A ‘Technological Gearing’ Strategy for Leveraging Geographic Information System Investment

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Abstract

Key clients’ requirements necessitated implementation of a Geographic Information System (GIS) to facilitate data storage, retrieval, analysis, dissemination and optimization to enable this small surveying firm to remain competitive.

A staged implementation strategy was developed based on ESRI’s Enterprise Implementation Strategy and Microsoft’s Process Model for System Design. The key components of this strategy included the early purchase and use of one ArcInfo desktop license to develop a number of small personal geodatabases and ‘prototype’ applications. This relatively substantial purchase was supported and extended through the use of ArcExplorer to provide free internal data viewing and map display, and Open Source Server Software to facilitate timely deployment of data to clients, for ventures such as seismic survey reporting.

This strategy is proving very successful in leveraging the company’s technology investment, hopefully rapidly facilitating the planned upgrade to Arc IMS and Arc SDE.

Paper Body

Background

BTW Company is a relatively small surveying company located in New Plymouth, New Zealand, a city of approximately 60,000 people. The company employs thirty staff to carry out a variety of work involving cadastral surveys, management of resource consent applications, and a considerable volume of land management and project management primarily for several oil industry clients. The company is keen to keep up with changing technology, and was quick to take advantage of the government’s ‘e-survey’ service for the on-line registration of cadastral survey plans. One of the primary drivers for the Geographic Information System was the need to ensure that critical lease renewals and payments were actioned in a timely fashion. It was also necessary to provide clients with timely access to data concerning the progress of various land use permitting negotiations and of the field component of works such as seismic surveys.

The potential benefits of establishing a Geographic Information System for this type of work were identified by the company in late 2004. An initial purchase of one license of Arc View software was made. Two staff were provided with a brief customized training

program, but both left the company shortly after, and no progress with the GIS implementation had been made. The decision was taken in late 2005 to employ a GIS manager to assist the company in establishing and expanding its GIS capability.

The first step for this project, as for any GIS implementation, was to carry out an initial investigation into the existing system. This revealed that the company's data resources consisted of a large number of drawings, and several small databases and spreadsheets, with this data being stored in folders, by job number, on one central drive. In spite of being a progressive company attempting to keep pace with technology, there was considerable diversity in the levels of computer literacy amongst the staff, with most people only conversant with the one or two software applications that they used on a daily basis, and only the system administrator having an understanding of actual computer technology. This company's experience with software implementations to date had been with the CAD drawing software, standard Microsoft products, and the occasional customized Access database. Consequently, it was soon evident that a "plug and play" set up of the GIS, involving only a limited timeframe, was expected. When a summary of the process involved in setting up even a small GIS was explained, management was still keen to progress with the project. A budget for capital expenditure was discussed and provisionally set at approximately fifty thousand New Zealand dollars.

Initial Life Cycle Selection

For any small company, it is important to keep the development time to a minimum to facilitate a rapid deployment of the system to enable costs to be recouped as quickly as possible. This requirement led to the search for a suitable life cycle for rapid development of GIS systems for small business applications.

The "ESRI Enterprise Implementation Strategy" was identified as providing an appropriate life cycle, in keeping with the existing GIS software. However, due to the size of the company and consequent limitations imposed by its budget, it was decided to seek a more 'agile' development cycle. While it was realized that no lifecycle would provide an instant solution to the complexities of system analysis and design, it was felt that rapid development of one or more key prototype applications would provide income to offset the company's initial investment. This would enable the development to meet the company's financial criteria while facilitating the use of sound analysis and design principles. Again in keeping with existing software, a search identified the "Microsoft Process Model for System Design" as a potential strategy. As the early stages both life cycles are essentially identical, it was determined to commence the project using a combination of the two development models.

Analysis Commenced

As part of the 'requirements investigation' a small prototype development was commenced. This application consisted of BTW data and the Core Cadastral record set purchased from Eagle Technology (New Zealand ESRI Distributors), and was created using the existing Arc View software. This sample application was distributed across the

company's network for testing using Arc Explorer. This led to a clearer understanding of the company's requirements.

It was determined that much of the company's data could be managed, at least initially, through the continued use of existing access databases, newly created personal geo-databases, and incorporating this data with layers extracted from the various CAD drawings. A number of potential applications were identified that could then be developed as prototypes without the early need for an enterprise database. However, for greater data integrity it was seen as desirable to acquire one Arc Info license to provide the capacity to create and manage topology and relationship classes. Acquisition of this software would essentially "blow the budget".

Investigations also showed that a key component of a successful system for this company, with its particular clients and requirements, was the internet deployment of the GIS data. This was required to allow both internal staff and external clients to view the progress of various activities and projects from within the company and from remote locations.

Initial investigation into the various ESRI internet deployment strategies ((Peters, 2005) seemed to indicate a requirement for the acquisition of Arc IMS, SDE or equivalent, at an estimated cost over double that of one Arc Info license. This would require a far greater expenditure than that originally envisaged by the company, and it was doubtful whether an expenditure of this nature could be recovered in a reasonable time frame. However without this capability, the benefits of the GIS to both BTW and its clients would be severely constrained.

With these (relatively costly) requirements identified, it was evident that an innovative strategy was would be required to ensure the success of the implementation.

Leveraging Strategy

Archimedes (287-212 GBC) stated, "Give me a lever long enough and a place to stand, and I could lift the world." The principle of the lever has been used since before written language, originally to move heavy stones with only muscle power. A practical lever consists of a lever (stiff beam) rotating on a fulcrum (fixed base). The length of the lever and placement of the fulcrum controls the ratio of the output force to the input force (mechanical advantage).

In our modern world, leveraging is frequently referred to as a way of increasing one's net worth. Just as leveraging provides a rapid method to acquire, for example, a portfolio of properties, so leveraging is possible in system development to speed up the acquisition of system components and the deployment of the system.

In property investment, borrowing (leveraging) is the catalyst that escalates the speed of the capital growth cycle: the greater the borrowing, the greater the return. This strategy is

curtailed by the amount one is able to borrow, which is limited by the value of the properties and the purchaser's ability to repay the debt.

In the case of information technology developments, financial borrowing is not necessary to enable leveraging. The investment in IT can be leveraged by the innovative use of the actual technology chosen and by the methodology used for system development. In this case the leveraging is limited by the available technology and the developer's choice of both technology and methodology.

As there are methods that will increase the success of property investment leveraging, there are methods of ensuring success in technological leveraging also. The first rule of leveraging is to select investments wisely, and this applies to both property and technology. With property investments there are three key criteria: rent increases must outpace interest rates, the right price must be paid for the property – no more than market value- and capital value must grow over a long term. To meet these criteria, the property should be in an area with something special about it: "Location, Location, and Location."

An investment in technology has three key criteria: benefits obtained through use of the system must be greater than the costs, the software and hardware should be appropriately priced in relation to other similar products, and the technology should address and solve the correct problem. To meet these criteria, the technology requires something special about it: innovation, innovation, innovation.

It was concluded that a substantial degree of innovation would be required to successfully leverage BTW Company's technological investment to the point of implementing a successful internet based GIS.

From Levers to Gears

Although they initially seem very different, levers and gears are actually closely related, with a gear being essentially a rotating lever. A gear is a lever bent into a circle (a wheel), with the center (axel) being the fulcrum, with teeth around it. Gears work in teams called gear trains, can be one of several types (spur, bevel) and can be joined (meshed) in a variety of manners (rack and pinion, worm and wormwheel, internal). Again as with property, financial gearing strategies are a common technique to leverage investment, with gearing essentially consisting of strategic borrowing (or leveraging) against, and re-investing in, the equity of the property on an ongoing basis. The objective is to rapidly increase the capital value of the portfolio.

The challenge in this instance was to develop the optimum gearing strategy to leverage BTW's technology investment. From a system development perspective, the available tools for leveraging purposes consist of the possible technology, hardware and software and the system development life cycle. An innovative approach to the use of technology was clearly required. To ensure this approach was taken, an innovative live cycle was developed.

The similarity between a life cycle (usually depicted as circular) and a gear led to the idea of a 'geared' life cycle. The need for more than one life cycle (gear) of potentially different sizes working in unison also seemed compatible with the initial understanding of BTW Company's requirements. The teeth on the gears would equate to the stages in the life cycle. It was decided that these stages should match the ESRI/Microsoft combination cycle previously chosen: namely: analysis, design, development, deployment. The decision to follow this life cycle based on a gearing strategy followed.

Putting the Gears in Motion

Clients had already been informed of BTW Company's expansion into GIS, and the tendering for two projects requiring such capabilities was imminent. With an appropriate life cycle chosen and the design phase underway, the next step was to decide on additional GIS software requirements and an appropriate technology to enable applications to be deployed over the net. This capability was essential to the leveraging strategy of rapidly developing a series of applications for clients' viewing that would begin to generate returns in the short term. These applications would be capable of adaptation and re-use on future projects. As the number and complexity of such applications was increased, the company's own GIS would be under development also.

While acquisition of Arc Info was not necessarily essential, the GIS software was seen as the pivotal structure of the system. The additional development capacity and the integrity that this would lend to the applications led to a decision to promptly purchase this software.

The next action was to investigate possible web hosting strategies as alternatives to the ESRI solutions that would enable GIS data, once created, to be viewed securely over the internet. A key requirement was the facility to restrict access to the data to only designated parties. A number of potential open source (free!) solutions were identified and evaluated, and a 'first iteration' solution finally determined.

Motoring Away

While the web component was still in the early stages of development, a contract was won for provision of a web-based Geographic Information System to serve as a management tool for an exploration project. This would provide information to allow the client to track the progress of a 3D Seismic survey, and provide a central repository of information to be used by all of the contract parties. The system was developed using the recently acquired Arc Info software, cadastral, landowner and address data from the Core Records, design and as-built survey co-ordinates, and existing and new databases
Thirty-eight layers were created on the GIS. Personal geo-databases were used to store the data, and the Info software enabled topology and relationships to be created and enforced. These layers were updated continually, usually on a daily basis, to permit tracking of all aspects of the work. The various layers and feature classes were exported

to shape file format for deployment to the web, where the layers could be selected, zoomed in and out, and queried.

In keeping with the development cycle, the application and technology were continually reviewed over the next few months. The initial open source server software application was superceded early in the development when a more functional alternative was identified. This was continually improved at various stages to incorporate client requests for added functionality. For example, the capability to print out the results of data queries in text format and to save and print large maps in PDF was developed to satisfy client needs.

This initial application proved the ability of the GIS to provide quality mapping and property information for contractors and it became the core generator for all administrative data and correspondence. With some 482 properties the GIS proved to be efficient and responsive, and facilitated a greater management of detail and coordination than previous systems used in past seismic surveys.

A number of the functions of the Arc Info software were used in the development of this first application, including making 'xy' event layers, spatial joins, selections by attribute etc. While much of the work could have been done with an Arc View license, it was the added integrity of creating topology rules and relationship classes etc. and the facility to automate many repetitive data update tasks through the development and use of geo-processing scripts that proved the value of the software, and helped to justify its choice.

Development of the first prototypes for BTW Company itself was commenced while the 3D Seismic project was progressing, and two further applications for the company's clients were also commenced. Each of these followed the customized system development cycle. Revenue from the client's projects (3D survey etc.) helped both to defray the capital cost of the Arc Info software and to cover the cost of staff time, providing some surplus towards the development of BTW Company's internal system. As further projects are carried out, the income will offset the costs of software and hardware upgrades, and enable the company to acquire more substantial server software, potentially appropriate Arc products.

The success of the GIS system has definitely rested with the choice to purchase Arc Info. It has proved an excellent hub for the system, enabling BTW to develop the required layers, for analyzing data, and maintaining data integrity. The company has developed several different applications for clients to help to manage their projects and keep them advised of progress. At the same time these applications provided revenue to offset the capital investment, while progress is continuing to be made on developing a total GIS for the company itself. This system will continue to assist with management of the company's data, and provide a superior tool for many different land and resource management tasks. Employing a technological gearing strategy coupled with customization of open source server technology has given the company a substantial boost, leveraging its investment to generate substantial ongoing returns.

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