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IBM Green Solutions for Automotive Industry

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Abstract. In the automotive industry, bringing products to market is a complex process that involves scores of suppliers, worldwide manufacturing networks, distribution channels and retail outlets. Web-based portals have emerged as a preferred tool for helping automotive companies distribute information more effectively. Portals aggregate information housed in the company's enterprise resource planning, human resource and customer relationship management systems, and package that information in ways that support specific roles within the enterprise. By simplifying access to a focused, browser-based view of relevant information, portals enable employees to identify emerging problems, access resources and make informed decisions with greater efficiency. The second part of the paper illustrates how automotive manufacturers can use product lifecycle management and business process management, including business activity monitoring methodologies and technologies, to develop and deploy optimized solutions. Such solutions help address the carbon impact of the post-sales management of hazardous vehicle materials and recycling of the vehicle materials.

Keywords. web-based portals, business process management, product lifecycle management

1. Introduction

The rapidly changing landscape of the automotive industry places new demands on automotive companies. An increasingly global marketplace has dramatically intensified competition. While manufacturers in emerging economies capitalize on lower labor costs, the longstanding industry leaders look for ways to keep pace and increase their efficiency. At the same time, the race to meet market demand for innovative designs, environmentally friendly models and quality post-sale service requires a smoother flow of information to support improved collaboration and better resource management.

Like virtually every segment of manufacturing, the automotive industry has recently undergone significant changes. The industry's traditional leaders face a growing list of nimble competitors with lower labor costs and greater operational flexibility. Automotive companies also compete in an increasingly global market, meaning that all facets of business, from sourcing to manufacturing to sales and marketing, require a multinational mindset and increased awareness of local economies and cultures. The balance of power in the industry may be shifting as well. Larger companies are finding that, despite growing revenue, margins continue to decline, primarily due to high fixed costs—especially labor costs in their manufacturing operations.

As original equipment manufacturers (OEMs) revamp their cost structures in an effort to become more profitable, they increase the pressure on their suppliers to reduce their costs. OEMs often mandate specific pricing terms to their suppliers, triggering corresponding price sensitivity throughout the automotive supply chain. Meanwhile, suppliers face their own labor, material and fuel cost challenges.

Consumers are eager for frequent innovation, which pressures automotive manufacturers to continually change their product and service lineup. In response, OEMs and their suppliers must adopt more flexible manufacturing practices. Rising oil prices have also affected demand by making traditionally successful models (such as sport utility vehicles) less attractive, leaving many automakers scrambling to develop new designs for an energy-conscious public.

In addition to higher consumer expectations, the industry is subject to closer scrutiny by the press and governmental bodies. Governments are tightening environmental legislation, which translates into new design requirements for automotive manufacturers. Rising fuel costs have also spawned increased media coverage of the automotive industry and its plans for more fuel-efficient and environmentally friendly vehicles.

Better communication and coordination among the diverse roles involved in bringing automotive products to market can help companies respond to these challenges more effectively. Improved methods of sharing information allow OEMs, suppliers and dealers to collaborate on finding innovative ways to meet rapidly changing demand. More automotive companies are also realizing that access to real-time information on performance is the key to developing the process efficiencies—internally and throughout the supply chain—needed for stronger margins and better performance. Making the right information available to the right people at the right time enables greater flexibility in the design, manufacture, shipping and selling of automotive products.

2. Using portals for focused views of critical, relevant information

In the automotive industry, bringing products to market is a complex process that involves scores of suppliers, worldwide manufacturing networks, sophisticated distribution channels and widespread retail outlets. The more adept an automotive company is at providing employees with the precise information and capabilities most relevant to their jobs, the better those employees can respond to the needs of the automotive marketplace.

Web-based portals have emerged as a preferred tool for helping automotive companies distribute vital information more effectively. Portals aggregate information housed in the company's enterprise resource planning (ERP), human resource (HR) and customer relationship management (CRM) systems, and package that information in ways that support specific roles within the enterprise (for example, engineer, brand manager and manufacturing supervisor). By simplifying access to a focused, browser-based view of relevant information, portals enable employees to identify emerging problems, access resources and make informed decisions with greater efficiency.

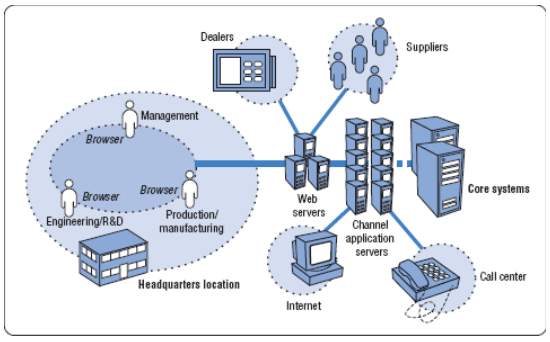

Fig. 1. Portals centralize access to multiple information sources, while allowing users to tailor their browser based views to fit their individual needs.

For example, in a typical order fulfillment process, portals streamline each user's access to the information and capabilities required for his or her specific role.

- Dealers can check product availability, review manufacturing lead times, initiate orders and inquire about the customer's warranty status and history.
- Manufacturing personnel can use the portal to process the dealer's order, verify inventory, assess production capacity, monitor supplier status and commitments, and route the order to finance for dealer credit approval.
- Finance employees can access the information needed to review the order in detail and analyze the dealer's credit status; finance employees can route approved orders to the appropriate manufacturing personnel for fulfillment.
- The manufacturing employee can use the portal to release the order for shipping.
- The dealer can monitor the entire process from the portal to track the status of the order at any time.

Users are provided with information based on their roles and according to their responsibilities in a process. In this case, a business need to ship an order overseas triggers a connection to an external shipping vendor.

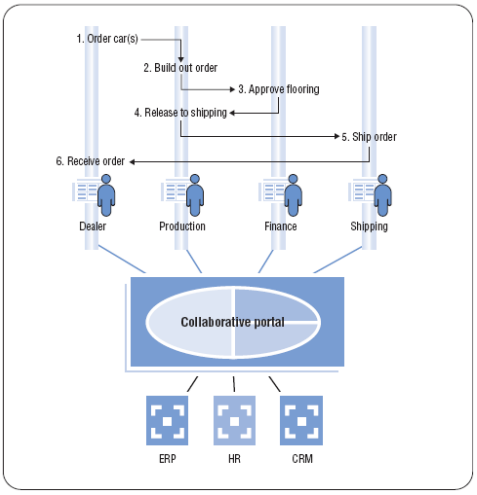

Fig. 2. Example for a business need to ship an order.

3. The business value of portals for automotive companies

The process of designing, manufacturing and selling automotive products draws on widely divergent roles and specializations. IBM WebSphere Portal software offers the ideal platform to coordinate communication and streamline the processes shared by the design and engineering, sourcing, production, purchasing, and sales and marketing functions. The increased availability of relevant information can help automotive companies and their partners address the core challenges facing the industry.

2.1. Driving costs out of the supply chain

The processes spanning the automotive industry's extensive supply chains are primary targets for cost-saving initiatives. A smoother flow of information and material translates into lower costs for automotive manufacturers. Portals provide access to collaborative tools such as presence awareness and instant messaging, which can promote efficient collaboration within the enterprise and with supply chain partners. They simplify the formation of collaborative teams, and help team members locate one another at critical times. Portals also enable more efficient business processes among departments and between supply chain partners. They allow users to accelerate review and approval cycles and enforce agreed-upon project time lines and milestones.

Document management and version tracking within a portal ensure that relevant parties have access to the same, consistent information—eliminating the delays that result from miscommunication caused by differing information.

2.2. Optimizing plant capacity

One of the top priorities for automotive executives is to determine whether manufacturing capacity exceeds demand and how to use existing plant capacity more effectively. A portal can provide access to analytical tools and key performance indicators (KPIs) that help executives set accurate benchmarks for what they produce and sell—and compare those figures to actual manufacturing capacity. That information can then be used to clarify strategic decisions about reducing or shifting plant capacity.

2.3. Increasing flexibility

Marketplace demands for more innovative automotive designs mean that automotive companies must be more flexible in the design, manufacture, marketing and selling of automotive products. Portals support innovative approaches to design, production and rollout by enabling virtual teams to collaborate and exchange information, regardless of where individual team members are located. New manufacturing initiatives such as the reusability of design and components require tight coordination of engineering, manufacturing and sourcing. Portals can help members of a globally distributed workforce understand their specific roles in larger enterprise-wide initiatives—with a focused view of timely, relevant information.

As products move from the assembly line to the showroom floor, marketing personnel can use portals to coordinate the effort and resources required to maintain multiple brands in multiple international markets. The portal offers increased visibility into key metrics on brand performance and can help support the research and decision making necessary for consistent brand application.

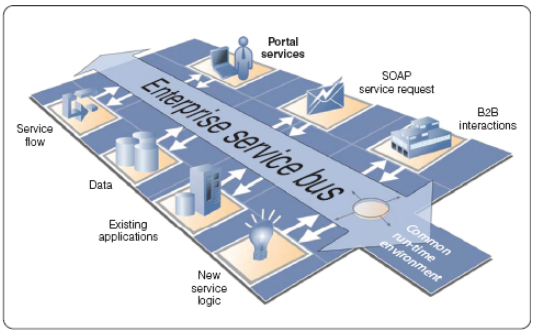

Fig. 3. A service-oriented architecture supports the more flexible use of applications and promotes smoother integration and sharing of information among an enterprise's various data sources.

Historically, applications for managing the various functions within an automotive company—for example, financial management, design and engineering, and production—have relied on monolithic, isolated applications with their own architectures and distinct interfaces. The proprietary design of these applications inhibited the sharing of relevant information throughout the enterprise.

With a service-oriented architecture (SOA), the various functions of traditional business applications are broken down into discrete components called services.

Services can be grouped and regrouped according to the information need. This modular approach enables the business to design processes that fit specific business and user needs, not the application's architecture.

4. Business Process Management for Automotive End of Life Processes

Automotive manufacturers in Europe are facing major changes to several processes. These processes include their new product introduction, manufacturing, and service after sales processes. The changes come in the wake of the European Union (EU) Directive 2000/53/EC on end of life vehicles (ELV) and Directive 2002/95/EC on the restriction of the use of hazardous substances (RoHS) in electrical and electronic equipment. Failure to reach regulation targets will cost each original equipment manufacturer (OEM) approximately 1 billion euros annually.

As the automotive industry continues to expand, the need for cost-efficient responses to regulation that strives for process efficiency grows increasingly important. According to IBM® research, the automotive industry shows the following trends:

- The global automotive industry continues to grow at 2.6% per year.
- In the next four years, the number of vehicles produced in the industry is expected

to increase from 60 million to 70 million due to expansion in the global marketplace.

- The automotive industry accounts for 15% of the world's gross domestic profit with a US$31 billion aftermarket industry growing 6% annually and new product introductions up by 34% since 2004.

Thus as the automotive industry grows and adheres to new government regulations, it demands robust, flexible solutions that provide insight into business processes in order to remain competitive and profitable.

This second part of the paper illustrates how automotive manufacturers can use Product Lifecycle Management (PLM) and business process management (BPM), including business activity monitoring (BAM) methodologies and technologies, to develop and deploy optimized solutions. Such solutions will help address the carbon impact of the post-sales management of hazardous vehicle materials and recycling of the vehicle materials upon end of life.

This paper unites existing methods and technologies including process operational status, event correlation, aggregation, and predictive analysis. It explores future technologies that create a vision for addressing ELV environment challenges. It also outlines some of the dynamics that drive change in the automotive industry and discusses ELV environmental challenges that are facing the industry. PLM, BPM, and BAM are introduced along with the key technologies that are used by those disciplines and how they all come together in a PLM implementation.

All automotive OEMs are publicizing their adoption of environmentally friendly methods, materials and processes to the extent that the environmental report of an OEM is often larger than its financial report. Most companies are significantly investing in programs, ranging from the operational efficiency of their own and suppliers' factories to investigating, through advanced research and development, how materials and fluids are most effectively processed. In addition, automakers must use as much recycled material as possible.

Generally recycling centers are optimistic that the 2015 target for recovery is achievable, although currently the processes and approach to monitoring the achievement of this target are disconnected.

The OEMs firmly perceive that their responsibility for managing the ELV is when it arrives at a contracted dismantler. However, general concern exists over the reconciliation of OEM and dismantler processes and reporting. OEMs are developing recycling tools and procedures. Most include environment and recycling engineering representation in their integrated teams. OEMs are working extensively on materials production specifications to ensure compliance with company and legislative requirements and are mandating their use throughout the value chain.

Figure 4 illustrates an overview of the design, development, delivery, disposal, and recovery cycle of automotive components, assemblies, and systems.

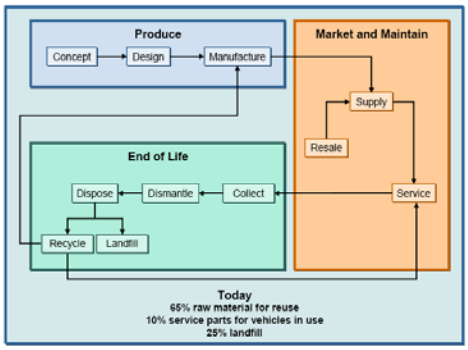

Fig. 4. Design, development, delivery, disposal, and recovery cycle of automotive components, assemblies, and systems

3. Product Lifecycle Management

PLM is a set of capabilities that enable an enterprise to effectively and efficiently innovate and manage its products and related services throughout the entire business life cycle, from conception through recycling or disposal.

To position PLM in the context of other parts of the business, consider the organization as being constructed from business controls such as customer relationship management (CRM), enterprise resource management (ERM), procurement, and value chain management (VCM).

PLM is sub-divided into six further domains: sales and marketing, research and development, concept design, detail design, manufacture and assembly, and service after sales.

PLM enables innovation through business and technology integration by bringing people and processes together, both internally and throughout the value chain. Turning innovative ideas into market-leading products requires flexible business processes that are supported by integrated PLM solutions, all built on a strong technology foundation.

PLM brings together a vision of open enterprise integration platforms with design, data management, enterprise resource planning (ERP), supply chain management (SCM), customer management, manufacturing, and existing applications. PLM thus promotes flexibility to execute the dynamic processes that are needed to run a complex enterprise such as those seen in the automotive business. The requirement for openness is intensified by the need to operate as a globally integrated enterprise, which is typical within the automotive industry.

PLM solutions maximize customer value by enabling technology collaboration and integration across the

value chain based on industry standards. IBM proactively supports PLM standards for the computing environment and uses technology such as J2EE™, Uniform Modeling Language (UML), Business Process Execution Language (BPEL), Web Services Description Language (WSDL), and the openness of Linux® and Open Source. In addition, IBM is a founding member of PDES Inc.,[1] which is an industrial consortium dedicated to the development and deployment of ISO standards for product data exchange (STEP).[2] IBM is actively involved in other standards organizations such as OASIS.[3] IBM plays a leading role in the PLM-specific open standards of STEP and Geometrical Dimensioning and Tolerancing (GD&T). PLM solutions can also use service-oriented architecture (SOA).

4. Business process management

At the heart of every business and PLM is a complicated web of processes that form the foundation for all operations. These business processes are the lifeblood of the organization and typically include all humans and systems that exist within the enterprise. Since they play such a central role, business processes must be efficient to make the business as effective as possible. As a result, finding ways to automate and improve business processes has become a major focus for today's organizations as they struggle to find ways to become more agile and responsive to changing business climates.

An entire discipline, BPM has grown out of the desire to improve existing business processes and build new processes and services that will differentiate a business from its competitors. BPM software suites aim to provide enterprises with a common platform that can tap into all resources, both human and system based, to create, manage, and optimize effective business processes that span the enterprise.

BPM includes the following capabilities:

- *Modeling and simulation* enables visualization, comprehension, documentation, and analysis of business processes. IBM WebSphere® Business Modeler provides advanced process modelling and simulation capabilities.
- *Human interaction and collaboration* enables the sharing of process model designs with other stakeholders and subject matter experts for review, comment and feedback. IBM WebSphere Business Modeler Publishing Server provides these human interaction and collaboration capabilities.
- *Business Process Automation* enables the implementation, deployment and governance of dynamic business processes. IBM WebSphere Process Server and IBM Business Services Fabric enable dynamic business process automation.
- *Monitoring, analyzing, and acting* enables monitoring of business processes in real time for visibility and insight into process performance and operational metrics to support continuous process improvement. IBM WebSphere Business Monitor brings these capabilities to market.

Underlying BPM is governance. Governance is an essential component of BPM because it provides the framework that ensures that business strategy and goals are implemented at the operational level. A governance framework also enables business and IT alignment by providing mechanisms that enhance collaboration and cooperation between the two.

The following figure illustrates the IBM BPM Enabled by SOA methodology and the WebSphere products that enhance a company's ability to realize the value of applying BPM to deliver business processes.

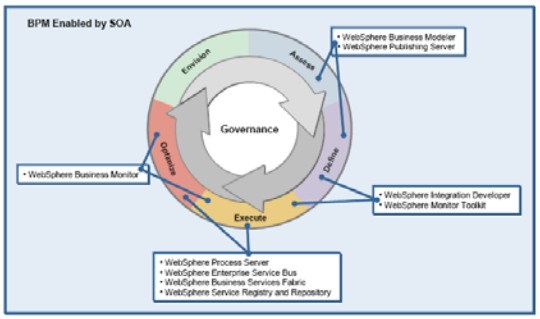

Fig. 5. WebSphere support for BPM Enabled by SOA Methodology.

The next figure is a high-level architecture for the IBM BPM products overlaid with the IBM BPM method. It illustrates how you can use the IBM BPM products to deliver business process solutions. The figure shows the relationship and interaction between these products and the relationship between these products and the methodology phases that they enable.

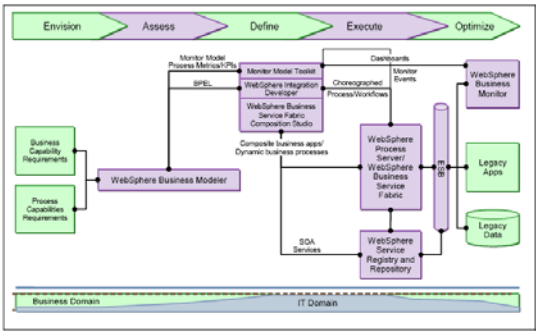

Fig. 6. High-level architecture for the IBM BPM products.

5. Business activity monitoring

Business activity monitoring refers to the aggregation, analysis, and presentation of real-time, role-based information. It includes tracking performance, processes, and operational activity by using key performance indicators (KPIs) that are visualized on business dashboards.

When working in conjunction with BPM, BAM also facilitates taking action, either by a business user or automated means, to proactively address current and potential issues that impact the business. As a result, business users can address problem areas quickly and reposition organizations to take full advantage of emerging opportunities. BAM and BPM position organizations to use marketplace or competitive changes almost instantaneously, without the lag time that can hinder companies in this global marketplace.

The following key technologies are used in a BAM solution:

- Flexible data acquisition to make information available via events for monitoring
- Monitor models, which contain information about the BPM aspects of an entity to be monitored

Web 2.0 business dashboards for business users to gain insight into the processes or information sources that are being monitored.

6. Adopting BPM and BAM with PLM

The adoption of BPM initially provides organizations with a solid understanding of the efficiency and effectiveness of their business processes. It offers the ability to create and restructure process-driven applications and integrations. It also offers the means to tightly integrate the organization and value chain, but with the flexibility to rapidly change and adapt as circumstances require.

One simple aspect to consider is that PLM users often need to combine information stored within PLM applications with information stored in other enterprise applications. By using BPM enabled by the *Smart SOA*™ approach, users can access all product data, regardless of its location, through single sign-on (SSO), accurately and quickly. Perhaps most importantly, the adoption of BPM does not mean replacing existing PLM implementations.

The BPM approach is based on optimizing existing capabilities and creating new functionality, enabled by the services-oriented approach, to deliver dynamic processes and improved business automation and data quality. Success in BPM projects is maximized by using the expertise of experienced practitioners to deliver and fulfill the promise of BPM.

BPM can be approached in many ways. In developing BPM content for PLM, organizations can start from any number of places depending on their type of project. Users can realize incremental benefits with their deployment of BPM or build out strategic BPM solutions.

BAM can be leveraged with BPM and PLM to enable real-time insight into end-to-end processes and mitigating and corrective action to be applied to key parts of the product life cycle. Also, actual business performance information can be used to optimize PLM processes.

In summary, PLM encompasses the management of all data and documentation relating to the idea creation, design, development, manufacture, production, delivery, and disposal of the vehicle. PLM can use BPM, enabled by the Smart SOA approach, for promoting integration and collaboration across the business and value chain, and BAM, which enables real-time insight, proactive corrective action, and process optimization.

7. Addressing environmental pressures on the automotive OEM

PLM is the core capability that manages the environmental footprint of the vehicle with processes such as materials management, product configuration management, release to manufacture, and change control. PLM defines what is delivered to the customer and ultimately manages it through the point of disposal.

Configuration management is the process by which the unique serialized and standard parts that are fitted on every vehicle are captured. The requirement is to track the configuration of the vehicle from “cradle to grave.” This tracking includes the following stages:

- As-designed
- As-manufactured
- As-driven
- As-maintained
- As-disposed

The transition of configuration states is often captured on different applications. Through the application of BPM and SOA technologies, it becomes a secure and fully automated integration activity.

Every part on the vehicle is defined by a part number, description, and quantity used. To ease the tracking of the parts fitted to a vehicle from the time of manufacture to the point of recycling, many components are fitted with either a barcode or a radio frequency identification (RFID) tag. By using these approaches, in conjunction with integration between various lifecycle management applications, the value chain realizes process automation through step driven processes. This automation allows instantaneous identification and validation of the as-maintained configuration of the vehicle. Ultimately, all typical work tasks can be driven through process automation. Consider the following example:

1. A fitter logs on to a mobile device, in this case using a ruggedized PDA, at the start of the day and identifies prioritized work tasks.
2. Through integration of the processes and lifecycle management applications, the fitter retrieves all task supporting documentation.
3. The fitter captures the current configuration of the vehicle and sees any variance between the as-driven and as-maintained views.
4. The fitter identifies which parts need replacing, and by using a RFID or barcode, scans the part number for removal, which results in the updating of current vehicle configuration.
5. The fitter replaces the part and updates the as-maintained configuration.
6. The fitter reviews the information for the disposal procedure of the removed part (identified by its recyclability or nature of hazardous content) and report status of recycling or disposal into the ELV system.

BPM and BAM technologies can be applied to the PLM techniques just described. A number of business procedures are involved in the PLM for the automotive OEM. A first step in the path of applying BPM principles to addressing the environmental pressures on the automotive OEM is to assess the current state of the business processes. IBM WebSphere Business Modeler can be used to document and model these processes both from a business and implementation perspective. Standard process constructs that use Business Process Modeling Notation (BPMN) formats are used to capture the existing process logic and share the current state with others.

Future state process models may be built, with collaboration from business stakeholders, to identify process optimizations. The future state view can be derived from open standard Process Classification Frameworks (PCFs). Although this approach is not meant to be a quick solution, these PCFs are a great starting point for process improvement.

Process modeling can employ sophisticated simulation capabilities that allow technical business analysts to understand and apply *what if* scenarios to a simulated running process.

This enables cost and efficiency of the processes to be understood and modified.

Technical implementation models can be built by using WebSphere Business Modeler. They can then be used to drive implementation of the processes by using workflow and process engine software, including incorporation of automated and human work services. Process implementation can be completed by using IBM WebSphere Integration Developer. The implemented processes can be deployed to workflow or process engine run times that provide a secure and robust implementation infrastructure, such as WebSphere Process Server. These techniques apply to both the realization of incremental gains from BPM and the building out of new processes and implementations.

While processes are executing, WebSphere Business Monitor can be used to allow business executives, process owners, and process operations personnel to achieve insight into a real-time process operational state. These personnel can also proactively address issues and anomalous situations, rather than wait until historical reports are generated. WebSphere Business Monitor can also be used in the optimization of the business processes. For example, if a recycling problem appears for a certain type of automotive material, manufacturing and recycle procedures for that material can be studied and potentially improved.

Changing worldwide markets, increasingly demanding customers, and rising fuel and material costs—the list of challenges facing the automotive industry continues to grow. In this volatile environment, effectively managing information has become as important to success as virtually any other element of business strategy. Automotive companies seeking to improve their competitive advantage through increased responsiveness, efficiency and adaptability can use IBM WebSphere Portal software to help deliver the right information to the right users in the most efficient and flexible manner.

As discussed by illustrating the vehicle creation and destruction process, the use of business process modeling, PLM processes and infrastructure, and BAM allows OEMs and other process stakeholders to implement processes and track key factors. An example includes the modeling of vehicle creation and destruction processes, the aggregation of data from several applications involved in the processes, the calculation of various process metrics and key performance indicators, and the tracking of these processes by using business dashboards to highlight the effectiveness of vehicle recycling efforts.

When these methods and technologies are applied, they can lead to improved OEM legislative compliance, improved reporting to legislative bodies, opportunity and insight for continuous process improvement, and better communication across OEMs and suppliers. Ultimately, these methods result in OEM cost savings related to all of these areas.

8. References

J. McGarrahan, M. J. Harris, Business Process Management for Automotive End of Life Processes, *ibm.com/redbooks*

A. Catts, J. St. Clair, Business Process Management Enabled by SOA, *ibm.com/redbooks*

H. Skalle, S. Ramachandran, M. Schuster, V. Szaloky, S. Antoun, Aligning Business Process Management, Service-Oriented Architecture, and Lean Six Sigma for Real Business Results, *ibm.com/redbooks*