Product Life Cycle Management and the General Recipe
a Case Study

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ABSTRACT

To adapt to today's shifting market and customer requirements, an enterprise must be increasingly agile to redefine its products. Organizational barriers introduce delays and inconsistencies in the transfer of this information. At the same time, a global enterprise needs to ensure that products are manufactured consistently, wherever they are developed or made in the supply chain.

This paper presents a case study of the development and implementation of an electronic Product Life-cycle Management application to successfully address these challenges, for a premium brand food manufacturer.

The business requirements are defined and mapped against the capabilities of commercial software products. To ensure that the application can evolve, as business needs change, the use of existing and emerging standards, recommendations and technologies is evaluated. The organization and project approach to involve all disciplines, redefine the product development processes and successfully introduce this new technology is described.

In the conclusion a brief overview is given of the scope and uses of the application, the expected benefits are illustrated and recommendations are made to improve batch standards.
The Innovation Challenge

To adapt to today's shifting market and customer requirements, an enterprise must be increasingly agile to redefine its products. Changes to products and the redefinition of required processes and resources must be made quickly. The time to market for a new product must be minimized to maximize market share and patent protection benefits. At the same time, a global enterprise needs to ensure that products are manufactured consistently, wherever they are developed or made in the supply chain.

Organizational barriers introduce delays and inconsistencies in the transfer of information. As businesses consolidate and increase the outsourcing of development and manufacturing, this becomes worse. These barriers inhibit knowledge sharing between organizations. Good designs are not leveraged and failing strategies are revisited. New developments often do not take manufacturing capabilities into consideration, resulting in months of manufacturing startup delays and errors.

Even though the hype around e-business seems to have crashed on the pavement of Wall Street, the connected economy offers lots of potential. Where initial e-business strategies focus on buying and selling over the Internet, the technology also offers a large opportunity to enable knowledge management and product life cycle collaboration between customers, (co) developers, (co) makers and suppliers. Innovating enterprises should take advantage of this opportunity in their e-business strategy and plan to optimize their (product development) value chain, eliminating processes and activities that add no value, resulting in an accelerating time to market.

ePLM the Silver Bullet?

The July 1998 *AMR Research Report on Manufacturing* introduced the concept of the Product Lifecycle Management (PLM) backbone as the successor to Product Data Management (PDM). Dubbed ePLM in 1999, it uses the Internet to facilitate the collaborative product development extending outside the enterprise to include customers and suppliers.

‘In innovation driven and fast moving markets, the winners are those that respond to new opportunities and changes in customer desires faster than competition. The intellectual property that defines the unique product or service is the key business asset. As more of the design and manufacturing is outsourced, ePLM is becoming necessary to stay in business.’

However: ‘Due to the nature of the product- and process- development and the many organizations and disciplines involved, there is a large amount of specialized solutions in the ePLM domain, making integration a nightmare.’

This case study describes the development of an ePLM solution for a CPG (Consumer Packaged Goods) company to address the innovation challenge faced with the integration nightmare.
Company Background

The J.M. Smucker company was founded in 1897 when Jerome M. Smucker opened a small, custom apple cider mill in Orrville, OH. Today, The J.M. Smucker Company is the number one producer of jellies, jams, preserves, dessert toppings, and fruit syrup in the U.S. Domestic brands include Dickinson, R.W. Knudsen, Laura Scudder, Mary Ellen, and others. Smucker is also known internationally through other brand names: “Double Fruit,” “Sheriff,” and “Good Morning” in Canada, and “IXL” in Australia. The J.M. Smucker company also produces industrial products, supplied to other leading brand manufacturers.

The J.M. Smucker slogan ‘With a name like Smucker’s it has to be good’, indicates that quality comes first. This translates into the following business objectives:

- Continuously improving product quality, operational productivity and supply chain agility
- Enforcing business rules for product integrity from Product Development to Shop Floor

In 1998, the product developers were using a custom developed legacy system, a number of specialized packages, 'office’ applications and the laboratory notebook. As part of a product commercialization, the product developer could spend weeks in a plant to ensure a new product was manufactured consistently.

Because the legacy system was becoming obsolete, a new solution had to be found. Since J.M. Smucker was also implementing the Oracle CPG solution and POMS MES, an opportunity was identified to streamline the product development process, replacing the legacy system and some point solutions, integrating with the business-systems and manufacturing execution systems.

Market Orientation

In trying to define a solution, the market was scanned for possible software applications that could function as a starting point. The objective was to have a minimum number of packages and resulting integration points.

- ERP as a starting point
  Designed to support financial and business planning functions. As such it focuses on modeling the enterprise level processes, not on modeling the manufacturing execution processes.
  - Lacks Recipe & Specification system functionality
  - Does not support Process Control data requirements
  - Lacks agility and detail to support flexible manufacturing

- Execution systems as a starting point
  Manufacturing execution systems (MES) and Batch execution systems both have recipe management capability that is geared towards the development of detailed, executable specifications. As a result of their respective pedigree, MES is focused on operator intensive execution and material management, Batch systems are focussed on automated execution and equipment management.
Typically all levels of automation are present and both material and equipment management is important. Both types of systems are typically S88 compliant, ensuring at least a common structure of the procedures.

- **Product Data Management (PDM) systems as a starting point**
  PDM applications were developed mainly for the discrete manufacturing (assembly) industry. They are typically oriented towards organization and management of (structured) document objects, such as Bills Of Material (BOM), instructions and drawings.
  PDM applications typically are not S88 compliant and do not naturally fit in a process environment.

- **Formula Management as a starting point**
  Point solutions designed for CPG (consumer packaged goods) industries, focussed on the development of formulas, taking the material specifications into account. The definition of processes and resources is typically very poor and not S88 compliant.

The J.M. Smucker company was already using Oracle GEMMS as an ERP system and POMS MES as an execution system. Since POMS was interested in expanding its specification management capability to better fit the requirements for the CPG market, a co-development project was defined between the two companies to develop an ePLM application that was tightly integrated with POMS MES and Oracle GEMMS.

**Project Approach**

Collaborative product and process development application spans many different departments. It was recognized that the new approach required re-engineering of the business processes to achieve optimal benefits from the new technology. Under the leadership of Earl Beery, an organization was put in place consisting of a core team of key users, representing product development, QA (responsible for standardization), manufacturing and plant-systems (responsible for plant automation). Consultants from POMS with extensive background in S88 and experience in similar projects assisted the team. This team was directly involved in the definition of the business requirements and development of the (new) business processes. To disseminate this information and ensure involvement of the rest of the organization an extended team from across the enterprise was defined to validate the requirements and review the intermediate results. During the requirements definition phase a lot of education was required to introduce the new concepts from S88, as well as familiarize the team members with the concepts of organization of information in an object-oriented manner.

Based on the functional requirements, a prototype was built to validate the presentation and use of the new concepts. The application was built and released in phases, to allow the core team to familiarize themselves with the functionality and provide feedback for improvements to the development team. In parallel the core team started defining the common attributes and classifications and experimenting with developing specification models. This was used to define the business rules and develop the business process oriented user training.
Requirements and Design

Complete Specification

The specification of a new product starts with the definition of the product characteristics. To achieve those characteristics a formulation is developed taking raw material characteristics and process transformations into account. Sometimes new raw or packaging materials need to be defined. To manufacture the product, different process stages need to be defined and characterized. This implies a resources requirement with the capability to perform the defined process. To develop the complete specification the application needed to include product and material definitions, formulation definitions, resource requirements and process requirements.

The S88 procedure and equipment models proved to be valuable and applicable for all levels of automation and most production topologies. To describe the requirements for an end product, the collapsible recipe model was extended with a product recipe, defining the required intermediate manufacturing steps (or recipes). To better map to the business planning and material management systems, the S88 formula was split into process parameters and a Bill Of Materials (BOM). The model needed to be enhanced with a material model to capture the product and material specifications.

All Development Stages

As products are developed, they pass through different stages, handled by different departments, with different requirements. The S88 General, Site and Master recipe types map well to these development stages. However, the General recipe, designed to capture a corporate standard, proved to be too constraining for product developers, who need the flexibility to experiment. In addition, the product development specification of the process typically is more abstract. These development stages also apply to the other specifications, such as materials and resources. Most importantly the need was identified to enforce the original requirements as the specifications are passed down to the next development stage.

The S88 recipe types were generalized with a collapsible definition of types corresponding to different developmental stages and uses of the recipe. In the default configuration a Development recipe type was defined that precedes the General recipe, analogous to the NAMUR source recipe (Ur-Rezept). This model was also applied to the material- and asset specification models. A framework of user-definable business rules was defined to develop, hand-over and enforce these specifications in a consistent way.

The Entire Extended Enterprise

The information to manufacture a product typically comes from many different disciplines and sources. Besides defining the product characteristics, the resulting requirements for raw materials, required intermediate products, the manufacturing process and the required manufacturing resources have to be defined.
This involves bringing together information from development, quality, planning, costing, regulatory (HAZOP, validation), process engineering, asset management, etc. Departments that often speak a different 'language'.

To define a common dictionary and language, the requirement was specified to provide a user definable common definition of meaning and structure of specification attributes. For the management and consistent use of specifications, a common classification needed to be maintained at enterprise level.

To be able to collaborate on the development of the specifications across the development stages and different internal and external organizations, a global repository is made available using Internet technology. This repository contains all product and material definitions, formulation definitions, resource requirements and process requirements. Security can be defined as low as the individual specification to ensure the right person can define the right specification.

**Adapt to Changing Business Requirements**

As the organization, supporting systems and product portfolio changes, the business processes and corresponding information and information flows change. The application has to be highly configurable to support the changing requirements of an agile business, without any code revisions.

The specification models were designed to be object-oriented, allowing the user to capture the best business practices in all parts of the organization and apply them throughout the extended enterprise. The consistent implementation of published (S88) and emerging (S88 part 2, ISA95) standards and recommendations (STEP, NAMUR) ensures that all information can be electronically exchanged throughout the supply chain. As XML standards are defined and become adopted, the application has to be capable of exchanging specifications in this format.

**Current Status**

The electronic Product Life Cycle Management application has been completed. It was pre-released early 2000 to the J.M. Smucker company. It was released as a commercial product in September 2000.

Currently, the core team is proceeding with the creation of detailed specification models and templates. Specification templates are re-usable objects that can contain complex algorithms to capture regulatory requirements and/or business practices. For example, a formula that calculates ingredient quantities based on FDA imposed constraints and material characteristics. The application is perceived as being very user friendly and flexible.

The application will be rolled out this year to multiple sites with different levels of automation. Plants that use MES execution systems will be integrated with the application, to generate executable procedures. Reports have been created to generate the complete specification (paper batch record) for plants that have no execution system in place.
The J.M. Smucker company has taken a very professional approach to reengineer their business processes and maximize the benefits of ePLM. Their willingness to adopt new standards and technologies made them excellent design partners to validate and enhance their usability. The development team has found the right balance between the Smucker’s specific requirements and general requirements for specification management, developing a model based highly configurable solution. This has made the co-development project a mutual success.

Conclusions

- Though the S88 recipe models proved to be very valuable they needed to be expanded to accommodate for product development and material specification requirements.
- Introduction of a collaborative product and process development application has to bring together many departments and disciplines. This involves a large amount of education and reengineering of the product and process development processes. It requires the definition of a common language and organization of specifications.
- J.M. Smucker identified the following benefits for integrated specification management:
  - Defines and controls resources and processes that result in a consistent product at the lowest possible cost (Stabilizes the process)
  - Support predictive quality and cost improvement by enabling research, best practice sharing, and operational flexibility (Optimizes the process)
- As a result of the introduction of this technology and the business process re-engineering in general the following benefits are expected:
  - Barriers between departments and supply chain partners are removed by providing a common language, global repository and collaboration environment.
  - By capturing and applying best business practices a company can capitalize on its intellectual assets.
  - By unifying the specifications, product consistency is enforced wherever a product is developed or made.
  - The faster and better innovation of products and business processes accelerates time to market.
  - By integrating the specification development with actual manufacturing, the loop is closed to continuous improvement, leveraging all benefits.