

Gaining Competitive Advantage on the Basis of Data Warehousing and Data Architecture

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Abstract: This paper discusses the relationship between data warehousing, data architecture, strategy and strategic thinking. How the business organizations can use these as business applications and competitive advantage tools.

This paper will attempt to demonstrate data warehousing and data architecture strategically, for that we must first understand strategy and strategic thinking. Once we understand those concepts, the strategic logic of data warehousing becomes clear and the path to an optimum implementation emerges. We will demonstrate that data warehousing is best appreciated as a realization of the deep and far reaching strategic idea of a *rising tide strategy*. The maximum return from data warehousing occurs when it is conceptualized, implemented, managed, and evolved within that context. Before doing that, however, it is beneficial to level set and review the data architecture origins of data warehousing.

Key Words: Competitive advantage, OLTP, ORS, Strategy, Value.

I. INTRODUCTION

When your strategy is deep and far reaching, then what you gain by your calculations is much, so you can win before you even fight. When your strategic thinking is shallow and near-sighted, then what you gain by your calculations is little, so you lose before you do battle. Much strategy prevails over little strategy, so those with no strategy can only be defeated. So it is said that victorious warriors win first and then go to war, while defeated warriors go to war first and then seek to win.

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The fundamental strategic logic of the first three is fairly well understood.

- **Manoeuvrability** is the strategic imperative that propels one to client/server computing. To cope with the extreme business turbulence of the 1990s and beyond, a company must be agile and fast. Client/server permits a business to respond quickly and forcefully to constantly changing times and circumstances in a cost-competitive manner.
- **Reach** is the strategic imperative that supports the unparalleled interest and investments in the *Internet*. Electronic commerce provides entirely new ways to distribute and sell to consumers-ways that are faster, cheaper, more informative, customer intimate, customer empowering, and that compress time and space.
- **Leverage** is the strategic imperative that motivates interest in object-oriented technology. Through the prospect of treating software as pre-engineered parts, new productivity levels can be achieved by shifting the unit of software development from a line-of-code to pre-assembled, reusable, and certified parts. So the strategic logic of the first three pervasive I/T trends is clear; they are, respectively, manoeuvrability, reach, and leverage (productivity).

Four key subjects dominate I/T landscape:

I/T Processing architecture, Developer productivity, Electronic commerce, Knowledge and learning

Data warehousing is the last of the four dominant trends but the underlying strategic logic has not been well articulated, as shown in Table 1.

Table 1. Various Industry Uses of Data Warehousing (sample industries).

Leading Edge Uses of Data Warehousing	Representative Companies
Retail Analysis of scanner check-out data Tracking, analysis, and tuning of sales promotions and coupons Inventory analysis and re-deployment Price reduction modeling to "move" product Negotiating leverage with suppliers Frequent buyer program management Profitability analysis Product selections for granular market segmentation	Wal-Mart Kmart Sears Oscor/Savon Drugs Casino Supermarkets W. H. Smith Books Otto Versand Mail Order
Telecommunications Analysis of: call volumes equipment sales customer profitability costs inventory Purchasing leverage with suppliers Frequent buyer program management	AT&T Ameritech Belgacom British Telecom Telestra Australia Telecom Ireland Telecom Italia
Banking and Finance Relationship banking Cross segment marketing Risk and credit analysis Merger and acquisition analysis Customer Profiles Branch Performance	Bank of America Citibank BancOne Merrill Lynch CBOE CNA

A Data Architecture Perspective of Data Warehousing: The business practices can generally be partitioned into two broad classifications:

- **The Business Applications:** Those business applications that operationally "run" the business on a daily, weekly, monthly, etc. basis. When they cease to run, the business literally stops operating.
- **The About-the-Business Applications:** Those applications that analyze the business. They aid both in interpreting what has occurred and deciding prudent actions for the future. When they cease to run, there is no immediate, obvious

business failure but their utility is critical to the long-term competitiveness of the enterprise. Data warehousing embraces these types of applications.

"The Business Applications" are often called On-line Transaction Processing Systems (OLTP) or Operations Support Systems (OSS) and have the following general attributes:

- "Heavy duty" production transaction record keeping systems that directly support the execution of a business practice.
- May have to provide 24 hour by 7 day service and have carefully managed outage periods.
- Database integrity and availability are crucial. The database must be recoverable from a failure within a guaranteed restoration period.
- Performance is measurable in terms of transactions per (sub)second and/or user response time (x % of the transactions must respond in less than y (sub)seconds).
- Structured applications with both pre-defined transactions and pre-defined transaction flows. The execution paths are predictable.
- Database schemas are quite complex in terms of number of entities and number of inter-entity relationships. The inter-entity relationships impose multiple dependency, referential integrity, and validation requirements on the system.
- Elaborate editing of input transactions is required to ensure and maintain database quality.
- Security of access is important.
- Sophisticated dialogue management is required.
- User ergonomics to maximize productivity is a big concern.
- Often large applications by the metrics of database size, total number of users, total number of concurrent users, and types of transactions.
- Extensive off-peak time batch updating and reporting must be completed within a tight batch window.

Business Performance is the payoff advantage from these types of applications. Consequently, they will often contain exception monitoring subsystems used to advise management when an abnormal situation has occurred or an undesirable pattern is developing.

II. DATA ARCHITECTURE CHOICES

Business applications are performed by programs that collect, create, modify, retrieve, and delete data, and programs that use, analyze, summarize, extract, or in other ways manipulate data. Data is the common thread that ties together the extensive corporate application portfolio. Data, as it is transformed into information as it flows between users, can provide current advantage in the form of superior operational systems and future advantage in the form of superior analysis for planning.

How the data asset is positioned is of vital long-term importance to the health of the enterprise.

Dedicated File Architecture: Each application has a set of privately designed files. The data structure is tightly embedded with the application and the data files are owned by the application.

Closed Database Architecture: A database management system (DBMS) is used to provide technological advantage over file systems (exemplary advantages are views, security, atomicity, locking, recovery, etc.) but distinct, separate, and independent databases are still designed for each application. The DBMS is used as a private and powerful file system with the data remaining the proprietary property of the application. As is true with the Dedicated File Architecture, there is a high degree of data redundancy and frequently poor data administration. "Spaghetti-like" interfaces move data between the Closed Databases. Since these interfaces often have to convert, edit, and/or restructure data as it moves between proprietary definitions, they are often called "data scrubbers" or translators. "Data scrubbers" do not add value; they compensate for inadequate data administration.

Subject Database Architecture: Data is analyzed, modelled, structured, and stored, based on its own internal attributes, independent of any specific application. Data is administered as a shareable resource through a data administration function that owns the data for all potential users. Extensive sharing of data occurs through application sensitive views. Subject Databases run the day-to-day operations of the enterprise.

Decision Support Database Architecture: Databases are constructed for quick searching, retrieval, ad-hoc queries, and ease of use. The data is normally a periodic extract from a Subject Database or public information service. To minimize the number of extracts and to insure time/content consistent data, data is shared at the corporate, departmental and local levels-not extracted per user. The recommended data architecture is a mixture of the Subject Database and Decision Support Database environments. Subject Databases to support "The Business Applications" and Decision Support Databases to enable "The About The Business Applications." This dual database architecture is most advantageous for the following reasons:

- Data quality, accessibility and sharing are maximized.
- Unplanned data redundancy is eliminated.
- Inter-application interaction is simplified.
- Data standardization is assured.
- Application life cycle productivity is maximized.
- Development of new applications is accelerated through the reuse of in-place data resource.
- Creation of centres of excellence in data management to protect the data asset is enabled.

Some data architects would prefer a single database environment where both OLTP and decision support needs are fulfilled concurrently against a single database and, thereby, eliminate duplication and extraction altogether. It is our assessment that the two user communities have fundamentally different and incompatible requirements that preclude this option. Table 2 summarizes the major points of conflict. These dichotomies present a formidable barrier to a single database environment.

Table 2. Subject Database and Decision Support Database Dichotomies. (Source: *Implementing Client/Server Computing*, Bernard H. Boar, Mc-Graw Hill, 1993)

<i>Operational Environment</i> Subject Databases The Business Applications	<i>Data Warehouse Environment</i> Decision Support Databases The About-The-Business Applications
Stores very detailed data Stores entire subject database Requires to the last transaction accuracy Disciplined, highly structured, and planned transactions Optimized for performance, efficiency and availability Maintains rigorous data structures Runs the business Emphasizes needs of all potential users	Short-running and engineered transactions Stores detailed and/or summarized data Stores only data of interest Requires "as of" accuracy Unstructured and ad-hoc transactions Optimized for flexibility and ease of use Supports dynamic data structures Analyzes the business Emphasizes needs of each user Potentially long running and dynamically defined transactions

When routine access of operational databases is given to decision support users, major problems can occur:

Performance, Data Retention, Logical Reasoning

III. STRATEGY AND SUSTAINABLE COMPETITIVE ADVANTAGE

From an academic perspective, the purpose of strategic planning is to provide direction, concentration of effort (focus), constancy of purpose (perseverance) and flexibility (adaptability) as a business relentlessly strives to improve its position in all strategic areas.

Strategy is mathematics and is equal to direction plus focus plus perseverance plus adaptability. At a very pragmatic level, strategy can be understood as finding a way short (the shorter the better) of *brute force* to accomplish one's ends. Strategy should be comprehended as the movement from a current position to a more desirable future position but with economies of time,

effort, cost, or resource utilization. There is neither elegance nor insight in brute force but there must be both in strategy.

The eternal struggle of business is the struggle for advantage. The one with more advantage wins, the one with less advantage loses. The purpose of strategy is the building, compounding, and sustaining of advantage. Consequently, business strategy must focus on:

- Building new advantages, which increase customer satisfaction and create distance from competitors?
- Maintaining existing advantages, which increase customer satisfaction and create distance from competitors, and
- Compressing or eliminating the advantages of competitors.

While there are many ways to build advantage, all advantages can be classified into five generic categories:

- **Cost advantage:** the advantage results in being able to provide products/services more cheaply.
- **Value-added advantage:** the advantage creates a product/service that offers some highly desirable feature/functionality.
- **Focus advantage:** the advantage more tightly meets the explicit needs of a particular customer.
- **Speed advantage:** the advantage permits you to service customer needs quicker than others.
- **Manoeuvrability advantage:** the advantage permits you to adapt to changing requirements more quickly than others. Being manoeuvrable permits you to constantly refresh the other types of advantage. It is the only advantage that your competitors can't take from you.

IV. DATA WAREHOUSING AND STRATEGIC THINKING

To understand data warehousing strategically, we should now appreciate that it is the consequence of strategic thinking, which means that it is the product (result) of some combination of strategic ideas. In this case, we must reverse-engineer strategic thinking. We know the result of the strategic thinking process, data warehousing, but what are the strategic ideas from which it emanated?

Data warehousing is an unusually rich strategic action. A strong case can be made that it is the product of numerous strategic ideas. If we argue, however, that data warehousing is the product of everything, we cloud our analysis. What are the key ideas that it realizes?

So the strategic ideas from which data warehousing emanates are the time-oriented ones:

- **Learning:** One must continually learn and adapt based on that learning. All progress includes making mistakes but the same mistakes should not be made twice.
- **Manoeuvrability:** This skill requires finding the best way to go. Forces must be able to manoeuvre to exploit gaps.
- **Prescience:** The leadership must have deep and far-reaching foresight. Leaders must see and know what others do not. The height of prescience is to see the formless and act on it.
- **Foreknowledge:** All matters require competitive intelligence. Nothing is more important than understanding the plans of your opponents and the needs of your customers.

These four strategic ideas are not just any set of strategic ideas; they are uniquely important. They are uniquely important because they overlay the time dimension of strategic thinking. Time is one of the three fundamental dimensions of strategic thought and data warehousing enables one to directly think in that dimension. Data warehousing is, therefore, not just another good result of strategic thinking, it is a very special result because it provides the tools to permit an organization, through the action of building data warehouses, to compete in the primary strategic dimension of time.

V. DATA WAREHOUSING AND STRATEGIC PARADOX

Business strategy, to the contrary, is executed against a background of hyper-conflict and intelligent counter-measures. Able and motivated competitors purposefully and energetically attempt to foil your ambition. Because of this excessive state of conflict, many strategic actions demonstrate a surprising paradoxical logic.

There are two types of strategic paradox:

- **Coming together of opposites:** A linear logic action or state evolves into a reversal of itself ("A" becomes "not A") or "you can have too much of a good thing". An example of this is that an advantage, un-refreshed, becomes a disadvantage. This paradox occurs because conflict causes an inevitable reversal due to the complacency of the winner and the hunger of the loser.
- **Reversal of opposites:** To accomplish your objectives, do the reverse of what linear logic would dictate. So, "If you wish peace, prepare for war", to accomplish "A", do the set of actions to accomplish "not A", or your primary competitor should be yourself. This occurs because the nature of conflict reverses normal linear logic.

Table 3. Comparative Ages. Knowledge is becoming the premier weapon of advantage and information technology is its basis.

<i>Attribute</i>	Age					
	Nomadic Society	Agrarian Society	Mercantile Society	Industrial Society	Knowledge Society	
<i>Dominant Technology</i>	Crude Tools	Hunting	Manual Farm Equipment	Sailing Ships	Machines	The Computer
<i>Icon</i>	The Hunting Club	The Plow	The Great Sailing Boat	The Gasoline Engine		The Microprocessor
<i>Science</i>	Superstition	Civil Engineering	Marine Engineering	Mechanical Engineering		Computer Science
<i>Output</i>	Slaughtered Animals	Farm Food	Trade	Mass Consumer Goods		Knowledge
<i>Energy Source</i>	Fire	Animals	Wind	Fossil Fuels		The Mind
<i>Basis of Wealth</i>	Hunting Ability of Tribe	Farm Land	Sailing Ships	Land, Labor, and Capital		Information
<i>What Makes The Difference</i>	Courage	Muscle	Fleets	Economies of Scale		Intelligence
<i>Defining Work</i>	Hunter	Farmer	Merchant	Laborer		Knowledge Worker
<i>What Are You Doing?</i>	Surviving	Eating	Trading	Automating		Informating
<i>Organizational Form</i>	Tribe	Feudalism	Trading House	Hierarchical Corporation		Networks
<i>Means of Logistics</i>	People	Animals	Ships	Airlines, Trains, Ships, & Trucks		Network
<i>Where is the Marketplace?</i>	Person-to-Person	Village Square	Town Stores	Shopping Malls		Cyberspace (The Marketplace)

Data warehousing also needs to be understood in terms of reversal of opposites. As shown in Table 3, we are moving from the industrial society to the knowledge society. Knowledge becomes the premier weapon of advantage and business-to-business conflict migrates from competing on industrial age economies of scale to information technology fighting (I/T fighting). Key strategic information technologies such as client/server computing and data warehousing, therefore, become subject to strategic paradox in their implementations.

The strategic paradox of data warehousing is that the strategist concerned about cost does not seek to use just enough means but an excess of means to accomplish her end. Data warehousing achieves, paradoxically, its greatest value for the business when it is used in excess. It is typical to observe customer teams engage in extensive and exhaustive cost justifications exercises (net present value, return on investment, cost/benefit justification, payback period, etc.) to convince cost conscious decision makers to approve data warehousing expenditures for a predetermined fixed set of uses. Their actions are linear

logic, understandable but inappropriate because of reversal of opposites. When the weaponry shifts to I/T fighting, data warehousing becomes subject to strategic paradox and must be managed as such to achieve optimum results.

In the information age, data warehousing is a key strategic weapon. As we have discussed, not only does it let you compete across time, it is a rising tide strategy that can elevate the strategic acumen of all employees. The attempt to cost justify such powerful weaponry in terms of net present value misses the whole point. When one invests in a national highway infrastructure, one does not cost justify or attempt to anticipate each event of commerce that will transverse the highway. Use data warehousing to position yourself so that you will surely win, prevailing over those who have already lost. Win through intelligence, not brute force. Cost justification is supposed to be a tool of strategy; not the reverse. Strategic paradox alters the rules; understand and justify data warehousing strategically.

VI. CONCLUSION

Our strategic analysis of data warehousing is as follows:

- Strategy is about, and only about, building advantage. The business need to build, compound, and sustain advantage is the most fundamental and dominant business need and it is insatiable.
- Advantage is built through deep and far reaching strategic thinking.
- The strategic ideas that support data warehousing as a strategic initiative are learning, manoeuvrability, prescience, and foreknowledge. Data warehousing meets the fundamental business needs to compete in a superior manner across the elementary strategic dimension of time.
- Data warehousing is a rare instance of a rising tide strategy. A rising tide strategy occurs when an action yields tremendous leverage. Data warehousing raises the ability of all employees to serve their customers and out-think their competitors.
- Data warehousing achieves optimal results when one understands strategic paradox. When used as a weapon of conflict in the information age, data warehousing, paradoxically, achieves the greatest economies when it is applied in excess. One always wants the tide to be at high tide.
- Data warehousing is a mandatory prerequisite to engage in a manoeuvre market style, which will be the dominant form of marketplace warfare as we begin the next millennium. To continually and abruptly change business direction requires both judgment and knowledge. Hard won experience provides the former and data warehousing provides the latter.

Companies enter markets to win profits, not to engage in expensive and endless pitched battles with competitors. Data warehousing is of strategic value because it enables us to achieve the former while deftly avoiding the latter. This is the strategic spirit in which we should understand, implement, and manage data warehousing. "Strategy is important to the nation-it is the ground of death and life, the path of survival and destruction, so it is imperative to examine it. There is a way of survival which helps and strengthens you; there is a way of destruction which pushes you into oblivion." Data warehousing is a path to survival that *helps and strengthens you*. Our strategic understanding of data warehousing is complete.

REFERENCES

- [1] Cost Effective Strategies for Client/Server Computing, John Wiley & Sons, 1995
- [2] The Art of Strategic Planning for Information Technology: Crafting Strategy for the 90s, Chinese Mandarin Edition, 1995
- [3] Practical Steps to Aligning Information Technology with Business Strategy: How to Build a Competitive Advantage, John Wiley & Sons, 1994
- [4] The Art of Strategic Planning for Information Technology: Crafting Strategy for the 90s, John Wiley & Sons, 1993
- [5] Implementing Client/Server Computing: A Strategic Perspective, McGraw Hill, 1993