# Intelligence Density

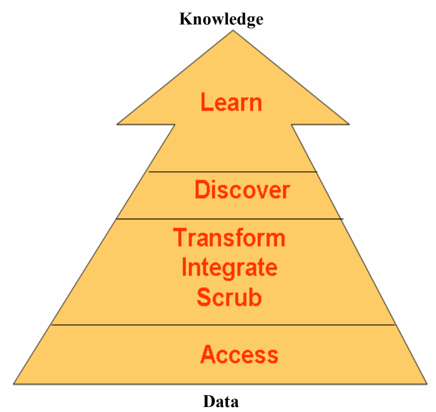
**David Sundaram**
*The University of Auckland, New Zealand*

**Victor Portougal**
*The University of Auckland, New Zealand*

## INTRODUCTION

The amount of information that decision makers have to process has been increasing at a tremendous pace. A few years ago it was suggested that information in the world was doubling every 16 months. The very volume has prevented this information from being used effectively. Another problem that compounds the situation is the fact that the information is neither easily accessible nor available in an integrated manner. This has led to the oft-quoted comment that though computers have promised a fount of wisdom they have swamped us with a flood of data. Decision Support Systems (DSS) and related decision support tools like data warehousing and data mining have been used to glean actionable information and nuggets from this flood of data.

*Figure 1. Steps for increasing intelligence density (Dhar & Stein, 1997)*




## BACKGROUND

Dhar and Stein (1997) define *Intelligence Density* (ID) as the amount of useful "decision support information" that a decision maker gets from using a system for a certain amount of time. Alternately ID can be defined as the amount of time taken to get the essence of the underlying data from the output. This is done using the "utility" concept, initially developed in decision theory and game theory (Lapin & Whisler, 2002). Numerical utility values, referred to as *utilities* (sometimes called *utiles*) express the true worth of information. These values are obtained by constructing a special utility function. Thus intelligence density can be defined more formally as follows:

$$\text{Intelligence Density} = \frac{\text{Utilities of decision making power gleaned (quality)}}{\text{Units of analytic time spent by the decision maker}}$$

Increasing the intelligence density of its data enables an organization to be more effective, productive, and flexible. Key processes that allow one to increase the ID of data are illustrated in Figure 1. Mechanisms that will allow us to access different types of data need to be in place first. Once we have access to the data we need to have the ability to scrub or cleanse the data of errors. After scrubbing the data we need to have tools and technologies that will allow us to integrate data in a flexible manner. This integration should support not only data of different formats but also data that are not of the same type.

Enterprise Systems/Enterprise Resource Planning (ERP) systems with their integrated databases have provided clean and integrated view of a large amount of information within the organization thus supporting the lower levels of the intelligence density pyramid (Figure 2).

But even in the biggest and best organizations with massive investments in ERP systems we still find the need for data warehouses and OLAP even though they predominantly support the lower levels of the intelligence density pyramid. Once we have an integrated view of the data we can use data mining and other decision support tools to transform the data and discover patterns and nuggets of information from the data.

## MAIN THRUST

Three key technologies that can be leveraged to overcome the problems associated with information of low

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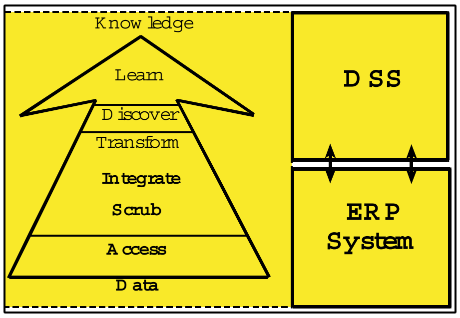
*Figure 2. ERP and DSS support for increasing intelligence density (Adapted from Shafiei and Sundaram, 2004)*




intelligence density are Data Warehousing (DW), Online Analytical Processing (OLAP), and Data Mining (DM). These technologies have had a significant impact on the design and implementation of DSS. A generic decision support architecture that incorporates these technologies is illustrated in Figure 3. This architecture highlights the complimentary nature of data warehousing, OLAP, and data mining. The data warehouse and its related components support the lower end of the intelligence density pyramid by providing tools and technologies that allow one to extract, load, cleanse, convert, and transform the raw data available in an organisation into a form that then allows the decision maker to apply OLAP and data mining tools with ease. The OLAP and data mining tools in turn support the middle and upper levels of the intelligence density pyramid. In the following paragraphs we look at each of these technologies with a particular focus on their ability to increase the intelligence density of data.

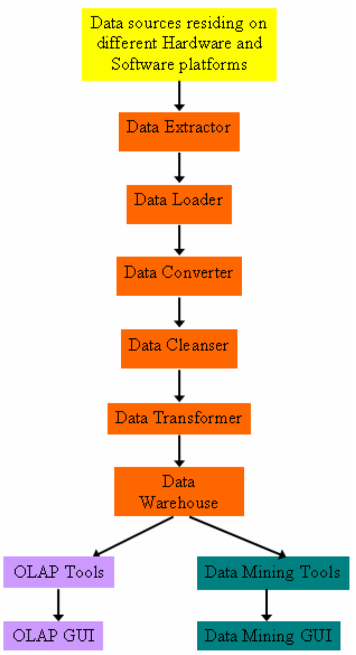
## Data Warehousing

Data warehouses are fundamental to most information system architectures and are even more crucial in DSS architectures. A Data Warehouse is not a DSS, but a Data Warehouse provides data that is *integrated, subject-oriented, time-variant*, and *non-volatile* in a bid to support decision making (Inmon, 2002). There are a number of processes that needs to be undertaken before data can enter a Data Warehouse or be analysed using OLAP or Data Mining Tools. Most Data Warehouses reside on relational DBMS like ORACLE, Microsoft SQL Server, or DB2. The data from which the Data Warehouses are built can exist on varied hardware and software platforms. The data quite often also needs to be extracted from a number of different sources from within as well as without the organization. This requires the resolution of many data integration issues such as homonyms and synonyms. The key steps that need to be undertaken to transform raw data to a form that can be stored in a Data Warehouse for analysis are:

- The extraction and loading of the data into the Data Warehouse environment from a number of systems on a periodic basis
- Conversion of the data into a format that is appropriate to the Data Warehouse
- Cleansing of the data to remove inconsistencies, inappropriate values, errors, etc
- Integration of the different data sets into a form that matches the data model of the Data Warehouse
- Transformation of the data through operations such as summarisation, aggregation, and creation of derived attributes.

Once all these steps have been completed the data is ready for further processing. While one could use different programs/packages to accomplish the various steps listed above they could also be conducted within a single environment. For example, Microsoft SQL Server (2004) provides the Data Transformation Services by which raw data from organisational data stores can be loaded, cleansed, converted, integrated, aggregated, summarized, and transformed in a variety of ways.

*Figure 3. DSS architecture incorporating data warehouses, OLAP, and data mining (Adapted from Srinivasan et al., 2000)*



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