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Competencies Development Framework Based on Best Practices

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ABSTRACT: Organizational knowledge is information about products, processes and customers that is held by the personnel and documentations within an organization. Institutionalization of best practices contained within this knowledge is essential for creating competencies. Unfortunately, organizations do not utilize this knowledge effectively. This paper introduces a framework that shows how establishing a prototype system to enhance product and process understanding can build organizational knowledge in the short-term. Along with external benchmarking, this internal knowledge can be used to form best practices based competencies. This framework is illustrated through a case study for an automotive sensor harness.

KEYWORDS: Organizational Knowledge, Knowledge Management, Competency Development, Best Practices Repositories.

INTRODUCTION

Organizational knowledge is rooted in the experiences, successes, failures, contexts and interpretations of the personnel within the organization. Regardless of size, product, industry or location, every organization contains a quantity of this valuable knowledge (Grayson, 1998). Unfortunately, organizations often are not aware of the vastness or the value of the knowledge that is resident in a subset of the personnel (Davenport et al., 1998). This lack of awareness, and subsequent limited utilization, is often due to the nature of the knowledge. When the knowledge is inferred, it is often difficult to articulate for use across the organization (Nonaka, 1991). However, even when the knowledge can be captured in a format that makes it usable, organizations often fail to exploit their knowledge assets.

This paper introduces a competency development framework that shows how establishing a prototype system to enhance product and process understanding can build organizational knowledge in the short-term and provides for organizational knowledge management practices in the longer term. Both objectives are achieved through the systematic development of best practices repositories. The proposed framework, which is discussed in the rest of the paper, is shown in Figure 1.

Internal specific and integrative knowledge is included in the best practices based competencies development through the first step; determine baseline process and product requirements. This step also assures that information from the supplier end to the customer end of the supply chain is incorporated. The second step of the framework achieves assimilation of deployment knowledge through experimentation or production. In the third step, external knowledge is detected through benchmarking.

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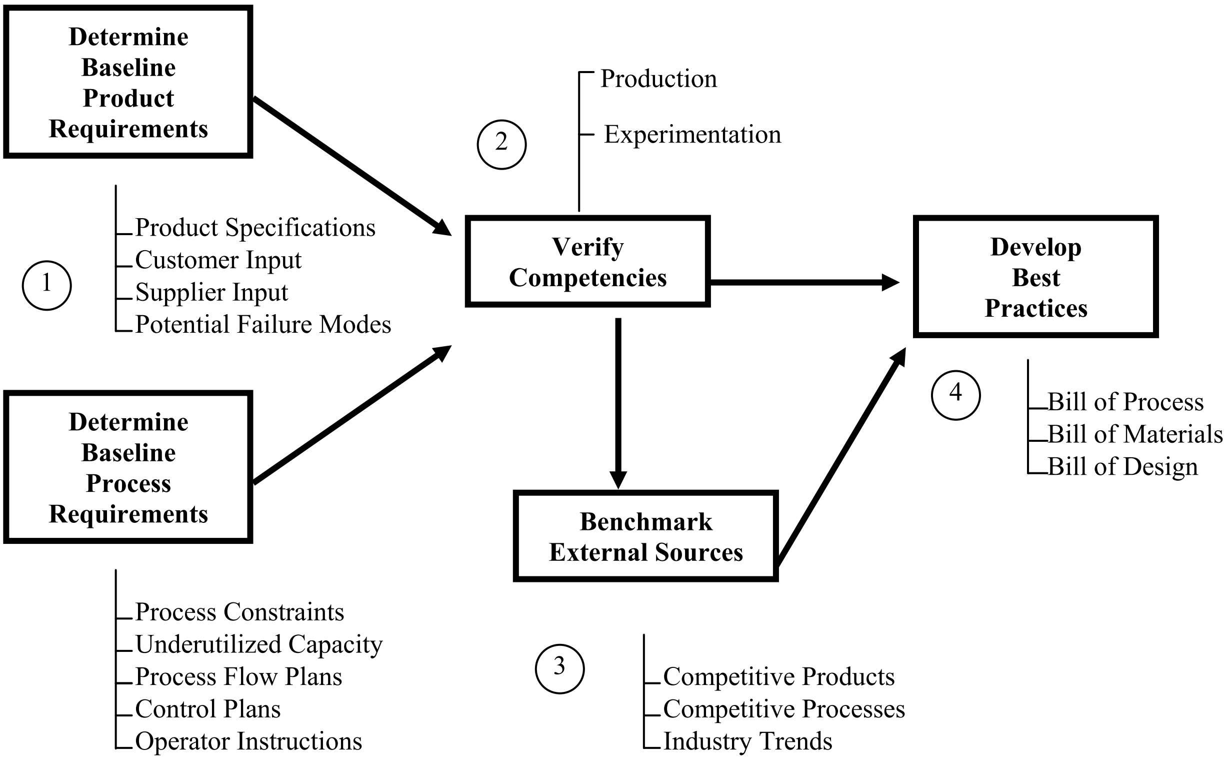

Fig.1. Competency Development Framework.

The final step integrates all of the acquired information to develop best practices based competencies for the organization. Persistently replicating the framework to continuously improve the best practices based competencies will assure that the repository contains the capabilities required to maintain a competitive advantage.

The rest of the paper proceeds as follows. In the next Section, we briefly review the related literature. In Section 3 we discuss best practices based competencies. The rationale for developing competencies and general development frameworks are introduced. The section details the preferred components of a competency development framework.

Section 4 introduces the proposed competency development framework. This framework incorporates internal knowledge institutionalization and external knowledge detection. This framework also includes experimenting or producing as a practice to enhance product and process understanding. The ultimate goal of the framework is to form best practices based competencies that can allow an organization to gain competitive advantage.

Section 5 presents the case study project utilization of the proposed competency development framework, and Section 6 details the results and conclusions based on the work completed during the project period. It closes with recommendations for further competency development framework extensions through an integrative best practices strategy.

LITERATURE REVIEW

This paper is mainly concerned with competency development based on best practices. However, the development and institutionalization of competency also includes benchmarking and knowledge management. Hence, in this section we briefly describe these closely related research streams: Knowledge management, best practices repositories, and benchmarking.

Knowledge Management

The concept of knowledge can be hard to understand for organizations willing to manage their knowledge. Even in the scientific community there are different views on what knowledge exactly is. Often a distinction between tacit knowledge and codified knowledge is being used (Nonaka, 1991, 1994). Codifiable knowledge is explicit and can be articulated (usually written down in books or stored, for example, in a database). However, for an individual, codifiable knowledge is interconnected with the tacit knowledge that is routed in personal mental models (i.e., individual skills, crafts and beliefs). Individual knowledge can become organizational knowledge through knowledge sharing, transferring, and conversion.[1] The most valuable knowledge shared will gain momentum that will allow it to be institutionalized as an organizational competency. However, knowledge sharing across an organization is not simple (Nonaka, 1994). In order to facilitate knowledge utilization, continued dedication of resources is required to assure that the information is in assessable formats. These resources are also required to enable continuous improvement to guarantee that the knowledge of the organization reflects the best information available.

Knowledge management enables utilization of the organization's informational assets. Effectively institutionalizing the best practices contained within the knowledge is an important step in creating organizational competencies (McEvily et al., 2000). At the center of knowledge management is the systematic creation, detection, collection, perception, adaptation, distribution and utilization of information.

Knowledge is developed through interactions with internal sources. These sources include the documentation that is utilized and the communications that are made in day-to-day business. Knowledge is also developed through interactions with external sources. External knowledge can be gained through processes such as benchmarking, competitive intelligence and reverse engineering. It can also be gained through information sharing with the customers and suppliers of an organization.

Best Practices Repositories

One powerful ingredient of knowledge management, especially one that focuses on practical knowledge, can be the best practice approach.[2] There is a tremendous amount of knowledge within organizations that is not applied in product or production process design. Since the personnel who should be utilizing the knowledge are not aware that it exists, exploitation of the knowledge does not occur. Centralized best practices repositories are created to methodically maintain the knowledge in order to solve this problem. These repositories, along with processes and procedures to utilize them, attempt to increase knowledge exploitation by providing accessible information for the entire organization.

Best practices repositories provide additional benefits. An organization's knowledge is centrally captured instead of residing with specific personnel who can leave the organization at any time.

[1] Nonaka (1994) describes this conversion process as "spiral of knowledge" creation through socialization, combination, externalization, and internalization.

[2] According to Arthur Anderson, best practices are the best ways to perform a process. They are the means by which world-class organizations have achieved top performance (www.globalpractices.com).

Providing accessibility to the organization's knowledge forces decisions to be less dependent on the responsible individual's depth of experience. Instead, the collective knowledge of the entire organization is utilized to make decisions. There is less dependence on costly repetitive creation of physical samples and more dependence on cost-effective centralized information. The best practices repositories provide a framework for product and production processes standardization when appropriate. Similarly, the repositories standardize the channel to communicate organizational knowledge.

Properly managed best practices repositories are comprehensive representations of organizational competencies. When guarded internally and used strategically, the knowledge within these repositories can offer an organization a competitive advantage (Lado and Zhang, 1998). The best practices can be utilized to simplify design, source and manufacture decisions. The goal of this simplification is to release human and monetary capital from re-engineering tasks. Then, these resources can be utilized on product advancement to exceed customer expectations and to improve the bottom line.

Benchmarking

Achieving and maintaining a competitive position in the global market requires an awareness of the competition and their capabilities. Benchmarking is a means to compare the capabilities of the organization against those of other industry participants (Compton, 1992). There are diverse sets of metrics that can be used to compare industry participants during benchmarking studies. Typical metrics fit into several broad categories including financial performance, organizational performance, quality performance and product performance.

Financial performance is evaluated through measuring and comparing typical financial indicators of the industry competitors. These indicators include return on investment, unit cost and unit profit. Assessing organizational efficiency statistics across an industry's organizations fosters organizational performance comparisons. These statistics include production per hour of labor, machine utilization and work-in-progress. Evaluating customer satisfaction and internal throughput information in an industry allows quality performance comparisons to be made. This information includes data on customer returns, percent on time deliveries and first time quality.

Product performance is evaluated through comparing features and functionality of products offered by businesses within an industry. Product features comparisons include identifying part counts and material types. Product functionality comparisons include determining field serviceability and operational repeatability.

Often, accurate information is not readily available for competitors' financial performance, organizational efficiency and customer satisfaction. Therefore, it is easier to focus on product performance metrics in benchmarking studies when idea generation is the goal rather than financial and operational comparisons.

BEST PRACTICES BASED COMPETENCIES

When guarded internally and used strategically, best practices based competencies can offer an organization a competitive advantage. However, developing competencies in every realm of an organization can be cost prohibitive. Similarly, improper management of best practices and organizational competencies can create a competitive disadvantage. If the best practices repository is inflexible or inaccessible the contents will not be utilized to gain a competitive advantage. Similarly, if the repository is not amendable, the competencies contained within will only be a competitive advantage for a moment in time. Organizations must continue to acquire new competencies from internal and external knowledge sources to meet the changing market needs and to remain competitive in an industry. In the extreme, a best practices repository that is not continuously improved contains outdated competencies that can become competitive disadvantages (Qingrui et al., 2000). Best practices based competencies can offer an organization a performance advantage over competitors. However, this can only occur when the competencies are accessible to personnel, limited in mobility and updated with frequency.

Increased speed in the market fosters an environment where competitive advantage is driven by the ability of an organization to rapidly learn new competencies when novel technologies appear (O'Dell and Grayson, 2000). Successful organizations will develop best practices based competencies using a framework that enables differentiation from the competition to gain competitive advantage. These competencies will be developed utilizing the best knowledge from inside and outside the organization at any moment in time.

Existing Competencies Development Frameworks

Institutionalization of organizational knowledge and development of best practices based competencies are not novel approaches to creating a competitive advantage in the market. Organizations typically initiate a strategy that utilizes the available resources to fulfill current or long-term knowledge requirements.

Some organizations develop best practices through the utilization of an external benchmarking framework. This practice ignores internal organizational knowledge based on the belief that best practices are found outside the organization (Cross and Baird, 2000). This is a farsighted view that can cause the institutionalization of practices that are worse than the baseline operation of the organization.

Other organizations utilize frameworks that are too nearsighted. These organizations solely consider internal knowledge and create structures that enable competencies to be continuously reused allowing for speed-to-market (Powers, 1999). However, these competencies often do not reflect the best practices in the industry, which can be incorporated through external knowledge detection. This can cause the knowledge institutionalized to become obsolete, leaving the organization speeding to market with inferior products and processes.

Some organizations utilize internal organizational knowledge and customer input when creating best practices based competencies (Elliot, 1998). The inclusion of external knowledge in the form of customer requirements and preferences will enable created competencies to be utilized to better serve the end users. However, this competency development strategy does not take advantage of the best practices in the industry through external knowledge detection.

Other organizations attempt to incorporate all available information. These organizations institutionalize internal organizational knowledge, incorporate external industry knowledge and integrate customer-supplied product knowledge. However, the full advantage of the acquired information is seldom achieved. Instead of reducing the information to practice, these organizations use simulation and modeling to verify that the knowledge is valid (Harrison, 1992). While this framework is better than the nearsighted internal knowledge institutionalization and farsighted external knowledge detection, it does not utilize experimentation to gain the learning that is essential to developing competencies.

Preferred Development Framework

There are three general categories of organizational knowledge. The first type, specific knowledge, is information that is restricted to a particular technology or discipline. The second type, integrative knowledge, is comprised of integrated specific information. The third type, deployment knowledge, is obtained through the utilization of specific and integrative knowledge (Parrup Nielsen, 1999).

Specific, integrative and deployment knowledge are all required for competencies development. Specific and integrative knowledge will be realized when internal information is institutionalized.

However, to obtain deployment knowledge the specific and integrative knowledge must be put into practice through experimentation or production (Linton and Walsh, 1999).

Beyond internal organizational knowledge, external knowledge must also be institutionalized for the competencies to be effective. The best of the internal organizational knowledge and the external industry knowledge must be put into practice for the organization to obtain the competitive advantage that is sought.

In order to gain competitive advantage, institutionalization of best practices based competencies is required. Additionally, to assure that the established competencies reflect best practices, internal knowledge capture, external knowledge detection and developed practice experimentation is essential (Thomke, 2001).

COMPETENCY DEVELOPMENT FRAMEWORK

In this section we provide a general description of the proposed competencies development framework shown in Figure 1. We describe each step within the framework in a rather generic manner to conserve its universal applicability in many settings. That is, specific applications may result in varying implementation details for each process within the framework. Our main contribution is in the framework and not the individual processes within the framework. However, a detailed application of the framework and each process within will be described in Section 5 using an automotive sensor harness as an example.

Determination of Baseline Requirements

Capturing best practices in a methodically structured manner through analytical or experimental means initiates institutional learning. This will foster support for further knowledge capture and momentum for competency development throughout the organization (Miller, 1996). At a minimum, internal knowledge discovered can be employed to represent a baseline of the current operations of the organization. Additionally, comprehending the advantages and disadvantages of internal organizational knowledge can prevent institutionalization of practices that are worse than the baseline operation of the organization.

In the first step of the framework, information from the entire supply chain is discovered. This includes supplier-provided technology knowledge, internal organizational knowledge and customer-provided product knowledge. This information represents the baseline knowledge resident within the organization's supply chain.

Suppliers are engaged to create capabilities where organizations have limited synergies in support of best practices based competencies development. Utilization of supplier competencies allows an organization to maintain a competitive advantage in products delivered and cost structure.

Suppliers' technological competencies are essential to the fulfillment of customer requirements. Therefore, suppliers should be instrumental in baseline requirement determination to assure that the corresponding capabilities are acknowledged and possessed (Nellore et al., 1999). Concurrence on baseline requirements will assure that best practices based competencies can be used in conjunction with supplier capabilities to satisfy customer requirements.

Furthermore, organizations must also concentrate on understanding and documenting knowledge about their customers. This knowledge should be utilized in the development of best practices based competencies to assure that the capabilities of the organization are aligned to support customer needs. Incorporation of customer-supplied information in competency development signals that there is a clear understanding in the organization of the expectations of the customers.

Verify Competencies

Without verifying the organization's ability to put best practices based competencies into practice, there is little likelihood that the capabilities will lead to a competitive advantage. In the second step of the framework, potential competencies are verified through experimentation or production. This step allows for the confirmation of an organization's ability to exploit the best practices. If confirmation does not occur, the outcomes of the experimentation offer information regarding the adaptation required in order to create legitimate best practices based competencies.

Experimentation or production alone is a poor basis for learning best practices and institutionalizing competencies. Experimentation without baseline requirements attains limited organizational learning. Unforeseen dynamics and misperception of results will confound unstructured experimentation or production (Lomi et al., 1997). Concentrated experimentation rooted in determined baseline requirements enables an organization to verify that there are appropriate best practices. These practices can then be transferred across an organization and utilized in the development of competitive advantage competencies.

Validating abilities through experimentation or production should be completed internally by the organization, externally by suppliers and jointly by both the organization and suppliers. The direct result of these efforts will be novel and creative solutions for developing products and processes. Individual and joint experimentation will also shorten the learning curve allowing an organization to introduce improved products in the market faster in order to gain a sustainable competitive advantage.

Benchmarking

In the proposed competency development framework, the benchmarking study is used to gain knowledge to incorporate into best practices based competencies development. Financial performance and organizational efficiency information regarding the competition would be powerful. However, this knowledge is difficult to acquire. Instead, we emphasize product performance in the benchmarking study. The end goal of the study would be the generation of best-in-class product features and functionality that are then used to determine design and process best practices based competencies.[3]

Conducting a benchmark study with a broad range of product and production systems presents a better chance that the best practice in the industry will be determined. In addition to industry competitors, information from other groups outside the organization should be gathered. Industry organizations, general standard setting bodies, and technical societies can be consulted to determine if there are standards or best practices available.

After external benchmarking is completed, best practices will be found and documented. Then, a comparative analysis, by internal experts, would be performed in order to verify external best practices and their potential contribution towards competence development (see Figure 7). This verification step has to be made because even some best practices of external sources can be a "worst" practice for a specific company. A decision would be made whether the best practice for the organization is the best external practice or the best internal practice. The chosen best practice will be institutionalized.

Best Practices Repositories

Centralized best practices attempt to increase knowledge exploitation by providing accessible information for the entire organization. This allows the collective knowledge of the entire organization to

[3] This approach may be infeasible for large-scale systems such as space shuttles or nuclear reactors. However, this type of benchmarking study can be conducted on the majority of manufactured products. Thus, the framework is applicable for general manufacturing and may not necessarily accommodate large-scale systems.

be utilized in product and process decisions. There are several repository structures that can be utilized by corporations attempting to implement a best practices repository. Three of the most common structures are bill of materials, bill of process and bill of design.

1. Bill of Materials – Parts required when producing a product.
2. Bill of Process – Proven manufacturing process sequences required to produce a product.
3. Bill of Design – Specifications required for product design utilizing design fundamentals.

The bills of materials typically exist within an organization. These lists are required to complete standard operating functions. The financial and logistics branches of organizations use these lists to track component cost and delivery. These lists are utilized to assure that products are produced to specifications by the production and quality sections of organizations.

The bill of process is developed to identify and to document the best manufacturing processes and process sequences for each product family. A goal of bills of process is to determine the best manufacturing systems that can be standardized globally to do more with less to become more competitive in the global market. An additional goal is to gain competitive advantage through shared innovation, consolidated activities and reduced costs. Product specific bills of process will be the baseline common manufacturing plan for a specific product.

Bill of design factors in the customer-determined requirements and industry trends that effect products and production processes. Design for manufacturing, design for assembly, design for serviceability and design for environment tools are utilized in best practices creation in order to meet the expectations of the product and process stakeholders.

The bill of materials, bill of process and bill of design are interconnected as shown in Figure 2 – the figure illustrates the iterative and interconnected development for the three bills. Best practices developed for one framework must be supplied into the development of the others in order to achieve overall best practices. Other information from inside and outside an organization should also be incorporated to create the broadest data set available. Such information falls into four major categories (AIAG, 1998):

1. Control Plans explain which product features need to be evaluated and how often to conduct inspections. These plans detail what tools to use when measuring the features. These plans indicate the acceptable criteria and the reaction plan to follow if the product does not meet the criteria.
2. Process Potential Failure Modes and Effects Analyses describe the potential product defects that can occur during processing, the cause of these defects, and the effect these defects can have on the customer.
3. Process Flow Plans illustrate the order of process steps in the manufacturing of a product.
4. Operator Instructions clarify how to set-up and operate equipment required to manufacture a product. These instructions also explain how to complete manual operations and quality inspections.

CASE STUDY: IMPLEMENTING THE PROPOSED FRAMEWORK

In this case study, an automotive supplier company has two divisions: A and B. Historically, Division A has designed one subassembly of products and procured the other subassembly from Division B. As the market's demand has shifted toward more technologically enhanced products, Division B has redeployed resources to compete in these higher margin markets and no longer produce other division's requirements.

Division A initial solution was to start prototyping the subassemblies at the same facilities that were developing the rest of the products. However, internal competencies for building these subassemblies needed to be developed. The organization started to build these competencies through the development of

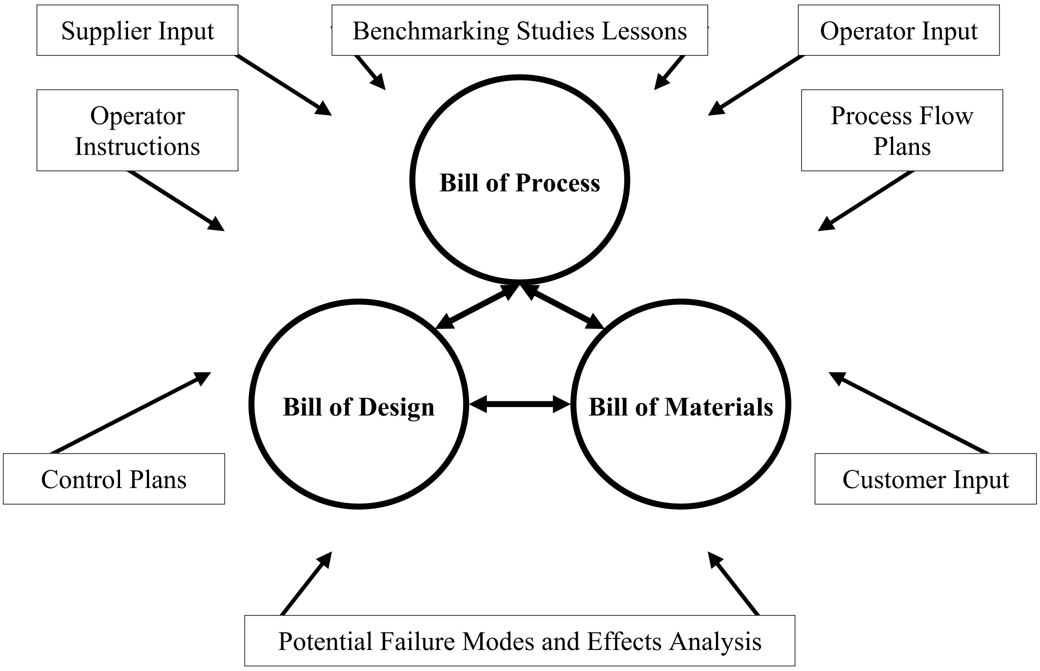

Fig. 2. Iterative and Interconnected Best Practices Development.

a prototyping system and a best practices repository utilizing the proposed best practices based competencies development framework described earlier in this paper.

Product and Process Requirements

The purpose of a sensor harness is to connect the sensor to the on-board computer and the electrical system in the vehicle to allow electrical signals to be interchanged. As shown in Figure 3, the harness is made up of three basic system blocks in order to complete these functions:

– The vehicle connection system – typically a plastic connector and electrical terminals.
– The signal transfer system – typically wires and electrical terminals.
– The sensor connections system – an insulating connector and electrical terminals.

The harness requirements are well developed since the sensor product has a relatively long history and strict regulations. A subset of these requirements is listed in Table 1 (GM, 1990). In addition to these specific structural requirements, there are customer-determined requirements. These requirements typically include wire lengths, vehicle connector geometries and environmental protective devices. The typical process flow utilized, in assembling the three basic building blocks of a harness, is outlined in Figure 4 (Szuba, 2001).

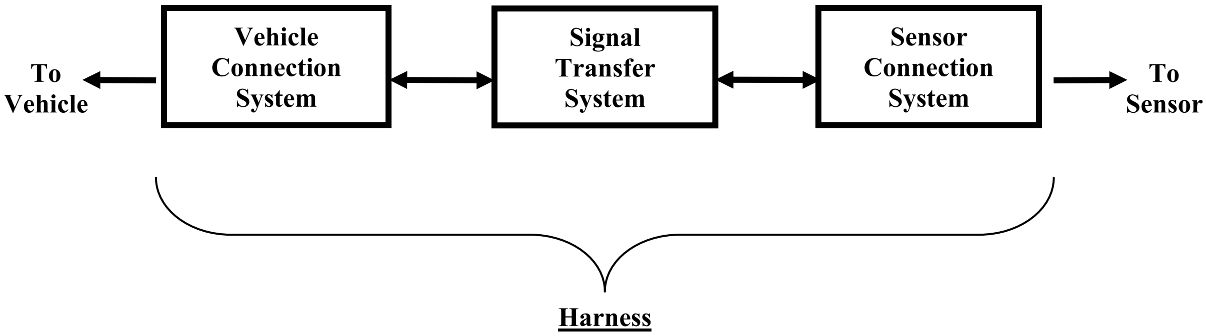

Fig. 3. Harness Basic Sub-Blocks.

Table 1
Requirements

Electrical Requirements	Mechanical Requirements	Temperature Requirements	Environmental Requirements
Operating Voltage	Lead Termination Tensile Strength	Low Temperature Operation	Structure Breathability
Output Voltage	Lead Termination to Connector Retention Force	High Temperature Operation	Withstand Immersion in Oil
Source Current	Vehicle Connector Mating Force	High Temperature Stability	Withstand Immersion in Coolants
Sink Current	Vehicle Connector Retention Force	Time to Temperature	Withstand Immersion in Automotive Fluids
Lead Termination Resistance	Vehicle Connector Disengage Force		Withstand Immersion in Salt Water
Signal Lead Resistance			Withstand Impact by Gravel
Power Lead Resistance			
Insulation Resistance			
Lead Continuity			

Verify Competencies by Prototyping

The goal of the prototyping system was to meet the immediate competency development and prototype source needs of Division A by manufacturing prototype subassemblies. Since the system was being developed near the end of a business year, there were limited budget dollars to procure equipment. The capacity required had to be found in underutilized equipment already in the organization. Predictably, this caused the system not to be as flexible or efficient as desired.

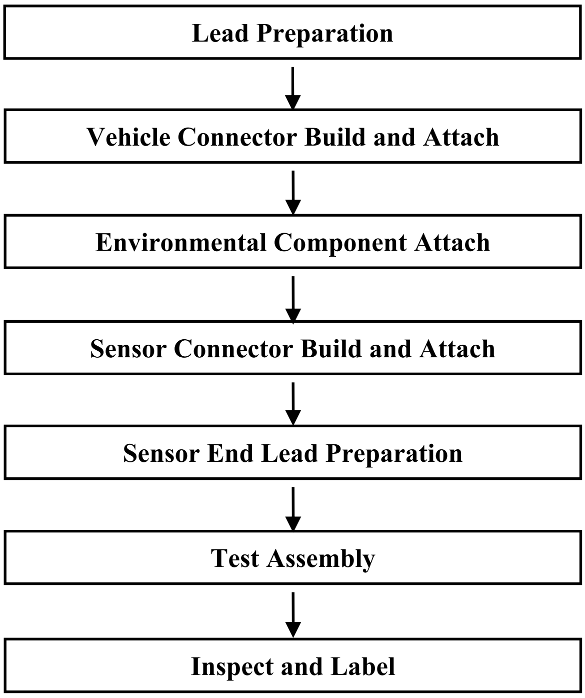

Fig. 4. Typical Harness Process Flow.

Within these constraints, a system concept was developed that would use equipment already available within the organization to fulfill the divisional need. The concept was developed using the best practice process flow from Division B, which is shown in Figure 5. The prototype system was activated to verify equipment operation. Figure 6 shows the layout and process for the prototype system implemented.

This system operation was used to create quality statistics from production and assembly information from utilization. The information acquired provided valuable lessons learned that contributed to best practices development. Further knowledge gained from additional manufacturing will be inputted into the development of process best practices and process sequence best practices. These best practices will then be used to efficiently develop manufacturing process sequences for harnesses across all sensor families within Division A.

In order to achieve the most learning from the prototype system, it should be reconfigured and equipped for sustainability. A dedicated flexible cell will offer the most in learning through investigating process parameters, testing process sequences and producing multiple harness families. The more flexible the prototype system, the larger the variety of harness families that it can produce. The larger the variety of harnesses produced, the higher the potential of finding universal best practices that can be copied exactly across the entire division.

Benchmarking Study

For the purposes of this project, the benchmarking study baseline was the current product and production system designs within Division A. The goal of the study was to utilize the benchmarking lessons in future product and production system designs. The process flow for the benchmarking study is shown in Figure 7.

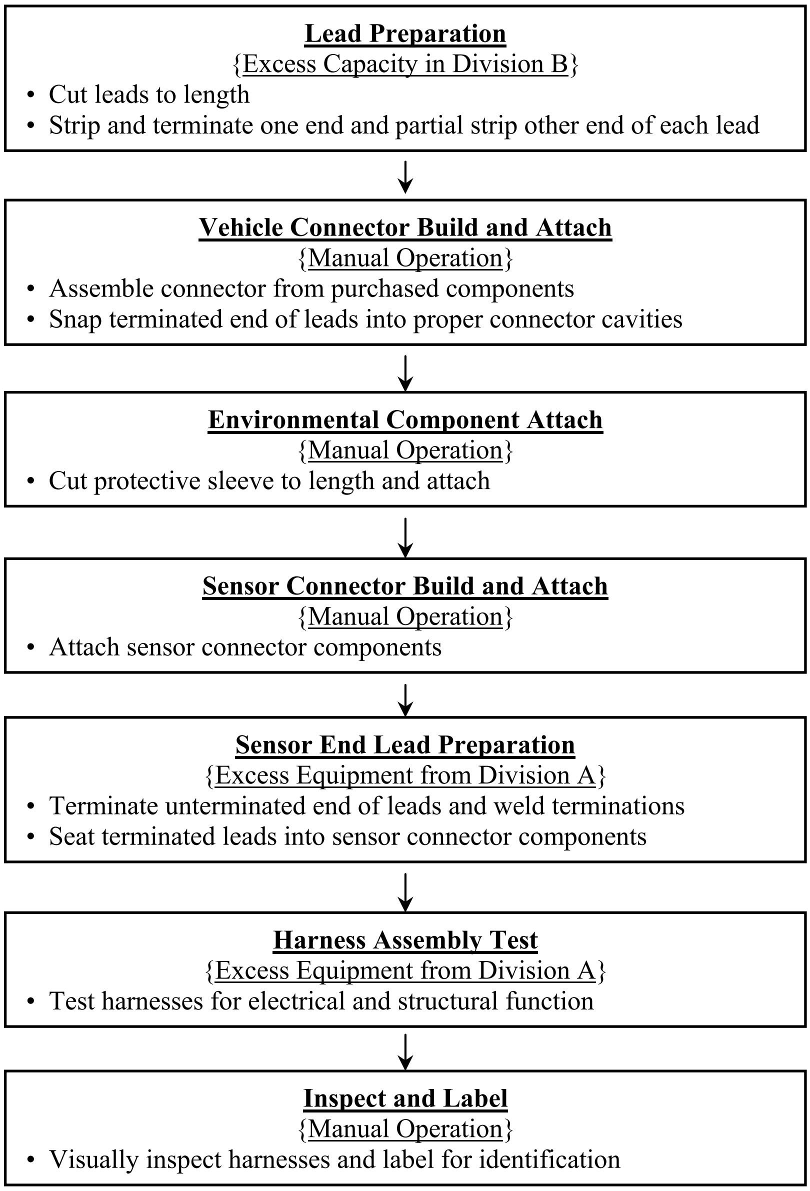

Fig.5. Exhaust Oxygen Sensor Harness Process Conceptualization.

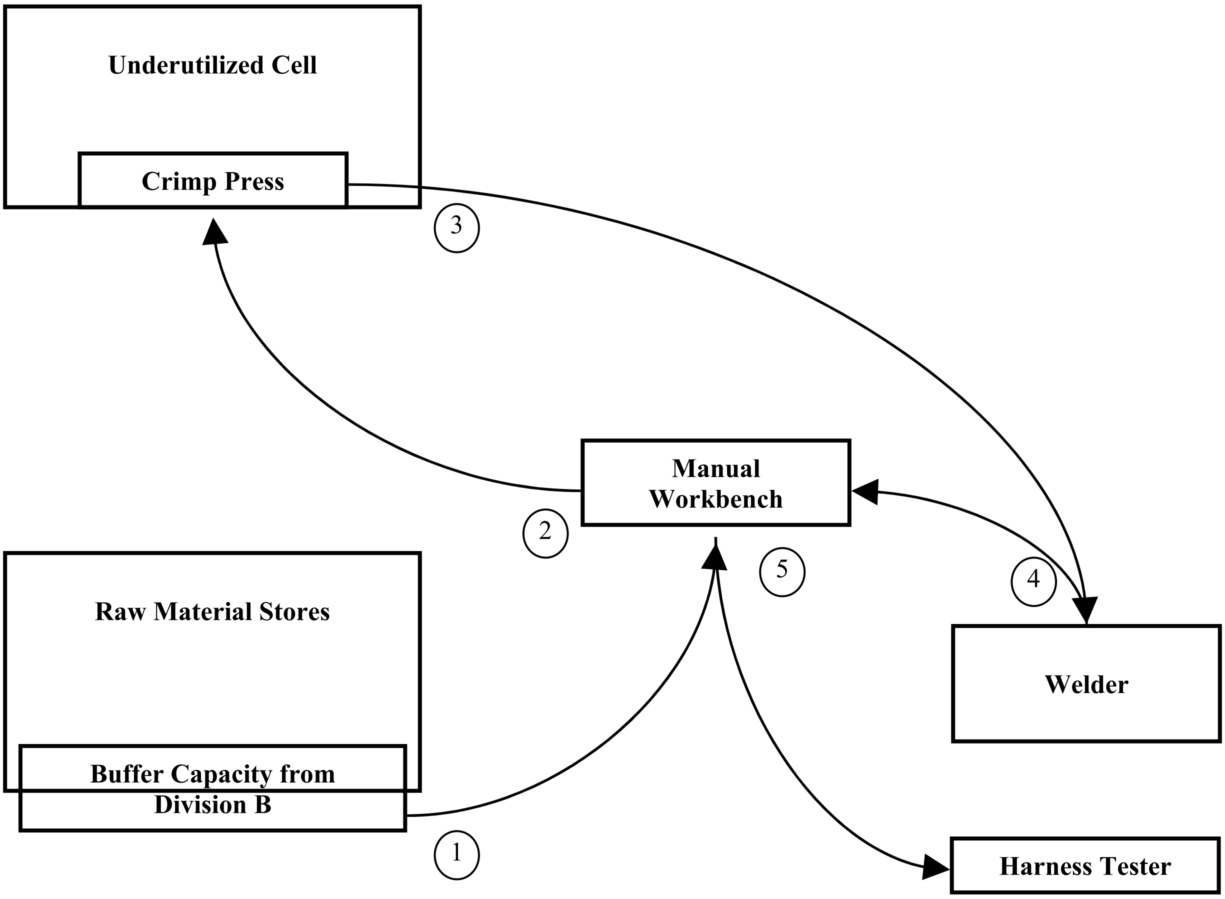

Fig. 6. Implemented Prototype System.

Organizational information regarding the baseline case for the subassembly was obtained. This information was in the form of bills of materials, process flow plans, control plans and potential failure modes and effects analyses.

Potential failure modes and effects analyses describe the potential product defects that can occur during processing, the cause of these defects, and the effect these defects can have on the customer. This information is vital to understanding when a more elegant design is encountered (Giammatteo, 2000). In order to acquire a complete understanding of the system requirements the seven steps of the Systems Failure Method were used to supplement the potential failure modes and effect analyses (Fortune and Peters, 1995).

1. Definition of the System
2. Description of System Operation

3. Description of the Environmental Conditions
4. Failure Detection
5. Analysis of Failure Mechanisms
6. Analysis of Failure Effects
7. Compensation for Failure

This framework provided the baseline of comparison for the benchmark study. It demonstrates where the current product and production processes may contain deficiencies. It also provides a basic understanding of the requirements of the product. These requirements will determine which of the material selection and design parameter lessons from the benchmarking study are compatible with the needs of the product.

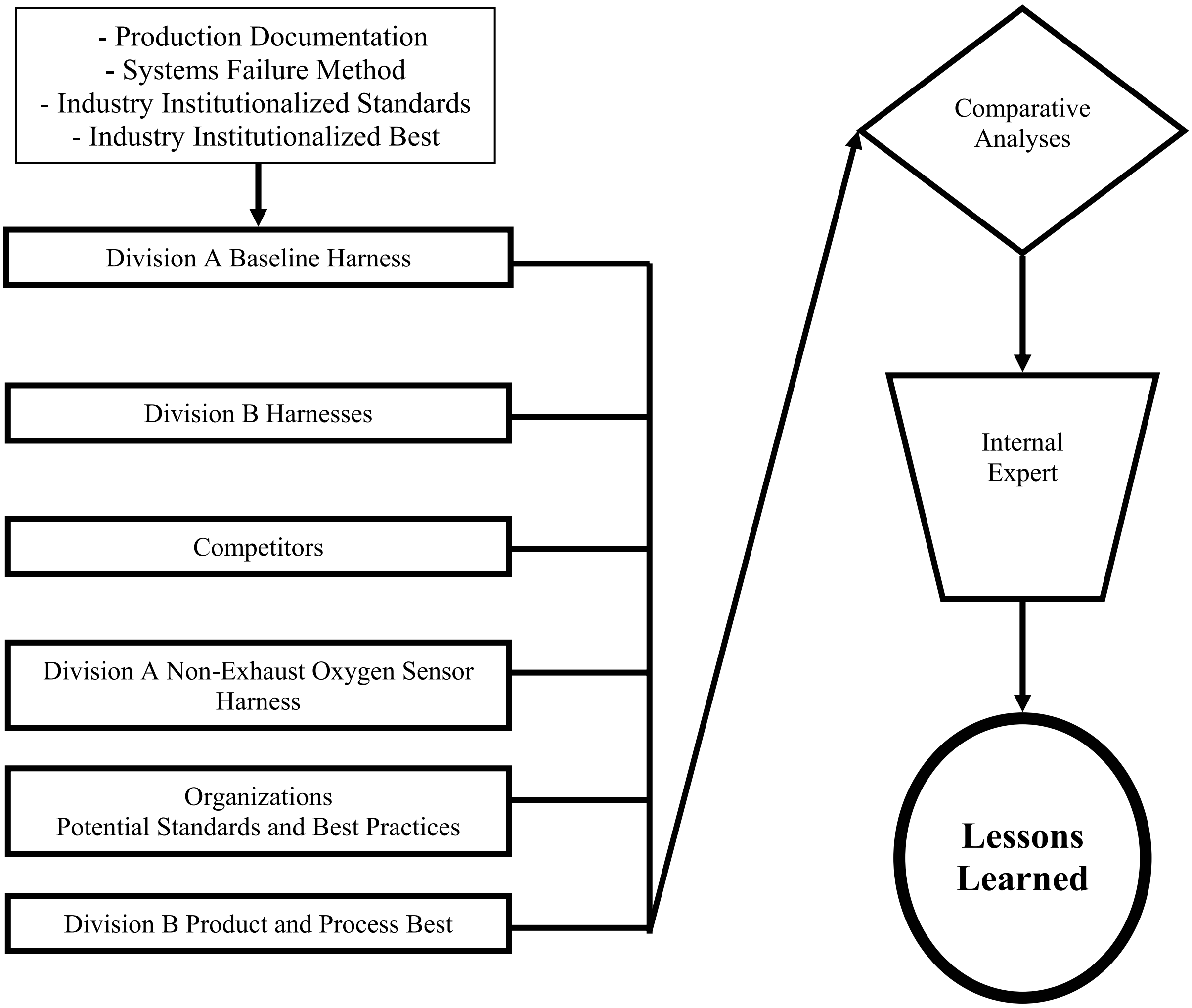

Fig. 7. Benchmarking Study Methodology.

The standards already institutionalized within the industry were added to the baseline internal information. This information was used as a starting point for the comparative analyses. Based on the failure detection and failure mechanism information developed in the Systems Failure Method, particular attention would be given to the problematic product and process subsystems during the analyses.

Ideally, operational evaluation of the competitive products would have been completed as part of the benchmarking study. However, differences in the exhaust oxygen sensors precluded this analysis. Instead, tear down analysis was completed to determine materials and processes utilized. This information was used to determine the best practices observed in the benchmarking study.

The data obtained was tabulated and discussed with technical experts within the division. These experts acted as a filter to determine which of the studies findings could be considered current lessons learned for the division. Conversely, these experts also suggested which study findings needed further research and analysis before being institutionalized within the organization. The tabulated information with the additional expert input became the benchmarking study lessons learned.

Lessons from the benchmarking study produced some insights regarding future trends in the industry. While some of these trends could not be immediately incorporated into the best practices repository, it is essential to understand the technological direction of the industry in order to build the competencies necessary to compete as these technologies become the customers' needs. Complete details of the benchmarking study and results are presented in Bergman (2001).

Best Practices Repositories

The knowledge obtained from acquiring the baseline requirements, manufacturing the prototype harnesses and benchmarking the harness industry was analyzed. The lessons learned from this information were used to determine potential best practices. This information was consolidated to become organizational knowledge through the development of a best practices repository. Within this repository, the structures of bill of materials, bill of process and bill of design were developed and integrated.

The bills of materials for the exhaust oxygen sensor products already existed within the division. The product specific bill of process was developed employing best practices created from the prototyping lessons and the benchmarking lessons acquired.

The bill of design best practices framework appears to be most relevant when the entire product is considered. Since the interactions between the sensor and harness have a considerable effect on overall product functionality, creating a separate bill of design for the harness would not produce advantageous best practices. Once a product level bill of design is complete the iterative and interconnected continuous improvement and development process between the three bills will be utilized to produce additional best practices.

Case Study Outcomes

Installation of a working prototyping system was achieved. The system was proven capable of producing built-to-specification subassemblies. Through the production and delivery of these subassemblies, internal best practices were developed. These were used along with lessons learned from the benchmarking study to develop a baseline best practices repository.

Improvements to the prototype system will promote additional best practices development through experimentation across multiple product families' harnesses. Experimentation across multiple harness families will enable development of a best practices repository for all sensor harnesses.

The bills of materials, bills of process and bills of design included in the best practices repository will enable the organization to rapidly produce new products and to completely utilize global capacity. In the long-term, the cost to implement an improved prototype system will be offset by the ability to sell prototypes to external customers and by creating effective best practices that foster improvements in competitive metrics.

CONCLUSIONS AND RECOMMENDATIONS

In recent years the manufactured components markets have switched from a few customers wanting a few high volume models to a larger number of customers wanting low volume customized models. This move to mass customization has forced suppliers to change the manner in which they conduct business, forcing them to thoroughly understand their products and processes in order to rapidly redesign and transfer them to the new architecture. A more current movement has been toward widespread globalization. At a minimum, this compels suppliers to be able to deliver products efficiently everywhere in the world. This forces more than optimization of the entire supply chain. It also forces suppliers to thoroughly understand their products and processes in order to produce them everywhere in the world at an acceptable profit.

Suppliers should maintain organizational knowledge centers to sustain a thorough understanding of their products and process. This accessible knowledge will allow suppliers to rapidly react to industry changes. This knowledge center should contain the best practices for products and processes to allow rapid fundamental changes to be made efficiently. This reinforces the need for extension of best practices development across multiple product families.

The best practices initiative assists the organization in meeting these challenges through the bills of materials, bills of process and bills of design. This initiative also fosters an organizational culture that enables common product, agile process and lean equipment programs to succeed. The success of these initiatives offers the organization competitive advantages. These advantages enable rapid global customer support. In the short-term, this includes the ability to do business in various global regions. In the long-term, this includes the ability to grow business in profitable core products.

In the manufacturing system, the optimization must occur across all products and processes to completely utilize manufacturing capacity and reduce structural costs. Common products and processes proliferated globally will enable capacity shifts with global demand shifts that will allow complete utilization of facilities, equipment and personnel. Optimization and commonization in manufacturing systems will increase speed-to-market enabling the organization to meet all global customers' needs. Optimized and commonized manufacturing systems will also promote global collaboration to eliminate effort duplication, share system innovation and reduce manufacturing costs.

A strategy to accomplish manufacturing system optimization is rooted in thoroughly developed product specific bills of process. These bills of process will standardize processes and equipment globally. In contrast to individually optimized products and processes, universal standardization enables utilization of capacity within a product and across products in all global facilities.

Bills of process will be created centrally at technical centers employing global input. Once thoroughly developed, the standardization of the bills of process will be supplied to global bills of process, global bills of materials and global bills of design development. This integration will enable the best product design to be matched with the best process practices to produce it. These well designed product and process pairings can then be proliferated globally. This facilitates manufacturing in any region of the world using common capacity and common practices. A flowchart illustrating this competency development strategy is shown if Figure 8.

Best practices development across multiple products will allow an organization to have accessible knowledge to rapidly and efficiently react to fundamental changes in the global market. When the market is fairly stable, best practices development will allow resources to be released from re-engineering tasks.

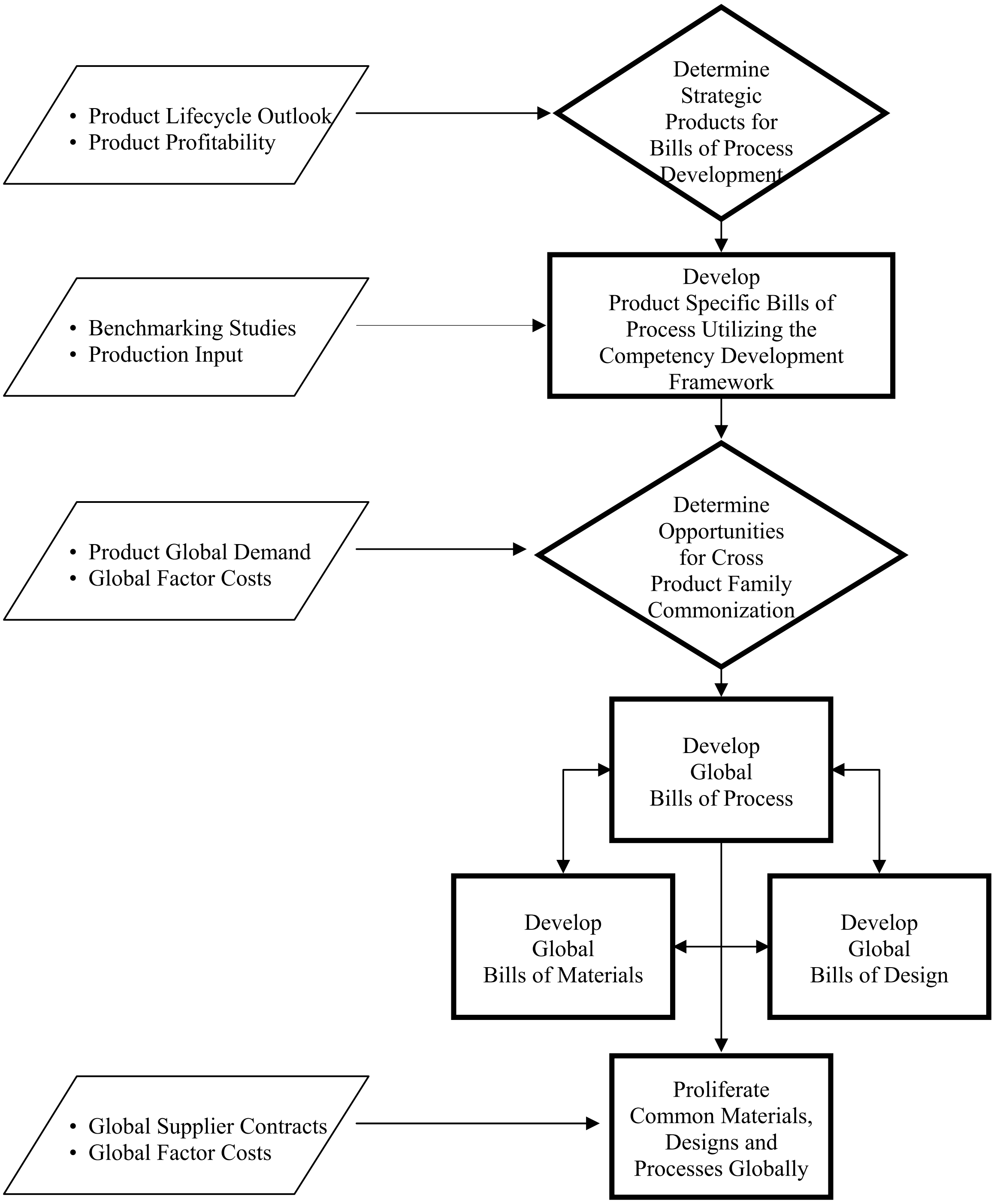

Fig. 8. Competency Development Strategy.

The resources can be refocused on product advancement in the core markets of the organization. This refocus can be utilized to exceed customer expectations and diversify the business to protect against any future downturn in the core markets.

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