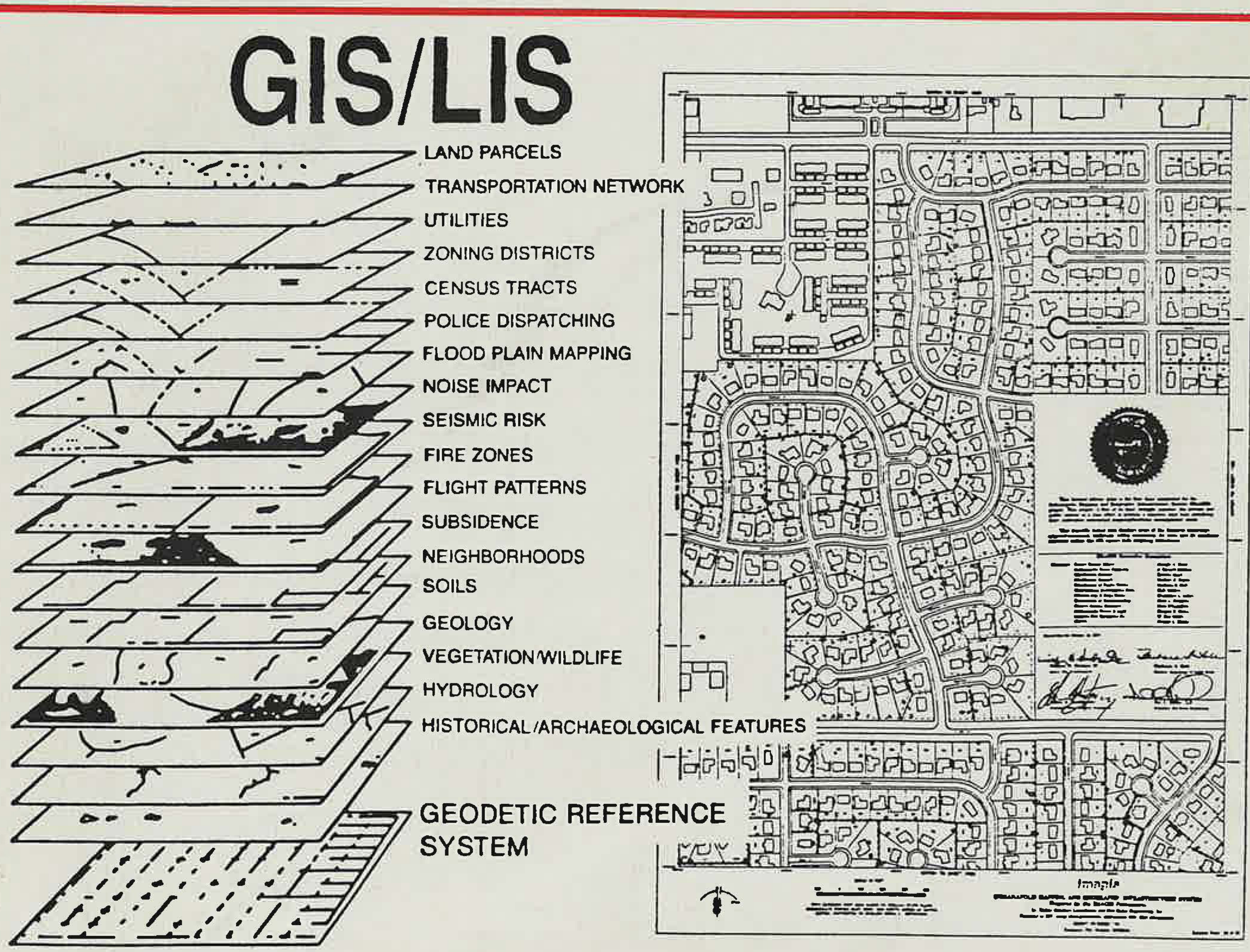
HOOSIER SURVEYOR

QUARTERLY PUBLICATION OF THE
INDIANA SOCIETY OF
PROFESSIONAL LAND SURVEYORS, INC.

VOLUME 17
NUMBER 2
FALL 1990

AFFILIATED WITH THE
AMERICAN CONGRESS ON
SURVEYING & MAPPING



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EDITOR'S NOTE

Deadlines for copy for various planned issues of the HOOSIER SURVEY are as follows: Winter issue - December 31; Spring issue - March 31; Summer issue - June 30; Fall issue - September 30.

The HOOSIER SURVEYOR is published quarterly by the INDIANA SOCIETY OF PROFESSIONAL LAND SURVEYORS, to inform land surveyors and related professions, government officials, educational institutions, libraries, contractors, suppliers, and associated businesses and stries about land surveying affairs.

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PRESIDENT'S THOUGHTS

by Roger Woodfill, ISPLS President, Lawrenceburg, IN

In the Winter Edition of the Hoosier Surveyor, I told you that my goal for 1990 is to have the Indiana Society of Professional Land Surveyors, Inc. win the ACSM/NSPS Affiliate of the year award. We have a while to wait, but I have instructed Dianne to make room on the library wall for a plaque. Here is a brief summary of the highlights of ISPLS committee activity since my last report.

I have met with the convention co-ordinating committee three times. They have convinced me that the Vincennes meeting January 16-18, 1991 is going to be worth the extra effort to get there. We will be having a membership meeting that Friday morning. It will be reminiscent of old ISPLS meetings, with committee reports and debates. The local convention committee has apparently adopted a policy of "fun" with casino night, mining tours, and everything from auctions to ventriloquist. Low room rates and the meals furnished with the registration fee will make our 1991 annual convention very affordable.

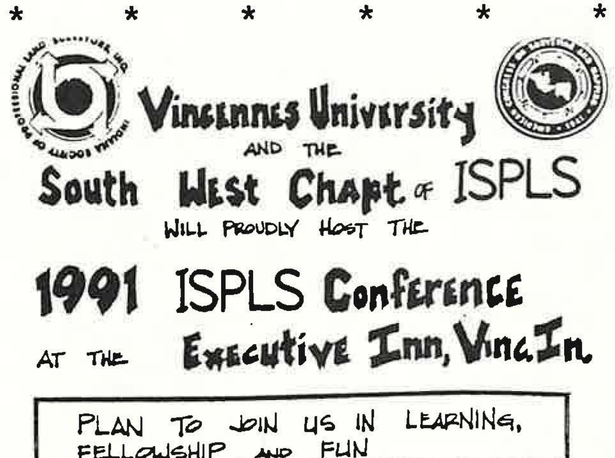
The education committee has met three times also. They organized the Robillard Workshop on "Easements" and the October Workshop on "Wetlands". Talk about organizing!! They have adopted a policy of three educational programs per year. Besides doing their part at the annual convention; next year they have tentatively scheduled a GIS/LIS seminar at Ball State University in April, and they booked thirty rooms at the Brown County Inn for October 1991. For an encore they expect to have a voluntary ISPLS professional development program ready for adoption at Vincennes. Oh yes, a subcommittee is investigating surveying courses being taught at Indianapolis and Gary.

The government affairs committee is in the best shape that I can remember. Today is September 27th and they already have a bill submitted to legislative services; they have Republican and Democrat sponsors in the house; they have Democrat and Republican sponsors in the Senate; they have a lobbyist; they are lining up support from various societies and boards; they have a fiscal impact report; they have a position paper; and the bill addresses the number #1 long range goal of ISPLS - they have a cause. When they implement their "Minuteman" and P.A.C. programs, please do your part.

The public relations committee is another committee that I have met with twice now. They did not just rest after their Boy Scout's success. Now they have divided the state into fifteen areas and selected a co-ordinator in each area to inform high school students about the surveying business. They contacted all 550 high schools in Indiana offering media and Trig-Star sponsors. If you are not yet familiar with these programs at your local school, call Dianne and volunteer. She will get you connected with the right person, and the image of "surveying" will shine.

Also, on public relations -we are workin with Hilltop Basic Resources, Inc., and th Switzerland County Parks Board on "Project East Point": On ISPLS's initiative we are marking the most easterly point of Indiana. Get out your map as you can see that this point is in Switzerland County almost two miles east of the First Principal Meridian. Actually it is in the Ohio River. Current plan's are to make a fourteen foot compass with six and a half foot peep sight-vanes in a quarter acre park on State Road #156. Got to hurry though - so that we can submit this project with our affiliate of the year application.

* * * * * *



ANNOUNCEMENT

Motion passed by ISPLS Board of Directors on Sept. 21, 1990

"Whereas the board of Directors has discussed the unusual procedure in establishing the mandatory scholarship assessment at the 1990 ISPLS Convention and whereas a question has risen regarding the mandatory payment of said $20 assessment as a part of total dues, the Board of Directors hereby rescinds the mandatory payment of said $20 assessment."

Those members of ISPLS who made a $20 donation to the ISPLS scholarship fund with their 1990-91 dues payment may apply for a credit toward their 1991-1992 membership dues thru December 31, 1990. All monies collected for the scholarship fund will remain in the fund, and ISPLS will continue to solicit "Voluntary" contributions for the scholarship fund. This extremely unusual reversal of the general membership vote by the Board of Directors will be more fully explained at the 1991 general membership meeting.

Professionally,

Roger Woodfill
President ISPLS

* * * * * * * * * * * * * * * * * *

PLANNING FOR COLUMBUS CONVENTION JANUARY 1992

Dear Fellow Surveyor:

ISPLS is a very unique group of over 200 individuals who work in and for sole proprietorships, partnerships, corporations, and government agencies that range in size from two man operations to over 200 employees and perform a variety of tasks that would fill this magazine if each were described. The only thing that we have in common is the training and skills to perform accurate measurements under a widely diversified set of conditions.

So what am I trying to say? As a member of the convention coordinating committee and general chairman of the upcoming 1992 convention, I would like to know what you want to hear about - business management, rule 13, wetlands, job safety, belly dancing, new equipment, review of standard traverse methods, satellite surveying, land parcel identifiers, source of best bean soup in Indiana, dern land records, liability, records nagement? You tell me.

Is there any interest in a garage sale, flea market, auction where ISPLS would oversee the sale of your junk to fellow surveyors for a percent of the sale price? Should this be at convention or during the summer outing?

Take a minute to scribble your thoughts on the back of an old print, matchbook, or other media capable of accepting data and send them to me. Our society is only as strong as the joint efforts of its individual members and our conventions only as successful as we make them.

Professionally Yours,
Orwic Johnson LS/PE
P.O. Box 1171
Columbus, IN 47202

Comments:

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Xerox and Send

INDIANA SOCIETY OF PROFESSIONAL LAND SURVEYORS INC.

39th ANNUAL LAND SURVEYORS CONVENTION

January 16-18, 1991

Executive-Inn
One Executive Boulevard
Vincennes, Indiana
(812) 886-5000

PROGRAM SCHEDULE

A.M. *Wednesday, January 16, 1991*

8:00 - Registration for Convention
10:00 - 11:45 ISPLS B.O.D. Meeting & Committee Meetings

P.M.

12:00 - 1:30 Board of Directors Luncheon
1:30 - 4:00 "Recent Changes & Policing of Rule 13"
Panel - Wes Day, Gary Kent, Ross Holloway, Mike Feldbusch-Board of Reg, Rep of the Attorney Generals Office
6:00 - 7:00 Cocktail Hour in Exhibit Hall
7:00 - 8:00 Welcoming Dinner
Welcome Address/Mayor William Rose
8:00 - 9:30 Casino Royale in Exhibit Hall
9:30 - Auction in Exhibit Hall

A.M. *Thursday, January 17, 1991*

8:00 - Registration - Coffee, Donuts and Orange Juice in Exhibit Hall
8:30 - 10:00 "Decisions For Selecting Microcomputer Hardware and Software"
Larry Goss, University of Southern Indiana - Engineering Technology
8:30 - 10:00 "Surveying After a Disaster"
Edwin O. Boyd, P.E., L.S. Petersburg
8:30 - 10:00 "Professional Liability and General Liability Insurance Regarding Job Safety"
Robert Horner - Victor O. Schinnerer & Co., Inc.
Dale Olson - Citizens Realty and Insurance Co., Inc.
10:15 - 11:45 "Customizing Your Microcomputer For Your Specific Needs"
Larry Goss, University of Southern Indiana - Engineering Technology
10:15 - 11:45 "Indiana Drainage Laws As Pertaining to Surveying"
David Ford, Attorney & Rep from DNR, Divison of Water
10:15 - 11:45 "Basic Mathematical Procedures for the Land Surveying Technician and Standardization Within the Company"
Gordon Richardson

P.M.

12:00 - 1:30 Luncheon - Recognition Awards & Address by NSPS Director
1:45 - 4:30 "Old Ben 2 - Surface Mine Tour"
1:45 - 4:00 "A Lesson of Historical Significance"
Kenneth W. Anderson - USDA Forest Service
1:45 - 3:00 "Indiana Drainage Laws As Pertaining to Surveying"
David Ford, Attorney & Rep from DNR, Division of Water
1:45 - 4:00 "Guidelines for Preparing A Surveyor's Report"
Gary Kent
3:15 - 4:30 "Tax Laws and the Small Business and Retirement Options"
Jaleigh White - Kemper CPA Group
6:00 - 7:00 Dinner Banquet
7:00 - "An Evening at Vincennes University"
Dessert Buffet
Music by the V.U. Show Choir
Presentation by V.U. President - Dr. Philip Summers

A.M. *Friday, January 18, 1991*

8:00 - Registration - Donuts, Coffee and Orange Juice in Exhibit Hall
8:00 - 9:00 Committee Meetings
9:00 - 12:00 Annual Membership Meeting

P.M.

12:00 - 1:30 Luncheon-Presentation by Mike Quayle - Publisher "Vincennes Sun-Commercial"
1:45 - 4:30 "Old Ben 2 - Surface Mine Tour"
1:45 - 3:00 "Professionalism and the Public View of Surveyors"
Mike Quayle, assisted by a panel of professionals related to the surveying industry
1:45 - 4:00 "Guidelines for Preparing a Surveyor's Report"
Gary Kent
1:45 - 3:00 "Flood Plain Management"
3:15 - 4:30 "Basic Mathematical Procedures for Land Surveying Technician and Standardization within the Company"
Gordon Richardson
3:15 - 4:30 "Stress Management"
Lisa Gossman Werner
6:00 - 7:30 Dinner Banquet
7:30 - 8:30 Comedy Roast by the Hasty Pudding Puppet Co.

FOR ADDITIONAL INFORMATION

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Matt Wannemuehler
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Evansville, IN 47708
Phone: (812) 426-1737

LAND SURVEYORS CONVENTION

GENERAL INFORMATION

Registration

A sincere effort has been made to give all registrants more value for their money. The registration fee of $150 for the convention will include all handouts, refreshment breaks, two luncheons, two dinners, one banquet, and three evenings of entertainment. The registration fee for the spouse's program is $75 and includes the two dinners and one banquet. The student registration fee of $25 includes meetings and luncheons only. Daily registration includes lunch and meetings only. Lunch is assured on pre-registration only.

Please return the attached registration form by December 15, 1990. Late and daily registration will be open after 8:00 A.M. on Wednesday, January 16th at the registration booth. Late registration is not encouraged. A $10 per day surcharge will be added to the registration fee for all late registrants. Late registrants will not be guaranteed handouts.

Exhibits

Be sure and take advantage of the opportunity to learn about the newest technology in equipment and services offered by the many exhibitors. The exhibitors are a valuable part of our convention so make them feel welcome and express your appreciation for their participation. Don't miss the opportunity to test your skills and luck at the Casino Royale on Wednesday evening, January 16th, in the exhibit area. Use your bogus winnings to bid on the many fine items donated by our generous exhibitors.

Programs

Come be a part of an exciting convention in historical Vincennes. Come listen, learn and exchange ideas concerning the many topics which should be beneficial for field and office personnel as well as managers and owners. The many topics include: Rule 13, computer technology, professional and general liability insurance, Indiana drainage laws, mathematical procedures and the standardization within a company, achievements of a 19th century county surveyor of Perry County, a guide to writing surveyor's reports, tax law and the small business, professionalism in surveying, flood plain management, surveying after a disaster, and stress management. The Board of Directors meeting and the annual general membership meeting will also be held.

Tour

A three hour bus tour of Old Ben 2 surface coal mine which produces approximately 1.5 million tons of coal per year, will take place on both Thursday and Friday afternoon January 17th and 18th. The tour will feature an explanation of the mining process which includes the blasting procedures, overburden removal, coal removal, coal cleaning and mine reclamation. Included in the tour will be a close view of a large stripping dragline at work. Registration will take place the morning of the tour at the registration table. No additional fee is required. Attendance will be limited.

Lodging

The Executive Inn is the Hotel of choice as it offers very reasonable rates ranging from $31 to $40 for a single room and from $35 to $44 for a double (see attached brochure). Enjoy the convenience of lodging within walking distance of the majority of the convention activities.

ENTERTAINMENT

One goal of this years convention is to entertain the participants as well as enlighten them. Three separate nights of relaxing entertainment have been planned starting with the Casino Royale on Wednesday evening. ISPLS bucks will be used to try and break the bank at the many gaming tables to be set up in the exhibit hall. The hall will then be transformed into an auction house where everyone will be given the opportunity to use their winnings to bid on the many items donated by our generous exhibitors.

Thursday evening dinner will be followed by a short trip to Vincennes University for a delicious dessert buffet. The culinary art students of Vincennes University will create before your eyes a variety of freshly prepared desserts from which your favorites can be chosen. Enjoy your dessert as you are entertained by the very talented University Show Choir. After dessert, you will be treated to an interesting presentation by Vincennes University president Dr. Philip Summers on the historical significance of Vincennes and southwestern Indiana and the role the early surveyors played.

The convention will draw to close on a funny note as Friday dinner will be followed by a Comedy Roast of some of our most prominent peers by the "Hasty Pudding Puppet Company", it promises to be the perfect way to end what should be an enlightening as well as entertaining convention.

SPOUSE/GUEST PROGRAM

Wednesday, January 16, 1991

NO SWEAT!

Have you ever envied those women who parade around in outfits decorated to reflect their own personal style? Well, now you have the opportunity to embellish a pair of sweats all your own--in a hands-on workshop that will allow you to experiment with the latest trends. It's fun and easy! Classes will be held at the Executive Inn so even late arrivals can join the activities. All materials are supplied.

Thursday, January 17, 1991

BACK IN TIME

Following a continental breakfast, pioneer escorts will help you board a Trailblazer bus for an Architectural tour of Old Town, which showcases the rich heritage of Indiana's oldest city. Museum restorations, neighborhood residences, and the splendid Knox County Courthouse and War Memorial show how Vincennes' past has merged with its present.

Enjoy lunch at the Market Street Pub, another Southern Indiana landmark, prior to an afternoon Historic Tour. Vincennes' "Mile of History" includes a wealth of historic sites ranging from the George Rogers Clark Memorial to Grouseland, the stately Georgian mansion of William Henry Harrison, 9th U.S. President.

Friday, January 18, 1991

Following a continental breakfast in the exhibit hall, the group will board a Trailblazer bus for a pleasant drive to the River-City, Evansville. A short bus tour of the city will be followed by a visit to the Historical Reitz Home. An ala carte lunch at Greeley's in the Old Post Office Place near the heart of downtown will be followed by a stop at the Olde Evansville Antique Mall which features three floors (131 shops) of antiques and crafts.

THE TWO-YEAR SURVEYING TECHNOLOGY PROGRAM AT VINCENNES UNIVERSITY

Vincennes University's award-winning program in Surveying Technology is recognized as a leader in preparing graduates for diverse opportunities in the surveying field.

"Employers believe our graduates are competent and well trained," says Art Haase, chair of the two-year VU program. "Our curriculum is dedicated to the needs of those in the field and our graduates can typically carry their own weight in the field from the first day, particularly as an instrument person."

In February the VU Surveying Technology program was the recipient of an Award of Excellence presented by the Indiana Commission of Vocational and Technical Education in cooperation with the Indiana Vocational Association. The award recognized the program's design, resource utilization, and positive outcomes.

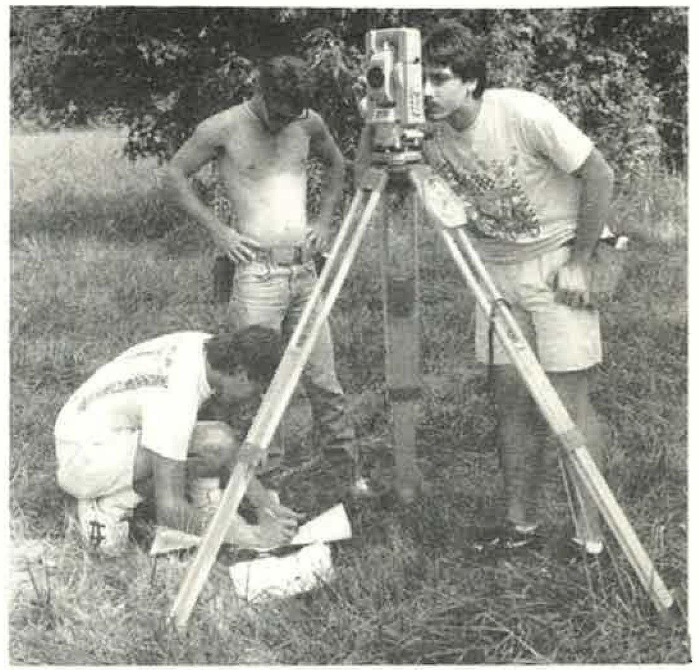
This year the program's enrollment of 39 students is at an all-time high. Haase cites more scholarships and the outstanding employment opportunities for VU's graduates as reasons for the increased enrollment.

"Our graduates have an average of three to four job offers. Although most of our alumni work in Indiana, we also have alumni working in California, Alaska, Colorado, Texas, Arizona, Florida, North Carolina, Louisiana, and Arkansas, as well as the states adjacent to Indiana," Haase says. Starting salaries for 1989 graduates ranged from $17,500 to $28,000, based on a 40-hour week.

The facilities and equipment available to students are among the finest anywhere. VU has an inventory worth approximately $250,000 in surveying equipment including the latest in laser-equipped total stations and computer accessories. Each student experiences extensive training using transits, levels, theodolites, infrared lasers, and total stations including Topcon GTS-3, Lietz Set2, and Wild T1000 U with on-board data recorder. Computer manipulation of data is accomplished utilizing Wild software on 22 IBM personal computer stations. Students also utilize VU's $1.75 million computer-assisted drafting facility and excellent mapping classrooms.

"We want to be a model program in computer manipulation and recording of data for surveying," Haase says.

VU's surveying graduates have been employed in mineral exploration, private and corporate engineering firms, governmental surveying offices, private surveying offices, and



PRACTICAL EXPERIENCE--From left, Vincennes University Surveying Technology majors Ed Sweetland of Greenfield, Jeff Powell of Vincennes, and Paul Reahard of Huntington utilize a Topcon GTS-3 Total Station during a field exercise.

major contractors. Some of these graduates have been promoted to chief of party within three months of employment. In addition to those immediately seeking employment upon graduation, approximately half of the program's graduates transfer to other colleges to continue their education.

In addition to sophisticated equipment and facilities, Haase cites small class size and extensive field work as reasons VU graduates can contribute so quickly when first employed. Approximately 75 percent of a student's class is spent outside in the field gaining practical experience dealing with real problems. Haase also cites the contributions of the Surveying Technology Advisory Committee as another major factor in the success of the program.

A typical first year of study in the VU Surveying Technology program includes classes in Surveying Fundamentals, Real Property Law, Surveying Computations and Construction Techniques, Mapping and Drafting, English

Composition, Physical Geology, College Algebra, Social Science, Physical Education, and Land Transactions, Remedies and Instruments.

A typical second year of study includes classes in Cadastral Surveying, Subdivision Design and Layout, Computer-Aided 2-D and 3-D Drafting, Structures and Testing, Social Science, Physical Education, Advanced Surveying, Advanced Surveying Topics, Construction Design and Estimating, Speech, and General Physics.

Although the program features an array of high technology, Haase says that the program has continued one of the best features of its past--a close relationship between students and faculty. "Our program is very close. We have our own club, athletic teams, and we encourage freshman and senior interaction. After 16 years on the VU faculty, I can tell you where 80 percent or more of our graduates are and their position," Haase says.

Because of this close relationship, Haase encourages prospective employers of VU surveying graduates to call him so he can share his knowledge of their abilities. "I have never had a complaint from a company that called about one of our graduates. I believe this is a service that companies should utilize to their own advantage," Haase says.

Haase encourages both prospective students and interested employers to tour the VU facilities and meet with the faculty. For those unable to visit there is a video about the Surveying Technology program that is available to be loaned for viewing. Those interested in learning more about the program may call Art Haase, (812) 885-4185 or Bill Clark, instructor of Surveying Technology, 885-5865. The VU Admissions Office also offers a toll-free phone for information at 1-800-742-9198.

FIELD EXPERIENCE--From left, Vincennes University Surveying Technology majors Erin Halley of McLeansboro, Illinois, and Brad Isaacs of Brownstown, Indiana, utilize the Lietz Sokkisha Set 2 Total Station during a learning exercise at a Vincennes subdivision site.

* * * * * * * *

GIS/LIS COMMITTEE OF ISPLS

Minutes of initial meeting, Sept. 28, 1990

The stated purpose of the first meeting of the GIS/LIS Committee was to begin to formulate goals and objectives for the immediate future. Discussion with President Roger Woodfill led us to the following consensus:

1) Establish and maintain lines of communication with the State office of GIS in order to be aware of developing ideas and to be involved in the decision making process.
2) Assist in setting technical standards that form the framework for GIS/LIS activities. This will probably involve reviewing federal guidelines and those of states with currently established standards.
3) Serve as a vehicle for the education of ISPLS members with regard to GIS/LIS. This will include disseminating information on the industry, and a look at how and why surveyors must be involved.
4) Investigate avenues for potential legislation with regard to GIS/LIS.

INDIANA SOCIETY OF PROFESSIONAL LAND SURVEYORS, INC.
55 Monument Circle, Suite 1222
Indianapolis, IN 46204
(317) 687-8859

APPLICATION FOR MEMBERSHIP

July 1, 1990 - June 30, 1991

(Type or print all information - check box for mailing address desired)

NAME ______________________________ AGE ________
Last First Middle

☐ HOME ADDRESS ______________________________ PHONE ________
St. & No. City State County Zip

☐ BUSINESS ADDRESS ______________________________ PHONE ________
St. & No. City State County Zip

PRESENT OCCUPATION ______________________________
Firm Name Position

SCHOOL ATTENDING ______________________________
School Name Grade

____
Degree You Are Pursuing Expected Month/Year of Graduation

REGISTRATION STATUS ______________________________
L.S., P.E. or S.I.T. Number State

MEMBER OF AMERICAN CONGRESS ON SURVEYING AND MAPPING? Yes_____ No_____

MEMBER OF LOCAL CHAPTER OF I.S.P.L.S.? Yes_____ No_____ Chapter_________

	TYPE MEMBERSHIP	DUES		MEMBERSHIP VOTED SCHOLARSHIP SURCHARGE		TOTAL DUES
☐	MEMBER	$175.00	+	$20.00	=	$195.00
☐	JUNIOR	$50.00	+	$20.00	=	$70.00
☐	ASSOCIATE	$55.00	+	$20.00	=	$75.00
☐	STUDENT	$10.00	+	•	=	$10.00
☐	LIFE			NO CHARGE		

REFERENCES

Name	Address	Phone

PLEASE FURNISH COMPLETE ADDRESSES, INCLUDING ZIP CODES

PLEASE MAKE CHECK PAYABLE TO ISPLS AND MAIL TO ADDRESS SHOWN ABOVE.

ISPLS DUES ARE NOT DEDUCTIBLE AS A CHARITABLE CONTRIBUTION FOR FEDERAL TAX PURPOSES, BUT MAY BE DEDUCTIBLE AS A BUSINESS EXPENSE. THE CONTRIBUTION OF $20 TO A SCHOLARSHIP FUND FOR SURVEYING STUDENTS MAY BE DEDUCTIBLE AS A CHARITABLE CONTRIBUTION.

I HEREBY CERTIFY THE ABOVE STATEMENTS ARE TRUE AND CORRECT AND THAT I WILL ABIDE BY THE CONSTITUTION AND BY-LAWS OF THE INDIANA SOCIETY OF PROFESSIONAL SURVEYORS AND WILL PROMOTE AND UPHOLD ITS PRINCIPLES AND OBJECTIVES.

______________________ Signature ______________ Date

MEMBERSHIP CLASSIFICATIONS

Member: A Member of this Corporation shall be limited to Registered Land Surveyors in good standing with the Indiana State Board of Registration. A Member shall be eligible to vote, hold office and to participate fully in the affairs of the Corporation.

Junior: A Junior Membership will be granted to those non-registered individuals who are endeavoring to make Surveying their chosen career. A Junior Member is entitled to vote and participate fully in the affairs of the Corporation but shall not be permitted to hold office.

Associate: An Associate Membership will be granted to anyone who is associated or affiliated with the Land Surveying profession but is not otherwise pursuing registration. Any non-resident who is regist[illegible] and in good standing as a Land Surveyor in their own State may also be an Associate Member. An Associate Member is not entitled to vote or hold office but will receive Society corresponde[illegible] and be invited to participate in meetings.

Student: A Student Member shall have the same eligibilty requirements as those of a Junior Member, except that this class of Membership shall apply for a period of four (4) years only. A Student Member is not entitled to vote or hold office but will receive Society correspondence and be invited to participate in meetings.

Life: Any person holding Member Status who has reached the age of 65 and has been a member of this Corporation for at least 20 years and has further been approved by the Board of Directors shall be eligible for Life Membership. Life Members shall not be subject to payment of dues, but shall enjoy all the rights and privileges of full Membership in this Corporation.

Why Should We Have A GIS?

by George B. Korte, P.E. Reston, Virginia

Previously I discussed the differences among the three principal kinds of automated mapping technologies in use today: Computer Aided Mapping (CAM), Automated Mapping/Facility Management (AM/FM) and Geographic Information Systems (GIS). We saw that CAM is used primarily for map production, AM/FM is used for utility system mapping and management, and GIS is distinguished by its ability to analyze spatial relationships in geographic data. In this article I will answer the question, "Why should we have a GIS?" Following are 5 reasons.

1. MAP DATA IS MORE SECURE AND BETTER ORGANIZED.

A common problem with traditional map files is lost, misplaced or misfiled sheets. In many cases there is also a problem with not being able to use a map that someone else has borrowed. And there are many map filing "systems" that are so poorly organized as to be nothing more than a place to get maps out of the way.

The GIS is a central computer file of all map data. Ideally, one group or person is responsible for maintaining the database. Although others may be permitted to update the contents of the database, the GIS manager is responsible for the security, organization and access to the data. If he or she is doing the job properly, the data is consistently available to all authorized users.

2. REDUNDANT MAP INFORMATION AND THE PROBLEMS ASSOCIATED WITH MULTIPLE MAP SETS ARE ELIMINATED.

The amount of data that can be portrayed on a paper map is limited by its size and scale. This usually means that a number of map sets are required to meet all of an organization's map requirements. These map sets have varying themes, scales and levels of detail. There is usually much information that is duplicated among these map sets. "Base map" information, such as roads, drainage, boundaries, etc, is usually repeated in each set. Thematic information is often repeated at varying scales to show different levels of detail. As a result, when the maps are updated the same revisions must be made on several different map sets. And not all map sets are updated at the same time. One set may be current while another has out of date and, therefore, conflicting information. Moreover, the quality of the content and appearance of map sets produced by different departments often varies considerably.

A GIS contains one set of map data. This single database can be used to present numerous maps at varying scales and showing different levels of detail. (In fact, the GIS can handle much more map detail than was normally feasible in the past.) The GIS can also produce maps with different combinations of information to cover a variety of mapping themes. This means that the "base" information on all types of maps can be updated by a single revision. Because all maps are derived from the same database, the quality of their content and graphic presentation is more consistent. And when a revision is made in the GIS database, all users will immediately have access to the most current data.

3. MAP REVISIONS ARE EASIER AND FASTER.

Modern manual cartographic techniques are much improved over earlier processes. Copper plate engraving, ruling pens and linen sheets have given way to scribing, drafting pens and mylar. Yet revisions to traditional maps still require erasing and reinking or opaquing and rescribing the map original. A trip to the photo lab is often required as well.

Similar to a CADD system, a GIS has a dramatic effect on drafting production. Changes are made by simply identifying the element to be modified. All nearby or intersecting elements remain unchanged. A 3:1 improvement in the time required to make map revisions is typical. Less time needed for revisions means fewer people and less cost to keep maps up to date. This is very conducive to keeping the map database current. And a GIS can produce multiple color plots or color film separates directly from its plotter, thus eliminating the need for a trip to the photo lab.

4. MAP DATA IS EASIER TO SEARCH, ANALYZE AND PRESENT.

Map users often ask questions like these: "What is nearby?" "What is in this area?" "What else can you tell me about this?" "What areas have both of these characteristics?" These questions usually require extensive research and analysis of maps and related data. With traditional paper map and manual filing systems, this analysis involves comparing maps sheets of different scales and different themes, as well as researching stacks of card files to correlate the graphic and nongraphic data. This is a tedious and time-consuming process. (One of Murphy's Laws must be, "Important map information always falls on the match line between two sheets. Critical information always falls at the intersection of four sheets.") Even where nongraphic data such as real estate records has been computerized, the researcher may still have to comb through sheets of computer printouts while visually comparing the data with the maps.

> **"...the GIS can automatically and quickly answer a question like, Where are the locations of all vacant parcels larger than one acre and zoned for commercial use?"**

A GIS provides the researcher with powerful automated tools to answer these questions. These make it much easier to analyze the data for special studies and reports. In fact, new types of analyses are possible that weren't feasible before. The GIS can quickly search through map data, looking for features with certain characteristics, or inspecting spatial relationships among features. Moreover, graphic data and attribute data are explicitly linked together. Thus the GIS user can search for map data using attribute data as a criterion and vice versa. For example, the GIS can automatically and quickly answer a question like, "Where are the locations of all vacant parcels larger than one acre and zoned for commercial use?" With traditional maps, this question would require a search through the real estate files followed by a visual review of the tax maps (and possibly a review of the zoning map if the real estate files did not include zoning data.)

...continued page 35

How Would We Use A GIS?

by George B. Korte, P.E. Reston, Virginia

We have looked at the differences between Computer Aided Mapping (CAM), Automated Mapping/Facilities Management (AM/FM), and Geo- graphic Information Systems (GIS); and we have talked about the benefits of a GIS. In this article we will discuss how a GIS might be used in a typical municipal government. There are five general areas of application: application: 1) Tax Mapping, 2) Planning and Land use, 3) Voter and School Districting, 4) Engineering and Public Works, and 5) Emergency Response.

Consider a typical town approximately 20 square miles in area with a population of 30,000. Let's look at the operations of the municipal government, assuming it installed a GIS several years ago. We will discuss tax mapping, planning, redistricting applications, engineering and emergency response.

TAX MAPPING

In the past, the Tax Assessor maintained two principal types of tax records. The first was a set of tax maps and the second was a set of real estate files.

The tax maps were drawn in ink on mylar at a scale of 1"-200'. Thirty map sheets were required to cover the town at this scale. These maps showed the city boundary, the right of ways and street names of all roads, the boundary lines of all property parcels, street addresses, and the lot numbers, block numbers, and section numbers for all parcels. Parcel dimensions had been penciled in on a few of the larger and more prominent parcels. The tax maps had been compiled by the state Department of Taxation from property records about twenty years earlier. The drafting section of the Engineering Department had been keeping the tax maps up to date as new subdivisions were recorded, roads were built, or the town limits changed. After the revisions were made the originals were copied and a new set of paper prints was distributed around Town Hall. Revisions were made on an irregular basis, but usually about every three months or so.

The Town bought a mainframe computer in the early 1970's. The real estate records were one of the first applications that the new data processing department tackled. The real estate records had been maintained on card files up until then. The Tax Assessor now has a full time data entry clerk who updates these real estate files daily. These updates are made necessary by new subdivision recordings, property transactions, and the annual reassessment. The updates are made at a computer terminal in the tax assessment department linked to the mainframe computer.

"...very few people now require paper copies of tax maps. Instead, when someone needs tax map information, it is called up on a GIS terminal."

When the Town installed a GIS, the tax maps were one of the first applications to be digitized. The Town hired a service bureau to take its thirty tax maps and digitize them in a format compatible with the GIS that was being purchased. As each of the tax parcels was digitized it was also tagged with the parcel identification number. After the tax maps were loaded into the GIS, the software was able to link the graphic files describing parcel boundaries with the real estate files containing tax parcel data. The parcel identification number makes this linkage possible.

Today the engineering department still updates the tax parcel boundary data in the GIS similar to the way it updated the tax maps in the past. However, now the updated information is immediately available to the Tax Assessor and other Town departments. It is no longer necessary to make a set of paper copies and distribute them around Town Hall. In fact, very few people now require paper copies of tax maps. Instead, when someone needs tax map information, it is called up on a GIS terminal. Town employees are particularly pleased that map information is no longer divided into map sheets. Instead, the GIS gives them a "continuous map" of the entire town.

The tax assessment department still updates the real estate files that reside on the mainframe computer, just as it did before. But the annual reassessment of all properties is handled much differently. In the past, the Tax Assessor would sit with a tax map and a computer listing of the real estate files to conduct his reassessment. It was a very tedious process for him to correlate tax parcel data shown on the maps with tax records in the computer printouts. Today, he sits at a GIS terminal and obtains the same information in a fraction of the time it used to take. He can ask the GIS to search the real estate files for properties with certain characteristics and the GIS will not only find them in the real estate files, but identify them on the tax maps as well. For instance, he may want to know what are all the properties in a neighborhood that have sold in the past year and their selling price. The GIS can quickly find these properties in the real estate files and display them on the screen along with their sales price.

Even routine daily questions are answered much faster with the GIS. When an engineer, developer, or real estate agent comes into Town Hall seeking information about a particular tax parcel, the GIS finds and displays the map and the real estate data on that parcel much faster than it could have been retrieved before.

PLANNING AND LAND USE

Now let's look at the Planning Department. In the past the Town Planner used the engineering department's draftsman to update the Town land use plan and zoning maps. The originals were drafted in ink on mylar at a scale of 1"=1,000'. These maps showed the town boundary, streets, street names, and major places, such as the local shopping mall. The land use map also showed planned land uses and the zoning map showed the current zoning of all parcels in the town. One of the problems with these two maps was that at this scale it was not possible to show parcel numbers or street addresses. Therefore, the planning department also kept a set of paper tax maps and added the zoning boundaries to it using a felt tip pen. The zoning boundaries were updated from time to time as zoning changes were approved by the Town Council. Unfortunately, there was not only a duplication of effort to keep these two zoning maps up to date, there was the problem of conflicting information between the more detailed tax maps and the "official" town zoning map

Since the Town's GIS was installed the planning staff has added the zoning boundaries and land use plan boundaries to the GIS database. This has given them several important benefits. When searching for routine information about a parcel, a planning department employee simply types in the parcel number or street address instead of trying to locate the parcel on the official plan and zoning maps or searching through the annotated tax maps. Moreover, special planning studies can be done much faster than before. For instance, the Town Manager frequently asks the Town Planner to research questions such as "Where are all the parcels that are larger than five acres and zoned for industrial use?" or he may be asked by a member of the Town Council "How much undeveloped land is planned for residential development?" He now uses the GIS terminal located in the planning department to answer these questions. He completes his research in a fraction of the time that it took him to do so in the past.

The Town Planner can also produce a variety of custom maps and reports with relatively little effort. Moreover, the maps can be plotted in color using the Town's color electrostatic plotter to make very attractive presentation materials for public hearings.

VOTER AND SCHOOL DISTRICTING

The Town's School Board and Registrar also make good use of the GIS. The School Board's Facility Engineer uses his GIS terminal to retrieve engineering data. He also works with the Transportation Manager to plan school bus routes. Because the GIS includes an overlay of U.S. Census Bureau demographic data, they have access to the most recent census data on school aged children. This data helps them to plan school bus routes that evenly distribute the student passengers on each bus.

The School Board also uses the GIS when planning new schools or considering the consolidation of schools. They can use the GIS to quickly determine the distribution of school aged children throughout the town or to report the number of students that live within a given distance, say two miles, of a potential school site.

The Registrar uses the GIS in two ways. When new citizens come in to register to vote she can quickly determine in what voting district they reside. She simply types in their address at the GIS terminal. The system searches for the address at the database and then compares this location with the overlay of voting precincts. Before the GIS was implemented she frequently had the problem of not being able to locate the citizen's house. This was usually because he was moving into a new subdivision and this new street had not yet been added to her copy of the Town street map. Today these street map changes are immediately available to her as soon as the GIS database is updated by the Engineering Department.

The Registrar also uses the GIS to analyze voting districts. State law requires that the voting districts be reexamined after every census. The GIS can compare precinct boundaries with the Census Bureau population data and count the number of voters in each district. The Registrar can try new precinct boundaries and immediately receive a recount of the population in the newly defined precincts. She can play this "what if" game to arrive at an even distribution of voters with a fraction of the effort that was required in the past.

ENGINEERING AND PUBLIC WORKS

The Director of Public Works is responsible for the town survey crew, the drafting operations, building inspection and permitting, maintenance and operation of the town water and sewer systems, and engineering design. He is also responsible for the maintenance of all the graphic data in the GIS database and the nongraphic engineering data.

The town survey crew uses automated survey data collectors in their survey operations. The crew uses a theodolite and added an electronic distance measuring (EDM) device about ten years ago. Two years ago they added an automated survey data collector. This device allows them to measure angles and distances without recording them by hand in field books. Instead, the data collector records the survey notes for them. This data includes the point being occupied, the backsight station, the foresight station, the angle turned and the distance to the station. The survey crew uses a keypad on the side of the instrument to record station identification numbers and other descriptive information.

When the survey is complete they bring the data collector into the survey department, connect it to a data port in their GIS terminal and copy the survey "notes" from the data collector to a file in the GIS. They next run a program which reads the survey data and calculates X Y coordinate values for all stations, as well as their elevation. The program also plots the data in the GIS graphics file using appropriate symbology. This automated process eliminates the time consuming and tedious process of "breaking down" field notes by hand and keying in the data to a coordinate geometry program.

The Public Utilities Department uses the GIS to manage the town's water and sewer systems. In the days before the GIS, the department used two sets of maps, one that showed the location of water mains and fire hydrants, the other showing the locations of sanitary sewer mains and manholes. These two utility system maps were drawn by hand at a scale of 1"=1,000'. They showed pipe size and slopes were appropriate. But they did not have any more detailed information such as pipe inverts, date of installation, pipe materials, manhole rim elevations, water pressures, etc. This detailed information was found by searching through construction drawings; however, there was sometimes a great deal of confusion, even conflicts, in these drawings. This was because not all "as built" information had been collected or kept up to date. So it was often necessary to verify utility data in the field. This required the survey crew to spend a half day or more gathering or verifying utility data.

Today utility department personnel can use its GIS terminal to research utility data. For information about a particular manhole they might call up the sanitary sewer system map for the town and "window" the area in which the manhole is located. They would then identify the manhole in question by pointing to it using the work station's "mouse". The system would then respond with a report on the manhole's attribute data, including invert elevations, rim elevation, date of installation, etc. Similarly, they can find out information about a section of pipe, including it's size, material, slope, capacity, date of installation, etc. Moreover, they can ask the GIS to search for information using questions such as "Where are all the storm sewer lines larger than 24" in diameter?" or "Where are all the water valves installed before 1950?" The system will search it's attribute files to locate these facility items, then display them on the work station screen.

The Public Utilities Department found that one of the great unexpected benefits of implementing the GIS was that it required a total "clean up" all of utility data. To load the GIS database, all unknown information had to be researched and all conflicts in the existing data had to be resolved. This was a major effort, but today the operation runs much more smoothly because the data is readily at hand and reliable.

In the future, the Public Utilities Department plans to add programs that link the engineering and topographic data in the GIS with standard engineering analysis programs. These include hydrology programs for performing rainfall runoff computations and hydraulics programs for analyzing the flow in pipe systems and performing flood plain computations.

The Engineering Department is responsible for utility and roadway design. The Department was successful in convincing the Town to get relatively detailed topographic mapping at 1"=50' with a 2' contour interval.

"The Public Utilities Department found that one of the great unexpected benefits of implementing the GIS was that it required a total `clean' up all of utility data

Although this cost more than the less detailed mapping required by other departments, it has been very beneficial. The detailed topographic data provided a much better base for registering the utility and tax map data that was added to the GIS. Also, less field survey work is required for engineering designs. Moreover, the Engineering Department sells topographic information from the GIS to outside engineering and surveying firms for a nominal fee.

The Engineering Department's engineers use the GIS to aid in roadway and utility design. The topographic and planimetric map data in the system provide "base sheet" information for engineering design. The topographic information in the GIS is compatible with their computer aided design and drafting (CADD) system's engineering design programs. These include programs for roadway design, site planning and utility system design.

The Engineering Department was also successful in convincing the Town to require that all plan submissions to the town, such as for new subdivisions or for new utility systems, be made in a digital format compatible with the Town's GIS. This has made it much easier to incorporate the new data into the database and keep it up to date.

The Public works Department established a GIS Department when the system was installed. The GIS Manager is responsible for overall GIS promotion, maintenance and operations. The GIS System Manager is responsible for supporting the GIS database. This includes daily file backup and archiving, contact with hardware and software vendors, and establishing user access privileges. A GIS Cartographer is responsible for maintaining the graphic files in the GIS database. This job involves updates to the tax parcel boundaries, topographic and planimetric data, utility data, and planning and land use data. The Town recognizes that as it grows and the GIS database grows, some or all of these database maintenance functions may have to be decentralized to the user departments.

The GIS System Manager also provides user training for new employees, advanced training for existing employees and technical support to the users. This technical support includes trouble shooting, answering routine questions, referring problems to the vendor, and minor programming tasks. The programming is done chiefly to customize the basic capabilities of the GIS for the GIS users. This programming is done principally using the GIS "macro" programming language.

EMERGENCY RESPONSE

The Town's Chief Dispatcher is responsible for the operation of the dispatch and emergency operations center. In the past his dispatchers used a variety of reference materials to direct responses to police, fire and rescue incidents. These included a collection of USGS maps, a town street map, and a collection of hand drawn subdivision "map sketches." The reference materials also included a directory of street address ranges and an index card file. This card file contained important phone numbers, property owners names and addresses, and an inventory of hazardous materials and buildings with invalid occupants. New dispatchers required several months on the job to master this eclectic set of references.

Shortly before the GIS was installed the town installed a 911E telephone capability.. When the GIS was installed it was linked to the 911E system. Today, when a call is received through the 911E system it transmits the caller's address to the GIS. The GIS then automatically locates the address and displays the tax map for the surrounding area on a console in front of the dispatcher. The caller's location is pinpointed by a target in the middle of the display. Thus, while the dispatcher is responding to the incident and directing response units he is also presented with a map of the surrounding area. Information regarding the address, such as the presence of hazardous materials, is provided by the 911E system from its database.

The police and fire departments also use the GIS for incident analysis. The GIS can read a file of police incident locations, then locate and display them on the town street map. This had proven to be a great aid to the analysis of trends in criminal activities.

CONCLUSION

As we have seen, our "typical" town has used its GIS for a wide variety of applications. One of the keys to its success in GIS was the GIS selection and implementation process it chose to follow.

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INDIANAPOLIS MAPPING AND GEOGRAPHIC INFRASTRUCTURE SYSTEM --IMAGIS--

Molly Laut, Marketing Manager, MSE Corp., Indianapolis, Indiana

A Progressive Atmosphere

Management of growth, facilities, information, and resources are just some of the challenges underlying business decisions in the public and private sectors. Under the progressive city-county government in Indianapolis, these challenges are met by encouraging public-private partnerships. Nowhere is the cooperative spirit more evident in Indianapolis than in the development of IMAGIS, believed to be the largest and most comprehensive mapping system in the United States.

IMAGIS, an acronym for Indianapolis Mapping and Geographic Infrastructure System, is an automated mapping and facilities management system (commonly referred to by engineers as an AM/FM system) that will weave together in a computerized database some 8,320,000 "land fabric documents," aerial photographs, satellite surveys, and in some instances, field surveys, into a map containing 54 layers of detail. IMAGIS, encompassing the 492 square mile area of Marion County, and a one mile collar around Marion County, will result in one of the most detailed and precise land maps ever made, accurate to within two feet.

What makes IMAGIS even more spectacular is the public-private partnership backing the project. A 9-agency consortium, including the Department of Public Works, the Department of Transportation, the Department of Metropolitan Development, the Marion County Assessor's Office, and each of the city's four major utilities, including Indianapolis Power & Light Company, Citizen's Gas & Coke Utility, Indiana Bell, and Indianapolis Water Company, as well as a local university, IUPUI, has committed $9.2 million to the IMAGIS project, completed August 1989.

With IMAGIS, many infrastructure management factors can be immediately assessed, from planning and maintenance to construction and operations of the city's assets. In the future, IMAGIS will overcome the problems inherent in manually generated and maintained mapping systems, allowing the users to be more proactive with customer service requests and regulatory information concerns.

Data Base Components

The goal of the eight major IMAGIS participants was to create a geographic infrastructure system that could be shared by all participating organizations in Indianapolis whenever maps and records are required. Three geographic information categories gave initial structure to the database:

* Planimetric (a map representing the exact locations of physical features of the land)
* Topographic (a graphical portrayal of the relief of a land surface, as by contour lines, in map form)
* Land Fabric (legal designations describing land parcels)

Prospective IMAGIS users were queried as to the specific land information they would need most in the database, and in turn they responded with a "wish list" of map features. To categorize these features, the IMAGIS database map actually contains 54 "layers" of information, each layer representing a set of geographic, topographic, or land fabric characteristics and parameters. These layers can be viewed simultaneously or independently on a computer terminal or can be printed and arranged as overlays.

MSE Corporation has designed a quality control software package that is crucial to the integrity of the IMAGIS project. Graphic standards, line weights, line color and other parameters are checked by the computer to ensure that each division of information is stored in the correct layer of the mapping system.

By using this computerized filing system, even the most minute bits of information about Marion County can be stored in the IMAGIS database, including:

*7,500 Subdivisions
*3,400 Miles of Streets
*325,000 Parcels of Property
*18,500 Intersections
*475 Bridges
*450 Railroad Crossings
*Rivers, Creeks and Streams
*Fire Hydrants
*Utility Poles
*All Man-Made Buildings

In addition to these above-ground features, each participating organization will further enhance the system by adding its respective below-ground infrastructure, including, for example, every gas line, water main, sewer and conduit in Marion County.

Not only will physical land features be captured in the database, the "invisible" information will be included as well. Property lines, elevations, centers of streets, easements, zoning designations, police and fire boundaries, and rights of way will be contained in the IMAGIS database. The database is being structured for future additional census information, tax data, and utility franchise areas, each aspect of the land fabric information creating another layer of the map.

When the database is fully loaded, work stations around Marion County will have access to the information stored in IMAGIS.

Data Conversion

Converting this geographic and land fabric information into a computerized database makes use of several mapping techniques, from the conventional to the state-of-the-art.

To ensure the utmost accuracy of the map base, the IMAGIS project leaders turned to global positioning technology, a system of computing a position on the earth by analyzing radio signals transmitted from satellites of U.S. Department of Defense. Four geodetic survey stations in Marion County established by the federal government in the 1930's, each pinpointing a longitudinal and latitudinal position, became the initial control sites for the satellite survey. Some 60 points forming a county-wide network of survey units were then established at intervals related to the four geodetic stations, and at each point a radio receiver was placed.

Orbiting thousands of miles above Marion County, the satellites beamed radio signals from space to the 60 receiving units. The data was captured and analyzed by computer, and the position of each unit was marked on a grid of the earth--with astonishing accuracy.

Next, the project made use of photogrammetry, the technology of obtaining reliable quantitative and qualitative information from photographs, as a primary source of land base data.

Some 1,600 aerial photographs were taken by a camera located in the belly of an airplane as it was navigated along various controlled flight lines. Along each flight line, a sequence of photographs was shot, one overlapping another by a margin of 60 percent, forming "stereo pairs". When viewed together through an optical instrument called a stereoplotter, a stereo pair has a three-dimensional effect, allowing the operator to measure not only horizontal distances, but also the elevation, or height, of the ground.

The photogrammetric features and satellite surveys were then compared with conventional plats and other land documents, which number some 8,320,000, to place the information in the "real world".

Once properly positioned and verified, the paper maps, subdivided into smaller, working sections, were then digitized, a process of converting line drawings and maps into digital form by manually tracing the position of the map features with a free-floating cursor on a drafting table embedded with a grid of electronic circuits.

After digitizing paper maps, an operator can add more detailed land fabric information in the database such as street names and lot numbers.

The Inception of IMAGIS

Development of the IMAGIS system began in 1985 when the federal government ordered the Indianapolis Department of Public Works to revamp the city's storm sewer system, a project that required a vast number of maps. With more than 3,000 miles of drainage channels, conventional mapping would, at best, duplicate existing maps, not improve upon them.

But the newest computer-mapping technology was too costly for one city agency to consider. It was then that the public-private consortium came into being. To spearhead the explorations of a composite database that would satisfy the needs of all users, a consulting firm, Utility Graphics Consultants (UGC), was engaged by the city of Indianapolis. MSE Corporation was selected to perform the data conversion process. Commitment to IMAGIS at the highest level in each participating organization remains strong today.

Economic Benefits

Manually generated and maintained mapping systems have been in use for centuries. As cities and utilities experienced rapid growth throughout the decades of this century, the number of paper maps and related documents grew accordingly.

It is estimated that any given utility serving a metropolis the size of Indianapolis (the nations 13th largest city) may have hundreds of thousands of maps, many of questionable accuracy, and some of which date back to the 19th century. This has resulted in an inefficient and outdated facilities management system, the cost of which continues to rise today.

With its commitment to IMAGIS, the city of Indianapolis, over the next three years, is paying about $7.3 million, or approximately 80 percent of the project. Each of the investor-owned utilities has committed about $400,000. However, it is expected that IMAGIS will pay for itself within five to seven years, with the city realizing a savings of $700,000 to $800,000 a year. Among them, the utility companies should realize savings of $1 million annually.

By using the IMAGIS database, facility planners will be able to conceptualize and address problems faster and more easily. For major event planners, the available parking, optimal routing of visiting dignitaries, and ideal location for street vendors can be ascertained at a moment's notice.

IMAGIS will also allow Indianapolis, its city agencies, and its utilities to compete more dynamically in economic development. When surveying sites for proposed development, city planners will have immediate access to infrastructure information, and can, in turn, quickly relay answers pertaining to business location decisions.

IMAGIS is considered a key element in the continued emphasis on eliminating redundancies among city organizations and utilities that were generating and maintaining maps of the same areas; increasing efficiencies; containing costs; and improving services in the Indianapolis regional infrastructure management area.

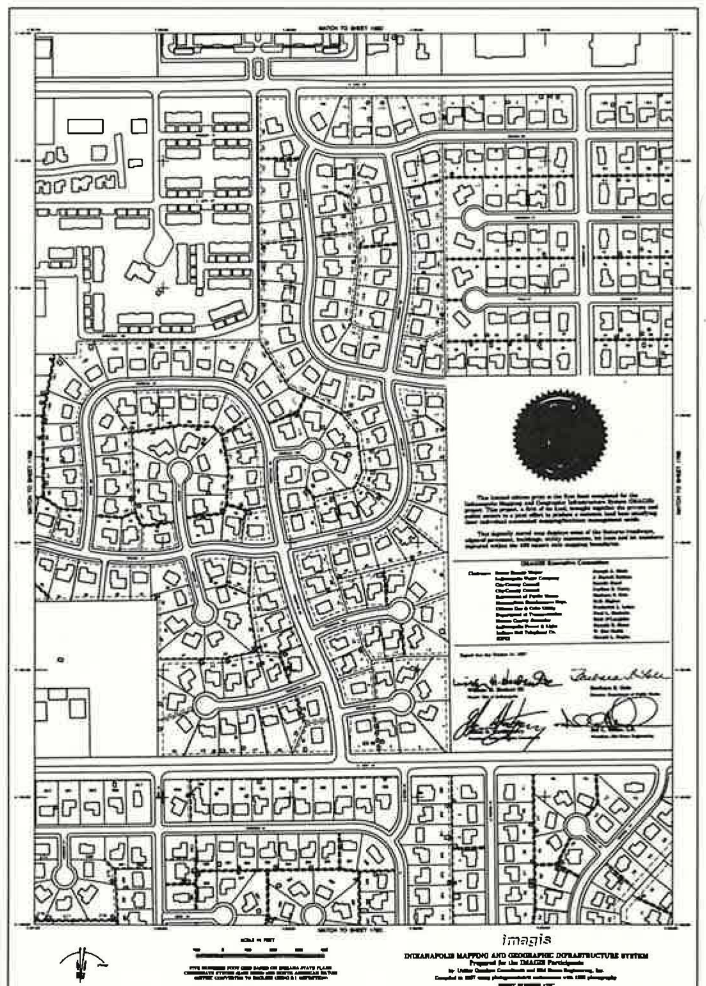
MSE Corporation

MSE Corporation, a major national engineering firm, is performing the conversion of the IMAGIS land base information into digital form. Established in 1960, MSE is headquartered in Indianapolis, Indiana and has a branch office in Austin, Texas. It recently opened a fourth full-service office in Carmel, Indiana, one of the fastest growing areas in the state of Indiana.

MSE worked with the city of Indianapolis prior to the inception of the IMAGIS project to generate a series of conventional general purpose maps. At that time, MSE was also investigating and gaining valuable expertise in the use of CADD (computer-aided design and drafting) systems and by 1985, when the IMAGIS project began, MSE had become sophisticated in CADD-based mapping techniques.

MSE continues to offer engineering, surveying, landscape architecture, and digital mapping to a wide range of clients in North America and Europe, and employs some 240 people.

MSE Corporation has designed and implemented over 125 AM/FM/GIS projects, including ones in Virginia Beach, Virginia and Austin, Texas.



IMAGIS: IT'S WORKING

Bob Montgomery, Director of Business Development
MSE Corporation, Indianapolis, Indiana

It's been just over a year since the City of Indianapolis' IMAGIS project has been officially up and running. As the largest multi-participant mapping project of its' kind, IMAGIS has served as a benchmark, a guide for similar projects all over the United States.

So what has happened after one full year of operation? Have users been satisfied with the early results? What is the status of IMAGIS?

According to Dee Revnyak, Manager/Engineer for the Indianapolis Department of Public Works, IMAGIS is not only meeting expectations, but it's offering users several surprises too. "The more staff members that get involved with the database, the more uses we develop for it. It's actually doing more than we expected at this point." Revnyak stated that while they have several applications still in the early developmental phases, DPW is currently working on a project which is "already generating a substantial increase in sewer fees." Working in conjunction with the Indianapolis Water Company, DPW is comparing water company billing lists with the IMAGIS database to locate service gaps. As these gaps are found, they are connected and normal billing can begin. Officials at DPW anticipate a massive recouping of lost revenues.

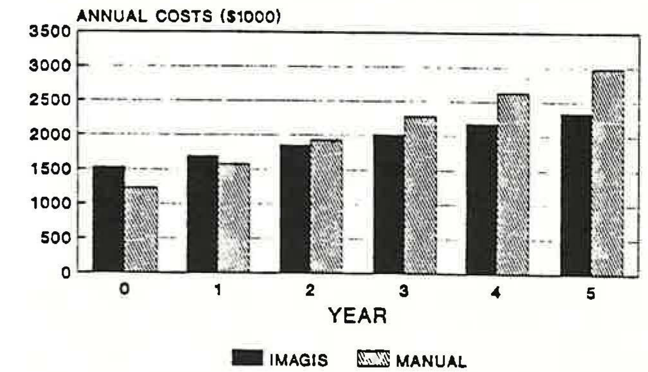
Also underway is a capitol improvements project with the Indianapolis Department of Transportation. In this project, DOT's 1990-1991 paving schedule is being added to the IMAGIS database. Quick access to this information will enable all IMAGIS participants to schedule their improvement plans accordingly, saving valuable time.

The removal system used for Marion County's solid waste has also seen marked improvements. In the past, the Department of Public Works and as many as 25 independent contractors were responsible for collecting the county's solid waste. This process was disorganized and badly in need of assistance, so IMAGIS software was customized to:

- *Create areas to assign to hauling companies
- *Count the homes in each area
- *Send bills to each address
- *Track billing and payment history
- *Track requests and complaints
- *Pay each hauler per number of homes

Since Marion County Engineers had already begun a manual process of organizing the removal of the county's solid waste, when IMAGIS was bought on-line it became very easy to compare this manual process with the new computerized system.

COST COMPARISON
Solid Waste Program



As the table shows, setup costs were higher for the computer-based system, but annual costs begin to drop dramatically and paybacks occur after just three years.

But the Department of Public Works is certainly not the only group actively involved in the project. The Department of Metropolitan Development (DMD) is busily updating building permits and all new subdivision plats are being added into the IMAGIS database. Participants such as Citizens Gas and Indiana Bell are currently adding their facilities, while Indianapolis Power and Light is completing their implementation study and the Indianapolis Water Company is transferring all of their facilities data to their AutoCad system.

Future plans for IMAGIS include participation in the development of state specifications which would enable any group to store and retrieve the IMAGIS information. Also under discussion is the development of standards that would guide engineering firms in the submittal of information in a digital format.

The participants agree, IMAGIS is working. But more importantly, IMAGIS is growing. As more and more agencies become involved in the processes and capabilities of the database, the system is evolving and changing to meet the users needs. What's next? At this point, the possibilities seem endless.

September 1990

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A Surveyor's Concerns About GIS Development

by Robert W. Foster, PE, PLS, Framingham, Massachusetts

There has been a good deal of hype and excitement in the surveying profession about the geographic information system (GIS) revolution. It has been called the most significant development in geographic information management since the sixteenth century when Gerardus Mercator introduced the curious idea of mapping the earth as round rather than flat. The surveying community anticipates benefits in two areas as a result of GIS development: work simplification and work generation.

Universal occupational frustration for surveyors is the difficulty of access to public information about the land and all of its attributes. A well-designed and constructed GIS should make life easier for every surveyor from the one-person practitioner to the commissioner of a large public surveying agency. And surveyors have more than a passing interest in the moneys that are to be spent in establishing control and in the data collection operations that will be required to support a new GIS.

THE INTEGRITY QUESTION

It's a bright horizon but one with a few clouds of concern. Surveyors are beginning to ask questions about design and the presentation of data from the GIS-to-come. Some of the new systems seem to be evolving with more concern for hardware and software than for the integrity of data being gathered and managed. Most of the elements of a GIS are quantitative and many are dimensional. Population statistics are quantitative while the location of infrastructure elements requires dimensional data. Data requiring dimensional definition may be available with a wide variation in levels of accuracy. The integrity of a geographic information system will be brought into question when data of differing levels of accuracy are mixed without qualification. The GIS evolution will be set back several generations if public agencies discover too late that they have created large, expensive computer systems that are not responsive to their needs with reliability. There is also the exclusivity concern: e.g., the possibility that a community will build a GIS to meet the needs of the city planner but without much thought for public works.

THE SPATIAL FRAMEWORK QUESTION

Perhaps the scariest scenario of all is the creation of a GIS by the mere digitizing of all available documents without careful consideration of the spatial framework needed to hold the whole thing together. Talk to a surveyor about an intended GIS and he is apt to ask first about ground control. Was it performed with precision appropriate for the accuracy intended for the final product? Is it permanently monumented for on-the-ground access and for future growth of the system? Does it relate to a larger geodetic framework that will allow interaction with neighboring or future systems? Creation of a geodetic framework is the least dramatic aspect of a system, one of the most expensive, and worst of all it has to happen at the start of a GIS. Mistakes or oversights in planning here will haunt the project for its whole life. Vendors of hardware and software, city planners and assessors, even engineers sometimes overlook these considerations. Municipal financial officers would rather ignore the subject altogether. (I refer to the formation of public agency GIS's but most of these principles apply to geographic information systems built by commercial users, as well.)

STRETCHING STANDARDS

Another concern that surveyors have is the manipulation of data once it has been entered into a system. Mapping, like other technical operations, must be performed to certain standards. The United States National Map Accuracy Standards are printed with the following preamble: "With a view to the utmost economy and expedition in producing maps which fulfill not only the broad needs for standard or principal maps, but also the reasonable particular needs of individual agencies, standards of accuracy for published maps are defined as follows..."

The standards refer to horizontal accuracy of maps published at specific scales. For map published at scales larger than 1:20,000 "not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured on the publication scale." The principal applies to maps digitized and stored in memory as well as to hard-copy maps. The trouble will come when a map is compiled to meet an accuracy requirement of one scale, but after storage in digital form is reproduced at a larger scale. The appropriate error limitation for a map of scale of 1:7200 (600 feet to the inch)is 20 feet. When the map is reproduced at a scale of 1:3600 (300 feet to the inch) the map is still good to only 20 feet, but according to the Standards not more than 10 percent of the points tested should be in error more than 10 feet on a 1:3600 map. The map produced at a larger scale than was intended in its compilation no longer meets National Map Accuracy Standards. The question is, how will a modern GIS, part of whose very purpose is to facilitate manipulation of data through the publication of multiple combinations of data at various scales, guard against violation of the National Map Accuracy Standards?

THE FORCE-FIT CONCERN

Then there is the problem of inclusion of inappropriate data in a GIS, described as the new-wine-in-old-wineskins syndrome. A complete GIS will contain parcel data for property assessment purposes. Many communities in the United States have parcel maps prepared over a period of many years, to uncertain standards, and not always well maintained. The finest computers and programs in the world cannot perfect poor data and it will be vitally important for someone to qualify a community's parcel maps before blindly entering them into a new GIS. The very qualification of these maps is an exacting, highly technical process. In 1980 the Massachusetts Division of Community Services printed the booklet "Procedures to Check and Qualify Local Property Maps" prepared for the Land Records Commission, by Gunther Greulich a registered professional land surveyor in private practice in Boston. No doubt similar documents are available from other sources, but whether cadastral data will be subject to such a rigorous qualification by every community building a GIS is questionable.

Skeptics in the surveying profession question whether all these concerns will be taken into careful account by the computer wizards, planners, and administrators who seem to be making the important decisions as the GIS revolution heats up.

Robert W. Foster, PE, PLS is vice president of the American Congress on Surveying and Mapping, ACSM.

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Surveying Scene

By Kenneth Gold
RPS 1223

Texas Surveyor

'It is my firm opinion that the start or origin of any GIS/LIS project should include a qualified registered surveyor on the project team.'

The URISA, ACSM, ASPRS and AAG GIS/LIS '88 was OK in SA! That just had to be said.

If you need to consult your secret code book for what it means, don't bother. In simple terms, there was an enlightening conference on Geographic Information Systems and Land Information Systems held in San Antonio. It started the last of November, lasted three days and was sponsored by several associations including the American Congress on Surveying and Mapping with the Texas Society of Professional Surveyors.

About 3,000 registered, but probably less than 100 were practicing surveyors. Yet this subject, GIS/LIS, must be built from the basis of surveying control, mapping and deed record interpretation. It may be the first opportunity any surveyor has to get involved in a multi-billion dollar business requiring the professional skills of the surveyor.

Yes, requiring the services of a registered surveyor! It is my firm opinion that the start or origin of any GIS/LIS project should include a qualified registered surveyor on the project team. Many specialized areas are involved with such a system and "qualified" is the important ingredient. Registration alone is not a qualifier. It takes time and preparation, and time is short. The race is on.

Some surveyors may not want to get involved. Some many not be able to get involved. Some may not know whether they can or want to get involved, and some shouldn't get involved at all.

It may be those highfalutin' terms like "geographic information" or "land information" just haven't registered as something tied to surveying. Terminologies for GIS/LIS, like most technologies, are abbreviated and acronymed to the point of appearing like a foreign language. To list a few of the most used: AM for Automated Mapping, CAD for Computer Aided (or Assisted) Drawing, FM for File Management, MPC for Multi-Purpose Cadastre, and the indispensable IMDMLS for Interactive Multi-objective Decision Model for Land Selection. The new kid has a real chore just trying to understand the lingo.

That may be part of the problem of not getting involved, but it can be solved with a little reading. Then, it's more complicated.

We need to have a better understanding of just where the surveyor should start to participate in GIS/LIS. Even better, we should start at the beginning.

Primitive man planted the seed for a geographic or land information system when he took a stick and scratched symbols in the dirt floor of a cave. It was a crude map, but the idea caught on.

So GIS/LIS is nothing new. However, it is the result of our technological evolution and ability to capture, manipulate and display information via computers, digitizers, scanners and sophisticated programs.

Definitions abound for these systems, so one more won't hurt. A geographic or land information system is a coordinated, manipulatable, electronic display or depiction, in graphic form, of a variety of collected data that has some level of influence on human interests or welfare. The basis for practically all data display is a map. The accuracy of the map will almost invariably have some effect on the accuracy of the data — and consequently the decisions made from the data. The GIS may bring to display any variety of information from the location of pine bark beetle infestation to Democrats who voted Republican in the last election.

LIS usually involves civil works data such as the location of and thing influencing real properties and countless improvements thereon. The data may be selectively merged, deleted or shuffled to satisfy some data inquiry.

There are programs and hardware galore to do just about anything anyone may want to do — and more are coming.

Not many years ago, engineers, architects and a few surveyors used a method of "pin-registering" to show overlays of different data on transparent film drawings. Each drawing used the same basis, usually a plot of land and often a structure of some sort depicted there on. The different drawings, showing existing conditions to planned facilities, from contour lines to foundations, sewer lines to top floors, were all plotted at the same scale. They could be exactly overlayed by use of prepunched holes in the film margins that were placed over tight fitting studs anchored in some rigid, metallic frame. The result was a layering of data — a "pancack stack" or information that could be combined in arrangement.

The basis, the data base, is usually a representation of some portion of the earth and is the equivalent of a foundation. It is common knowledge that the primary assignment given a foundation is to support

The Texas Surveyor
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that which is placed upon it. Any failure to remember this through haste, misdirected economics or ignorance of incompetence will likely produce unsatisfactory results, additional costs, user confusion, erratic plans, slipped schedules, client displeasure, tarnished image, loss of income, an irate boss, unexpected dangers and maybe even some really serious things.

So don't overload the foundation with things it was not designed to hold.

All data to be entered into or used as part of a data base must be thoroughly analyzed as to its appropriate quality, accuracy and reliability.

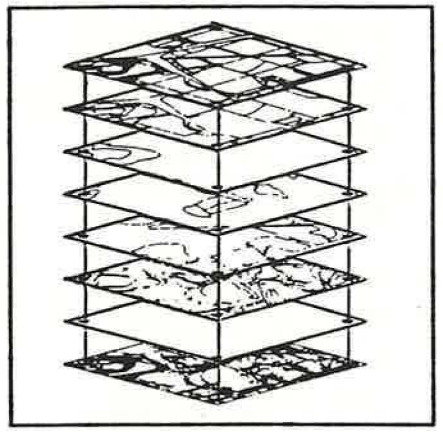
What is equally important is that the data selected for use must not only be satisfactory for the initial or perceived use, but it must also hold up to "overuse" and probably "abuse." That is because of the inherent, and obviously unavoidable, inclination of man not to be blessed with 20/20 foresight. Therefore, anything planned for tomorrow will probably fall a bit short of tomorrow's actual needs. Contingency planning is mandatory.

A case in point would be the popular decision to use the U.S. Geological Survey large scale or quadrangle maps as the first entry for a data base. Scale ratios on some of these maps are 1:1,000,000 or higher. Initially this is a prudent, economical, reasonable decision IF it satisfies the quality, accuracy and reliability needs of the project and can withstand "overuse or abuse."

Texas is blessed with 7½ minute quadrangle maps all across the state. They have a ratioed scale of 1:24000 or 1" = 2000'. The USGS map makers claim no greater accuracy on these maps than plus or minus 20 feet in any direction and up to 40 feet of possible displacement in a few areas. These tolerances would be expected on film copies or GS data tapes. Any digitizing of paper map copies could far exceed that displacement.

Using the USGS maps at their published scale would present few, if any, significant problems. But there are handy features on many data base or GIS programs that provide a procedure called "windowing," the enlargement of a certain block of data to examine in some detail. If one were to "window up" to a scale of 1" = 200' from a 7½ quad to look at a residential lot, what "accuracy" would you expect?

There is a distinct probability you wouldn't even be looking at the right lot. The idea of "blowing up" a USGS map even to twice its size automatically creates significant accuracy problems, even if it is done with sophisticated computer equipment. The tolerances that exist on the **original** product **cannot** be improved by electronics or programmers, unless through Divine intervention.



Electronically, any spot, place or item on a map can be ratioed to a larger or smaller scale, but if it starts out 20 to 40 feet out, it can never be anything better and will probably be worse.

There are programs that allow a user to graphically show width of streets on a display. It will convert a one line street to a double line, based on width of paving or right of way, whichever is desired. Neat and practical! Hypothetically, the trouble is someone will "blow-up" a GS quad to a scale of 1" = 50' and show the width of curb-to-curb pavement as 27 feet, but still not know the real location of the street to within 20 to 40 feet and perhaps not even to 100.

Is that really bad? It depends on whether you want to locate something by coordinates that should be on one side of the street but ends up on the other.

Why would anyone want to increase the scale? Because it can be done electronically and there is nothing to indicate the inherent errors. Any prudent map maker should know that and know better. Surveyors should be accutely aware of it.

Now, suppose the city's 911 system for emergency service obtains a GIS that shows streets, street addresses of structures, fire hydrants, electric service transformers and disconnects, telephone locations, gas valves, storage of hazardous materials, building floor plans and a variety of other pertinent information. The data for most of this special information was furnished over a period of time by several entities and utilities in state plane coordinate form. It was accepted as "good" work and entered into the system — the system that was economically built on USGS 7½ minute quads as a data base.

The data is interactive and furnished to all emergency services. An ambulance needs to find an address. No big problem, because the street map is sufficient. A burning building is usually evident from several hundred feet away. However, if a floor plan is needed by the firefighters, what will they get?

The electric company might be able to see an overhead transformer or switch and go to it directly if not hidden by trees or multi-story structures, but underground and ground based switches are hardly visible from the street. Gas cut-off valves are seldom visible and rarely used. And where are hazardous materials? These things play an important part in safely and quickly controlling an emergency.

Now, if the original scale of the data base is 1" = 2000', and the accuracy of any point is no better than plus or minus 20 feet at the original scale, what is the probable error of a valve or switch location at a 1" = 100' window? And how long will it take to find it if it is posted on the wrong side of the street or in a back yard instead of a front yard, and in a different lot than displayed? And what about the burning building's floor plan — will it be correct or will it be for the building next door or across the street?

Why would there be such an error? Because the original data base had tolerances of no better than 20 feet to start with and occasional 40 foot displacements. An independent coordinate from a different source will not necessarily have any workable relationship with such a base.

That may be a worst case example. It may be, but it probably isn't.

A knowledgeable GIS/LIS project director would not allow such "time bombs" to get into his system. However, to prevent such a happening, more has to be done and that means money. Money involves potential profit and profit encourages competition.

The tragic part is that a lot of money is wasted on systems that either overkill the project or fall far short of ultimate requirements. Worse, clients with a little bit of information may be dangerous to themselves and impossible to convince that a "cheap system" is not what they need. That could be because some clients may only need a "cheap system."

Cheap systems have several excellent selling points. They use existing, off-the-shelf data. They can be installed in much less time. They **appear to** work well and do, within certain limits and, of course, they cost much less.

How can a "buyer" go wrong? That is where professional expertise comes in. The client must be courteously and intensely interviewed to determine the probable **ultimate** use of a geographical or land information system, explaining that retro-fitting is often impractical, expensive or impossible. When off-the-shelf data is sufficient, that is all that need be sold. But the professional must understand the ramifications and potential problems of interfacing a variety of off-the-shelf data.

Some acquirable off-the-shelf materials one can expect to be readily available are: USGS maps; commercial ownership maps; utility locations; natural resources, crop data, census information. Much of this material is public domain and relatively inexpensive. But care must be taken as to source, date of accumulation, scale compatibility and required accuracy.

There should always be concern over the acceptable quality and compatibility of these products. Since the USGS maps have been discussed, let's look at commercial ownership maps. Several companies have performed a commendable service by creating ownership maps that overlay the USGS 7½ minute quads. Some have conveniently doubled the scale to 1" = 1000'. Seldom, if ever, did they **start** their projects with the intention of having it used as a data base. Yet, enterprising companies have digitized their ownership maps, and some are now incorporated in data bases. They can and do serve well if they are not overused or abused.

The overuse or abuse comes when data is used for something for which it was never designed or intended. An ownership map generally displays and accepts data as it is recovered from records. Some "massaging" may be required to get a reasonable fit, but seldom would it have been economical to undertake an analysis that would properly correct apparent errors.

The inclusion of raw record information to overlay a first order mapping project is like putting $20 tires on a Ferrari. Yet this is too often done, plus it does several other things. Take a tax appraisal district as an example.

There is the high probability that the district is not assessing, collecting or even billing for taxes on all the real estate in its district. If the ownership maps from the tax office or from commercial sources had been correct, there would be no need for a review of the record data. Another high probability exists, one that suggests an excess of real estate in the district, an excess that has never been taxed and may never be unless the records are reviewed by the likes of a professional surveyor. That is an excess above and beyond parcels that have just been overlooked by the assessor.

The inexperienced eye views a deed description as an absolute, as a piece of the puzzle that should fit next to the last piece. That's not all wrong and that is why it is difficult to explain to a client why a record analysis is important.

The client needs to know that every tract of land has not been surveyed; every description was not written by a surveyor; many descriptions were written expeditiously but not expertly, and that some were written by persons who have never burdened themselves with the thought that they may not know they didn't know what they were doing. Some deed descriptions are so faulty that the tract described may be significantly larger or smaller, may not form any specific shape (much less a polygon), and may in fact not be in the correct survey or county. It is not rational to believe these problems can be satisfactorily laid to rest by individuals unfamiliar with boundary construction and the laws pertaining to boundaries.

But it is being done, and the service is sold for appreciable fees without fear of losing a license or registration because none is required. Yet it would seem rational that any person compiling record data that involves putting land parcels together for a fee and which compilation will be relied upon by other parties for major decisions, should be certified, registered or licensed by a responsible public authority. And they really need to be surveyors — qualified surveyors.

Not every surveyor or mapper, not every geodesist, geographer, engineer, forester or social science expert, not every mathematician, tax appraiser, computer scientist, statistician, lawyer, architect or business-person is qualified to develop a GIS/-LIS. However, those who are have and use a little bit of each of these occupations' strong points to build a successful system.

So what is a "successful system"? It is one that will accomplish a client's present and future needs, one expandable beyond expected use. It has a data base that can accept quality data from any reliable, relevant source with an ability to withstand windowing to locate important objects within the expected accuracy. Such a data base is transferrable to most users and is often compiled for some joint use through cooperative funding.

Any lesser system should insert cautions throughout the program, warning that accuracies in all locations are limited to plus or minus the scale tolerance of the data base. That tolerance on a "hard copy" map is about the equivalent of between 1/50th and 1/100th inch, converted to feet, meters or the appropriate scale. (A USGS map scape of 1" = 2000' would show a tolerance of 20 to 40 feet, as noted earlier. A map scale of 1" = 200' would show a tolerance of 2 to 4 feet.)

Public protection on this subject probably will become a major consideration soon. No incompetent or charlatan should be allowed to flim-flam clients with buzz words, high powered computers, bright colors and a collection of unverified, badly measured or erroneous data.

Surveyors should recognize there are "damsels in distress" out there. We need to don our white hats and get into the fray. But only the qualified should apply. Please.

Survey Technology for Mapping Control

RICHARD L. BEAMAN, L.S.
Manager of Geodetic Surveys, MSE Corporation, Indianapolis, Indiana

■ GLOBAL Positioning Satellite receiver system consists of a radio receiver and antenna assembly, precise timing device, and a system for recording radio signals.

THE earliest surveyors were the artisans who laid out the Egyptian pyramids. The equipment available to the surveyors of that period were a perpendicular wood cross used to set out angles and a knotted hemp rope with which to measure distance. Since that time, the equipment has evolved through the steel tapes and electronic distance measuring equipment that measured distances using light waves to today where the measurements are achieved by recording the differences in the wavelengths of radio signals transmitted by the Global Positioning Satellites (GPS) orbiting the earth.

Although essentially a background attribute of a geographic information system (GIS), the survey control is also an important part of the framework of the geographic relationship of all the graphic elements in the system. The surveyors' ability to measure and establish positions on the ground can be a great aid in strengthening a GIS system from the initial stages of photogrammetric or mapping control to updating and expanding an in-place system.

In the past few years several new techniques have emerged that drastically change the methods by which we establish control on mapping projects. The standard conventional ground surveying techniques are now augmented by field data collectors that electronically record the angle and distance readings from the survey instrument. Also, the technologies of global positioning satellite surveys and inertial survey systems can now be used to either supplement the conventional systems or provide the major control network. By the application of the laws of physics, together with very sensitive measuring devices and microcomputers, these high tech measurement systems can determine positions on the earth with limited manpower and to astonishing levels of accuracy.

Within many modern computer assisted design and drafting mapping projects these new technologies offer higher productivity while being less costly than the conventional survey techniques.

Photogrammetry

The first major effort in map production is the establishment of the survey ground control from which the map positions will be derived. In the past, this control was located using conventional ground survey methods of differential leveling, traverse, and occasionally, triangulation.

Photogrammetry is the science of measuring objects from controlled photographs. In the case of aerial photographs, the controlling dimensions are taken between large paint marks or flags set out on the ground, which are visible in the aerial photographs. Aerial photographs are taken from a camera located in the belly of an airplane so that the lens is facing down. The adjacent photographs overlap by 60 percent forming a "stereo pair."

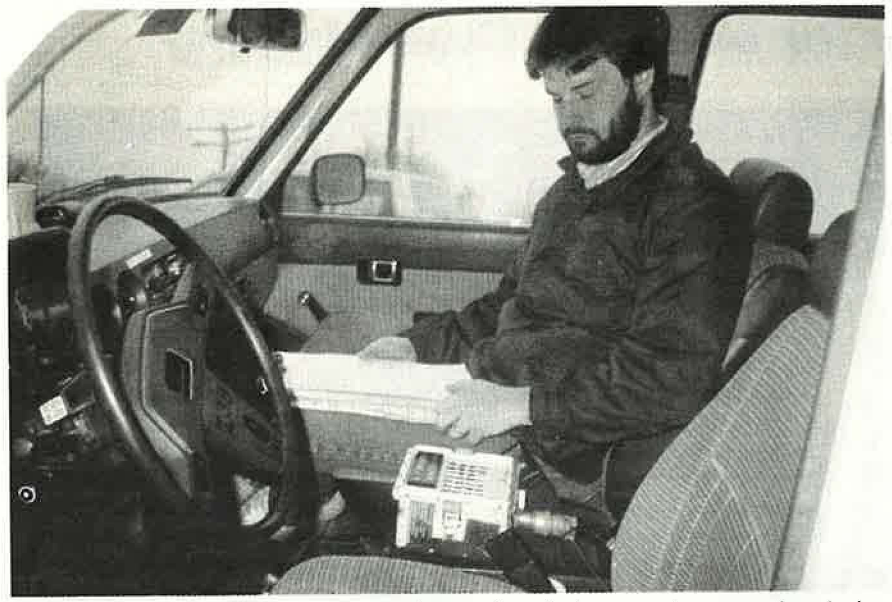
In current map making, the measurements are made by viewing two photographs that form a stereo pair. This allows the operator to see the ground in "3-D" and enables him to measure not only the horizontal distances from the photographs, but also to measure the elevation or height of the ground. When using a conventional stereo machine for the compilation, the optimum location of the aerial flags within the photographs is at the four corners. Today with the computerized programs to analyze the geometry of an entire flight line, the amount of control required is greatly reduced.

When the former amount of control was required, conventional surveying equipment was ideal since the control panels were spaced about the same distance apart as the distance the survey equipment could measure. With modern aerial triangulation, the ground control panels are three to four times farther apart than with conventional model control. But using conventional survey equipment the surveyor is still required to traverse the same routes and would probably occupy the same number of traverse stations as before.

Project Planning

The criteria for any mapping project is driven by the needs of the client. These needs include the level of detail required by the end users and the accuracy of placement of the elements within the files. The density, accuracy, and technology used for performing the survey control for a mapping project are dictated by the local terrain factors, the map scale, and the required map accuracy, which in turn is stipulated by the level of detail and accuracy desired of the final map product.

For instance, if the planimetric information within the completed GIS system is to contain the smaller utility features, such as fire hydrants and water valves, and include the topography in the form of contours at an interval of one foot, the mapping would be performed from photographs at a scale of 1 in. equals 300 ft to 500 ft scale. The accuracy of the survey control for these scales of mapping would need to be located both horizontally and vertically to about 0.1 ft or about 1½ in. However, if the final GIS system were to include the public



■ **INERTIAL survey system consists of a precise clock, computer, recording device, and sensistive accelerometers and gyroscopes. The accelerometers measure acceleration of the vehicle in all three axes and relate acceleration rates and time into motion.**

roads, boundary fences, and houses, the mapping could be performed from photography at a scale of 1 in. equals 600 ft to 1,300 ft. The amount of survey control required for a photo scale of 1 in. = 400 ft is greater than that required to control mapping from a photo scale of 1 in. = 1,300 ft by a factor of nine.

Global Positioning System

GPS is the technology of computing a position on the earth by the analysis of radio waves transmitted by the Department of Defense NAVSTAR Satellites orbiting the earth at an altitude of 12,500 miles. Some GPS receiver systems use the actual timed signal from the onboard satellite ephemeris, while others compare the frequency shift in the radio wave resulting from the satellite orbit. This frequency shift is known as the Doppler Effect. This is the same frequency change heard when a train whistles as it passes and the noise pitch changes from high to low.

GPS receivers can be used in two modes. One is as a stand alone navigational unit from which positional accuracies of plus or minus ten meters can be achieved. This mode is usually used to determine positions that do not require the higher accuracy of the typical mapping projects, such as geologic investigations for the energy industries. The other mode is the differential or relative positioning mode in which a master unit is stationed on a pre-existing survey control station of known position, and a second unit is set on a point for which the position is to be determined. Through the analysis of the differences in the readings received at the two sites, the direction and distance between the units can be calculated to a precision of 1 to 2 centimeters, or about 1 in.

A GPS receiver system consists of a radio receiver and antenna assembly, precise timing device, and a recording system for the received radio signals. From the known satellite orbit data and the received differences in the radio waves from the individual satellites, the position of the ground station can be computed to an accuracy of over one part in 500,000 parts when the system is employed in the differential mode. Network closures in the magnitude of 1 part per 100,000 parts can be achieved using the GPS systems. Since the GPS receivers do not require inter-visibility, the distance between the master and the remote unit can be as great as 75 kilometers (about 45 miles). The production achieved by a set of GPS units in the relative positioning mode is from 4 to 10 points per day when one master and two remote units are employed.

GPS would usually be employed to increase the frequency of the existing survey network that would be the basis for the mapping control located by either conventional or inertial survey system surveys. However, GPS can be used to survey all the ground control for a project if the higher accuracy is desired, or if the terrain factors indicate that conventional or inertial methods would be uneconomical.

The one area where GPS control requires assistance from conventional techniques is the establishment of elevations. The two surfaces considered are the "spheroid," the mathematical model selected to best fit the surface of the entire earth, and the "geoid," the actual shape of the earth at sea level or zero elevation. The elevation derived during the GPS computations are based on the three dimensional spheroid. This surface can be different from the geoid by several meters. For example, in Marion County, Indiana this difference is about 35 meters (Table 1).

The GPS elevations shown on Table 1 were derived using a program that applied the height and elevation corrections based on the gravemetric reading of the National Geodetic Survey for the project area. Further refinement of the values can be performed by establishing elevations on common points to the GPS survey. These "corrections" would be used to "index" the computed elevation to their corrected geoidal height.

The FGCC has completed a set of specifications for GPS surveys just as they have for conventional traverse, triangulation, and trilateration surveys. The Federal specifications applicable to GPS surveys are: *Specifications for Geodetic Surveys Using Relative Positioning GPS Techniques by the National Geodetic Survey in Rockville, Maryland.*

Inertial Survey Systems

The inertial survey system (ISS) is the technology of determining positions on the earth by the analysis of the movement of the transport vehicle, usually a light duty truck or helicopter in which the inertial system is installed.

Table 1 — Marion County GPS Elevations

Point Number	Geoid Height	GPS Elevation	Conventional Elevation	Difference
1	248.65	282.51	282.69	+.18
7	199.75	233.83	234.03	+.20
14	214.19	248.14	248.32	+.18
17	219.95	254.13	254.26	+.13
21	200.34	234.28	234.39	+.11
23	229.61	263.32	263.36	+.04
35	184.54	218.47	218.49	+.02
46	217.40	251.59	251.43	−.16

The ISS system consists of a precise clock, computer, recording device, and sensitive accelerometers and gyroscopes. The accelerometers measure the acceleration of the vehicle in all three axes and relate acceleration and time into motion.

Very simply, the vehicle containing the ISS equipment is driven from a known location through several unknown locations and the run or circuit terminated at another known location. During the transit time the accelerometers have been recording the motion of the vehicle in all three dimensions. To achieve accuracies of 1 part to 10,000 or 20,000 parts, the circuits must be double run to acquire sufficient data for mathematical smoothing of the results. A double run means running the course from each end, thereby canceling some of the instrument errors caused by the earth's rotation and magnetic field.

The production rate for this equipment is 8 to 10 mph when mounted in an automobile or all terrain vehicle. Production rates of as high as 420 miles per day have been achieved in areas of Alaska when the equipment was mounted in a helicopter.

The accuracies achievable by the inertial systems are directly related to the frequency of the primary control network to which the inertial circuits are connected and to the inertial network configuration. Therefore, the achievable accuracies are specific to each project and to quote system accuracies here would be misleading. In the example project of Marion County where the primary control was set out at four to five mile spacing and the road network was rectangular, the accuracies achieved were 1 part in 20,000 parts, or less than 2 in. per half mile. The vertical accuracies achieved were within 0.5 ft of conventional surveying verifications performed in the area.

ISS can be successfully employed to densify control for aerial mapping and to locate cadastral points when the accuracies desired are within the limits of the system.

Conventional Surveys

Just as the draftsperson has not been totally replaced by CADD systems, the classical methods of surveying have not been replaced by the automated survey systems. Conventional survey methods are frequently employed to supplement the other systems. Both GPS and ISS have limitations of access to the desired surveys station, and in these instances the best way to transfer coordinate values from the control to the required location is by conventional traverse methods.

The one major change is a theodolite or "transit" that incorporates into one unit the capabilities of angle and distance measurement. The data collector can be used very effectively in recording the field observations during standard traverse work, but is virtually mandatory when field locating the planimetric and utility features commonly associated with a small GIS system.

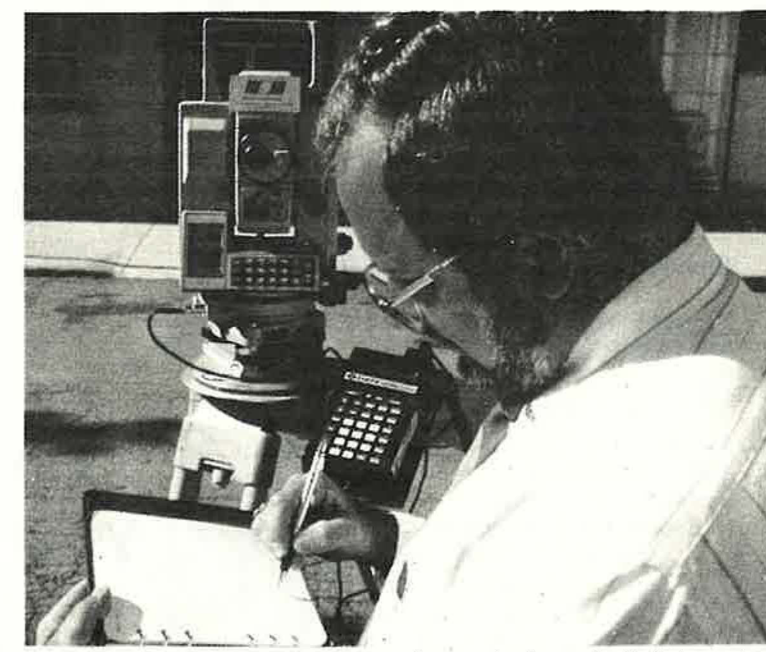
The production rates achievable with conventional survey equipment is from one to three hours per mile in average terrain depending on the accuracies to be achieved. The accuracies achievable with conventional survey equipment suitable for geodetic measurements is from 1 part in 20,000 parts to 1 part in 100,000 parts or from 0.1 ft to 0.03 ft in a half mile.

The Federal specifications applicable to conventional surveys are: *Classification Standards of Accuracy and General Specifications of Geodetic Control Surveys by the National Geodetic Survey in Rockville, Maryland.*

Case Histories

Virginia Beach, Virginia Virginia Beach wished to map into its Intergraph system (Intergraph Corp., Huntsville, Alabama) the entire city of about 310 sq mi at a planimetric scale of 1 in. to 100 ft and at a contour interval of 2 ft. The city also requested that a survey control station be established at about 6,000-ft intervals such that any location in the city would be within 1 mile of a survey control station. This was to satisfy a need for land subdivisions to be placed on a common coordinate system.

After analyzing the control requirements and the terrain factors, including point inter-visibility and road network alignment, we proposed to establish all 200 of the required control stations using GPS technology. The actual field work was completed within two months and the network computations completed soon afterward. The vertical control for the project was performed in the field using conventional differential levels to maintain an accurate vertical datum over such a large area. Nearly 1,000 miles of differential levels were performed throughout the city. As a comparison, this work took one survey crew nearly six months to complete, whereas the GPS location work for the same monuments had taken only two months.



■ **CONVENTIONAL electronic surveying methods retain their importance despite the availability of other sophisticated automated survey systems.**

Marion County, Indiana IMAGIS. The Marion County Department of Public Works was also mapping a large area into a CADD system at a scale of 1 in. to 100 ft. The area of the project was 492 square miles. Since the county had existing contour maps, the survey control would be performed to accomplish the planimetric mapping and the elevations would not be a critical factor. A careful analysis was made of the required frequency of the photo control. It was concluded that we could make the photo control coincide with the corners of the public land survey system, thereby providing the required photo control and simultaneously capturing the control for boundary line locations with little or no additional effort.

The existing geodetic control network within the county was sparse and consisted of one monumented point in the extreme southwestern corner. A system for control densification would be required to control the inertial survey routes. The primary control network was established by setting 60 survey stations throughout the county and interconnecting them with GPS surveys to a minimum accuracy of 1 part in 50,000 parts. This process was completed in about two weeks and the final computations returned in another two weeks.

The GPS survey data were reviewed and organized for use by the inertial survey contractor. The inertial surveying established horizontal positions on 700 public land survey section corners in 14 days. The equipment was operated two shifts each day to complete within this time frame. The inertial subcontractor also returned a final report within three weeks of the completion of the field measurements.

In several areas that were inaccessible to the inertial vehicle, the horizontal position of the photo control was determined by conventional traverse from either the GPS control stations or from the nearest inertial control point.

(For an in-depth discussion of IMAGIS, see Public Works, April 1988 Vol. 119, No. 4, *IMAGIS: A Joint-Use Infrastructure Management System* by Patrick Stevens and Ginger Juhl, pg. 55.)

Economy and Production

These two example projects show the use, in the first case, of one system exclusively and, in the second case, the use of all three of the major survey systems in unison.

They also show how pre-planning of a project from the beginning of the survey work can provide locations not only of the control for the mapping, but for the future input of engineering projects to the system and for the control of the cadastral or property boundary locations throughout the life of the GIS project.

The average person or agency interested in creating a GIS system for a city or county government should consult with companies that provide full consulting services to the computer graphics community. The consultant will evaluate their particular circumstances and outline a program to take full advantage of the surveying and mapping technologies currently available. □□□

This article is based on a presentation made at AM/FM International's Conference XI, Snowmass, Colorado, July 18 to 21, 1988.

* * * * * *

BLM OFFERS VOLUNTEER OPPORTUNITIES

The Eastern States Office of the Bureau of Land Management (BLM), Department of the Interior, has a large variety of volunteer positions and projects available, including a number in the office of cadastral survey. BLM is interested in recruiting active and retired professionals and students to fill these positions.

Projects include updating oil and gas tract books; abstracting old deeds to identify federal mineral ownership; researching archives for title clearances; researching land patents and cadastral survey records; designing exhibits and displays for land programs; conducting inventory of cadastral survey archives; working with federal land titles; and digitizing maps.

For more information or a catalog listing volunteer opportunities, contact Janice Mosher, Volunteer Coordinator, U.S. Department of the Interior, Bureau of Land Management, Eastern States Office, 350 S. Pickett Street, Alexandria, VA 22304. Phone: 703/461-1509.

GPS SURVEYS FOR BARTHOLOMEW COUNTY

Rik Sanders, Surveys Coordinator
Office of County Surveyor, Columbus, Indiana

BCS\GPS 88

In the spring of 1988 the city of Columbus was studying the needs of a pilot mapping project for the city. Bartholomew County Surveyor E.R. Gray, III, meeting with Columbus city officials suggested the best control for a pilot mapping project would be United States Public Land Survey System (U.S.P.L.S.) section corners based on the Indiana State Plane Coordinate System. Having recently received word from Geophysical Service, Inc. of Dallas, Texas of a GPS survey in this area, Mr. Gray inquired about the possibility of providing the control survey for this project. On June 10, 1988 a proposal was accepted to provide 5 new control points by GPS surveying at a total cost of $5500.00, which the city of Columbus agreed to fund. The proposal called for a survey of 1:100,000 accuracy; all monumentation, site preparation, permitting, reconnaissance, and site descriptions to be provided by the County Surveyor's Office. The field recon and data collection by GSI personnel was estimated to take 2 days. GSI would provide 3 GPS service units/vehicles, 1 GPS crew chief, and 2 GPS operators. Final computations with a detailed operations report, including WGS-84 ellipsoid and NAD-83 Datum coordinates was to be delivered to the county within 30 working days of completion of field data collection operations.

On June 17 the crew from GSI arrived and was escorted to the five section corners selected to be used as control. These corners were selected based on accessibility, permanence, and their proximity to the pilot project. Arriving back in the office, NGS was contacted for NAD-83 data on the stations selected for control. Station Clinton 1920 was used for control of the survey, although with reservations. This station was established via precise traversing from North Vernon to South Bend, Indiana in 1920. Recent surveys by Purdue University School of Surveying and a GPS survey by "Elstone, Luther and McCauley" of Jeffersonville experienced problems with the published position of Clinton.

The next day GSI personnel started the differential GPS survey and finished on June 20. A constellation of four space vehicles was used for each observation session. Precise relative positions were then obtained by processing the data with Magnovox Magnet 4100 differential GPS survey software programs. Satellite observation times available were from approximately 8:30 P.M. to 9:30 P.M.; local time. Approximately 60 minutes of data was collected on each site. Three receivers were utilized for this survey, one as the master station and the others as remotes. High precision conventional traverse surveying was then employed by the County Surveyor's office to carry state plane coordinates to all section corners in the pilot project. Sun shots were taken for astronomical azimuths on traverse lines to check and ensure accuracy of the work.

BCS\GPS-90

Having acquired monies in the budget requests in 1989 for more GPS surveying in 1990, we started working on approximately 30 more points in the county. One of the more difficult tasks was drawing up the specifications for the project. Several sources were researched to write the most efficient and precise specs. The list of potential vendors was gleaned from surveying publications available in the Surveyor's office, and by word of mouth. The location of stations to be surveyed were selected with the following criteria in mind: section corner, accessibility, permanence, county growth patterns, visibility, and maintenance. A 2 mile grid was drawn up and placed over the county map to try and locate the stations on as many section corners as possible and still maintain a fairly even and practical system of points. Several different locations were added and deleted until a final list of stations was agreed upon. Visibility charts were then drawn up for each proposed station. Each quote solicitation packet included individual visibility charts and a map of the county with each station location marked. Sixteen requests for quotes were sent out, with 8 companies responding. Prices ranged from $15,516 to $32,340 for 30 points. The BSC Group, a Surveying and Mapping firm from Boston, Massachusetts was awarded the GPS contract.

Up to six months prior to the crew from BSC arriving, individual location sketches for each station were drawn and monuments were set at points where section corners were not accessible for use. Discussion was continued in house concerning the problems that kept haunting station Clinton's position. Subsequent to the 1988 GPS survey (BCS/GPS-88) the U.S. Corps of Engineers, Louisville, Kentucky Division, had performed a GPS survey for Monroe Reservoir near Bloomington, Indiana. They had incorporated 3 National Geodetic Reference System points in their survey for control. Those being Knobs 1946, Lemen 1939, and Clinton 1920. Stations Knobs and Lemen are approximately 30-40 miles west of Bartholomew County. The Corps of Engineers report of survey stated that they had found station Clinton to be "in error 8.5 feet in relation to stations Lemen and Knobs." The report went on to state that if funds had permitted, Clinton would have been tied to the national network farther to the east. This would have provided a better solution of station Clinton 1920, in relation to the total network. It was decided to send a recon crew to recover a NGRS point to the east to have ready in case it was needed. The crew members from BSC arrived on January 25, 1990 and, meeting with our office, hammered out last minute details. It was decided that in the best interest of the county, now and in the future, to tie this survey into stations Lemen and Knobs, and a third NGRS point east, being station Fenley 1939. It was also decided that 3 of the 30 original proposed points to be occupied were unsuitable because of visibility problems. One point was eliminated and the two others were traded for set up on stations Fenley and Knobs. It was agreed that personnel from the Surveyor's office would set up and man the receiver on station Lemen. BSC also agreed to incorporate previous GPS points to update data due to the "better solution" of station Clinton.

The survey commenced January 25, 1990 and ended February 3, 1990. Six Trimble 4000SL receivers were used with session lengths varying depending on logistical constraints and on the length of the baseline being measured. Between 3 and 4 sessions were observed on any one day, the satellite observation times being approximately 1:30 A.M. to 5:30 A.M. The conventional static method of differential GPS surveying was used to measure all of the baselines. All of the loops easily met the guidelines for first order GPS surveys as set out in Table 5 of the 'Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques' FGCC publication version 5.0, May 1988.

With these and other related projects performed by and for this office, we feel that a solid foundation is being laid for a complete GIS that will face minimal revisions in the control network. In closing, the following was stated in the executive summary of the Final Report from The BSC Group concerning this survey, "Owing to its high accuracy, the distribution of the points, and the permanency of the monumentation, the network provides a suitable basis for integrating a wide range of activities including cadastral, engineering and digital mapping surveys."

* * * * * * *

PROFESSIONALS ARE...

Professionals are people who know their chosen specialty so well that they know which of its rules can be broken and when, under what circumstances, and with what results.

Professionals are people who know both strengths and the limitations of their specialty and respect both.

Professionals are people whose own standards of excellence are so high that their work becomes the standard by which others in the field measure theirs. People whose demands upon themselves preclude the need for someone to nag them about the quality of their work. People who might not be entirely satisfied with their work, even when everyone else thinks it's outstanding.

Professionals are people who never stop learning about their work, never turn down an opportunity to further extend the boundaries of their knowledge. If there is no one available to teach them more than they know, they will find ways to teach themselves. And they will look to other fields for new ways of looking at their own specialties.

Professionals are teachers. They're good enough at what they do to have something to teach. They are people from whom others want to learn. And they are secure enough in their own professionalism to believe that they can teach others without creating competitive threats to themselves.

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ACSM FOR GIS

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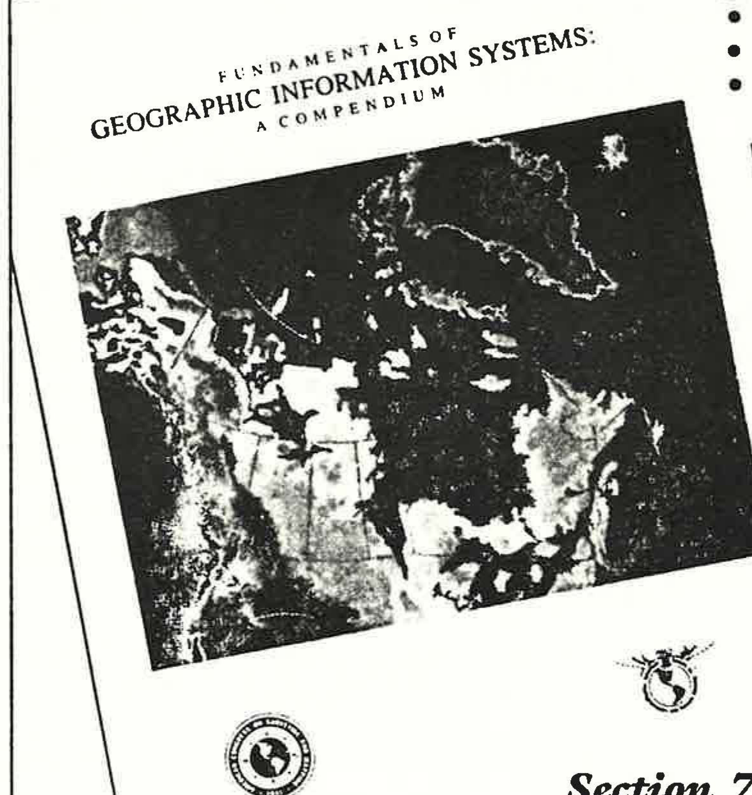

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Continued from page 9

Why Have a GIS

The GIS can also greatly reduce the cost of producing customized maps and reports. The user can go directly from the GIS display of the results of an analysis to a plotted map, graphic or report. Maps can be produced at any scale, covering any area and in any combination of data. The problem of map data falling on the match line between sheets is eliminated because the GIS contains a "continuous map." It is not only easier to conduct special studies of map data, but retrieving routine data is much easier and faster as well. This can be a big help to the municipal employee providing general information to the public. It represents an even greater benefit to the police or fire dispatcher directing emergency response operations.

5. MAP DATA IS INTEGRATED THROUGHOUT THE ORGANIZATION

Most organizations have departments which maintain their own independent filing systems. These files often use very different geographic reference systems. For instance, a municipal tax assessor may reference real estate records to a parcel number, while the public utilities department references water and sewer customers to an account number, the public works department references sewer data to a manhole or sewer line number, the building inspector references construction permits to an address, and the police dispatcher references building information in his 911E system to a telephone number. These systems may work well within each of the departments, but it is very difficult to correlate the data from different departments. Each system exists as an independent "island" of information.

A GIS provides the opportunity to relate all map and map-related data to a common reference system. Usually this is an X-Y coordinate system, such as the state plane grid. All the data used for reference purposes before is still available to the users so they can continue to use the retrieval process with which they are most familiar. But the data for all departments is now linked to a common reference system. This permits all departments to have access to the common database. Therefore, the operations of all GIS users can be more fully integrated. However, this is more than simply building "bridges" between "islands" of files. The GIS represents a "mainland" to which all users can go for information.

George B. Korte, P.E. is consultant in geographic information systems (GIS), automated mapping and facility management (AM/FM) systems and computer aided design and drafting (CADD) systems. He can be reached at P.O. Box 3547, Reston, VA 22090, (703) 435-6783.

Permission to reprint this article was given by the author and CIVIL ENGINEERING NEWS where it was originally published in the March 1990 issue.

COMPLETED CAREERS

ROBERT R. SCHERSCHEL, 75, Life Member, Dies

Robert R. "Big Red" Scherschel, 75, died Sunday, August 26th at University Heights Convalescent Center in Indianapolis. He was a resident of Greenwood.

He was born in Bedford May 9th 1915. His parents were Rudolph Scherschel and Ida E. (Mise) Scherschel. He was married to Doretta (Correll) Scherschel. She survives. Other survivors include two brothers, Frank Scherschel, Bedford, and Hugh Scherschel of Palmetto, Florida.

He was a self employed surveyor for 52 years before retiring in 1977. His business was called Robert Scherschel Company. He was a Navy veteran.

* * * * * * * * *

TALBERT "TED" ABRAMS, 95 Abrams Aerial Survey, Michigan

Talbert, "Ted" Abrams, Michigan aviation and aerial survey pioneer, died Sunday, August 26th.

Abrams, who held pilots license number 282 signed by Orville Wright, was the founder of Abrams Aerial Survey Corp. and Abrams Instrument Corp., both of Lansing. He was born in Tekonsha, Michigan August 17, 1895.

He began flying in the Marine Corp Aviation Section in 1917 and was one of the earliest U.S. air mail pilots. He later developed aerial survey techniques and built instruments for survey and military applications that became standards throughout the world. Before World War II he designed and built the first aircraft solely intended for aerial photography, the Abrams Explorer, which he later donated to the Smithsonian Air and Space Museum.

During the war Abrams designed and built numerous scientific and imaging instruments for the Air Force, Navy and Atomic Energy Commission. Later inventions were used on space probes and moon landings.

His life long commitment to science education was affirmed in 1961 when he donated the Talbert and Leota Abrams Planetarium on the Michigan State University campus in East Lansing. The Talbert Abrams Award, begun in 1945, annually honors outstanding scientific research through the American Society of Photogrammetry and Remote Sensing.

For his work Abrams received honorary doctorates from three Michigan Aviation Hall of Fame.

Abrams Aerial Survey Corporation, still headquartered in Lansing, is one of the world's leading aerial mapping and aerial engineering organizations with a branch at St. Petersburg, Florida and operations throughout the country.

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