Continental Airlines Continues to Soar with Business Intelligence

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Abstract As the business intelligence industry matures, it is increasingly important to investigate and understand the nature of mature data warehouses. Although data warehouse research is prevalent, existing research primarily addresses new implementations and initial challenges. This case study of Continental Airlines describes how business intelligence at Continental has evolved over time. It identifies Continental’s challenges with its mature data warehouse and provides suggestions for how companies can work to overcome these kinds of obstacles.

Keywords data warehousing, business intelligence, maturity model, case study

We have a very mature data warehouse at Continental—we have been doing business intelligence for a long time, about a decade. New ideas for leveraging the warehouse keep coming up as we continue to evolve. Many are not the kinds of major applications that would have justified our initial investment in warehousing. But, these are the kinds of things that create a constant return on our investment.

– Anne Marie Reynolds, Data Warehousing Director, Continental Airlines

Much has been written about the potential for data warehousing; how to build a data warehouse; and how some companies are benefitting from business intelligence; but most of the writings have been focused on companies’ initial experiences. Data warehousing is known to be a journey, not a destination. Although it clearly is important to start off strongly, it is equally important to know how to move ahead over time. Managers need to understand how to evolve data warehouse initiatives to meet the changing and growing needs of the business. Companies need to continuously extract value from their significant on-going warehousing investments.

On a journey, if you know what lies ahead, the more apt you are to overcome obstacles and take the most satisfying route. In data warehousing, many folks are blind to what lies ahead when they begin. We have much to learn about the opportunities and challenges posed by a mature data warehouse. How do early decisions, such as data modeling technique or platform selection, impact later capabilities? What mechanisms best enable a warehouse to expand its reach and business impact? What obstacles do warehousing teams need to overcome over time? Answers to these questions may better guide even the most adventuresome of warehousing journeymen.

To explore these questions, the authors conducted a series of interviews with business intelligence users and technologists at Continental Airlines. The airline has had a data warehouse in place since 1998 and is considered a leader in business intelligence (Watson, Wixom, Hoffer, Anderson-Lehman, & Reynolds, 2006). Over time, the warehouse has grown and evolved in exciting ways, spreading out across the enterprise’s business areas and geographical locales. Applications have moved from being strategic and tactical in nature to ones that are highly operational. The numbers of users, applications, and data increase annually.

In this article, we begin by discussing the characteristics of a mature data warehouse. The characteristics are drawn from the maturity or stage models that have been developed for data warehousing. Next, we describe the current state of Continental Airlines’ data warehouse, highlighting evidence of the warehouse’s maturity. Then, we discuss three ways in which Continental has expanded the reach of its data warehouse, and we explore the mechanisms that enabled the expansion. We
conclude with challenges that Continental now faces with its mature data warehouse and with some suggestions for how companies can work to overcome these kinds of obstacles.

**Mature Data Warehouses**

An organization does not develop a mature data warehouse overnight; rather it is the result of a progression through a series of earlier stages. It is rare that a warehouse skips stages. Each stage builds on a previous stage and provides a greater set of capabilities. A “mature” warehouse is one that has evolved to the point that it is part of the institutional fabric and integral to the functioning of the organization.

In order to better understand mature data warehousing, it is useful to step back and look at antecedents of the concept. Maturity, stage, and evolution models, as they are variously called, have been popular in disciplines for many years. The fundamental concept is that things change over time, in sequential, predictable ways. Stage models have been used to describe, explain, and predict organizational life cycles, product life cycles, and biological growth. They also have been popular in the information systems field. The classic model is Nolan’s Stages of Growth Model that identifies specific characteristics that firms demonstrate as their IT departments mature (Nolan, 1979).

Though various stage models may differ in terms of the number of stages and what the stages are called, they are all similar in that they break down a phenomenon’s evolution into a series of distinct phases with characteristics associated with each phase. For example, Nolan originally had a four stage model (i.e., Initiation, Expansion, Formalization, and Maturity) that he later expanded to a six stage model to reflect advances in practice.

Each stage model is composed of component stage models, which collectively identify the stage of the higher-level model. For example, Nolan’s model includes dimensions of application growth, personnel specialization, and management techniques. Possibly, each of these components reflects a different growth stage; application growth may be mature, while personnel specialization is expanding. However, overall and collectively, the components define a stage of evolution.

The data-warehousing field also has maturity models. Watson, Ariyachandra, and Matyska (2001) suggest that business intelligence has Initiation, Growth, and Maturity stages. Eckerson (2006) proposes a five-stage model (i.e., Prenatal-Infant, Child, Teenager, Adult, and Sage). Each of these models uses characteristics or dimensions in categorizing the stages. For example, Watson, et al categorize the stages based on a data warehouse’s data, stability of the production environment, warehouse staff, users of the warehouse, impact on users’ skills and jobs, use of the warehouse, organizational impacts, and costs and benefits. Eckerson uses scope, funding, warehouse staff, governance, standards, architecture, executive perception, data latency, and business intelligence focus. Together, the models provide a comprehensive list of characteristics to use in categorizing various maturity stages; see Figure 1 for a list of characteristics of data warehouses in mature stages.

The research around these models teaches us that maturity is an elusive state. Often, maturity means that an organization repeats and likely improves upon what has worked well in the past in new areas of the organization. Maturity means that the initiative is part of the culture. There is learning from success and failure,

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<tr>
<th>Eckerson Maturity Model</th>
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<td><strong>Adult Stage</strong></td>
<td><strong>Maturity Stage</strong></td>
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<tr>
<td>• Scope. Enterprise</td>
<td>• Data. Enterprise, well integrated, for multiple time periods.</td>
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<td>• Funding. IT/Business.</td>
<td>• Architecture. Warehouse, with dependent data marts.</td>
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<td>• Team. Corporate IT.</td>
<td>• Stability of the Production Environment. Procedures are routine and documented.</td>
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<td>• Governance. Business Intelligence Stewardship Team.</td>
<td>• Warehouse Staff. Experienced in-house personnel, with well-defined roles and responsibilities.</td>
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<td>• Flexibility/Standards. Plan global, act local.</td>
<td>• Users. Organization-wide, suppliers and customers may be users.</td>
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<tr>
<td>• Architecture. Enterprise data warehouse.</td>
<td>• Impact on Users’ Skills and Jobs. Users throughout the organization need improved computer skills to perform their jobs.</td>
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<td>• Type of System. Strategic System.</td>
<td>• Applications. Reports, predefined queries, ad hoc queries, DSS, EIS, data mining, and integration with operational systems.</td>
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<td>• Executive Perception. Drive the business.</td>
<td>• Costs and Benefits. Benefits include timesaving, new, and better information, improved decision-making, redesigned business processes, and support for corporate objectives.</td>
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<td>• Data Latency and Freshness. Low latency, high freshness.</td>
<td>• Organizational Impact. Organization-wide and often strategic, tactical, and operational.</td>
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<td>• Business Intelligence Focus. What should we do?</td>
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**Figure 1.** Characteristics of mature data warehouses.
but also there is a perception of enough success that the initiative is allowed to continue and grow, until some radical event or new opportunity makes the initiative obsolete.

According to the characteristics listed in Figure 1, Continental Airlines has a mature data warehouse. The rest of the article will describe the warehouse, with a focus on its maturity in terms of the growth of its applications and usage. As data warehouses mature from an application perspective, their scope and reach increase. The warehouse delivers the most direct business value by maturing in this way.

**Continental’s Mature Data Warehouse**

Continental’s original data warehouse team was formed in 1998 and charged with integrating a diverse set of data from the key mainframe source systems throughout the company onto one platform. Two specific areas drove the original project: revenue management and marketing.

The Revenue Management department is responsible for determining the number of airlines seats offered at a particular price point (i.e. booking class) for every Continental flight. In 1998, they needed to capture detailed booking data at the lowest level of detail for analysis. Improvements in the ability to understand passenger behavior in order to optimize pricing decisions were expected to result in significant revenue opportunities for the airline.

At about that same time, the Marketing department needed to understand customers better. The existing frequent flyer system measured customer activity based on miles flown, but the Marketing department wanted insight into the revenue associated with each customer. They also wanted to know which customers were affected by flight delays and cancellations and other service interruptions. Understanding customers better was expected to improve Continental’s profitability and its ability to respond to customers’ needs, thus increasing customer loyalty.

A Teradata platform was chosen, primarily for scalability and ease of administration reasons. Even though two specific departments were funding the initial investment, the executive sponsors had the vision to conceive of a data repository that would ultimately encompass the entire population of corporate data required to support decision making, so scalability was critical.

Continental recognized the need and planned for real-time business intelligence at the outset of its data warehousing initiative. The warehouse group built a data acquisition infrastructure whereby source systems would feed a queue in either batch mode or in a constant flow. A warehouse loading process continuously monitored data sources and pulled data into the warehouse. The initial feeds of data were all performed in batch. Currently, fifteen percent of the subject areas are loaded continuously, yet the original data acquisition infrastructure is still a highly effective loading mechanism.

The data within the warehouse was modeled using a strict third normal form modeling technique, and the data used standard naming conventions. A dedicated and strong-willed database administrator ensured that there were few exceptions to these policies over time, regardless of short-term pressures. The intent was to create an underlying data layer that was not shaped by unique needs, but instead was kept “vanilla” so that it could easily evolve over time to meet a wide breadth of requirements.

The general philosophy was to grant users access to all data, unless there was a reason not to do so. Thus, when users received a warehouse ID, they immediately were able to access a common enterprise-wide data layer. Some data in the data warehouse, such as credit card numbers and employee salaries were restricted, for obvious reasons. This “open data” philosophy remains intact today.

By 2002, the Revenue Management and Marketing initiatives were successful, more than offsetting the data warehouse investment (see Anderson-Lehman, Watson, Wixom, and Hoffer, 2004). Both functional areas worked with the data warehouse team to calculate and document the most tangible and significant benefits, which established credibility for future funding.

Over the nine years that the data warehouse has been in existence, the scope has grown to include more than 50 subject areas and 1400 named users writing ad-hoc queries. In addition, the data warehouse is the “single source of the truth” for 70 applications developed by Continental. These applications fall into three general categories (see Figure 2).

In 2007, the Continental data warehouse had truly achieved a global scope. About half of the user community accesses the warehouse from the company headquarters in Houston, while the other half is spread across 75 cities throughout the world. The data warehouse staff has conducted international training sessions in London, Guam, and Tokyo, which are some of the airline’s centers for international sales and pricing; and there are plans to visit Latin America. These user groups are becoming data warehouse analysts, rather than simply consumers of prewritten reports.

A team of 15 people supports the Continental data warehouse, and this group is responsible for the data transformation development, application interface development, user support and training, database administration and production support. The 24 × 7 production support is shared by all of the members of the group and rotated weekly. Production incidents are reviewed each week to ensure that the root cause of each incident is addressed.
The data warehousing team size remains relatively small because application development is primarily done within the functional areas. Each department has at least one fairly technical employee who serves as a liaison between the warehouse group and the department. This employee ensures that the appropriate business needs are communicated to the warehouse group; he or she builds warehouse queries, reports, and/or applications for use within the department.

Initially, a steering committee prioritized warehouse initiatives and actively managed the warehouse evolution; however, once the enterprise data foundation was firmly in place and new projects became more focused on niche functional needs, the steering committee evolved into an advisory body. The warehouse management now prioritizes projects, with input from steering committee members. Annually, the warehouse management presents the core development projects to upper management for approval.

The funding model for the warehouse also changed over time. Initially, areas like revenue management and marketing built a business case for the warehouse and provided its funding. Each time the warehouse required a significant upgrade to the infrastructure, a different functional area would make the necessary investment although all areas would benefit. A significant shift occurred recently when the warehouse director secured a multi-million dollar capital investment for the warehouse through the IT budget. The belief is that the warehouse has become a critical part of the IT infrastructure and should be funded as such.

**Application Maturity**

Over time, Continental's data warehouse application portfolio has grown, and with this growth Continental has realized considerable business value. The airline has generated warehouse application growth in three unique ways: by constantly adding new business groups to the warehouse user base, with new applications to meet their needs; widening the user base across the globe; and integrating warehouse capabilities into operational business processes. The following sections provide examples of how each type of expansion has occurred.

**Enterprise Expansion**

One way to expand data warehouse applications and usage is by increasing the number of departments or sub-groups that use the warehouse. Initially, the revenue management and marketing groups championed the development and use of the warehouse. Over time, usage spread to other groups, such as Human Relations and Technical Operations. The following sections describe how this expansion occurred.

**Payroll Department**

Continental, like many organizations, has legacy systems that are cumbersome to use for querying and reporting. Processes that require data from legacy applications often are time-consuming and require manual intervention. For example, prior to the data warehouse, a person in the Payroll Department was responsible for ensuring that the amount Continental is billed for benefits matches the amount of benefits actually being used by its employees. Each Monday, this employee received a benefits report and then worked all week to reconcile the numbers.

Being a part of the overall Human Relations (HR) Department, Payroll had watched the HR area leverage the data warehouse, and over time, the Payroll Department began to realize they, too, could tap into warehouse data for their own needs. At first, paycheck information was loaded into the data warehouse. The group created simple queries...
against that data to review payroll data. This was easy for Payroll as the users were already familiar with the data. “Once we were comfortable with that, we started realizing we could get a lot more out of the data warehouse. That is when we started thinking of having the data warehouse do some payroll calculations for us.” Currently, the warehouse group is designing a data warehouse report to perform benefit deduction reconciliations against YTD coverage information from Continental’s Benefits Provider. This one task will free up an employee to spend his week doing more value-added tasks for the department.

And, there are additional plans for the data warehouse. Payroll is working to transfer time and attendance data to the warehouse to meet more unique departmental needs. The current goal is to be able to input an employee number and immediately have access to all related HR data so that the group can answer employee questions within the duration of a phone call. Once time and attendance data exist in the warehouse, Mullan predicts that the company as a whole will have the capability to even better understand what happened at the airport on a specific date. “The more data we put in for ourselves, it seems like other divisions get more and know more about how things are happening at the company level.”

Reliability Engineering Department

Reliability engineers currently are moving their processes from a legacy COBOL Focus system to queries and applications based on the data warehouse. Reliability engineers ensure that the Continental fleet operates reliably, and they work to reduce delays, cancellations, and aircraft returns. Although their previous Focus system was highly useful, it was extremely costly to use. EDS maintained the system as an outsourcer, so each time the engineers asked for a report or query in the past, they had to write a check to EDS. Continental as a company began to push the group to lower costs; the data warehouse offered the engineers a much better value proposition, with expected savings of about $100,000 annually.

The engineers also anticipate that the warehouse will increase their capabilities. The Focus tables had a very narrow scope; the warehouse allows reliability engineers to join tables like never before possible. The engineers suspect that having access to a larger scope of enterprise data may allow them to tap into special needs, some that currently may be unknown. “The warehouse should allow us to think outside the box . . . or think into a different box.”

Although the reliability engineers are still in transition over to the warehouse, they have used it enough to believe in its value. Recently, Reliability Engineering received a call from a related area within Technical Operations, inquiring about options for storing their data. “We recommended that they go with the data warehouse,” explains a Sr. Systems Analyst. “The warehouse group is knowledgeable and easy to communicate with. They generally recognize what our role is at Continental and what our needs for the data are. They provide data access pretty rapidly.” The data warehouse group’s high level of service and close working relationship with Reliability Engineering, along with the warehouse’s value proposition, will encourage the reliability engineers to recommend that others also leverage the data warehouse.

Enterprise Expansion

Continental continuously adds new organizational groups and users to the warehouse, and this happens in a fairly predictable way (see Figure 3). First, an organizational group observes a related area using the data warehouse to do things easier, cheaper, or better. Typically, the groups rely on similar kinds of data and systems; therefore, it is reasonable to deduce that if the related area is leveraging the warehouse, then the new group can derive value from the warehouse as well. Next, the group begins by asking simple data queries of known data. This important step builds user skills, confidence, and trust in the data warehouse. Finally, the group fully leverages the warehouse by developing custom applications based on the warehouse and by designating a liaison within the group who will ensure that business needs align with the data and capabilities of the warehouse.

Global Expansion

A second way to expand data warehouse applications and usage is by rolling out applications globally. The initial warehouse applications were headquarters-centric; they best met the needs of employees based in Houston. At times, these same applications also served global needs; but this was not always the case. The
following sections explain how Continental was able to engage international areas to leverage warehouse capabilities.

Revenue Management, Japan

Aaron Sacharski, Continental’s manager of pricing and revenue for Asia Pacific, began working for the airline in its Headquarters Revenue Management group in 2002. When Aaron arrived, Revenue Management was heavily involved with the data warehouse, using it to make micro and macro types of decisions. The warehouse enabled important capabilities; its value to the Revenue Management group was obvious. During this time, he met people in the data warehouse group and built up his own querying and data analysis abilities.

In 2005, Aaron moved to Japan to manage pricing and revenue for Asia Pacific, fully intending to continue leveraging the data warehouse in his new role. Two obstacles hindered his progress. First, the technical environment in Asia was not as mature; bandwidth was narrow, and software and hardware were expensive.

The second and most challenging hurdle was that the data, queries, and analytics that worked at headquarters were not applicable to the Asian market. For example, in Continental’s domestic market, there is a smooth booking curve that can be analyzed to predict flight demand behavior. In Japan, there is a high percentage of travel agent bookings, and agents are not required to migrate their bookings to the Continental reservation system until 30 day prior to departure. Thus, until a month in advance, analysts have minimal knowledge of flight bookings; it is nearly impossible to create a demand curve based on current flight booking data.

Another reason that Japan analysts could not effectively use data, queries, and analytics from headquarters was the time difference. Some of the data warehouse revenue management tables used to predict future bookings were populated by batch loads each night at midnight. This was fine for analysts located in Houston, but the data was not as useful to analysts in Asia who received the data a day and a half later.

For these reasons, the analysts in Japan perceived that the warehouse could not meet their unique needs, and there was little interest to learn about the tool. Aaron, however, had deployable knowledge of the warehouse data acquired in Houston. Although the existing techniques from Headquarters did not fit Asia as well, Aaron used his data warehousing knowledge in working with Japan to identify data that could improve pricing and revenue decisions.

Since 2005, the Japan pricing and revenue management team worked in earnest to understand what warehouse tables were relevant to Japan, and a warehouse team member built specialized tables to directly meet their needs. They began to develop queries using PNR (passenger name records) data because it is loaded into the warehouse in real-time. At the same time, the technology group for Asia invested in extra bandwidth for the analysts to improve querying efficiency. As the warehouse increasingly helped the group to make better decisions, usage of the warehouse spread.

Tax Department, London

In the United Kingdom, Continental must pay a departure tax for passengers who leave the U.K. on Continental flights. Each month, employees in the London office calculated this departure tax by manually reviewing the records for every passenger who traveled out of London, and the employees submitted the appropriate amount to the government. If passengers are passing through the U.K. in less than 24 hours, they are exempt from the tax, but the manual process could not always identify those individuals. Thus, Continental regularly overpaid the departure tax, which equated to a $300,000 annual cost for the airline.

Last year, several members of the Continental London office were visiting Houston for routine training, which included a presentation by the warehouse group. During the presentation, the London employees noticed that data in the warehouse potentially could identify passengers who were exempt from the departure tax. They approached the warehouse team to build a specialized application. Now, the group runs a monthly query to the warehouse, prints out a report with an accurate departure tax amount, and submits the report. The application eliminates significant time and overpayment.

Global Expansion

The global spread of warehouse applications begins with the development of core capabilities in a headquarters or central locale. As skills in the base location mature, employees transfer knowledge by physically transferring to global locations or by conducting training programs for global groups. Seasoned warehouse users can use their strong skills to identify gaps between existing warehouse capabilities and unique global needs. Over time, applications can be developed to meet those unique needs. This builds confidence in the warehouse by global users and encourages use. Figure 4 illustrates the global expansion process.
A third opportunity for expansion includes changing processes, looking for ways in which warehouse data can change the way business is done, making things easier and faster—or doing things differently. Potentially this kind of change can create a competitive edge for Continental.

Reservation Complaint Handling

In the past, when a customer called a Continental reservation agent with a complaint, the agent would simply listen to whatever the customer told them and send the information through an antiquated communication process to the Customer Care department. Members of the eighty-person Customer Care team would then take the information, print it, scan it, re-key it into a customer care system, and then work to resolve the case. The process was time consuming, and it left open the possibility that customers could game the system and receive duplicate compensation for the same incident. Continental estimates that this duplication cost the company $1 million annually.

Other airlines have addressed this issue by only allowing customer complaints via web or email; complaints are no longer accepted by phone. Continental has a different approach:

*If the customer is calling us with a complaint, then they want us to listen to them. If we can put in place a process that reduces the overhead and so streamlines the process that literally there really is no reason for us to discontinue telephones as a channel for customers to communicate to us, we are better off.*

- John Brinker, Senior Manager CRM Strategy and Architecture

Continental created an automated process that takes a variety of data inputs from the warehouse, runs those inputs through a proprietary rules engine, and generates a recommendation on how a particular customer should be handled (see Figure 5). A reservation agent can trigger this process while a customer is on the phone, and act on the automated recommendation, which is available within seconds. The automated process eliminates several steps from before, and it has reduced the customer-care group count by ten people. This new process reduces costs so that Continental can continue serving customers in a manner that meets customer needs. The customer complaint application is now in pilot with 50 reservation agents, and will be rolled out to the entire Reservations department in Q3 2007.

Flight Performance

Prior to the data warehouse, Continental Operations built and managed their own information and reporting systems. The systems support staff was very small; when a support employee went on vacation or was sick, systems were put on hold until the person returned to work. Eventually, management mandated a move to the warehouse to improve continuity of the support operations.

Steve Hayes, a manager within this operations support group, has leveraged the warehouse for his area in significant ways. For example, he has built a real-time status application that communicates up-to-the-minute performance statistics on how the airline is operating. And, when Jet Blue and American Airlines were criticized for incidents that involved stranding passengers in planes for long periods of time (Cummings, 2006; Zeller, 2007), Hayes was able to adapt his application, and help Continental avoid similar situations. Continental’s old process for detecting these kinds of events was manual and time consuming. Hayes explains, “You had to hunt and peck through flight logs. In the middle of a snow storm, you don’t have time to do that.”

Once Operations identified the need to monitor planes on the tarmac, Steve added an alert to the real-time performance statistics application. Now, flights that sit on the ground away from a gate for at least two hours immediately appear on the screen. In real-time, Operations can work to get those flights off the ground, or get them back to the gate in a timely manner.

The warehouse also has helped streamline Operations reporting processes. In the past, Continental manually tracked the reasons for flight delays (e.g., weather, part failure); there are about a hundred delay codes. Sometimes stations forgot to record the reason for delay, so Operations regularly ran a query on the legacy system, downloaded the results into Excel, emailed the results to the general managers, who would then fill in the blanks and send information back by email or telex. According to Hayes, “It would take
forever to track down the information and update the codes into the legacy system.”

Using the warehouse, Hayes built an application one weekend that automatically lists flights that need delay codes for each station. The general manager now directly logs into the application, clicks on a flight, and enters the delay code. The new process eliminates multiple steps, and creates much more accurate results. Hayes explains that this situation is representative of how he now can quickly develop simple applications or application enhancements using the data warehouse that have high impact to Operations processes.

### Process Expansion

Process change can be difficult because people often are reluctant to change. However, users are much more willing to embrace change when warehouse applications clearly reduce steps, eliminate costs, or save time. To recognize change opportunities, users must first understand the breadth of data that exists within the warehouse. Then, when key business needs arise, users can better match these needs to warehouse capabilities; at that point, they can leverage data for business process improvement, or even re-engineering (see Figure 6 for the steps of process expansion).

### Maturity Challenges

Maturity does not equate to easy. Thus, once organizations establish mature data warehouses, they should not expect a guaranteed smooth journey. Although early obstacles have been overcome, new challenges emerge as

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**Figure 5.** The warehouse-enabled customer complaint process.

**Figure 6.** Process expansion.
a warehouse matures. Below we discuss some of the maturity challenges faced by Continental.

Staffing

Only recently, since the mid-1990s, has database marketing gained a stronghold in the marketing industry. The supply of people who have database marketing skills, such as SQL and query writing, data warehousing, and an appreciation of data has not yet caught up with demand. Continental’s marketing group proactively hires people with those skills; in fact, new marketing employees must take an SQL test as standard operating procedures. But, the right hires are hard to find. And, once employees are hired and trained, they can be difficult to retain. Once employees develop strong analytical and data skills, they can leave for higher salaries and promotion opportunities.

The staffing problem is not limited to functional areas like Marketing; the IT group grapples with these same issues. Talented data warehouse professionals are valuable, and the turnover in the group has been fairly high. The warehouse management strives to address this by providing opportunities for cross training and advancement where possible, and to keep employees challenged.

Scalability and Performance

Continental currently views technology as a major hurdle for continued success. For one, applications, such as the customer complaint application, must perform quickly. Reservation agents are uncomfortable if their system does not respond in at least five seconds; thus, much effort has focused on ensuring the data warehouse can deliver fast performance. Global locations increasingly need to adapt their technical environments to expanding usage and more data moving across the network. In short, Continental understands that the data warehouse must be viewed as an operational tool. The warehouse team invests in significant hardware upgrades so that the processing power of the warehouse sufficiently meets usage requirements.

Data Volume

The expansion of warehouse usage and applications leads to a growing volume of data within the warehouse. Brinker senses that the incredible amount of marketing data can impede Marketing’s ability to perform true analysis. Large volumes of data are “hard to digest.”

This observation is consistent with the increased interest in predictive analytics within the data warehousing community. At the 2006 The Data Warehousing Institute conference, business leaders ranked predictive analytics as their number one area for opportunity in business intelligence. Predictive analytics may be one solution when data volumes grow too large for the human mind to manage.

Real-Time Data

Common wisdom says that as users become accustomed to business intelligence, they increasingly want to see data in real-time. Rarely do we think of global expansion as a driver of real-time data, but that certainly was the case at Continental. Batch loaded data was typically fine for analysts working in headquarters in Houston, but that same data did not meet the needs of analysts located around the globe. As organizations roll out applications, they must be aware of the latency needs of their analysts and impact of time zones on the freshness of the warehouse data. It may be that latency plans have to be “refreshed” with global expansion.

Business Continuity

Recently, the warehouse group scheduled a system upgrade that required a window for system outage. Bad weather was predicted for that same time period. Operations contacted the warehouse group and asked them to reschedule the upgrade; the warehouse had to be available for use during the bad weather to help Operations manage airline performance. The data warehouse was critical for managing the severe weather event.

The warehouse management acknowledges that business continuity and disaster recovery are clearly becoming mandatory now that the warehouse enables important operational processes. It costs a lot of money to maintain an alternate data warehouse location for an emergency, but if Operations needs the warehouse to manage a critical weather event, this implies that investments must be made in warehouse disaster recovery. The data warehouse management is still assessing the alternatives to address these issues.

Service Delivery

Initially, the warehouse team developed the applications for the warehouse users. The users were unfamiliar with data warehousing, and they had a hard time conceptualizing the kinds of applications that would be possible. Thus, the warehouse team used a prototyping approach to develop user applications for them. Sometimes the approach resulted in applications that were highly successful. Other times, the approach was unable to capture
the underlying user requirements; users found the application too hard to use, or not useful for their needs.

As the user skills around the data warehouse matured, the warehouse team moved away from application development, encouraging functional areas to develop their own warehouse applications when possible. Currently, the warehouse team plays much more of an advisory role, traveling around the world to educate users, listen to needs, and ensure that the warehouse remains relevant to the user base. This approach is highly effective. Functional areas perceive that the warehouse team delivers high quality service and responds quickly to their needs.

Conclusions

Although Continental continues to face challenges with its data warehouse, the organization has realized an enviable level of warehouse maturity. Continental realizes significant cumulative benefits from the use of applications that cross the enterprise, span the globe, and enable fundamental business processes.

Stage models are sometimes criticized for failing to explain how organizations move from one stage to another. The experiences at Continental, however, provide insights into what facilitates the movement into a mature stage, particularly from an applications and usage perspective. Several facilitators make the wide variety, growth, and spread of applications possible. We conclude by discussing and illustrating these facilitators, each of which are at their own stage of evolution.

A Culture of Data

Continental is fortunate to have a data-driven culture that was initially developed by former CEO Gordon Bethune and his management team back in the late 1990's. Employees across the enterprise view data as a corporate asset that can be turned into competitive advantage when used properly. Functional areas intentionally hire employees who will perpetuate this view. Thus, using the warehouse as a decision support aid is consistent with the fundamental employee mindset.

A Common Data Foundation

Continental warehouse users advise not to underestimate the value of standard naming conventions, a normalized data structure, and user-friendly metadata. Steve Hayes from Operations explains, "Uniform naming conventions across tables is a big deal. This means that I can access a table that I have never worked on before, but because we have standard naming conventions and a web-based data dictionary, I can determine the field's purpose, value, and be able to include it in my queries and reports." Warehouse management observes that the deeper and broader a users understanding of the data, the more creative and usefully the data is applied.

“Open Data” Philosophy

Most companies initially give users limited access to data in the warehouse, likely restricting access to a subject area or two most appropriate for their function. At Continental, the philosophy is exactly the opposite. When users receive a warehouse ID, they immediately have access to all data in the warehouse that does not require special permission. Although only some users can access human resources data or passenger credit card numbers, everything else is fair game.

This philosophy helps generate new uses for the warehouse. According to Brinker, "If I had not had access to the broad scope of information that was in the warehouse, I probably would have never drawn the conclusions that I did regarding how we could automate the customer complaint process." Brinker explains that in other organizations, a typical marketing user would have visibility only into the company's customer loyalty program, and he or she would not interact with operational performance data, check-in information, or passenger name records. Because Brinker did have access to the latter information, he was able to match the known business need of improving customer care with warehouse capabilities.

Business-IT Hybrids

In some companies, the warehousing staff has strong technical skills but limited business knowledge, and the business side has limited technical skills but good business knowledge. At the intersection of the warehousing and business organizations, there is a dramatic change in the technical/business skills and knowledge mix. At Continental, liaisons work in each functional areas and manage the communication between the warehouse group and business unit. These liaisons are highly technical people with deep functional area knowledge and expertise. They eliminate disconnects between the technology and business groups and ensure that the right business needs are met, in the right way.

Final Thoughts

As organizations begin or continue their data warehousing journeys, they are advised to assess the current maturity of their efforts, and then look ahead to better prepare
for what is to come. There is a chance that making the right moves now will avoid future missteps. Clearly, Continental provides excellent insights for warehouse journeymen, as the airline soars ahead with business intelligence.

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References

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