emphasized that packaging was a very important part of the production process because governmental regulations and customer satisfaction are both important as the company tries to make a profit.

Several key indicators are used in cereal plant performance monitoring and control. Three key indicators have been chosen that relate to the quality control of packaging and also to the quantity packaged. The indicators for a given product are as follow:

	Weight	Fullness	#Produced
a. Normal state	12 oz. Lowest/ Highest	3 in. Lowest/ Highest	2.5 K Lowest/ Highest
b. Conflict state	10/14	2.7/3.3	2.3/2.8
c. Crisis state	8/16	2.4/3.6	1.9/3.2
d. Failure state	6/8	2/4	1.25/3.85
e. Success state	11.85	2.9	2.48

The EPM system can display/print results in different colors, and furthermore, if each state of affairs is preprogrammed with ways of action, then a manager not only has a concept of the state of affairs but also knows what to do in the case of negative outcomes.

KMS-KNOWLEDGE MANAGEMENT SYSTEM

General Architecture

The desire to preserve knowledge is as old as our civilization. The practice of keeping records in archives was used in 4,000 B.C. in Syria, and later in 4th century B.C. a large library (*Bibliotheca Alexandrina*) was created in Alexandria in Egypt, which lasted almost 1000 years, and at its peak storaged about 700,000 handwritten works. Copies of these documents were distributed by this library throughout the world. The development of papyrus allowed us to record academic and administrative documents and it took almost 1400 years (between 5th century B.C. and 9th century A.D.) to develop a reliable technology. At the same time the alphabet was transformed from mnemonic into phonetic and it allowed for reading and writing as common skills around the 12th century A.D. The discovery of print in the middle of the 15th century

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pushed the development and dissemination of knowledge very fast. As a consequence, modern sciences were defined and the social analysis in the Age of Enlightenment (18th century) led to the American and French Revolutions that created democracy and modern capitalism, which triggered the Industrial Wave and eventually led to the Information Wave. The latter developed digital media (computers, their networks, and databases) for knowledge recording and dissemination.

From this short review of how knowledge supported the development of civilization one can find that knowledge has the same potential for the development of business if it is properly created and disseminated within the organization. Hence, knowledge potential is better understood by many business leaders who develop Knowledge Management Systems in their own organizations to achieve a competitive advantage in the marketplace.

A Knowledge Management System creates, captures, and shares knowledge from internal and external sources through an interactive computer application. By *knowledge* in the enterprise ecosystem we understand an intangible business resource that helps people to be better aware of problems and their solutions. Using the models developed by Saint-Onge (1995), Nonaka and Hirotaka (1995), Pollard (2000), and others, one can assume the following structure of knowledge in the enterprise ecosystem:

1. Tacit Knowledge (Human Capital) – skills, competencies, know-how, and contextual knowledge in people's heads;

2. Explicit Knowledge (Structural Capital) – the knowledge that is captured or codified in the company's knowledge-bases, tools, catalogues, directories, models, processes, and systems;

3. Customer Knowledge (Customer Capital) – the collective knowledge about and of the company's customers, their people, their needs and buying habits;

4. Innovated Knowledge (Innovation Capital) – the collective knowledge about as-yet undeveloped or unexplored markets, technologies, products, and operating procedures.

Knowledge creation is largely a result of converting Human Capital to Structural Capital, and afterwards knowledge is applied by Customer Capital and Innovation Capital which impact Financial Capital and Physical Capital,

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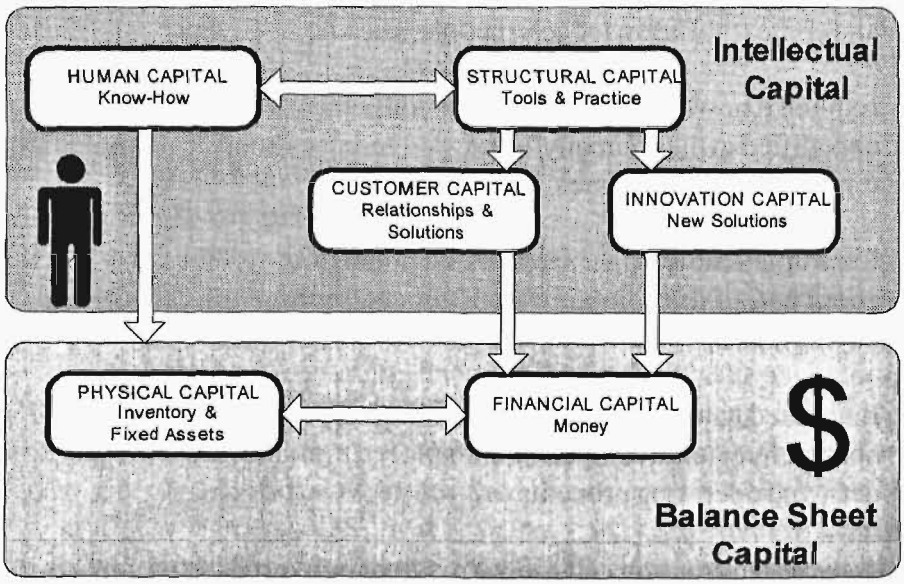
which later provide a feed-back to Human Capital. This cycle is illustrated in Figure 4-9.

Examples of where and how to invest in enterprise knowledge are provided by each type of knowledge:

- Human Capital – salaries for new expert hires, training programs, mentoring and retention programs, and profit sharing programs;
- Structural Capital – call center with customer history database, e-commerce systems, competitive analysis database, and accelerated solutions center;
- Customer Capital – customer satisfaction survey with follow-up visit blitz, multimedia marketing & branding program;
- Innovative Capital – New Product and Knowledge-embedded Product Incubator, Product & Service Life-Cycle value-add program, Value Exchange program, Pathfinder, and thought leadership program.

Figure 4-9: The Enterprise Capital's Cycle Management



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A Knowledge Management System, such as the one which is provided by Ernst & Young, is composed of a mix of:

- Catalogues and Directories – that allow users to browse sequentially through relevant knowledge (analogous to reading a book's Table of Contents);
- Search Engines – that allow users to find a list of knowledge objects that contain certain keywords or meet other specified search criteria (analogous to reading a book's index);
- Portals – that point users to a small, organized subset of knowledge from a much larger knowledge warehouse which can be browsed;
- Road Maps – that provide users with dynamic step-by-step instructions to learn or find pertinent knowledge about a particular subject;
- Profiling or Subscribing – using the Net to continuously catch knowledge that meets specific criteria.

The process by which the user navigates through knowledge warehouses often involves both "push" (into e-mail) and "pull" (via browsers) mechanisms. The results of the application of KMS are as follows:

- New behavioral patterns of stakeholders,
- New business rules,
- New success and failure practices,
- Other.

For example, Wal-Mart has discovered a certain customer behavioral pattern that after weekends men buy pampers and beer, apparently replenishing a home's inventory which was used during that time. Hence, the store puts both products on the same shelf to facilitate the sale.

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Data Warehouse

A data warehouse (DWH) is an organized database for the purpose of supporting business and management Online Analytical Processing (OLAP). The architecture of data warehousing processes is illustrated in Figure 4-10. It identifies the data sources, management processes, analytical tools, and their applications. An average DWH package usually contains the following features:

- Data extraction from different sources and transformation (data integration for a given model and summarization) tools,
- Data loading from different sources in real-time,
- Design/developmental tools such as a visual data modeller,
- Database Management System,
- OLAP tools (data mining, statistical, optimization, spreadsheets, reports, vertical applications, etc.),
- Extensive use of wizards for configuring activities,
- Excellent Graphic User Interface,
- English query facility to retrieve query,
- Easy to use system management tools of maintaining DWH in a right status,
- Scalability – to Very Large Database (several terabytes) and Very Large Memory,
- Other.

Data warehousing in the business modern environment is an ongoing affair. Without proper administration the warehouse will soon fail or become redundant for all practical purposes. The overriding requirement in data warehouse management is the ability to maintain central control over metadata from

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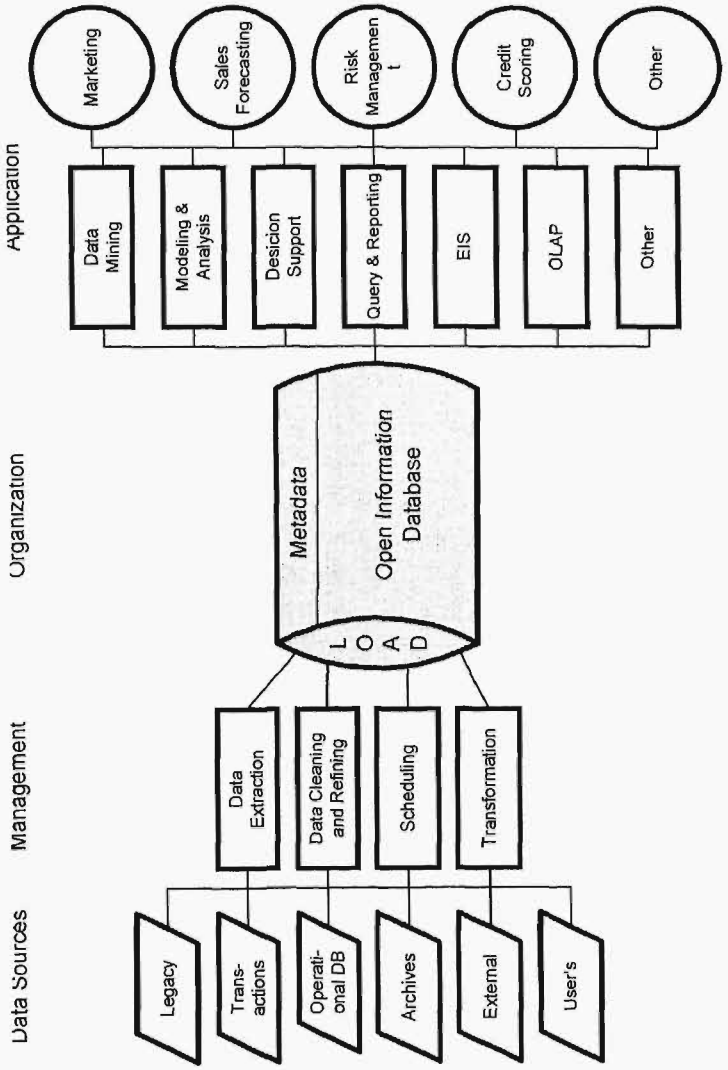
Figure 4-10: Data Warehousing Process



different sources. Data warehouses are non-dynamic when compared to the databases they exist in and are an important part of a dynamic environment.

Data Mart

A data mart is a subset of data for a specific enterprise function or activity; for example, measuring the impact of marketing promotion, or measuring and forecasting sales performance, or measuring the impact of new product

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introductions on company profits, or measuring and forecasting the performance of a new company division.

Data marts may store substantial data, even hundreds of gigabytes, but they contain less data than an enterprise's data warehouse. Because data marts are less expensive to implement than data warehouses, they therefore become a popular alternative to data warehouses.

Data Mining

Data mining is a computerized process of discovering patterns and trends of an enterprise's activities based on a large volume of stored data in data warehouses to solve a business problem. For example, data mining tries to determine the most significant factors involved in the question "Why do low sales take place in the Midwest, while high sales occur on the West Coast?" In traditional database querying we can find out the basic fact, for example, "What is the difference in sales in both mentioned regions?," but we won't find out "why" this difference happens. The data mining tool does not require special assumptions in computing, it just discovers hidden patterns and trends based on a large volume of stored (archived) data.

The typical business problem solving may focus on:

- Which of my customers are most profitable?
- Who is most likely to purchase this type of product?
- Which customers are most likely to leave?
- What other products is this customer likely to buy?
- What is the best channel to reach my customer base?
- Which customers may not pay their bills?
- How can I tell if a transaction is fraudulent?
- What will the demand be for a particular product?

According to Groth (1998) and others, data mining processing is composed of the following stages:

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- Business understanding – defining a problem or a task to be solved,
- Data preparation – data cleaning (from synonyms such as "Pepsi," "Pepsi Cola," and "Cola"), correcting missing values, creating derivations (e.g., differences in sales in different periods), merging data from different sources into two-dimensional tables, etc.,
- Defining a study – defining a goal, .e.g., "To understand customers who are loyal versus those who are lost to competitors,"
- Building a model – gathering all indicators, (e.g., frequencies, weight, conjunctions, differentiations, etc.) for a given study that will be criteria for screening data sets,
- Understanding the model – analyzing correlations among indicators, developing a data distribution and a summary,
- Prediction – choosing the best possible outcomes based on historical data, e.g., "a customer was overdrawn," and understanding why a prediction was made in a discovered manner,
- Decision-making – based on discovered knowledge, the right decision should be made.

Data mining models are very extensive, since they can apply a lot of mathematical techniques which have been defined through the whole last century but could not be implemented since there was not enough data and warehousing technology. Among the most popular techniques one can mention: decision trees, genetic algorithms, neural networks, intelligent agent networks, statistics, and hybrid models.

Data mining can be illustrated in the following example. The Big Bank had a target of acquiring 200,000 new accounts, a number that would require mailing offers to 10 million prospects using a 2% return rate, an expected rate for direct mail. Instead, The Big Bank used the data mining technique to mail to a "refined" subset of all prospects yielding a response rate of 12%. Instead of mailing to the 10 million prospects, discovered patterns of customers' behavior allowed the bank to send mail only to 2 million, which generated required new accounts at a five times smaller cost. In addition to reducing cost,

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the average profitability of an acquired customer was 3 times higher than usual because data mining had targeted the customers whose needs best matched The Big Bank's services.

Some examples of data mining applications in business are as follows (Dan Pratte – www.techrepublic.com):

- Revenues and profitability:
  - Identify the products, services, and channels driving a company's revenue and profit,
  - Rank customers and customer locations by profitability,
  - Automatically alert when critical costs, such as non-billable overtime rates, fall out of control,
  - Know when a company's sales reps/managers are on target and when it is necessary to intervene in time to make a difference.

- Customer relationship management:
  - Identify low-value customers and try to improve their value or take them out of a company's business,
  - Spot customer relationship problems early by monitoring leading satisfaction indicators, such as product or service quality.

- Marketing and sales:
  - Target high-volume customers in order to lower my marketing risk,
  - Rank the success of product promotions to know what is effective by product and market segment,
  - Know what is in a company's pipeline.

Data mining provides a way of unlocking the value hidden within collected data. This technique is an example of "How to informate?" rather than "How to automate information processing?" and achieve an added value from data assets.

A role of data mining in the data warehouse evolution can be perceived in the following stages:

1. Reporting – WHAT happened at the strategic level? Answered through integrated different sources of information within one data warehouse and with pre-defined queries;

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2. Analyzing – WHY did it happen at the strategic level? Answered with increased ad hoc queries (questions are unknown in advance) and through human discovery (query, OLAP tools, SQL);

3. Predicting – WHAT will happen at the strategic level? Solved with analytical modeling through machine-assisted discovery (statistics a la SAS, machine learning, data visualization and processing of hundreds of complex metrics for hundreds of thousands (or more) of observations);

4. Operationalizing – What IS happening at the tactical level? Solved with continuous updating and time sensitive queries. It typically means providing access to information for immediate decision-making in a field. For example: inventory management with just-in-time replenishment or scheduling and routing for package delivery. To make useful decisions, information must be extremely fresh and up-to-date and query response time must be very fast.

5. Active warehousing – What do I WANT to happen? Solved with event-based triggering of patterns and rules. For example, the updating of prices on shelf labels with traditional Mylar labels may be replaced by digital labels controlled by the computer from a remote location without any manual labor. A data warehouse may serve as sophisticated price management to control mark-down strategies in a labor free environment; otherwise it is prohibited by high costs (Brobst and Rarey, 2001).

Analytical solutions of typical business problems are provided in Table 4-1.

Table 4-1: Typical Data Mining Business Problems and Analytical Solutions

Business Problem	Data Mining Analytical Model
Segmentation	Clustering, Factor Analysis, Ranking
Propensity to Buy	Induction Trees, Logistic Regression, Neural Nets
Attrition	Induction Trees, Logistic Regression, Neural Nets
Life Time Value	Net Present Value, Structural Equation Modeling
Purchase Sequence	Association and Sequence Analysis, Affinity, Time Series
Prospecting and Lead Generation	Induction Trees, Logistic Regression, Neural Nets
Profitability Analysis	Activity-based Costing, Process-based Costing
Campaign Effectiveness Assessment	Induction Trees, Logistic Regression, Neural Nets, Discriminant Analysis

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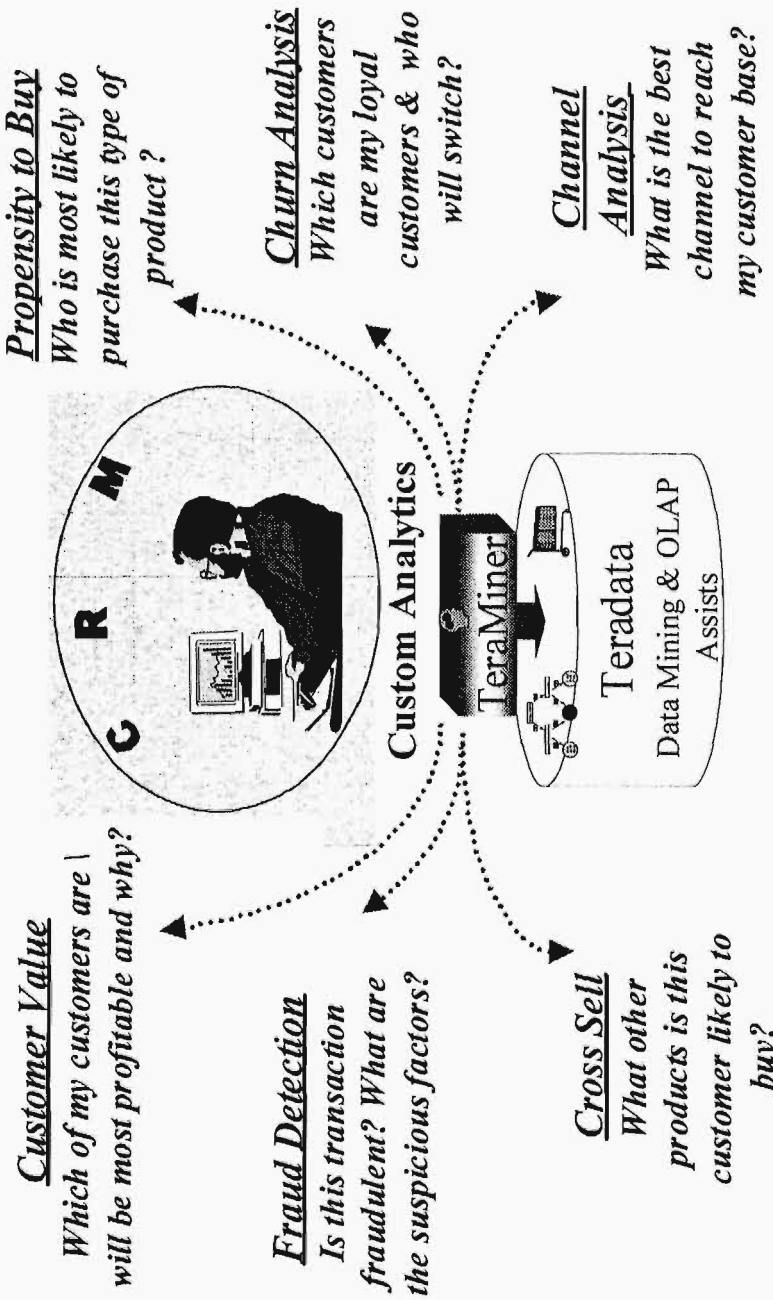
The application of data mining in the Customer Relations Management is illustrated in Figure 4-11.

Figure 4-11: Data Mining Makes CRM Smarter (NCR Teradata)



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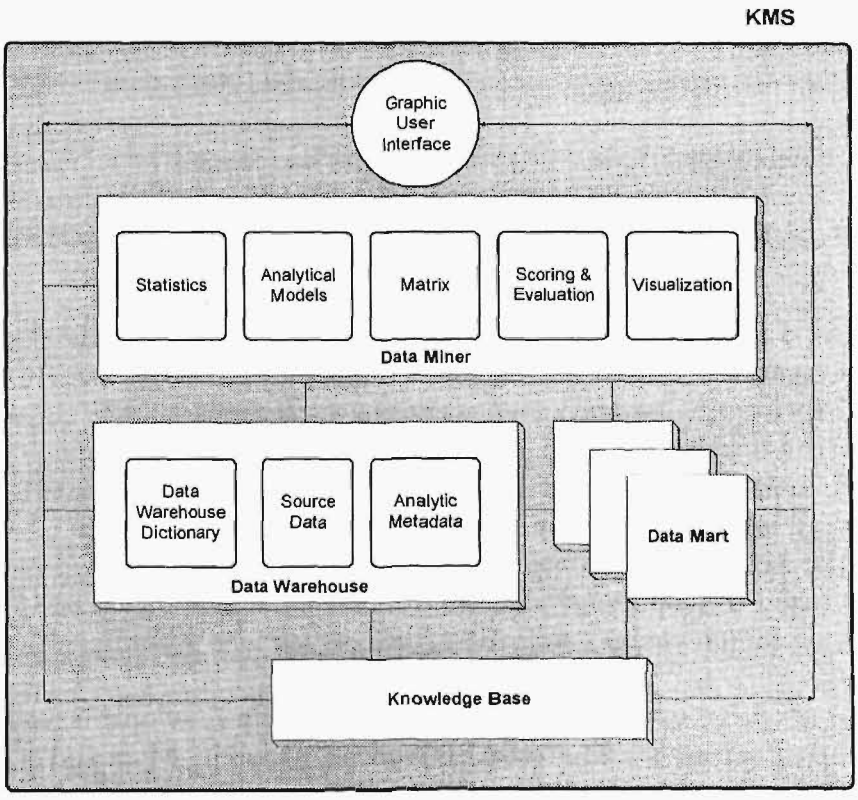
KMS Generic Architecture

The generic architecture of a KMS is shown in Figure 4-12.

A model in Figure 4-12 illustrates a relationship between a Data Warehouse, Data Miner, Data Mart, and Knowledge Base within a KMS. A Data Warehouse provides a source of data repository which provides inputs to a Data Miner engine, which categorizes data and computes behavioral patterns and rules of a given business/organization, applying different mathematical techniques. Data Mart collects knowledge applied by a specific user, and Knowledge Base stores all defined business/organization rules and behavioral patterns of stakeholders. The results are visualized, mostly graphically, to end-users via a Graphic User Interface (GUI).

The present state of KMS does not permit its operations without a considerable human intervention. One of the new positions that steers the development of KMS is a Chief Knowledge Officer (CKO). Appointment of

Figure 4-12: The Generic Architecture of Knowledge Management System



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a CKO provides a focus on the knowledge development strategy within the organization.

A KMS is evolving in an Enterprise Information Portal[5] which is described in the next section. EIP's are one way of disseminating knowledge through an organization, Internet-based training, and what is now called e-Learning. Many companies combine their portal strategies with their online courses and make courses available through portals. Since 1999, the rise of EIP's (from enterprise home pages) has been a noteworthy trend in knowledge management. EIP's are also called corporate portals, enterprise knowledge portals, and collaborative portals. They give users one-point access to knowledge and application resources through the Web browser.

The outlook for KMS is upbeat, as EIP's provide information outside traditional organizational bounds and collaboration work (via an EIP) calls for higher levels of knowledge sharing. The adoption of EIP's will accelerate the establishment of KMS within organizations. Because of the widespread familiarity with Yahoo! and other consumer portals, more users will expect their corporate intranets to offer similar capabilities (such as search engines and automatic document summaries) across the enterprise-wide collection of structured and unstructured documents. Along the way, this trend will help organizations to transform from unwieldy corporate intranets into KMS.

EIP-ENTERPRISE INFORMATION PORTAL – *INTRA-OFFICE AUTOMATION*

EIP is an info-communication system which applies Web technology (on the intranets and extranets) to create a single place where one could start a search for information and knowledge using a search engine, data mining, On Line Analytical Processing (OLAP), and query and reporting techniques. The model for this type of a system comes from the successful Internet portal such as *Yahoo!* which is used by both consumers and business people.

The architecture of EIP is provided in Figure 4-13. EIP's are now being constructed to help knowledge workers locate, manage, and use all this information/knowledge within the context of their jobs' informated decision making.

Some software companies offer toolkits to help develop this read-only software. For instance, Microsoft has launched a toolkit – Microsoft Nuggets – which is a part of its Digital Dashboard strategy.

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