A DEMONSTRATION GEOGRAPHIC INFORMATION SYSTEM for ConnDOT OPERATIONS

Interim Report
by
C. Roger Ferguson

JHR 93-219

Project 90-8
May 1993

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16. Abstract

An interim report of the preliminary work required to begin a demonstration GIS for ConnDOT operations.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimetres	mm
ft	feet	0.305	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.093	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometres squared	km^2
VOLUME				
fl oz	fluid ounces	29.57	mililitres	mL
gal	gallons	3.785	Litres	L
ft^3	cubic feet	0.028	metres cubed	m^3
yd^3	cubic yards	0.765	metres cubed	m^3
NOTE: Volumes greator than 1000 L shall be shown in m^3.				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(F-32)/9	Celcius temperature	°C

*SI is the symbol for the International System of Measurement

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometres squared	0.386	square miles	mi^2
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F

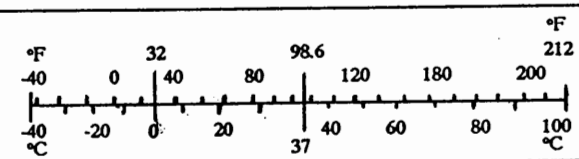


TABLE OF CONTENTS

INTRODUCTION

The December 1990 proposal for the Demonstration Geographic System (GIS) was for a two and one-half year project. Both the June 1991 and the January 1992 updated proposals were for a three and one-half year project. The project was funded only for one investigator's salary for four weeks in the summer of 1991. There has been no funding for the project for fiscal year 1992-1993. This report will describe activities relevant to the original proposal, which have occurred between June 1991 and September 1992.

The work plan for the 1991-1992 fiscal year proposed developing a technology to integrate route and cumulative mileage information into a GIS database and to write a report describing the translation methodology.

It became evident fairly early in the investigation that Intergraph Corporation was developing a methodology to perform the required translation, and that it would be available within the time allocated to develop the technology. The feature of the Intergraph GIS which will accomplish the translation is known as Dynamic Segmentation. As a consequence of the availability of Dynamic Segmentation, it was decided that working on other objectives of the demonstration GIS would be a better use of the principal investigator's time.

The second objective of the project is to design and identify elements for a Connecticut Department of Transportation (ConnDOT) GIS. Other objectives include working with the Intergraph hardware and software utilized by ConnDOT and creation of a demonstration GIS. Work on these objectives and a report on the implementation of the Intergraph GIS containing Dynamic Segmentation will comprise this interim report.

DYNAMIC SEGMENTATION

The almost universally accepted standard method for identifying the location of objects and events along our nation's highways is route and cumulative mileage. As we slowly move to GISs to provide us with a means of relating our voluminous collections of data about our highways to a graphic, or visual, display of the positions of objects and events, we must use geographic positioning (latitude and longitude) rather than route and cumulative mileage. There are, however, many good reasons for maintaining the route and cumulative mileage system. Consequently, we must have a means of translating our positions from one system to the other; that is, from route and cumulative mileage to latitude and longitude, and from latitude and longitude to route and cumulative mileage. For ConnDOT, the translation must work within its Intergraph GIS hardware and software

system.

In their multi-state, pooled-fund study "Application of Global Positioning System (GPS) for Transportation Planning" investigators from the Center for Mapping at The Ohio State University developed a method for simultaneously recording geographic position from a GPS receiver and mileage from a starting point using a wheel counter device. While this may be the ultimate, long-term solution to the problem, ConnDOT needs to make the translations now, rather than some number of years in the future when they are able to purchase new, sophisticated vehicles which collect photolog data; event, or object description, data; and GPS position data simultaneously.

The first step in the process of integrating route and cumulative mileage information into the ConnDOT GIS was to meet with Richard Gaulin of ConnDOT's Bureau of Planning, Division of Forecasting and Data Analysis to determine how the route and cumulative mileage information would be used. Mr. Gaulin is the operator of the Division's GIS, the one GIS in ConnDOT that is operational at this time. Mr. Gaulin is working at constructing some of the databases to be used in Forecasting and Data Analysis's special purpose GIS. The purpose of the meeting was to determine how the route and cumulative mileage information was used, how it could be integrated into the databases, and how it could be related to the visual displays of ConnDOT Intergraph GIS.

With this understanding in hand, contact was made with Intergraph's regional GIS specialist, Dr. David DiGiammerino, who agreed to come to ConnDOT headquarters to discuss the problem with Gaulin and Ferguson. DiGiammerino, incidentally, agreed to make the trip and spend time without considering it one of the educational visits promised to ConnDOT when they purchased the Intergraph hardware and software. Gaulin suggested that an address-matching function available in other GISs might be the methodology for translating between route and cumulative mileage and latitude and longitude. During this visit, DiGiammerino answered several other questions Gaulin had about implementing the, then relatively new to ConnDOT, GIS, but was unable to provide an immediate solution to the translation problem. He did, however, alert us to the fact that Intergraph was developing a new feature called "Dynamic Segmentation" which would provide the required translation mechanism and which would be available in the first quarter of 1992 (this was late September 1991).

During late October 1991, principal investigator Ferguson spent a considerable amount of time at the Intergraph booth at the GIS/LIS '91 Annual Convention in Atlanta. One of the Intergraph representatives responded patiently and thoroughly to all of Ferguson's questions

about Dynamic Segmentation and demonstrated on the pre-release upgrade of the GIS software how Dynamic Segmentation could produce the map products ConnDOT wants to produce, using Dynamic Segmentation as the translator from route and cumulative mileage to latitude and longitude.

Intergraph provided a demonstration of their GIS software upgrade, containing Dynamic Segmentation, at the ConnDOT Training Center on January 30, 1992. During the demonstration, Intergraph personnel reaffirmed the availability of Dynamic Segmentation on June 1, 1992. Since this was within the time frame conceived for this project to produce the same result, it was decided that attention to other, future tasks in the project would be advisable.

ConnDOT has acquired the Intergraph GIS upgrade and Gaulin is currently working on inserting the route and cumulative mileage attribute data to the database.

ELEMENTS FOR A ConnDOT GIS

Inherent in the charge to design and identify elements for a ConnDOT GIS is continuing to acquire as much information about GIS as is possible. One way to do this is to attend GIS presentations and exhibitions. Although none of them were funded from this project, Principal Investigator Ferguson attended and participated in several GIS-related meetings. Among them were:

National States Meeting on GIS, October 1991, attended at the request of, and as the representative of, the State of Connecticut Office of Policy and Management (OPM) and prepared a report of the meeting for dissemination to the State GIS Steering Group;

GIS/LIS '91, October 1991, including a paper presentation on integrated survey control network adjustment;

New Hampshire Land Surveyors Association Quarterly Meeting, September 1991, presentation of status of GIS in NH, including an introduction to the fairly new state GIS;

ACSM/ASPRS Spring Convention, March 1992, including a presentation on computer-aided tax mapping;

Towson State University's Fifth Annual GIS Conference, March 1992, including a presentation on creating a local and regional GIS;

State of Connecticut GIS Exposition, June 1991, including a presentation on

GPS control for GIS; and

Highway Engineering Exchange Program Conference, July 1992.

Paper presentations at many of these meetings expanded the Principal Investigator's knowledge of GIS possibilities, limitations, and problems. Sharing experiences with other GIS professionals helps us avoid the mistakes others have made and gives us ideas of how to do things differently from preconceived methods. Many of the experiences shared at these conferences contributed to the recommendations and conclusions contained in a later section of this report.

One vital element for a comprehensive ConnDOT GIS is the ability to exchange information with the Connecticut Department of Environmental Protection (ConnDEP) GIS. This does not yet seem to have a high priority in either ConnDOT or ConnDEP. During this project, however, a meeting was set up between two ConnDOT GIS personnel, three ConnDEP GIS personnel, and Principal Investigator, Ferguson. The meeting was held on December 30, 1991. The exchange of ideas about the accuracy required for a GIS base map, the files maintained by one or the other of the agencies which may be shared, the multitude of purposes of a GIS, and the methodologies utilized to attain those purposes was encouraging. The ConnDOT GIS is comprised of Intergraph hardware and software. The ConnDEP GIS is comprised of Sun workstations and IBM compatible personal computers using ARC/INFO software. ARC/INFO is the most widely used GIS software package for natural resources applications. At the time of this meeting, information exchange between the two systems was difficult.

Two significant actions resulted from the meeting: a visit to ConnDOT by ConnDEP with some ARC/INFO files to integrate into the Intergraph GIS and the idea of reinstituting the Connecticut Universal Mapping Committee as the State Mapping Advisory Committee (SMAC).

Although the attempt to integrate the ARC/INFO files into the Intergraph GIS was unsuccessful, a result of the meeting was a conversation with Intergraph in which it was revealed that there was to be a two way translator between ARC/INFO and Intergraph database files available on June 1, 1991. Both ConnDOT and ConnDEP have the software upgrades necessary to make these exchanges, but there has been no activity in that area that has come to the attention of this project's investigators. The ConnDOT GIS is in its formative stage and, therefore, has a limited number of personnel and hours devoted to its development. Building and altering the database for the output products having current high priority are keeping them busy now. As the commitment to expansion of the functions carried out by the

GIS is evidenced, it is expected that utilization of databases already created by others, such as some of the ConnDEP natural resource files, will be integrated into the ConnDOT GIS. When that occurs, along with sharing with ConnDEP and others of ConnDOT files, the cost-saving benefits of GIS for the State will begin to be fully realized.

There has, unfortunately, also been no further action on the SMAC. The SMAC was to deal with data-sharing ideas and standards for a GIS which will include state agencies, local and regional agencies, utilities, academic institution, and private industry. Although there are some individual efforts at coordination of GIS activities by the OPM-led State GIS Steering Committee and, more recently, by a University of Connecticut (UConn) committee organized by the Provost's office, and their activities are somewhat coordinated, these committees are not as encompassing in scope and participation as the SMAC envisioned.

INTERGRAPH HARDWARE AND SOFTWARE

The project's initial conception included the expectation that Intergraph hardware and software would be purchased to be utilized by the project investigators. As it became evident that funding levels would be reduced, there was some thought that the UConn Civil Engineering Department might purchase an IBM-compatible computer so that the investigators might use it with the PC version of the Intergraph GIS software. More careful investigation revealed that only the MGE module and not the MGA module of the Intergraph GIS software package is available for PCs. Without MGA, the query and analysis features of the GIS are not available, so the investigators would not be able to simulate the operations of the ConnDOT GIS. Consequently, the use of the PC version of the Intergraph GIS was not pursued. Finally, it was decided that a PC would be purchased by the UConn Civil Engineering Department for use by the investigators with another GIS software package. This would allow investigation of some other elements of a ConnDOT GIS. Changes in priorities for computer purchases by the UConn Civil Engineering Department resulted in the postponement of the GIS computer purchase so that it was not available to the investigators during the time that this project was funded.

The UConn Civil Engineering Department was able to purchase a suitable IBM-compatible computer in August 1992, and this project's principal investigators have recently acquired the ArcCAD GIS software package as part of another project, so "hands on" GIS research is now possible for these investigators.

CREATION OF A DEMONSTRATION GIS

Funding for this project ceased long before this phase of the project was reached. ConnDOT has engaged a consultant to investigate the GIS possibilities for ConnDOT and recommend a GIS implementation plan. It is the opinion of this investigator that there is still a great deal of benefit to be derived from a demonstration, or pilot, project before full-blown implementation of a GIS. It is also the opinion of this investigator that looking at the GIS from outside the organization with the cooperation of organization personnel, as would be done by the UConn Civil Engineering Department investigators, is the best way to create the demonstration GIS.

In response to the above statement, in its review of this document, the ConnDOT Office of Inventory and Forecasting, Bureau of Policy and Planning offered the following comment: "Recognizing the Department's current involvement and initiatives in this area, additional expenditures to provide for 'A Demonstration Geographic Information System for ConnDOT Operations,' as suggested in the subject report, would not be appropriate."

CONCLUSIONS AND RECOMMENDATIONS

There are a multitude of uses for GIS in ConnDOT. Many ConnDOT personnel see some of the uses, but it seems most see the GIS as a single, or few-purpose, tool which can do some tasks more efficiently. Not many seem to envision it as a tool which will allow technical and managerial personnel to change to very different methodologies. Engaging a consultant to study a ConnDOT GIS is a positive step which should lead to more comprehensive ideas of the capabilities and benefits of GIS.

The cost-sharing and cost and laborsaving benefits of GIS are a long-term phenomenon. They do not come without cost, commitment, and problems to be solved. Without a long-term commitment to building AND maintaining the databases, the GIS cannot succeed. There must also be a commitment to upgrading the hardware and software periodically.

The cost savings of GIS are not always quantifiable. For instance, managers now make decisions based on much more, and better, information which is available much faster. It is difficult to measure the cost savings from making a better decision, but the savings are real.

Involvement of ConnDOT personnel in the activities of various committees working on GIS policies is beneficial and should continue to be encouraged. ConnDOT has representatives on the State GIS Steering Committee and its

GPS Subcommittee. These committees will be eventually working on standards for data exchange and it will be desirable for ConnDOT to have its views heard before standards are set. It might also be beneficial for ConnDOT to take the lead in reforming the SMAC, which will deal with the broader, or statewide, issues in data-sharing and cost-sharing in the creation of GIS base maps and data bases. ConnDEP has volunteered to take the lead in this process, but has evidently done little in the year since they volunteered. Other committees working on GIS in a manner which may affect ConnDOT, and which ConnDOT may wish to encourage their personnel to participate in, are the Connecticut Association of Land Surveyors (CALS) GIS Committee, and the New England Section - ACSM Northeastern Regional Task Force Committee on Geo-Informational Systems Management.

The benefits of a demonstration or pilot project have been extolled in virtually every presentation, heard by this investigator, which described a project that had one. The desire to have had a pilot has often been mentioned in presentations about GISs that did not have one. It is anticipated that the consultant studying GIS for ConnDOT will suggest a demonstration project as did the principal investigators for this project. A demonstration GIS for ConnDOT is still highly recommended by this investigator.

Appendix I

An Updated Proposal
Prepared for the
Joint Highway Research Advisory Council
University of Connecticut
Connecticut Department of Transportation

JHRAC PROJECT NUMBER: 90-8

PROJECT TITLE:
A DEMONSTRATION GEOGRAPHIC INFORMATION SYSTEM
for
ConnDOT OPERATIONS

PRINCIPAL INVESTIGATORS: Christian F. Davis & C. Roger Ferguson

December 1990
Revised June 1991
Updated January 1992

1. Project Identification

The title of the proposed research is "A Demonstration Geographic Information System for ConnDOT Operations." The co-principal investigators will be Christian F. Davis, Professor of Civil Engineering and C. Roger Ferguson, Lecturer in Civil Engineering.

2. Problem Statement

The project report "Application of the Global Positioning System to ConnDOT Operations" (JHRAC project no. 90-2) details many aspects of geographic information systems (GIS) that will improve the operations of ConnDOT operating units. The improvement can be in taking lesser time to complete some tasks, in performing tasks that are too cumbersome or time consuming utilizing available tools, or in performing more of the same tasks than are currently completed in a given time period. One of the biggest advantages of GIS is that users of the same information can share the cost of acquiring the information and can store the information in a single location which is easily accessible to all users. Unless it is well planned, however, a GIS can be purchased and implemented without achieving any of the efficiencies that should be inherent in a GIS.

3. Background and Significance of the Work

"A GIS is a computer based system used to capture, manage, edit, manipulate, analyze, synthesize and output geographically referenced information." This is becoming a consensus definition of GIS. A major benefit of GIS is the ability to link spatial and descriptive data and to produce graphic displays from descriptive or attribute data.

The investigation of global positioning systems (GPS) and GIS in JHRAC project 90-2 demonstrated that there is considerable interest in creating a statewide GIS. A demonstration GIS will focus on a small part of such a system, but will be designed to focus on problems that may be encountered in both a ConnDOT GIS and a statewide GIS. As was the case in 90-2, the potential beneficial use of GIS/GPS extends to every functional unit within ConnDOT.

4. The major objectives of the research will be to:

- Study a series of research tasks identified by ConnDOT Planning & Research personnel in the prioritized order set by Planning personnel on June 6, 1991.
- Work with the same Intergraph hardware and software packages which ConnDOT units have and investigate integration with other currently operating hardware and software packages for potential statewide GIS use. This investigation will address the critical data sharing possibilities which are a key ingredient in minimizing database acquisition costs.
- Study available database and other ConnDOT information files to decide which, if any, can be integrated into GIS software packages. Investigate the possibility and feasibility of sharing database information with ConnDEP.

- o Create a demonstration GIS. The objective will be to create a system which will be usable and expandable for ConnDOT, and possibly for a statewide GIS.

- o Utilize GPS receivers to demonstrate methodologies for acquisition of higher precision database information for the GIS.

- o Identify specific applications for functional areas within ConnDOT.

5. Implementation

It is expected that the product of this research will be implemented by many operating units within ConnDOT.

6. Accomplishments to Date

Although there is not yet available an Intergraph Work Station and the appropriate Intergraph GIS software for the Principal Investigators to use, we have been successful in meeting with ConnDOT personnel and Intergraph personnel (both locally and at the GIS/LIS '91 meeting in Atlanta, GA) to attempt to solve the problem of integrating route and cumulative mileage into the GIS database. In response to our discussion, and the requests of other users, Intergraph has developed a process called "dynamic segmentation," which will allow the translation between route and cumulative mileage and geographic position. Dynamic segmentation is in the Beta test site stage now and is expected to be available to Intergraph GIS users, including ConnDOT, on June 1, 1992.

One of the principal investigators was able to arrange a meeting between ConnDOT Bureau of Planning and ConnDEP Natural Resources Center GIS personnel. The exchange of ideas about the accuracy required for a GIS base map, the files maintained by one or the other of the agencies which may be shared, the multitude of purposes of a GIS, and the methodologies utilized to attain those purposes was encouraging. Two significant actions resulted from the meeting. The first was a visit to DOT by DEP with some ARC/INFO files to integrate in the Intergraph GIS. Although the attempt to integrate the files was unsuccessful, a result of the meeting was a conversation with Intergraph in which it was revealed that there will be a two way translator between ARC/INFO and Intergraph database files available on June 1, 1992. The second important result of the meeting was the idea of reinstituting the Connecticut Universal Mapping Committee as a State Mapping Advisory Committee (SMAC). The SMAC is to deal with data sharing ideas and standards for a GIS which will include State agencies, local and regional agencies, utilities, academic institutions, and private industry.

7. Work Plan

Task A - Study the Prioritized Series of Research Tasks

1. Develop a technique to integrate route and cumulative mile information into the database. Investigate the possibility of integrating curve and grade information from photo logs. Attach cumulative mileage to Tiger File lat-long data.

2. Develop a methodology to include the Pavement Management System, the Sign Inventory System, and the Bridge Inventory System into the GIS database. This will probably require GPS input.

3. Develop an interface between the Intergraph GIS and the mainframe DB4 files.

4. Develop an interface between the Intergraph GIS and the PC based TRANPLAN transportation modeling package.

5. Evaluate three dimensional geocoding. Is this cost effective with and without GPS data input?

6. Design and identify elements for a ConnDOT GIS. List what is needed in the database for a GIS. Evaluate what available data, such as TIGER Files, can be used.

7. Investigate the integration or interface between the Intergraph GIS and DEP's ARC/INFO database.

Task B - Acquire the Necessary Training and Experience to Operate the Hardware and GIS Software

The learning curve for operating GIS is generally considered to be long and steep. Intergraph, for example, will not sell their software without on and off site training included. In addition to vendor training, it is expected that several familiarization exercises will have to be completed at the research site.

Task C - Interact With ConnDOT and ConnDEP Units Which Have Established Databases

Attempt to integrate as much existing database information as is feasible into the GIS. ConnDOT's "Integrated Highway Information System" and ConnDEP's "Natural Resources Information System" are examples of potentially useful existing databases.

Task D - Prepare Interim Report

In addition to the interim report, it is expected that associated papers will be written for publication and presentation at meetings such as GIS/LIS '92, '93, '94 and the TRB Annual meeting.

Task E - Database Transfer and Acquisition

This is the most time consuming and labor intensive aspect of creating a GIS. Integration of ConnDOT and ConnDEP databases into the GIS, if possible and feasible, will be accomplished at this time. Additionally, GPS data acquisition for GIS database creation will be a significant feature of this task.

Task F - Operation of GIS

Investigation of data entry and data sharing methodology. Consideration of security of data and data file maintenance responsibilities. Preparation of GIS reports and graphic displays.

Task G - Follow-Up

Interaction with appropriate ConnDOT units. Although this is listed as a separate task and chronologically placed near the end of the project, interaction with several units is expected throughout the project. At this stage, the expectation is that GIS communication problems will have occurred and been addressed. Reactions to the problem solutions will be assessed to see if further action is necessary.

Task H - Prepare Final Report

8. Work Schedule

A work task schedule is provided as Attachment "A."

9. Budget

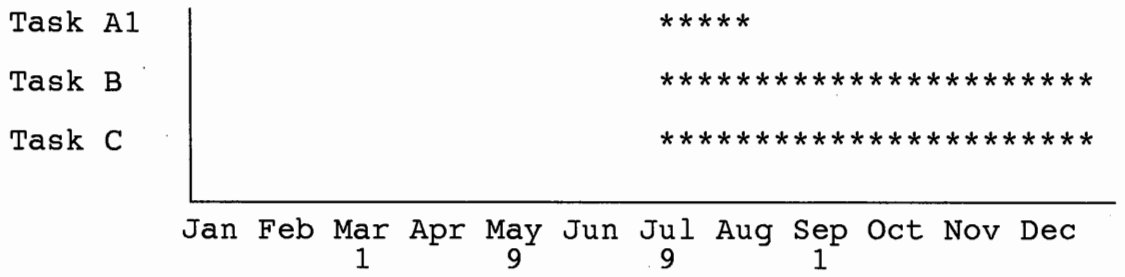
The project budget is presented as Attachment "B."

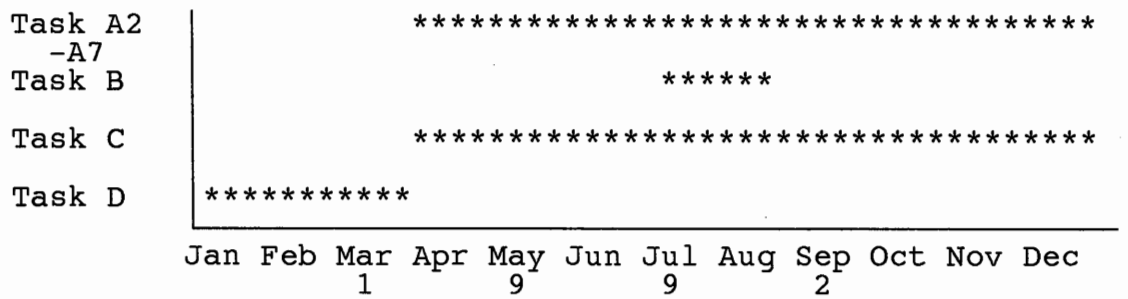
Although the maximum benefit from this project will be realized if the project proceeds as proposed, significant benefits can be realized from scaled down projects. Alternate proposals for 1992-1993 are presented as Attachment "B1."

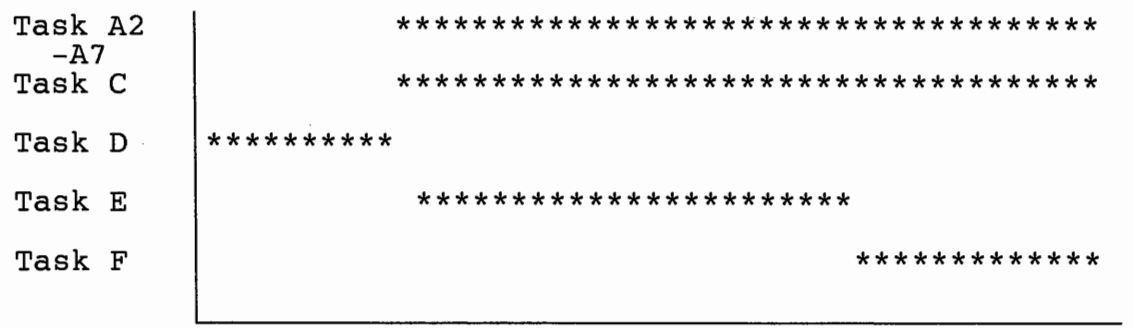
The first alternative proposal lessens the amount of time spent on the project by one of the principal investigators and supplies a lesser amount of Intergraph hardware and software. The second alternative proposal contains the same project diminution as the first, but additionally eliminates provision of any Intergraph equipment and eliminates a graduate student from the project. This project would demonstrate the GIS possibilities and value for Conn DOT, but does it with software and hardware different from that used by ConnDOT. There would still be a considerable amount of benefit to this undertaking, but it would not be directly transferable to the ConnDOT Intergraph GIS.

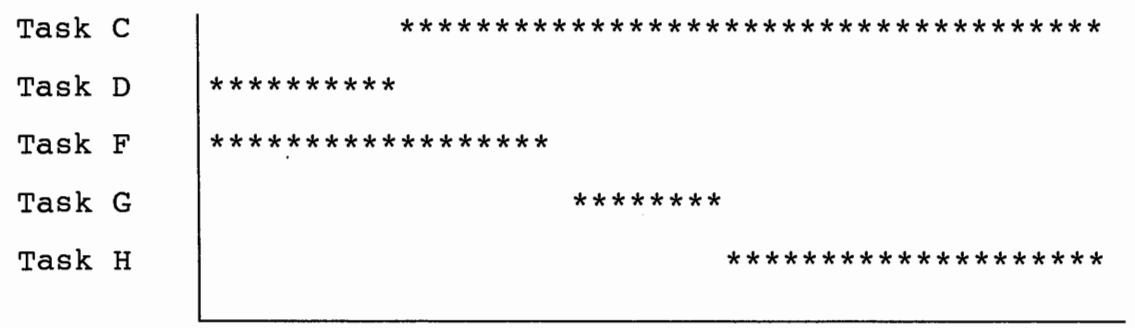
Another possibility is to attempt to obtain some portion of the Intergraph equipment cost from the University of Connecticut Research Foundation. This avenue will be pursued, and the results of the investigation reported to JHRAC.

Attachment A - Work Task Schedule









Attachment B - Demonstration GIS Project Budget

1 9 9 1

	June Wks	June Amount	July/Aug Wks	July/Aug Amount	Total Wks	Total Amount	Total
Salaries							
C.R.F.			4	$6,400	4	$6,400	
1991 Project Total							$6,400

1 9 9 2

	June Wks	June Amount	July/Aug Wks	July/Aug Amount	Total Wks	Total Amount	Total
Salaries							
C.F.D.	2	$3,552	6	$11,286	8	$14,838	
C.R.F.	1	$1,501	7	$11,249	8	$12,750	
Grad Assts - Summer and AY						$24,000	$51,588
Mileage							
1000 miles @ $0.21							210
Travel							
Out of State							4,000
Printing							265
Intergraph Hardware & Software (estimate)							65,000
1992 Project Total							$121,063

continued on page 8

Attachment B - Demonstration GIS Project Budget

continued from page 7

1 9 9 3

	June Wks	June Amount	July/Aug Wks	July/Aug Amount	Total Wks	Total Amount	Total
Salaries							
C.F.D.	2	$3,762	6	$12,076	8	$15,838	
C.R.F.	1	$1,607	7	$12,036	8	$13,643	
Grad Assts - Summer and AY						$24,000	$53,481
Mileage							
1000 miles @ $0.225							225
Travel							
Out of State							4,300
Printing							280
GPS Receivers & Software (estimate)							50,000
1993 Project Total							$108,286

1 9 9 4

	June Wks	June Amount	July/Aug Wks	July/Aug Amount	Total Wks	Total Amount	Total
Salaries							
C.F.D.	2	$4,025	6	$12,921	8	$16,946	
C.R.F.	1	$1,719	7	$12,878	8	$14,597	
Grad Assts - Summer and AY						$24,000	$55,543
Mileage							
1000 miles @ $0.225							225
Travel							
Out of State							4,500
Printing							300
1994 Project Total							$60,568

Attachment B1 First Alternative - Demonstration GIS Project Budget

1 9 9 2

	June Wks	June Amount	July/Aug Wks	July/Aug Amount	Total Wks	Total Amount	Total
Salaries							
C.F.D.	2	$3,552	2	$ 3,867	4	$ 7,419	
C.R.F.	1	$1,501	7	$11,249	8	$12,750	
Grad Assts - Summer and AY						$24,000	$44,169
Mileage							
1000 miles @ $0.21							210
Travel							
Out of State							4,000
Printing							265
Intergraph Hardware & Software (estimate)							35,000
1992 Project Total							$83,644

Attachment B1 Second Alternative - Demonstration GIS Project Budget

1 9 9 2

	June Wks	June Amount	July/Aug Wks	July/Aug Amount	Total Wks	Total Amount	Total
Salaries							
C.F.D.	2	$3,552	2	$ 3,867	4	$ 7,419	
C.R.F.	1	$1,501	7	$11,249	8	$12,750	
Grad Assts - Summer and AY						$12,000	$32,169
Mileage							
1000 miles @ $0.21							210
Travel							
Out of State							4,000
Printing							265
Intergraph Hardware & Software (estimate)							0
1992 Project Total							$36,644