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Challenges of implementing GIS in a gas utility

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Abstract

Bord Gais Eireann, a gas utility responsible for the transmission and distribution of natural gas in Ireland successfully implemented a corporate GIS within a two-year project period. This paper recounts the BGE experience from the initial stages of learning about the relative complexity of the technology, through acquiring a thorough understanding of the design and planning process of GIS; by developing an implementation strategy that reflects the business needs - focusing on the applications that deliver realistic benefits and by understanding the complexity of data capture. The need for an effective management structure to deal with the inevitable organisational conflict that arises on such projects had to be recognised, together with the importance of utilising a competent project management team. Finally ensuring the readiness of personnel within the organisation to embrace the technology.

The main conclusion in the paper is that given a systematic approach to GIS, the technology can and does deliver the anticipated benefits to organisations, provided organisations apply universally known methods of developing and managing projects including utilising the necessary skills throughout the lifecycle of the project.

Introduction

The decision to implement a corporate GIS in not one that can be taken lightly, the cost of implementation for even a medium sized organisation can run in to millions of Euro/Dollars. While the benefits of successful implementations are great, there are numerous GIS projects that have failed to deliver anything like the anticipated benefits. Understandably organisations are cautious and when they first begin examining the technology many find it difficulty to distinguish between fact, fiction and reality. Bord Gais Eireann (BGE) is one such organisation. The early GIS projects BGE first looked at were less than impressive; in fact some did not appear to deliver any tangible benefits. Yet there was much hype about the wonders of GIS, which prompted BGE to further research GIS and widen their search of organisations deploying the technology.

The approach taken by BGE to the implementation of GIS is broadly reflected in Figure 1 'BGE's GIS Implementation Planning Chart'

At the outset it should be noted that one of the most fundamental differences between a gas distribution company and many other types of businesses is the gas distribution business is 'asset/customer' driven as compared to the normal 'process/customer' driven company. So many of the real benefits from GIS can only be fully realised when all of the assets are in the system. Therein lies one of the major challenges for any utility implementing GIS – capturing the network and asset information in to GIS.

There is however a maze of other activities that must also be accomplished in order to reap the benefits of GIS. Having the system incorporated into the organisation's working environment and achieving wide acceptance by users is the ultimate goal. To achieve this the system must make data more manageable and provide rapid, easy access to information across the organisation. It must integrate with legacy systems and

improve the organisations products and services. In short the GIS should deliver all the anticipated benefits and in particular those specified.

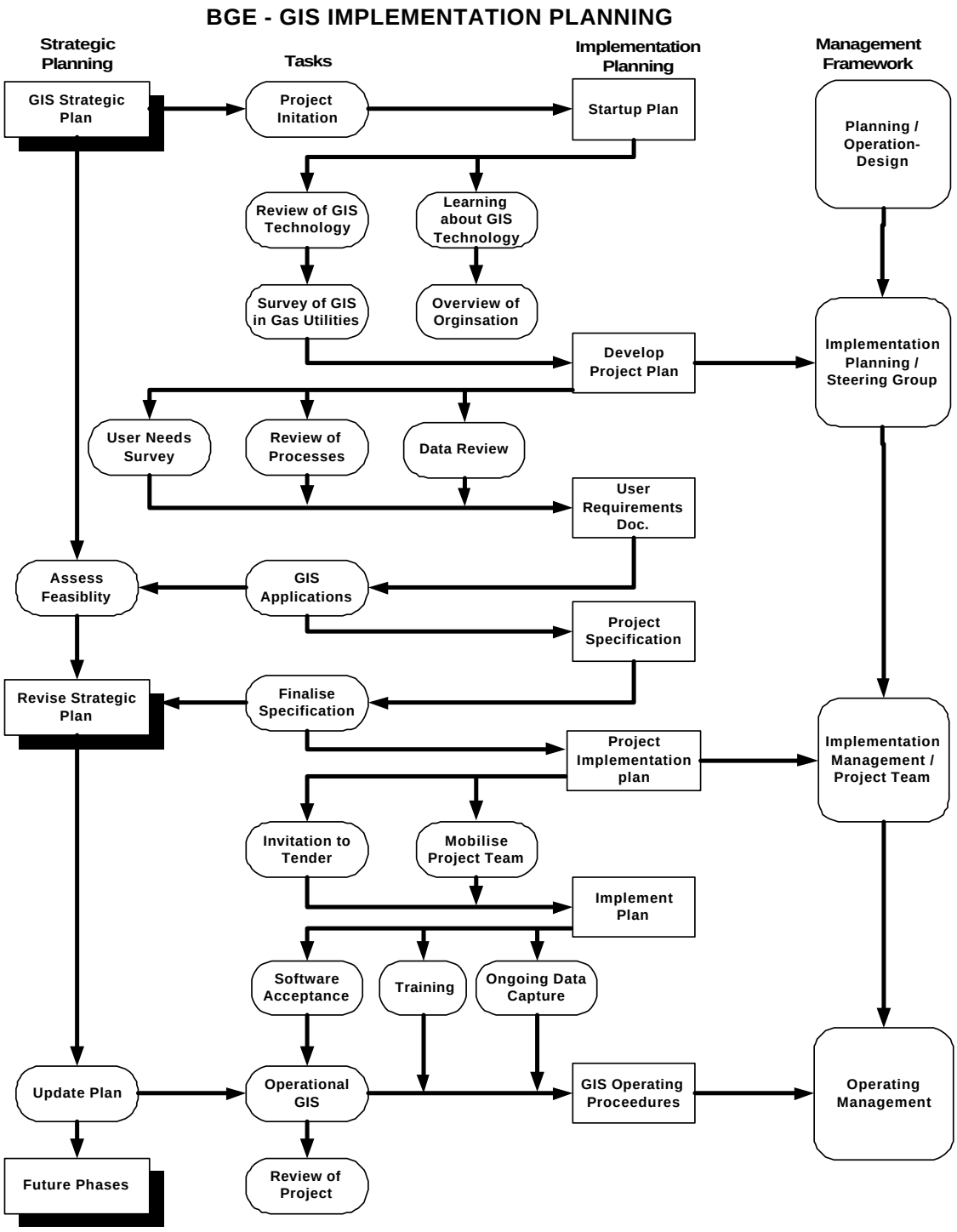

Figure 1

Like most other utilities that have spent many years fine-tuning their business processes BGE were acutely aware that the level of service provided to customers is directly related to the effectiveness of those processes. Therefore when they set about examining the technology they were mindful that GIS must, as a minimum, be capable of replicating those processes and to justify the expenditure it must substantial enhance/improve productivity. This was the premise from which BGE began the design of their corporate GIS.

Project Review

- The major factors that influenced the successful outcome of the project are discussed here under the following broad headings:

- Researching and learning about the Technology
- Understanding the Business
- Developing a GIS Strategy
- Effective Management Structure
- Developing an Implementation Plan
- Project Specification
- Project Deliverables
- Project Execution
- Design Phase
- Data Capture
- Training
- Introduction of GIS into the Organisation
- Conclusion

Researching and learning about the Technology

BGE were eager to implement a corporate GIS and had been monitoring the progress of the technology for almost a decade. They did however differentiated between the hype and the reality of GIS and while they remained committed to utilising the technology BGE were adamant they would not proceed with implementation until they were satisfied that the time was right.

They, like many other organisations had experience of successfully implementing CAD into their design offices. When they began looking closely at the state of GIS in the early 1990's they realised that GIS was much more complex than CAD and that belief was further reinforced by what they found during site visits to early implementers.

They found a lot of organisations involved in implementing the technology at the time were 'stuck' in the pilot phase for too long and that productive operational sites were rare and difficult to locate.

The initial site visits revealed that organisations were not prepared for the huge data capture problem that lay before them, many were attempting to do data capture in-house with inadequate resources. Putting data into GIS and getting data out of GIS was problematic - data capture tools were inadequate.

The Hardware was expensive, not very powerful and had very limited storage capacity. Software was not reliable, it was still maturing and it was not user friendly. Vector data was not as readily available then as it is now, all systems appeared to be using their own proprietary formats, which made the transfer of data a major obstacle. The non-availability of geo coded National Address data was also a discouraging factor.

Further investigation and research of literature on the state of GIS in general revealed that virtually all organisations were encountering numerous obstacles in their efforts to implement systems, notably the following:

- Lack executive management support
- Lack of user involvement
- Lack of business-oriented strategy
- No clear statement of requirements
- Insufficient awareness of technology
- Lack of competent skills
- Unrealistic expectations
- Insufficient staff to implement data capture
- Inadequate financial resources
- Poor data quality
- No clear GIS applications implementation plans
- GIS/IT responsibilities unclear
- Lack of ownership

While the above list is not exhaustive, it does highlight many of the issues faced by organisations adopting the technology. Perhaps in many ways it explains the extraordinary high failure rate of GIS projects and why GIS has in the past remained hidden away in the back rooms of many design departments for so long.

It was clear that many of the above issues stemmed from a lack of understanding of the technology and unrealistic expectations. 'Expectations' that were fuelled by GIS vendors who understated the limitation of an emerging technology to meet even modest business needs.

In the early nineties BGE remained 'unconvinced' and decided to continued monitoring the progress of the technology –this was despite all the hype about GIS. However by the mid-nineties they witnessed the dramatic drop in hardware cost and the huge increase in computing power and storage, which coincided with similar improvements in GIS software functionality. It was really only then that operational systems delivering real and tangible benefits to organisations began to emerge. The numbers were small but were enough to influence BGE to start more serious planning.

Personnel continued to seek out and visit a wide variety of GIS operational sites, not just gas utilities. Selected staff were also sent on formal GIS training programs and BGE embraced the concept of the GIS "Hybrid Manager" suggested by Silk (1991) where he writes; "it is now evident that it is necessary to have personnel trained both in the technicalities of GIS and in the business of the organisation within which GIS is to be used" This approach adopted by BGE provided the necessary in house expertise to confidently proceed with GIS implementation planning.

Understanding the Business

Understanding the technology was a prerequisite to being able to identify the areas within the organisation that were compatible with GIS. It is naïve to simply assume that because it is reported that some other organisation has had an extraordinary achievement using GIS that others can easily achieve similar (reported) results. Decision-makers need to be made aware that every organisation's situation is different

when it comes to utilising GIS and it presents an almost unique challenge to individual organisations, for which they must prepare and plan very carefully if they are to avoid becoming another failure statistic!

Organisations use different external data, different internal data and different processes, which are the lifeline of the organisation. If for example BGE have to design a gas network for a new town extension project, they will acquire data from circa five different sources – local authority, electricity, water, telecommunications and numerous building developers, and all of this data will be available only in one or two of a variety of formats. Therefore it is essential that the GIS adopted by the organisation is capable of integrating disparate sets of data otherwise the process gets 'stuck'. Ironically this was one of the areas that stalled the successfully completion of Site Acceptance Testing (SAT) on the BGE project.

To ensure that processes do not become stuck requires examination of the various processes in sufficient detail to ascertain firstly whether or not they can be done in GIS and secondly will utilising GIS substantially improve the processes. It is then a matter of identifying the processes that would yield high early benefits within an acceptable timeframe.

The high priority areas identified within the Operations Department were notably in reducing the effort associated with traditional mapping of records, making graphic information more manageable and accessible throughout the department and the wider organisation, Improving Network Management /Asset reporting and the efficient design of network extension project drawings etc.

Developing a GIS Strategy

The GIS strategy evolved naturally rather than by design. The drive to implement GIS came almost entirely from within the Operations Design Department, as indeed did the funding for the project. A preliminary feasibility study was done by Operations Design, which identified the areas that would benefit most from GIS. However to realise the benefits identified GIS would have to integrate with a number of legacy systems such as the customer information system and the job management system etc. The effect of GIS was clearly going to impact on the wider organisation and the need for a corporate approach was essential. The 'organisational approach' ensures that where GIS crosses organisational boundaries, roles and responsibilities can be redefined where necessary in line with business requirements.

The decision on how best to scope the GIS becomes one of getting the balance right between the need for the GIS project to provide sufficient benefits in order to get broad management expenditure approval, whilst at the same time constraining the incremental development and thereby increasing the chances of success!

BGE decided to adopt a phased introduction of GIS into the organisation to meet the more immediate needs of the Operations Design Department. The plan was to minimise disruptions, manage incremental changes to existing paper-based and computer-assisted processes and to achieve early payback in specific process areas.

The approach was to develop, build and implement in manageable portions and then continue to develop applications to meet the needs of other areas e.g. Marketing, Transmission, Gas Trading, Full integration with Work Order Management, Automated Vehicle Locating for Emergency Response, SCADA.

Senior management/ executives were keen that a productive GIS would be operational within twelve months of project award. This was prompted by the history of GIS projects where support and interest waned because of projects running on indefinitely. In order to achieve their objective the software build and site acceptance test had to be scheduled to occur in month ten and coincide with the return of the pilot data capture batch. It also required the loading of OSI vector data and the scanning, loading and aligning of BGE's entire network records to coincide with system acceptance. This enabled BGE designers to be productive immediately upon system acceptance - using current OSI vector data with the raster 'backdrop' of the BGE network.

Effective Management Structure

GIS cuts across existing lines of authority/departments and creates a need for change. Such change may be outside the control of the 'GIS team' and therefore senior managers must be ready to deal with the 'wider' impact of changes. The need to have an effective management structure in place to deal with such matters including the inevitable political conflict that arises on such projects cannot be overstated.

The BGE management structure was as follows:

- Executive Sponsor
- Project Sponsor – Head of National Distribution Opera tions
- GIS Steering Group – Department Managers (including IT)
- GIS Working Group – nominees of the above managers
- Project Team

The steering group consisted of department managers and a representative from the project team and they effectively were responsible for approving the GIS strategy and implementation plans. The project sponsor chaired the group meetings and regularly appraised them of GIS progress. He also directed managers when necessary to facilitate/help manage resources and implement necessary change.

"There is an increasing body of opinion that believes the lack of success with GIS systems lies not so much in any technical limitations, but rather in the neglect of human and organisational aspects of computing" - Reeve and Petch (1994)

As noted in the NYS archives GIS Development Guides (2000) - GIS is still an evolving new technology, the individuals involved (management, users, GIS staff) may have very different expectations for the project, some based on general perceptions of computing, which may or may not be correct. This, along with the long time period for developing the GIS, makes it very important for substantial involvement of management in the project.

BGE had both a member of the executive staff who was seen to be actively supporting the project and a senior manager who was project sponsor. The project sponsor was constantly appraised of progress and he attended all of the scheduled project sponsors meetings. It is believed this definitely sent a very powerful message to all associated directly or indirectly with the project.

One of the important points to make here is that selecting and having the right people assigned to the project will only happen if direction comes from above. Invariably the staff required for their input to GIS is the same (motivated) staff that managers least want to release. During the lifetime of the project numerous occasions will arise when project team members will require direct access to such individuals for clarification purposes etc and if such access was not readily available then the project could have been impaired.

This is just an example of where personal and organisational commitment is required and managers must make the necessary arrangements to ensure that willing staff was not overburdened as a result of their participation. The very fact that such issues were being aired at steering group meeting was often enough to ensure the necessary support and commitment was forthcoming down the line.

Similarly it is prudent to have an auxiliary plan that can be operated through the above forum if the need arises to deal with very busy periods on the project e.g. peaks during data capture and QA.

Developing an Implementation Plan

Implementation planning for the BGE project was not rigidly structured in the beginning, however once the decision to proceed was taken, a project lifecycle was planned with tangible milestone deliverables for each stage.

The implementation planning process was broadly as shown in Figure 1, and can be summarised as follows:

- Project formation and planning
- Feasibility analysis of business requirements and preparation of technical requirements specification for issue with Tender Documents
- Analysis of GIS proposals and appointment of GIS implementer
- Detailed design including specifications for Functional Requirements, Database Design and Data Capture
- System Acceptance Test and Pilot batch Data Capture QA/acceptance
- Development and implementation of a comprehensive training program
- System rollout and data capture of remaining nine batches of BGE network

The actual process of taking an overview of the organisation, examining all of the data, examining data flows and carrying out user needs surveys required a significant amount of cooperation from a cross section of the organisation. The value of having an effective management forum like the steering group was essential to facilitate orderly progress.

The importance of having staff particularly those involved in the consultative process attend vendor demos etc cannot be overstated. However there is a need to almost 'stage manage' some vendor demos for fear they raise peoples expectations too high.

BGE made a number of in-house presentations to various sections of the organisation and took those opportunities to temper expectations and state what could reasonable be expected from the proposed phased implementation and where possible indicate when it was scheduled to occur in specific areas.

During the development phase there was strong emphasis placed on setting achievable goals and getting the scope right. As the requirements became clear a comprehensive plan was prepared and presented to the steering group giving details of the areas with the highest potential benefits that were deemed by the group to be manageable in term of risk. The proposal contained an indicative budget, which included estimated costs of a GIS consultant, OSI landbase mapping, national address database and internal costs. It also highlighted the areas (outside of operations) that would be affected. The plan was approved with minor but important amendments i.e. the inclusion of the long-term requirement.

Project Specification

A comprehensive detailed project specification is the cornerstone of all projects, not just GIS; it must clearly define user requirements, data requirements and the business needs. BGE put substantial effort into preparing the project specification and engaged the help of a GIS consultant, yet there were a few areas that lacked sufficient detail or clarity, which resulted in some extra cost being incurred on the project. The documents included inter alia detailed description of the following requirements:

- Map management
- Address management
- General GIS Software input, output, data manipulation
- General Gas Network Data Manipulation
- Interfaces with Gas Network Analysis, Job Management System, Customer Information system, Hazard Management System
- Entity Relationship Model
- General software User Interface

- General software applications development
- Spatial analysis and display
- System Hardware
- System Network
- Training
- Support
- Data capture/conversion
- Contractor's Responsibilities

One of the lessons learned from the project was that any lack of detail or clarity in the specification will almost certainly incur extra costs and if they are extensive they will seriously impair if not cripple the project. In preparing a GIS specification one should be mindful of Gilb's (1997) comments where he says "we must differentiate between commentary and requirements which should be defined in terms of future and end state: testable and measurable"

Simply put if one fails to specify what is required, then it is unreasonable to expect an implementer to deliver a 'desired' solution!

Project Deliverables

The project deliverables were detailed in the contract document and can be as summarised as follows:

- Agreement of detailed definition of system performance
- Provision and customisation of software
- Provision of hardware
- Preparation of Network Source Maps for data capture
- Scanning, loading and alignment of BGE source network records
- Data capture
- Acceptance and loading of Ordnance Survey of Ireland (OSI) Data
- Acceptance and loading of Geo-Directory Address Data
- Training of Bord Gáis staff
- Testing and Acceptance of fully operational system by BGE

BGE opted for a 'Turnkey GIS Project' solution to be completed within a twenty-three months period. A major critical milestone on the project was in month ten as previously referred to when a fully functional site acceptance testing (SAT) was carried out on a ten percent sample (Data Capture Pilot Area) of BGE's converted data. On successful completion of SAT the system went into production. The rationale of 'Bulk Raster Scanning and Loading of the BGE's network record maps ' enabled BGE designers to use the GIS in production immediately after SAT.

The balance of the network data was then captured over the remaining period of the contract.

Project Execution

The BGE GIS project was executed in a remarkably similar fashion to the way BGE manage major engineering projects. They ensured they had a comprehensive project specification document including contractual and commercial terms. They appointed an experienced project manager, went to tender,

conducted tender evaluation and ensured every effort was made to eliminate ambiguity at the time of contract award.

One of the key factors in successfully executing such a multi-disciplinary project such as GIS was having an experienced project manager who applied well-tried and tested project management techniques to the project.

BGE were conscious of the spectacularly poor success of IT type projects and noted Gilb's. (1997) comments that "we need to convert the software engineering profession to genuine engineering and management practices" The central problem with technology projects he believes is a management problem. Given the statistical comparison between successful engineering and GIS projects BGE felt more comfortable opting for an experienced engineering project manager.

The project manager was selected on the basis that he had previously worked before with members of the team and had successfully project managed significant BGE projects (all were engineering projects).

Progress on the project was constantly monitored, resources were regularly assessed, and possible risks to the project were highlighted early and corrective action directed. Indeed all-essential elements of project management were applied, scope containment, rigid change and cost control, adherence to recognised quality standards which ensured the implementers met all of their contractual obligations. The project manager also ensured that BGE made the necessary commitment and ensured all BGE dependencies were fully met on schedule.

Design Phase

BGE found the design phase of the project proved to be very demanding and apart from the 'data capture effort' it was the most challenging periods of the GIS project. This was particularly true during the development/review of the Functional Design Specification and the Database Design Specification, which was an extremely busy period on the project. Every single object and attribute to be included in the database was by necessity scrutinised and every single functional requirement in the BGE specification was re-examined in detail.

Careful consideration and definition had to be given to Design rules, Manifold rules, Symbology and Validators as they would ultimately affect the behavior and functionality of the GIS.

It proved to be a rigorous test of the BGE project specification and it also challenged the knowledge and ability of the BGE project team - both their technical and managerial skills. BGE was aware that any omissions/errors during the design phase could seriously impair the usefulness of the system for the future.

To accomplish this phase of the project in a timely manner required a through understanding of the data, user requirements and the business needs. The following project documentation was required to be submitted by the implementers for review:

- Project Plan
- Quality Plan
- Project Program
- Functional Design Specification
- Database Design Specification
- Data Capture Specification
- Acceptance Test Procedures
- Training and Operating Manuals

There was considerable effort involved for BGE in the review of the vast amount of documentation generated on the project and the project team was stretched to its limits to cope satisfactorily.

Data Capture

Data capture was the single biggest cost on the project and arguably required the greatest effort over a prolonged period. The factors that ensured successful data capture on the project were in providing a complete description of the quality of data and quantifying as accurately as possible the amount of good and poor quality data for conversion and in using an experienced data capture specialist. Rectifying any major problems with network records in advance of project award was an essential step taken by BGE in order to avoid delays during data capture.

There was a commendable effort expended by all parties in compiling a comprehensive data capture specification. BGE's data capture team were constantly under pressure responding to all the issued raised by the data capture vendors. The data capture vendor had over seventy operators on data 'prep' and conversion at one point and BGE had to respond to between fifty and one hundred queries a day. This as already stated is why an auxiliary plan to quickly draft in extra resources to deal with such peaks was essential.

The data capture specification in particular went through a number of reviews and indeed it was necessary to issue an addendum to the specification during the Pilot.

The Implementers and the data capture vendor prepared the following documentation in consultation with BGE:

- Data Capture Plan
- Data Capture Specification
- Quality Assurance Specification
- Logistics Specification
- Acceptance Specification

The above documents contained detailed information on the complete data capture lifecycle; the data capture processes, records preparation, data conversion, quality assurance and quality control and acceptance quality levels.

The agreed Acceptance Quality Levels for data capture was as defined in the Data Capture Quality Assurance Specification and was as follows:

- Connectivity: 100%
- Completeness: 98%
- Placement: 98%
- Attribute: 98%

The data capture was successful primarily because all parties worked closely as a team resolving many problems and issues and were prepared to work through many unplanned obstacles to meet the ultimate project goal of having a topologically correct gas network model delivered on schedule.

Training

The implementers and the BGE project team including key users jointly developed the Training Plan. The first training course was delivered one month prior to the pilot data capture QA review. It was attended by key users and QA operators and was held in the project office. There was to some extent 'a train the trainer' approach taken. It is worthy of note that during the software development phase two workstations in the project office were made available to give key users access to 'play around with the system' well in advance

of formal training. This casual exposure to the system by users greatly assisted BGE in tailoring the training modules to suit individual user groups and helped eliminated any surprises. There were eight different training modules developed which were specifically tailored to meet the requirements of users in different departments with varying abilities.

Since the implementation of GIS all training has been done in-house using BGE 'super users' as trainers.

Introduction of GIS into the Organisation

The actual introduction of GIS i.e. commissioning the system and going live went smoothly. This was as a result of developing a plan in consultation with those directly affected by the introduction and by ensuring users had sufficient training. It is important that extra resources are available to relieve pressure of meeting work deadlines while new users become familiar and 'up to speed' with operating the system.

The level of training provided ensured users quickly became productive using GIS and the extra cover was only necessary for a relatively short period. The preparation and implement of new procedures for users doing work in GIS as soon as was practicable, was also an essential element in making user feel comfortable with the 'new tool'.

Conclusion

The approach to implementing GIS in BGE could be described as that of having a 'healthy scepticism' towards the technology. They were acutely aware of the high rate of GIS project failures and from the outset they strived to fully understand the complexity of the technology. They established a very clear view of what benefits they expected to be delivered from the GIS. They took on board the thorny issues such as managing technological change and endeavouring to understand the impediments to change. This was done essentially by putting in place appropriate management structure that was sensitive to user needs and by ensuring their involvement throughout the entire project –user inputs were taken seriously and reflected in the final solution.

The project is BGE believe a good example of where GIS technology has delivered all of the anticipated benefits within time and on budget. However to achieve success the organisation must inter alia scope the project into manageable phases and apply universally known methods for developing and managing projects including employing the necessary skill throughout the various stages of the project. The organisation must also ensure that the necessary preparation and training takes place within the organisation to facilitate the successful introduction of the 'new' technology.

Field Information Systems (FIS) & GIS Intranet Web

The implementation of FIS or an Intranet GIS Web was not part of the original GIS project scope. However FIS became number one on the priority list after successful completion. The selection of FIS began immediately on project completion and within four months rollout began. There are now fifty-five users accessing network information on laptops in the field that was previously only available in the office.

It is a relatively easy to use application which provides simple red lining facilities to external personnel involved in the utilisation of the gas network such as maintenance crews, contractors, sales personnel etc.

Similarly following on from the implementation of FIS the demand for wider access to the network information by the 'occasional' user became apparent and in order to meet their requirements a low cost Intranet application was sourced and implemented some eighteen months after the main GIS project completion.

Summary of Key Success Factors

The following is a list of key success factors from the BGE project;

- Examine and learn from what has happened with GIS in other organisations and look beyond one's own industry

- Learn about GIS technology, understand how the network needs to be modeled, the dependence of GIS on data and how it must be customised to become useful in the organisation.
- Have a proper management structure in place to ensure all aspects of project gets adequately resources.
- Do a critical analysis of all network records and data required for GIS
- Get the necessary resources and bring the records to a level that they can be understood by a data capture vendor – eliminate 'network gaps' in advance of contract award.
- Find out what legacy systems GIS needs to integrate with.
- Carry out a survey of external data required for GIS – availability, currency and cost of OS mapping, National address database.
- Determine what types/formats of data that needs to be imported into GIS e.g. drawings from local authorities, developers, consultants' etc.
- Understand the business requirements – what precisely is expected from GIS
- Clearly define what GIS applications are required to produce the desired products from GIS
- Involve users in all aspects of the GIS design processes, including analysis of data, data 'prep' and particularly in the QA of data
- Conduct a thorough review of project feasibility and scope.
- Develop a detailed project specification – any lack of detail will hurt.
- Employ GIS consultant only when needed.
- Use implementers that have a successful track record.
- Use an experienced project manager with a track record of delivering significant projects on schedule and within budget.
- Remove any ambiguity during tender evaluation period.
- Have clearly defined roles and responsibilities for all project team personnel.
- Be prepared for extremely busy periods and have an auxiliary plan to use extra resources when the need arises.
- Clearly define the roles of internal staff dealing with the issue and return of source data, answering queries from data capture vendor and train staff on how to carry out QA.
- Expose users to the system during the development phase, take on board their comments – eliminate surprises
- Insist that site acceptance testing be done in a logical fashion similar to organisation's production processes
- Involve users in the development of the training plan.
- Prepare for the commissioning/introduction of GIS, employ extra resources to deal with ongoing design work and allow staff time to get up to speed.
- Prepare internal procedures for staff and remove any confusion about how things are to be done using GIS
- Celebrate with all involved and enjoy watching users demonstrating the power of the system to colleagues and visitors!

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