

2008

University of North Carolina Wilmington
Master of Science in
Computer Science and Information Systems
Proceedings

<https://csbapp.uncw.edu/mscsis>

Utilizing Web Technologies to Provide Historical Data Relative to the Economic Health of Southeastern North Carolina

Capstone Project

Josh Tobey

MS-CSIS Candidate

May 2008

Committee:

Dr. Tom Janicki (Chair)

Dr. Woody Hall

Dr. Bryan Reinicke

Dr. Ron Vetter

Table of Contents

I.	Introduction.....	1
II.	Background and Analysis	2
	A. History.....	3
	B. Problems	7
	1.Data Gathering	7
	2.Data Accessibility.....	8
	3.Data Usability	9
	C. Importance.....	9
III.	Methodology and Plan – System Analysis/Design Methodology.....	11
	A. System Development with the Unified Process	11
	1. Inception	12
	2. Elaboration	14
	3. Construction	15
	4. Transition	16
	B. Alternatives to the Unified Process	17
	1. Waterfall Development Methodology.....	17
	2. Spiral Development Methodology.....	18
IV.	Activities Completed.....	19
	A. Fall 07 – Inception Phase (first iteration)	19
	B. Spring 08 – Inception Phase (second iteration).....	22
	1. Interviews.....	22
	2.System Objective	25
	C. Spring 08 – Elaboration Phase.....	25

1. Analysis.....	25
2. Design.....	26
3. Ease of Input Process.....	27
4. Output Medias	28
D. Spring 08 – Construction Phase.....	30
1. Technologies Employed.....	30
2. Database Upgrades	31
3. Graphing.....	34
4. Touch Screen Capabilities.....	37
5. Creating Functionality per User Role	39
6. Export of Data.....	42
7. Automated Collection of Data	42
E. Spring 08 – Transition Phase	43
V. Timeline of capstone project milestones.....	44
VI. Lessons Learned	45
A. System Analysis Skills	45
B. N-Tier Development Learning	45
C. Technologies Employed.....	46
D. Human Computer Interaction	46
E. Managing / Working with Others	47
F. Areas of Improvement	47
G. Helpful Courses	47
VII. Conclusion	48
VIII. Future Work	50

IX.	Acknowledgements	50
	References	52
	Appendix A – Interviews	53
	Appendix B – System Objective	61
	Appendix C – Use Cases	62
	Appendix D – Use Case Diagram	65
	Appendix E – Database Diagram	66
	Appendix F –Wilmington Business Journal Article	67

I. Introduction

In a 2007 article in the Greater Wilmington Business Journal, UNCW Senior Economist, Dr. William Hall, predicted a 5 percent growth in the southeastern North Carolina economy in 2007 and a 4.5 percent growth in 2008. These forecasts were based on historical data relating to construction permits and unemployment rates. Referring to the decline in growth percentage, he compared it to the growth in previous years and said “We are still moving forward. We’re just going forward less rapidly.” (Bon 2007)

Dr. Hall bases these economic growth predictions on the various economic data sets he collects on many counties in southeastern North Carolina. As a result of this collection of historical economic data and his forecasting abilities, Dr. Hall is in high demand as a speaker to government and business organizations in southeast North Carolina. He is recognized as one of the premier economists in the area. These predictions become highly important to those considering expanding or relocating to this area and leads to increased economic prosperity in the region.

There are two major goals of this capstone project. The first is to assist Dr. Hall in the collection, storage, and presentation of the data he collects. The goal is to efficiently automate many of the processes that Dr. Hall must go through to make forecasts, leaving him with more time for data analysis and predicting the economic future. The second goal is to take the data that resides on Dr. Hall’s desktop computer and share the historical data with groups interested in the economic health of the regional. For example, this publically available data may be used by such groups as the Wilmington 100, which works to recruit new industries to the southeast North Carolina region.

This project is of high importance to the University of North Carolina Wilmington, as it fits into one of the university's Seven Strategic Goals. One of these goals states that the university should promote economic development in the area by providing intellectual and human capital as a collaborative effort between the university and the community (UNCW Mission). In addition this project will assist the Cameron Business School achieve one of its UNC Tomorrow goals for CBES to make their economic data publically available on the web in an easy format for users to read and analyze (UNC Tomorrow/CSB and CBES specific goals).

This paper discusses the analysis, design and programming involved in developing the data and web processes to make the initial set of data for four counties available to the public on the web. It details the background of the project including its conception and maturation. It provides an analysis of the prototype, detailing some problems with possible solutions to be researched and the importance of continuing work on this project. The project follows an Object Oriented Unified System Design methodology and also compares this methodology to alternative methodologies. The initial work plan presented in December is contrasted to the actual work completed and the actual time line. The paper ends with a discussion of future enhancements.

II. Background and Analysis

The original concept of providing an improved system for easily accessible economic data began as a research grant provided by the State of North Carolina to foster faculty/undergraduate research in 2004. This section discusses the history of the project, problems identified with the

current prototype, and the importance of the project to the economic vitality of southeastern North Carolina.

A. History

The collection of economic data was started and managed by Dr. William Hall, the Senior Economist for the Center for Business and Economic Services (CBES) within the Cameron School of Business (CSB) at the University of North Carolina Wilmington (UNCW). Dr. Hall is a Professor of Economics at UNCW and has been doing economic research since he joined UNCW in 1974. For roughly the past 20 years, Dr. Hall has been collecting various types of economic data relative to southeastern North Carolina. Shown in Table 1 are Dr. Hall’s initial categories and breakdowns for data he collected:

Data Category	Data Breakdown(Data Pod)	Units
ILM Air Traffic	Cargo on Cargo off Passenger on Passenger off	Tons Tons Units Units
Residential Construction Permits	Duplex-New Duplex-Alteration Multifamily-New Multifamily-Alteration Single Family-New Single Family-Alteration	Units and Dollars all categories
Non Residential Construction Permits	Commercial-New Commercial-Alteration Industrial-New Industrial-Alteration Institutional-New Institutional-Alteration	Units and Dollars all categories
Employment/Unemployment Rates	Employment Unemployment Unemployment Rate	People People Percent
Vehicle Sales	Car Truck Total	Units Units Units

Table 1: Initial Data Collection Categories

These data sets were first captured for Brunswick, Columbus, New Hanover, and Pender counties. Since this project was started it has been Dr. Hall's goal to expand the types of data sets collected and to include all counties east of I-95. Eventually, he envisions expanding to all counties in North Carolina.

To enable Dr. Hall to perform analysis, he stored the data in multiple spreadsheets that span multiple counties and many years (each data category had its own workbook file with multiple sheets). He employs this data to analyze historical trends and provide economic projections. Finally, the data is utilized to assist in his presentations about economic conditions and the economic outlook of southeastern North Carolina. For example, CBES sponsors an annual Economic Outlook Conference each October to discuss the economic health of southeastern NC in which Dr. Hall, his data, and the resulting projections are a key component of the conference. This past October marked the fourth annual meeting of this conference and was attended by approximately 250 participants from southeastern NC. The importance of accurate and easily analyzed data is evident in that Dr. Hall gives roughly one presentation every five to six weeks, usually to local civic and professional organizations. He also makes several presentations a year to regional organizations. The media frequently contacts him for comments on the economic aspects of current events, such as Federal Reserve action and forecasts of holiday sales.

Student involvement with this project began as a result of the Grid Computing Grant. The Grid Computing Grant began in 2004 with the goal of fostering undergraduate research within North Carolina public universities. In addition to having undergraduates involved, a goal of the grid project was to enable the sharing of computer resources and data throughout the state. UNCW received a portion of this grant and a segment of that was set aside for the UNCW Economic

Web Application. This allowed students to build a prototype system to store and display the collected data via the web. A total of four undergraduate students worked on this project at different times over the course of 2004 to 2006. These students included Bryan Foster, Jon Werner, Dianne Angeli, and myself, with each student working on the project for approximately one semester. Initially, the system was programmed utilizing a SQL Server 2000 Database to store the data, and an ASP.Net 1.1 web interface.

My involvement began in 2005 when I assisted the other students in completing the initial prototype of the project. This prototype included the ability to:

- Store data in a relational database
- View data from the database in a web environment including calculations of moving averages and comparisons and seasonally adjusted indices.
- View data from the database in graphical format including relatively primitive bar and line charts.
- Edit existing data or insert new data into the database. (administrative users only)

A major contribution that I made early in the project was a database redesign. At the time, each data set had its own table in the database. The original database design in 2004 was more a 'flat file' structure versus truly being a relational data model. Whenever a new data set was added, a new table had to be created in the database, and the program coding had to be changed. To solve this problem I created a generic table to hold all of the data sets and built the appropriate relationships between the tables. With this change, all that is needed to add a new data category is to add a row to a database table defining the data category and corresponding reports. The same is now true for adding a location, whether it is a county, city, or any other

type of location such as an airport or commerce port. This relational database contains raw data only, meaning that all calculations are done as functions in structure query language (SQL) or ASP.Net. As part of the redesign, the database was updated to the 2005 version of SQL Server.

Naming conventions were enacted as a result of this change and another redesign of the database structure made in Fall 2007. A Data Category refers to highest level of identifier (see Table 1 and Figure 1). Examples of a Data Category include:

- Air Traffic
- Construction Permits
- Ports
- Retail Sales
- Unemployment
- Vehicle Sales

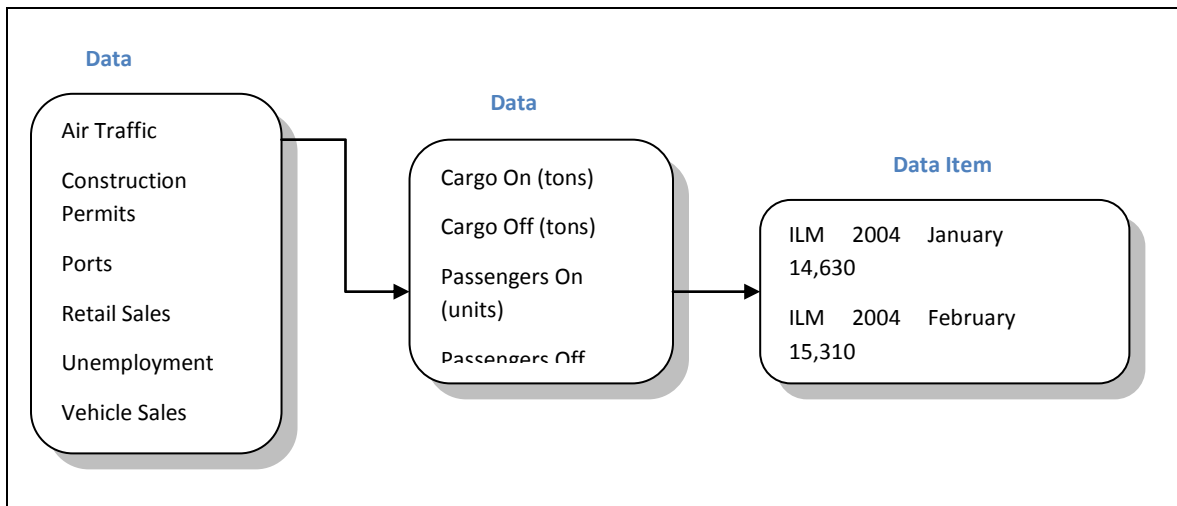


Figure 1: Breakdown of one data category and one data pod

The next level is a Data Pod which refers to the subcategories of a Data Category (see Figure 1).

For example, the Data Pods for the Data Category Air Traffic include:

- Cargo On (tons)
- Cargo Off (tons)
- Passengers On (units)
- Passengers Off (units)

The lowest level is the Data Item which is the actual unit of data for a particular Data Pod (see Figure 1). This refers to the value of a Data Pod for a given Month, Year, and Location.

B. Problems

Funding for the project ended early in 2006 and the prototype was moved to limited production. As it was developed as a prototype there were some underlying problems with the system, which are listed below.

1. Data Gathering

Dr. Hall collects this data from various public and private sources. However, the format and source of this data vary from cutting and pasting from individual emails to data available on government websites. For example:

- Employment and unemployment data are provided by county by the Employment Security Commission of North Carolina in an email message.
- Retail sales tax collections data are provided by the North Carolina Department of Revenue via a web page.
- Air Traffic data are provided by the Wilmington International Airport via an email.
- Port Data are supplied by the North Carolina State Ports Authority via an email.
- Vehicle sales data are supplied by the North Carolina Automobile Dealers Association via a published paper report.

A goal of this project was to compile this information into **one** database in order to make informed decisions and forecasts. Compiling data from multiple sources becomes difficult when the data is not given in the same format; it takes time to put it in the same format and can lead to errors. It is also a time consuming process to retrieve the information from the various sources and then compile it. As noted earlier, these sources vary from emails, to websites, to publications. Data accuracy, data integrity and reliability should all increase as a result of the uniformity of the collection and storage of data in one format and one database.

2. Data Accessibility

Dr. Hall relied on his spreadsheets to give presentations and help organizations with economic forecasting rather than the database because it was still a prototype. This becomes an issue if Dr. Hall needs to access the data when he is not at his local PC. Through the use of a website connecting to the database, Dr. Hall could have access to the data anywhere there is an internet connection.

One of UNCW's strategic goals is to serve the southeastern North Carolina region (UNCW Mission). There are currently limited capabilities accessible by the public, and many potential users are not aware of this project's existence. Many people and organizations could benefit from access to this data. The southeast region of North Carolina may benefit in its recruitment of industries to this region as the data becomes more accessible and easier to read and interpret.

3. Data Usability

The multiple spreadsheets in which Dr. Hall stored the data are complex and sometimes difficult for non-economists to understand. These spreadsheets have grown to be quite large and the amount of data can be hard for the untrained eye to comprehend. Since the spreadsheets do not follow a relational data model, it is difficult for others to interpret.

Human-Computer Interaction (HCI) is the study of “how best to design interactive systems that are both productive and as pleasurable to use as possible by their intended users” (Smith-Atakan 2006). HCI theory recommends increasing the visualization of data. The initial prototype provided limited graphing options, including only bar graphs and line charts. New graphical applications would increase the understandability of the information by supporting a variety of presentation modes and more captivating graphics.

The initial prototype provided data on the web only in table and graph format. The initial prototype provided no web services or any capability for the data to be exported in an XML or a spreadsheet format. Increased export capabilities would allow potential users to write their own algorithms that could access the data.

C. Importance

The collection and dissemination of this data is extremely important to the economic community of southeastern North Carolina. CBES is an objective, impartial source of data that has no particular agenda in sharing the public information. The collection and analysis of this data is important to Dr. Hall because he and the CBES receive numerous requests during the year from businesses that need information to help support major business decisions such as

applying for a loan to expand or create new operations in the area. The CBES also receives requests from public officials for data to help them prepare budgets. Again, this supports the CBES mission statement. From their web site a portion of the CBES mission statement reads:

“The Center for Business and Economic Services in the Cameron School of Business at UNC Wilmington is the business research and outreach division for Cameron School of Business. Center Staff collect and analyze local, state, and national economic data that impact our region and its growth.”

This project fits in with the fifth strategic goal for UNCW as a way to “enhance the university’s ability to perform larger scale multidisciplinary applied research programs that focus on issues important to southeastern North Carolina” (UNCW Mission). It is also a way to “strengthen regional engagement through student and faculty service, outreach and applied scholarship” which is CSB’s fifth learning goal (CSB Mission). Finally, this project provides the means to “promote and support economic development in southeastern North Carolina” which is one of the major goals of CBES (CBES Mission). The UNCW Tomorrow draft document (May 2008) details that the Cameron School of Business includes these two goals: a) Make available the CBES economic data for 40 counties on to the web, b) and, complete remaining 60 counties. This project supports the University’s and the Cameron School of Business’ goals.

Converting the prototype to a production data source that can be shared was of high interest to me because of my previous investment in the project. I desired to leave UNCW with a completed project. The enhanced work on this project also provided additional learning opportunities that span several different topics in web computing, including: Human-Computer Interaction, system analysis, design and web development, and an increased knowledge of economic analysis. Working on this project allowed me to learn and go through all the steps in the system development process, as well as learn new cutting edge web technologies.

III. Methodology and Plan

This section defines the steps undertaken to take the prototype to a production ready system.

A. System Development with the Unified Process

The Systems development methodology for this project follows the Object Oriented Unified Process methodology. The Unified Process system development life cycle is made up of four phases: inception, elaboration, construction, and transition, which can then be divided into iterations (Figure 2). Some form of deliverable is due at the end of each iteration, rather than waiting the entire duration of the phase. This permits enhanced user feedback during the development life of the project. Each phase has specific tasks, or disciplines, that should be accomplished as shown in Figure 3. (Satzinger et al. p. 45-47)

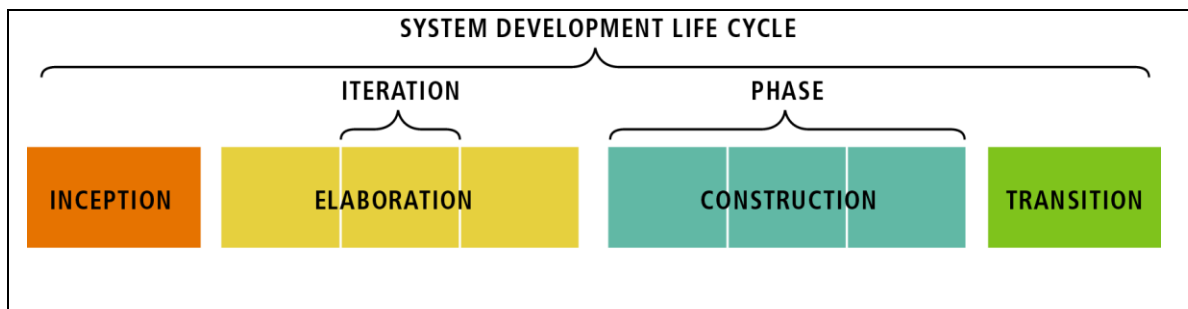


Figure 2: The Unified Process System Development Life Cycle (Satzinger et al. 2005)

The Unified Process methodology grew from the systems development process originally created by the Rational Software development group within IBM to produce “high-quality software that meets the needs of its end-users, within a predictable schedule and budget” (Rational Unified Process). The Unified Process is “an object-oriented system development methodology” that “uses Unified Modeling Language (UML) to design system models and the Unified Process system development life cycle” (Satzinger et al. p 50-51).

It is an iterative process that defines specific activities and deliverables at each phase of the development life cycle. This system development methodology is very useful because it allows a developer to revisit items from previous phases. For example, Figure 3 shows that while requirements are focused on more in the inception and elaboration phases, they can be modified throughout the life of the project. Figure 3 also shows each of the Unified Process Disciplines (tasks), and where each of these tasks is emphasized during the development life cycle.

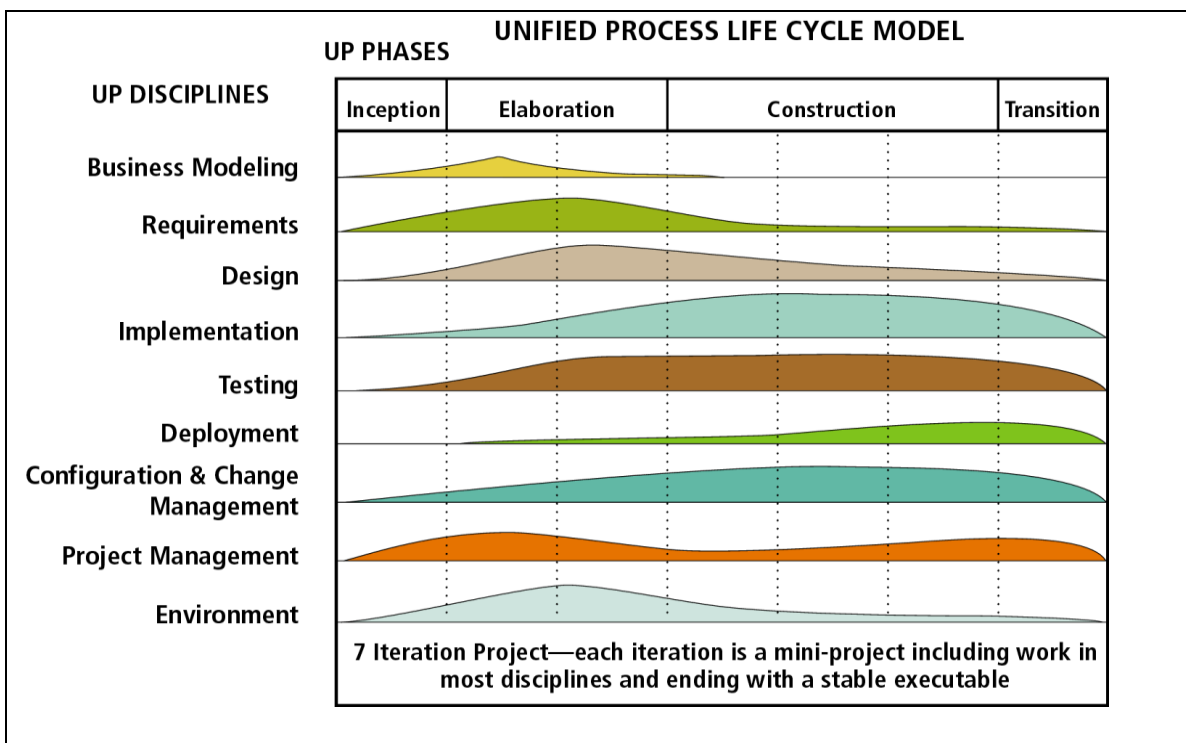


Figure 3: Unified Process Life Cycle with Phases, Iterations, and Disciplines (Satzinger et al. 2005)

1. Inception Phase

The business modeling discipline involves understanding the business processes and environment where the problem lies and which the system must solve. To do this, the analyst must understand the business goal of developing the proposed system. Similarly, in the requirements discipline the business needs are discovered and documented. This involves

interviewing all types of potential stakeholders to ascertain the requirements for the system, as well as documenting these requirements for future use (Satzinger et al. p 55-57). Many of the business models and requirements are already complete as a result of the prototype, but to follow a system development methodology more work needed to be accomplished.

Specific tasks to be completed during the inception phase include:

- A System Objective must be developed to document the goals and benefits of the project.
- The potential major stakeholders of this system should be determined and they should be interviewed to learn their specific needs for the system. There are two main sets of users for this system, internal and external. Internal users will be members of CBES team including:
 - Dr. William Sackley, Director
 - Dr. William Hall, Senior Economist
 - Mr. Jonathan Rowe, Program Director
 - Ms. Jennifer Mackethan, Administrative Assistant

External users are divided into three subcategories:

- Public organizations such as Progress Energy
- Government agencies such as New Hanover County and city of Wilmington officials
- Not-for-profit economic developers such as Wilmington Industrial Development, Inc.

- Use Cases should be developed for the major interactions with the system by all stakeholders, including:
 - Updating current data for a data set
 - Displaying a subset of the data in a graphical format
 - Adding an entirely new Data Category (i.e. several requests have been made to determine if the database could also manage non economic data for the region such as demographics and crime statistics).
- Use Case Diagrams should be developed to map the actors to the use cases they are involved in.

More detail on the work completed during this phase is described in the “Activities Completed” section of this report.

2. Elaboration Phase

During the elaboration phase, requirements are continuously gathered and modified. Also, the design and implementation disciplines begin in this phase. The design discipline involves developing a model of the major components of the system based on the gathered requirements (in this case, updating the existing database and system prototype as part of the iteration process). Using this design, the implementation discipline builds the key components of the system. (Satzinger et al. p 57-58)

Specific tasks to be completed:

- A class diagram and database diagram should be created to show the underlying system architecture.

- Activity diagrams should be developed for the major use cases and interactions with the system.
- A CRUD (create, read, update, delete) diagram should be created to show the use cases relative to the domain classes.
- Redesign the database model to be more generic in nature and accept more types of data with various types of units (i.e. units, tonnage, people counts, dollars)
- Upgrade the current web prototype to newer technologies such as upgrading to ASP.Net 2.0.

Again, more detail on each of these may be found in the “Activities Completed” section.

3. Construction Phase

The construction phase involves implementing the secondary features of the system and revisiting the primary features that have previously been implemented. The testing discipline is also extensively involved in this phase. (Satzinger et al. 58-59)

Specific tasks to be completed include:

- Error checking will be implemented for all inputs into the system.
- Implemented code will be tested for bugs.
- The web service or alternate means of exporting the data to public users will be built.
- The graphical representation will be implemented.
- Alternate display vehicles such as a touch screen to display the data will be investigated.

4. Transition Phase

The focus in the final (transition) phase is deployment. It is assumed that some finishing touches will have to be made to the implementation, but it is imperative in this final phase to roll the system out to the end-users. In larger systems, this may involve installing additional hardware and software and even training users to use the system. (Satzinger et al. p 59)

Specific tasks typically completed during this phase include:

- End-users from each type of stakeholder should be trained on how to use the system.
- All features will be rolled out into production.
- Evaluation will be done based on performance and usage of the project.
- The website and its capabilities will be promoted through advertising by CBES.

In summary, the deliverables of the project as first proposed and following the Unified Process development model are:

- Establish a clear System Objective statement which supports the overall mission of CBES
- Interview internal/external stakeholders
- Develop appropriate Use Cases for the major interactions with the system
- Develop Use Case Diagrams as appropriate
- Develop Class Diagrams as appropriate
- Develop Activity Diagrams for the major interactions with the system
- A completed website including easy input and graphing capabilities
- A service as part of the system to enable exporting of data
- Recommendations on alternate display media such as a touch screen in CBES

- Propose a means to easily import data by month by data category.

B. Alternatives to the Unified Process

Some alternatives to the Unified Process were considered, specifically the Waterfall Model and the Spiral Model. Other methodologies, such as Rapid Application Development (RAD), were not considered as a goal of the capstone was to learn a more robust development method. In this section, the alternative methodologies and they reasons they were not chosen are presented.

1. Waterfall Development Methodology

The waterfall approach to system development takes the phases of the system development life cycle and completes each one sequentially (See Figure 4). First, a detailed plan of the system is developed that will be used throughout the system development life cycle. Then, the requirements are gathered and from those requirements a system design is created. Using the design guidelines, the entire system is then implemented. However, the waterfall approach is not an adaptive approach to software development and does not allow for the revisiting of earlier steps. Developers are human and make mistakes during system development, and therefore should be allowed to revisit steps during the development process (Dennis et al. p 10-11). This development process was not viable for this project due to the restrictive nature of not permitting revisions after a phase had been completed. It was recognized that part of the construction phase would be occurring while the interviewing process was also occurring, and that flexibility in requirements was necessary.

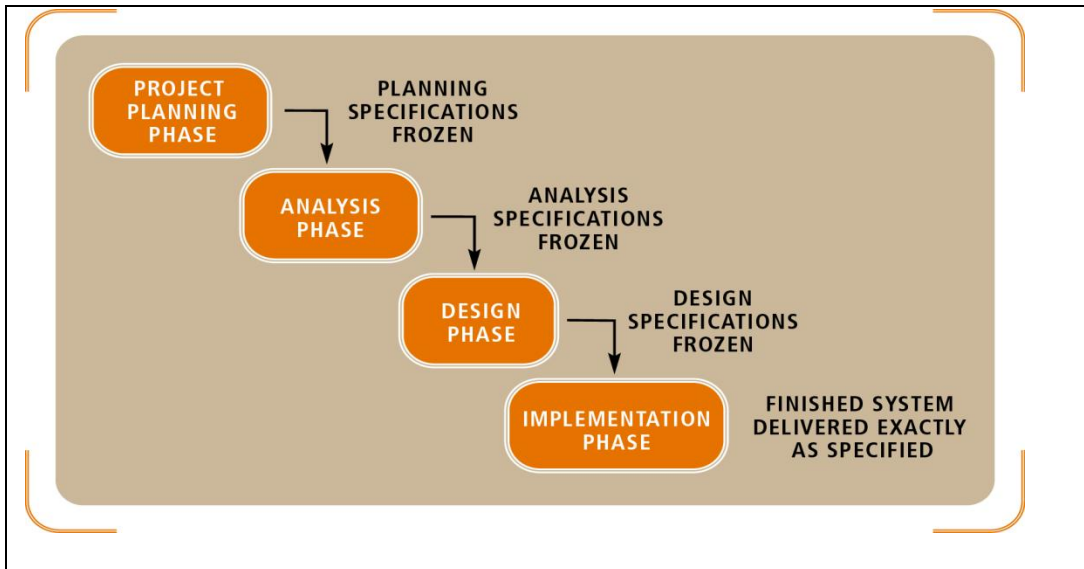


Figure 4: The Waterfall approach to system development (Satzinger et al. 2005)

2. Spiral Development Methodology

The spiral model of development is based on evolving prototypes (See Figure 5). A prototype is a “preliminary working model showing some aspect of a larger system.” This process begins with the usual initial planning. Then a prototype is created based on the first thoughts of how the system should work. The prototype is then tested to see what changes or additions need to be made to the system. These steps are repeated until an acceptable solution is reached. This method is adaptive because it allows the developer to make changes after every iteration. However, it is not very predictive because there is not much focus on analysis and design in the beginning of the system development process. The spiral model works as a reactive approach to software development. This development methodology solves immediate problems but does not focus on the big picture (Satzinger et al. 42-44). Thus, this methodology was not appropriate for this capstone project.

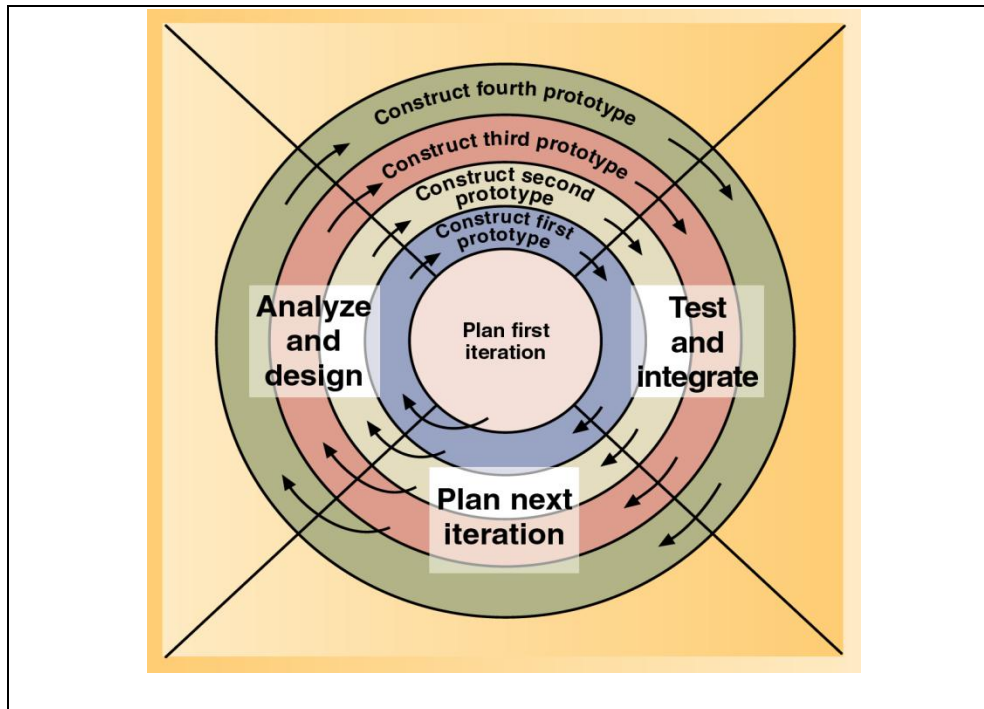


Figure 5: The spiral life cycle model (Satzinger et al. 2005)

IV. Activities Completed

The Unified Process encourages multiple iterations within each phase. It was determined that since this was a smaller project involving one developer and minimal user types, each phase will be given one iteration. In addition, an iteration of the Inception Phase has already occurred as part of the Grid Project in 2005-2006. This section will go into detail on what was accomplished during each phase to meet the end user requirements.

A. Fall 07 (First Iteration)

As a result of a user demand, the first phase (Inception) shifted from purely system analysis and design and definition of user requirements to the quick implementation of a working “limited feature” system for the users.

There was a need for a limited feature to be 'live' system by the fall of 2007. A major change to this limited feature version (and second prototype) was the conversion of the underlying technology platform from ASP.Net 1.1 to ASP.Net 2.0. Since 2004, when the original prototype was built, ASP.Net 2.0 became the standard back-office platform for Cameron School of Business projects.

This 'rushed' timeframe was placed on the developer due to the University's desire to make limited data available as soon as possible. This request came as a result of an October 2007 presentation by Dr. Hall at the Fall 2007 Economic Outlook Conference. Outside users made many requests for the data provided by this project. This limited feature system became available online in December 2007. As of December 2007, the external users of this system include members from public organizations, government agencies, and not-for-profit economic developers. According to Google Analytics, this limited data site (<http://csbapp.csb.uncw.edu/grid2007/>) had 235 visits, 181 of which were unique and 1,083 page views from January 1, 2008 to April 30, 2008.

The features available for typical users at this iteration included:

- The ability to search and display data from each of the Data Categories in a table format (see Figure 6). Not shown in Figure 6, is the fact that the user must previously select a Data Category (i.e. Ports), location, start date, end date, and Data Pod (i.e. Port Tonnage).

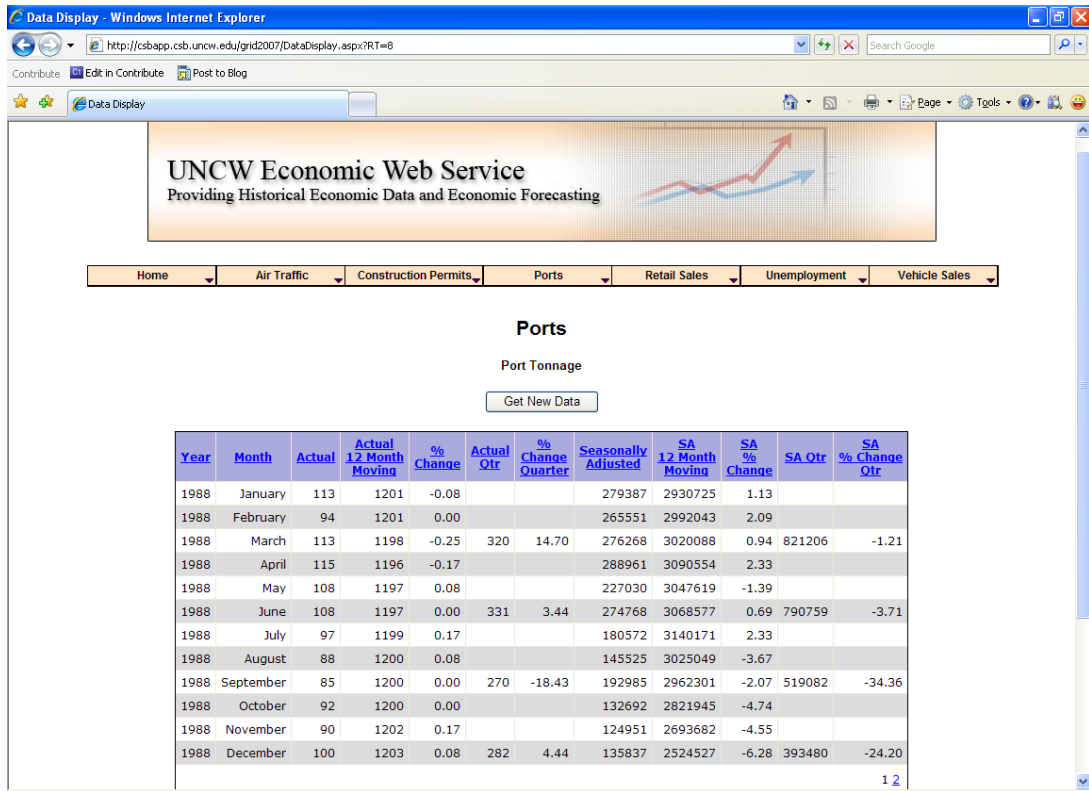


Figure 6: Table display from the limited feature version

- The ability to display data in graph format was not implemented with this limited version because the limited graphing utility being used was only available for ASP.Net 1.1. When the limited version went live a new graphing utility for ASP.Net 2.0 had not been researched.
- With this limited version the CBES team had the ability to enter and edit data for specific Data Pods via 'elementary' input screens. The administrative functions of adding a new Data Category or Data Pod and managing users were not implemented with the fall release.

B. Spring 08 – Inception Phase (second iteration)

The inception phase received a second iteration (as the Unified Process encourages) during the spring of 2008 as the interviews and system objective was shifted to the second semester due to the need for the limited edition system being live in the fall.

1. Interviews

In order to discover the true needs of the stakeholders in this system, attempts were made to interview a member from each type of user (See Table 2). Following meetings with Dr. Hall, Dr. Sackley, and Mr. Rowe a list of possible contacts to interview from each type of user was developed. Unfortunately, due to job changes and personnel changes at the government agencies, I was unable to schedule an interview with a Government Agency. In its place, the number of Not-for Profit companies was increased.

Type of User	Stakeholder
Internal	CBES (4 individuals)
External – Public For Profit Organization	Progress Energy
External – Government Agency	New Hanover County or City of Wilmington * *was not accomplished due to personnel changes
External – Not-for-Profit	Wilmington Industrial, Inc. and North Carolina’s Southeast

Table 2: Stakeholders

Significant new information was gathered during the interview process. It became obvious that the outside users had been previously been receiving the data directly from Dr. Hall. They all seemed to value this interaction with Dr. Hall and particularly his forecasting ability. Thus, it became a priority during the development of this project that it be just as easy for the users to

retrieve the data from the system, as it was for them to get it from Dr. Hall. Additionally, it must be just as valuable as the data received from Dr. Hall. Thus screen design and exporting of data was a priority, as well as making sure the users knew they could still contact Dr. Hall directly.

Ultimately, the users needed access to the historical data for forecasting purposes. The goal of many of the users is to promote the economy in southeastern NC by encouraging business to relocate or expand into the area. Using this data, one industry professional interviewed stated that their organization would like to estimate the impact a major industrial company has on other industries by expanding or relocating here (telecommunications, utilities, housing, etc). A goal of another interviewee is to be able to assess trends so that their company can estimate future growth. This would enable them to more accurately hire new employees or spend money on new resources. Thus access to the raw data was as important as was the graphical and tabular data published on the web.

Though some of the users disagreed on whether or not they would truly use the data display format provided on the web, they unanimously agreed on the following items:

- The graphical display format would be very beneficial for meetings and presentations.
- An export to Excel feature was recommended for performing calculations and manipulations.
- The importance of a true web service was not desired, as the end users preferred to be able to download the data in an Excel format directly, permitting them to do the statistical analysis native to Excel.

Most users like the idea of the graphical display format because they are giving presentations using the data, and viewing the data in graphical format gives them the ability to show trends over time. As a result of this request, an important feature of the graphical application was to allow for the users to be able to download an image file (such as .jpeg) to their machines, so they could embed it in their presentations. This would eliminate the necessity for a live internet connection for each of their presentations.

Every person that was interviewed for this project wanted the ability to download their own copy of selected data in a spreadsheet format. Every company or organization has their own practices when it comes to economic forecasting and predictions, so they would like a copy of the data for themselves. One interviewee even asked for an export to Microsoft Word feature, which demonstrates the high demand for a user's own copy of the data.

It should be noted that the interviewees did not want to remove Dr. Hall from the forecasting business, as his ability to combine multiple data categories and to analyze many years of data was something they did not have in their organizations. In some respects, Dr. Hall's abilities and the CBES would be drawn on more for their expertise as the 'historical data' become more publicly available, and the need to take advantage of this data become apparent to organizations. Making this data and the ensuing forecasts more publically available will assist the Center for Business and Economic Services in achieving more of its mission. As previously noted the 'limited version' has had over 175 unique visitors in the first four months of 2008 accessing over 1000 pages. This was accomplished with almost no publicity except for a link on the CBES website.

The details of the each of the interviews may be found in Appendix A.

2. System Objective

Following the interviews and summarizing the needs from internal and external users, an overall system objective was developed. The objective is summarized below, with the full objective found in Appendix B.

The objective of the UNCW Economic web service is to provide companies/government agencies/nonprofits various levels of access to historical data relative to the economic environment of the southeastern North Carolina region.

The primary business benefit from this new system is that it helps the University of North Carolina Wilmington and the Center for Business and Economic Services achieve their strategic goal of regional engagement and outreach. The economic data collected in this system can assist companies in making economic decisions that benefit the region.

The system will be one of the largest aggregations of economic data on the region. Users will have easy, user-friendly access to information in various formats that may assist them make difficult business decisions.

C. Spring 08 -Elaboration Phase

1. Analysis

Based on the requirements gathered from these interviews, Use Cases were developed for the major interactions with the system. A sample Use Case is shown below in Figure 7 and details viewing data as graph. The remainder of the Use Cases may be found in Appendix C.

The major interactions are viewing data in a table format, viewing data in a graph format, inserting or updating data, inserting a Data Category, and inserting a Data Pod.

Flow of activities for <i>View Data as Graph</i>	
Main Flow:	
1.	User connects to UNCW Economic Web Service homepage
2.	User selects the Data Category
3.	The system populates the Data Pod based on the selected Data Category
4.	User selects Data Pod
5.	The system populates the location, start year, and end year based on the Data Category
6.	User selects location, start year, and end year
7.	User selects chart type
8.	The system sends selected criteria to the database
9.	The database returns two data sets: <ul style="list-style-type: none"> • One with information about the Data Pod • One with the actual data for the Data Pod
8a.	If the Data Pod is a calculated field, then the database returns two data sets: <ul style="list-style-type: none"> • One with information about the Data Pod • One with the fields that make up the calculated Data Pod and their associated calculation description <p>The second data set is returned to the database, which performs the calculation required for that Data Pod. It then returns the actual data for the Data Pod.</p>
10.	When the actual data is returned, the system attaches the data set to the charting control
11.	The graph is displayed to the user
Exception Conditions:	
1.	If a user does not select an item from one of the drop down lists, then <ul style="list-style-type: none"> a. They will receive an error message telling to select an item from the list

Figure 7: View Data as Graph Use Case

2. Design

As a result of the Use Cases, a Use Case diagram (Appendix D) was developed showing all actors and their relationships with the system. The major actors are internal administrators, data entry clerks, public with limited downloading rights, and public with viewing rights only. In addition to the domain class diagram, a database diagram (Appendix E) was created to show the database tables and their relationships.

Following the understanding of the major system objectives, the major actors, the existing database needed to be reviewed to ensure the optimal design. It was at this time that the

database was redesigned for a number of reasons. First, it was determined in the analysis phase that the previous design would not allow complete extensibility in adding new data sets.

Second, if the new data sets should be anything other than economic data, there needed to be some type of identifier of the type of data. This need brought about the Data Global Category, which at this point for all Data Categories is Economic. However, if another type of data were to be stored in this database, it could be stored under a different Data Global Category and belong to a different data owner. Some examples of other Data Global Categories may include Crime and Population statistics.

The third major issue with the existing database design was its inability to handle new types of calculated columns. Users desired not only auto and truck sales, but also a total of vehicle sales. It essentially forced the solution to become hard-coded and not dynamic. By adding a Calculated Field table, an admin user can now add any number of individual fields and give a specific calculate action to each one. For example, three individual fields can be added together to make a total calculated field, or any number of component fields can be added together and divided by any number of component fields to make a rate calculated field.

It was also anticipated that end users will want the capability to combine not only 'data pods' (cars and trucks) but also locations, such as wanting a graph or tabular display of the four southeast counties in North Carolina. This generic capability to add data pods as well as locations will be a well used feature, and is included in the Future Work section of this paper.

3. Ease of Input Process

An administrator will have the ability to insert new data or edit existing data in the database. The prototype allows administrators to do this through input forms. This approach will be evaluated to make sure it is the most efficient and effective way to allow this feature. Also, because of the fact that all or most of the data that is collected is available publicly, there should be a way to automate this process. The possibility of capturing or scrapping the data from government websites and emails will be researched to determine if there is an acceptable solution.

4. Output Medias

A visual aid can help a user understand and interpret data more easily. New and alternative graphing software was investigated to enable more graphing capabilities on the website, and to have a more visually stimulating look and feel. This new graphical application was necessary due to the switch to the .Net 2.0 framework.

Another interesting way to present this data is in the form of a touch screen. The CBES office in the CIS building is a prime location for a touch screen because of the number of business professionals and students that visit. The feasibility of implementing a touch screen with this project was investigated. HCI theory, as discussed previously, was used to ensure the optimal interface design is used for this website.

To gain skills with touch screens, an undergraduate independent study student and myself investigated various touch screen options. We proposed as our optimal solution the Microsoft Surface because of its ease of use and graphical capabilities.

However the cost to purchase the Microsoft Surface was prohibitive (\$10,000-12,000). The ISOM department chair was approached to purchase a smaller 15" touch screen monitor from Dell for \$600. Between the undergraduate student and myself, we have developed and built an application that permits users to select counties and data categories via touch screen technology. Following this prototype, CBES purchase an ELO 19" touch screen monitor.

A final output media investigated was development of a web service. A web service is a programmatic interface for application to application communication (W3C). It is a standardized means for platform independent communication between software applications (Connolly p. 906). In order to make this project a true web service, certain information would be provided to the users from the database to use in their own programs. The needs of the users in a web service were captured in the interview process. Research was done into the best way to provide this web service in terms of the information to provide and how to provide that information.

Following the interviews with external users, a full web service of economic data was abandoned in favor of adding the capability for users to download "Excel" spreadsheets. Thus, the design moved to support the downloading of data in a spreadsheet format. However, one web service was still designed to provide a 'proof of concept' and developer learning.

Deliverables from the Inception and Elaboration Phases were:

- A System Objective
- Interview Summaries
- Use Cases
- A Use Case Diagram

- A Class Diagram
- Database Design
 - Test extensibility
- Activity Diagrams
- New graphical options investigated and implemented
- Touch screen capability and purchase of a small touch screen
- Exporting of data implemented

D. Spring 08 – Construction Phase

1. Technologies Employed

ASP.Net 2.0 and SQL Server 2005 were used in the implementation of this project. The possibility of using ASP.Net 3.0 and SQL Server 2008 was researched, but the decision was made to stay with the previous versions because the new Microsoft versions were still in 'beta versions'. The rollout of SQL 2008 and Visual Studio are currently occurring in 2008, well after the beginning of the construction phase.

It may be a task in the future to upgrade this project to the newer versions of ASP and SQL Server. When the project was started it was done in ASP.Net and SQL Server because that was what was available. The MIS 413 Web Development class still uses ASP.Net 2.0 with SQL Server 2005.

A Java or PHP solution for this project was not considered due to the fact that the existing CSB systems have been developed using ASP.Net, and the students going through the Management

Information systems curriculum are taught ASP.Net. Using ASP.Net provides a rapid business solution and ease for future upgrades by students.

The existing code needed to be updated to reflect the changes made to the database design, which allowed for the optimization of the code structure. Key changes to the code was the addition of more 'objects' and the creation of many additional 'Public' functions and subroutines to make the code more modular and more easily upgraded as necessary. The modularization of the code made the addition of a 'touch screen' implementation easier than originally anticipated.

Originally, calculations, such as 12 month previous totals, quarterly totals year to date versus prior year to date percentages, were calculated on the fly and inline in the coding. These calculations were moved to functions for global use in the project.

2. Database Upgrades

The only information stored in the database is the hard "RAW" data for each Data Pod, excluding a calculated data pod. New data categories are easily inserted via web screens by administration users. No 'manual' opening of the database is required to add additional data categories, data pods, or data units. Another advancement at this time was dynamically naming the columns and specifying the type of unit for each Data Pod. All queries to the database are done as stored procedures to limit SQL injections as well as speed up processing. See Appendix E for the database design.

A major hurdle in the project was to solve the calculated field problem (i.e. total vehicle sales). Previous versions of the prototype 'hard coded' this calculation in the ASP.Net application for each specific data type. This would limit the expandability of additional calculations for new and unanticipated data categories and data pods.

This was ultimately solved by developing a unique stored procedure in SQL. If the user selects a data pod that is a calculated field, instead of returning the data that was previously added in the ASP.Net application (hard coded for each specific data item), a list of the data pods (keys) involved in that calculated field and a calculation description are returned. The types of calculations currently supported are either a sum or a numerator and denominator in case a ratio is desired.

An example using the sum calculation would be the data pod Total Vehicle Sales, which would return Car Sales and Truck Sales, both with the calculation description 'SUM'. An example of a rate calculated field is the data pod Unemployment Rate. This data pod would return Unemployment with the calculation description of "NUMERATOR", and both Employment and Unemployment with the calculation description of "DENOMINATOR".

These rules (specific columns to sum or divide) are then sent back to the database which performs the calculations in the calculated stored procedures. The "SUM" stored procedure accepts up to 12 data pod items to add together, whether it is a sum or a rate calculated field. For these sum calculated fields the SUM function in SQL is used and the fields that are passed back to the database are used in the WHERE clause. Figure 8 details a portion of the stored procedure.

```

SELECT      tblDataItem.YearID, SUM(tblDataItem.Data1) AS Data1,
            SUM(tblDataItem.Data2) AS Data2, tblDataItem.LocationID,
            validMonth.MonthName,
            tblDataItem.MonthID
FROM        tblDataItem INNER JOIN
            validMonth ON tblDataItem.MonthID =
            validMonth.MonthID
WHERE       (tblDataItem.DataPodID = @Pod1 OR tblDataItem.DataPodID =
            @Pod2 OR tblDataItem.DataPodID = @Pod3
            OR tblDataItem.DataPodID = @Pod4 OR
            tblDataItem.DataPodID = @Pod5 OR tblDataItem.DataPodID = @Pod6
            OR tblDataItem.DataPodID = @Pod7 OR
            tblDataItem.DataPodID = @Pod8 OR tblDataItem.DataPodID = @Pod9
            OR tblDataItem.DataPodID = @Pod10 OR
            tblDataItem.DataPodID = @Pod11 OR tblDataItem.DataPodID = @Pod12)
            AND (tblDataItem.LocationID = @LocationID)
GROUP BY   tblDataItem.YearID, tblDataItem.LocationID,
            validMonth.MonthName, tblDataItem.MonthID
ORDER BY   tblDataItem.YearID, tblDataItem.MonthID

```

Figure 8: SUM stored procedure

The calculation for a rate field (i.e. unemployment) is more complicated because one cannot divide columns directly. For both the numerator and the denominator, the SUM function has to be performed first for any number of data pods returned to the database. These results are stored in separate temporary tables in SQL, so that then the numerator field can be divided by the denominator field. The stored procedure then returns results in exactly the same format as if it were a regular data pod. Figure 9 demonstrates a portion of the code for division and rate.

```

Create TABLE #NumeratorTable
(
    YearID int,
    MonthID int,
    MonthName varchar(10),
    LocationID int,
    DataPodID int,
    NumData1 decimal(18,3),
    NumData2 decimal(18,3)
)
Create TABLE #DenominatorTable
(
    YearID int,
    MonthID int,
    MonthName varchar(10),

```

```

        LocationID int,
        DenData1 decimal(18,3),
        DenData2 decimal(18,3)
    )

INSERT INTO #NumeratorTable (YearID, MonthID, MonthName, LocationID,
DataPodID, NumData1, NumData2)
SELECT tblDataItem.YearID, tblDataItem.MonthID, validMonth.MonthName,
tblDataItem.LocationID, tblDataItem.DataPodID, tblDataItem.Data1,
tblDataItem.Data2
FROM          tblDataItem INNER JOIN
              validMonth ON tblDataItem.MonthID =
validMonth.MonthID
WHERE        (tblDataItem.DataPodID = @Num1 OR tblDataItem.DataPodID =
@Num2 OR tblDataItem.DataPodID = @Num3
              OR tblDataItem.DataPodID = @Num4 OR
tblDataItem.DataPodID = @Num5 OR tblDataItem.DataPodID = @Num6)
              AND tblDataItem.LocationID = @LocationID

INSERT INTO #DenominatorTable (YearID, MonthID, MonthName, LocationID,
DenData1, DenData2)
SELECT      tblDataItem.YearID, tblDataItem.MonthID,
validMonth.MonthName, tblDataItem.LocationID, SUM(tblDataItem.Data1) AS
Data1, SUM(tblDataItem.Data2) AS Data2
FROM        tblDataItem INNER JOIN
              validMonth ON tblDataItem.MonthID =
validMonth.MonthID
WHERE        (tblDataItem.DataPodID = @Den1 OR tblDataItem.DataPodID =
@Den2 OR tblDataItem.DataPodID = @Den3
              OR tblDataItem.DataPodID = @Den4 OR
tblDataItem.DataPodID = @Den5 OR tblDataItem.DataPodID = @Den6
              OR tblDataItem.DataPodID = @Den7 OR
tblDataItem.DataPodID = @Den8 OR tblDataItem.DataPodID = @Den9
              OR tblDataItem.DataPodID = @Den10 OR
tblDataItem.DataPodID = @Den11 OR tblDataItem.DataPodID = @Den12)
              AND (tblDataItem.LocationID = @LocationID)
GROUP BY tblDataItem.YearID, tblDataItem.LocationID,
validMonth.MonthName, tblDataItem.MonthID
ORDER BY tblDataItem.YearID, tblDataItem.MonthID

Select n.YearID, n.MonthID, n.MonthName, n.LocationID, n.NumData1 /
d.DenData1 as Data1, n.NumData2 / d.DenData2 as Data2
From #NumeratorTable n, #DenominatorTable d
Where n.YearID = d.YearID AND n.MonthID = d.MonthID

```

Figure 9: Division stored procedure

3. Graphing

The next major step in the development process was process of graphing. As stated previously, the graphing software used in the prototype of this system was strictly for ASP.Net 1.1. To choose a graphing solution, the options were narrowed down to two by researching compatibility with ASP.Net 2.0 and the purchase price. The final two products were dotNetCharting2005 and Infragistics. After downloading the trial versions of both of these products, a recommendation was made to go with dotNetCharting2005. Infragistics provided a viable solution but it is a total presentation layer software package that had more features than needed for this project. Correspondingly, the price of Infragistics was much higher, which ultimately lead to the selection of dotNetCharting2005. The dotNetCharting2005 solution was easy to work with and provided many ways to enhance customization of graphs. Table 3 shows the features and benefits of the two graphical packages investigated.

dotNetCharting2005	Infragistics
.Net Framework 2.0 support	.Net Framework 2.0 support
2D and 3D rendered charts	2D and 3D rendered charts
Chart mentor, gives detailed error messages	Wizard for building charts
Multiple image outputs	Multiple image outputs
Smart color palettes	
HTML hotspot and graph drilldown support	

Table 3: Comparison of Graphing Software

During the construction phase it was found that the dotNetCharting2005 Chart control was a robust product that had a substantial learning curve to truly customize the graph. The dotNetCharting tool had a different ‘engine’ to select data from the database, and with some experimentation the developer was able to use the standard dataset and datareader objects in ASP.Net versus the dotNetCharting Engine. Once over the learning curve, the flexibility to do

various types of graphs and formats became options offered to the end user through drop down select boxes. Figure 10 shows a 3D line chart using dotNetCharting.

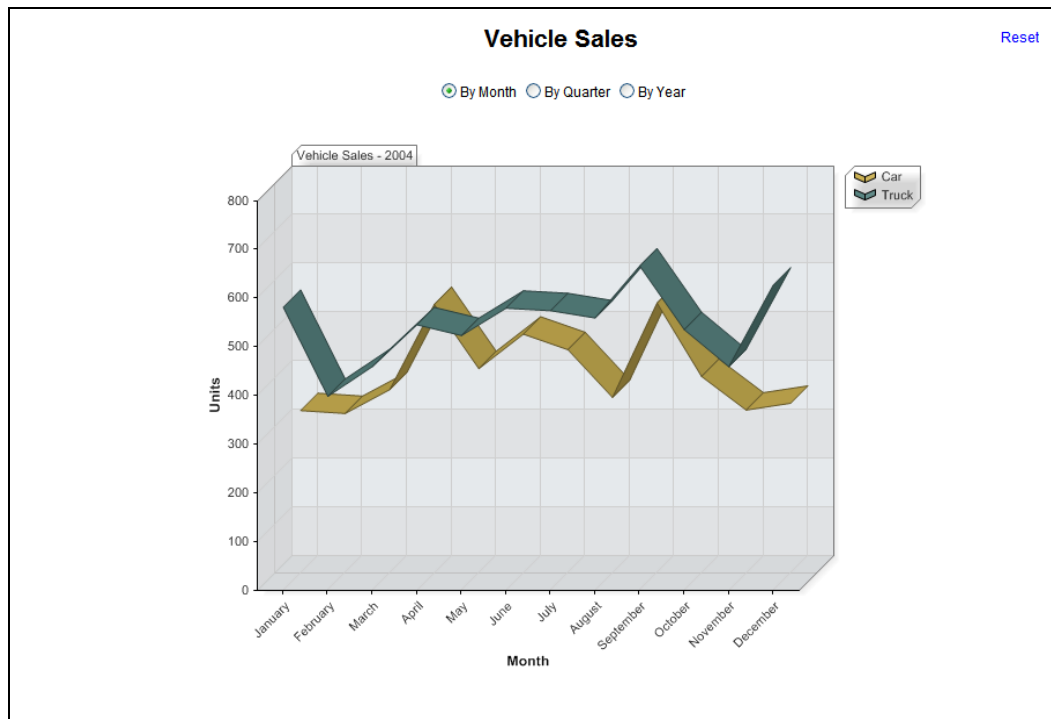


Figure 10: Graph of Vehicle Sales – Car vs. Truck for New Hanover County in 2004

To build a graph, the user first goes through the selection process of choosing the following items (similar to the tabular process)

- data category
- data pod or data pods to graph,
- the location or locations,
- start year and end year.

The user does have the capability to graph more than one data pod within the same data category. It was an initial desire of this project to be able to graph any data pod with any other data pod; however, this was not possible to implement because of the scaling issues. Very few of the data pods are on the same scale so it would be pointless to attempt to plot them on the

same graph. If the user selects only one data pod, they then have the ability to graph multiple locations. As a disclaimer, some locations may not scale well together.

Another major feature of graphing in this system is the “graph by” option. The system displays the data in its optimal graph form. If the user selects data in a range of 1 year, the data is displayed by month. If the user selects data in range of 2 or 3 years, the data is displayed by quarter. If the user selects data in a range greater than 3 years, the data is displayed by year. Once the graph is displayed the user has the option to change the graph by selection. If a user selected data with a range of 5 years and the system graphed this data by month, there would be a large number of data points making the graph look cluttered. Some users, such as Dr. Hall, may want to see this time of graph in order to see trends over the years, but most users would be satisfied seeing the yearly totals of this data.

4. Touch Screen Capabilities

One desire for output medias was the possibility of placing a touch screen version of this system in the CBES lobby. Under the developer’s supervision, Andrew Chappell became the researcher on touch screen solutions during the course of the spring 2008 semester. The research began with an investigation of touch screen hardware and software solutions. Some of the touch screen brands researched included Dell, Elo TouchSystems, and Microsoft. The ISOM department purchased a 15 inch Dell touch screen for students to experiment with, which was ultimately used in the prototyping of the touch screen version of this system.

Using a touch screen proved to be quite simple as the touch screen works similarly to a mouse. The touch screen is plugged into the computer using a VGA cable for display, but it also uses a

USB cable for output to the computer. It even shows the mouse cursor to begin with so a solution was developed to hide this for the full effect. The user must use one finger to tap the touch screen, if more than one finger is used simultaneously it will actually take the average of the touched points. Since the touch screen was essentially used like a mouse, the code used for development of the touch screen application is ASP.Net.

Mr. Chappell worked with the developer on the graphical interface and an image map of the southeastern NC counties. A map was of the counties east of I-95 was used in an image map control in ASP.Net 2.0. Then areas of that map were sectioned off to become links for the counties. This was a tedious process because the links must be rectangles and most of the counties in North Carolina are not rectangles. So a rectangle of 'best fit' had to be applied to each of the counties used. Figure 11 shows the image map used in the prototype of the touch screen application.

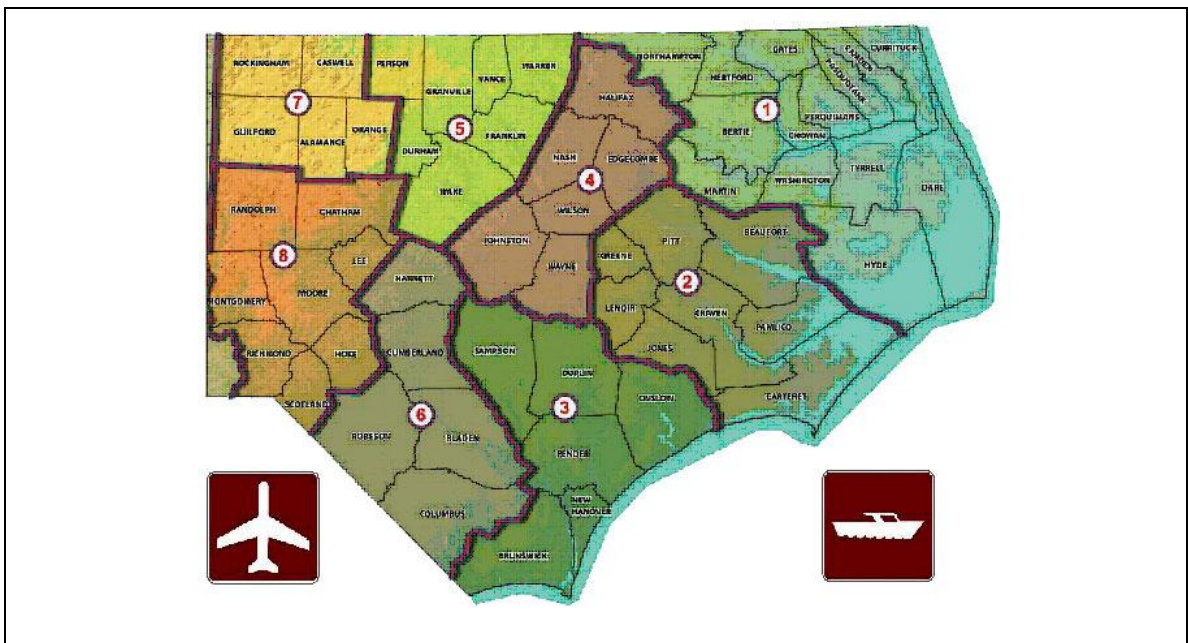


Figure 11: Touch Screen Image Map

The selection process for the touch screen versions of this system is different from the tabular and graphing features of the web based system in that it starts with the location. The next selection is the data category, but the system must only display the data categories that are available for that specific location. Then the user selects a data pod, and the range of years they desire. Key to his development was the ability for the touch screen portion of the application to use the same functionality as the tabular and graphical interface from the web site. This was accomplished with the modular programming.

This step has now been implemented in the CBES Suite. The CBES team purchased an Elo TouchSystems 19 inch touch screen and acquired a dedicated computer for this touch screen implementation. After Mr. Chappell's work on the prototype, the developer revised the map, developed new icons, and upgraded the coding.

5. Creating Functionality per User Role

Another segment of this system was the establishment of different users and different roles and permissions. The different types of users are:

- administrative including the 'super' admin and data managers
- data entry
- 'selected public' user with additional permissions
- public user

All but the public users will need to log in to achieve their full functionality. A user can login to the system, provided that an administrative user has added them into the system. If a 'selected public' user logs in, they will then have permissions to export the data they select into Microsoft

Excel. This is currently the only added feature to selected public users who have logged into the system. Users may register with the system to gain access to this feature.

After development was completed on the user side of this system, development switched over to administrative functionalities. The three main functions of administrators are the establishment of new users and their roles, data entry, and also the establishment of new data categories and data pod items.

This part of the system became much more intricate as a result of the latest database changes. An administrative user has the ability to add a new data category which involves naming the data category, assigning it to a data global category, and giving it a description. Once the administrative user has added a data category they will then be allowed to add as many data pods to that data category as needed. This involves giving the data pod a name, a sequence order for dropdown display, the number of decimal places, and the type of unit for its Data1 and Data2 values. Figure 12 details the category, data pod, and data item needed to add a new item.

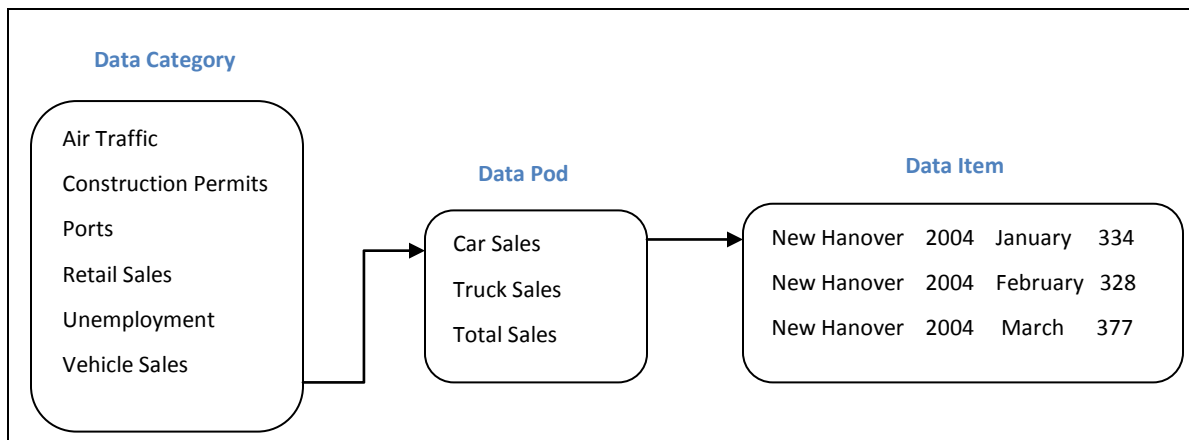


Figure 12: Vehicle Sales - Data Categories and Data Pods

The database maintains two types of data for each data item. One is the raw data (data1) and the second is known as data2 or seasonally adjusted data. Data1 and Data2 values are in the database because most data pods have an actual value and then a seasonally adjusted value or a value with another type of unit. A seasonally adjusted value is a statistic in which the seasonal component or holiday impact has been removed.

Finally the administrative user can also select whether or not the data pod is a calculated field; in which case they are allowed to choose data pods from those that have already been entered assign them a calculation description (sum, numerator, denominator). Once the data pods for the data category have been entered, the administrative user can then add data for a specific location and year.

Manage Data				
DataCategory	Data Pod(s)	Locations	Years	
Airport Traffic	Passengers On Passengers Off Cargo On Cargo Off	ILM	1983-2004	Edit Edit Data
Construction-NonResidential	Commercial-New Commercial-Alteration Industrial-New Industrial-Alteration Institutional-New Institutional-Alteration	New Hanover	2000-2004	Edit Edit Data
Construction-Residential	Duplex-New Duplex-Alteration MultiFamily-New MultiFamily-Alteration SingleFamily-New SingleFamily-Alteration	New Hanover	2000-2004	Edit Edit Data
Ports	Port Tonnage	Wilmington	1987-2006	Edit Edit Data

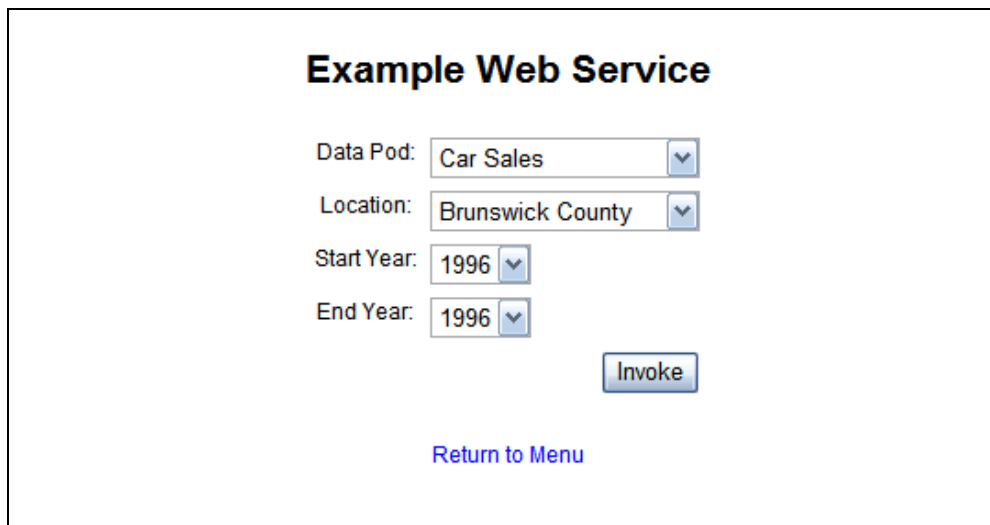
1 2

Figure 13: Manage Data Screen

Figure 13 shows the administrative Manage Data screen. This screen displays all the data categories with their corresponding data pods, locations, and years. The administrator is allowed to edit any one of these items as well as insert new records for each of them.

6. Export of data via Excel or a web service

A user who has logged on to the system has the ability to export data to Excel for the category of data desired. As mentioned previously, this became a major desired feature of the website when during the interview process. It was determined that few users had the need for a web service. Thus to enable developer learning a proof of concept web service was completed providing yearly data for a specific data pod at a specified location (Figure 14), but this service was not implemented for the public.



Example Web Service

Data Pod: ▼

Location: ▼

Start Year: ▼

End Year: ▼

[Return to Menu](#)

Figure 14: Example page consuming the Grid Web Service

7. Automated Collection of Data

This feature was not implemented as part of the project. It was on the initial set of objectives to investigate, but was not completed due to the changes in requirements (especially the need for a live version by December 2007).

Deliverables from the Construction Phase are:

- A completed website including new data sets

- The ability to display data in table or graph format
- The ability to insert or edit data (Administrator)
- The ability to add new data categories, data pods, and data items (Administrator)
- The ability to insert users and give them roles (Administrator)
- Testing of code
- Export of data via Excel and a proof of concept web service
- Touch screen implemented in the CBES offices

E. Spring 08 – Transition Phase

Training sessions with CBES personnel were scheduled for May. The developer was hired by CBES for the month of May to develop documentation and build additional features into the system once the administrators have used the system for a period of time. In addition, the promotion of the web site and services was initiated by CBES during this time frame.

On June 12, 2008 a press conference was held for Dr. Hall's update to his economic outlook for the year. Various members of the press attended this event including WECT, WWAY, Star News, and the Wilmington Business Journal. This system officially went live at this press conference, with a demo of the website and touch screen versions. Since the press conference approximately 50 users have registered with the site. In addition, our article with the Greater Wilmington Business Journal can be found in Appendix F.

Deliverables from the Transition Phase will be:

- A completed project (per original functionality)

- Training of users (was completed in May)
- Promotion of the site (was not part of the original deliverables)
- Additional Google Analytics placed on the site to track user requests.

V. Timeline

Table 4 details the original project plan and timeline for the capstone project versus the actual timeline.

Phase	Action	Planned Completion	Actual Completion
Inception	Website with limited functionality	Fall 07 *note this was added to the project after the initial timeline was proposed	December 07
Inception	Capstone proposal completed	Fall 07	December 07
Inception Pt. 2	System Objective	January 08	February 08
Inception Pt. 2	Interviews	January 08	February/March
Inception Pt. 2	Use Cases	January 08	March 08
Inception Pt. 2	Use Case Diagram	January 08	March 08
Elaboration	Database Diagram	January 08	March08
Elaboration	CRUD Diagram	January 08	April 08
Elaboration	Investigate automated collection of data	February 08	April 08
Elaboration	Investigate web services	February 08	April 08
Construction	Fully functional website	March 08	April 08
Elaboration	Touch screen investigation	March 08	April 08
Transition	User training	March 08	May 08
Transition	Evaluation	April 08	May 08

Table 4: Estimated Completion versus Actual Completion

VI. Lessons Learned

A. System Analysis Skills

A key learning was the capability to follow a methodology to upgrade an existing prototype and meet user requirements. Previously, I had worked on only pieces of a project. In this project, I was responsible for gathering user requirements, defining those requirements in terms of use cases, activity diagrams and designing (or redesigning) the database. I was able to increase my systems analysis skills as I worked on the system for the entirety of the development life cycle. I developed UML diagrams to map out the design of the system

Interviewing external users was a new experience. Here I learned how to conduct a professional interview and how to prepare for the interview. I also learned how to communicate ideas of the system to the average user who knows little about the technologies and capabilities of the system.

An additional part of the analysis involved the acquisition of hardware and software from outside vendors. I was involved in the investigation and acquisition of touch screen hardware/software and the investigation, recommendation and acquisition of the graphing software package.

B. n-Tier Development Learning

Part of the learning was implementing a solution following an n-tier development process. The presentation layer was improved with the use of the graphical package as well as user suggestions for the web site itself. I worked on the business logic layer through the object orientation of ASP.Net 2.0 as well as the creation of 'generic' functions and subroutines for

future growth. In addition the creation of generic SUM and DIVISION functions within SQL was a great business logic application. Finally, the data access layer was improved to provide all processing in stored procedures and the passing of data from the database to the ASP.Net programs was accomplished. Changing the program from performing one feature for one data item to becoming more generic was a real learning opportunity.

C. Technologies employed

During the completion of this project I was able to learn Microsoft's ASP.Net 2.0. I had previous experience with version 1.1 from the MIS 413 course and working on various projects for the Cameron School of Business. This project allowed me to gain experience with version 2.0. Specifically, the .Net 2.0 framework added additional capabilities related to object orientation. As noted earlier, significant work was accomplished with the modularization and object orientation of the programming application. Finally my knowledge of converting a database from SQL 2000 to SQL 2005 was enhanced, and especially enhanced was the use of stored procedures, relational database design and standards.

D. Human Computer Interaction

In addition to redesigning the input, external user and administrative screen, I also got the chance to implement a brand new graphing software solution. I had worked with graphing software before in the prototype of this system, but that particular solution was not as intricate as dotNetCharting2005. Also, the development of image maps, touch icons, and the flow of user interaction with the touch screen enhanced learning.

E. Managing / Working with others

Finally, I received the opportunity to work with an undergraduate student and help guide him as it pertained to the touch screen application. It was rewarding to be able to use the functions and subroutines created for tabular display of data immediately into the touch screen functionality. I coordinated the permissions and assisted in the development of ASP.Net 'user controls' to enable this to occur

F. Areas of Improvement

One of the major points I learned from this project is the fact that development will always take longer than expected. Something will always come up; whether it is an alteration of a requirement by the user, or a new found flaw in the database design, or just waiting to hear from a client for a potential interview.

This leads into the second point I learned which is to allow plenty of time for the interview process. It takes time to determine who will be a good potential interviewee, and then it takes more time to schedule the interview. This was a difficult process during this project and I ultimately was unable to schedule an interview with a Government Agency user.

G. Helpful Courses

Many of the MS CSIS courses assisted me in the completion of this project. I learned the basics of the analysis and design portion of the development process from the Computer Science Software Engineering (CSC 550) course as well as the Information Systems course Systems Analysis and Design (MIS 565). I also learned about UML diagramming in these courses. Another helpful course was MIS 513 Information Analysis and Management. We covered the 'bigger'

picture in the class, discussing the impact of systems development on more than just IT personnel. We also talked about the importance of knowing the return on investment of IT projects; they will only succeed if the parties involved can see the benefits in the long run.

On the development side, the MIS 555 Database Management class was very helpful. I learned complex database skills such as indexing and relational design structure that played a key role in the development of this project. Though this project did not require any immensely complex algorithms, the CSC 532 Analysis of Algorithms course taught me the importance of code optimization and completion in minimum time period. The undergraduate MIS 413 class was definitely helpful to have taken to give me experience with working on a web-based project and coding with ASP.Net.

On a more personal note, I learned to procrastinate less. It is inherently human nature to procrastinate, a trait that I am definitely guilty of. I believe that through the development of such an extensive project as this one, that I have learned the lesson of procrastination.

VII. Conclusion

This section will summarize the work, observations, and deliverables completed during the course of this capstone project.

The Unified Process system development methodology worked very well for this project, allowing for the flexibility of adapting in a changing environment. As part of the analysis portion of this development methodology, interviews were conducted with potential users of the

system. Individuals were interviewed from the internal user group, another from the external public organization group, and two from the external not-for-profit organization group.

Unfortunately, the analyst was unable to interview a user from the external government agency group. The entire CBES team was also interviewed to develop a clearly stated system objective.

As part of the design portion of the Unified Process, many UML diagrams were created. Use Cases were developed for the major user interactions with the system, and a Use Case Diagram was created based on those Use Cases. Activity diagrams were also created for the major interactions with the system based on the Use Cases. A class diagram was created to depict the classes of this system and their interaction. A database diagram was developed to show the tables and their relationships. Finally, a CRUD diagram was created to show the Use Case actors and their interaction with the database.

As part of the development work completed for this capstone project, a fully functional website was implemented. The features of this website include the ability for any user to view data in a table format or a graphical format, the ability for a registered user to log in and export data from a table to Excel, and the ability for administrative users to manage the data and users. New data categories may be easily added by the administrator.

Finally, as part of the deployment of this project, users were trained and promotion was done by the CBES team.

VIII. Future Work

After reviewing the completed project with the internal end client, the following items were discussed as possible future work items with the committee of this capstone project and the CBES team:

- The data stored in the database has only been updated to around 2004 or 2005 for most data categories. Dr. Hall has current data for all data categories so this information will be updated by a work assistant.
- Some inconsistencies in the data have been found so the information in the database should be verified for accuracy.
- Graphical icons should be created for the data categories and data pods with a consistent look for the touch screen application and possibly the website.
- The graphing capabilities may be expanded to include pie charts and drilldown graphs. A drilldown graph could start out displaying yearly totals for a certain series. When any of the years is clicked, a graph will be shown displaying the monthly data for that year.
- A map selection similar to the touch screen version should be included into the website as another way to access the data.

IX. Acknowledgements

I would like to thank the CBES team for their time over the past year. Without Dr. Hall (the WoodyOMeter) there would be no need for this project. Mr. Rowe's words of wisdom were very encouraging during the course of this project. It was a pleasure working with both of them.

I would also like to thank my committee: Dr. Woody Hall, Dr. Tom Janicki, Dr. Bryan Reinicke, and Dr. Ron Vetter. They continuously donated their time and support. I would like to specifically thank Dr. Janicki, the Committee Chair, for the countless hours of guidance and advice during the course of this project.

Finally, I would like to thank my parents, Bob and Michele. With the demand and stress of this project, I could not have made it through without their encouragement and support.

References

- Bon, Sarah (2007, November). "Area economy still growing, but at slower pace: UNCW economist predicts 5 percent growth for 2007, 4.5 percent for 2008". Greater Wilmington Business Journal.
- CBES Mission (<http://www.csb.uncw.edu/cbes/about.htm>)
- Connolly, Randy (2007). Core Internet Application Development with ASP.NET 2.0. NJ: Pearson Education, Inc.
- CSB Mission (<http://www.csb.uncw.edu/about/mission.htm>)
- Dennis, Alan, Barbara Haley Wixom, Roberta M. Roth (2006). Systems Analysis and Design, Third Edition. Hoboken, NJ: John Wiley and Sons, Inc.
- Rational Unified Process White Paper
(https://mail.uncw.edu/exchweb/bin/redirect.asp?URL=http://www.ibm.com/developerworks/rational/library/content/03July/1000/1251/1251_bestpractices_TP026B.pdf)
- Satzinger, John W., Robert B. Jackson, and Stephen D. Burd (2005). Object-Oriented Analysis and Design with the Unified Process. Boston, Massachusetts: Thomson Learning, Inc.
- Smith-Atakan, Serengul (2006). Human-Computer Interaction. Boston, MA: Thomson Course Technology.
- UNC Tomorrow (<http://www.nctomorrow.org/>)
- UNCW Mission (<http://uncw.edu/www/7goals.html>)
- W3C (2007). Web Services @ W3C. Retrieved November 26, 2007. Website: <http://www.w3.org/2002/ws/>

Appendix A
Stakeholder Interviews

Interview 1

Internal User

What are your job responsibilities? What do you do on a day to day basis?

The Director of CBES

He is in charge of CBES's two major areas: economic forecasting and professional development.

Is there any way you could use this data? How?

This project falls under the economic forecasting and impact studies area of CBES. The data collected by Dr. Hall is used to help local companies make major business decisions and to also consult companies that are thinking of relocating or expanding to the area. This project could also be used in the professional development area as a teaching aid.

Could anyone else in your company use this data?

N/A

What if it was easily accessible (easy to come by)?

N/A

What type of economic data would be useful to you?

He is content with the data in the system as long as the system has the data needed to assist companies.

What format would be best for you? Webpage? Something you can manipulate? Preformatted charts?

He believes that the export to excel function is an important one; however, we may need to include a disclaimer saying that CBES is no longer responsible for the data or forecasts. He is also interested in the idea of preformatted charts that show some interesting trends in the data.

Interview 2

External User – Public Organization

What are your job responsibilities? What do you do on a day to day basis?

Manager for a public utility

Is there any way you could use this data? How?

The organization desires to use the construction permits data to assess trends in order to determine the need to hire more or less employees, or to purchase more material. They are specifically interested in new construction permits. If there is new construction, it is more than likely that they will be putting a meter in at that location. If they can predict trends in new construction, they can attempt to determine their personnel needs as well as material needs, in terms of equipment.

Could anyone else in your company use this data?

The data on construction permits is currently being used by multiple people within the company.

What if it was easily accessible (easy to come by)?

It would always help for it to be easily accessible, but they are happy with their set up as it is now. They currently contact Dr. Hall for data and forecasts personally.

What type of economic data would be useful to you?

The interviewee knows that they would be interested in continuing the use of this data, and though they cannot foresee another data set that they would use, they are interesting in exploring other data sets.

What format would be best for you? Webpage? Something you can manipulate? Preformatted charts?

The organization would be interested in looking at the website, but they are more interested in getting a copy of excel, something they can manipulate. They are also interesting in the graphing capabilities in order see trends. It would also be beneficial to them to see a total new construction category within construction permits.

Interview 3

External User – Not-for-profit

What are your job responsibilities? What do you do on a day to day basis?

N/A

Is there any way you could use this data? How?

Yes, the organization works with three universities, Fayetteville State, UNC Pembroke, and UNC Wilmington, to compile the regional data book. This book is made up of various data sets relative to the region including climate, population, employment, etc. The not-for-profit uses this data to help companies make the decision to move to the area or expand to the area. They also use this information for people and families wanting to move to the area.

Could anyone else in your company use this data?

N/A

What if it was easily accessible (easy to come by)?

They currently get the data directly from Dr. Hall, but if we can figure out a way to make the process more efficient and easy, they might be interested.

What type of economic data would be useful to you?

The organization currently receives all the data they need from the three universities.

What format would be best for you? Webpage? Something you can manipulate? Preformatted charts?

A web-based system would be useful in getting the data they need. The organization is content in getting the data from Dr. Hall, but by making this system web-based it might be easier for them to get the data. They are interested in the export to excel function to perform their own manipulation and also an export to word function. The web-based charts would also be a plus as they give many presentations during the year.

Interview 4

External User – Not-for-profit

What are your job responsibilities? What do you do on a day to day basis?

The mission is to assist companies who are thinking about relocating to the Wilmington area or companies that are planning on expanding in the Wilmington area. They gather information that would be helpful to those companies in making such a major decision.

Is there any way you could use this data? How?

The organization currently uses this economic data as well as forecasts from Dr. Hall to help promote the greater Wilmington area. They attempt to show the economic impact from a company relocating or expanding in the area. They would even like to show the impact down to the industry; for example, how a major company moving to Wilmington affects a certain industry like telecommunications (e.g. a telephone company).

Could anyone else in your company use this data?

N/A

What if it was easily accessible (easy to come by)?

N/A

What type of economic data would be useful to you?

The firm is interested in data that can depict the economic impact of a major industrial company expanding or relocating to the area. The current data sets they are using from Dr. Hall are housing permits and unemployment rates. These data sets do a fairly decent job depicting the impact on certain industries such as utility companies and telephone companies; however, it could be beneficial to have some specific information from electric companies and telecommunications companies.

What format would be best for you? Webpage? Something you can manipulate? Preformatted charts?

The ability to access information on the web seems of interest. It would be very helpful to have access to this information during presentations to show data or even graphical trends. They would also be interested in have an export to excel function to perform their own analysis on the data.

Appendix B

System Objective

The objective of the UNCW Economic web service is to provide companies/government agencies/nonprofits various levels of access to historical data relative to the economic environment of the southeastern North Carolina region.

Business Benefits

The primary business benefit from this new system is that it helps the University of North Carolina Wilmington and the Center for Business and Economic Services achieve their strategic goal of regional engagement and outreach. The economic data collected in this system can assist companies in making economic decisions that benefit the region.

System Capabilities

The system will be one of the largest aggregations of economic data on the region. Users will have easy, user-friendly access to information in various formats that may assist them make difficult business decisions.

Appendix C

Use Cases

Flow of activities for <i>View Data as Table</i>
<p>Main Flow:</p> <ol style="list-style-type: none">1. User connects to UNCW Economic Web Service homepage2. User selects the Data Category3. The system populates the Data Pod based on the selected Data Category4. User selects Data Pod5. The system populates the location, start year, and end year based on the Data Category6. User selects location, start year, and end year7. The system sends selected criteria to the database8. The database returns two data sets:<ul style="list-style-type: none">• One with information about the Data Pod• One with the actual data for the Data Pod8a. If the Data Pod is a calculated field, then the database returns two data sets:<ul style="list-style-type: none">• One with information about the Data Pod• One with the fields that make up the calculated Data Pod and their associated calculation description<p>The second data set is returned to the database, which performs the calculation required for that Data Pod. It then returns the actual data for the Data Pod.</p>9. When the actual data is returned, the system computes additional economic calculations to display10. The data is displayed in a GridView table one year at a time
<p>Exception Conditions:</p> <ol style="list-style-type: none">1. If a user does not select an item from one of the drop down lists, then<ol style="list-style-type: none">a. They will receive an error message telling to select an item from the list

Flow of activities for *View Data as Graph*

Main Flow:

1. User connects to UNCW Economic Web Service homepage
2. User selects the Data Category
3. The system populates the Data Pod based on the selected Data Category
4. User selects Data Pod
5. The system populates the location, start year, and end year based on the Data Category
6. User selects location, start year, and end year
7. User selects chart type
8. The system sends selected criteria to the database
9. The database returns two data sets:
 - One with information about the Data Pod
 - One with the actual data for the Data Pod
- 9a. If the Data Pod is a calculated field, then the database returns two data sets:
 - One with information about the Data Pod
 - One with the fields that make up the calculated Data Pod and their associated calculation description

The second data set is returned to the database, which performs the calculation required for that Data Pod. It then returns the actual data for the Data Pod.
10. When the actual data is returned, the system attaches the data set to the charting control
11. The graph is displayed to the user

Exception Conditions:

1. If a user does not select an item from one of the drop down lists, then
 - b. They will receive an error message telling to select an item from the list

Flow of activities for *Inserting/Updating Data*

Main Flow:

1. User connects to UNCW Economic Web Service homepage
2. User logs into system
3. System verifies user
4. User selects the option to Insert or Edit Data
5. User selects Data Category
6. User selects Data Pod
7. User selects location and year
8. User inputs monthly data for the selected year

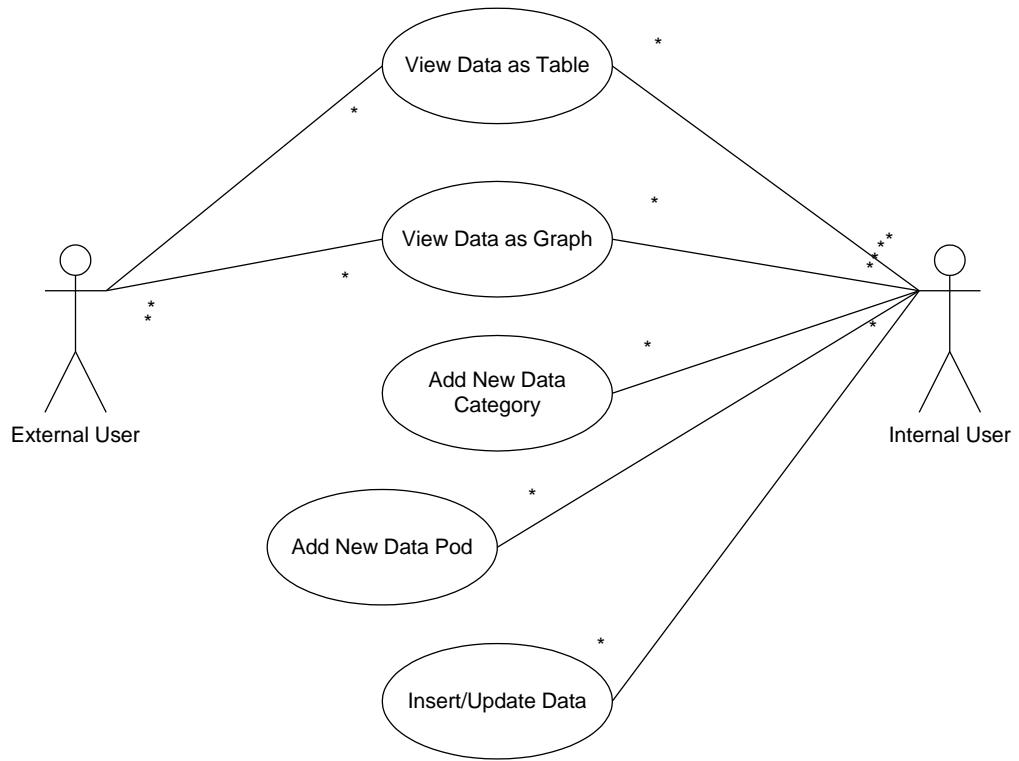
Exception Conditions:

1. Verify that the data is of the proper type and within the range of acceptable data for this entry

Flow of activities for <i>Adding A New Data Category</i>
Main Flow: <ol style="list-style-type: none"> 1. User connects to UNCW Economic Web Service homepage 2. User logs into system 3. System verifies user 4. User selects the option to Add New Data Category 5. User inputs information about the Data Category such as name, the Data Global Category it belongs to, and a brief description 6. The user is then taken to <i>Adding A New Data Pod</i>
Exception Conditions: <ol style="list-style-type: none"> 1. Insure that the data category does not already exist

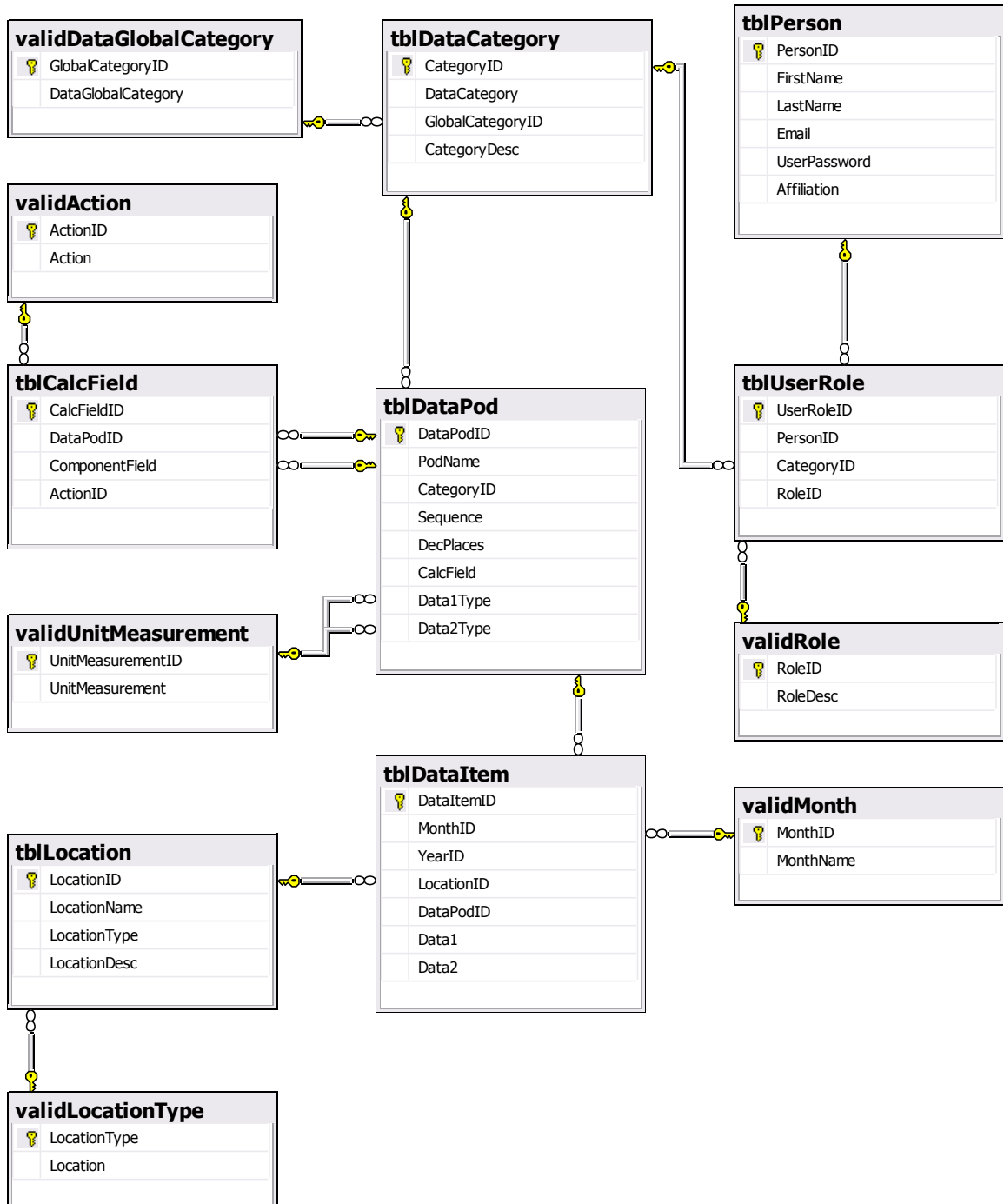
Flow of activities for <i>Adding A New Data Pod</i>
Main Flow: <ol style="list-style-type: none"> 1. User connects to UNCW Economic Web Service homepage 2. User logs into system 3. System verifies user 4. User selects the option to Add New Data Pod 5. User inputs information about the Data Pod such as name, the Data Category it belongs to, the decimal places, and whether or not it is a calculated field 6. The user is then taken to <i>Inserting/Updating Data</i>
Exception Conditions: <ol style="list-style-type: none"> 1. Insure that the unit of measurement exists in the database, or ask the user to insert a new data unit type.

Appendix D
Use Case Diagram



Appendix E

Database Diagram



| In the news |

UNCW releases economic data service

BY JOSH SPILKER

University of North Carolina Wilmington (UNCW) economist Woody Hall has been tracking economic data in southeastern North Carolina for 28 years. Now, some of that data is accessible via a database established by the UNCW Center for Business and Economic Services.

"The purpose of this website is to take data and make it public to the community," said Josh Tobey, during a press conference on June 12 to introduce the website. Tobey is a UNCW student who used the NC Economic Data Service as his capstone project for his master's in computer and information sciences.

The website features charts and graphs on various economic topics for Southeastern North Carolina, such as retail sales, residential construction and airport traffic. Most data sets begin in the last eight years, but some reach back to the 1980s. The sets are primarily focused on data for New Hanover County, but some data, such as retail sales, have multiple counties east of I-95.

"There's a lot of opportunities and potential, you can't find anyone in North Carolina providing it more effectively," said Cameron Business School Dean Larry Clark about the data service. "The opportunity behind this is exciting and it wouldn't have been possible if Woody Hall hadn't spent a lifetime of work."

Tobey also developed an interactive touch screen map for the data that can be accessed at a kiosk in the Center for Business and Economic Services. The hope of the business school is to one day install the touch screen kiosks in public school classrooms.



PHOTO BY JOSH SPILKER
Updating the forecast: UNCW's Woody Hall delivers an address on the service.

"There's an opportunity for sponsorship over time to be able to take this to the classroom," Clark said.

Clark and Hall agreed that there were not other sites like this available for the region or state. Hall noted that North Carolina State and University of North Carolina Charlotte track state data, but do not necessarily compile regional data.

"I'm not sure of anybody that has data like we do in North Carolina," Hall said.

Work on the site started in 2006 with a research grant. Continued funding from the project has come from Progress Energy.

The website for the North Carolina Economic Data Service is www.uncw.edu/NCeconData.