Small Shop
Geographic Information Technology

Getting Started On a Shoestring

TABLE OF CONTENTS

INTRODUCTION

What is GIS?

GIS, or geographic information systems, is a system of hardware, software and associated technologies used for storage, retrieval, mapping, and analysis of geographic data. Practitioners also regard the total GIS as including the operating personnel and the data that go into the system. Features, such as points representing fire hydrants, are stored in a coordinate system (typically latitude/longitude), which references a particular place on the earth. Information about those features, such as the water pressure of the fire hydrant, is associated with the spatial features shown in a spreadsheet or attribute database form. Spatial data and associated attributes in the same coordinate system can then be layered together for mapping and analysis. GIS can be used for resource management, development planning, emergency management, scientific investigations and many other applications.

Using GIS in small communities for big benefits

The range of GIS development across the State of Missouri varies widely. The dream of seamless, statewide GIS coverage will only become a reality when small communities can and do actively participate in the development of geospatial datasets. Geographic or geospatial information technology (GIT) is a "tool of choice" for informed local decision makers to study, understand and communicate past, current and anticipated conditions to staff, elected officials and the public.

GIT includes three distinct, but increasingly integrated forms of technology, including geographic information systems (GIS), global positioning systems (GPS), and remote sensing, which includes both aerial and satellite-based sensors and digital photogrammetry (i.e. air photos or imagery). In simple terms, remote sensing and GPS generate geo-referenced data that are often used with GIS software. GIS can be used alone, or in conjunction with these other forms, to manage, manipulate, display, and provide customized access to meet needs. Current GIT focus is on increasing the accuracy and quality of geographic information, web-enabling GIS for wider use by the public, as well as enabling tabular data to be displayed, integrated and analyzed geographically. Estimates state that between 80% and 90% of all government data can be geographically referenced, and in turn, can be used within a GIS.

GIT use is strengthened by other information technology advances, in particular such areas as the Internet and other networking; information storage, access and processing; and graphical display capabilities. However, a "digital divide" between the larger, more affluent communities and those smaller or with less resources and technological sophistication will impact nationwide adoption of GIT and implementation of "e-gov" National Association of Counties, *Technology in America's Counties*, (Washington, D.C.: National Association of Counties, 2000).

This is particularly the case as goals increasingly include provision of "seamless" services by multiple governments.

Nationwide analyses of local government GIT conditions must consider that most Americans reside in, and receive services from, more than one local jurisdiction simultaneously. The country's land mass is governed by literally thousands of localities, some with few inhabitants. Inherent differences among states and in local government functionality directly impact the use, development, financing, and measurement of GIT.

- Most counties serve relatively few people (e.g. 74% have fewer than 50,000 inhabitants), but have jurisdiction over a larger land area.

- Almost half of all Americans reside in approximately 200 cities with more than 100,000 inhabitants.

- Of the remaining cities more than 2000 serve between 10,000 and 100,000 people, and over 16,000 jurisdictions serve fewer than 10,000 inhabitants (U.S. Department of Commerce, Bureau of the Census. 1997 *Census of Governments*, vol.1, "Government Organization," (Washington, DC: U.S. Government Printing Office, 1999).

- "Metro/urban areas can be defined using several criteria…nonmetro/rural is then defined by exclusion -- any area that is not metro/urban is nonmetro/rural…

- The Census Bureau classifies **61.7 million (25 percent)** of the total population as rural, OMB classifies 55.9 million (23 percent) of the total population as nonmetro.

- According to the Census definition, **97.5 percent of the total U.S. land area is rural**; according to the OMB definition, 84 percent of the land area is nonmetropolitan.

- USDA/ERS estimates that, in 1990, 43 percent of the rural population lived in metropolitan counties.(**USDA Rural Information Center** -- http://www.nal.usda.gov/ric/ricpubs/what_is_rural.htm)

Local government functions, roles, responsibilities and financial resources and mechanisms vary significantly by state and region. For example, townships may have important roles and responsibilities in some states concerning geographic information, such as property records management and assessment, similar to the roles and responsibilities of counties elsewhere. School and special districts also may use GIT and have important data roles. Some investigations also query regional entities such as councils of governments, metropolitan planning organizations (primarily to address transportation issues), and other regional planning organizations. [T.Haithcoat, ICMA-12-22.doc]

Making the leap from analog information (e.g. mylar tax parcel maps, paper-based service records) to a digital format alone is a monumental task that will most likely take a small community years to complete. Even more difficult is confronting the digital divide that often exists between technology capable communities and those lacking local infrastructure (e.g. high speed internet), technology, skills and motivation to change. Considering that the 'analog' system of information management has been comfortably in use for decades and decades, the idea of switching to a technology that may seem financially unsustainable or require special training for staff does not hold great appeal – regardless of the potential benefits.

GIT has been hailed as an indispensible tool for promoting efficiency, better customer/citizen service, convenient data storage and generally a 'ground-breaking' technology that can address many of the most difficult problems we face. Why is successful implementation so difficult, precarious and daunting? One reason may be that choosing to limit the technology you invest in can be counterintuitive when confronted with the vast options available. While GIT can certainly address a very broad and deep scope of issues, success requires understanding and acting on the community resources and needs. Even as a basic practice GIT can lead to significant benefits for communities as long as decision-makers are vigilant about their cost vs. their benefit. Sustainability of a GIT is critical because the benefits are 'long' and 'longer' term. Costs to support geospatial technology can be very significant, seemingly infinite. Taken together, the cost of software, services, hardware and (especially) personnel can be daunting or even out of the question. Geospatial technology can easily cost hundreds of thousands or even millions annually for communities that choose server-based systems, internet services and wireless field capability. Cost can be quite reasonable, though, as long as a community chooses the scale of technology and skill to fit their capability and needs – not a scale that is determined by what is available. For small communities, particularly those in slow growth/no growth areas, one computer, one software license and one technician can serve the initial and basic needs. Keep in mind that geospatial technology is inherently an interdisciplinary and ever-growing practice, maintaining your 1computer -1licens -1 technician model may not last forever as your community identifies growing benefits and needs.

The benefits your community receives by implementing a GIT program is directly related to the quality of the planning and implementation over the long-term. Even small scale geospatial shops can realize consistent benefits and returns, some directly and some indirectly:

- **Tax assessment records:** Updated, complete, corrected and sharable real estate and assessment records help locally, regionally and beyond. Anecdotally, many assessors identify mistakes and incomplete records that, when corrected, lead to efficiency and improved long-term record-keeping. These records can be shared with others to reduce staff time and improve service for citizens.
- **Transportation:** Accurate and complete records of road length, surface type and condition help local officials with budgeting and planning. Regionally, all communities benefit when the condition of the transportation system can be easily conveyed for funding requests and state system planning.
- **U.S. Bureau of the Census:** Small communities benefit from having accurate and complete information about their population. Every person counted translates directly into local resources. Geospatial technology is the best, current way to make sure everyone gets counted.

- **Disaster preparedness:** Every community will experience disaster. Geospatial technology is one of the best tools officials can use to not only prepare for a disaster locally, but also help non-local officials prepare and respond. Sharing your geospatial data with agencies unfamiliar with your community helps them with immediate response and helps the local community receive the maximum resources for recovery.

Keeping stakeholders engaged in the process, with a designated steward and leader, of your geospatial activity is key to tracking benefits and identifying future opportunities.

Purpose of This Guide

- Address a lack of consistent and basic information for small GIS shops, particularly those operating in geographically isolated areas.
- Provide a common guide to encourage and support state-wide GIT development and maintenance
- Introduce or reinforce the existence of best practices and standards
- Provide strategies for funding and maintaining GIS
- Provide planning criteria and considerations
- Encourage data sharing and maintenance
- Identify key milestones for coordination and collaboration

The Nature of this Guide

This document is a dynamic text meant to convey a great deal of information and provoke thought. As the community of small shop GIS practitioners and experience grows so will the information contained here. Contribute your own material and knowledge. This is just a start.

Contributions and Support

Many people have contributed, supported and edited this document so far:

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1. BEFORE YOU START…CONSIDER

GIS PROGRAM PREPARATION

Many communities, particularly smaller population local government offices, have considered developing a GIS or tried to develop a GIS only to find the process and product to be daunting, disappointing and in rare cases disastrous. The process of developing an efficient and productive GIS is complicated and requires a great deal of investment, particularly staff resources. Important to understand from the beginning is that developing a GIS is a long-term, on-going program and the planning should reflect such a sizable investment.

TOP 10 SIGNS YOU NEED A GIS? (check all that apply)

- ☐ We need to identify and demonstrate the needs in our community for state and federal assistance.
- ☐ Coordination and collaboration with other organizations or agencies is limited because of the limited access to information
- ☐ Resources are shrinking and efficiency must be maximized
- ☐ Record-keeping is digital and we need to get on the bandwagon
- ☐ We need to know more about the places where we live and work
- ☐ We need to clearly identify and convey the issues facing our community to build effective community work groups.
- ☐ Institutional wisdom is currently stored in employee heads
- ☐ We want to share our infrastructure and information with potential investors or developers
- ☐ We need a better way to communicate with our citizens.
- ☐ Need help complying with federal accounting standards (GASB 34)

If you answered 'yes' to any of the above issues, then a GIS can help you.

A. What are your real business needs for geographic information technology (GIT)? (Check all that apply.)

- ☐ Store, search and retrieve
- ☐ Improve customer service
- ☐ Emergency preparation
- ☐ Tracking crime
- ☐ ID gaps in information
- ☐ Share information
- ☐ Evidence to leverage more resources (e.g. grant money)
- ☐ Analysis for quality & efficiency
- ☐ Reduce staff time
- ☐ Other_____
- ☐ Other_____
- ☐ Other_____

B. What in-house resources do you currently have to develop and support GIT? (Check all that apply.)

- ☐ Stakeholder supporters
- ☐ Primary GIT (Trained) staff
- ☐ GIT users
- ☐ Computer
- ☐ Office space for workstation
- ☐ High speed internet access
- ☐ GIS software
- ☐ Existing staff have basic computer skills
- ☐ Access to software training and retraining
- ☐ Other_____

C. What timeframe do you have in mind to apply and benefit from GIT? In other words, how long are you willing to wait for useful information? Keep in mind that shorter time needs will require a lot more resources (Check one.)

- ☐ Less than 1 year
- ☐ 1-3 years
- ☐ About 5 years
- ☐ As long as it takes

WHO DO I NEED?

A. Who are the **needed** stakeholders? (Write in names.) Stakeholders are defined as people or organizations that could experience a cost or benefit from development or expansion of a geographic information technology (GIT) program.

- ☐ Elected Officials:_____
- ☐ Administrators:_____
- ☐ Department Heads:
  - Property Assessment:_____
  - Taxing Agency:_____
  - Road & Bridge:_____
  - Water/Wastewater:_____
  - Solid Waste:_____
  - Emergency Mgmt.:_____
  - Economic Development:_____
  - Engineering:_____
  - Public Works:_____
  - Finance:_____
  - Code enforcement:_____
  - Planning:_____
  - Human Resources:_____
  - Parks & Rec:_____
  - Other:_____
- ☐ Workers knowledgeable about the systems and information to be digitized or integrated:
  - Property Assessment:_____
  - Taxing Agency:_____
  - Road & Bridge:_____
  - Water/Wastewater:_____
  - Solid Waste:_____
  - Emergency Mgmt.:_____

- Economic Development:_____
- Engineering:_____
- Public Works:_____
- Finance:_____
- Code enforcement:_____
- Planning:_____
- Human Resources:_____
- Parks & Rec:_____
- Other:_____

☐ Community Partners:

- Public Health:_____
- Red Cross:_____
- Technology Centers:_____
- Academic Institutions:_____
- Volunteer Emerg. Response:_____
- Intel. Agencies:_____
- Tourism:_____
- Real Estate/Development:_____
- Regional Planning Commission:_____
- Other:_____

☐ State and federal agencies:

- United States Dept. of Agriculture:_____
- Department of Conservation:_____
- Missouri Spatial Data Information Service:_____
- State Emergency Management Agency:_____
- State Highway Patrol:_____
- Missouri Department of Transportation:_____
- Department of Health and Senior Services:_____
- Department of Natural Resources:_____
- Other:_____

☐ Others:_____
_____
_____

B. Who are the stakeholders most likely to be supportive?

Draw and asterisk (*) next to the names above of people most likely to be actively supportive of GIT development or expansion.

IDENTIFYING SUCCESS

Two important points to note about measuring success:

1. Define success in the planning stage – know what success means before you start
2. Make sure your definition of success is measurable

CONSEQUENCES OF SUCCESS AND FAILURE

"GIT is a long term project for success, and a short term project for failure." – P. Kelrick

For all of the time, effort and resources that can be devoted to GIT towards a successful program you may find it remarkably easy to experience program or project failure. Most communities that commit to developing a GIS have done quite a bit of thinking about what they want, but very little about what success means and how to measure it. Time devoted to defining and measuring success will pay dividends when it's time to evaluate personnel, equipment, training and your return on investment (ROI). If you skip this step, consider what the cost of accountability will be if you cannot demonstrate success. Failure may not only set you back, waste resources and lead to uncomfortable disappointment, but may cause the program to fully collapse until another champion convinces management to try again.

Success is nearly just as complicated as failure. If the boxes of success are all checked off, where to go from here…sensible, consistent planning can keep you moving forward and gaining returns on your investment. Sustaining success requires the same devotion to careful planning as your initial investment. Consider the following:

- Are your business needs still the same? If not, what has changed?
- Are your resources still the same? Do you need more resources?
- What timeframe can you work with to get another useful project 'in maintenance'?
- Does your stakeholder group match your resources and needs?
- What is measurable success for the updated agenda?

Juggling all of these considerations from the beginning and as an on-going practice takes a great deal of time and knowledge. Be sure that from the beginning you have identified who will be asking and answering these questions on a regular basis. Do not underestimate the skill and time that will be required to keep on track.

MEASURES OF SUCCESS

Choose categories that make sense for your organization. Choose categories that are measurable. Think about the measures of success that matter to stakeholders and will move your program forward. There will be both short term and long term measures. There are many ways to measure success, review the examples below and add your own based on the priorities for your organization.

BASIC MEASURES	**SHORT TERM 1-2YRS**		**LONG TERM 3-5 YRS**	
	successful	***unsuccessful***	***successful***	***unsuccessful***
Stakeholders				
Satisfaction				
Quantity of stakeholders				
Type of stakeholders				
Data				
Development				
Distribution				
Completeness				
Use				
On schedule				
Cost				
Sustainable				
Predictable				
Planned				
Insurance				
Metadata				
Backup data				
Critical sharing				
Planning				
Comprehensive Program				
Project Based				
Training				
Software				
Administrative				
Database management				
Equipment				

2. IMPLEMENTATION

WHAT DO I NEED?

PERSONNEL AND TRAINING

One of the most difficult challenges for small communities considering an investment in geospatial technology is hiring and keeping skilled staff to develop and maintain their GIS. The market demand for trained geospatial workers is high and anecdotally we know that urban centers are often more of a draw with higher pay and promotion opportunities. In fact stories of clerical staff being trained to maintain the geospatial databases only to relocate for a better paying tech job has happened more than once. At least one lesson to keep in mind is to take the position and the personnel need seriously. Whether your organization is going to invest in an 'in-house' or 'hired-in' employee make sure that you know what their goals are and how you can meet them, or not. Consider how long you expect the employee to stay. I have observed that in many small communities workers tend to reside in the same job for perhaps longer than in urban centers. This may not hold true for a geospatial worker and turn over is costly in terms of time, money and quality.

What qualities are important if you are looking for someone to develop, manage and maintain your GIS? I have observed that in many cases communities are thinking too narrowly about the skills a good geospatial employee offers. There are more and more people trained for the technical aspects of GIS, but many other skills are equally important and should not be underestimated for a successful program.

- **People skills** – GIS is meant to benefit and spread to most of your organization's operation. Make sure that the employee has a good, pro-active working relationship with a diverse set of stakeholders. This skill set also includes public speaking. Often the person who has created the data will need to explain what the information means.
- **Business skills** – Geospatial technology is still new and innovative in small communities and therefore will require some initial marketing. The employee will often need to have an entrepreneurial mindset looking for opportunities where GIS can save the organization time and money.
- **Technical skills** – Although this is an obvious trait it is also the easiest skill to train. There are many training options (listed below) and if the person is dedicated they will pick up the knowledge.
- **Networking skills** – The geospatial industry is growing by leaps and bounds. Your organization will benefit if your employee reaches out and participates in the industry growth. When new data, imagery, skills or technology is needed knowing the right people can save on local resources. Usually veterans of the industry are willing to provide some free advice, direction or documents.

TRAINING – backing up and enhancing your institutional knowledge

There are lots of options for technical training, both for starting and advancing your program. If you are hiring 'in-house' it probably makes the most sense to start with a structured training, at least until the person is comfortable with the technology. The idea would be that the trained employee would eventually start to develop training that can meet the needs within your local organization to save on training costs and address specific training requests. Years of observation of non-geospatial employees in training to apply the data to their work needs leads one to conclude that the more local the training can be, the more relevant and engaged the workers will be. Providing structured training, using non-local data with too

many abstract concepts that employees won't use often results in un-trained, un-interested employees. Remember, if your data doesn't get used, you aren't getting a return on investment. Redoing the same structured training sometimes just results in frustration and you would be wise to consider how you can foster institutional skill and knowledge. How can the 'knowledgeable' train the 'unknowledgeable'? Consider the following options for keeping your training costs low and effective:

- Travel to training centers of your software provider. If you only have one employee to train initially this is an option. If you have many employees, check to see if they have a mobile class room that can train at your facility and save on travel expenses.
- Local education institutions (e.g. community college).
- Coordinate with other regional GIS users to pay a trainer to hold a local class; this option lowers the travel costs and per person training costs.
- Many software providers offer on-line classes for small tuition or for free
- Take advantage of workshops and conferences provided at low or no cost by your state advisory council and its partners.

HARDWARE AND SOFTWARE

The cost and quality of technology changes constantly, but the following table is meant to get you started. At least consider the minimum hardware and software requirements; remember, the sky's the limit. Many communities jump in with both feet when it comes to hardware and software. If you have the resources to make a substantial upfront investment, that's great – you're lucky. Consider though that most computers, particularly ones for this purpose, will need to be replaced every 3 years without fail. Even if you are fortunate enough to have the resources to hire out initial database development it will be 6 months or more before you will have functional data. If your 'GIS computer' and software is not operating for 6 months because you don't have data you've lost over 15% of the useful life of the computer. If you are developing the data in-house it may be a year, or years, before you have functional data. Make sure that you spend resources wisely. In the beginning you need the biggest investment in skilled personnel. Technology is the easiest part to get, but doesn't get you the data.

HARDWARE	EST. COST	COMMENTS
Minimum		
Computer workstation	$1500.00	HP Workstation xw4400 w/ 22" flat screen; w/ basic software pre-installed
External HD	$150.00	Maxtor One Touch HD 500GB; See section on back-up options
Battery backup/surge protection	$299.00	SmartUps 750VA USB SER-120V
Handy additional equipment		
Plotter printer	$3500.00	HP 42" wide color plotter
Highspeed internet access	$100.00/mo	
GPS	$3500.00	Submeter GPS unit w/ ArcPad

There are lots of GIS software options, some cost money and some are free. Keep several things in mind when you review software. How much is the initial cost and how much is the annual maintenance. Is the software expandable, upgradable for the long term? Remember your timeline for development. If you choose a free version, how long has it been in use? Have you talked with anyone who has used it for some time? Free software can be very useful and functional – not to mention cheap – if it has been used a lot so 'bugs' have been worked out. Note that if you have trouble with free software there may not be adequate support to help you figure out your problem

or fix a software bug in a timely way. There are also lots of 'extension' (software 'add-ons' that expand the capability of your existing software) options. You can get through basic data development with basic software, but extensions for free software are not likely as available to expand the capability of your software as your needs grow. The format of your data, however, IS likely to be transferable among free and 'for purchase' software, so if you choose to start with free software just check the format with someone who is using the software you might consider down the road. As you understand more about geospatial technology you can consider whether an investment in extensions make sense in your cost vs. return equation.

SOFTWARE	EST. COST	COMMENTS
GIS options		
ESRI, Inc ArcView	$1200.00	Government pricing; add $3-400/yr maintenance
GRASS GIS	Free	http://grass.itc.it/
Quantum GIS	Free	http://www.qgis.org/
Handy additional software		
ESRI, Inc. ArcPublisher (extension)	$2000.00	Creates 'viewable' (not editable) data packages for distribution to anyone for free; add $600/yr maintenance
Metadata production	free	http://www.fgdc.gov/metadata/geospatial-metadata-tools

DATA AND METADATA DEVELOPMENT

Data development literally refers to the gathering and consolidation of bits and pieces of information about locations into a GIS database. Some examples of this include: assembling a list of emergency shelter locations/addresses; using a GPS unit to identify locations of fire hydrants; or transfer owner names from a paper record to a digital format. The flexibility and broad scope of information that may be maintained in a GIS often means that the sources of information to be assembled are equally broad. In addition to the previous examples, information may also come from employees' heads, professional organizations, academic institutions, 'free' data clearinghouses, archived records or 'data for purchase' companies.

BASIC DATABASES

If you are diving into a GIS for the first time there are a few basic databases that you will want to concentrate on creating before all others. These databases create critical context and structure for nearly all other future databases, or information you would like to add to the basic set. The good news is that some of these are available in relatively short order, at least until you can add more detail or improve the quality. The basic database set includes: (Dictionary of GIS Terminology: The ESRI Press, Heather Kennedy editor, Redlands, CA, 2001)

- **Cadastre** (real estate parcels) – a public record of the dimensions and value of land parcels, used to record ownership and calculate taxes
- **Road centerlines** – a line digitized along the center of a linear geographic feature, such as a street or a river, that at a large enough scale would be represented by a polygon
- **Imagery** – a graphic representation of a scene, typically produced by an optical or electronic device such as a camera or a scanning radiometer

- **Point data** – a single X,Y coordinate that represents a geographic feature

The quality and accuracy of the information and locations represented in the database are the two most important and time consuming issues to be addressed when creating these databases. Several resources describing standards or guidelines are available to help guide the quality and accuracy of your databases.

STANDARDS, GUIDELINES AND BEST PRACTICES

Missouri has adopted several state standards for GIS datasets, and more are in the works. These ought to be followed as a 'best practice':

- Real estate parcel number
- Addressing standard
- GPS — mapping grade
- GPS – survey grade
- Imagery

If Missouri does not currently have a standard to address your needs, there are many appropriate standards from surrounding states or national standards that may be used as a guide. Most states have a state GIS data clearinghouse, use the internet to find one nearby.

TIMEFRAME FOR DATABASE DEVELOPMENT

Anecdotally we know that time and resources (e.g. people time, funding, office space) are the most significant obstacles toward database development. While the time for development of basic files will vary, here are some general guidelines to keep in mind.

- Cadastre and Road Centerlines will take approximately 1-year for about 15,000 parcels and about 1-year for the road centerlines for about 700 miles – with one person working very consistently. Further detail work on the databases to have them broadly functional for a range of uses will take longer – months to an additional year or more.
- Imagery will take several months, depending on time of year, accuracy and additional features (elevation data included).
- GPS point data varies enormously based on distance between points (i.e. travel time), additional on-site data collection, GPS unit quality, environmental conditions. Time on-site with a mapping grade unit varies between 30 seconds and 3 minutes. Add in travel time between sites for a more accurate estimate. As a rough guide, approximately 3200 water meters covering all of Adair County, MO took a full-time, trained employee about 3 months to collect.

BASIC DATABASE DEVELOPMENT

Cadastre

Methods of development:

- 'Heads up' digitizing imagery (HU imagery) – use reasonably accurate imagery (2 foot per pixel in rural areas; 6 inch per pixel in urban areas) to draw in parcel boundaries according to fence lines and other landmarks
- 'Heads up' digitizing maps (HU maps)– scan existing real estate parcel maps; 'rubbersheet' or 'georeference' the digital picture of the map; trace each parcel; verify quality of the existing versus created parcels

- ‘Heads up’ digitizing deeds (HU deeds)– gather real estate parcel deed descriptions; start from appropriate reference points; draw in real estate parcels according to the legal descriptions
- COGO (coordinate geometry) (COGO)– automated mapping software used in land surveying that calculates locations using distances and bearings from known reference points and legal deeds

METHOD	COST	ACCURACY	TIME	ACCEPTABLE USES
HU imagery	Low*	Low (est. 5+ ft at best)	Low (est. 6 mo.)	Tracking land use, land marks
HU maps	Moderate	Moderate (est. 0-6ft)	Moderate (est. 12 mo.)	Rural real estate property assessment; ownership
HU deeds	Moderate	Moderate**	Moderate (est. 18 mo.)	Rural real estate property assessment; ownership
COGO	High	High***	Moderate (est. 12 mo.)	Professional surveyor quality; urban real estate property assessment

*Assumes imagery is free.
** Depends on the quality of the deed legal descriptions.
*** Requires high quality, verified surveyed legal descriptions.

Applications for database:
The cadastre database in its most basic form is typically used for property valuation for taxation. Substantial information can be added to the database to broaden the scope of use to include anything associated with the ownership or address. Examples of information that could expand the use of this database include: parcel zoning, rental status, quality survey, code violations, crime offenses, vulnerable residents, hazardous materials, flood zone status, voting district assignment, billing/invoicing, land use, damage assessment and/or resource use.

Standards:
Missouri:
- Cadastre standard is in development. Stay tuned for details.

Tips:
The cadastre database requires the most preplanning of all the basic database set. Carefully consider the current needs you are trying to satisfy; future needs; the quality of your existing information; and what quality of information can reasonably be maintained into the future. The cadastre database is typically, initially created for use in the assessor’s office. The quality of the existing information in the assessor’s office is critical to consider – hence the phrase ‘garbage in, garbage out’. Many rural areas have not and do not require surveys by licensed surveyors for the conveyance of land. Further, for the scattered surveys that are completed, they are not always verified for quality. If your community fits this description it would be unreasonable to create and maintain a COGO-quality database. ‘Heads up’ digitizing in the map or deed options poses complications as well. In many rural counties the parcel maps do not necessarily match the deed descriptions. Over time the parcel maps represented the deeds to the best fit possible, creating the visually acceptable description of land. If your digitizing process changes the visual description of the land, but is actually more accurate, be prepared to educate citizens. Each decision-maker

or creator needs to determine what is possible to create and maintain based on the existing information and expected benefits.

Road Centerline Database Development

Methods of Development:

- Vehicle-based, voice activated GPS equipment is available on loan from MODoT. In return for using the equipment and receiving training MODoT wants a copy of the finished database. A mapping grade GPS unit may be used for updating the map.
- Trace the road centerlines over imagery that is at least 2 foot per pixel – the newly available 2 foot per pixel imagery for the entire State of Missouri can save a great deal of time and money (particularly fuel costs). Keep in mind, however, that it is easy to miss roadways, the full extent of roadways or verify road names using this method. Also, this method will not result in accurate surface type information.
- Download road centerline database from the Missouri Spatial Data Information Service (MSDIS) www.msdis.missouri.edu

METHOD	COST	ACCURACY	TIME	ACCEPTABLE USES
GPS	Moderate to High	<6 feet	High (est. 12-18 mo.)	calculate needed surface materials; calculate distances; use as framework for 'rubbersheeting' cadastre mapping; track naming
Trace Imagery	Low*	10-15 feet	Low (est. 6-12 mo.)	Calculate distance; track naming
Download	None	varies	Immediate	Calculate relative distance; track naming; some roads may be missing

* Assumes that free and appropriate imagery (2-foot/pixel rural; 6-inch/pixel in urban) is available.

Standards:

- Road centerline standard is not available.

Tips:

Development of the road centerline database is valuable not only as a product, but equally valuable as a process. The key elements of a road centerline database will require careful scrutiny of road names/spellings, surface type, private versus public access and length. In many communities, resolving this information is more complicated than first considered. Unless a pre-existing source can confirm the information, confirmation will usually come from a variety of sources, including: field investigation, communication and negotiation.

One of the key elements missing from the 'trace imagery' method is 'calculating needed surface materials'. Consider the value of being able to precisely calculate the amount of materials needed to maintain roadways. Resources for maintaining roadways come from several sources and knowing the

details of roadways helps to inform the needs and requests. Detailed information about the exact extent and location of road surface type is also very useful for emergency management agencies with response vehicles that are vulnerable to muddy or otherwise compromised roads.

Imagery

Methods of Development:

- Contract with private vendor for imagery production
- Existing imagery can be purchased in a variety of forms and formats. The imagery may or may not be current.
- Missouri has produced state-wide imagery which is free and available for download. This imagery is expected to be updated on a 3-year rotation and includes a local 'buy-up' program for communities that would like imagery with better than a 2-foot/pixel resolution.
- Use free imagery provided by state or federal programs if the quality meets your needs – in rural communities 2-foot/pixel will generally suffice, unless you are in a high development area

METHOD	COST	ACCURACY	TIME	ACCEPTABLE USES
Private Vendor	Moderate to High	Varies (inches/pixel and up)	Weeks during appropriate season	Imagery is purchased to meet all appropriate specifications and uses
Existing imagery	Low to High	Varies (inches/pixel and up)	Varies	Imagery is purchased to meet all appropriate uses
MO imagery	free	2-foot per pixel	Immediate download	Rural cadastre context, road centerline and feature mapping; emergency response
Other	free	2-foot to multi-meter per pixel	Immediate	Above 2-foot, feature mapping; emergency response

Standards:

- Imagery standard is available for Missouri. Contact MSDIS.

Tips:

Imagery can provide a uniquely important context for conveying and showing data. Imagery can also be an important for creating some databases. Consider several factors when determining the imagery appropriate for your community:

- What quality of imagery will meet your current and future needs? Resolution, color/black or white, leaf on or off…
- What quality of imagery will control points (a point on the ground whose location has been determined by a horizontal coordinate system or a vertical datum) in your community support?
- How often will you need new imagery? Purchasing from a private vendor will meet any timeframe, on-demand. Free imagery may follow a longer schedule, political changes or budget constraints.

- What resources can you devote to acquisition of imagery? Can these resources be reconstituted as quickly as would be required to meet the needs? Even if you can afford to purchase high-quality imagery now, consider whether those same resources will be available when you will need updated imagery.
- If you choose to purchase imagery, have a plan for an independent and capable person/agency to check the quality of the imagery product BEFORE you pay for the final product.

Point

Methods of Development:

- Private contract by GPS
- Field collection by GPS
- Feature ID by imagery

METHOD	COST	ACCURACY	TIME	ACCEPTABLE USES
Private Contract	Moderate to high	Survey to mapping grade	.5-3 minutes per point + travel time	Sub-centimeter locations for surveying to water meters
Field Collection	Moderate to high	Survey to mapping grade	.5-3 minutes per point + travel time	Sub-centimeter locations for surveying to water meters
Feature ID by imagery	Low*	Depends on quality of imagery	Seconds/point	Location of buildings, water bodies, soil types

* Assumes the imagery is available for low or no cost.

Standards:

- GPS standards are available for both 'mapping' and 'survey' grade GPS activity. Contact MSDIS.

Tips:

Point database development is a relatively quick and essential way to gather, store and analyze information. The required accuracy of the information will typically determine the cost of the data collection. If the need for accuracy is high, then the quality (and cost) of the equipment, operator training and method of collection will also be costly. Weigh the options carefully because recollecting to improve accuracy at least doubles your total cost.

In addition, operating GPS equipment accurately and well is often underestimated. Both training and implementation of a short 'pilot project' are key to full project success. Quality control of data and error checking are important throughout the entire project, not just in the beginning. GPS software can also vary in ease of use and probability of file corruption. Make sure that you save your data progressively as backups in case you experience quality control or file corruption issues. Remember that the expense of collecting a data point will automatically double if a point has to be recollected. Further, backing up your data properly is the surest way to protect against file corruption. Think about how much data you are willing to lose versus the time you are willing to spend backing up.

Existing Databases for download and purchase

There is an ever-growing list of sources for data for free download or purchase. The utility of the data, however, depends on the needs of the application. Not all data is available, especially cadastre and road names. Some data can get you started, such as the Missouri Department of Transportation road centerline database. As such, all data has a limit of usefulness. Review the metadata to learn more about the quality and utility of the information. If no metadata is available, exercise caution when using the data or making claims about its utility. Remember that properly collected local data nearly always results in a higher-quality database.

CATEGORY	TITLE/AGENCY	ADDRESS
Government-sponsored	Geospatial One Stop	www.geodata.gov
	National Map	http://nationalmap.gov/
	National Atlas of the United States	http://www-atlas.usgs.gov/
	FGDC – National Geospatial Data Clearinghouse	http://clearinghouse1.fgdc.gov/
	National Historical GIS	http://www.nhgis.org/
	USDA	http://datagateway.nrcs.usda.gov/
Missouri	Missouri Spatial Data Information Service (MSDIS)	http://www.msdis.missouri.edu/
	CARES	http://cares.missouri.edu/default.aspx
	Upper Midwest Environmental Sciences Center	http://www.umesc.usgs.gov/
Private or purchase	TopoDepot	www.topodepot.com
	GIS Data Depot	http://data.geocomm.com/
	Geography Network	www.geographynetwork.com

THE VALUE OF METDATA

Two very similar paintings of circus performers by Picasso from 1904 are put on the auction block; one brings tens of millions of dollars, the other hundreds of thousands. What is the difference? In one case, the ownership of the painting can be traced through sales slips and auction house records back to the estate of Picasso's dealer. The other painting appeared suddenly on the art market. It looks almost identical, but lacking documentation, how can one be sure it's authentic?

Just as a work of art can change hands many times, so can geospatial data. Once created, data can travel almost instantaneously through a network and be used for any number of different kinds of spatial analysis. Thus transformed, these data can be retransmitted to another user.

Change is the essence of geospatial data in a networked environment. Metadata can benefit the primary creator and secondary users of the data by maintaining the value of the data and assuring their continued use over a span of years through data and personnel changes.

What are Metadata?

The concept of metadata is familiar to most people who deal with spatial issues. A map legend is pure metadata. The legend contains information about the publisher of the map, the publication date, the type of map, a description of the map, spatial references, the map's scale and its accuracy, among many other things. Metadata are simply that type of descriptive information applied to a text file that uses a common set of terms and definitions to make the information sharable.

Why bother with Metadata?

Metadata helps people who use geospatial data find the data they need and determine how best to use it. Metadata benefit the data producing organization as well. As personnel change in an organization, undocumented data may lose their value. Later workers may have little understanding of the contents and uses for a digital data base and may find they can't trust results generated from these data. Lack of knowledge about other organizations' data can lead to duplication of effort. It may seem burdensom to add the cost of generating metadata to the cost of data collection, but in the long run it's worth it.

How can Metadata be produced?

The information needed to create metadata is often readily available when the data are collected. There are several standard formats (or data forms) that will lead the data creator through the process of filling out a metadata file. Many of the most common GIS software packages include a metadata utility to encourage and support easy metadata file creation.

Why use a standard?

First, metadata is most valuable for those who are least familiar with the data (i.e. new personnel, data purchasers, emergency responders, government agencies). Utilizing a standard format to outline the details about the file allows these secondary users to understand all of the most important information about a file without even communicating with the file creator directly – saving time and effort. Second, metadata is an insurance policy for the institution maintaining the data. Sudden loss of personnel who maintain data leaves the value of the data at risk if the new personnel cannot interpret the existing data.

(Thanks to Mark Duewell, Senior GIS Specialist MSDIS, for the text on metadata.)

For more information

If you would like to explore available training or seek information about the FGDC Metadata Standard or the National Geospatial Data Clearinghouse contact:

FGDC Secretariat
c/o U.S. Geological Survey
590 National Center
Reston, Virginia 22092
Telephone: (703) 648-5514
Facsimile: (703) 648-5755
Internet: fgdc@fgdc.gov
Anonymous ftp: fgdc.er.usgs.gov

3. PROGRAM ADVANCEMENT

DATA DISTRIBUTION AND USE

HOW DO I GET THE INFORMATION OUT AND USED?

All of the planning, resources and data available will not result in a successful program. Useful database information must be available and accessible for users. There are several general considerations: Who are the users? Where are the users? How can I distribute the information?

A. Who and where are you distributing the information to? (Check all that apply.)

- ☐ Internal to organization and building
- ☐ Internal to organization, but outside the building
- ☐ Among several organizations and buildings, for free
- ☐ Among several organizations, for a fee

B. What is the technology skill level/capability of the user(s)? (Check all that apply.)

- ☐ No computer experience.
- ☐ Basic email, internet and word processing
- ☐ Comfortable with organizing computer directories, moving information, using spreadsheets
- ☐ Makes computers get up and dance!
- ☐ Mixed capability

The next step in database distribution is getting the information used. The key considerations are skill/capability of the users and meeting the publishing needs. In general, an agency or organization ought to first consider what kind of technology will be the most accessible without training intervention. First, employees and volunteers need to feel comfortable in order to use the technology and data. Choosing technology that greatly exceeds their skill tends to squelch use. Second, choosing technology that is immediately accessible 'in-house' is the most affordable approach. When starting in GIT, the sky is the limit, and staying in the budget is key to keeping the broadest range of people comfortable. There are plenty of affordable options for distribution and use before diving into the snappy, but expensive, options. Finally, the literal location(s) where data needs to be accessed or distributed to matters in your choice. Small communities tend to have a very 'tight knit' group of GIS users. If all of the users are in the same

building and never do field work then they can easily get away with burning CDs or using flash drives and walking them down the hall to the next person. If an organization has the luxury of a networked server system, this will be the best method and open up the option of more new users in time – access typically translates into use. The table below shows a list of options for the most common ways to distribute information. The comments provide some direction about use and maintenance.

EQUIPMENT	COMMENTS AND DETAILS
Server	post databases for users to access or download at local terminals on a network
Global Positioning System (GPS) unit	Used particularly by field users, mobile units can store, edit and retrieve context and data to be changed in the field; this unit can also collect satellite location data
Workstation	Identify computer GIS terminal, with appropriate security in place, for users to update, view or save data to a media device
Personal Digital Assistant (PDA) unit	Used particularly by field users, mobile units can store, edit and retrieve context information and data to be changed in the field; this unit cannot collect satellite location data
SOFTWARE	
Data Viewers	e.g. ESRI ArcReader, TerraGo GeoPDF; these software packages allow users to view and query data, but not to edit data; these are typically free, but some require the creator to purchase software to publish the viewer databases
Indexing	create map indices for easy printing of plat books, utility system atlases
MEDIA	
CD/DVD	label the media with date and file name; include disclaimer and use statement
Flash drive	Good for moving a small number or small size files; requires some tech skill
External Hard Drive	Good for moving imagery and large sets of databases; requires some tech skill
Paper	print maps at cartographic quality; most everyone can use a map

DATA MANAGEMENT CONSIDERATIONS

DATA STEWARDSHIP

The data layers comprising a GIS are never 'complete', they are either 'in maintenance' or 'in stewardship' unless they are explicitly a short-term, one-time project that ends. This distinction in terminology will serve to build the understanding and expectations of users and non-users alike. The steward is the person and/or organization that acts to consistently maintain and update the GIS database(s) as needed. All of the information in the GIS is subject to change or update; people move, homes are built, roads are closed and water meters are installed. Identify a person, or people, in your organization who have agreed to both supply the new information and make the database changes to reflect the updates according to the agreed database standards. Establish a schedule of approximately when databases will be updated to build a sense of expectation for participants at all stages of development and use. Even though the GIS steward is responsible for updating the database, the data are usually collected by others and sent

to the steward. In addition to planned data maintenance, also keep in mind that training regular users to identify database errors and how to report them is a very efficient strategy for continuous data improvement.

BACKING UP DATA

The primary issues to consider when deciding about data backup include security, cost, long-term recoverability, accessibility and time. Even if you decide to take advantage of the cheapest options available, redundancy (i.e. use multiple free or cheap options) and off-site storage can provide a substantial amount of data security as long as you can **consistently** keep the stored data up to date. Keep in mind that storage security refers not only to file corruption, but also natural/man made disasters. The two objectives to meet when deciding on a backup method(s) are: 1.) maintain a way to access data locally at all times; 2.) maintain a consistent protocol with SEMA (State Emergency Management Agency) to store the most critical databases before and during a disaster. Considering the relatively low cost of backing up data, this is the cheapest insurance you will have on a very large investment.

CHECK	METHOD	EST. COST	COMMENTS
	MO GIS Clearinghouse (MSDIS)	Free	Metadata strongly preferred; designate 'public' or 'no public' access; direct SEMA access
	CD/DVD media	$52.00/yr	Once/week; catalogue disks off-site; may not have enough memory space
	External Hard Drive	$100-200	Once/week; keep off-site except for updates
	Off-site network server	varies	Daily
	Off-site private network server	varies	Daily to persistent

EXPANDING DATABASE HOLDINGS

Some of the reasons organizations expand their database library include: data needs for special projects (e.g. grant applications, planning exercises), increase or broaden data usability and applications, enhance data accuracy, achieve new data standards, accommodate collaboration or cost-sharing arrangement with another organization. There is never a good reason to add data to the operational database without adequate justification or planning – just for the sake of doing so or "in case you need it one day" - is a data maintenance work multiplier and should be avoided. Data acquisition should be well thought out and integrated into a functional database library and maintenance schedule.

After you have the basic databases 'in maintenance' think about building on your investment. Lots of very useful information can be added to the existing databases. Some examples have been mentioned earlier for the cadastre/parcel map. New databases that can leverage your basic databases include:

- Voting districts
- Special districts (e.g. nursing home, taxing districts, fire, law enforcement)

- Utility systems (e.g. water, sewer, storm sewer)
- Join existing attribute databases with parcel database for analysis and resource use (e.g. combine existing water billing records with parcel database to analyze water use)
- GPS crime event locations

In addition to local ideas for useful databases, consider exploring the needs of your broader stakeholder group. Collaborations to develop databases for homeland security, regional planning commission or public health department can save existing resources and perhaps position your organization for future resources.

Collaborations, cost-sharing, coordination, consortia

Developing and maintaining a GIS is inherently a collaborative process. You and your organization are definitely not alone in this process, or in your needs. The broad application of geospatial technology translates into a broad range of people and skills available for asking questions and working together. It stands to reason that in small communities developing and maintaining geospatial data and technology must go one step farther for the sake of cost, skill and success. That is, often multiple organizations must organize to support the technology their community needs. 'Support' doesn't just mean cash. An interagency geospatial program needs office space, equipment, supplies, utility service and all of the resources of other programs. Engage key stakeholders by making support and contributions mean more than cash. Consider the stakeholder list you filled out earlier in this process. Who on that list can help the program get off the ground? Who can help and existing program improve and move forward? As your program grows so will the database holdings, local skill, technology and opportunities to expand all of these. Generally, the more data you have in your library, the broader your collaborative circle – and vice versa. Reasons to expand your collaboration and coordination include: desire to share database information; cost-sharing projects; cost-sharing programs and technical or staff expertise is lacking. Remember to review your stakeholder list over time as your needs change and those of your stakeholder group. Your state advisory committee or a local user group should be able to provide contacts for collaboration and coordination and – possibly – consortia opportunities.

DATA USE AND SHARING POLICIES

Above all, small communities need to consider from the beginning who can have their data and under what circumstances. At the least it stands to reason that sharing data with emergency management offices on a regular basis is in everyone's interest. Your data is/will be valuable for your organization and many, many others. Expect that once you have information you will be asked to share it, for free or fee. Assuming that you do share your data, under any circumstances, you will need to get up to speed on relevant state statutes, recent court rulings and disclaimer statements.

The single biggest utility of geospatial data is the ease of sharing the data with others who can use the information. One of the best returns on investment includes increased efficiency, especially for staff time and customer support. In fact, legally licensing database holdings, whether you sell the data or give it away, may be worth considering in order to clarify proper use of data, track usage of the data and establish institutional standards for managing the data. Even so, there is an ongoing discussion on the efficacy of trying to recover even some of the costs associated with data development across the wider GIS community by selling data. The Missouri GIS Advisory Committee has also struggled with establishing their position on this issue, finally crafting the 'Data Sharing Position Statement' posted on

the MGISAC website (www.mgisac.org) as a guide. Diversifying the return on your investment may be appealing and smart for small communities who can really reinvest proceeds into updated equipment and training for example. The pros and cons and ins and outs of selling data is complicated though, and may or may not justify the time spent to establish an appropriate exchange program. If you consider selling data do your homework and talk with other communities who have experience. We are currently not aware of any agency recovering their GIS development costs from selling databases under any circumstances, anywhere. Selling databases opens the door to many management complications you will need to address that giving databases away for free may not require. On balance though, giving data away for free may create other issues, some of which may also need to be legally explored. Selling data is relatively uncharted territory and while legislation sanctions it, standards are lacking for appropriate cost structure, licensing and ordinances.