Holistic database for management of device, manufacturing and product data including cost, customer satisfaction and other operational metrics

S Orsila,[a] M Aho[a]

[a]Modulight, Inc., Hermiankatu 22, FI-33720 Tampere, Finland

Abstract: This paper describes a holistic database system that stores all Product, Product Development and Production data in a relational database, and how it is integrated with commercial ERP & CRM applications. The outcome is a system that serves practically every business process in the company by truly transforming the business into eBusiness. Presentation shows how such system can be implemented using industry standard components and tools, and concentrates on demonstrations that best elaborate the benefits of successful implementation.

1. Introduction

A semiconductor fab requires a rigorous quality management system (QMS) which can be supported for example with Six-Sigma or Total Quality Management (TQM) [1] efforts. One key problem in implementation of all these programs is (semi) real-time data acquisition at a reasonable cost. Traditional manufacturing execution systems (MES) are either clumsy or lack business critical data such as cost/pricing/availability data in readily available format for everyday process improvement. Traditional systems have difficulties especially when information they produce is needed for other processes such as finance, marketing, sales and strategy. Having this embedded in the system provides large cost savings, more agile customer service and improved profits.

   At Modulight [2] all manufacturing functions are integrated in a database-centered MES [3]. The relational database stores all data related to products, production and product development, and helps the company manage, monitor and control operations in real-time [4]. The system has been built around a single relational database, which operates on a standard multiprocessor IBM server running Microsoft SQL Server. Information is stored in a highly structured and non-redundant way, unlike in most commercial systems, which is one key to cost effectiveness and agility at system level. Production equipment is directly connected to the database, and the system is primarily accessed by a Web-based user interface.
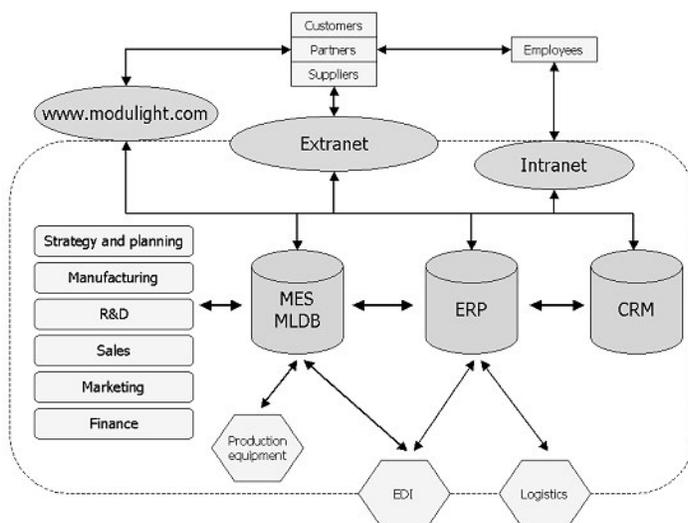
Figure 1. Modulight's holistic database-centered management system

Usually a great deal of time is spent doing the same task over and over again – basically entering the same data in different programs or even within the same database. Integrating e.g. financial applications with MES not only improves accuracy by avoiding manual work related to data entry, and by propagating the data to all parts of the business that needs it. This speeds up and improves accuracy of cost accounting, which finally translates to better support for factual decision-making in pricing, resource allocation and profitability analysis among many other activities. Numerous similar benefits can be achieved in other activities.

2. Benefits

Financial applications from a commercial enterprise resource planning (ERP) system are integrated with MES data. In Modulight environment, ERP and CRM systems operate on an Oracle database server. The integration allows the generation of important operational metrics to everybody involved in production from shop floor to top management. The system enables the use of more sophisticated algorithms than is possible in even semi-automated data acquisition schemes and direct real-time linkage to real operational data. This moves the way of doing business from weeks and months to seconds and hours as well as allows for example complete financial projections update with a few clicks of a mouse based on the most recent actual yields and design changes.

In this system for example invoices, salaries and other costs are allocated to different projects, products, departments and other accounting objects automatically. Allocation is based on different drivers, which can be either static or dynamic. Dynamic drivers can vary over time and always represent the current situation enabling the significant improvement in internal (cost) accounting accuracy. Thereby enabling improved accuracy of data based on which decisions are being made. Drivers vary from headcount to equipment time used by a certain manufacturing process. With a holistic database based MES system the possibilities for exact Activity Based Costing (ABC) [5] to determine the true cost of a product - by focusing on indirect costs and tracing each expense category to a particular cost object - are practically unlimited. The benefits of a highly structured way are very helpful e.g. when CFO or Product Engineer wants to drill-down to product costing or see it from different perspectives. This can be done in minutes instead of days. The applications of this particular example include product pricing, scheduling of manufacturing, cost analysis and high-level forecasting. Rapid change management is possible, as varying cost implications on product margins can be quickly understood and their implications to the overall business plan or product profitability can be exactly calculated.

Due to recent changes in product data management (PDM) [6] efforts, company can now locate and manage hundreds of products in a structured manner at a low cost. Product features and characteristics are parameterized in the relational database. Products have different life cycles and they can be priced individually with different price breaks or processed as groups based on a variety of rules. System suggests sales personnel limits in which to operate in terms of pricing and product availability in order to conform to the overall business plan as well as market pricing. Automatic generation of up-to-date real-time product datasheets is currently being enabled, even with the smallest entity details from real production data and product data. This makes marketing less expensive and much faster. The customer benefits are clear from the fact that internal inspections, test and quality (ITQ) take their instructions directly from the same information source that was established by R&D and translated by marketing to a product specification. Most of the hassle, human errors and delay can be avoided through this approach.

As the data in MES is accurate, it can be automatically pushed to ERP's inventory management – a fundamental requirement for staying up-to-date on the situation and ensuring best possible delivery times and customer service.

In order to make everything readily available to users, a high level of IT knowledge is still required. However, by developing intranet applications and ready-made views anybody can have jump-start to real-time information. Intranet also allows easy access to functions of ERP, MES and CRM remotely without opening stand-alone applications at all. Benefits of this are quite obvious as factual, detailed information can be fetched for customers even during tradeshows and customer visits. As the web interface is independent of operating system, intranet – and because of that, basically all important company applications – can also be accessed remotely through secure virtual private network (VPN) connection. A database-centered enterprise not only allows faster more accurate information but also enables business mobility.

3. Challenges

The development of a database-centered manufacturing system was started in early 2000. Even though the system has been more or less continuously developed now for 5 years, it is still updated and developed on a regular basis. Actually one could say that applying eBusiness is not about deploying some application but changing in a fundamental way a company's processes and operational practises. This naturally poses challenges in terms of employee understanding and willingness to use systems as well as taking IT or Business Infrastructure as a part of top management agenda rather than leaving it to IT-support. Usually in a holistic approach like discussed here, the benefits start to appear only after a certain maturity. Executive management might be sceptical of custom-made systems and its benefits, because they are hard to find in the income statement and balance sheet. After five years of development and data gathering efforts, the system finally starts paying back by providing almost unlimited analytical capabilities to support factual decision-making. Our experience has also been that the further you go in the transformation, the higher the return on investment (ROI) to the system development becomes. After more than five years we have seen only constant acceleration of ROI.

4. Towards a true eEnterprise

Having everything in electronic format significantly improves the agility of the company. In future scenarios it would be possible to launch web based sales for standard products, and the life cycle of a general formal quotation process could be shortened dramatically. These are some examples of applications that we believe can be realized with relatively little practical effort due to the highly sophisticated philosophy described above. These applications could help for example in (semi) automating the quotation process for cost reduction, improved accuracy and reduced delay for customers. Today much time is spent responding to quotations manually, creating company and contact details in ERP and finding a suitable product from product portfolio. If desired, customers could connect to CRM and ERP systems through extranet applications, make requests for quotations and study product details and measurement values online. Based on customer input, formal quotations could be created in just a matter of seconds by automatically propagating the data to all systems, and sales personnel should only approve quotation before sending it to the customer. This would allow the company to have a really rapid response time for standard products. Obviously such systems also require more of the human contact, which yet is the most important. Such a tool would allow supplier and customer to concentrate on important matters and save time in document handling.

   Even today we have integrated 3rd party courier services in our e-commerce environment and production process chains. Once a certain manufacturing step is finished, our system automatically sends a courier dispatch request and prints required labels. With different industry standards for electronic data interchange (EDI), it is possible to automatically transfer data between different vendors as long as you have your data in usable format, which more or less always means in a highly structured format.

5. Conclusion

We believe that this system is unique in the industry in its high-scalability, completeness and adoption in a real manufacturing environment as well as in its integration with ERP and CRM systems. It is a clear step towards a paperless office where all information is stored and transferred in electronic format and information is readily available for right people. Employees in every business process can benefit from the speed, completeness and effectiveness of the system in their everyday work and thereby provide better customer service easier and faster. Information is easy to locate and it can be used as a basis of factual decision-making also for intra-process decision making. Some manual tasks are already automated, which allows the company to focus its resources on work that requires imagination and talent as well as avoid human errors in boring data entry and retrieval. Finally everything translates into a capability of making rapid and controlled change management. While applications such as ERP, CRM and MES enable everything – they are still only enablers of the database-centered strategy, which allows company agility, profitability, customer focus and reliability.

References
[1] Tricker R. 2001. *ISO 9001:2000 for Small Business.* **1** 49-54.
[2] http://www.modulight.com
[3] McClellan M. 1997. *Applying Manufacturing Execution Systems.*
[4] Orsila S, Ryynanen T, Sipila P. 2002. Compound Semiconductor. *New integrated manufacturing system boosts fab productivity.*
[5] Atkinson A A, Kaplan R S, Young M S. 2004. *Management Accounting: International Edition.* **4** 157-215
[6] Saaksvuori A, Immonen A. 2005. *Product Lifecycle Management.*