts introduced in the previous white papers; a proposed element classification taxonomy to make technology integration effective in practice; and the role of technology structures, granularity and mappings in technology composition.
- The 4th white paper examines the current state of the practice for defining process architecture in a multimodel environment, methods and techniques used for architecture development, and underlying questions for a research agenda that examines the relationship of technology strategy and composition to process architecture as well as the interoperability and architectural features of different process technologies.
- The 5th white paper addresses the implementation challenges faced by process improvement professionals in multimodel environments, where it becomes necessary to coordinate roles and responsibilities of the champions for different technologies, to integrate and coordinate training, to optimize audits and appraisals, and develop an integrated approach to project portfolio management.

Note: The 2nd and 5th white papers are in development and presently highlight the proposed content. The completed papers will be available in May 2008.

THE VALUE OF MULTIPLE TECHNOLOGIES



Every day your engineering and operational staff do the work that is expected in your organization, using the processes available to them. High performers use improvement models to mold and refine their front line processes to improve their performance—both in terms of efficiency and effectiveness. This paper is about how to gracefully leverage each model for what it does best, comply with multiple external model compliance mandates, and focus your front line people with an internal process that drives to your performance goals.

All highly effective businesses face challenges to achieving and sustaining competitive advantage while complying with regulations. To meet these challenges, the highest performing organizations apply reference models, standards, and other improvement technologies[1].

Different challenges require different tools, so your organization is probably using more than one model, standard, or technology. Some are discipline-oriented; others are discipline-neutral and serve the overall enterprise. Some describe what to do; others prescribe how to do it. All offer unique features and address particular problems, to be sure.

In this environment—where several improvement initiatives are concurrently implemented at different hierarchical levels and across different organizational functions—different parts of your organization are championing those technologies that best address their problems. This leads to competition between technologies and their associated improvement initiatives—with each vying for the same resources within the organization to meet their respective implementation needs:

- providing infrastructure to support the implementation
- tailoring each technology to suit the organizational culture
- developing training
- ensuring compliance
- measuring performance results

This competition costs you because of overlapping efforts and subsequent erosion of the benefits from any single effort. In the face of this reality, you might ask

[1] In this series of white papers, we use the terms *improvement technologies*, *technologies*, or *models* somewhat interchangeably as shorthand when we are referring in general to the long list of reference models, standards, best practices, regulatory policies, and other types of practice-based improvement technologies that an organization may use simultaneously.

- Can there be one way to operate and improve our business that is used effectively by our front line people, while achieving verifiable compliance with the improvement technologies that assure our goals?
- How do we capitalize on multiple technologies, extracting the best from each, and manage the complexity and confusion?
- Can this be made simpler?

The consequences of not understanding or managing your organization's overall improvement landscape is to increase the overall cost for, and erode the benefits of, your investments in improving business performance. However, there is a way to realize the benefits and manage the costs; it involves harmonizing the technologies to create a multimodel improvement solution.

By supporting such harmonization, you can realize both tangible and intangible benefits:

- Business focus rather than model focus
- Cost reduction through economies of scale for all aspects of model implementation
- Cycle-time reduction for improvement efforts and the realization of performance objectives
- Culture change related to establishment of enterprise processes, measurement systems, and more
- Process robustness to an ever-evolving and dynamic world of models and regulations
- Long-term, robust, and effective organizational approach to technology and model selection
- Ability to deal effectively with different structures and terminology of implemented models
- Cost reduction in relation to audits and assessments for operational units and projects

It is seldom anyone's intent to implement several improvement technologies simultaneously. Technologies are typically adopted one decision at a time and accumulate over decades from different points within an enterprise and for different reasons. This is particularly acute in software and systems engineering, which not only have their own relatively young histories of improvement efforts, but are increasingly being called to also adopt the models and standards of the overall enterprise.

Rightfully so, the authority to select technologies rests at different levels in the organization. Accordingly, adoption decisions about enterprise initiatives—such as Six Sigma, Lean, or the European Framework for Quality Management—are made by senior executives. Using enterprise initiatives might even be mandated by government policy, as is the case with Sarbanes-Oxley or FDA regulations.

And, functional or business unit process improvement groups often are charged to select discipline-specific initiatives, such as those oriented to establishing organizational processes (for instance, the CMMI framework or ITIL—in the systems and software engineering and the IT fields, respectively). The most tactical of the technologies, such as particular programming methods or requirements management methods for software developers, may be selected by improvement groups or by those responsible for creating products.

Additions are often made without coordination or consideration of how new performance improvement technologies integrate or interoperate with existing ones. Questions about the interfaces between enterprise and discipline-specific technologies—including overlapping and distinctive capabilities—are seldom asked and even more rarely answered. For instance, risk management is a capability that is present in numerous improvement technologies; but it is applied in different ways, at different levels of granularity, for different disciplines within the enterprise.

Gaining on the Competition with Multimodel Process Improvement Solutions

A growing number of companies have realized a competitive advantage from an integrated, multimodel approach, for instance

- **Lockheed Martin IS&GS**, with their "Program Process Standard," has reported productivity gains of more than 50% and cost reductions nearly 25%. [Siviy 07-01]
- **Northrop Grumman Mission Systems** reports on their culture change realized from leveraging multiple models and significant cycle time reductions to achieve improvement and performance objectives as well as to complete audits, [[Hefner and Sturgeon 02; Hefner and Caccavo 04].
- **Wipro** reports cost and cycle time reductions. Their veloci-Q Enterprise integrated system, includes ISO 9001, CMM, P-CMM, TL9000, British Standard 7799, and Six Sigma. They estimate a 30 percent reduction in cycle time and have determined their return, in the short-term, will be "six to eight times the total investment we put into Six Sigma" [Subramanyam et al. 04]
- **Tata** with their modular framework called "Integrated Quality Management System" has achieved their business goals for productivity, capacity, agility, reliability, and service. [Srivastava 05]
- **The University of Pittsburgh Medical Center (UPMC)** used a collaborative model effort to prioritize and align processes to implement, leading them to become the first non-profit medical system in the country to be certified compliant with the most stringent provisions of Sarbanes-Oxley. [Carmody and Maher 07]

A HARMONIZED APPROACH HELPS AT EVERY LEVEL

In a harmonized multimodel approach, decision authority can remain at the appropriate level. What changes are decision, design, and implementation considerations, as well as the degree of coordination and communication among the decision-makers and other stakeholders. These changes will improve the environment for all stakeholders through such things as

- Integrated and cooperative improvement organization(s)

  Rather than compete for priority and resources, change agents will work cooperatively toward the same objectives. Improvement personnel will become expert in multiple improvement technologies and be able to recognize and leverage the common and distinct features of each.

- Managed and aligned improvement project portfolio

  The line of sight to business objectives and priority for each effort is understood, which enables the appropriate business case to be constructed—from both the view of managers and improvement personnel.

- An integrated and aligned measurement system, tied to the corporate success indicators

  In a harmonized approach, there is a line of sight between each improvement plan and the corporate objectives and bottom line. Thus, all projects have appropriately aligned success measures as well as progress and technical measures, including "enabling projects," whose indirect success measures can now be used to gauge contribution and traceability to corporate success.

- Shortened improvement cycles

  Relationships between efforts are understood, which allows a coordinated implementation and reduces improvement cycle time.

- Training on the organizational way

  Operational units are trained in the organizational way of doing business, with the knowledge that the improvement technologies of interest are built in.

- Establishment of enabling relationships between technologies

  The overlaps are acknowledged and economies of scale are realized—in implementation, training plans, resource allocations, and auditing and appraisal.

- Model transparency "in the trenches"

  Project and operational staff are no longer subjected to an array of improvement technologies, but rather use their organizational processes with the confidence that the improvement technologies of interest are "built in." Chaos, confusion, frustration, lost confidence, and other factors that can undermine an improvement effort are significantly reduced if not prevented entirely.

HOW IS HARMONIZATION ACHIEVED?

What follows is our initial reasoning framework for multimodel harmonization. It can be used regardless of where you are today in your process improvement journey. It contains some basic steps to follow, questions to address, and principles to use—all working together to achieve alignment in the layers and levels of an integrated business. We present this framework in the context of reconciling the technologies of systems and software engineering with those of the enterprise; however, it can be easily extended to other disciplines.

Align organizational and improvement objectives and identify candidate technologies

Mission and business drivers should govern the selection of each improvement technology adopted within an organization. For this to be so, the mission and highest level strategic goals must be decomposed to operational objectives. Technologies should then be selected based upon their ability to directly provide or indirectly enable process features and functions that are needed to achieve mission and operational objectives.

Take customer satisfaction, for instance. An IT organization decomposed this goal (Figure 1) into subordinate objectives related to improving an existing IT system, creating a new IT system via "acquisition" (contracting/outsourcing), and ensuring that the right resources are available to do the work[2].

After developing a diagram like the one in Figure 1, the improvement group for the IT organization identified the strategies, tactics, and measures to achieve each objective. The group inherited Lean, which had already been chosen as a governance model by the enterprise. But, the decision for models and standards to support process establishment was at their discretion. And, they chose to blend process maturity models and ISO standards to support their objective regarding the establishment of acquisition processes.

[2] There are numerous, valid decompositions of customer satisfaction goals to operational goals. In this case, the organizational and system situation called for a significant product development focus. In other cases, a set of more traditional cost/schedule/quality operational goals may be listed. The important thing is to identify those subgoals that are relevant.

They also identified reusable/extendable "engineering" (as opposed to "acquisition") processes. At a tactical level, the maturity models were used to guide the process definitions and ISO standards—which contain guidance for many of the same processes, but at a different level of detail—were used to ensure their process descriptions were feature rich. Finally they used the value stream mapping tool from Lean to finalize their process architecture and "design in" efficiency and attention to customer value.

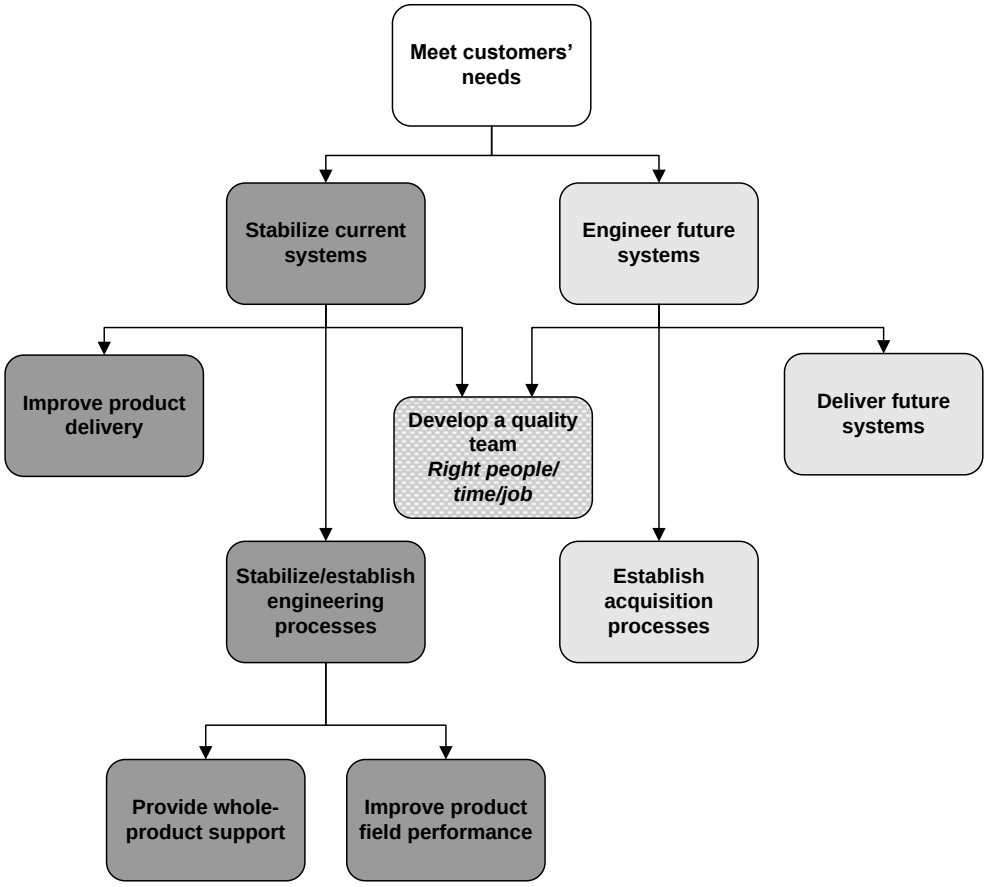


Figure 1: Decomposition of goals

Categorize the improvement technologies strategically

When managers and improvement professionals jointly categorize improvement technologies based on how they might contribute to the organization's objectives, they ensure that models can be associated with one another according to their governance, infrastructure, or procedural/tactical propensities. Working together, managers and improvement professionals also set the strategic relevance and high level relationships for the overall improvement landscape.

Reference taxonomies, like the one in Figure 2, can be an aid in strategic categorization. This figure shows three major types of technologies: governance, infrastructure, and tactical. It also divides these categories into domain-specific and non-domain-specific segments. We have populated this figure with a sampling of technologies, but this sampling is by no means exhaustive. This particular taxonomy is also annotated with directional arrows indicating decision authority of engineering (domain-specific) improvement groups. These groups have increasing decision authority toward the discipline specific and toward the tactical technologies.

Using such a taxonomy provides a basis for examining the selection patterns of similar organizations and making choices that are logic- and principle-based. For instance, IT organizational patterns and principles tend toward combinations containing ITIL, and telecommunications industry combinations typically include TL9000. Taxonomy-based pattern analysis can also shed light on the preferred implementation sequence in similar organizations.

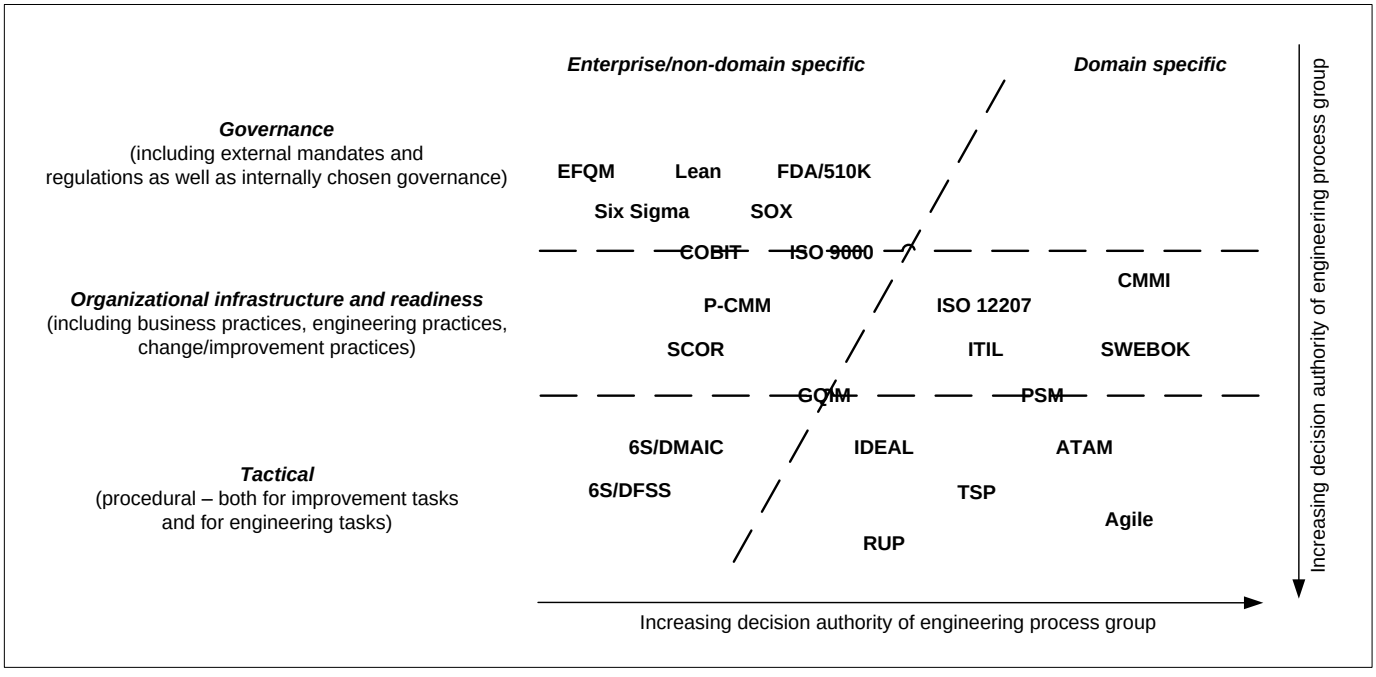


Figure 2: View of a strategic taxonomy for improvement technologies

Design your improvement solution

As categorization will reveal, the reference models your organization uses have undoubtedly been tailored for implementation and you probably have also developed internal solutions. In our harmonized approach, we recommend considering tactical connections and process architecture along with strategic model selection and categorization to develop the joint implementation plan for the technologies you have selected.

Strategic categorization, tactical connection, and process architecture do not necessarily follow in that order. In practice, they may be quite iterative, and the starting point may vary. Some organizations may find it most effective to begin with process architecture and back into model selection and composition. Others may find it most effective to move through these steps "top down" (strategy to tactics).

We've already discussed strategic categorization and selection of models; we now look at tactical connections and process architecture.

Categorize and compose the improvement technologies

When it comes to designing your overall improvement solution, understanding the details about how technologies connect with each other is critical. This specialized task represents one of the major contributions that improvement groups can make to the process and improvement integration within their own organizations. It also is one of the major factors in reducing process improvement costs, as it integrates the output from previously disparate groups—enabling less disruption of projects and operational units during improvement rollout.

Strategic categorization is about "macro level" technology relationships that enable high level decisions about selecting and aligning technologies to objectives and to needed process features. In tactical connectivity, however, we address overlapping, distinctive, and enabling functionality among the models so that we can properly "compose" them. Both additional taxonomies and detailed mappings (typically pairwise) are appropriate supporting approaches here.

In a simple taxonomic approach, there is usually a group of technologies oriented to "what" you should do, and a group oriented to "how" you do it. Relative to the above strategic classification, infrastructure technologies often focus on "what"; tactical technologies,

on "how." For instance, engineering process maturity models and ISO process standards (such as the aforementioned CMMI and ISO 12207) provide comprehensive guidance on what system and software engineering processes are needed. The frameworks of Six Sigma provide specific steps and methods for how to problem-solve and achieve required process performance; and the Project Management Body of Knowledge provides specific methods and measures for how to manage cost, schedule and other aspects of programs and projects.

A what/how relationship is a useful but insufficient view of model relationships, however, simply due to the complexity that occurs as you add more technologies. We have been developing what we call element classification, which is essentially a tactical taxonomy that helps reduce complexity and enables composition when there are multiple technologies in use.

Element classification has arisen out of the need to understand the commonalities among numerous technologies without being sidetracked by the details of how they are implemented. From this examination, we recognize just three element types that provide:

- "good practice" guidance
- change management and organizational change guidance
- guidance for making the changes introduced by using the first two elements permanent (or institutionalized)

Element classification using those three types can allow your organization to see the parts of different models you should try to combine.

In addition to taxonomies, pairwise mappings of one technology to another can provide a means of understanding and tactically connecting models point by point, feature by feature. Such mappings are typically done by process improvement personnel or technology developers/stewards. In many cases, mappings are general. However, for technologies whose implementation is often highly tailored (such as Six Sigma) or for pairs of dissimilar technologies, detailed mappings are better done in the organizational context.

Taxonomies and mappings together provide the relational insights and detailed technical connections that inform process architecture.

Architect your processes to achieve mission

For the most part, engineers and operational staff do not execute improvement technologies to get their daily work done. Instead, they execute the organization's process. Model composition is not the equivalent of process architecture/definition. Both are needed. And, in fact, it is a big leap from one to the other. Process architectures and descriptions are what define the day-to-day operations—the corporate way—how work gets done and product gets out the door.

From our research observations, the most successful organizations using multiple improvement technologies create a process architecture and accompanying process descriptions—their "corporate way" —and then map the technologies of interest to it. This mapping serves both to verify features and ensure compliance, where the latter is needed. With this approach, improvement technology implementation is made "seamless" and transparent to the engineers and operational staff. The process is also rapidly and effectively deployed and easily updated over time.

Implement your multimodel improvement solution and measure results

In the implementation of a multimodel improvement approach, all of the traditional elements of organizational change management apply—including the participation of these stakeholders in the up-front design activities, communications, documentation, training, and effective measurement infrastructure—typically among the core responsibilities of improvement groups. Additionally, in the context of the multimodel improvement approach, improvement groups face several implementation challenges distinct from singular model improvement:

- Shared and coordinated roles and responsibilities

  Rather than allowing the champions of each respective technology to be isolated, consider cross-training improvement personnel in multiple standards. Additionally, consider having the respective experts work in the same group or identify another means of establishing a seamless partnership. The objective is for the champions of different technologies to have a shared sense of organizational mission and goals and a shared sense of responsibility to establish an integrated process improvement program that achieves all of their objectives.

- Integrated and coordinated training

  While an integrated process architecture relieves the organization from needing to train everyone about every technology, there remains a need for the improvement personnel to learn about technologies of interest as well as how they connect. Typically, each technology has its own training regimen, and certainly much of that will need to remain intact to ensure the development of deep understanding. But typically, organizations often are left to their own devices to figure out the connections. Supplemental training that focuses on strategic and tactical connections between technologies (general principles as well specific combinations) ensures a consistent and more efficient learning process. While some organizations are developing such training internally, there is an emerging body of research, along with training resources, to support such efforts.

- Coordinated (possibly shared) audit and appraisal processes and data

  An integrated process architecture brings substantial benefits. However, the organization needs to make progress in integrating, as far as feasible, the numerous audits and appraisals associated with the various technologies implemented in the organization. Otherwise those audits and appraisals will remain a major source of cost and effort duplication, especially for the project and operational staff.

- Coordinated improvement project portfolio management

  In a non-harmonized approach, improvement projects can be isolated from each other and from the overall organizational mission. Goal decomposition, as we said, gives all improvement projects a line of sight to the topmost organizational goals and an explicit relationship to one another. Such methods can be incorporated into the organizational standard processes for identifying and defining projects.

  The integrated improvement project portfolio that arises from a harmonized multimodel approach also gives the organization an understanding of

  ~ the role of "enabling" projects in establishing processes and measures needed for subsequent improvement efforts that have direct bottom line benefit (This need is often seen in the implementation of maturity models and other domain technologies in conjunction with Six Sigma.)

  ~ the use of technologies, such as Six Sigma methods, to transform "fuzzy" problem statements into quantitative improvement objectives against which specific improvement projects can be launched.

IN SUMMARY: INVEST IN PROCESS IMPROVEMENT BY HARMONIZING TECHNOLOGIES

All highly effective businesses face challenges to achieving and sustaining competitive advantage while complying with regulations. To meet these challenges, the highest performing organizations rely on multiple technologies to comply, improve, and compete in their markets. The challenge of multimodel improvement is to select, compose and sequence the desired set of improvement technologies. In addition, the organization must develop processes to deliver the capability of each technology in a way that enables work to get done and the subsequent achievement of business objectives.

Success Depends on Senior Management

While the details of harmonizing models are executed by the improvement professionals and change agents within your organization, it is critical that senior managers state the vision, set the tone, and establish expectations through

- Ensuring that mission focus is the driving motivation for process improvement
- Establishing an organizational structure that builds bridges rather than forces competition
- Ensuring that the appropriate resources for a harmonized approach are firmly in place.
- Insisting on the quantifiable results that arise from an aligned and integrated improvement project portfolio
- Setting the expectation for harmonization and requiring that improvement professionals establish a focus on internal process capabilities which are derived from and map to a harmonized suite of selected improvement technologies.

References

The following are the references used in this white paper. Additional reading materials are listed in the "References" and the "Additional Resources" appendices of CMMI & Six Sigma: Partners in Process Improvement. This listing includes both model-specific references (for CMMI & Six Sigma, as well as other combinations) and multimodel references.

URLs are valid as of the publication date of this document.

[Carmody and Maher 07]

Carmody, Christian, and John Maher. "One Size Fits All: Integrating SOX, CMMI, and ITIL for Enterprise-Wide Process Improvement." SEPG Conference, 2007.

[Hefner and Caccavo 04]

Hefner, Rick, and Dean Caccavo. "CMMI Benefits at Northrop Grumman Mission Systems." SEPG Conference, 2004.

[Hefner and Sturgeon 02]

Rick Hefner and Michael Sturgeon. "Optimize Your Solution: Integrating Six Sigma and CMM/CMMI-Based Process Improvement." Software Technology Conference, 2002.

[Siviy 07-1]

Jeannine M. Siviy, M. Lynn Penn, & Robert W. Stoddard. *CMMI & Six Sigma: Partners in Process Improvement*, Addison-Wesley, December 2007.

[Siviy 07-2]

Jeannine M. Siviy & Patrick Kirwan. Process Improvement in a MultiModel Environment: An Investigation, SEPG Europe, 2007.

[Srivastava 06]

Nidhi Srivastava. "Harvesting CMMI Benefits—The Six Sigma Sickle." SEPG Conference, 2006.

[Subramanyam et al. 04]

V. Subramanyam, Sambuddha Deb, Priya Krishnaswamy, & Rituparna Ghosh. *An Integrated Approach to Software Process Improvement at Wipro Technologies: veloci-Q*, CMU/SEI-2004-TR-006, ADA421628. Software Engineering Institute, Carnegie Mellon University, 2004. http://www.sei.cmu.edu/publications/documents/04.reports/04tr006.html