

Research, development and technology management

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best practice brief

- Successful companies recognize the crucial importance of managing their R&D investments and processes on a systematic and repeatable basis. Effective technology planning is essential for aligning R&D spending with current and future business strategies, balancing product and process innovations, and leveraging a company's intellectual property to its fullest potential.

PLM Software

Answers for industry.

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► **Research, development and technology management**

Table of contents

Overview of R&D management	1
Challenges	3
Best practice solutions	5
Key Siemens solution capabilities	11

► Overview of R&D management

Gaining value from R&D spending. Companies that aspire to market leadership realize that innovation is crucial to their business success. In a recent study of 940 executives by The Boston Consulting Group¹, 87 percent of all respondents agreed that organic growth through innovation is essential to success in their respective industry. In addition, three-quarters of these executives said that their companies' spending on innovation would increase during the current fiscal year.

However, the same report also found that 51 percent of the respondents expressed dissatisfaction with the financial returns on investment (ROI) they receive from their innovation initiatives. This anxiety is compounded by additional research that shows "there is no correlation" between R&D spending and sales growth, earnings or shareholder returns.²

At first glance, these conclusions are disturbing. In principle, increased R&D spending should lead to more and better ideas – and it logically follows that better ideas should result in better new products and a corresponding growth in revenue.

Analysis by AMR Research suggests that the disconnect between R&D spend rates and business results stems from the maturity of the management processes used to oversee R&D investment.³ As the study indicates, creating ideas and technology is one thing; leveraging those elements in the market place is another. At the end of the day, it would appear that "How you spend is far more important than how much you spend."⁴

According to the Product Development Management Association (PDMA), the ultimate goal of technology management is:

To prioritize and focus research and development efforts on technology opportunities today that will have a positive effective on corporate revenues in the future.⁵

Looking at new product development processes holistically, these studies suggest that today's increasing demand for faster, better and less expensive product development requires more effective upfront planning and a cohesive alignment between strategic planning, technology planning, product research and product development. In essence, the alignment and integration of these functions is the delineating factor in determining business winners from business losers.

PDMA expands on this conclusion:

To accomplish their goals, corporations should invest in tools, processes and structure that support the identification of technological opportunities to fuel product innovation and product-to-market excellence.⁶

Stakeholders in effective technology management. Technology management's stakeholders involve a wider range of interested parties that extends beyond a company's R&D organization. Effective technology management needs to be aligned on a cross-discipline basis to meet the needs of the business.

In brief:

To maximize success, companies require management processes that enable them to oversee their R&D investments and connect their R&D spending to real-world business results.

These new product development processes demand more upfront planning and a close alignment between the company's strategic planning, technology planning, product research and product development functions.

Parties with a vested interest in technology management

Stakeholder	Why technology management matters
Research managers and leaders	Efficient technology planning and management should sharply focus research efforts, share knowledge and directly influence downstream product development and manufacturing.
Product development management	Effective technology management should result in standardized technology platforms and increased understanding of the important roles these platforms play in meeting market requirements. These improvements provide the product development organization with a clear opportunity to increase quality and reduce development cost.
Product management and marketing	By mapping technology to specific market requirements and product capabilities, product managers are able to more clearly outline how product architectures relate to customer benefits.
Legal	Technology management provides the legal organization with a relatively simple method for signing and witnessing process performance as it relates to regulatory compliance.

In brief:

Research organizations, product development groups, product managers, marketing managers and legal organizations are stakeholders in technology management.

3M's Post-It Note innovation illustrates how an outstanding technology management process makes the difference between an interesting idea and a highly profitable real-world success.

Real-world results. 3M Company has a solid reputation for innovation. One of its best known and widely storied successes involves the invention of the Post-It Note.

3M research scientist Dr. Spence Silver first developed the technology in 1968 while looking for ways to improve the acrylate adhesives used in many of 3M's tapes. While Dr. Silver realized that he had invented a highly unusual new adhesive, he now faced an intriguing challenge: What was the company going to do with it?

For the next five years, Dr. Silver presented seminars and buttonholed 3M decision makers, extolling the potential of a new adhesive and showing spray-can samples and bulletin board usages. Eventually, Dr. Silver raised interest within the new product management organization – whose members championed the technology as a potential product. Ultimately, the company embraced the concept and the Post-It Note concept was born.

But, that is not the end of the story. 3M performed extensive market research to ensure there was a market for its product. Engineering and production overcame substantial technical difficulties to establish effective manufacturing practices. The rest, as they say, is history. In 1981, one year after its introduction, the Post-it Note was named the company's "Outstanding New Product."

Often 3M's success is portrayed in mythic terms – almost as if it was accidental. In fact, nothing could be further from the truth. 3M's research group has somewhere to go with its ideas. The ensuing steps follow a rigorous process for new product development that is open to exciting and different innovation. The Post-It Note could have been nothing more than inexpensive scrap paper. But it wasn't – and 3M's technology management process made the difference.

► Challenges

Impediments to effective technology management. Industry research consistently demonstrates that – across all industries – the time it takes to get new products to market is being reduced while the overall number of products being launched is increasing.⁷ These improvements are driven by increasingly aggressive consumer demands and competitive marketplace pressures.

Now more than ever before, companies are expected to sustain and better these improvements. To accomplish this, companies need to plan more effectively up front by cohesively aligning and integrating their strategic planning, technology planning and product development operations.

Five main challenges inhibit companies from effectively managing their R&D and technology operations, including the ability to:⁸

- Identify and align resident technology to current and future business needs
- Determine gaps between resident technology and current/future business needs
- Identify resident technology no longer viable for meeting current/future business needs
- Determine best approach for obtaining new technology (i.e., through internal development or external acquisition)
- Identify opportunities for expanding technology usage beyond current business processes

Avoiding potential pitfalls. To ensure the success of their technology management initiatives, companies need to avoid a series of common pitfalls.

Common problems inhibiting effective technology management

Pitfall	Effective counter-measures
Isolated focus on investment	<p>Product and process innovation represent two different types of technology investment. Typically, <i>product innovation</i> is the initial investment that companies make when they want to establish dominance in a given market segment. By developing new technology for their product offerings, companies are able to establish early marketplace advantages.</p> <p>In contrast, <i>process innovation</i> is adopted by companies that compete in mature markets and want to maximize the return on their product development investments by applying new technology to their development-related processes. Companies that <i>balance</i> product and process innovation are able to sustain their product advantages while continuing to optimize their operational processes.</p>

In brief:

Companies can effectively manage their R&D operations if they:

- Understand how the technology they have pertains to their business needs
- Determine the gaps that this technology fails to satisfy
- Identify technology that has become obsolete
- Determine the best approach for developing or acquiring new technology
- Identify opportunities for future expansion

Common problems inhibiting effective technology management

Pitfall	Effective counter-measures
Failure to adopt an aggressive patent strategy	<p>Some companies simply fail to adopt any sort of effective patent strategy; others do not utilize the patent portfolios they have in place, or fail to screen their organization's patentable ideas.</p> <p>Texas Instruments, Zenith and Dow Chemical illustrate the importance of leveraging an aggressive patent strategy. Each of these companies has licensed their unused patents to generate more than \$100 million in royalty revenues.⁹ Dow Chemical has taken this approach even further by saving \$40 million over a 10-year period through the use of patent screening and reduced patent maintenance fees.¹⁰</p>
Failure to leverage intellectual property	<p>Many companies are unable to track the output generated by their combined R&D programs. This failing is attributable to the project-oriented nature of many R&D programs, the secrecy that sometimes surrounds these programs and the proliferation of data generated by these projects. This problem is further exacerbated by a multitude of information silos whose data cannot be readily shared.</p>
Failure to align R&D investment with business strategy	<p>Effective technology planning requires more than just successful management on the part of the R&D organization. Effective technology management requires companies to map their strategic business needs to the needs of their target markets. Failing to establish this connection results in wasted R&D investment from beginning to end. In fact, even the most technologically advanced product innovations will be doomed to commercial failure if these innovations are misaligned with the company's business strategy.</p>
Failure to account for disruptions and the negative impact of business as usual	<p>R&D organizations frequently ignore the more disruptive aspects of their product innovations – or succumb to the temptation of proceeding with “business as usual” assumptions.¹¹ In both instances, product developers need to familiarize themselves with the voice of the customer and understand how the customer's requirements directly relate to specific product innovations.</p>

In brief:

Technology management improvement initiatives will encounter problems if they fail to balance product and process innovation, if the company has a non-assertive patent strategy, if the intellectual property generated by R&D programs is not effectively leveraged, if R&D investment is not properly aligned with business strategy or if product developers succumb to “business as usual” assumptions.

► Best practice solutions

The value of technology planning. PDMA¹² references well known research¹³ in its definition of “technology planning.”

Technology planning is the process of knowledge acquisition, which can be later used in the design of new products to meet market needs.

Ultimately, technology planning enables companies to:

- Align their technology acquisition efforts with business and strategic goals
- More clearly focus their technology development efforts
- Better understand, leverage and protect their intellectual property
- Better identify general technological advances for current and future product development
- More effectively utilize technology in product development processes
- Better understand their core competencies
- Provide their products with a competitive edge

PDMA furthers this discussion by indicating that:

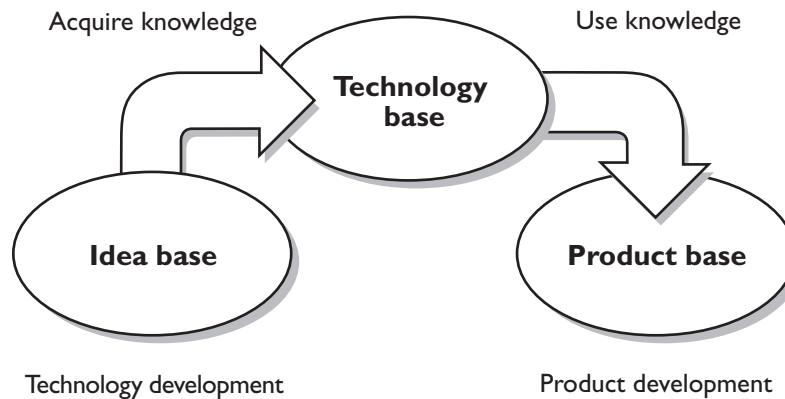
Technology planning is the process that results in an actionable plan to leverage new and existing technologies, consistent with business strategies and customer needs.

In this context, technology is defined as scientific know-how that is embodied in people, plants, patents, laboratories and equipments.¹⁴ In essence, technology represents the framework that underpins a company's future products, as well as the development and manufacturing processes that support these products. As a result, it is imperative for companies to clearly understand what technology is available to them and how these technologies can be used to meet the needs of their target markets.

In brief:

Effective technology planning is crucial to enabling new products to meet their market needs. These planning efforts require companies to adopt an actionable plan that details how new and existing technology will be used to satisfy strategic customer requirements. Technology insight, competitive insight and marketing insight are critical for any successful technology planning process.

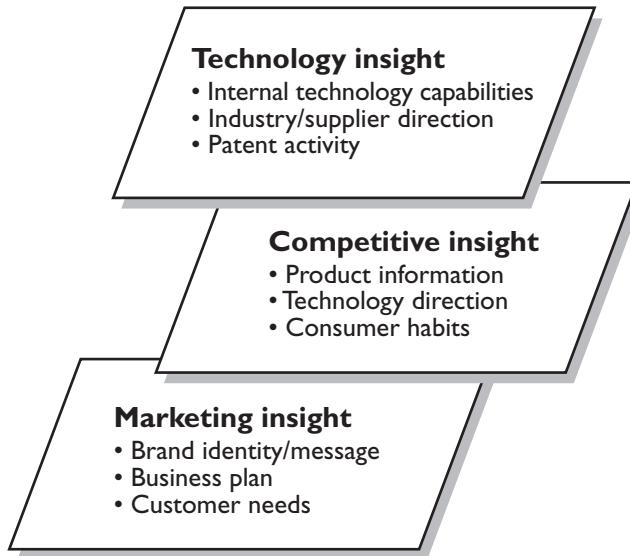
PDMA: Technology development vs. product development



Technology planning process and framework. PDMA defines a framework for the technology planning process that consists of three key areas of input: technology insight, competitive insight and marketing insight. By considering these three knowledge bases together, companies are able to place their technology planning process within a broader business context that helps maximize the company's business success.

The technology planning process begins with the formation of a cross-discipline team that best represents the functional areas crucial for identifying and developing critical technology. Typically, this team includes key R&D staff having both technical background and strategic vision, their marketing counterparts and consultants/industry experts.

PDMA technology planning process inputs



In brief:

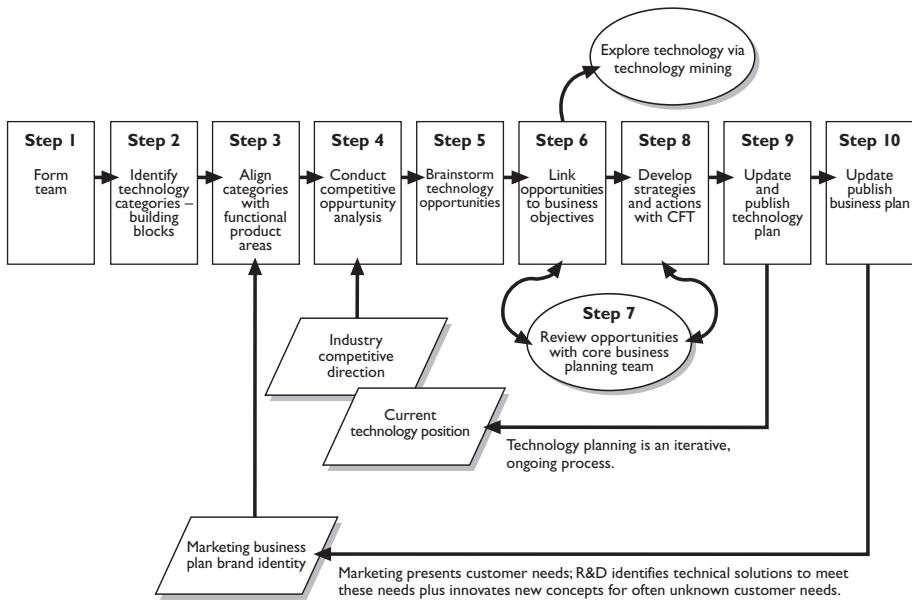
Technology planning starts with the formation of a cross-discipline team that will identify what technology, capabilities and competencies are required to develop a particular product. As the planning process proceeds, the team further defines where these technologies will be applied and what aspects can be commonized. Then, the team looks at the competitive landscape to perform a strengths, weaknesses, opportunities and threats (SWOT) analysis.

Once the team is in place, members are tasked with outlining key capability and competency building blocks. Core capabilities will vary from industry to industry and cover both product and process technological expertise. Ultimately, these building blocks will be utilized across multiple business segments.

With core technology capabilities in hand, the team can align these technologies with functional marketing product categories – providing the team with understanding that is crucial for determining what technologies will be utilized, where they will be applied and what aspects can be commonized.

Then, the team can leverage this alignment – together with an in-depth competitive marketplace review – to position this internal technology and the products it supports against the marketplace as whole. The team typically leverages tools, such as a strengths, weaknesses, opportunities and threats (SWOT) analysis, to facilitate the review.

PDMA technology planning process: 10 steps



In brief:

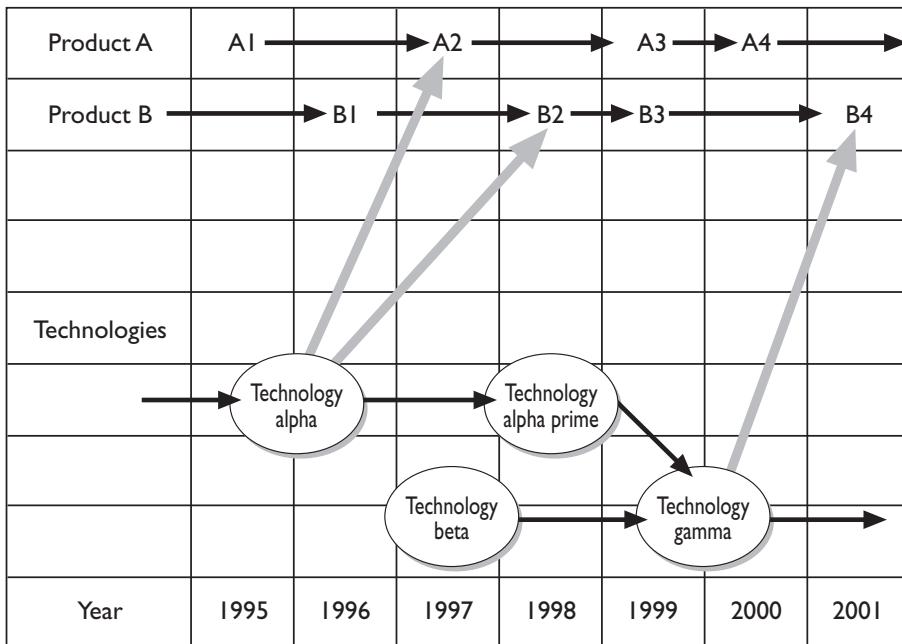
PDMA provides a 10-step process to outline and articulate a full-fledge technology planning process. The first four steps in this process describe the brainstorming techniques required to assess new ideas from a short-term, medium-term and long-term technology perspective.

Later steps are taken to ensure that these technology opportunities are aligned with the company's strategic objectives – with conceptual product prototypes and product roadmaps being prepared in many instances.

As the accompanying diagram indicates, the initial four steps in the PDMA technology planning process form the basis for brainstorming about new ideas for the short-term, medium-term and long-term technological opportunities defined in step 5.

Once these opportunities are identified, the team should review this comprehensive list to ensure their fit with the company's strategic business needs. This step provides an initial screen that should extend beyond the company's own internal technologies. At this point in the process, the team often outlines "philosophical product prototypes" and product roadmaps.

PDMA product – technology road-mapping



In brief:

During the planning process, a cross-discipline team needs to establish a prioritized list of go-forward opportunities. This focus can be further broken down in gated due-diligence decisions that need to be made for each technology strategy.

A core business planning team should review, screen and filter the shortened opportunity list to establish a *prioritized* list of short-term, medium-term and long-term opportunities. The planning team will use this list to focus its energies on a relatively small number of go-forward technological strategies.

Ideally, this focus should be broken down into a series of gated due-diligence decisions (technical feasibility studies) that are undertaken for each technology strategy.

With these broader actions in mind, the core planning team can then outline the commercialization strategies. Once these strategies have been reviewed, they can be published and distributed to the wider team, along with appropriate business plans.

An internal advisory team should be established to regularly review the initial technology plan (with an annual review being the bare minimum).

Organizational structure. Effective technology plans are not the work product of the R&D planning group alone. Effective technology management needs to support the strategic needs of the company as they have been mapped to the needs of the marketplace. As a result, technology planning requires key input from corporate management, R&D, marketing and sales on a cross-discipline basis.

In essence, the entire company needs to be organized to ensure that the technology plan is successfully executed. If the company fails to establish clear goals, effective drivers, understandable success metrics, structural components and/or committed resources, the technology planning process will come to naught.

The increasingly complex nature of today's products and their related supply chains makes technology planning exceedingly difficult. Recent research by the Aberdeen Group indicates that less than one-quarter of companies surveyed have C-level executives in charge of the full innovation processes, including identifying product ideas, engineering them and bringing them to market. This contrasts with 60 percent of best-in-class companies that have a chief product officer, chief innovation officer, or the equivalent.¹⁵

More and more companies now recognize the need to restructure their R&D organizations to better recognize, capture and leverage their technological assets. Central R&D offices, technology councils, chief technology officers and chief product officers have emerged in an effort to better coordinate and assume responsibility for managing corporate wide technology planning processes.

The same Aberdeen Group research also shows the importance of getting a company's different groups to work more effectively together. Best-in-class companies are more likely to centrally manage their product knowledge than laggard competitors. Top-performing companies were 4 times more likely to integrate data and process automation capabilities into a collaboration infrastructure they can leverage for managing multiple projects and products.

In brief:

Effective technology plans also require improved organizational structures and management tools to ensure their success. Planning input must be provided by corporate management, marketing, and sales – as well as the R&D organization.

Best-in-class companies place C-level executives in charge of their total innovation process – with centralized technology officers and technology councils responsible for coordinating the planning process itself. In addition, top performing companies centrally manage their product knowledge and ensure collaboration through automated processes and a global infrastructure.

► Key Siemens solution capabilities

Basic capabilities. Siemens' Teamcenter® software powers innovation and productivity by connecting people and process with knowledge. Teamcenter's comprehensive portfolio of proven digital lifecycle management solutions is built on an open PLM foundation.

Teamcenter provides a digital backbone that allows companies to streamline and improve planning, development, manufacturing and support processes throughout the product lifecycle. Teamcenter is able to manage large amounts of data created under diverse authoring applications in a single source of product and process knowledge.

Teamcenter provides key infrastructure capabilities that allow distributed and cross-functional teams to work together in a secure environment where entitled users can share and leverage enterprise's collective intellectual property. Global users can access this knowledge from any location using any kind of web-enabled device.

Improving technology planning. Teamcenter's basic PLM capabilities allow the cross-functional teams that participate in the technology planning process to collaborate effectively, share ideas and work together on a real-time basis.

Teamcenter provides a layer of integration for effective workflow and process management. Companies are able to streamline the interactions and transactions that occur during the discovery research chain by pushing the right data in the right format and right context to the right people at the right time. Formal templates allow companies to implement best practices – such as the stage-gate process – as standardized and integrated processes that can be executed across the entire product lifecycle.

By facilitating integration beyond the technology planning process and into the rest of the product lifecycle, Teamcenter ensures that companies do not undertake their technology management initiatives in isolation. Using Teamcenter, companies can effectively map technology to market requirements and product architectures. Ultimately, teams can track this alignment through to product development and manufacturing – bringing all critical lifecycle processes together.

Teamcenter's common data and process management infrastructure enables the company to monitor information maintained on multiple authoring systems dispersed around the world. Teamcenter can show who is working on any assigned work task and the state of individual's deliverables. It can roll up this information and display these summaries on project-level dashboards.

Companies can leverage Teamcenter's comprehensive project and program execution capabilities to tie high-level planning to functional execution activities. Since Teamcenter integrates its workflow and project tracking mechanisms, teams can automatically manage program execution as a by-product of the technology planning process.

In brief:

Siemens' Teamcenter provides an open PLM foundation that companies can use to manage their technology planning process and facilitate cross-discipline collaboration by the technology planning team.

Teamcenter enables the planning team to streamline the interactions and transactions that occur during discovery research. By delivering the right data to the right people, Teamcenter ensures that technology management is not performed in isolation. Formal Teamcenter templates allow companies to implement best practices, including the stage-gate process. Teamcenter's project and program management capabilities allow managers to tie high-level plans to executable functions – as well as to track this execution at both a task and rolled up level.

R&D-specific capabilities. Teamcenter's electronic lab notebook capabilities provide specific support for R&D-related processes. Companies can configure their processes and data models to support either fully electronic or printed paper record processes that meet a comprehensive series of regulatory, cultural or legacy data requirements.

Teamcenter supports a diverse set of domain-specific application integrations and workgroup-level data management solutions. These capabilities range from integrations with Microsoft Office (to facilitate primary laboratory record authoring) to more specific integrations, such as those for adjunct laboratory notebook applications (e.g., NuGenesis and CyberLab). Along these lines, Teamcenter enables companies to closely tie adjunct records to primary records.

Teamcenter's open capabilities support numerous technical options that companies can use to flexibly integrate legacy and commercial laboratory applications. For example, companies can use Teamcenter to provide notebook repository services so that notebook records can be created, searched and related across multiple applications.

Teamcenter provides a rich array of capabilities to ensure regulatory compliance for a wide variety of disciplines. For example, Teamcenter leverages DOD 5015.2 standards for records management – enabling companies to perform internal and external audits and support the use of digital signatures. Teamcenter implementations have been certified for 21 CFR Part I, while companies use its authorized data access capabilities to control the export of regulated information as specified by requirements such as the U.S. International Traffic in Arms Regulations (ITAR).

Teamcenter process management capabilities include the ability to configure processes according to company-specific business needs. These processes can be derived from standard templates provided by Siemens PLM Software. Supported business processes include Siemens templates for record lifecycle management, patenting, litigation, acquisitions, divestiture, employee training, internal/external auditing and certification.

Ultimately, Teamcenter enables companies to not only acquire knowledge, but also to efficiently leverage it. Teamcenter links technology development to product development – thereby allowing organizations to map their idea base to their technology base and finally to their product development and manufacturing base.

In brief:

Teamcenter supports integrations with Microsoft Office to enable work groups to author primary laboratory records. It also provides specific integrations to adjunct laboratory notebook applications, including NuGenesis and CyberLab.

Teamcenter can function as a notebook repository service, as well as facilitate regulatory compliance. Teamcenter also supports business processes for record lifecycle management, patenting, litigation, acquisitions, divestiture, employee training, internal/external auditing and certification – all of which pertain to technology management.

Footnotes

¹ *Innovation 2005*, The Boston Consulting Group.

² “*Money Isn’t Everything*,” *The Booz Allen Hamilton Global Innovation 1000*, Barry Jaruzelski, Kevin Dehoff, Rakesh Bordia, 2005.

³ *Unmanaged R&D Spending is the Leak that Shareholders Want Plugged*, Kevin O’Marah, Laura Carillo, AMR Research, 2005.

⁴ *Op. cit.*, *Booz Allen Hamilton*.

⁵ *The PDMA Handbook of New Product Development*, Kenneth B. Kahn, George Castellion, Abbie Griffin, Second Edition, 2005.

⁶ *Ibid.*

⁷ *Op. cit.*, *Unmanaged R&D Spending*, AMR Research.

⁸ *Op. cit.* *PDMA Handbook*.

⁹ *Intellectual Property: Smart Management*, A.K. Jain, 1999.

¹⁰ *The Knowledge Management Handbook*, W. Burkowitz, R. Williams, 1999.

¹¹ *The Innovator’s Dilemma*, Clayton A. Christenson, 2003.

¹² *Op. cit.* *PDMA Handbook*

¹³ “*Developing Effective Technology Strategies*,” Steve Bone, Tim Saxon, Research-Technology Management, 2000.

¹⁴ *Ibid.*

¹⁵ *New Product Development: Profiting from Innovation*

About Siemens PLM Software

Siemens PLM Software, a business unit of the Siemens Industry Automation Division, is a leading global provider of product lifecycle management (PLM) software and services with nearly six million licensed seats and 56,000 customers worldwide. Headquartered in Plano, Texas, Siemens PLM Software works collaboratively with companies to deliver open solutions that help them turn more ideas into successful products. For more information on Siemens PLM Software products and services, visit www.siemens.com/plm.

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