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Development of Key Performance Indicators for Knowledge Management

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Abstract

A global heavy truck development organization is engaged in an aggressive campaign to improve its efficiency, speed, and effectiveness in developing new products. One of the cornerstones of this initiative is knowledge management, which is recognized as a significant challenge in part because so few practical tools exist to help manage knowledge growth. This paper presents the results of a collaborative project to develop key performance indicators (KPIs) for knowledge management in a lean product development context. We present a framework that outlines three key touch points where product development organizations should focus attention in order to encourage rapid knowledge growth and effective knowledge reuse in a project-oriented matrix organization. We then outline the collaborative approach used to develop KPI's for these touch points, along with preliminary results and future work.

Keywords
Knowledge management, key performance indicators, performance measurement, lean product development.

1. Introduction
Lean product development is an emerging model for the design, development and market introduction of new products and services to the marketplace. Since it is an emerging model, consensus around a definition of lean product development has yet to solidify. However, the literature contains a number of principles and practices borrowed from lean manufacturing as well as from high performing product development organizations such as Toyota Motor Corporation. We define lean product development as consistently producing profitable operational value streams while minimizing waste [1].

Increasingly, both the practitioner and academic communities appear to be recognizing the critical role that knowledge management plays in high performing product development systems. The ability to capture technical product and manufacturing knowledge, and "how to" knowledge about business processes, then reapply that knowledge to future projects while continuing to build upon that knowledge is likely a critical element in an organization's ability to continually improve (a central tenet of lean thinking). Further, it is likely a powerful tool for decreasing time-to-market while increasing product/service quality without increasing costs. And yet, little detailed work has been done to understand how to best structure knowledge management systems to support lean product development.

An important aspect of putting any methodology into practical use is the possibility for the user to be able to judge whether the methodology is providing the desired effects or not. The overall methodology of knowledge management is claimed to enable large gains in both the effectiveness (doing right things) as well as the efficiency (do things right) of business processes. However, the practical question of "how do you manage it?" is largely an open question.

In this paper we describe a project in which a large global manufacturer has decided to initiate a significant overhaul of their PD systems using principles of lean product development. One of the cornerstones of that initiative is knowledge management, and yet management recognized that they did not yet have robust systems to encourage, track or monitor knowledge growth and reuse. We embarked on a collaborative project to elicit novel key performance indicators (KPI's) uniquely suited to the context of lean product development and the host company's existing performance management system. In doing so, we contribute a methodology for knowledge management KPI development that can be used in other contexts as well as a proposed set of KPI's for lean product development.

2. Background

The host company is a global manufacturer of heavy trucks, with research and development facilities located in a number of countries globally. The work conducted for this project took place at one site, an R&D facility located close to the company's corporate headquarters and employing thousands of development personnel. Product development in the studied company is strongly project-oriented. The projects are initiated by product planning with input from the marketing and sales organization. Product planning, together with product design and validation, resides under the product development function. The projects are set up, run and governed by a project management division within the product development function who makes formal requests for engineering resources. The project model that governs the development activities has been in use for more than 10 years and has been developed and refined to reflect the development needs of highly complex commercial vehicle products that the company develops, manufactures and sells.

With such a strong project focus in the organization, it has meant that long-term development of technologies, processes, methods and so forth has received less attention as most engineering resources are dedicated to development projects. In reality, this means that knowledge management has been very thin (or almost non-existent). Its main carriers have been the individual engineers who, through their experience, have carried knowledge with them as they are re-assigned to new projects.

In order to increase the overall efficiency of the research and development activities, the company embarked on an initiative in 2009 with the aim to address both the project management model and associated main processes as well as to increase the systematic creation, capture and reuse of knowledge in and between development projects. This has made knowledge management in and between projects a relevant area to systematize in terms of methods and processes as well as new organizational roles and responsibilities to offset the previous strong project focus in the company.

To make improvements in product development performance, the company leadership conducted a significant investigation into the current literature related to lean product development. Based upon this research, the company identified nine so-called "cornerstones" of lean product development, as follows:

1. Knowledge Management
2. Portfolio Management
3. Chief Engineer Concept
4. Visualized Performance Management
5. Set-based Engineering
6. Lean Innovation
7. Systems engineering
8. Virtual Test and Optimization
9. Optimized Organizational structure

The basic model of their development system is pictured in Figure 1 below. A "knowledge growth" arrow is shown in the background, in theory illustrating that each new project draws upon existing knowledge, and then builds upon it for the next project. The company developed lengthy documentation as to what is involved in each of the cornerstones, and defined a number of best practices associated with each cornerstone. They then mapped the cornerstones to the R&D operating model, with the idea being that through application of lean principles, as defined by the cornerstones, the capability of the product development organization would be enhanced.

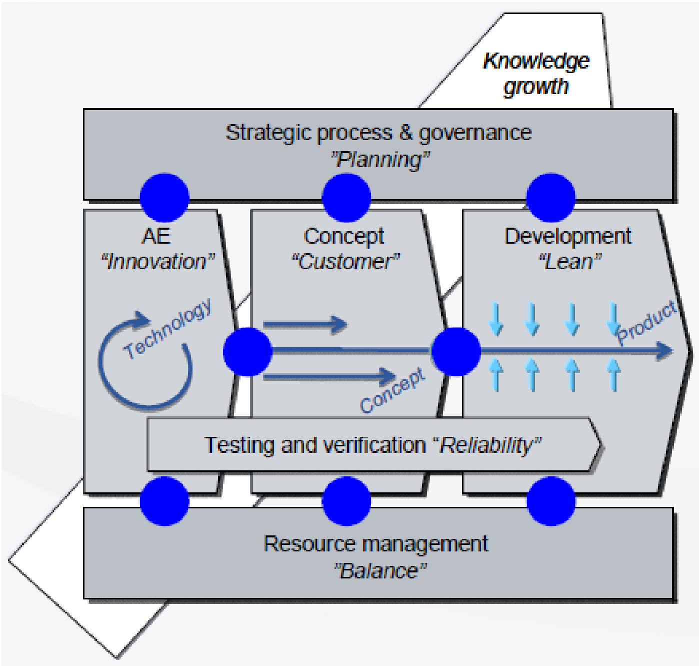

Figure 1: Operating Model for Research and Development

As we met with the leadership involved in deploying the application of these cornerstones throughout the organization, one of the areas identified with the greatest opportunity to have lasting impact was in the area of knowledge management. And yet, the leadership had few, if any, tools at its disposal to encourage and monitor progress in this area. In order to give the organization a way to assess knowledge creation, capture and reuse from the projects, and at the same time stimulate the mindset of "knowledge as a deliverable" among engineers and managers, the need for a "knowledge management KPI" was expressed to the authors of this paper.

3. Literature Review

The term "knowledge management" applies to a broad spectrum of activities used to create, exchange, enhance and manage intellectual assets [2]. Since the idea was introduced by Nonaka and Takeuchi [3] in the mid-1990's, the amount of attention dedicated to it has continued to increase [4]. Increasingly, the consensus seems to be that organizations can increase their effectiveness by judicious targeting of enhancements to their knowledge assets [5]. Enhancements can be made by increasing the organization's capacity to discover or generate knowledge, share it, acquire it, or integrate knowledge from different domains [5].

Broadly speaking, knowledge management systems follow one of two models [6]. The first is a repository model, which requires the codification of knowledge in some fashion. That information is then stored in an electronic knowledge repository (e.g., a database) or an organizational memory information system (e.g., a file share system), and supposedly retrievable for future use. Repository models tend to focus on explicit knowledge—knowledge that can be codified, made external to the knower, and transferred easily between people. The second model is a network model, which assumes that much knowledge is highly personalized. With network models, organizations focus on tacit knowledge—knowledge which is highly personal to the individual, context-specific, and difficult to transfer between individuals. Sharing of tacit knowledge therefore requires a high degree of interpersonal interaction. Some organizations have developed knowledge directories (sometimes called "yellow pages") or established "communities of practice" where individuals with complementary knowledge and skill sets are formally or informally brought together to share best practices. Of course, hybrid models can also be found [7].

As the literature on knowledge management continues to burgeon, so has interest in knowledge management performance measurement [4]. A significant number of frameworks have been proposed, including: Balanced Scorecard, Intellectual Capital Index, House of Quality approaches, Intangible Assets Monitor, and citation-weighted patents to name a few [6]. Similarly, a sizeable number of performance indicators have also been proposed. Shannak [2], for example, lists more than 50 potential indicators. However, the literature is scant when it comes to performance indicators for knowledge management in a product development context. Little is known about how knowledge is attained and managed within design groups, much less on how to do it effectively and measure it [8]. In some cases, the performance indicators identified for knowledge management within product development are high-level indicators of overall product development performance, e.g., budget, schedule, innovation rates, time-to-market [9], and not specific to knowledge management. It seems that performance indicators focused on knowledge management, and uniquely suited to the product development context, would be useful for product development managers.

For performance indicators (or metrics) to be effective, they should be aligned with the organization's strategic objectives and overall performance targets [10]. It is generally accepted that non-financial indicators are the most appropriate for knowledge management, and that indicators should encourage appropriate behaviors among individuals and departments, such as collaboration and cross-functional work. They must work with the existing performance measurement structure. Furthermore, for indicators to be effective, the people who will be affected by them should be involved in the process used to identify them. Also, the time required to collect and process the data must not be too onerous, and the metrics must be presented in a way that is readily comprehensible and easily disseminated [11].

4. Framework

The overall framework of lean product development developed by the host company recognizes two main value streams of product development: the knowledge value stream and the product value stream. (A similar notion is put forth by [12].) In this model, the product value stream delivers specific solutions to a well-defined set of customer needs. The knowledge value stream is the knowledge that flows across projects, e.g., learning from one project that is applied to the next. As shown in Figure 2, the two streams are connected in the sense that product development projects flow out of and are supported by the knowledge value stream; and the knowledge value stream grows with the knowledge generated in each project. Three key performance indicators are proposed and evaluated in this paper.

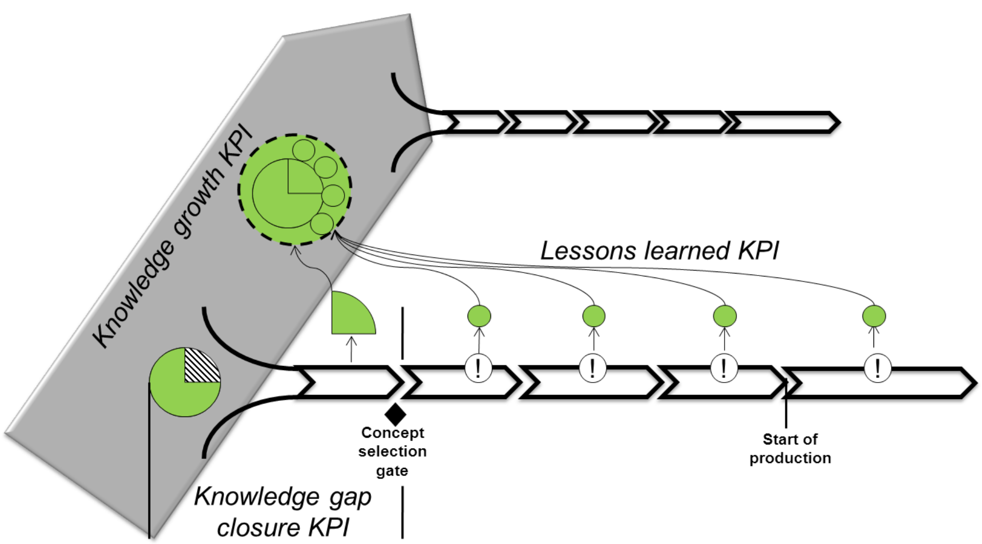

Figure 2: Three Key Performance Indicators to Support Knowledge Management

4.1 Knowledge gap closure indicator

This indicator is primarily concerned with stimulating the front end of the product value stream to be performed in an enlightened and knowledgeable fashion. It focuses on the "early phases" of product development, namely the phases before final concept selection. The ideal behavior in the early phases is to work with sets of conceptual solutions according to the principles of set-based engineering [1,13], each of which is characterized by the knowledge gaps that the organization has in whether and how the conceptual solution can fulfill the needs of the customer. The knowledge gaps can be concerned with requirements (e.g., which technical requirements the different parts of the conceptual solution impose on each other as well as on the logistics, industrial and aftermarket system), technical performance (e.g., whether a material can withstand the stresses needed to fulfill the customer needs), or the development process (e.g., whether the concept can be simulated, tested or manufactured in the process solutions present in the company).

Because the knowledge gaps for different conceptual solutions can vary in level of detail and extent, the primary behavior that the performance indicator addresses is to encourage the development team to actively identify, document and close knowledge gaps. The reason for this is twofold. First, it is desired to achieve a concept selection process that is as objective as possible in order to converge on a concept where (ideally) all knowledge gaps have been closed before the organization commits to the resource demanding phases of detailed development and industrialization. Second, it enables future projects to pick up on promising concepts from previous projects in a more precise way by knowing exactly the challenges (i.e., knowledge gaps) associated with those concepts as well as their benefits.

4.2 Lessons learned indicator

Ideally, all knowledge gaps for a conceptual solution should be closed before the concept is taken further for detailed development and industrialization for final delivery to the customer. This may not be possible because the key resources needed for the knowledge gap closure are not available, thus forcing the project to continue with known knowledge gaps. It is also often the case that there are undiscovered knowledge gaps (i.e., unknown unknowns) which are discovered later during testing, production or use of the product. Regardless of reason, such a discovery constitutes a problem that needs to be solved. The purpose of this indicator is to encourage a behavior where the organization systematically exploits such problem solving as opportunities to create knowledge by exploring root-causes, implementing countermeasures to correcting the problems, and verifying that the problem was indeed resolved. The knowledge can then be applied to improve practices and technical solutions for future coming products.

4.3 Knowledge growth indicator

Both of the indicators above have the purpose to stimulate knowledge creation from projects and from the product lifecycle phases, i.e., the product value stream. In order to encourage behaviors related to receiving, taking care of and using the created knowledge in future or concurrent product value streams, this third indicator is needed. The purpose of this indicator is to stimulate the set up of organizational entities with the responsibility to act as owners of strategic knowledge bases, and to encourage knowledge growth by: a) making the knowledge from the product value stream as explicit as possible, b) validating that knowledge, and c) making sure the knowledge is reused in relevant contexts (e.g., during initiation of new employees, at decision making points, during knowledge gap closure, for direction of research and technology development, in problem solving, etc.).

To summarize, the three performance indicators aim at reducing risk in projects by making knowledgeable concept decisions, by systematically exploiting opportunities to learn from problem solving, and by capitalizing on the knowledge through an active ownership and management of strategic knowledge bases in which knowledge is made explicit, is validated, and is made available in relevant contexts for reuse. This "knowledge cycle" of creation, capture and reuse—and how the indicators relate to them—are illustrated in Figure 2 above.

5. Methodology

Owing to much skepticism that we could identify an existing set of KPI's that would be suitable for this application, the authors proposed a methodology to develop a customized set of KPI's. We based our methodology on the framework provided by [14] where KPI's are developed in three stages. The first stage is at the strategic level, and results in the top-level measurement system. This step was already completed by the host company. The second stage is a set of "bridging" steps to translate measurements from the strategic level to the operational level. This stage includes identifying the outcomes of the knowledge process, the impact on the business process, and measureable actions teams take or should take within the knowledge process. The third stage is at the operational level, where the measurable actions are translated into performance indicators, which are then piloted to refine the performance indicators and identify the key ones.

The proposed approach was to conduct a series of workshops with representative organizational members to develop a set of draft KPI's. Then the KPI's would be tested in a pilot, and revised as needed. In this way, development of the KPI's would involve key stakeholders from within the organization, which in theory should improve the applicability of the result and ownership thereof.

Prior to the workshop, a good deal of thought went into participant selection. Each of the KPI's would have its own set of stakeholders, as shown in Table 1 below. Therefore, appropriate representation was needed for each of the workshops. Once we identified the type of individuals desired, we worked with management and through personal networks to invite specific individuals to participate.

Table 1: KPI Stakeholders

Key Performance Indicator	**Stakeholders**
Knowledge Gap Closure	Product knowledge owner Development process manager Project management
Knowledge Growth	Technical experts Line managers at all levels
Lessons Learned	Technical experts Line managers Customers

For the first KPI (knowledge gap closure), we conducted interviews with the participants to get their perspectives on:

- Term definitions
- Stakeholders and stakeholder needs with respect to the proposed KPI
- Existing knowledge processes
- Primary outcomes
- How well existing processes are working

The researchers synthesized the information, then developed a draft KPI set to bring the first workshop. At the first workshop, results of the interviews were presented and the draft KPI's proposed, discussed and modified. At the second workshop, the revised KPI was again presented and discussed (minor changes made), then discussion focused on how to test the KPI through some kind of pilot.

For the other KPI's (knowledge growth and lessons learned), we conducted the initial interviews as a group interview for better efficiency. It was felt that after the first round on the knowledge gap closure KIP, much of the information obtained was repetitive, so a group interview would be more economical. Otherwise, the workshop approach remained similar.

In all cases, field notes of the workshops or interviews were taken, and used in the next stages. The following section describes the results of the KPI development workshops.

6. Preliminary Results

All of the KPIs presented here are intended to be used in a manner of self-assessment. It is implied that the gains of creating, capturing and reusing knowledge are motivating enough for the organization to actually to use them. It is also important to note that the KPIs are not intended to be used for team or project evaluation by an external auditor. The KPIs should be used by the teams or projects themselves to support them in self-assessing relevant aspects of the actual state of their knowledge management in order for them to self-improve and gain the benefits of this improvement. In other words, trying to "game" the KPIs results only in self-deception and brings no actual value to the team or project.

6.1 Knowledge Gap KPI

Before explaining the details of this KPI it is important for the reader to understand the conceptual model of knowledge gaps used in this paper (essentially reflecting the definition of knowledge gaps proposed by the authors). A knowledge gap is defined to exist only with respect to requirements and design parameters. A knowledge gap arises when it is not known whether a conceptual product solution can be defined in the available design parameters to meet a certain requirement or criteria. Therefore a knowledge gap can arise if new requirements are posed and it is not known whether a design parameter can be stretched to meet the new requirement. But a knowledge gap can also arise if it not known for certain a new requirement can be validated. In other words, the knowledge gap can be product-related (e.g., stretching a product design parameter value) or process-related (i.e., how to validate a proposed design). Using this logic, the following scale is defined to assess the knowledge gap level of each identified knowledge gap in a project:

0. Neither the requirement/criteria nor the design parameter is known
1. Requirement/criteria is known but it is not known with which design parameter(s) to address it and consequently how this is validated
2. Requirement/criteria is known and it is known which design parameter(s) address it as well as how to validate
3. In addition to level 2, previous knowledge of how the design parameter related to the requirement/criteria (e.g. through trade-off diagrams) is known. Thus the knowledge gap is fully defined. It is not known how to close the knowledge gap.
4. In addition to level 3, it is also known how the defined knowledge gap can be closed, but that has not yet been demonstrated.
5. Tests or previous experience of the design parameter show that it is known that the design parameter can be defined to meet the requirement/criteria and it is known how this is validated, i.e. there is no knowledge gap due to previous knowledge or it has been closed through creation of new knowledge.

Development teams can use the above scale to score each customer requirement as the project goes through the early development phases. Discussions can then take place on how to prioritize resources to close the most significant gaps. Threshold levels can be set for passing a given development process gate or milestone.

6.2 Knowledge Growth KPI

The main concern of this KPI is to stimulate the establishment of knowledge ownership with respect to certain knowledge areas for the purposes of making all appropriate knowledge explicit, and assuring the reuse of that knowledge in relevant contexts. To achieve this, the knowledge growth KPI is divided into three sections, each of which is comprised of two or scales covering different aspects of knowledge growth within a given specialization. The three sections concern knowledge bases, knowledge application (or reuse) and knowledge roadmaps.

For the **knowledge base KPI** (see Table 2), the first scale concerns the accessibility of the knowledge base to relevant users. This is in order to stimulate knowledge sharing behavior as well as to demote the mindset that "knowledge is power" which negatively affects the knowledge flow in general. The second scales concerns coverage of the knowledge base, mainly implying that no important knowledge areas should be missing and thus reside only in an implicit form in the heads of people. The third scale concerns the frequency of updates to the knowledge base. Ideally, any new knowledge gained from the knowledge gap closure or lessons learned should lead to an expansion or modification of the knowledge base to make it available for others to use.

In the **knowledge application KPI** (see Table 3), each item aims at making sure that the knowledge base is referenced from relevant contexts and available for reuse. Four main contexts are identified:

1. Early phases and concept development – applying existing knowledge to concept elimination decisions and to identify and close knowledge gaps.
2. Design reviews – applying existing knowledge in decision-making in detailed design.
3. Issue/problem solving – resolving issues/problems that arise by using existing knowledge, and not spending resources on reinventing solutions.
4. New employee training – using existing knowledge to bring new employees up-to-speed quickly, and to avoid repeating problems because of the inexperience of a new employee.

Finally, the **knowledge roadmap KPI** (see Table 4) stimulates teams that have ownership of a particular knowledge area to actively pursue strategic development of new knowledge. The purpose is to encourage teams to establish a roadmap, which is frequently updated, that directs knowledge development activities (such as research or advanced engineering projects) towards relevant areas. In other words, the team should not only grow the knowledge based upon what is going on in development projects in the short term, but should also grow knowledge to position the organization to adequately meet future challenges over the long term.

Table 2: Knowledge base KPI

	0	1-2	3-4	5
Access	No users have access to the knowledge base	Some users** have access to the knowledge base	Most users have access to the knowledge base	All users have access to the knowledge base
Coverage	No formal knowledge base in use	Many important areas missing from knowledge base	A few important areas missing from knowledge base	No important areas missing from knowledge base
”Updatedness”	Knowledge base is never/rarely updated	Knowledge base is updated on some event*	Knowledge base is updated on most events*	Knowledge base is updated on every event*

* ***Event*** *refers to a design/quality problem or success from which particular lessons can be learned. Also it means the closing of each knowledge gap related to a particular knowledge area.*
** ***Users*** *refers to individuals that have a particular interest in either contributing to or benefiting from a particular knowledge base.*

Table 3: Knowledge application KPI

Where used?	0	1-2	3-4	5
Concept development/ Early phases	Not at all	Sometimes	Often	Always
Design reviews	”	”	”	”
Issue/problem resolution	”	”	”	”
New employee training	”	”	”	”

Table 4: Knowledge roadmap KPI

	0	1-2	3-4	5
Roadmap direction and development	No outside input	Team developed Little outside input	Team developed Internal stakeholder input or Industrial trends input	Team developed Internal stakeholder input and Industrial trends input
Frequency and level of usage	Used rarely	Reviewed anually Used in advanced engineering budget process	Reviewed semi-anually Identify gaps in expertise Used in AE budget process	Identify gaps in expertise Reviewed at least quarterly Used to influence and inform decision makers Used in AE budget process

6.3 Lessons Learned KPI

The work with defining a Lessons Learned KPI turned out to be quite complex, and required much more time and resources than were available to the authors. For this reason the authors choose to present the findings of aspects and dimensions that were highlighted as important for this even though a proposition for the KPI was never finalized.

The main question marks raised by the practitioners were: When is a lesson "learned?", and when does an event qualify for being included in the KPI?

The first question concerns the different levels at which a lesson can be learned. At one level, a problem is solved and its root cause delivered to someone who has the mandate to do something about it, i.e., implement it in some fashion. A second level can be defined when a change has actually been incorporated into working processes, standards or guidelines to prevent the problem from recurring (from that cause, at least). Yet a third level might be when the new process or standard is actually followed. The main issue here is that often problems arise in one part of the organization, investigation and root cause identification might be done in another part of the organization; whereas the root cause prevention must be done in a totally different part of the organization. In setting up a KPI, it is difficult to "give points" to only one part of this chain as the responsibility for action can be distributed across several units and, even more importantly, across several budgets.

For the second question, ideally it would be desirable for an organization to maximize their learning from the events that occur during development, i.e., "problems." Ideally the organization should even try to push the limits of the conceptual solutions under development with the sole purpose of learning about them. As the studied company only applies systematic recording and follow-up of problems of a certain magnitude, it would be hard from a practical point of view to base a KPI that requires the documentation of every problem regardless of magnitude, importance or impact (or even problems induced by "testing to learn"). Although from the perspective of maximizing the learning of lessons based on events, it would be beneficial to use the KPI to stimulate behavior that anticipates, solves and learns from problems before they occur in late phases or even after start of production.

7. Future Work

The next steps are to validate the developed KPI's with appropriate and willing teams within the host company. To do that, the KPI's must receive a least tentative approval from appropriate levels of leadership. Then, teams will need to be identified and asked to participate. Training and education in the purpose of the new KPI's and how they can be usefully applied would need to be provided. Next, teams would use the KPI's for self-assessment, and their feedback on the usefulness and usability of the KPI's gathered. This information will be used to improve the KPI and/or training materials. Depending on the nature of the improvements or feedback, additional pilot studies may be warranted.

For the particular case of the knowledge gap KPI, the evaluation is planned to be done in pilot projects which apply the KPI in the early phases. These projects will be compared with similar ones and the primary measure for comparison will be the risk levels (which are documented for all projects using the same methodology). The authors expect that the risk levels at the concept selection gate will be significantly lower for the projects which use the KPI. Simultaneously the expectation is that the amount of testing and validation hours will be higher for these projects indicating activities related to knowledge gap closure.

The knowledge growth KPI is more likely to affect the line organization and a direct effect of the KPI where applied will be the formation of knowledge owning and maintaining roles as well as an increase in the amount of formalized documentation that is done outside of projects. The authors plan to pilot this KPI with two or three knowledge specialty groups and assess the usability and usefulness of the KPI for encouraging knowledge growth. Eventually, the authors hope to see the knowledge growth KPI incorporated into the organization's self-assessment process.

For the lessons learned KPI there is still a large portion of work left on its definition according to what was described in section 6.3. At this point it remains largely conceptual idea until such time as we have better understanding of how to assess business processes that flow across organizational boundaries.

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References

1. Ward, A., 2007, Lean Product and Process Development, Lean Enterprise Institute, Cambridge, MA.
2. Shannak, R.O., 2009, "Measuring Knowledge Management Performance," European Journal of Scientific Research, 35(2), 242-253.
3. Nonaka, I., and Takeucihi, H., 1995, The Knowledge-creating Company: How Japanese Companies Create the Dynamics of Innovation, Oxford University Press, New York, NY.
4. Chen, M.Y., and Chen, A.P., 2006, "Knowledge Management Performance Evaluation: A Decade Review from 1995-2004," Journal of Information Science, 32(1), 17-38.
5. Erickson, G. S., and Rothberg, H.N., 2011, "Assessing Knowledge Management Needs: A Strategic Approach to Developing Knowledge," International Journal of Knowledge Management, 7(3), 1-10.
6. Kankanhalli, A. and Tan, B.C.Y., 2005, "Knowledge Management Metrics: A Review and Directions for Future Research," International Journal of Knowledge Management, 1(2), 20-32.
7. R. Sanchez, 2004, "'Tacit Knowledge' versus 'Explicit Knowledge' Approaches to Knowledge Management Practice," white paper available from: http://www.knowledgeboard.com/download/3512/Tacit-vs-Explicit.pdf. Last accessed 16 January 2013.
8. Roworth-Stokes, S., 2010, "Capturing and Retaining Knowledge to Improve Design Group Performance," Journal of Research Practice, 6(2), Article M14. Retrieved 15 January 2013, from http://jrp.icaap.org/index.php/jrp/article/view/207/195.
9. Hong, P., Abraham, W.J.D., Nahm, Y. and Li, X., 2004, "Knowledge Sharing in Integrated Product Development," European Journal of Innovation Management, 7(2), 102-112.
10. Lohman, C., Fortuin, L., Wouters, M., 2004, "Designing a Performance Measurement System: A Case Study," European Journal of Operational Research, 156, 267–286.
11. Neely, A., Gregory, M. and Platts, K., 2005, "Performance Measurement System Design: A Literature Review and Research Agenda," International Journal of Operations & Production Management, 25(12), 1228-1263.
12. Kennedy, M.N., and Harmon, K., 2008, Ready, Set, Dominate: Implement Toyota's Set-based Learning for Developing Products and Nobody can Catch You, Oaklea Press.
13. Sobek II, D.K., Ward, A. and Liker, J., 1999, "Toyota's Principles of Set-Based Concurrent Engineering," Sloan Management Review, 40(2), 67-83.
14. Del-Rey-Chamorro, F.M., Roy, R., van Wegen, B. and Steele, A., 2003, "A Framework to Create Key Performance Indicators for Knowledge Management Solutions," Journal of Knowledge Management, 7(2), 46-62.