Forging the Road Ahead:
An ArcIMS/.NET System Implementation

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ABSTRACT

Starting in 2002 the Department of Development and Environmental Services (King County, DDES) began a transition from a legacy ESRI environment to the ArcGIS platform. A part of that transition was a plan to move away from legacy ArcView 3.x counter applications to ArcIMS and ArcSDE. Charged with creating and maintaining this new environment, a two person development team faced a daunting task. An innovative Web-based solution was devised which consists of Informix, SQL Server and ArcSDE (database tier), ArcIMS (GIS Tier), .NET Web Services (business tier), and ASP .NET (client tier). The separation of the GIS, database and business tiers along with a modular development approach allows for an extensible system that is easy to maintain and independent of changing backend technologies. This paper will focus on a step-by-step design and implementation of this new system and the challenges in migrating from ArcView 3.x to ArcGIS technologies.

INTRODUCTION

Located on Puget Sound in Washington State and covering more than 2,200 square miles, King County is nearly twice as large as the average county in the United States. With more than 1.7 million people, it ranks as the 12th most populous county in the nation. The Department of Development and Environmental Services (DDES) issues building and land use permits for properties located in unincorporated King County. GIS plays a pivotal role in enforcing county land use and building codes, assisting the Fire Marshal's Office in arson investigations and in issuing business licenses.

BACKGROUND

For the past 10 years, permitting and geographic data have been delivered to DDES staff (approximately 200 users) in a custom ArcView 3.1 (20 concurrent licenses managed on a network install) application called Base2 (**Figure 1**). Base2 allows a user to search for a specific property using one of several different criteria (parcel number, address, taxpayer, permit number) or to navigate to any area of interest by panning and zooming into a map of the county. Once a property or other area of interest is located, a user can add or remove any of the dozens of themes available in Base2, and query the value of any given theme at any given location in the county. Base2 provides access to multiple data layers through various reports (Parcel Information Report, Legal Description, and Permit Information Report) that are used daily by permit technicians to help evaluate permit application requests.

In addition to Base2, our users have access to two countywide Internet IMS sites: iMAP and Parcel Viewer. Both of these provide the general public and internal staff with spatial information for properties in King County.
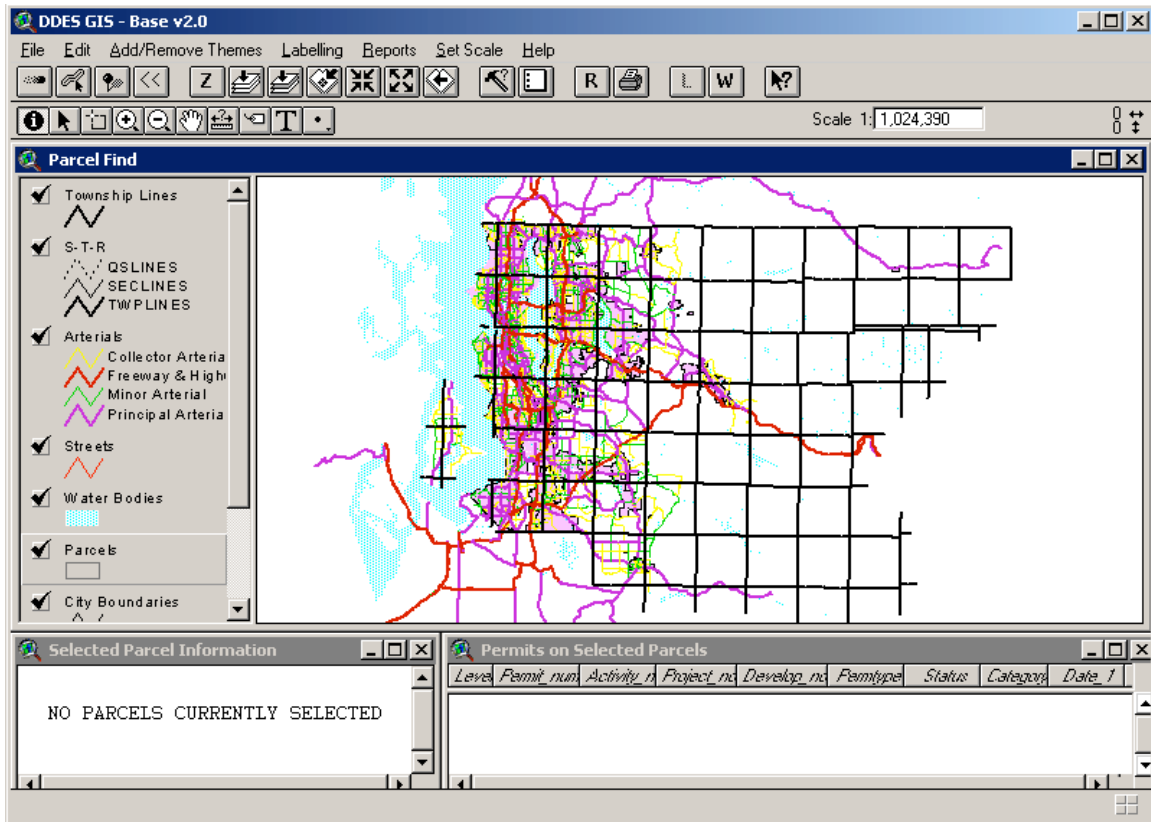
Figure 1 ArcView 3.1 DDES Base2 main interface

PROBLEM STATEMENT

In late 2001 DDES hired a team of GIS Specialists to assist in the transition to ArcGIS, the development of new user tools and the automation of backend maintenance procedures. During the planning phases of this transition a number of problems were identified:

Base 2

- ArcView 3.1 could not view ArcSDE 8.x layers and the cost of upgrading 20 3.x clients was not desirable.

- ESRI was lowering its level of support for 3.x clients.

- Support of Base2 functionality in an ArcView 3.x environment was not desirable and was client specific.

- Base2 Avenue code was bloated and unmanageable.

- Base2 could not access data from its native source (Informix).

- GIS staff updated data tables manually and replicated data from other systems (Informix).
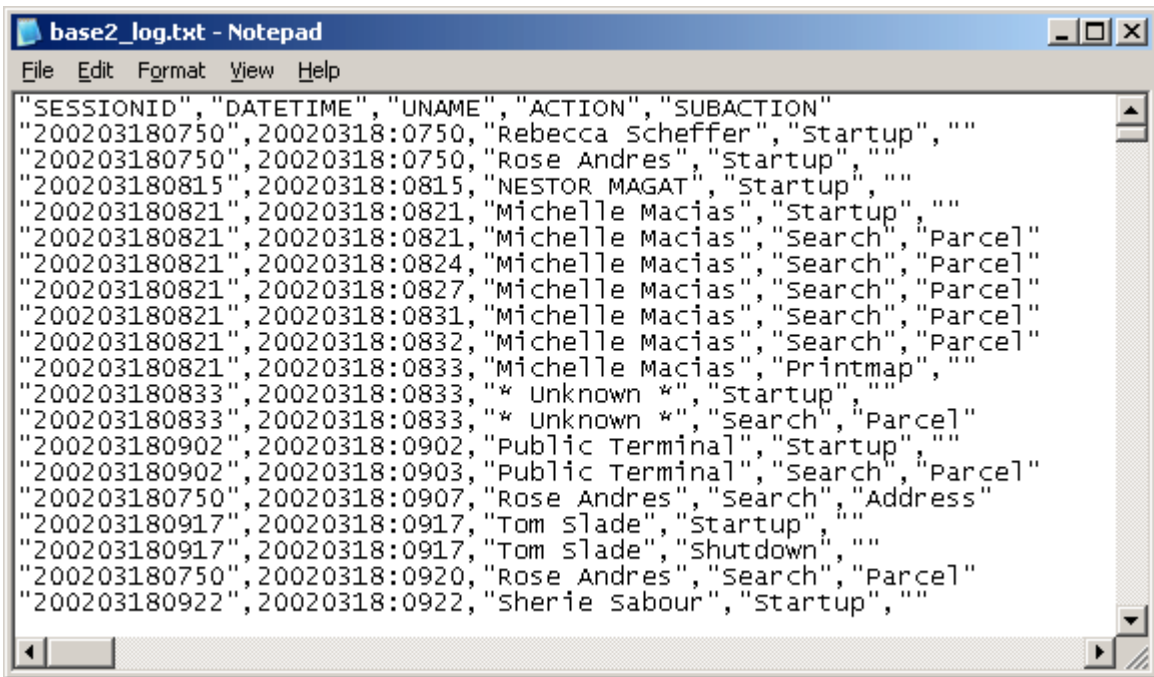
iMAP, Parcel View and standard ArcIMS template

- iMAP was a public site and could not be modified easily to accommodate sensitive data for internal staff only.

- The standard ArcIMS html template that iMAP was based on did not offer the flexibility and control to deliver a highly customizable structure.

- The html template was designed as a single purpose application for a specific platform (pc web browser) and did not offer alternative deployment options (mobile field devices).

PLANNING

Usage Logs

Early in the planning it became evident that essential information was missing about Base2 usage that needed to be obtained before proceeding. Usage logs were implemented in Base2 to determine who was using the application, how often and what tools they were using. Avenue code was inserted into Base2 that captured a unique session id, date/time stamp, action and sub-action that was written to a comma delimited file on a network drive (**Figure 2**). Over a period of approximately six months this data was compiled and used to gather general Base2 user statistics.

Figure 2 – Base2 comma delimited log file extract

The reports (**Figure 3**) were used to compile a list of known Base2 users and identify power users in each section. GIS staff was also able to compile general usage statistics such as the number of daily sessions, number of hours in use, session duration, number of actions and tool usage.

BASE 2 USAGE LOGS
FOR MARCH - AUGUST 2002

TOP 10 USERS
BY ACTION AND NUMBER OF SESSIONS

MONTHLY

USER	ACTIONS	%		USER	SESSIONS	%		AVG. TOTAL DAILY HOURS	
Public Terminal	4,306	15%		Public Terminal	654	13%			
Trudy Parman	2,090	7%		Beverly Harrelson	269	6%		MONTH	HOURS
Beverly Harrelson	1,411	5%		Trudy Parman	252	5%		03	88
* Unknown *	1,239	4%		* Unknown *	240	5%		04	85
Rose Andres	907	3%		Patricia Malone	155	3%		05	78
Beth Cheshier	813	3%		Bill Kerschke	154	3%		06	82
Patricia Malone	605	2%		Beth Cheshier	121	2%		07	82
Bill Kerschke	601	2%		Rose Andres	119	2%		08	83
Sonja Hardy	586	2%		Sonja Hardy	116	2%		AVG.	83
Arlene Chan	579	2%		John Sage	115	2%			
SUBTOTAL	13,137	46%		SUBTOTAL	2,195	45%			

SUMMARY TOTALS

AVG. DAILY SESSIONS

TOTAL HOURS

TYPE	COUNT		MONTH	SESSIONS		MONTH	HOURS
Users*	147						
Actions	28,512		03	28		03	882
Startups	5,767		04	26		04	1,878
Shutdowns	4,875		05	23		05	1,945
Avg. Session Length (Hours)	2.2		06	25		06	1,880
Max Session Length (Hours)	11		07	24		07	1,967
			08	24		08	1,982

Figure 3 - Base2 usage report

User Survey

To get a better idea of what functions and data would go into Base2's successor, a comprehensive list of Base2, iMAP and Parcel Viewer functionality was compiled into a survey (**Figure 4**). The survey was administered to key users of each section which were previously identified in the usage logs. The survey posed questions about individual functions and data layers to determine their usefulness, usage, and importance in daily tasks. Users were also given the opportunity to provide comments and suggestions for how the tools could be enhanced and to request new tools.

The survey was analyzed and the functions and data were assigned individual ranks which were grouped into like functionality. The results also showed what elements each section valued most.

User Login: admiacab

Web - Parcel Viewer - Search Features　Skip this Section

On a scale of 0 - 4, with 0 being the lowest and 4 being the highest, please rate how important this feature is (in the specified application) to your workflow and estimate the percentage of time it is used when in the application. There is also a link that allows you to provide Comments for each question if you have additional feedback.

1.) Find by Address　Image Help　　　　　　　Comments

0 ○　　1 ○　　2 ○　　3 ○　　4 ○　　　　　--Percent Used-- ▼

0 (Not Important) --- 4 (Essential)

2.) Find by Parcel Number　Image Help　　　　Comments

0 ○　　1 ○　　2 ○　　3 ○　　4 ○　　　　　--Percent Used-- ▼

0 (Not Important) --- 4 (Essential)

3.) Find by Cross Street　Image Help　　　　　Comments

0 ○　　1 ○　　2 ○　　3 ○　　4 ○　　　　　--Percent Used-- ▼

0 (Not Important) --- 4 (Essential)

Submit Answered Questions and Save Survey Progress

Previous Page　　　　　Percent Complete:　68%

Figure 4 – Comprehensive GIS User Survey

Prioritization

Once the data and features were given ranks and grouped, GIS staff assigned a priority list was devised. In creating the priorities, a few items were taken into consideration:

1. Elements should be grouped with like items when possible.
2. Element groups should be prioritized in a way that takes into account user importance.

It became immediately obvious that many of the report elements in Base2 were surfacing as top priorities followed by search functionality, map visualization and output.

Project Phases

With over one hundred functions, reports and data elements it was decided that a phased implementation was the best approach to move away from Base2. The following were the criteria used in developing these phases:

1. Small easily implemented function blocks.
2. Function blocks that slowly transitioned users away from Base2.

Goals were identified for each function block and grouped into four phases:

Phase I – Reporting

Interface Changes
The interface changes will be made at the end of this development phase:

- – Parcel Information Report UI
- – Permits Report UI
- – Legal Description Report UI

Goals

- – Improve speed of reports.
- – Improve overall usability and usefulness.
- – Access report data in its native format to improve data currency.
- – Eliminate some dbf tables and manual processes.

Phase II – Map Output, Searching, Map Interface

Interface Changes
The interface changes will be made throughout this development cycle in phases to slowly transition the users to the new tools and interfaces:

- – Map Output UI
- – Search UI's
  - o PIN
  - o Address
  - o Cross street
  - o Condo
  - o Permit number
  - o Vicinity (city, zip-code, council district, etc)
- – Map UI
  - o Navigation and Interaction
  - o Table of Contents and Legend
  - o Map Generation

Goals

- – Create an environment (map output, search, interactive map interface) that is equivalent to Base .2
- – Improve map output portability.
- – Provide direct access to GIS tools (search, reports, output, etc).
- – Improve overall usability.
- – Complete access to GIS data in its native format to improve data currency.
- – Eliminate data redundancy (shapefiles and dbf's).
- – Create a full replacement for Base 2.

Phase III – Enhanced Map Output, Rapid Map, Custom User Settings, User Specific Modules

Interface Changes
The interface changes will be made throughout this development cycle in phases to slowly transition the users to the new tools and interfaces:

- – Rapid Map UI
- – Advanced features added to the Map UI

- Custom User Settings UI
- Section specific UI's

Goals
- Create templates and user customizable environment to produce rapid maps
- Enhance current mapping features.
- Improve overall usability and usefulness.
- Allow users to customize the GISMO environment with savable settings.
- Create custom UI's for sections specific needs that leverage the robust GISMO code base.
- Create a full replacement for Autoplot.

Phase IV – Data Editing UI

Interface Changes
The interface changes will be made at the end of this development phase:

- Editing UI
  o User Editing Module
  o Management Review Module
  o Data Integration Module

Goals
- Allow users to edit GIS data directly and the changes be reflected in "real time".
- Improve overall usability and usefulness.

DEVELOPMENT

APPROACH

ArcIMS was determined to be the best solution to distributing GIS functionality to multiple non-GIS users to multiple clients (e.g., pc, mobile, handheld). Unlike many internet implementations of ArcIMS that present the application as a mapping interface, GIS staff wanted GIS mapping functionality that could be designed as building blocks to be reconstituted into multiple interfaces. GIS developers devised the following goals for the new DDES application:

GIS Mapping Operations (GISMO) Goals:

- The ability to interface with multiple client types.

- Functions developed as loosely coupled building blocks (**Figure 5**).

- Tier that is loosely coupled with the client and server tiers.

- Reduce data redundancy by providing direct access to the native data source.

- Single point of communication to various systems (e.g., ArcIMS, SQL Server, Informix).

- Configuration files that allow for simple modifications without touching code.

Given these goals and the adoption as .NET as the DDES development standard, the development would be completed in VB.NET with a combination of ASP.NET and Web Services as the delivery medium.
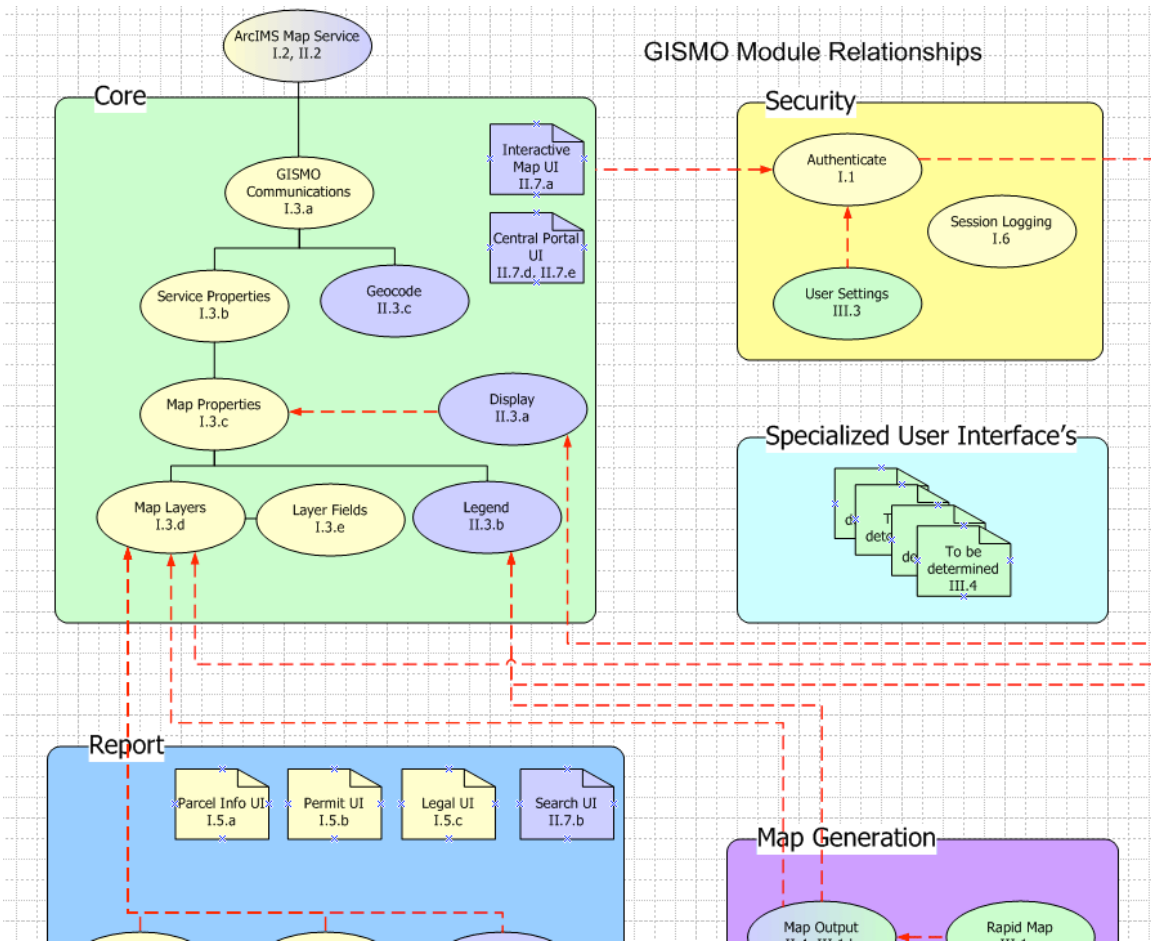
Figure 5 – GISMO module building blocks

GISMO developers decided that GISMO would be designed within a three-tiered structure (**Figure 6**) and would reside in the business tier. This would allow for separation from server technology and allow it to be delivered to multiple client types. Phases I and II would deliver GISMO to web clients only and would consist of Web User Interfaces (ASP.NET in the client tier) connecting to the GISMO Core (Web service in the Business Tier).
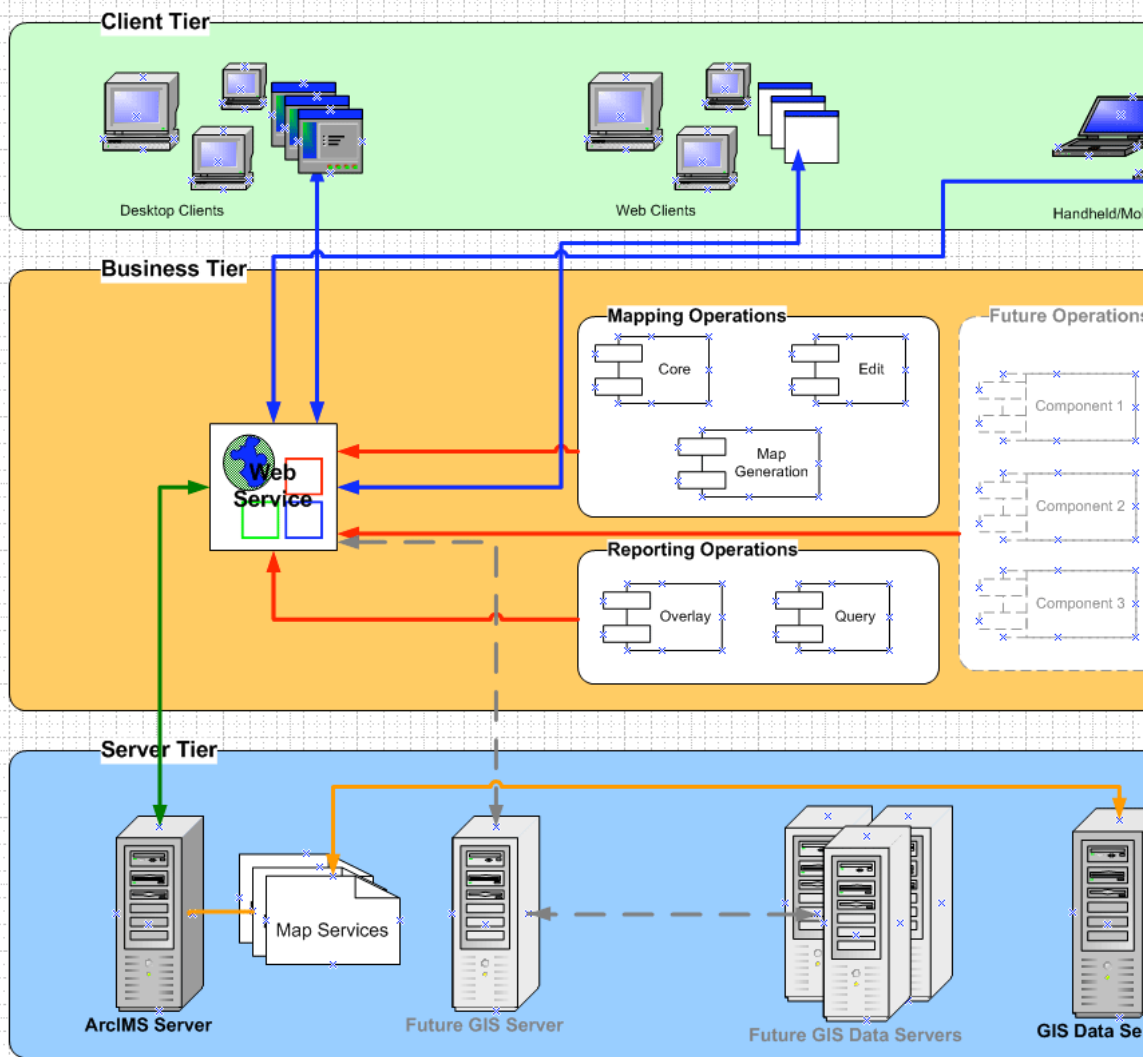
Figure 6 – GISMO three tiered structure

APPLICATION DEVELOPMENT

The GISMO development effort consisted of 2 DDES programmers. The programmers adopted a modified version of the Extreme Programming and went with a team programming approach for all phases of development. This practice ensures that all code is reviewed by at least one other programmer which in turn results in better code and fewer errors.

SUMMARY

Road Blocks

Like any project the GISMO planning and implementation (Phase I) encountered many setbacks which were beyond the control of GISMO programmers. The following are a few items that made implementation more challenging:

- Staffing changes -
  Early in the planning process a new manager and developer were added to the DDES staff.

- Functional spec/Technical spec:
  In an effort to "save time" a hybrid functional and technical spec was created. This proved to cause more problems than it solved and doubled the effort with half of the desired result.

- Priority changes:
  Shortly after the Phase I development effort began there were several priority shifts of other projects that split the GISMO development team and resulted in a loss of 3 months.

LESSONS LEARNED

Many lessons were learned during this effort:

- Planning is good:
  Although the documentation process caused minor setbacks, the end result was a highly detailed outline of what GISMO would include (Phase I) that proved invaluable during development.

- Team development is the right approach:
  This approach at first looks like it is double the effort, but DDES staff found it was just the opposite. The GISMO development team's effort resulted in better code which required less code cleanup and a firmer comprehension by both developers.

- Smaller phases are more desirable.

- Separate technical and functional specs:
  Keeping these two documents separate is a time saver and results in a product that is more desirable to the developer and manager.

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