Best Practice for Implementing a Data Warehouse: A Review for Strategic Alignment

Rob Weir, Taoxin Peng and Jon Kerridge

School of Computing, Napier University
10 Colinton Road, Edinburgh EH10 5DT UK
Email: {r.weir, t.peng, j.kerridge}@napier.ac.uk

Abstract. A review of literature pertaining to data warehouse implementations over the last eight years has been undertaken. It was found that the views of data warehouse practitioners in particular have changed over the period's pre and post 2000, to the extent that fewer authors place any emphasis on the need for a clear business purpose before embarking on a data warehouse project. Notably, pre 2000, there was no reference to the need to deliver a return on data warehouse investment, but today it appears to be critical that data warehouses prove their financial value. However, data warehouses do have strategic and therefore long term value for an organization. The case study review in this paper supports the notion of strategic alignment but it is the mapping of their experiences to the configuration school of strategic management that explains the degree of success.

1. Introduction

Late 1997, the author embarked on a study to define 'Best Practice for Implementing a Data Warehouse', which was used to explain the experiences of a bank's data warehouse project and ultimate implementation failure [Wei02]. At that time, the available literature was limited to practitioners' accounts of data warehousing projects but there was enough information to build a 'best practice' framework:

- Project must fit with corporate strategy and business objectives
- There must be complete buy-in to the project
- Manage expectations
- Data Warehouse must be built incrementally
- Build in adaptability
- Project must be managed by both IT and business professionals
- Develop a business / supplier relationship
- Only load data that has been cleaned and is of a quality that is understood by the organization

- Do not overlook training requirements
- Be politically aware

Since then, the literature has been reviewed and updated. The practitioners' reports are now supplemented by academic studies and the result is that we have a clearer picture of the issues that are important to today's data warehousing project teams.

This paper originates from an information gathering exercise that concentrated upon further investigation of the elements of 'best practice' and whilst not a formal experiment, there is sufficient information to illustrate how the data warehousing literature has changed over the last eight years. The literature review demonstrates that fewer authors place any emphasis on the need to align their data warehouse with corporate strategy and business objectives, which may suggest that project teams are not being encouraged to think of data warehousing as a strategic tool and raises one fundamental question; is strategic alignment an unattainable goal? If not, what do organisations have to do to realize their data warehousing vision?

The examination of best practice will be presented in section two of this paper in order to highlight the issues affecting data warehouse implementation projects both pre and post 2000. This will be followed by a case study in section three, which will emphasize the strategic potential for data warehousing. The organization at the heart of the case study managed to successfully align the data warehouse with the corporate strategy, but alignment itself does not fully explain the scale of success. Success is rationalized by mapping the organization's experiences with the configuration school of strategic management. Finally, section four will summarize the issues raised in this paper with the conclusion that organisations should be prepared to reconfigure many aspects of their operational structures in order to successfully integrate and exploit the potential that data warehousing has to offer for long term benefit.

2. Best Practice for Implementing a Data Warehouse

Pre 2000, the literature was dominated by practitioners' reports. The authors highlighted subject areas that they considered to be of particular importance to data warehouse projects. Alternatively, the writers would suggest that problems experienced could have been avoided had a particular course of action been taken. Wixom and Watson [WiW01] concur; "There is considerable practitioner wisdom on the keys to data warehousing success; however, it is based on anecdotal evidence from a limited number of companies. There has been no academic research that systematically and rigorously investigates the keys to data warehousing success." Since making this statement, more academic studies have surfaced and in general, these papers have been found to confirm the content of the elements of best practice as previously defined. For example, Wixom and Watson empirically demonstrated that the quality of data, management buy-in and end user buy-in contribute to a successful implementation

A feature of the literature over the years has been the lack of case studies describing failed data warehouse projects. Organisations are understandably content to be associated with success [Kig96] but reputational risk would appear to be the key

factor in preventing the development of our understanding of the reasons for failure. Significantly, only one article has been found that described a failed data warehouse project [Pau97], the company and personnel identities were masked.

The following section demonstrates that the issues uppermost in the mind of authors have changed over the last eight years. The descriptive nature of both academic and practitioners' reports leads us to conclude that data warehouse implementation practices are changing.

2.1 Methodology

Best practice was initially constructed from the reports of practitioners by simply counting the number of times a subject area was highlighted as important to the implementation of a data warehouse project. For example, of the nineteen articles that referred to data warehouse implementations pre 2000, fifteen authors concluded that the 'Project must fit with corporate strategy and business objectives'. The elements of best practice, pre 2000 have been graphically displayed in figure 1.

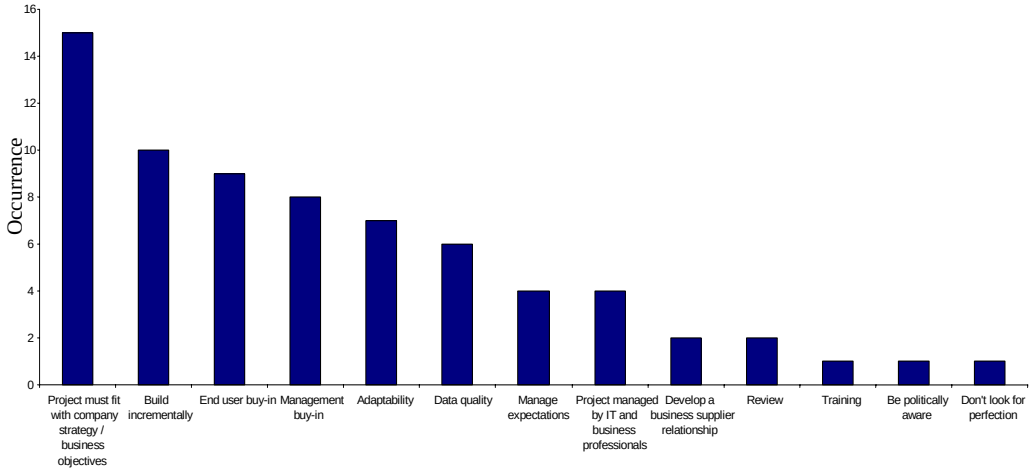

Fig. 1. Elements of Best Practice Pre 2000

The same exercise was carried out for twenty relevant articles post 2000 compared to nineteen articles covering the period pre 2000. The fact that there are comparable numbers of articles pre and post 2000 is not a matter of design but a reflection of the lack of material to draw from. A simple comparison has therefore been made between the two study periods, which have been graphically represented in Figure 2. This illustrates that the experiences of data warehouse practitioners and academics has changed significantly post 2000.

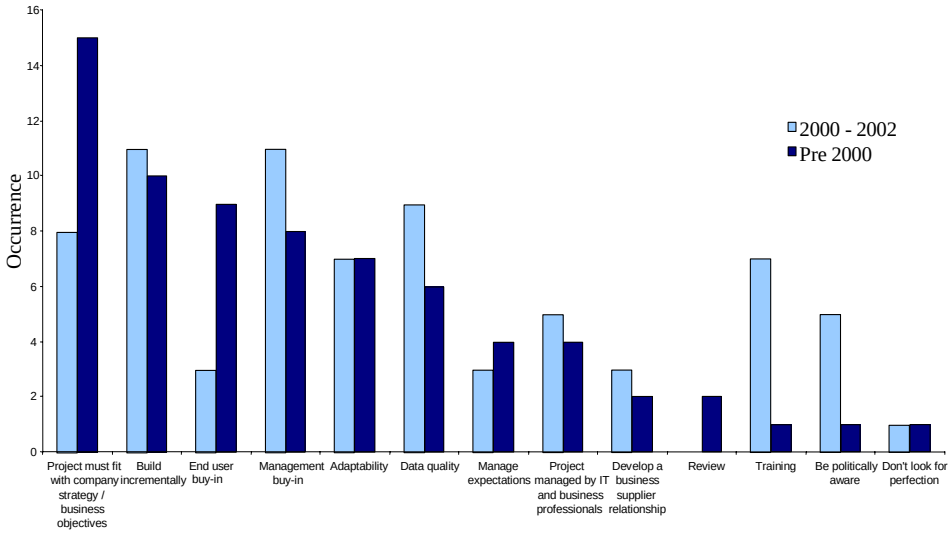

Fig. 2. Elements of Best Practice Pre and Post 2000

2.2 Best Practice for Implementing a Data Warehouse – Post 2000

Figure 2 suggests that there has been little or no change to the following elements of best practice:

- Data Warehouse must be built incrementally
- Build in adaptability
- Manage expectations
- Project must be managed by both IT and business professionals
- Develop a business / supplier relationship
- Don't look for perfection

We may assume from this that these issues continue to be relevant to the successful implementation of a data warehouse.

The post 2000 literature review has highlighted a number of changes in the approach to data warehouse implementations. The following table categorizes the elements of best practice that are more or less influential in data warehouse implementations post 2000.

Table 1. Category of Best Practice Elements

More influential
Only load data that has been cleaned and is of a quality that is understood by the organization
Do not overlook training requirements
Be politically aware
Management buy-in
Less influential
Project must fit with corporate strategy and business objectives
End user buy-in
Manage expectations
Make time to review progress

During the initial study of best practice, end user buy-in and management buy-in were comparable in their importance to the successful implementation of a data warehouse. It was therefore decided to express these issues under the broader principle that 'There must be complete buy-in to the project'. However, post 2000, authors have placed more emphasis on management or more importantly, executive buy-in [SaF00, Tre01, WiW01, WAW01, MaF01, Don02, Shi02] and significantly less credence is given to end user buy-in. The executive sponsor, most commonly the CEO or CIO, should have cross functional authority to address the problems that are encountered when business functions put up barriers preventing implementation progress. However, end user buy-in was considered important to data warehouse projects as they were regarded as the people who would deliver the perceived benefits, in terms of analysis. Their involvement would help guide the project with necessary business logic and help users understand development problems such as data quality. This sense of involvement allows users to take part of the development and accept some responsibility for successful deployment [Kig96, Shi02]. The notion of end user buy-in seems to have been replaced by the increased attention paid to the need for training. In the absence of end user buy-in throughout the project, authors have argued that attention needs to be given to training, which will increase user confidence and reduce any delays in warehouse operability [Mar01, WAW01]. Although, the needs of end users must be evaluated in order to provide appropriate training and continued support [CSM00].

The sharp reduction in interest in that fact that data warehouse projects 'must fit with corporate strategy and business objectives' is extremely important. An organization implementing a data warehouse must have a clear business purpose and view the technology as an enabler of improved decision making and business development [Fol97, Kig96, RhM95]. Reduced attention to this area suggests that either data warehousing is routinely incorporated within strategic plans or organisations no longer place a strategic value on warehousing. The increased attention to management buy-in suggests that business purpose may be missing. Perhaps data warehouse project teams now perceive success as simply the ability to

implement the data warehouse on time and that the fit with business strategy and objectives is no longer a success factor. This argument is supported by the increased focus on delivering an acceptable return on investment [Whi03], which shifts the emphasis on to users and their immediate management to deliver payback from the data warehouse investment.

Pre 2000, little reference was made to the political behavior of people involved in data warehouse projects. Today, there is open acknowledgement of the importance of organizational politics in warehousing projects. However, it is not surprising to find that there is also very little information about the nature of political behavior, except that politics prevent the required level of cross functional cooperation at executive or operational levels [MaF01,Tre01, Mar01, WiW01]. Barriers may be put up to protect organizational fiefdoms [TeA00]. Despite this, it is clear that organizational politics play a significant role in the development of data warehouse projects and reinforces the belief that the problems encountered in data warehouse projects tend to be business issues and not technical difficulties [SaF00].

Best practice for implementing a data warehouse provides a guide to the potential pitfalls in data warehouse developments but as previously stated, it is the business issues that are regarded as the key impediments in any data warehouse project. This may be reflected by the poor level of management buy-in although; management may be unable to buy-in to data warehousing until the business purpose has been clearly presented. These issues are likely to have an impact on the success of data warehousing for both the short and long term. If there is no alignment between the technology and business purpose, how do organisations measure success? IT departments would regard success as being measured in terms of the timely implementation of the technology and within budget. The business on the other hand, may have a different perspective. If the organization has not paid enough attention to the business application of data warehouse technology it will undoubtedly become more difficult to measure success.

Return on investment (ROI) is one method of measuring success and appears to be used by many organisations as it satisfies a need to justify capital outlay in the short term. However, it is difficult to put a financial value on an intangible benefit such as data or information [SaF00, WAW01], despite the courses and tools supplied by organisations such as the Data Warehouse Institute, NCR and Oracle that have been designed to help overcome such problems. Kaplan & Norton [KaN96] are clear about the problems of using short term measures such as ROI to measure data warehousing success: “an overemphasis on achieving and maintaining short term financial results can cause companies to over invest in short term fixes and to under invest in long term value creation, particularly in the intangible and intellectual assets that generate future growth.”

The increased use of ROI indicates that organisations may be taking a short term view of their data warehouse investment. Longer term success needs a forward thinking approach that aligns data warehousing technology with an organization’s strategic ambition. Measuring success in these terms is significantly more complex than merely measuring the payback on a particular investment. Longer term success is dependent upon the organization’s ability to use the data warehouse to fulfill strategic milestones. We know that measurement systems exist that may be designed to take care of short term business performance such as Kaplan and Norton’s [KaN96]

Balanced Scorecard. This is based on measuring performance across four business perspectives: financial, customers, internal business processes, and learning and growth. Measurements in these areas help to focus companies on the most important company wide issues that are key indicators of their performance against strategic plan. The problem is finding a method that allows an organization to anticipate and therefore plan for the changes that data warehousing can bring to any organisations that view data warehouses as strategic tools. If this is known then it will be possible to use short term measurement tools more effectively to assess the contribution of data warehousing to the strategic plan.

The following case study demonstrates how data warehousing can change the way a company operates and enable strategic objectives. The organization's experiences are mapped to the configuration school of strategic management, which provides a framework for examining an organisations purpose, support structures and subsequent transformation processes. This provides a rationale for the degree of success enjoyed by the organization in question.

3. Case Study

The case study [CWW00] demonstrates that data warehouses can be aligned to organization's strategy and illustrates that while the data warehouse is a key component of the organization's plans, many areas of the organization are affected by the changes heralded by data warehousing.

3.1 First American Corporation

In 1990, First American Corporation (FAC) lost $60 million and was operating on letters of credit. The executives knew that they had to change their strategy and attempt to compete with other financial organisations on terms that were more favorable to FAC. This resulted in the adoption of an ambitious customer relationship strategy, Tailored Client Solutions (TCS). Data warehousing enabled the organization to extract good quality customer data, which supplied the knowledge to customize products that would be more desirable and offer them via preferred distribution channels. In addition to extensive customer information, the data warehouse was designed to supply product profitability information, together with distribution channel data and revenue costs, as the organization had to justify its business activities on financial terms.

It took just over two years from initial strategy conception for the extent of the TCS strategy to be unveiled to the organization as a whole. This rather cautious approach was attributed to the executives' concerns that elements of their strategy had to be proven in order to secure broader organizational acceptance. However, the executives were committed to the strategy and took time to appoint the right person to the position of Head of Marketing as the appointee had the responsibility of developing the customer focus theme into cohesive business strategies. The TCS strategy itself was comprised of four customer focused components; client information, a flexible product line, consistent service and distribution management.

The bank's structure, processes and policies were adapted to ensure that the new strategy could be fulfilled.

The data warehouse was an essential strategic investment that had to be implemented before FAC could fulfill its strategic ambitions. However, implementing the technology was not a simple exercise as FAC's IT department initially attempted to build a data warehouse and failed. NCR, a data warehousing technology supplier, were subsequently engaged to deliver an IT solution that would supply both the data warehouse technology and consultancy expertise. NCR's consultants and FAC's IT staff worked together to develop the data warehouse, which was implemented incrementally with the first phase being released in the first quarter of 1996 and regularly thereafter until the fourth quarter of 1998.

The alignment of data warehousing technology with strategic ambition was coupled with considerable organizational change and restructuring. The success that FAC subsequently enjoyed can be measured in terms of survival and the fact that a $60 million loss had been transformed into a $211 million profit in 1998. There is no reference to ROI as there is no value in attempting such a calculation. As A. Morris [Mor00] states: "A good data warehouse project, like any other project, should not need to justify itself. The advantages should be self-evident. If they aren't, then it either needs to be dropped, or you need to get the message across better".

Whilst this may be the case, there exists a need to understand what FAC did that made it so successful. We know that the investment in a data warehouse was a fundamental necessity for such an ambitious strategy but that does not, in itself, explain the degree of success. The configuration school of strategic management offers a potential solution. Success on this scale is the result of the organization's ability to transform from one configuration to another that is designed to maximize the potential of data warehousing.

3.2 Theoretical Model – Configuration School of Strategic Management

The Configuration School of strategic management has been summarized as follows: "One company can copy another's strategy. It can reverse engineer its technology and benchmark its systems. But it cannot copy the way strategy, technology, systems and routines are configured into a thematic, synergetic whole. It is this complex configuration among the parts that constitutes the most vital source of competitive advantage", [MiW99]. An important point to note is that the Configuration School does not disregard the other schools of thought such as Positioning or Planning Schools, but accepts that organisations will utilize management practices from the various schools that are deemed suitable at a given time. The result is that organisations evolve into unique entities. For example, there are many banks servicing the UK marketplace while operating within the same legal framework but each bank's composition is unique.

According to Mintzberg *et al* [MAL98] the Configuration School has two distinct aspects:

1. The organization's state and surrounding context (configuration)
2. The strategy making process (transformation)

Based on this, the form that an organization takes depends upon the resources available to the organization and the many influences that affect the organization's constitution. The result will be that the organization has been configured in a unique fashion that makes it as effective as or more effective than other organisations in the same market place. This configuration will evolve over time and move through different 'states', 'periods' and organizational 'life cycles'.

Miller and Whitney [MiW99] elaborate on the first of the two Configuration School aspects, configuration. In their elaboration, configurations are described as 'constellations of organizational elements that are pulled together in a unifying theme'. There are two such constellations; the first is the 'core', which is comprised of the organisations mission, means and market. The second 'supports the systems, processes and structures that support the core'. Competitive advantage, it is argued, is driven from the synergetic relationship between the two constellations. The creation of configuration is where an organization makes choices about what it does, how it will pursue those decisions and making sure that the organisations' activities 'reinforce' each other.

Market forces generally alert organisations of the need to configure or reconfigure their operations in order to continue competing in their marketplace. Significantly for FAC, some configurations are borne out of crisis, which 'causes a theme to surface and forces the pieces of a company to adjust to one another', Miller & Whitney [MiW99].

3.3 Case Study Analysis

3.3.1 The Reconfiguration of First American Corporation

The FAC case study supplies sufficient insight to permit the mapping of their experiences to the configuration model of Miller and Whitney [MiW99]. The first part of the analysis examines FAC's fit with the core elements of mission, means and market.

MISSION - A Clear Set of Priorities and Goals that are Shared by Many Managers.

Although the mission statement is not available, we do know that FAC discounted a number of possible strategies such as becoming a low cost provider or focusing on product differentiation since they did not feel that they were in a position to compete on that basis. FAC decided to concentrate on competing on service and to do this; the company knew that it had to become 'intimate' with the customer in order to develop long standing and profitable relationships.

A customer focused strategy known as 'Tailored Client Solutions' set out the organization's priorities:

1. Client Information – know the client better than anyone
2. Flexible Product Line – provides what the client needs
3. Consistent Service – help the client achieve goals
4. Distribution Management – offer the client preferred channels

MEANS - Focusing Attention, Activities, and Resources for Attaining these Goals.

With customer intimacy as the organization's theme, FAC utilized data warehousing technology to; redesign products, amend its distribution channels, change processes to ensure consistent service levels, and develop detailed customer analysis.

The accomplishments of FAC fit very well with Miller and Whitney's assertions that means 'help define work', 'create unique products or services', 'reflect a central theme'. Indeed 'means must also incorporate methods of learning and improving'. It would appear that the continued development of the warehouse and ongoing learning associated to the evolving customer data analysis, contributes to this principle concisely.

MARKET - A Viable Target Audience that Values the Outputs the Means Creates.

In 1990, FAC had lost $60million and was operating under letters of agreement with banking regulators. By 1998, FAC had posted profits of $211 million, which is attributed to the means described above. There is no doubt that the market has responded to the products and services offered by FAC.

It could be argued that FAC's assessment of its circumstances and selection of a suitable strategy fits well with the Positioning School whereby strategies can be picked from Cost Leadership, Differentiation or Focus. In FAC's case, differentiation appears to match well as the customer focus option had not been attempted by any other bank. However, the Positioning School suggests that strategies are selected as a result of analysis and any decisions taken are based on the quantifiable. This does not fit with the experiences at FAC. The strategy selected was indeed one of rationalizing the situation but the executives did not have the comfort of rigorous analysis to validate their choices. Indeed, the strategy was new for a bank in that market, which suggests that the executives had arguably opted for an entrepreneurial solution.

The second part of the analysis looks at how well FAC managed its support structure. Miller and Whitney identified six areas that require attention in order for this 'bedding in' process to occur.

Directing Attitudes - Rituals and Ceremonies

Cooper *et al* stated that 'FAC concurrently developed the component parts of the strategy with each part providing significant financial impact. Once those component parts had been successfully implemented, the full TCS strategy was formally

announced. Using meetings and FAC's newsletter, the TCS strategy was communicated to everyone in the company'.

Directing Influence - The Power and Reporting Structure

The care taken in the appointment of a new Head of Marketing was a key statement of the bank's intention to move the bank from having a product orientation to one of customer centricity. The appointee had a clear remit and the power to develop the necessary strategies.

Directing Resources - Strategic Plans and Budgets

While no budgetary information is available, FAC took greater control over costs and any development work in support of the new strategy had to have a positive financial impact on the organization. FAC were acutely aware of their financial position and adjusted their financial controls accordingly.

Directing Attention - Information Systems

The data warehouse was crucial to the attainment of FAC's strategy. The data from the warehouse was used to design products, distribution channels and measure profitability. FAC understood the potential data warehousing offered and invested in the right technology with a clear and unambiguous purpose.

Directing Motivations - Recruitment, training, Promotion and Compensation

FAC recruited people not only with the right skills but also at the right time to drive the strategy forward. For example, new senior management were brought in to direct operations, NCR was engaged to deliver the warehouse and transfer skills to existing IT professionals while staff was assessed to establish competencies. Financial rewards had to be restructured to ensure that staff activities were in line with the organization's objectives.

Directing Effort - Administrative Routines

Staff had to adapt to new customer focused work routines. The data from the warehouse also helped the organization assess the type of skills and number of staff required for particular branches. This allowed the bank to tailor its corporate presence according to local customer needs. The extent of working practice changes was reflected in 100% staff turnover in some areas over a one year period.

3.3.2 The Transformation of First American Corporation

According to Mintzberg, transformation is the next logical step when an organization adopts a 'state of being'. The Configuration School regards change as a

'quantum' event where many things change at the same time in response to the organization's movement from one state to another.

As Cooper *et al* [CWW00] explain in their case study, FAC adhered to Kotter's [Kot95] top down approach to business transformation. However, FAC did not communicate the new strategic vision until the executive had sufficient confidence to do so. This is contrary to Kotter's belief that communication motivates those within the organization to act and carry the vision forward. Despite this deviation, FAC were highly successful in changing from a product to a customer focused bank.

This supports Mintzberg's view that successful transformation will happen if you set up the conditions for change and refrain from over managing the transformation process i.e. it is not essential to strictly adhere to the sequence of the change model. Mintzberg's Change Cube (Figure 3) also illustrates that change may occur at various levels in an organization from the 'conceptual' vision and culture to the 'concrete' products and people. This means that if an organization wishes to change the strategic vision and organizational culture, it will be necessary to change everything below that point of entry in the cube. The configuration model complements this approach since each of the items listed in the cube are accounted for within the 'core' and 'support constellations'. The configuration model can be said to create the conditions for change.

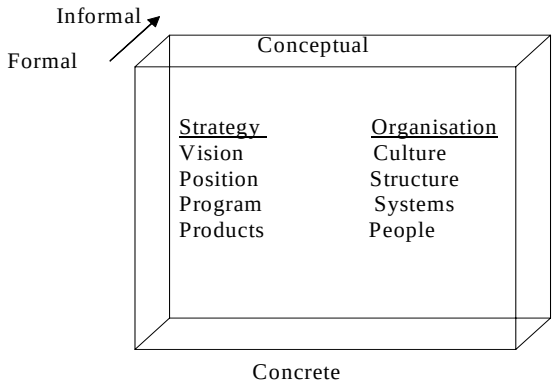

Fig. 3. Change Cube

4. Conclusions

Pre 2000, the majority of authors that contributed to 'Best Practice for Implementing a Data Warehouse' were clear that data warehouses had to fit with an organization's strategy and business objectives. Figure 2 illustrates that post 2000; the picture has changed as fewer authors feel the need to promote the strategic advantages of data warehousing. The impression today is that managers have to be encouraged to

buy-in to data warehousing and end users may becoming less involved than before, resulting in a loss of business participation during the implementation phase. The increased emphasis on the need to justify the investment by delivering an acceptable ROI indicates that some businesses need to be quickly convinced of the potential of data warehousing. In order to make a substantial contribution to the attainment of strategic objectives, senior managers must take a long term view of their data warehouse investment. However, as FAC demonstrated, changing an organization's course is not an easy task as many parts of an organization are affected by change of this scale. The alignment of data warehousing to strategic goals played a significant part in the bank's turnaround but it was the configuration school that demonstrated that successful alignment affects many parts of an organization. Once the core elements of the configuration have been selected, it is essential that the entire support network of the organization is tuned to complete the organisations configuration. The mapping of FAC experiences to the configuration model illustrates that data warehousing permeates through the configuration's core and support elements. Organisations that regard data warehouses as enablers of strategic vision ought to take a holistic approach in assessing the impact that the data warehouse is likely to have on the organization. The configuration model discussed in this paper provides a framework for such an approach.

Organisations must also be aware that the process of configuration will eventually result in the company's transformation from one strategic path to another. FAC's transition followed Kotter's top down change model almost perfectly. The fact that FAC were unaware of Kotter's model is testament to Mintzberg's assertion that change does not need a great deal of management. Again, the configuration framework contributes to the transformation process by setting the right conditions.

References

[CSM00] L. Chen, K. Soliman, E. Mao, and M. Frolik, Measuring user satisfaction with data warehouses: an exploratory study. *Information & Management* Apr 2000 Vol. 37 No. 3 pp103 – 110.

[CWW00] B. Cooper, H. Watson, B. Wixom and D. Goodhue, Data Warehousing Supports Corporate Strategy at First American Corporation (FAC). *MIS Quarterly* Vol 24, No. 4, Dec 2000, pp 547 – 567.

[Fol97] J. Foley, Data Warehouse Pitfalls. *Information Week* 19th May 1997 pp 93, 94 & 96.

[KaN96] R. Kaplan, D. Norton, The Balanced Scorecard. *HBS Press* 1996, pp 21 – 24, 38 – 40.

[Kig96] B. Kight, The Smart Way to Build a Data Warehouse, *Datamation*, Oct. 1996 pp91-94.

[Kot95] J. Kotter, D. Cohen, Leading Change. *HBS Press* 1995.

[Mar01] D. Marco, Top Mistakes to Avoid when Building a Data Warehouse. *The Data Administration Newsletter* July 2001.

[MaF01] W. Marks, M. Frolick, Building Customer Data Warehouses for a Marketing and Services Environment: Case Study. *Information Systems Management* Summer 2001, pp 51 – 56.

[MiW99] D. Miller, J. Whitney, Beyond Strategy: Configuration as a Pillar of Competitive Advantage. *Business Horizons* May / June 1999, Vol. 42, N. 3, pp 5 – 17.

[MAL98] H. Mintzberg, B. Ahlstrand and J. Lampel, Strategy Safari. *FT Prentice Hall* 1998, Chapter 11, pp 301 – 348.

[Mor00] A. Morris, Thar's gold in them hills. *Application Development Advisor* January – February 2000, pp 66 – 69.

[Don02] A. O'Donnell, Rethinking data warehousing. *Insurance & Technology* May 2002, Vol. 27, No. 6.

[Pau97] L. Paul, Anatomy of a Failure. *CIO Magazine*, November 1997.

[Rob96] T. Robinson, To Avid Pitfalls, Walk Before You Run. *Software Magazine* October 1996.

[RhM95] D. Rhodes, B. Mehta, Customer Information: Turning Ore into Bullion. *Boston Consulting Group* 1995.

[SaF00] D Sammon, P. Finnegan, The Ten Commandments of Data Warehousing. *Database for Advances in Information Systems* Vol 31, No. 4, 2000, pp 82 – 91.

[Shi02] B. Shin, A Case of Data Warehousing Project Management. *Information & Management* Vol 39, No. 7, July 2002, pp 581 – 592.

[TeA00] T. Teo, J. Ang, Building a Data Warehouse at the Housing Development Board. *Database for Advances in Information Systems* Vol 31, Issue 2, Spring 2000, pp 35 – 45.

[Tre01] A. Trembly, Technology is not to blame for data warehouse failures. *National Underwriter* November 2001.

[WAW01] H. Watson, D. Annino, B. Wixom, K. Avery and M. Rutherford, Current Practices in Data Warehousing. *Information Systems Management* Winter 2001 pp 47 – 55.

[Wei02] R. Weir, Best Practice for Implementing a Data Warehouse. *Journal of Data Warehousing* Vol.7, No. 1, Winter 2002, pp 22 – 29.

[Whi03] B. Whittemore, The Business Intelligence ROI Challenge: Putting It All Together. *Journal of Data Warehousing* Vol. 8, No. 1, Winter 2003, pp 4 – 10.

[WiW01] B. Wixom, H. Watson, An Empirical Investigation of the Factors Affecting Data Warehousing Success. *MIS Quarterly* Vol 25, Number 1, March 2001, pp17 – 41.