

U21Global

Working Paper

No. 003/2005

Fenton Online: An Instructional Case for Enterprise Application Integration

Wing Lam

April 2005



Fenton Online: An Instructional Case for Enterprise Application Integration

Wing Lam, Universitas 21 Global, Singapore ¹

wing.lam@u21global.edu.sg

ABSTRACT

Organisations launching enterprise-wide initiatives such as e-business, customer relationship management and supply chain management face a challenge of integrating multiple information system (IS) applications. In response, many organisations are turning to Enterprise Application Integration (EAI) and the associated EAI tools marketed by an increasing number of technology vendors to facilitate their integration efforts. This instructional case describes an authentic EAI project to integrate the IS applications at the mortgages division of Fenton Online, a provider of online financial services. The case first provides students with a brief introduction to EAI concepts. The case details, the main part of the paper, brings out several important issues in EAI, including the rationale for EAI, EAI project planning, EAI tool and vendor selection, business process analysis and EAI roll-out.

INTRODUCTION

Enterprise Application Integration

Application integration has become of major significance in many large organisations (Cummins 2002). This is particularly true given the prevalent interest in enterprise-wide solutions such as e-business, supply chain management (SCM), customer relationship management (CRM) and enterprise resource planning (ERP), which require integration between ‘islands of applications’ (Sawhney 2001) that have traditionally operated in isolation in their own functional silos (Pan and Lee 2003; Storey et al. 2000; Markus 2000; Jayaram et al. 2000; Themistocleous et al. 2001). Indeed, a study by research firm IDC (2002), based on 1,350 interviews, indicated that more than 80% of CIOs and CTOs believed integration was either mandatory for addressing mission-critical activities or a key enabler for meeting business-critical needs.

However, organisations face several challenges in application integration. First, the scale of integration and sheer number of applications to be integrated can be overwhelming. Second, the nature of applications to be integrated is usually quite diverse, including:

- ‘best of breed’ COTS (Commercial-Off the Shelf) systems, such as SAP R/3 and Siebel, procured to address a specific functional purpose,
- legacy applications based on older, mainframe technology such as CICS and MVS, that handle an organisation’s ‘back-office’ processing needs,

¹ Wing Lam is Associate Professor and Director, MISM Program at Universitas 21 Global.

- bespoke applications specifically tailored to meet the unique requirements of the organisation,
- database management systems such as Oracle and MS SQL Server, that manage an organisation's data assets

Individual applications often have significantly different underlying architectures, with some based on legacy and others based on more modern computing technology (Lam 2004). Third, older legacy applications may have been inherently designed to be standalone, or integrated with in only very limited ways. Unfortunately, replacing legacy applications, which represent huge investments in corporate knowledge, is not always desirable or feasible (Brodie and Stonebraker 1995; Robertson 1997).

It is therefore not surprising that both academics and practitioners are showing an increasing interest in Enterprise Application Integration (EAI). Kale (2000) refers to EAI simply as “the process of tying together multiple applications to support the flow of information across business units and their information systems”. McKeen and Smith (2002) provide a more elaborate definition: “the plans, methods, and tools aimed at modernizing, consolidating, integration and co-ordinating the computer applications within an enterprise”. Although EAI can be viewed as a ‘backroom technology’, the growing importance of integration means that EAI is now being seen as a strategic enabler for new business models and processes (Sharif et al. 2004).

Integration Architecture

EAI proposes an alternative architecture to how organisations may have attempted application integration in the past. Traditionally, organisations have integrated applications in a ‘point-to-point’ fashion where interfaces are directly crafted between applications. However, a limitation with this approach is that as the number of applications grows, the cost of building and maintaining a large number of interfaces becomes prohibitively expensive and often results in ‘spaghetti integration’ (Linthicum 2001). In EAI, this problem is addressed by the deployment of an integration broker that serves as a hub for inter-application communication (Lee et al. 2003; McKeen and Smith 2002). Figure 1 illustrates the difference in integration architecture between the point-to-point integration and the EAI approaches.

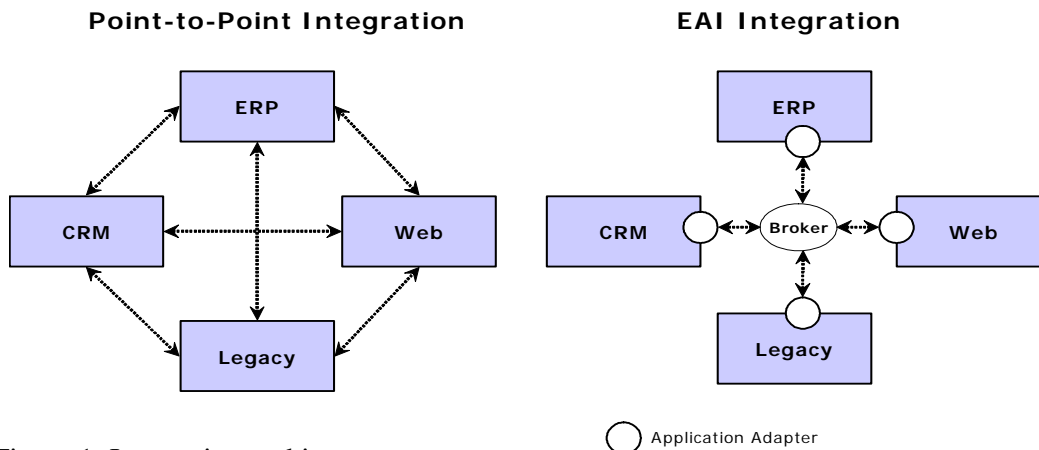


Figure 1: Integration architectures

Because each application need only be integrated with the broker, EAI integration significantly reduces the overall number of interfaces that need to be built and maintained. Furthermore, applications can be external to the enterprise, such as a supplier's stock control application, in an extended SCM solution.

EAI Tools

Unsurprisingly, there is a growing market for vendors (including TIBCO, IBM, WebMethods, SeeBeyond, BEA, Mercator and Vitria) selling EAI tools that support the creation, maintenance and administration of EAI integration architectures. Such EAI tools generally comprise of an integration broker, messaging middleware and pre-built 'adapters' that connect applications to the messaging middleware.

An adapter can be considered a kind of sophisticated gateway or wrapper (Brodie and Stonebraker 1995), enabling packaged, mainframe and other applications to be connected to the messaging middleware with little or no invasive coding or reengineering of the existing application. For example, there is a pre-built TIBCO adapter for the ERP application SAP R/3, which enables SAP R/3 to be connected to the TIBCO EAI tool. At a technical level, adapters typically make use of interfacing technologies such as application programme interfaces (APIs), SQL queries and even Web Services. For some type of applications, and in particular bespoke applications, pre-built adapters will not exist and there will be a need for organisations to write their own custom adapters using adapter development kits supplied by the EAI vendor.

The applications in an EAI architecture communicate with other applications by sending messages along the messaging middleware via the integration broker. The integration broker normally supports additional functionality, such as the translation of messages into different formats, transaction management and the ability to apply business rules and logic.

EAI Projects

EAI projects differ from traditional IS application development projects in several significant ways:

- EAI projects involve activities associated with application integration rather than the development of new applications.
- EAI projects require upfront strategic IS planning regarding what and how applications are to be integrated.
- EAI projects impact multiple applications existing within an organisation, and in particular, legacy applications.
- Because individual applications tend to have different owners and stakeholders, EAI typically involves collaboration and communication across divisional boundaries and stakeholder groups.
- There is a lack of established methodologies for EAI, unlike application development and software engineering.

It is therefore not appropriate for project managers to view an EAI project as simply another type of application development project.

An Instructional Case

The remainder of this paper presents an instructional case for EAI that introduces students to a range of issues relating to the justification, planning and management of an EAI project. EAI is a relatively new and emerging area of IS, so few cases of EAI currently exist in the literature. The case is based on the EAI initiative in a real company, although the actual name of the organisation, its demographics and the names of those involved in the project has been changed to maintain confidentiality at the organisation's request. Certain aspects of the EAI initiative have been deliberately left out in order to maintain a clear focus throughout the case and heighten its pedagogical usefulness. However, the description of the project in the case and the quotes used accurately reflect actual case materials such as project documents and interview transcripts. Students are therefore presented with an authentic case of EAI. Good practice for writing teaching cases (Farhoomand 2004; Cappel and Schwager 2004) was also observed in the preparation of the case.

CASE DETAILS: FENTON ONLINE

Company Background

The Fenton Financial Services (FFS) group has been providing corporate and consumer financial services across Europe for more than half a century. In 1995, at the emergence of the e-Business boom, FFS decided to spin-off a separate enterprise, known as Fenton Online (FO), to handle the provisioning of online consumer financial services under the Fenton brand. Headquartered in Ireland, FO operated in an autonomous manner and was free from many of the existing business, organisational, and technological constraints within FFS that might have otherwise held FO back from achieving the nimbleness required to be an e-Business market leader.

Organisation Chart

FO employs about 150 people. The organisation chart in Exhibit 1 shows FO's senior management team. Several members of FO's senior management team were seconded from FFS. Chris Halliwell is CEO of FO and was previously vice-president (VP) for consumer banking at Fenton Bank. Chris Halliwell is supported by Mike Goldberg, VP for the savings division, and Sally Roper, VP for the mortgages division. Both Mike and Sally oversee groups of about 30 staff each. Jane Watt is VP for customer services and oversees a group consisting of about 20 customer service agents. As chief information officer (CIO), Edwin Yeo is responsible for all of FO's technology and IT capabilities. Directly under Edwin, Peter Ross is head of the application development group, a team of about 40 IS professionals that handle the development and maintenance of all of FO's IS applications.

FO's Changing Business Strategy

FO launched its first online product, a high-interest savings account, in 1997. This was followed by a suite of mortgage products a year later. However, even after a two-year period of consolidation and active marketing, the combined revenues from these two products remained insufficient to cover FO's operational costs and doubts

were cast over FO's viability. In 2000, the board of FO comprised of Chris and other senior FFS executives re-examined FO's business strategy. Two strategic thrusts emerged from this re-examination, namely:

- 1) FO needed to expand its current portfolio of online financial products and services in order to position itself more prominently in the market.
- 2) In parallel, it was crucial for FO to strengthen customer relationships, become more customer-centric, and move from an organisation that offered singular financial products to one that offered its customers a comprehensive range of financial services.

In conjunction, Chris was also eager to expand FO's mortgages business, which was projected to grow between 15-20% in revenues annually over the next three years. The mortgage business represented FO's largest source of revenue, so Chris identified it as a high-priority area for improvements in customer-orientation

When FO first launched its suite of mortgages in the late 90's, the emphasis was on being first to market. FO had achieved this, offering online mortgages a year before any other major provider was able to do so. This enabled FO to gain first mover advantage, albeit temporarily, as by 2001, most financial institutions had caught up and were also offering financial products and services online, sparking a re-think in strategic emphasis at FO.

Chris (CEO): "The dynamics of the industry have changed considerably over the last 5 years. Today, people are no longer locked into mortgages for 25 years or more. Switching mortgage providers is now very easy to do. Also, customers have a much greater choice of mortgage providers to choose from, so the market is much more competitive. Customers can either get their mortgage from an online provider like FO, high-street bank or one of the main mortgage brokers. With a long-term product like a mortgage, having a good product is no longer sufficient to be competitive...the product must be sold and delivered in a high service-oriented environment."

Jane (VP Customer Services): "In the olden days of branch-based banking, bank managers knew their customers so were able to build relationships and deliver a high level of personalised service. In the era of tele-banking and e-business, relationship and high-quality customer services are still important, but organisations rely a lot more on technology. So when a customer phones in or sends us an email, it is important for us to have detailed electronic records of that customer's financial status and history at our finger tips so that we still provide customers with a personal level of service."

For FO, the strategic emphasis was changing from being first to market to that of offering the highest level of customer service in order to attract new customers as well as to retain existing ones.

Current IS Architecture

As an online provider of financial products and services, there was no question that technology was pivotal to FO's success. FO had created its existing IS architecture by using a 'best of breed' strategy to procure packaged applications that were best in their class. This enabled FO to rapidly build its IS architecture and avoid the long and often problematic development cycles associated with developing applications from

scratch. In FO's IS architecture, a total of fifteen different IS applications supported the major operational needs of the mortgages division. Five out of the fifteen applications were considered core applications because they served mission-critical business functions:

- 1) Financial portal: A web-based front-end application through which individuals can apply for mortgages online, and which existing customers can track their mortgage and savings accounts.
- 2) Mortgage management system (MMS): A packaged application that manages the workflow associated with the processing of mortgage applications. The MMS accesses back-end support services such as address and credit checks.
- 3) Account management system: A bespoke account management system written in COBOL ported over from FFS. Once a mortgage has been approved, an account is set up on the account management system.
- 4) Call-centre application: A customised version of the Siebel package, used by FO's customer service agents for handling enquires over the phone.
- 5) Mortgage products and quotation management system (MPQ): Another bespoke account management system ported over from FFS. The MPQ holds the product record for each type of mortgage offered by FO and also is also capable of generating mortgage quotations.

A more detailed description of the functionality of each core application is given in Exhibit 2. The remaining ten applications provide a variety of supporting back-end services such as auditing and data cleansing.

As is typical with a best-of-breed strategy, each core application had its own technology architecture and utilised its own set of databases to store data. Furthermore, the core applications were predominantly standalone in nature, and did not 'talk' directly to other core applications. Instead, where information needed to be exchanged between applications, batch processes would run on a regular basis to export data files from one application and import into another application. For example:

- A text file containing mortgage applications was exported from the financial portal and imported to the MMS at the end of each business day.
- An XML file containing customer profile information was exported from the financial portal and imported to the call-centre system at the end of each business day.

In addition, manual business processes existed in which staff would key data directly into applications where needed. For example, mortgage account details taken from the MMS were keyed directly into the account management system because neither a direct interface nor batch process existed between the two applications.

Limitations of the IS Architecture and Impact on the Business

While the current IS architecture had satisfied the needs of FO so far, Edwin (the CIO) acknowledged that with the new strategic emphasis on broadening the portfolio of financial services and enhancing of customer relationships and services, the limitations in the current IS architecture would need to be addressed. In a nutshell, the crux of the problem was the lack of real-time integration between individual IS

applications. Although the batch processes currently used by FO would be acceptable for periodic processing such as the generation of monthly reports, they were not deemed suitable for e-business. For example, the lack of integration had a direct effect on FO's customers and business in a number of ways:

Sally (VP Mortgages Division): "The financial portal is only a front-end for capturing mortgage applications. It is not until the following day that we can begin to process those mortgages in the MMS. Customers these days want as quick a turnaround on their mortgage applications as possible. That's what e-business is all about."

Jane (VP Customer Services): "Call-centre staff currently do not have a single, consolidated view of a customer or mortgage applicant. Siebel is a good tool, but call-centre staff still need to log into the other core applications to get information held in those systems. For example, they need to log into the account management system to get specific information about the current state of mortgage payments and the MMS to find out the status of a mortgage application. It's not an ideal scenario because it means that customers are kept waiting on the phone for a longer period of time than is necessary. This can be frustrating for the customer. The average length of each call is just over 3 minutes. We can reduce that if we had all the information available either in Siebel or a single tool. It also means that customers spend less time in the wait queue. At present, the average waiting time is 25 seconds. That's on-par with the industry benchmark, but we need to do better than that. It's not just about customer service though, it's also about operational costs and efficiency and call-centre productivity."

The lack of integration between the core applications in the IS architecture therefore limited FO from delivering the desired level of customer services. Indeed, behind the glossy veil of the FO Website, 'islands of applications' (Sawhney 2001) existed that reflected how FO's IS architecture had been rapidly assembled rather than strategically planned within a longer term vision.

Edwin (CIO): "When FO first began, the emphasis was on being first in the market to launch mortgage products online. We created the IS architecture within a short space of 8 months by acquiring the best packaged applications for each job, and keeping the level of custom and bespoke development work to a minimum. However, what we now need to do is to knit all our applications together in order to provide a seamless end-to-end process for mortgage processing and for delivering high quality customer services."

Given the new strategic emphasis, Chris gave the go-ahead for a major project to integrate all the core mortgage applications in FO. Chris set a 12-month timeframe for the project. Given the technology-driven nature of the project, overall responsibility for the project was given to Edwin Yeo. A steering committee for the project was established consisting of members of the management team and would meet on a monthly basis.

Feasibility Study

Edwin asked Peter to form a team to conduct a feasibility study to examine different options and provide recommendations for integrating the core applications. Peter asked two of his senior architects to conduct the study. Peter also enlisted the

help of Gerry Kaplan, an external consultant with significant application integration from one of the big 5 consulting firms to work on the study with the two architects.

The team looked at the feasibility of a point-to-point integration architecture, where the batch processes used to transfer information between applications would be replaced by a set of programmatic interfaces that could facilitate information transfer in real-time. However, the point-to-point integration architecture was rejected for the following reasons:

- A high level of custom development would be involved. A minimum of eight separate point-to-point interfaces would need to be written from scratch. For example, developers would need to write an interface between the back-end mortgage application and the legacy accounts management system.
- There was a high level of development risk. The legacy accounts management system was based on old mainframe technology and it was not certain that a robust integration interface could be built from scratch.
- There was a high level of business risk. It was envisaged that the existing applications would need to be taken offline for a significant period of time.
- It would take too long to develop all the interfaces, easily exceeding the 12 month timeline given to the project.
- The existing IS staff at FO had little experience of integration projects and lacked the necessary expertise to complete the project in-house.

The team agreed that a point-to-point integration approach had too many high-risk elements, and that an EAI solution appeared more appropriate.

Gerry: “FO’s IT architecture is constantly in a state of evolution. I know that individual applications will eventually be retired and replaced by better ones. However, what is really needed is an integration ‘backbone’ whereby applications can be ‘plugged in and out’. This will allow FO to easily retire or replace applications with minimal disruption other applications and to the overall business. The EAI approach seems very well-aligned for this purpose.”

The team recommended an EAI approach be used to integrate FO’s core applications. The team gathered marketing materials from the Web for several of the leading EAI tool vendors, and put together a description of how such tools could be used to provide an EAI integration architecture at FO. The report was submitted to Edwin and the senior management team.

Project Initiation

Having gained a clearer focus for the project, and with support from the Christ the CEO, Edwin asked Peter to proceed with the recommendations from the feasibility study. A core team of six individuals was assembled, including the two senior architects originally involved in the feasibility study, two business analysts from the mortgages division, and a customer services manager from the customer services division. Gerry was also retained on the project for his obvious experience of EAI.

Although at this formative stage of the project the exact nature of the EAI work was still being defined, Peter felt it was necessary to put forward a tentative project

plan that the team could work towards (Exhibit 3). The team had limited experience with EAI projects, so Peter depended heavily on Gerry's experience for advice on project planning. It was agreed that a checkpoint meeting would be held after the integration requirements gathering phase when a much clearer scope for the project was expected to have emerged and where the project plan could be revised if necessary.

Integration Requirements Gathering

Although the main parameters of what needed to be achieved was clear, more detailed integration requirements still needed to be etched out. A number of interview sessions were held with various project stakeholders, including members of the management team who had initiated the project in the first place. High on Sally's priority list was the turnaround time for processing mortgage applications and ability to handle higher volumes:

Sally: "At the moment, we take on average 10 working days to process a mortgage application from the time when a customer submits his or her application. That's puts us at average in terms of industry benchmark. However, we need to cut our turnaround time by a third, from 10 to 6 days, if we want to be ahead of our competitors. But we also need to be able to handle higher volumes. Right now, we handle about 120 mortgage applications per week. We need to be able to comfortably scale up from 120 to 300 mortgage applications."

From a technology viewpoint, it was important that the underlying architecture of the integrated solution was both stable and secure.

Edwin: "We need seamless integration and transfer of information between all core applications, and potentially the non-core applications in the future. We need a reliable and robust solution that gives a maximum level of uptime. When one application fails, we don't want that to have a knock-on effect on the other applications. The applications need to be integrated, but at the same time, the integration architecture should be fault-tolerant. Security is also an important consideration. We already have existing security policies place, so the integration of applications should not weaken the existing level of security."

It was also important that any integration work would have minimal disruption to business operations, i.e. there should not be an extensive period of downtime where customers would be unable to submit mortgage applications or carry out normal operations on the financial portal. Any such outage would be unacceptable to an e-business organisation such as FO.

Business Process Analysis

In conjunction with requirements gathering, there was also a parallel activity of understanding and analysing FO's business process. Although the team had been hand-picked for their intimate knowledge of FO's current business processes, they needed to synthesise their knowledge to establish an improved set of business processes that could be brought about by an EAI solution. The team started by examining the current business process and pinpointing areas of weaknesses. In particular, the reliance on manual processes was identified as a major area of inefficiency and error:

Team member: “Once a mortgage application has been accepted, a new mortgage account is created by viewing the customer details in the MMS and re-keying the data into the accounts management system. As a manual process, this is really tedious and error-prone. The manual processing also becomes a bottleneck when we launch marketing campaigns for new mortgage products. We get a flood of new applications and our manual processes just can’t cope. It can become really slow when staff take holiday or fall ill.”

In addition, data was duplicated in multiple applications, and manual processes were relied upon to keep the information consistent across each application. For example, when a customer phoned in with a change in their details (e.g. address), the customer service agents would enter this change into the call-centre application, but also needed to remember to re-key the new details into the financial portal. Also, when the processing of a mortgage had been complete in the MMS, staff had to manually set a flag on the financial portal. This was required so that the next time the customer entered the portal, they would see that a decision on their mortgage application had been reached. The manual processes were tedious and error-prone, and could, in some cases, lead to data inconsistencies across different applications.

Integration Architecture Analysis and EAI Tool Evaluation

Having more thoroughly understood the weaknesses in FO’s business processes, the team proceeded to more detailed design of the integration architecture and evaluation of candidate EAI tools. An overview of the proposed EAI architecture is shown in Exhibit 4.

Under Gerry’s lead, the team conducted an ‘on paper’ evaluation of several of the market leading EAI tools based on literature downloadable from the vendors’ website and various industry articles sourced from the Web. Gerry had identified several key criteria in the selection of EAI tools based on FO’s requirements (Exhibit 5).

Gerry: “Selecting the right EAI package is as much a strategic business decision for FO as it is a technology one. The EAI package will become a hub that brings all of FO’s applications together, so there must be a close match to FO’s overall application integration needs. But the EAI vendor must be more than just a vendor; they must also be capable of becoming a strategic partner of FO. That means understanding FO’s business needs and working hand-in-hand with FO on the implementation to ensure project success.”

From an initial short-list of four of the market-leading EAI tools, two were quickly eliminated because they did not appear to have the necessary pre-built adapters. For example, the call-centre application used at FO was based on the Seibel application, so it essential that a Seibel adapter was available for the EAI tool.

More in-depth face-to-face presentations and discussions were held between the team and the remaining two EAI tool vendors. The two EAI tool were closely matched in functionality. A consensus was reached amongst the team, however, to go with TIBCO, the vendor that had a stronger track record working with financial institutions on large-scale EAI implementations. However, even after this decision had been reached, a month of negotiation between Peter and the vendor followed regarding a combined package of tools and consultancy, training and support services. As part of

the package, two of the EAI vendor's consultants were appointed to the project to facilitate the deployment of the EAI solution.

Proof-of-Concept Development and EAI Tool Configuration

The team felt that it would be far too risky to introduce the EAI tool directly into the live production environment at FO. Although the EAI tool provided some simulation capability (it could simulate the flow of data between applications), this was a far cry from a real working EAI solution. Instead, a proof-of-concept would first be developed in a test environment to demonstrate that an EAI solution was feasible and to iron out any unexpected problems that might arise. Only when the proof-of-concept had undergone rigorous testing would it be rolled out into the live environment.

A test environment was created which mirrored FO's live production environment as closely as possible. Installation of the EAI tool in the test environment was relatively problem-free. However, the team spent considerable effort configuring the EAI tool. Configuration was performed in two main phases:

- Adapter configuration—this enabled the services and/or data within a core application to be visible to the EAI broker.
- Business process configuration—the business processes of FO needed to be captured in the EAI tool in order to specify the flow of information between the core applications.

For example, adapter configuration was required to enable the data structure of the database in the account management system to be visible from within the adapter. Next business process configuration was needed to model the passing of new account details from the MMS to the account management system and the firing of the relevant SQL queries to add a new account to the database. A GUI-interface within the EAI tool enabled such business processes to be configured visually. However, what was critical was an understanding of the business rules associated with FO's processes:

Team member: "Knowledge of the business rules that governed the mortgage application process was essential for proper business process configuration so that business events would trigger the appropriate information flow. For example, if an applicant already had an existing mortgage when they applied for a mortgage at FO, additional checks would be needed to determine the applicant's track-record in servicing their existing mortgage payments. Hence, this would trigger checks in supporting applications. The process isn't simple. There are lots of rules and procedures that we follow."

One major issue was that business rules were not centrally documented, and in some cases, did not seem to be documented at all. The team therefore had to interview several business analysts from the mortgages division in order to explicitly uncover the business rules. However, the elicitation, definition and validation of business rules were a non-trivial process that took much longer to complete than expected.

Custom Adapter Development

There were instances where pre-built adapters were unavailable and where custom adapters had to be developed. For example, the MMS was a specialist

packaged application for which no pre-built adapters existed. Instead, the MMS provided an integration interface through a set of Java APIs. The EAI package included an adapter software development kit (SDK) with a Java application programming interface (API) that enabled a custom adapter to be created for the MMS. The IS staff at FO did not have the necessary technical knowledge to undertake the development work themselves so the work was outsourced to the development services of the EAI vendor. The EAI vendor had done many such custom adapter development projects before, so were well versed in the design and development of adapters. However, the development work for the custom adapters extended the project by an additional 4 months.

Proof-of-Concept Testing

Testing was conducted in two main parts: unit testing, which involved testing application-to-EAI broker integration, and end-to-end testing which involved application-to-application integration via the EAI broker. Several different kinds of tests were conducted:

- Adapter testing. This was to ensure that adapters were installed and configured properly.
- Message consumption. This was to ensure that individual applications connected to the messaging infrastructure consumed the messages properly, i.e. performed the correct behaviour and database update functions after receiving a message.
- Business-scenario testing. This involved the simulation of certain business scenarios. For example, the submission of mortgage applications, ensuring that the relevant business events generated the right messages and that a mortgage application moved through the business process as intended.
- Performance and load testing. This simulated various loads on individual applications, ensuring that the overall response times were within an acceptable range.

Several bugs were identified that required subsequent investigation and fault-finding. This in turn extended the time for testing, and the team ended up spending one month additional effort on testing than they had originally planned.

Rollout Planning in the Live Production Environment

The rollout of the EAI solution into the live production environment was envisaged by Peter and Gerry as a non-trivial process, and any problems that occurred could potentially affect FO's live business operations. Gerry and Peter therefore decided to work out a detailed EAI solution rollout plan. Unlike, a typical application development project where there was a clear 'cut-over' from the old to a new application, the EAI project involved the introduction of adapters, the EAI broker and other components the EAI solution into the live environment. As such, there was no clear cut-over per se.

Rather than introduce the full EAI solution into the live production environment, a phased approach would be adopted where the core applications would be integrated in phases. In the first phase, the financial portal and MMS would be integrated. This

would allow mortgage applications made at the financial portal to be immediately processed by the MMS. This first phase of the rollout would also include, as a preliminary step, the installation of the EAI broker and necessary messaging infrastructure.

Peter: “A phased approach is less risky than trying to introduce a full EAI solution into the live environment in a shotgun approach. Introducing different elements of the EAI solution in phases makes things much more manageable. We also isolate risk so that any problems that occur don’t affect the other core applications. We can also rollback more easily what we’ve done.”

Apart from a few minor technical hitches, the first rollout phase was relatively problem-free. Peter decided he would let the EAI solution ‘settle in’ before deciding to proceed to the next phase of rollout in two months time. Encouraged by the stability of the EAI solution, the next rollout phase saw the integration of the mortgage accounts application and then an additional core application each month. This allowed FO to monitor and address any problems with the integrated application before proceeding to integrate the next application.

Project Review by Senior Management

The EAI project at FO had clearly been a difficult project. The original 12-month timeframe set for the project had been extended to almost twenty months. The project costs had also exceeded the initial cost estimates by almost 50%. However, the team at FO had managed to deliver a working EAI solution, had laid down the foundation for future integration needs, and gained valuable experience and knowledge of EAI that gave them confidence to tackle future EAI projects that would be needed within FO.

Edwin: “I’ll admit that the project scores low if we use our standard evaluation metrics like sticking to budget and on-time delivery. But the project is unlike a typical IS project and we’ve managed to successfully overcome the challenges on the first project we’ve done of this type. More importantly, we’ve implemented a cornerstone piece of our IS architecture that will allow FO to integrate applications more easily in the future. Going forward, this will place us in a much better position for addressing our new strategy in the marketplace. So from a business perspective, it ranks as one of our most important technology projects to date.”

ACKNOWLEDGEMENTS

The author wishes to thank employees at the real Fenton Online for their support and assistance in the writing of this instructional case.

Exhibit 1: Organisation chart for FO

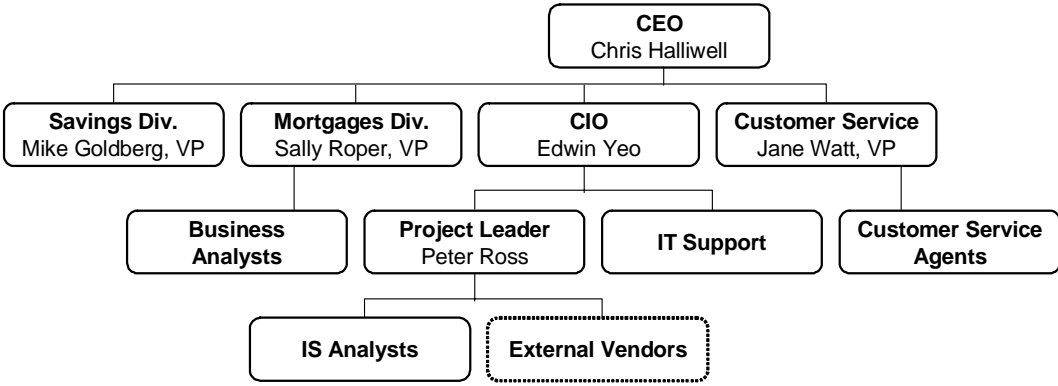


Exhibit 2: Core applications

Core Application	Functionality
Financial portal	<ul style="list-style-type: none"> • a Web-based front-end application • enables individuals are able to apply for mortgages through a set of Web forms; mortgage applications details are captured in the portal's database • provides a collection of mortgage calculators and tools • allows marketing and other information about mortgage products to be published via the content management function • allows existing customers to track their mortgage and mortgage payments • captures a customer's profile and their personal details in the portal's database • developed using HTML, Javascript and Java Server Pages (JSP), utilizing a MS SQL Server database
Mortgage management system (MMS)	<ul style="list-style-type: none"> • a back-end application that processes mortgage applications and tracks the workflow associated with mortgage processing • mortgage applications are transferred from the financial portal to the MMS by a daily batch process • has been customized to use FO's business rules for mortgage processing • accesses a variety of back-end services such as address checking and credit rating • a packaged application running on Windows NT provided by a specialist financial services technology solutions provider
Account management system	<ul style="list-style-type: none"> • a back-end application that manages mortgage accounts • when a mortgage application is successful, a mortgage account is created on the account management system • different kinds of mortgage accounts (fixed, variable payment etc.) are handled by the account management system • accesses banking gateways for account transfers from customer's bank account • a legacy mainframe application based on VME and COBOL
Call-centre system	<ul style="list-style-type: none"> • used by call-centre staff to handle telephone enquires • captures details of caller and the nature of the enquiry • issues a problem ticket for enquires that can not be sorted out during the call • based on the SEIBEL, an industry leading call-centre application, running on Windows NT
Mortgage product and quotation management system (MPQ)	<ul style="list-style-type: none"> • a back-end application used to store all the different kinds of mortgage products offered by FO • allows a user to maintain the product record for each mortgage product • can also be used to generate mortgage quotations

Exhibit 3: Tentative project schedule

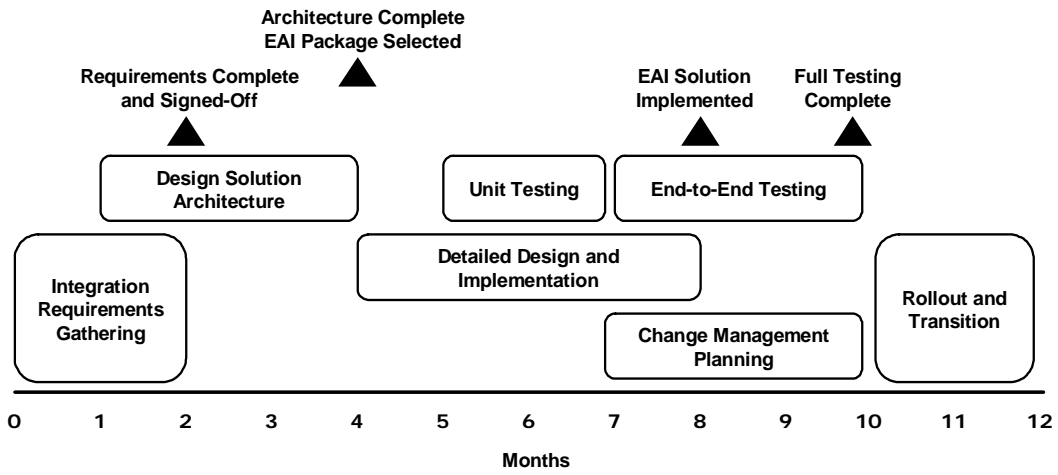


Exhibit 4: EAI Architecture

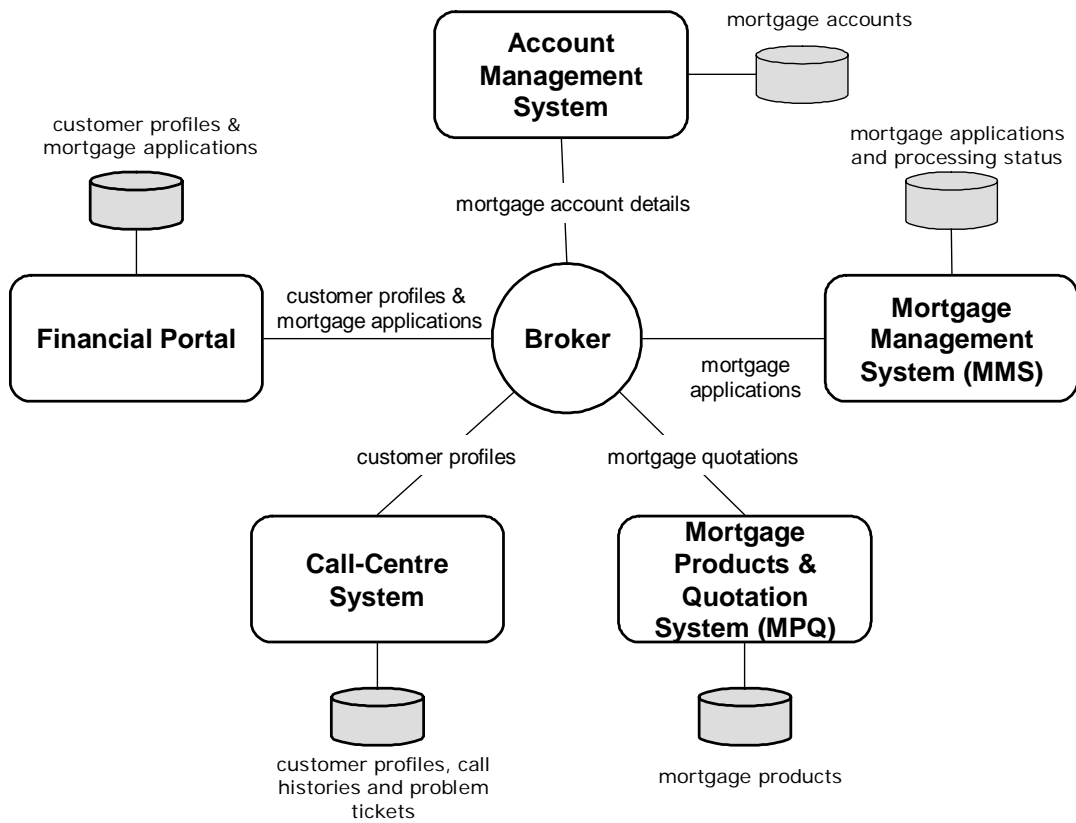


Exhibit 5: Selection criteria for an EAI package

-
1. Availability of pre-built adapters, either supplied by the EAI vendor or a third-party, that could connect all of the core home loans applications together with the least amount of effort. For example, FO needed to be sure that adapters were available for its VME based legacy account management system.

 2. The back-end mortgage application was a specialist application that provided a set of Java APIs for interfacing. It was therefore important that a Java adapter existed for the EAI package.

 3. Sufficient flexibility in the EAI tool to support the business rules inherent in FO's mortgage application process.

 4. Load-balancing to handle high business volumes (even though the volumes being considered here were far less than what one might find in a typical trading application) and 'hot' failure standby to provide maximum server uptime.

 5. Ability to integrate new applications in the future. FO was planning to launch a business intelligence initiative in the near future which would involve integration with a data-warehouse.

 6. An established track-record of large-scale deployment in financial institutions.
-

TEACHING NOTES

Learning Objectives

This rich description of Fenton Online's enterprise application integration (EAI) project provides students with an opportunity to discuss several issues related to EAI and application integration more generally. The case has been crafted to support a number of learning objectives—specifically, students who have successfully examined the case should be able to:

- Explain the critical role of application integration in supporting broader enterprise-wide business solutions.
- Describe what enterprise application integration (EAI) is and how EAI projects differ from more traditional IS application development projects.
- Differentiate between EAI and more traditional point-to-point integration architectures.
- Discuss key issues in the planning of an EAI project and the role of stakeholders.
- Describe some of the key criteria that should be considered in the evaluation and selection of an EAI tool.
- Explain the relationship between business processes and application integration.
- Describe the potential role of external vendors and consultants on an EAI project.
- Discuss risk management issues in the roll-out of an EAI solution into a live production environment.

EAI is a relatively new area of IS, so few cases of EAI currently exist in the literature. However, one distinguishing characteristic of this particular case is that it provides an end-to-end view of an EAI project rather than focussing on one specific aspect of a project such as EAI justification or EAI tool selection. Instructors will also find the case sufficiently concise to enable students to follow the main thread of the case without getting distracted by peripheral details.

Case Suitability

The case is ideal for a course such as EAI, systems integration or enterprise integration that specifically teaches the subject of integration. However, not all schools, in particular business schools, are likely to possess such a specialised course in their curriculum. Instead, EAI may be an advanced topic that is covered in a course on software engineering, information systems development or IT architecture. Hence, this case could be used in any of these courses as a more advanced case after the student has been introduced to cases which ground more fundamental concepts in software engineering, IS development or IT architecture. In addition, because the case touches upon issues related to business process improvement, instructors may also find the case useful in courses in the area of business process management.

In terms of student profile, the case is best suited to graduate students with at least a couple of years work experience in an IS-related area, preferably in a project-based environment. Ideally, students should already possess:

- a basic understanding of software engineering and IS development lifecycles, e.g. requirements, design, implementation, testing and roll-out
- an appreciation for project management issues on IS projects, such as project planning and risk management,
- an awareness of integration concepts such as application programming interfaces (APIs), interfaces, middleware, and data exchange

Undergraduate students, with little or no IT experience sometimes struggle to appreciate the nature, depth and complexity of application integration problems. MBA students whose academic grounding or work experience is in a non IS related field may also get lost in the architectural and technical aspects of the case. However, the case would suit an MBA with IS specialisation where the students are already expected to have some exposure to IT, a Masters programme in information systems management or similar.

Teaching Format

It is timely to present the case to students once they have been given an introductory lecture on application integration and the basic concepts of EAI. The case is well-suited for use as a descriptive instructional case. A descriptive instructional case presents a description of past events and decisions in which students analyse what went wrong and the lessons learnt (Cappel and Schwager 2004). Descriptive cases are ideal for discussion purposes.

The following teaching format, with involves both group and class discussion, has been used with good success on a Masters programme in Software Engineering and an MBA programme in IT Management:

- Students are grouped into teams of 3 or 4.
- The case and eight study questions (described later on in the paper) are distributed to teams prior to class (at least 1 week before), allowing them sufficient time to digest the case and prepare for in-class discussion.
- Teams are told they will be leading the in-class discussion for 1 or more selected study questions (depending upon the number of teams) and are assigned individual study questions.
- Students work in their respective teams on the assigned study questions. As part of their preparation, each team may produce a short discussion paper or mini-presentation to be given during the in-class discussion.
- During class, the instructor opens with a brief 10-minute recap of the case. Each team then leads the discussion for their assigned study questions, handing out any materials they have prepared, and responds to questions raised by other students in the class.

It is recommended that the case is discussed in one class period rather than spread over fragmented periods so that the 'heat' of the discussion does not get lost. The instructor will need to allocate timing taking into account the number of groups and contact time available. With a class size of 24 for example, 6 teams of 4 students can be created. Each team can be assigned 2 study questions, but lead the discussion for only one of these study questions in class. Assuming all 8 suggested study questions are used, allocating a 15 minute slot per question equates to a total of 2 hours

discussion, ideal for the 3-hour period often given in a graduate or evening programme when breaks and rest periods are factored in. Alternatively, as a variation in teaching format, an instructor may select only 4-6 questions out of eight, allowing more time for students to discuss each question in greater depth.

Suggested Study Questions

The eight suggested study questions have been crafted to get students not only to think about the lessons from the Fenton Online case, but also to ponder about the implications for application integration projects more generally. Students are therefore encouraged to think ‘beyond’ the case. The study questions, preferably discussed in the order given here, are as follows:

1. How did the lack of integration between IS applications in FO’s mortgages division impact on the business? The adage ‘islands of applications’ is often used to characterise applications which are standalone and non-integrated. State reasons why you think organisations often end up with islands of applications in their IT architecture.
2. What was FO’s business case for application integration? FO produced a qualitative case for application integration. However, a more critical or sceptical senior management team might have asked for a calculated return on investment (ROI). Describe how FO might have gone about producing a quantitative business case for application integration within the organisation.
3. How important were external consultants to FO and what value did they bring to the project? List the main criteria by which external consultants should be selected for such a project. FO potentially faces a “knowledge-drain” when the external consultants eventually leave the project. Describe what practices FO might encourage to retain knowledge within the organisation.
4. How did FO justify using an EAI integration rather than a point-to-point integration architecture? Under what situations do you think a point-to-point approach would be a more suitable integration architecture?
5. Why was choosing an EAI tool as much a strategic decision for FO as it was a technological one? List the criteria which you would advise organisations to consider when selecting and evaluating EAI tools.
6. How do pre-built adapters differ from custom adapters? Explain why it is sometimes necessary for organisations to write custom adapters. Search the Web for an EAI tool and list the adapters available for the tool. What facility does the tool provide for the creation of custom adapters?
7. What role did business process analysis play in application integration at FO? What difficulties did FO face in business process analysis? Describe what recommendations you would make to future EAI projects in light of FO’s experience.

8. What was FO's strategy for rolling out the EAI solution and what were their reasons for using this approach? What factors do you think a project manager should take into account when formulating an appropriate rollout strategy?

Suggested solutions for each question are presented next. The suggested solutions can be used by the instructor to guide and facilitate in-class discussion, ensuring that the main issues surrounding the question have been covered. In addition, instructors will find the suggested solutions useful as model answers for the purpose of assessing in-class discussion and any supporting materials prepared by each team.

- 1. How did the lack of integration between IS applications in FO's mortgages division impact on the business? The adage 'islands of applications' is often used to characterise applications which are standalone and non-integrated. State reasons why you think organisations often end up with islands of applications in their IT architecture.**

The lack of integration between IS applications in FO's mortgages division impacted the business in several ways. First, there was no real-time processing capability. Mortgage applications were captured at the front-end, and then fed into the back-end mortgage application by a daily batch process. Second, customer details had to be keyed into several applications, rather than entered only once. As a manual process, this was tedious and error prone. At FO, manual processes became a bottleneck particularly when there was a high volume of mortgage applications such as during the launch of new products or promotions. Third, the call-centre staff at FO did not have a real-time view of all the customer details. Instead, multiple applications needed to be accessed to retrieve information. Customers were therefore kept waiting on the phone for a longer period of time, causing frustration and lowering call-centre productivity.

There are several reasons why organisations often end up with 'islands of applications'. First, divisional silos within an organisation tend to lead to a situation where each division develops its own set of IS applications. Second, in the past, it may have been acceptable for individual divisions to operate autonomously without the need to share information. However, this is no longer the case when an organisation wishes to launch enterprise-wide initiatives such as e-Business, SCM and CRM. Third, an organisation may lack strategic IS planning which would have provided a holistic view of IS needs across all divisions within an organisation. Fourth, a rigid functional view of IT rather than a process view might also lead to a situation where islands of applications emerge.

The instructor may find it helpful to direct students to the paper by Sawhney (2001), 'Don't Homogenize, Synchronize', Harvard Business Review, July-August 2001, which discusses issues around 'islands of applications' in greater depth.

- 2. What was FO's business case for application integration? FO produced a qualitative case for application integration. However, a more critical or sceptical senior management team might have asked for a calculated return on investment (ROI). Describe how FO might have gone about producing a quantitative business case for application integration.**

FO's business case for EAI was built on a number of arguments. First, to reduce the turnaround time required to process a mortgage application and return a decision to the

applicant. This is essentially about improving the level of customer service. Second, to reduce the amount of time customers are waiting on the phone by improving the information access of the call-centre staff. This again is about improving the level of customer service, and also about raising the productivity of call-centre staff. Third, to eliminate the need for manual processing and the re-keying in of data, a process that was proving to be both tedious and error-prone.

To provide a qualitative business case for EAI, FO would need to provide some estimates relating to anticipated cost savings, reduction in processing times, or the expected increase in business. For example, the average cost of processing a mortgage applicant can be calculated in terms of the average amount of manual processing involved (person-hours). The same kind of calculation can be also be made in relation to the average cost of dealing with a customer enquiry over the phone. Hence, a quantitative business case can be made on the basis of a simple calculation of the reduction in effort, multiplied by the volume of mortgage applications and customer calls. For example:

Before:

Average length of customer enquiry over phone = 5 minutes

Average cost of dealing with customer enquiry over phone = US\$2.50 (at US\$30 per hour)

Number of calls per month = 4500

Average monthly cost of dealing with customer enquiries over phone = US\$11,250

After integration:

Average length of customer enquiry over phone = 3 minutes

Average cost of dealing with customer enquiry over phone = US\$1.50 (at US\$30 per hour)

Number of calls per month = 4500

Average monthly cost of dealing with customer enquiries over phone = US\$6750

Monthly Saving = US\$4500, Annual Saving = US\$54,000

In addition, the increase in call-centre productivity may lead to the need for less customer service agents, an additional saving. A similar type of calculation could also be made for the elimination of the manual re-entry of data in different applications that EAI would enable.

3. How important were external consultants to FO and what value did they bring to the project? List the main criteria by which external consultants should be selected for such a project. FO potentially faces a “knowledge-drain” when the external consultants eventually leave the project. Describe what practices FO might encourage to retain knowledge within the organisation.

The FO employees on the team had an intimate knowledge of FO’s existing IS applications and business domain. However, unlike Gerry, they lacked experience of EAI projects, and application integration projects in general. One area of contribution that Gerry made was in project planning, given that integration projects are different from the kind of application development projects that both Edwin and Peter were used to. Another area was in supporting the team in formulating an appropriate integration architecture, and determining how this could be realized using an EAI tool. A further area of contribution was in the evaluation and selection of EAI tools. The EAI vendor’s consultants added value to the project by virtue of their intimate knowledge of the EAI

tool. They also had the necessary expertise to develop the custom adapters needed on the project.

There are several important criteria to taken into account in the selection of consultants, including:

- Knowledge and successful track-record of EAI and integration projects.
- Experience of the industry domain, e.g. financial services.
- Range of consultancy services available, from strategy through to implementation.
- Availability of reference projects.
- Accessibility to experienced consultants.
- Price and willingness to provide a package of product and consultancy services.
- Availability of additional services such as adapter development, training etc.
- Level of on-site support.

There are a number of steps FO can take to minimise knowledge-drain. First, requiring full and complete documentation of project deliverables to ensure that even when the consultants leave the project, important project information is captured. Second, asking the consultants to provide workshops and training sessions during the project to facilitate knowledge transfer and address any knowledge gaps that FO employees may have. Third, FO could adopt a 'shadowing' policy, where consultants are shadowed by an FO employee during the project and then carry on the role of the consultant when the consultant eventually leaves the project.

4. How did FO justify using an EAI integration rather than a point-to-point integration architecture? Under what situations do you think a point-to-point approach would be a more suitable integration architecture?

FO rejected a point-to-point integration approach in favour of an EAI approach for several inter-related reasons. A point-to-point architecture would have involved a high-level of custom development work in the creation of interfaces. As well as extending the project beyond the anticipated timeframe, this would have also entailed a high level of development risk as there was some doubt whether robust integration interfaces could be created for the legacy applications. There was also a high level of business risk, as existing applications would have needed to be taken offline leading to a significant outage period.

Although the case of FO has espoused many of the advantages of EAI over a point-to-point architecture, there may be situations where a point-to-point architecture may be more appropriate. For example, when there are only a handful of applications to be integrated and when there is no business requirement for the real-time transfer of data. In such cases, the use of batch processes may be used to achieve point-to-point integration in a relatively easy to implement and cost-effective manner. Organisations should therefore consider what integration architecture best suits their integration needs, taking into account the number of applications to be integrated and need for real-time data transfer.

5. Why was choosing an EAI tool as much a strategic decision for FO as it was a technological one? List the criteria which you would advise organisations to consider when selecting and evaluating EAI tools.

The EAI tool would be forming the integration 'back-bone' through which FO would be integrating its applications, not just within the mortgages division, but across the whole enterprise. As a core part of FO's IS architecture, it was essential that the EAI tool would be able to support FO's business initiatives now and in the future.

FO considered a number of criteria in the selection of the EAI tool:

- Availability of pre-built adapters for its existing applications in order to minimise custom development work.
- Ability to create custom adapters for its bespoke applications.
- Flexibility to support FO's business process and business rules.
- Resilience and reliability levels appropriate for an online business.
- Ability to cater for applications that may need to be integrated in the future.
- Vendor has track record of implementation in transactional environments within the financial services industry.

FO had a specific set of applications it wished to integrate, and these determined which adapters would be needed. Clearly, it would have been a mistake to select an EAI package that did not have the necessary adapters. Organisations should therefore consider the availability of adapters as one of the first criteria in their evaluation of EAI packages. Adapter unavailability not only needs to be considered for current applications, but also applications the organisation may wish to integrate in the future. Importantly, adapters are a major cost item in the acquisition of an EAI package. It is not unusual to find adapters costing in the range of US\$40-50k each, exclusive of the cost of the EAI package itself. Such costs need to be taken into account in the initial budgeting of an integration project.

6. How do pre-built adapters differ from custom adapters? Explain why it is sometimes necessary for organisations to write custom adapters. Search the Web for an EAI tool and list the adapters available for the tool. What facility does the tool provide for the creation of custom adapters?

Pre-built adapters are plug-and-play in nature, allowing an application to communicate with the EAI broker through a configuration process. No coding is required. For example, the Siebel adapter was configured via a GUI interface in the EAI tool. The GUI interface provided an instant view of Siebel services and a visual scripting language to specify the events and conditions under which such services were called. However, for the back-end mortgage application, a Java adapter needed to be created to interface the back-end mortgage application with the EAI tool. This involved non-trivial and specialised custom adapter development work which, in the case of FO, was carried out by the EAI vendor. Pre-built are generally available for common packaged applications. However, when organisations have custom applications or use less popular or highly specialised packaged IS applications, some custom adapter development work may be unavoidable.

In searching the Web for EAI tools and adapters, the instructor may wish to direct students to the main EAI vendors such as TIBCO, IBM, WebMethods, SeeBeyond, BEA, Mercator and Vitria.

7. What role did business process analysis play in application integration at FO? What difficulties did FO face in business process analysis? Describe what recommendations you would make to future EAI projects in light of FO's experience.

FO did not rush into the implementation of an EAI solution. Rather, the team spent considerable time understanding business integration requirements and business processes (in fact, significantly more time than they had originally planned for). A major part of this exercise was spent modelling the existing mortgage processing process, and analysing weaknesses in the process (e.g. batch processing, manual processing, duplication etc.) rather than focussing immediately on suggestions for technology improvements. By doing this, FO ensured that technology changes were traceable to improvements in the business process. Organisations that are planning application integration projects need to factor the effort required for business process analysis during project planning. This is essential in the case of complex business processes that may involve many steps, stakeholders and business rules.

FO faced several difficulties in business process analysis. The team did not have a single, holistic model of the end-to-end business process. The mortgage process was distributed across different applications, so the team had to understand the part of the process model handled by each application and the data that resided in each application. Furthermore, the information and business rules were not always explicitly documented, and had to be manually elicited from business experts within FO. Organizations are recommended to create enterprise process and data models of their applications before embarking on any major EAI project, or to factor this activity into the overall project planning. Furthermore, key business experts who understand business processes should be closely involved in the project.

8. What was FO's strategy for rolling out the EAI solution and what were their reasons for using this approach? What factors do you think a project manager should take into account when formulating an appropriate rollout strategy?

FO considered the introduction of the entire EAI solution into the live environment as a high-risk manoeuvre. Instead, an incremental approach was adopted for rollout where the EAI solution was rolled out in stages. This approach made rollouts more manageable because the EAI solution did not need to be rolled out all in one go as with a 'big-bang' approach. In addition, the approach contained risk so that any problems or issues with that part of the EAI solution had minimal impact on the other applications in the live production environment. By using an incremental approach, FO could also let the EAI solution 'settle' and address any problems before moving forward with the next stage.

For very large integration projects involving tens, perhaps hundreds of different applications, a phased approach may be the only real practical approach to rollout. Devising an appropriate rollout strategy is therefore essential. As part of this strategy, organisations should determine which applications should be integrated first, taking

into account factors such as business urgency and the degree of business disruption. Organisations also need to take into consideration their level of risk tolerance. To minimise risk, they may wish to consider for example, rolling out 'easier' or less complicated integration components before more difficult or complex ones. Or they may chose to rollout integration components that affect the business least before rolling out components that are more critical and have a higher impact on the business.

Additional Teaching Resources

The instructional case is self-contained in nature. However, instructors might find the following additional teaching resources helpful.

Books

Cummins, F. (2002), *Enterprise Integration*, New York: John Wiley.

Linthicum, D. (2001), *B2B Application Integration*, Reading, MA: Addison Wesley.

Ruh, W.A., Maginnis, F.X. and Brown, W.J. (2001), *Enterprise Application Integration*, John Wiley, New York, 2001.

Papers

Markus, M.L. (2000), 'Paradigm Shifts – E-Business and Business/Systems Integration', *Communications of the Association for Information Systems*, 4(10).

McKeen, J.D. and Smith, H.A. (2002), New Developments in Practice II: Enterprise Application Integration, *Communications of the Association for Information Systems*, Volume 8:451-466.

Puschmann, T. and Alt, R. (2004), Enterprise application integration systems and architecture – the case of the Robert Bosch Group, *The Journal of Enterprise Information Management*, 17(2), pp.105-116.

Sawhney, M. (2001), 'Don't Homogenize, Synchronize', *Harvard Business Review*, July-August.

Websites

Business Integration Journal (<http://www.bijonline.com/>) contains many articles and white papers on all aspects of EI, with excellent coverage of management and architectural issues.

Intelligent Integration (<http://www.intelligenteai.com/>) publishes short articles on industry movements in EI and new EI tools and technologies.

CIO Magazine Online (<http://www.cio.com/>) provides good insight into strategic issues related to EI planning and implementation.

The EAI Industry Consortium (<http://www.eaiindustry.org/>) describes standards, guidelines, and best practices emerging in the EI field.

REFERENCES

- Brodie, M. and Stonebraker, M. (1995), *Migrating Legacy Systems*, Morgan Kaufmann Publishers, San Francisco, CA.
- Cappel, J.J. and Schwager, P.H. (2004), Writing IS teaching cases: Guidelines for JISE submission, *Journal of Information Systems Education*, 13(4), pp.287-293, 2004.
- Cummins, F. (2002), *Enterprise Integration*, New York: John Wiley.
- Farhoomand, A. (2004), Writing Teaching Cases: A Quick Reference Guide, *Communications of the Association of Information Systems*, 13, pp.103-107, 2004.
- Hasselbring, W. (2000), Information Systems Integration, *Communications of the ACM*, 43(6), 2000.
- IDC (2002), Enterprise Integration: Market Drivers and Challenges, IDC#28549, Available from <http://www.idc.com/>.
- Jayaram, J., Vickery, S. and Droge, C. (2000), The effects of information systems infrastructure and the process improvement on supply chain performance, *International Journal of Physical Distribution & Logistics Management*, 30(3-4), 2000.
- Kale, V. (2000), *Implementing SAP R/3*, ISBN 0-672-31776-1, Indianapolis, Indiana, Sams Publishing.
- Lam, W. (2004), Technical Risk Management for Enterprise Integration Projects, *Communications of the Association of Information Systems*, Volume 13, pp.290-315, 2004.
- Lee, J., Siau, K. and Hong, S. (2003), Enterprise Integration with ERP and EAI, *Communications of the ACM*, 46(2), pp.54-60, 2003.
- Linthicum, D. (2001), *B2B Application Integration*, Reading, MA: Addison Wesley.
- Markus, M.L. (2000), 'Paradigm Shifts – E-Business and Business/Systems Integration', *Communications of AIS*, 4(10), 2000.
- McKeen, J.D. and Smith, H.A. (2002), New Developments in Practice II: Enterprise Application Integration, *Communications of the Association for Information Systems*, Volume 8:451-466.
- Pan, S.L. and Lee, J.N. (2003), 'Using e-CRM for a Unified View of the Customer', *Communications of the ACM*, 46(4), April 2003.
- Robertson, P. (1997), Integrating legacy systems with modern corporate applications, *Communications of the ACM*, 40(5), 1997.
- Sawhney, M. (2001), 'Don't Homogenize, Synchronize', *Harvard Business Review*, July-August 2001.

Sharif, A.M., Elliman, T., Love, P.E.D. and Badii, A. (2004), Integrating the IS with the Enterprise: Key EAI research challenges, *The Journal of Enterprise Information Management*, 17(2), pp.164-170.

Storey, V.C., Straub, D.W., Stewart, K.A. and Welke, R.J. (2000), 'A conceptual investigation of the e-commerce industry', *Communications of the ACM*, 43(7), July 2000.

Themistocleous, M., Irani, Z. and O'Keefe, R. (2001), ERP and application integration, *Business Process Management Journal*, 7(3), 2001.

U21Global is the world's pre-eminent online graduate school, designed to meet the needs of individuals and corporations in the 21st century. It is a joint venture between Universitas 21, an international network of distinguished research-led universities, and Thomson Learning, a worldwide provider of tailored learning solutions for businesses and institutions.

More details about U21Global can be found at www.u21global.edu.sg

U21Global
5 Shenton Way
#01-01 UIC Building
Singapore 068808

Tel: +65 6410 1300
Fax: +65 6410 1358