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The Benefits of Data Warehousing at Whirlpool

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EXECUTIVE SUMMARY

In today's competitive, high-velocity business environment, companies are focusing their attention on several key areas, including:

- incremental continuous quality improvement;
- more radical redesign of business processes;
- supply chain management;
- improved customer orientation; and
- globalization of business operations.

At Whirlpool, data warehousing is providing important support in all of these critical areas (see Table 1). To illustrate, Whirlpool's data warehouse enables quality engineers to easily track the performance of component parts. This allows the engineers to assess new components that are being field tested, to quickly detect problems with particular parts, and to identify the high and low quality suppliers. From a different perspective, suppliers can check on the performance of the parts they supply and, consequently, can manage proactively the quality provided to Whirlpool. Purchasing managers have parts information from around the world so that they can find the lowest-cost, highest quality part available on a global basis.

This case study briefly describes Whirlpool, the business need that suggested a data warehouse, the approval process, and the data warehouse that was built. It describes how the data warehouse is accessed, how users are trained and supported, and the major applications and benefits. The lessons learned also are described to benefit those companies that are implementing or thinking about implementing data warehousing.

Table 1: Key Strategic Areas for Whirlpool

incremental continuous quality improvement
more radical redesign of business processes
supply chain management
improved customer orientation
globalization of business operations

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Like most companies, Whirlpool is continually changing. This case study describes Whirlpool and its data warehousing initiative through the end of 1997.

THE WHIRLPOOL CORPORATION

Whirlpool Corporation is the world's leading manufacturer and marketer of home appliances. The Whirlpool family consists of over 45,000 people who manufacture fine appliances in 12 countries and market them under 11 major brand names. The company is based in Benton Harbor, Michigan and reaches out to approximately 140 countries around the world. It is the only major home appliance company with a leadership position in North America, Europe, and Latin America, plus a growing presence in Asia.

Whirlpool began as a small family-owned business in 1911, and it now ranks 159 in the Fortune 500. The corporate vision for the company fosters growth and progress: *Whirlpool, in its chosen lines of business, will grow with new opportunities and be the leader in an ever-changing global market.* This vision is manifested in Whirlpool's Worldwide Excellence System (WES), its blueprint for approaching quality, customers, and continuous improvement. Initiated in 1991, WES incorporates the best of all Whirlpool quality programs, worldwide, with Malcolm Baldrige Award and International Standards Organization criteria to establish a common approach to quality, one that dedicates the company to the pursuit of excellence and total customer satisfaction.

Whirlpool is an information-intensive business. In North America, it has three or four thousand products that it sells at any point in time. Every one of the products has hundreds or thousands of components that are assembled every day in 12 major factories. The products are stored in 28 places. Over 16 million appliances are sold a year and they are tracked throughout their lifetime.

THE BUSINESS NEED FOR DATA WAREHOUSING

One of the keys to thriving in this information-intensive environment is the ability to effectively coordinate and control its myriad processes and activities. This can be challenging from an information systems perspective. Business units need a complete understanding of the processes for which they are responsible, and the diversity and heterogeneity among systems make it difficult for them to get the information they need and to manipulate it in a useful, timely manner.

In the early 90's, several business units identified a variety of specific information needs. For example, Quality wanted to create an application (later called Customer Quality Information System (CQIS)) that would proactively identify quality problems based on customer complaints. Data existed in several places, including Whirlpool's OneCall System that allowed any customer to take care of any necessary business, be it services, product information, or complaints with one phone call. CQIS was to provide an environment in which the data could be queried and analyzed.

These applications had obvious value to the business, and senior management understood that the information systems infrastructure was inadequate to effectively support the various initiatives. In fact, around that timeframe an expensive executive information system initiative had just been discontinued after several years of trying to combine data from multiple data sources and manipulating the data in a meaningful way for its users.

It was apparent that an infrastructure had to be put in place at Whirlpool to support the numerous decision support initiatives that its business units had identified and were expected to demand in the near future. At that time, the marketplace was promoting data warehousing as a viable alternative to organizations that wanted to create a decision support infrastructure. Data warehousing is the process of creating, maintaining, and using quality data for decision support purposes, and its technology had become cost effective and mature enough for organizations to implement. In the spring of 1993, the first efforts to use data warehousing at Whirlpool were approved, and CQIS was the first application to utilize the new infrastructure. It was expected that data warehousing would allow IS to provide business units with their applications quickly, with less cost, and with a greater likelihood of meeting their needs.

Many business initiatives, which rely on data warehousing, have emerged since 1993. Currently, the data warehouse contains 14 specific collections of data (i.e., subject areas) that

describe important facets of Whirlpool's business, like competitors, business partners, and facilities (see Table 2). Table 3 presents a listing of the ten primary applications that use information from the subject areas along with the sponsors of the applications and the business needs that they address. With enhancements and alterations, the data warehouse has effectively evolved to support each of the applications.

THE DATA WAREHOUSING APPROVAL PROCESS

The business needs for Whirlpool's data warehouse and its applications were examined and assessed throughout their approval processes. Whirlpool gives approval for systems initiatives through a unique process called Value Oriented Systems Planning (VOSP). The idea of VOSP is to

Table 2: Subject Areas Represented in Whirlpool's Data Warehouse

BUSINESS PARTNER	Information about an organization or individual with whom Whirlpool has a business relationship (e.g., customers and vendors).
BUSINESS TRANSACTION	Information about the transaction of business between Whirlpool and a business partner (customer, supplier, etc.) such as sales, purchases or shipments; and the documentation of those transactions (e.g., orders, invoices, bills, manifests, etc.).
COMPETITOR	Individuals or organizations that presently offer, or may in the future offer, competitive products and services to Whirlpool's customers.
CONSUMER	A person who owns and/or uses a unit of any brand of product sold by Whirlpool.
EQUIPMENT	All the fixed assets other than land and buildings of a business enterprise. This includes machines used with tools in the factory.
FACILITY	Information about property and plants owned or used by Whirlpool Corporation. Includes location, size, cost, value, depreciation, usage, classification, etc.
FINANCIAL	Information about the assets and liabilities of the Corporation, the internal and external reporting and management thereof. Includes general ledger and sub-ledger information, income and expense, taxes on profits, information about currency, and all financial reports.
GEOGRAPHIC AREA	An area of jurisdiction; may be state, province, county, township, city, etc.
HUMAN RESOURCE	Information about rewards and services provided by Whirlpool for its employees.
MANAGEMENT SUPPORT	Information about the mechanisms used by management to perform day-to-day activities. Includes communication, computer systems and related components, messages, projects, records, reports and surveys.
MANUFACTURING	Information about the procurement of parts and materials, and assembly of parts and materials into other parts, assemblies or finished products.
ORGANIZATION	Information about the structure of the company. Includes business components, organizational units, branches, divisions, parts distribution centers, and departments.
SERVICE	Information about the provision of product diagnostic and repair services to the customer or consumer.
PRODUCT	A standard group of items that is, or has been in the past, manufactured or purchased by Whirlpool and competitors for distribution and sale.

Table 3: Data Warehousing Applications and the Business Needs That They Satisfy

Application	Sponsor	Business Need
Consumer Quality Information System (CQIS)	Product Quality	Early warning system for product quality issues
Customer and Model Profit Analysis (CAMPA)	Sales	Analyze profitability by specific dimensions
Global Procurement (GPDW)	Global Procurement	Identify lowest cost part available globally
Logistics Information for Everyone (LIFE)	Logistics	Provide availability analysis, inventory analysis, inventory turn analysis, and analyze overall cost of delivery
Online Waste Elimination Network (OWEN)	Manufacturing	Identify and eliminate inefficient processes through scrap analysis
Product Cost Analysis System (PCAS)	Manufacturing	Analyze costs associated with production by design changes and production mix
Super Efficient Refrigeration Program (SERP)	Sales	Track sales and customers of the high efficiency refrigerator in order to qualify for rebates from the SERP association
Marketing (DIALS)	Marketing	Analyze external market information on price points and demographics
SEARS POS	Sales	Analyze Sears Point of Sale Information
Service Management Analysis and Reporting Tool (SMART)	Consumer Service	Analyze cost and quality of service
Parts and Accessory Information System (PAID)	Consumer Service	Analyze profitability of part and accessory business by specific parts and customers

identify the value of an initiative to the company and the funds necessary to provide that value. The VOSP document has two parts. The first part is owned by the customer and identifies the functionality that is needed to meet some business need. The second part is completed by IS and describes the specific actions that IS will take to address the specified business needs and the funding required to accomplish this. The executive committee then ranks the VOSPs and decides whether or not to fund each one. A blanket IS VOSP is approved for significant hardware upgrades. The VOSP process continues after a system or application is in place; a post-implementation audit is conducted to ensure that the stated business needs are met.

Because data warehousing is an infrastructure investment, with benefits typically coming from subsequent applications, it was included under the blanket IS VOSP. Therefore, data warehousing per se has not received a post-implementation audit. However, individual VOSPs were created for each data warehousing business application. In keeping with the VOSP approach, each of these applications was reviewed for its value after its implementation. The successful audits of these dependent applications show data warehousing's importance. In addition, it is thought that the benefits from the data warehousing applications are much greater than the post-implementation

audits demonstrate. (Interestingly, business units admit to downplaying benefits for fear of a negative impact on budget levels or future funding.)

CONSTRUCTION OF THE DATA WAREHOUSE

Before data warehousing, Whirlpool traditionally relied on IBM mainframe systems running DB2 for major systems initiatives. When data from these operational systems were needed, Whirlpool used IBM's QMF as the data access tool. However, Whirlpool's new business needs created data access requirements that were not achievable on operational data stores that included data in raw form, in inconsistent formats, and without the ability to support queries, reports, and historical requests. Whirlpool needed to handle large amounts of data, support batch loads, and perform hundreds of complex, often ad hoc, queries from large numbers of users.

NCR was selected to provide Whirlpool with a total data warehousing solution that included hardware and software. A careful review of multiple data warehouse solutions and technology alternatives led to the best solution for Whirlpool. This decision was based on several points:

- the ability to handle complex, ad hoc, multi-table queries against data stored in third normal form;
- ease of data warehousing administration;
- low cost of database management (e.g., database administration resources over a long period of time);
- superior mainframe integration for data loading, archiving, and user access;
- the ability to integrate a multidimensional dependent data mart (Pilot Analysis Server) into the same data warehouse hardware and software environment; and
- a proven data warehousing methodology and expertise in implementing successful data warehousing environments.

The decision has been reexamined a number of times since NCR was first introduced, and each time NCR was found to be the most cost-effective solution and one that best meets Whirlpool's business needs.

Whirlpool's production data warehouse platform in North America is the NCR WorldMark 5100MPP system configured with three 8-way SMP nodes running the Teradata Relational Data Base Management System (RDBMS) and one 4-way SMP node running Pilot Analysis Server. The 5100M is directly channel connected to Whirlpool's MVS mainframe and LAN connected to the corporate and remote LAN sites. This configuration provides over 200 gigabytes of usable storage to Whirlpool whose current levels of raw data exceed 90 gigabytes. For development, Whirlpool uses an NCR 4500 4-way SMP server also running the Teradata RDBMS, Pilot Analysis Server, and a development Web server that provides limited browser access to the data warehouse. The 4500 supports 40 gigabytes of RAID-protected disk storage.

Until 1994, data warehousing activity was limited to North America; however, global initiatives prompted the creation of a second regional data warehouse in Italy to support European information requirements. Ultimately, Whirlpool hopes to integrate regional data warehouses to meet global information needs. The North American data warehousing team members were instrumental in communicating the existing data warehousing methodology, practices, and technology choices to their European counterparts. However, to date the two warehouses remain segregated. One global application (i.e., Global Procurement) is running on the North American data warehouse, and is accessed by procurement users from all regions.

Figure 1 illustrates Whirlpool's data warehousing environment. Currently, the North American data warehouse is fed by at least six external data sources (e.g., data for appliance newspaper advertisements; POS information from appliance retailers) and over one hundred mainframe sources. Additionally, the warehouse provides data to dependent data marts that support marketing, logistics, manufacturing, and procurement applications. Overall, 1,700 users (from Logistics, Sales, Quality, Engineering, etc.) have access to warehouse applications, and 400 to 600 unique users access the

Figure 1: Whirlpool's Data Warehousing Environment

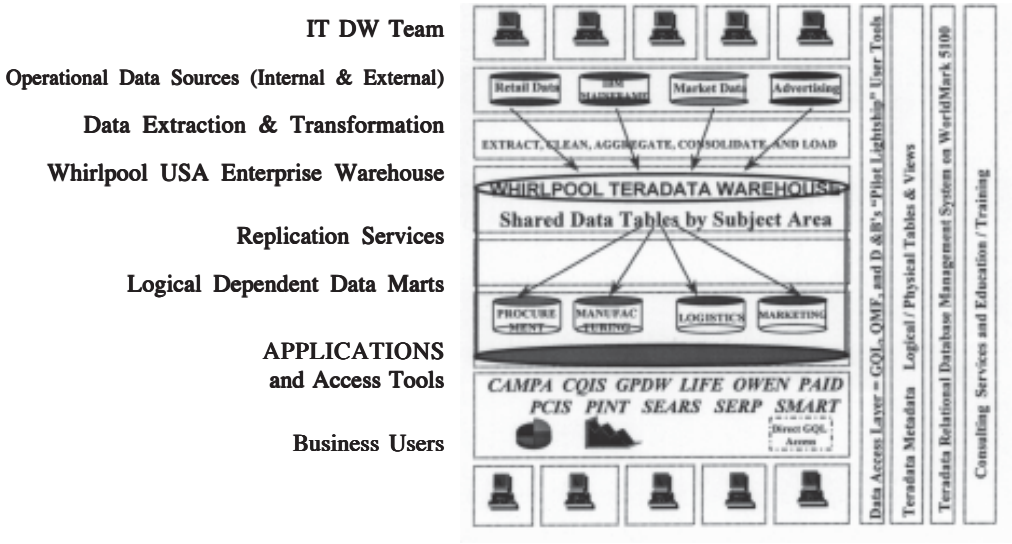

Table 4: Use of the Data Warehouse as of Final Quarter 1997

Total users	1,700
Active users per month	400-600
Queries per month	> 40,000
Views	500

applications each month (see Table 4). The volume of queries has risen to 40,000 in one month, and this figure continues to grow. Six full-time Whirlpool employees comprise the team that supports all of the North American data warehousing initiatives. This includes the team that designs the applications, develops the designs, loads the data, manages the Teradata RDBMS, provides security to the data warehouse, and assists the business users with their queries and future requirements.

USE OF THE DATA WAREHOUSE

Accessing Data

Three primary access tools are used to access Whirlpool's data warehouse. Originally, QMF emulation was used because QMF already existed at Whirlpool. However, QMF has a number of limitations, including its unwieldy user interface and its requirement for advanced knowledge of structured query language (SQL). In 1992, a Windows-based managed query environment called GQL from Andyne Computing was introduced to serve as a generic access tool for all applications that were supported by the data warehouse. The tool has become accepted as the ad hoc access tool of choice because it has an improved graphical user interface, and it supports flexible, ad hoc queries. However, users still need to know the data well before they can execute effective queries. Recently, Pilot Corporation's Decision Support Suite (desktop software) and Analysis Server (a multi-dimensional database) were implemented to complement GQL, and these will be used for predefined queries. Pilot Decision Support Suite does not require users to be quite as skilled in order to access data.

Whirlpool's Marketing Department has taken a different approach than other organizational units in terms of how warehouse data are accessed. First, most marketing users access data marts instead of the warehouse. They cite two reasons for this – better response time and less data complexity. But, data in the data mart are updated only monthly; consequently, marketing users still

must turn to the data warehouse for the most current data. The big difference between Marketing and other areas lies in the user interface tool. For standard marketing applications, PowerBuilder has been employed to develop simple interfaces. This approach has evolved because of a highly skilled and respected application developer within Marketing who has learned to create intuitive marketing applications using PowerBuilder.

Educating Users

The data warehousing education provided to Whirlpool users varies greatly depending on the area within the company. In the Washers area, all new employees get an overview of CQIS as a part of orientation. However, one manager explained that in Quality, *"there are engineers that don't have the foggiest idea of what the data warehouse is about. So we haven't communicated that it exists and what its contents and potential benefits are."*

Overall, there are three approaches to warehousing education at Whirlpool:

- no education;
- education during employee orientation; and
- classes available for employees to sign-up on an as-needed basis.

A combination of the two latter approaches has the best results. Education allows employees to understand the ways in which data warehousing can support their jobs and to understand how to use the data warehouse tools effectively. Mary Schmidke, Decision Support Analyst, performs warehousing training: *"I find that if I get one or two people from a department that is not using the data warehouse to come to training – all of a sudden I have a massive entourage of the whole department coming and wanting to find out how to use the warehouse that same day."* Education improves users' understanding of how data warehousing can meet business needs, and educated users have great enthusiasm for using the data warehouse to do their jobs.

Supporting Users

A six-member group exists within IS to support warehousing and to help with future initiatives. But, in terms of supporting users, the most effective support has been found to come from the business units. Several business units have identified a functional person or persons to help in the use of the warehouse. The profile of such a person includes functional knowledge, technical know-how, and the ability to communicate with the users. This approach works well. The CAMPA application has a business analyst appointed to be its decision support analyst. Former data warehousing manager Laura Sager explains: *"She is in the business, she does all of the training for the CAMPA application, and she is the center of CAMPA's data warehousing support."*

Informal power users have sprung up for areas that do not have formalized data warehousing support in place. For example, in Washer Engineering, quite a few people try to access the warehouse. A power user in this group states, *"Once they make mistakes then I end up running all of the queries for them. They come to me and I write them. They know that I am the expert at it and I can do it better. Now I'm a product engineer, and I do very little product engineering because I'm doing this."* Whirlpool is working to minimize this situation. For example, Sager has made concerted efforts to identify business areas that heavily use the data warehouse and to encourage them to formally assign business users to data warehouse support roles.

THE BENEFITS FROM DATA WAREHOUSING APPLICATIONS

The benefits from data warehousing can be considered in a variety of ways. Figure 2 provides a generic framework that is used to organize the discussion of the data warehousing benefits at Whirlpool.

Time Savings

Now you can access a whole division in a matter of seconds. Now you can do just about anything you want to do to analyze the production for that plant in a matter of minutes; whereas,

Figure 2. The Benefits from Data Warehousing

- Time savings
  - for data suppliers
  - for users
- More and better information
- Better decisions
- Improvement of business processes
- Support for the accomplishment of strategic business objectives

somebody would have keyed in for hours to provide that to you before we had the warehouse.
– Jason Denman, Financial Analyst

Time savings can occur for two groups: data suppliers and end users. While developing a data warehouse is time consuming for IS, once it is in place, there should be less time spent responding to ad hoc requests for data because users can help themselves. More importantly, data warehousing creates the decision support infrastructure upon which future applications are built. If data warehousing is conducted effectively, the start-up costs associated with new decision-support initiatives are dramatically reduced. On the users' side, business analysts spend less time accessing data, processing it, and putting it in a format appropriate for their needs.

Before the data warehouse was in place, IS and functional area personnel were often called upon to make data available. This required a combination of downloading files, re-keying data, and creating extract files. These time-consuming tasks are no longer required because of the existence of the data warehouse.

Jerry Briney is a former manager in Quality, and he uses CQIS to investigate quality problems. Before CQIS, Briney would read upwards of twenty thousand service call tickets a month looking for and investigating problems. Tickets had to be (1) sorted by product and brand, (2) sorted by defect, (3) manually counted, and (4) read thoroughly. This was a mind-numbing task, as Jerry explains, *"After a while you don't know what you are reading. You would read a ticket and not pay any attention to it."* With CQIS, Briney can specify a problem of interest and access all of the service tickets that report that problem. About 30 to 40 times as many service tickets can be checked using the data warehouse. Briney explains how this translates to the bottom line: "*We produce 17,000 washing machines each day. If we find a problem as small as a .1% service incident rate (SIR), we save 17 service calls per day (17,000 * .001). Each call is $75 which results in $1,275 saved in service calls per day and in a $38,250 savings per month."*

More and Better Information

The data warehouse gives us backorder information so that we can expedite what we need to expedite. There was no backorder report in the company before the data warehouse.
- Bill Friend, Logistics Manager

A data warehouse lets users get at data that were previously locked away in legacy systems or that did not exist. Through cleansing, aggregating, and possibly augmenting (e.g., external data) processes, warehouse data are used to create better information than was previously available. John Doyle is a manager in Procurement Quality. He helps insure that parts received from suppliers conform to standards. The data warehouse makes it feasible for him to access and use data in new ways. Previously, Doyle had difficulties getting information that required aggregation. As he describes it, *"I couldn't really use or summarize information without manually going through all the data. It was very difficult and cumbersome to do that. With the data warehouse, I can tell it what I want to see. I want to see an alphabetical listing of all the suppliers, and I want to know how many*

receipts that we have had from them, how many rejects we have, and what their PPM (parts per million) value is." With this information, Doyle is able to track the performance of individual suppliers. Only suppliers who meet expected performance levels are given additional business. Prior to the warehouse, Doyle had to write complex queries to a mainframe, and even then could not access the information that he receives today.

Warehouse data make it possible to think about, ask questions, and explore issues in ways that were not previously possible. Sue Bailey describes her experience with the warehouse in the following way*: "In the past, you asked standard questions that were related to the reports that you got. Now we are able to think about our business differently. I can get information in response to very specific questions. If I see a problem, I can ask a series of questions to get a much better understanding of the dynamics of what is going on."* For example, using the data warehouse, Bailey and colleagues obtained actual sales and margin impacts by contract segmentation for a contract strategy study. The actual margin was obtainable rather than estimates based on samples. The savings in manual effort plus the actual data provided insights that would have been missed using small sample sizes. Additionally, they could change segmentation codes within the data warehouse and observe the impact on the prior year sales. Bailey explains that "*in essence, the data warehouse allowed us to test an approach prior to implementation."*

Better Decisions

> *Our analyst really doesn't spend less time analyzing. The data warehouse is providing for a much more thorough analysis and a much better understanding of what is happening in our business. Our top-level analysts are no longer just cranking data.*
> - Jason Denman, Financial Analyst

The fact that employees now access more and better information impacts the quality and process of decision making. People can ask questions that they could never ask before, rely on facts instead of intuition, and understand situations at a much lower level of detail. Sue Bailey explains that the data warehouse has made people at Whirlpool *"rethink the way we solve problems."*

Whirlpool is continually looking for ways to produce a higher quality, lower cost product. A major way to do this is through the component parts used in its appliances. When a potentially better component is identified, it is placed in a test run (possibly 100,000) of appliances, and then monitored using CQIS. Before the warehouse, it took up to a year to learn about its performance. Now it is possible to more quickly decide whether to put it into all of the appliances. As Jerry Briney describes it: *"You want either a quality improvement or a cost improvement. Either one, you want to get it as fast as possible, and it (CQIS) makes it much faster to do this. If you don't see any failures for six months in that 100,000, you say 'let's put it in four million per year.'"*

The CAMPA application supported hard dollar benefits through improved decision making. Bailey describes the process: "*Analysis of floor planning costs compared to sales of those floor planned models provided hard data to support change in flooring policy. This was one area that the field operations managers actually tracked hard costs reductions of over $1.0 M in the first year to the change in policy."*

Improvement in Business Processes

> *We have realized that now with these tools we can detect a hazard that was not recalled two years before, versus two years after, it was out in the field.*
> - Larry Latack, Product Safety Manager

Many of the biggest returns from the use of IT is when it is used in the redesign of business processes. This redesign can take place at the individual worker level. Before the warehouse, most of the quality data were based on 3 months of rolling data. Averages computed over the 3-month horizon tended to hide important developments. With the warehouse, monthly data became available for control chart purposes. According to John Doyle, *"when you get into actually charting the monthly data, you can see the swings in the data. When something 'pops' on the control chart, you*

can take immediate action and find out what is going on with that particular activity." When Doyle sees that a part is out of control, he is able to drill down into the data warehouse to see whether the problem is occurring in a particular plant or is due to a particular supplier. The ability to quickly identify and correct the problem source results in tremendous savings. Before the warehouse, problems were slow to detect and difficult to correct.

Some business processes are being changed to include a broadening of the organizational boundary. As mentioned earlier, parts suppliers can access quality information by querying data from the warehouse and analyzing it using GQL. This allows suppliers to see the entire history of a part failure from the initial customer call to the final resolution by a service technician. In addition to studying a single part incident, suppliers can look at the performance for all parts of a single type in order to gain a higher-level perspective on parts performance.

Supplier access to the warehouse has also affected the cost recovery process for failed parts. Because supplier and Whirlpool personnel have access to the same parts failure data, it is easier to determine and agree upon the reason for a failure; decide who is responsible for it; and if it is the supplier, decide upon the suppliers' share of the warranty cost payment.

Support for Strategic Business Objectives

The most significant impact of IT is when it becomes an integral part of corporate strategy. At Whirlpool, senior management recognizes the need to align IT with business needs and corporate strategy (as identified earlier in Table 1). Like many companies, Whirlpool's systems were developed separately and in an unintegrated manner, which limits Whirlpool's ability to operate. Even though Whirlpool is in the early stages, senior management feels that the warehouse will ultimately allow the company to function more effectively as a "global, customer-oriented" company.

Whirlpool is beginning to work toward making IT and the data warehouse important parts of its corporate strategy. There are several reasons that make this a challenging undertaking: multiple production and business processes that frequently differ from facility to facility (i.e., plant or warehouse), different data definitions, and a variety of computing platforms and databases. For example, it is a challenge to develop performance metrics for various processes (since they differ) and then compute the associated performance measures (since the data are not easily accessed). The data warehouse is a partial solution to this problem since it intended to provide a single source of clean, consistent data to support decision making and planning and controlling activities.

INSIGHTS ABOUT DATA WAREHOUSING

Other companies' experiences are helpful to organizations that are involved in similar activities. Through the evolution of data warehousing at Whirlpool, ideas surfaced and practices were put in place that have made the data warehouse more effective. For companies that are planning to build a data warehouse, the insights gained at Whirlpool can help guide their efforts.

End Users Are Heterogeneous

End users differ in ways that should be considered when designing a data warehouse. Some users, for example, need narrow slices of detailed data that they manipulate further using a spreadsheet. For them, a dependent data mart and copy and paste capability may be the best solution. Other users may have broad data needs that are best served by a comprehensive "enterprise data warehouse" that provides a cross-organizational and cross-functional view of Whirlpool information. Users also differ in their computer skills, how often they need data in the warehouse, and their willingness and ability to be power users. At one extreme are users who simply want to click on a button to receive a report based on predefined queries. Power users, on the other hand, are more willing to deal with complexity in order to be able to access and analyze data in flexible ways.

Carefully Understand Users' Information Needs

Like any systems analysis and design effort, the starting point is to understand the existing

system and the requirements of the new one. This is done through individual and group interviews with future users. There are several requirements for doing this well. Designers should understand that users and their needs are heterogeneous. Designers must also have the ability and willingness to communicate using the users' mental models and terminology. Users have little understanding and interest in the data models, relational tables, and primary and foreign keys that are so important to the world of database professionals. Users will not be able to articulate all of their data needs initially; many needs will surface only after they have used the data warehouse for awhile.

Provide Appropriate User Interfaces

Because users and their data needs differ, it should be expected that different interfaces (and the associated underlying software) will be needed. Managed query environment software, such as GQL, provides a friendlier interface than using straight SQL, but it is still perceived by many users to be difficult to use correctly. The result may be that either the data warehouse is not used or someone emerges (either formally or informally) who prepares the queries for their technically challenged colleagues. From an IS perspective, it is tempting to blame users for being unwilling and unable to master what is believed to be easy-to-use data access software, while from the users' perspective, they find the software difficult and time consuming to learn. For many users, the simple point-and-click access to information that is associated with executive information systems is a better solution when their information needs can be well defined.

Meta Data for Users Is Important

Being computer literate and able to use data access tools are necessary but not sufficient conditions for successful data warehousing. Users must also understand the data that they are accessing, including the data definitions, the source systems used, when the data were last updated, and peculiarities (e.g., the result of merging two data sources). Most data access tools provide a semantic layer that shields users from having to know cryptic database table and attribute names, but they do not eliminate completely the need to understand the database. Users without this understanding either refrain from using the warehouse, spend inordinate amounts of time developing and testing queries, or ask someone more skilled to write the queries. Well-developed meta data can address these inefficiencies by giving users a helpful tool that explains the relevant pieces of the data warehousing environment. This should be viewed as an important task, and personnel who provide the meta data must be end user oriented, knowledgeable about the subject area databases, and willing to actively involve users in the development process.

Business Units Need to Support Their Data Warehousing Applications

A skilled data warehousing team is critical to provide effective technical solutions that meet users needs; however, it is the business unit that understands the full potential of the data warehouse for its members. A data warehouse will best meet the business needs through the involvement of the business area during all phases of data warehousing, including the post-implementation phases. Too often the assumption is made that technology can meet needs without much effort. Instead the business units need to devote resources to continuous education and internal marketing so that warehousing can support the necessary business objectives. In fact, business users should be assigned permanent roles that support data warehousing efforts.

Benefits from Time Savings, More Information, and Better Decisions are Easy to Realize

Virtually everyone who has access to a data warehouse can give examples of these benefits being realized. These benefits are intertwined. Because data can be more quickly and easily accessed, it is possible to do a more thorough analysis, which results in higher quality decisions. Whirlpool's data warehouse has delivered significant benefits on this front.

Benefits from Changing Business Processes and Support for Strategic Objectives are More Difficult to Actualize

The benefits from the improvement of business processes and support for the accomplishment

of strategic business objectives are more difficult to realize. At the individual level, a warehouse affects how workers perform their jobs. It's more difficult to affect changes, however, at the organizational level. Changes require a clear vision of what should be done, a champion, commitment, groups to work together, the handling of political resistance, as well as the data and technical infrastructure required to support the change. The potential benefits are great, however.

CONCLUSIONS

The evolution of data warehousing at Whirlpool reflects significant growth in data warehouse usage, support for an increasing number of business needs, a variety of benefits to the company, and valuable learnings. As mentioned earlier, nearly six hundred business users access data from the data warehouse each month, and this number should continue to grow. The data warehouse supports many business applications, and interest in these applications deepens with training and internal marketing efforts.

Most importantly, Whirlpool has experienced numerous benefits from data warehousing at the operational and strategic levels, in both quantifiable and intangible forms. An in-depth, exhaustive analysis of these benefits has not been conducted, per se, primarily because the analysis would be time-consuming and expensive. The identified benefits and high satisfaction with the data warehouse make this investment unnecessary. Instead, assessments of benefits are conducted during the post-audit process on an application-by-application basis. There are opportunities for Whirlpool to increase the return on investment from data warehousing by focusing on the high-level benefits derived from changing business processes and alignment with corporate strategy. In this way, Whirlpool can move forward with its business objectives supported by a sound and responsive information infrastructure.

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