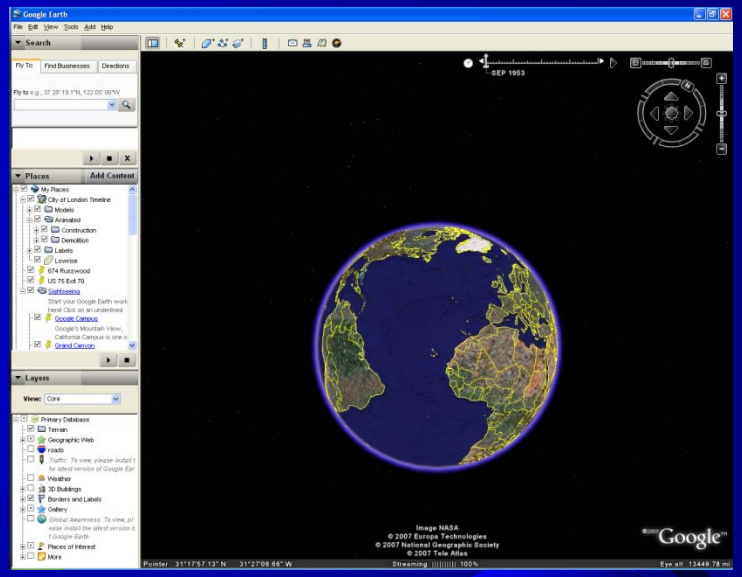
Geospatial Sciences: From Ph.D. to Google Earth

Dr. Ronald Briggs
The University of Texas at Dallas
Program in Geospatial Information Sciences
briggs@utdallas.edu

From Ph.D. to Google Earth



1990

2008


You are here!
Current *Google Earth image* at least 7 years old .
SOM Building opened 2003
© 2007 Europa Technologies
©2007 Google

Image as of February, 2007

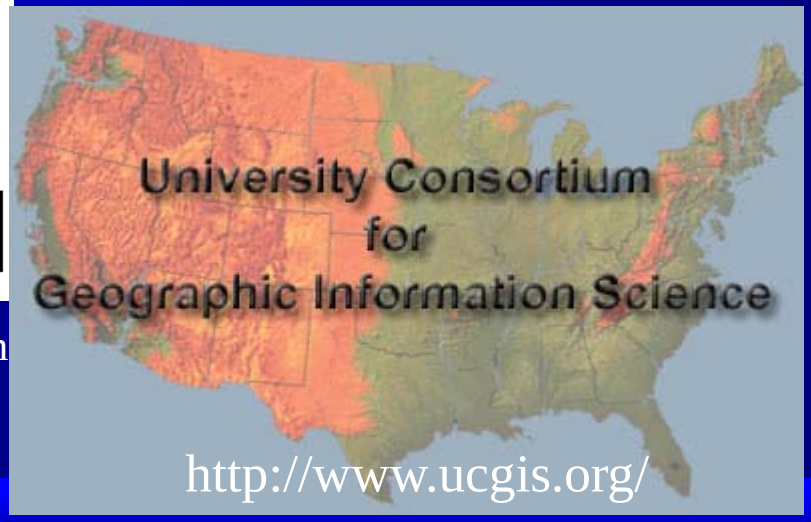
Source: *North Central Texas Council of Governments*

Geospatial Science
What is it?

GEOSPATIAL INFORMATION & TECHNOLOGY ASSOCIATION

http://www.gita.org/about-gita/geospatial.asp

http://www.careervoyages.gov/geospatialtechnology-main.cfm



http://www.ucgis.org/

Geospatial Science
What is it?

- Activities, technologies and sciences incorporating *explicit location on the earth's surface* as their fundamental focus of study or organizing principle

Geospatial *Technologies*

- Global Positioning Systems (GPS)
  - a system of earth-orbiting satellites which can provide precise (100 meter to sub-cm.) location on the earth's surface (in lat/long coordinates or the equivalent)
- Remote Sensing (RS)
  - use of satellites or aircraft to capture information about the earth's surface
  - Digital ortho images a key product (map accurate digital photos)
- Geographic Information Systems (GISy)
  - Software systems with capability for input, storage, analysis and output/display of geographic (spatial) information

The *Synergism* of Three Technologies

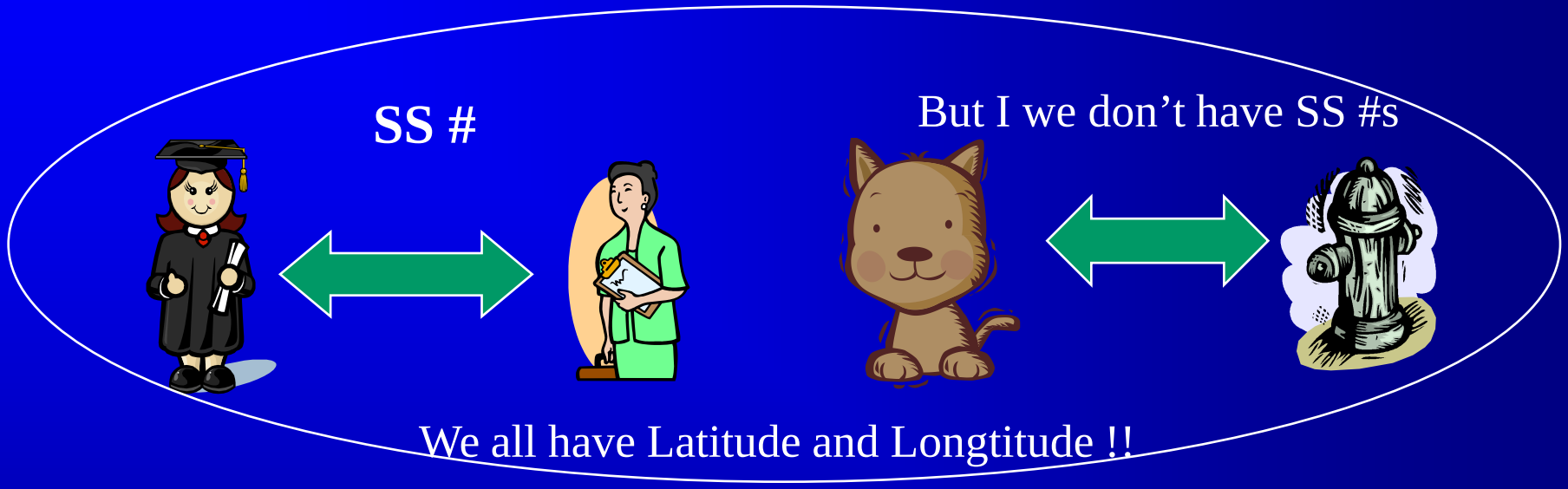
- Geospatial Science has emerged over the last three decades through the synergism of these three technologies
  - GPS and Remote Sensing are *sources of input data* for GI Systems.
  - GI Systems provide the *means for storing, manipulating and making effective use of* GPS and RS data.

Saving Time and Labor

- These technologies made it relatively easy to do things which in the past had been time consuming and expensive
- GI systems gave us inexpensive map production/display
  - didn’t need a professional cartographer
- GPS gave us exact locations inexpensively
  - didn’t need a surveyor
- Remote Sensing gave us reams (and reams) of data
  - and absorbing it is one of the current challenges!

The Uniqueness of GIS

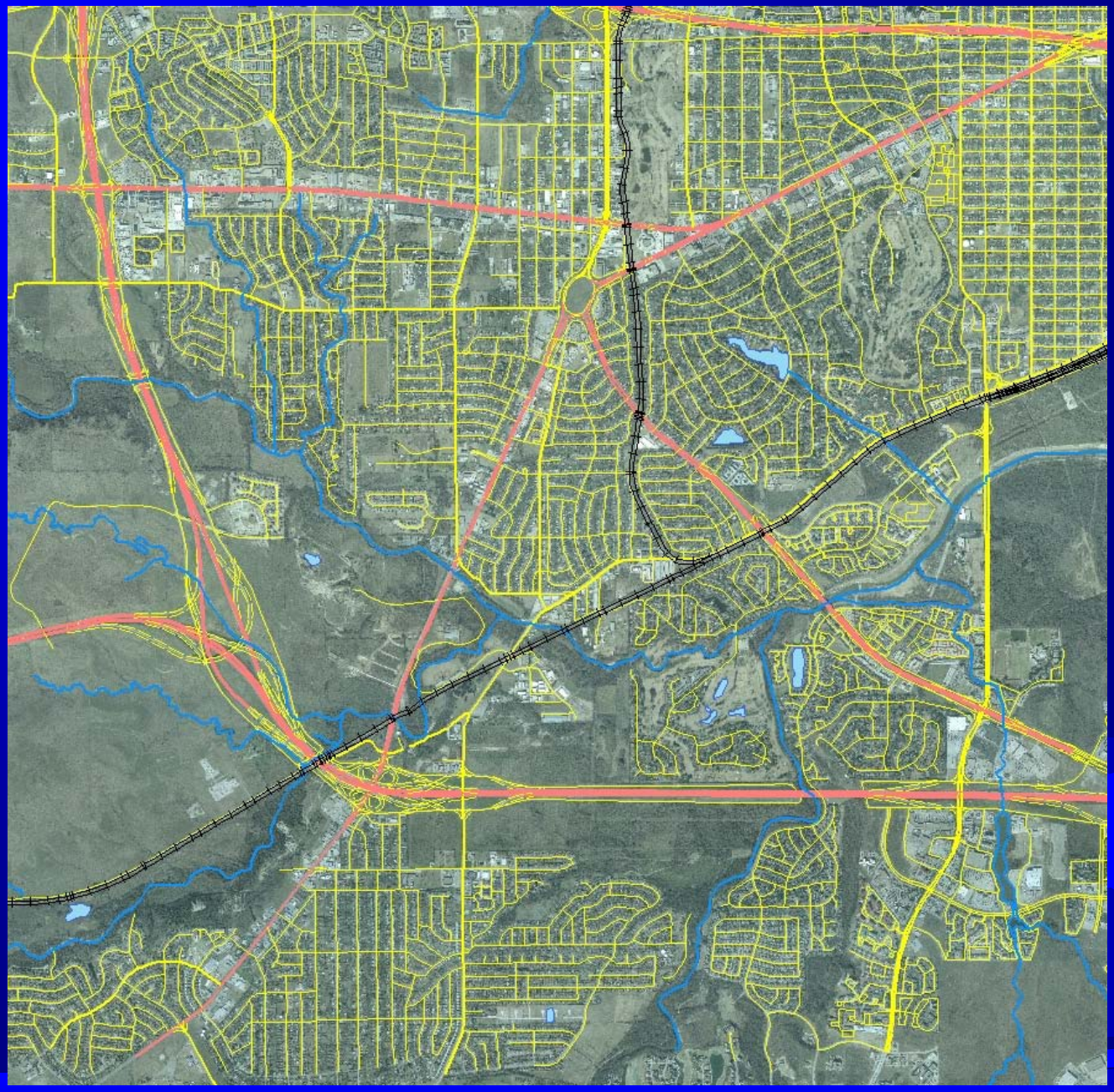
uses explicit location on earth's surface to relate data



Everything happens *someplace*. Is there anything more *in common*?

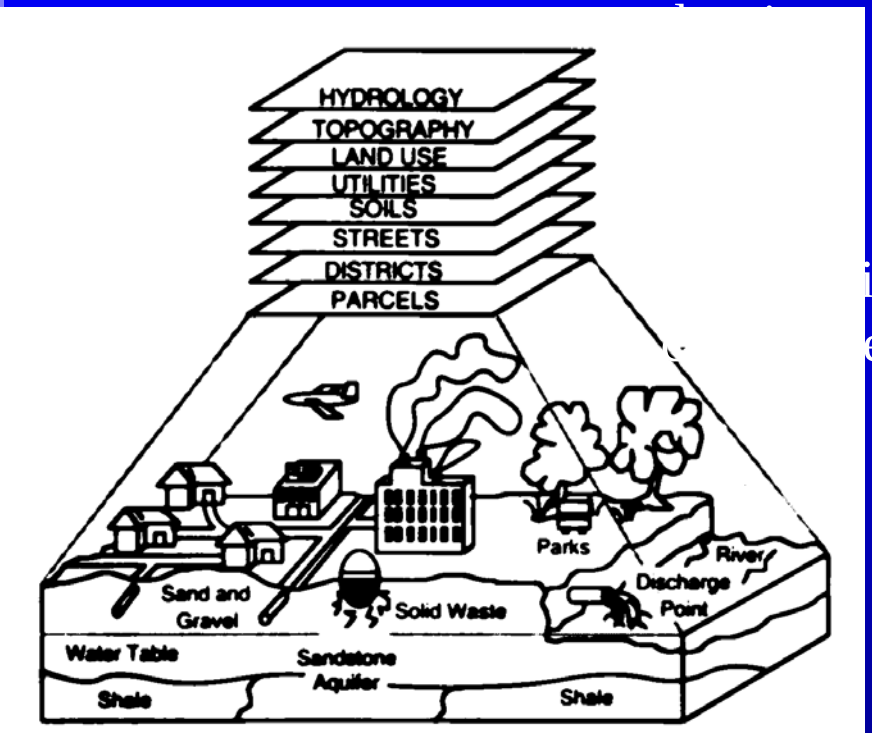
GIS "*Allows the integration of disparate data hitherto confined to separate domains*"

--Maps and aerial photographs for example



A layer-cake of information

Disparate



A number of related data layers can represent the many geographies of the real world.

ic

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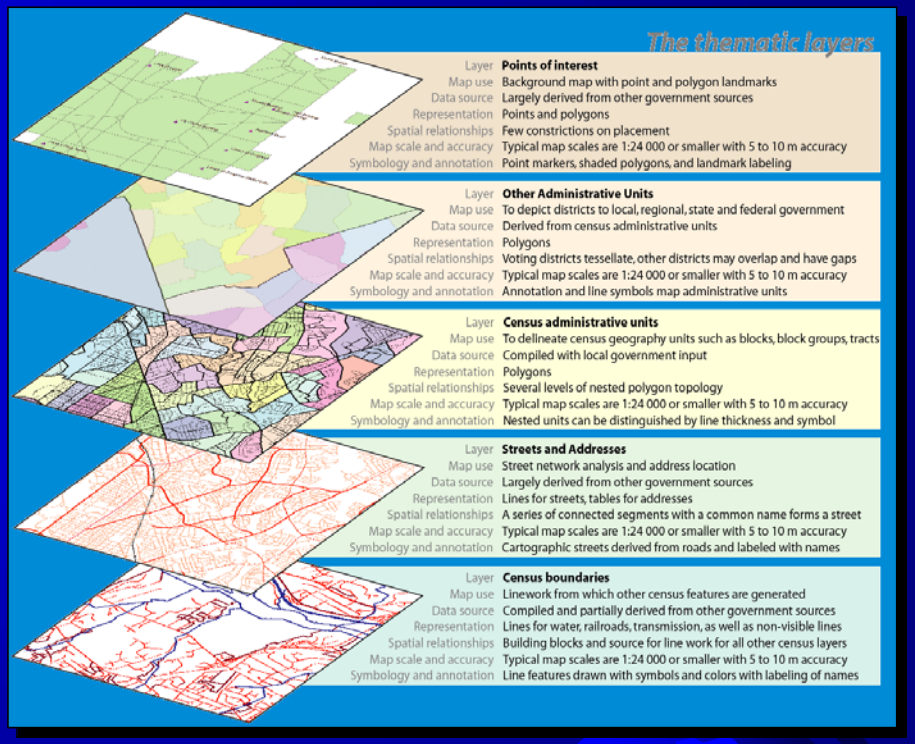
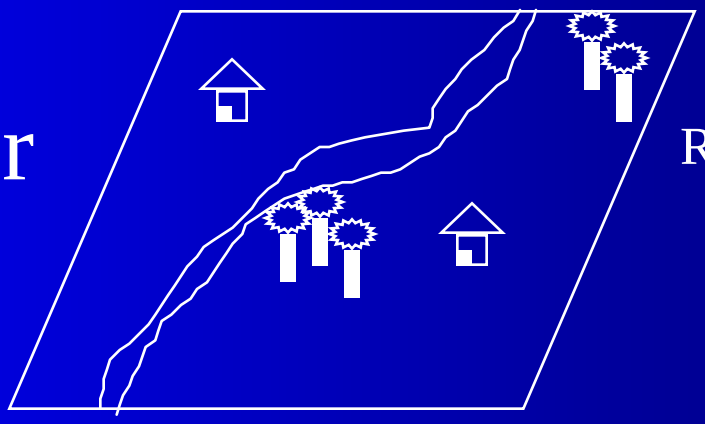


The GIS Data Model

Concept of Vector and Raster

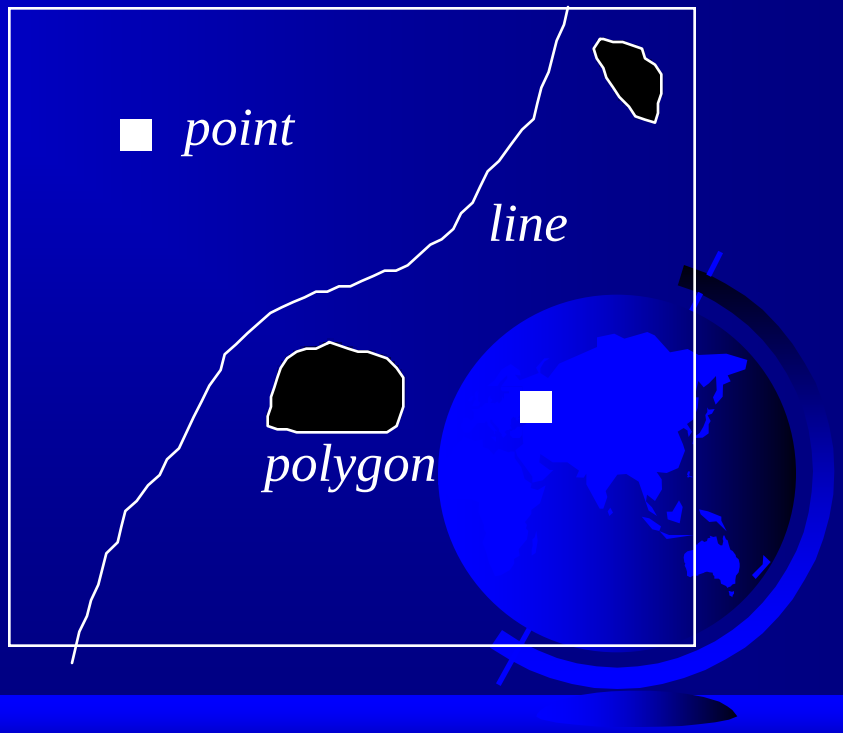


Real World

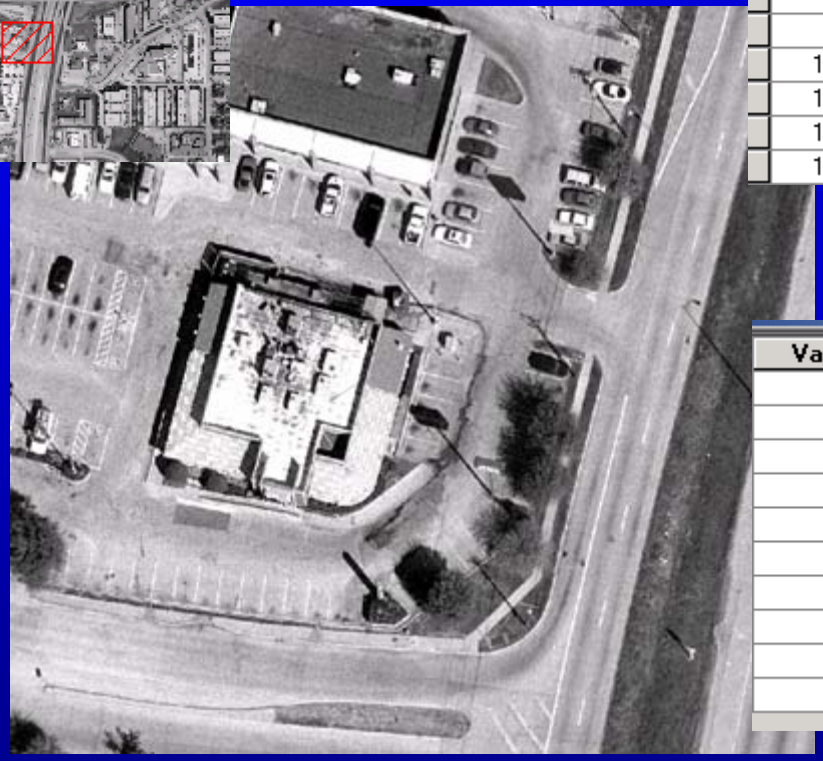
Raster Representation

	0	1	2	3	4	5	6	7	8	9
0								R	T	
1							R			T
2		H					R			
3							R			
4					R	R				
5				R						
6			R		T	T		H		
7			R		T	T				
8		R								
9		R								

Vector Representation

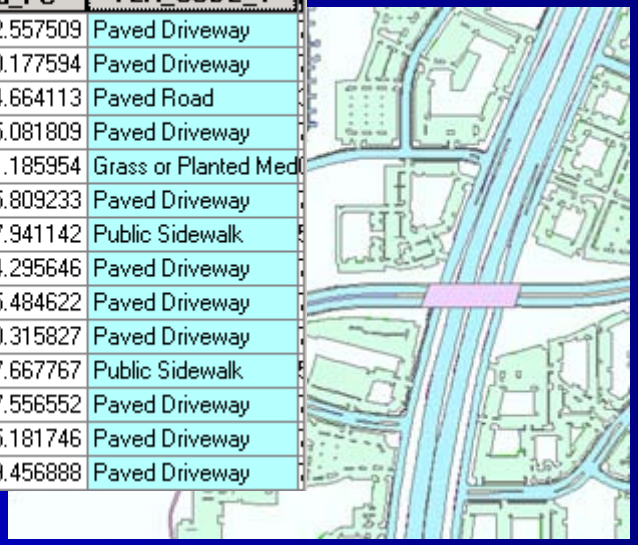


Dumb Images & Smart GIS Data



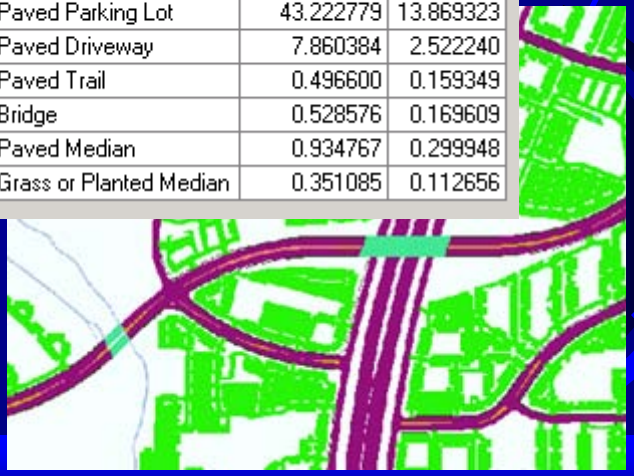
Smart Vector—Pavement polygons

OID	FEA_C	Area_PC	FEA_CODE_1
0	165	2.557509	Paved Driveway
1	165	0.177594	Paved Driveway
2	161	404.664113	Paved Road
3	165	25.081809	Paved Driveway
4	169	11.185954	Grass or Planted Med
5	165	85.809233	Paved Driveway
6	163	27.941142	Public Sidewalk
7	165	104.295646	Paved Driveway
8	165	85.484622	Paved Driveway
9	165	80.315827	Paved Driveway
10	163	17.667767	Public Sidewalk
11	165	147.556552	Paved Driveway
12	165	75.181746	Paved Driveway
13	165	199.456888	Paved Driveway



Smart Raster—5 feet grids

Value	Count	FEA_CODE	Prct_tran	Prct_land
160	62306	Paved Alley	5.056571	1.622552
161	441326	Paved Road	35.816712	11.492865
162	350	Unpaved Road	0.028405	0.009115
163	70285	Public Sidewalk	5.704123	1.830339
164	532582	Paved Parking Lot	43.222779	13.869323
165	96854	Paved Driveway	7.860384	2.522240
166	6119	Paved Trail	0.496600	0.159349
167	6513	Bridge	0.528576	0.169609
168	11518	Paved Median	0.934767	0.299948
169	4326	Grass or Planted Median	0.351085	0.112656



Images—dumb rasters
(although they look good!)

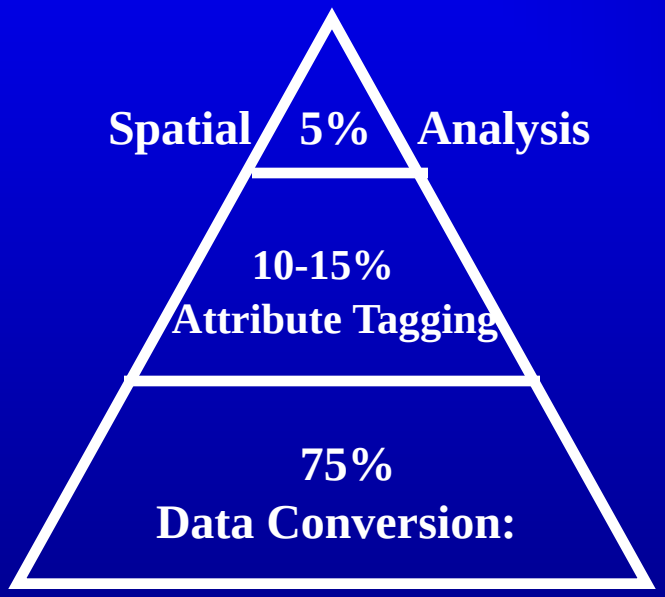
Who Uses GIS?

- 80% of **local government** activities estimated to be geographically based
  - plats, zoning, public works (streets, water supply, sewers), garbage collection, land ownership and valuation, public safety (fire and police)
- a significant portion of **state/federal government** has a geographical component
  - natural resource management
  - highways and transportation
- **businesses** use GIS for a very wide array of applications
  - retail site selection & customer analysis
  - logistics: vehicle tracking & routing
  - natural resource exploration (petroleum, etc.)
  - precision agriculture
  - civil engineering and construction
- **Military, defense, homeland security**
  - Battlefield management
  - Intelligence through satellite imagery interpretation
- **scientific research** employs GIS
  - geography, geology, botany, forestry
  - archaeology, political science, sociology, economics
  - Epidemiology, criminology

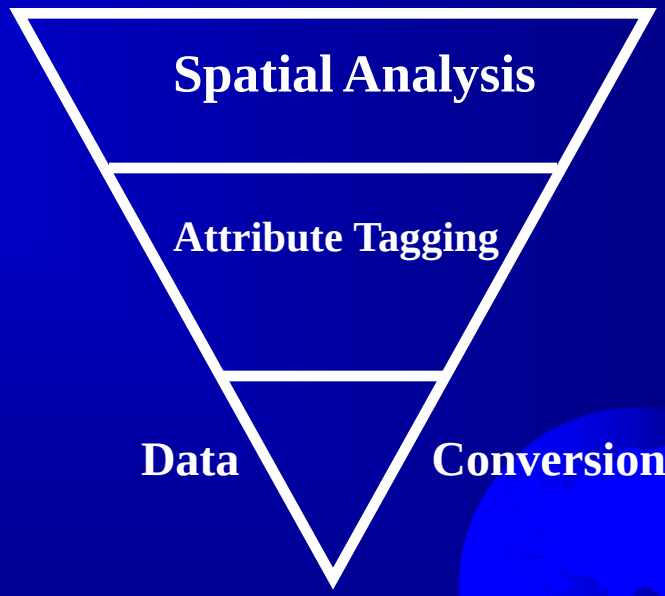
Current Trends
and
Future Prospects

…if I really knew, would I still be here?

From Data to Analysis



Past



Present/Future

From Description to Simulation & Modeling

Picture worth a thousand words:

maps & diagrams of how is, or how was

Web portals serve static data sets previously compiled manually

Visual simulation & virtual reality:

real time display of how is, and how might be
-forest fire
-freeway traffic flow

Web portals serve continuous, sensor-derived data

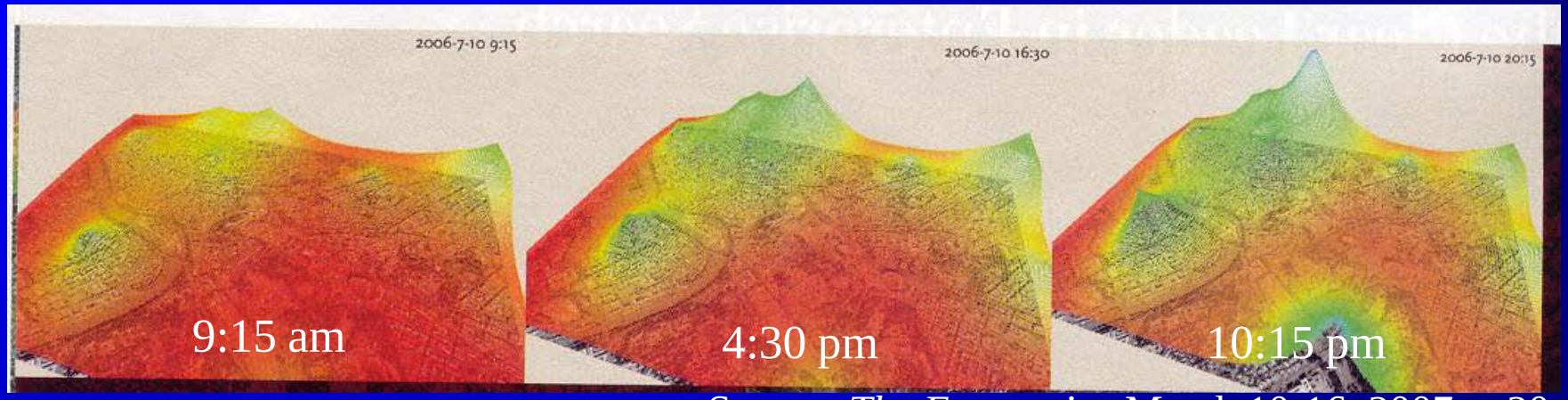
Past

Iconic models: scaled down representations of the real thing

Future

Symbolic models: based on logical relationships in mathematical or statistical form make predictions

Cell phone location is constantly tracked by the network to enable calls to be received.



Source: *The Economist*, March 10-16, 2007 p. 20.

- Population density (green is high) at different times during the day, as tracked by cell phone data. Rome, Italy, July 10, 2006.
- Applications:
  - real time traffic information,
  - drive-by data for retail store location, etc., etc..
  - Correct crime statistics at last!

From 2-D Description to 4-D Interaction

Past

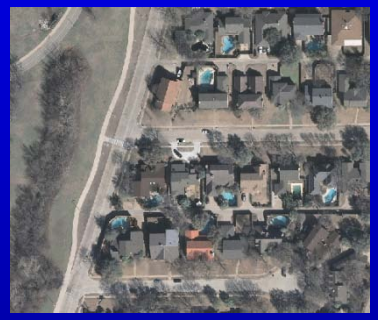
- 2-D flat map display of static data
- User as observer

Future

- Effective 3-D visualization
  - Via the merger of CAD and GIS? Gaming and GIS?
  - What is the data model?
- 4-D incorporation of time: *"The time has come for time."*
  - Via agent-based modeling / cellular automata? Or how?
    - agents (e.g. vehicles, fires or people) interacting over time in a raster (cell)-based environment according to established rules
- User as participant
  - Users (researchers, professionals, the public) interact with the model
  - Participatory GIS: the public as the planner

From human interpretation to automated identification

- The human mind is a brilliant interpretive machine



- But the volume of imagery is overwhelming

- Automated image interpretation is a major research thrust
- But countervailing trends exist

…but there are alternatives

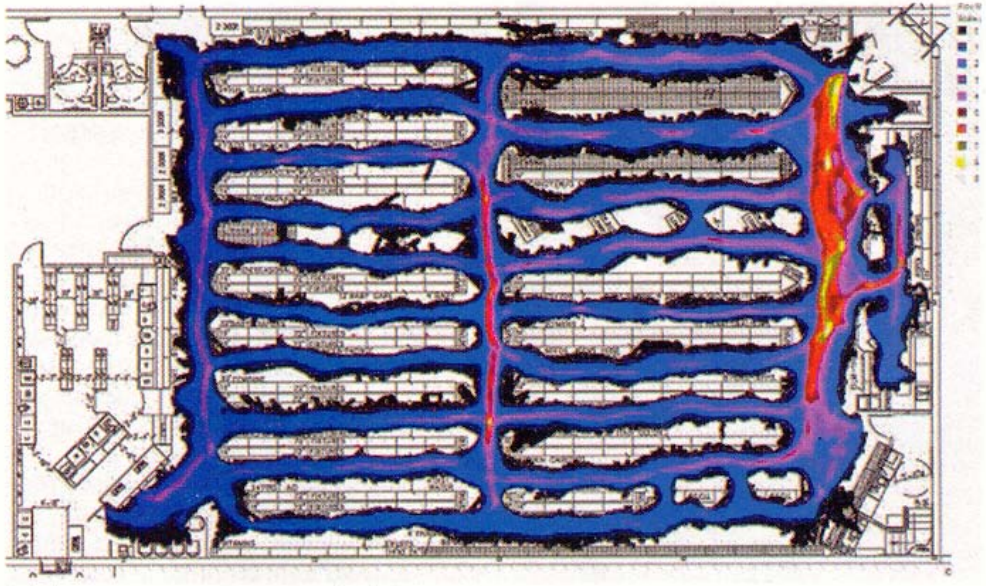
- africa@home
- Local residents volunteering to interpret imagery to produce maps in areas lacking current coverage

Source: *The Economist, December 8, 2007, p. S21*

http://africa-at-home.web.cern.ch

The Mainstreaming of Location I

- From specialized niche to business central
  - Location at the heart of many business systems (e.g. FedEx)
  - Will geography become <u>the</u> basis for data management?
    - Everything happens someplace, but discarded or only implicit in the past
  - Geography now supported in standard database environments (Oracle, etc.)



Brickstream maps a supermarket's hot spots

What could be more mainstream than your local supermarket?

Source: *The Economist, December 2007*

The Mainstreaming of Location II

- From professional product to a consumer good
  - GPS in cell phones, personal navigation systems
  - Google Earth challenging ESRI's ArcGIS, the professional standard
- From professional GIS analysts to general public: poets who don't know it
  - Google Earth Sketch-up
  - Web-based community information systems for neighborhood crime control
  - Geotagged bloggers as GIS specialists: they know the local scene

The Market Takes Over

- From government to private sector data provisioning
  - Commercial data vendors (TeleAtlas, Navteq) replace Census Bureau Tiger Files
  - Imagery from commercial not government satellites
- Data moving from free access in the public domain to commercial ownership
- The future of GIS will be determined by the market place, not by government and GIS professionals as in the past

The Dominant Role of Data

- ☞ Dominant Information Technology issues:
  - Hardware in the 1970s and 1980s
  - Software in the 1980s and 1990s
  - Data in the 2000s
- October, 2007: Nokia buys Navteq for $8.1 billion
- November, 2007: TomTom outbids Garmin for Tele-Atlas at $4.1 billion

TomTom is the "European Garmin" (GPS vendor)

Navteq and Tele-Atlas are the two dominant suppliers of digital road data

Source: Wall Street Journal, January 14, 2008; Page B1

The Data and Analysis Challenge

- Acquiring data and dumping it to everyone's desktop
  - The past model
- Content tailored for the individual's current needs at their current location
  - The present mantra
- What will it be like *where* I am going *when* I get there?
  - The real need is for future predictions
  - Requires data coupled with predictive models

The Future Dilemmas for Data

Will its availability be

- ☞ Plentiful and cheap?
  - ☞ The past, public domain model
  - ☞ The future, ad. supported model
- ☞ In infinite detail, if you can afford it?
  - ☞ The coming private sector model?
- ☞ Severely curtailed by legal controls to ensure personal privacy?
  - ☞ or is this the future?

Is the past the future?

A Self Generating System

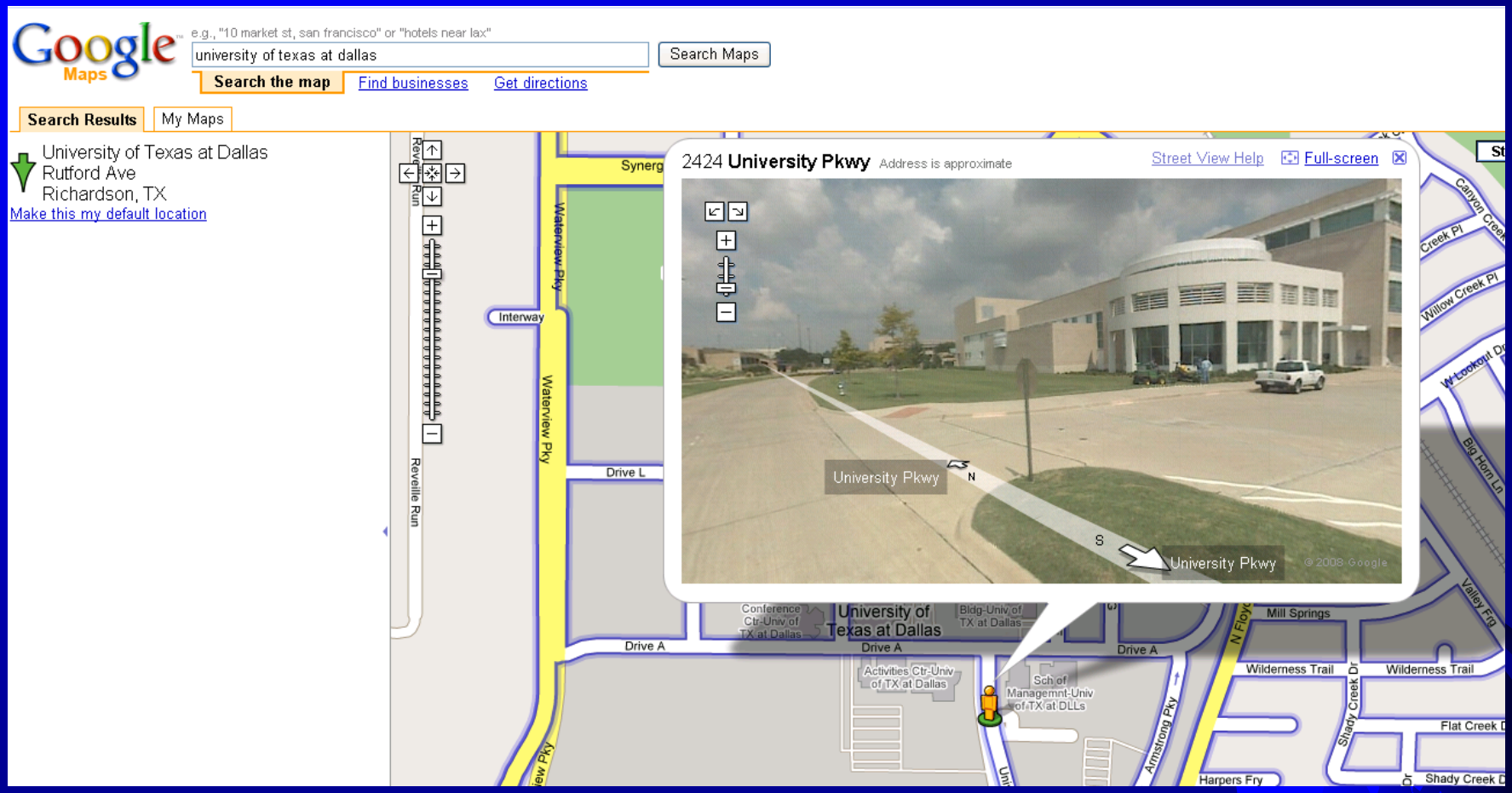
Better data

More GIS use

Better decisions
(or more revenue from ads)

More investment in
Data/GIS

From public domain to private sector provision



As appraisal districts removed their photographs under State privacy mandate, Google has replaced them (and with more detail)

Is a *Tragedy of the Data Commons* in the making?

- Will detailed data collection and its pervasive distribution produce a backlash of demand for privacy?
  - *No call, no spam, no appraisal photos, no red light cameras:* are they the beginning?
  - Could *geotagging* with RFID devices become reality ?
    - From pets to people
    - for sex offenders, service personnel, employees, evacuees, to everybody?

And what are the appropriate public policy responses?

Will this contribute, or choke it off?

Microdrone $21,367
Base Station $19,424
Video Transmitter $1,545
Video Receiver $1,000
Daylight Video $1,545
Lowlight Video $3,100
GPS Hold $1,934

Complete Package $59,681
August 2007

Source: http://www.microdrones.com/

There are many challenges for the future.

Thank you for your attention

Today, I hope we will be able to explore at least some of these issues.

briggs@utdallas.edu

www.utdallas.edu/~briggs

www.gis.utdallas.edu

And be sure to explore our programs

- Graduate Certificate in Geographic Information Systems
  - ***Training for novice and experienced GIS professionals, combined with 15 hours of credit applicable to a graduate degree.***
- Master of Science in Geospatial Information Sciences
  - ***A professional degree program focused on the management and analysis of spatially-referenced information.***
- Doctor of Philosophy in Geospatial Information Sciences
  - ***An interdisciplinary research degree focused on advancing the frontiers of knowledge and understanding of spatially-referenced information***

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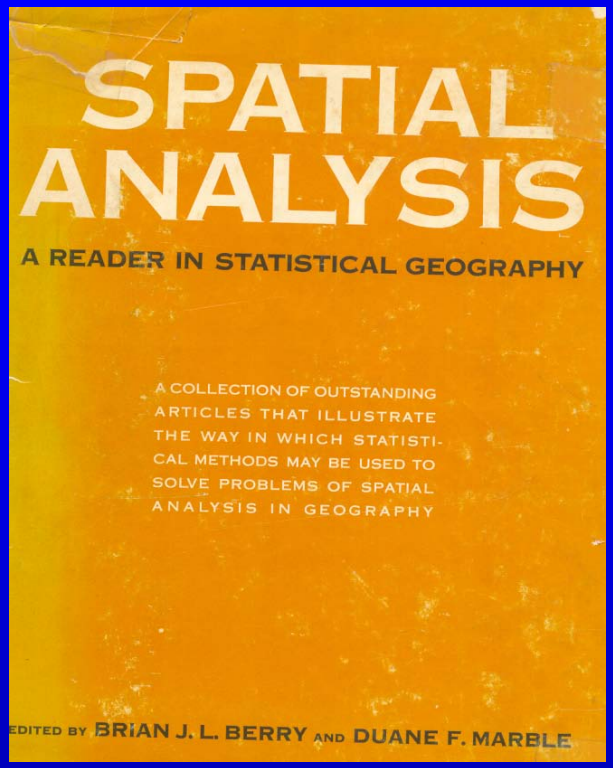

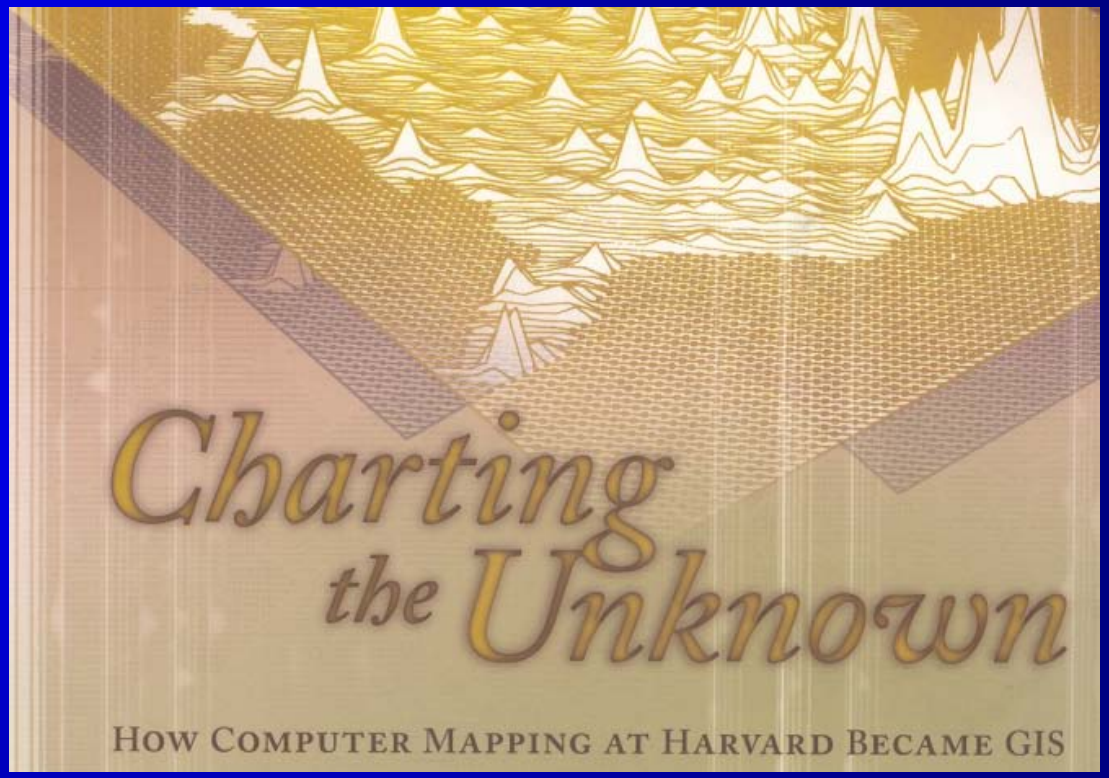

Dr. Brian Berry: chair

Bringing Locational Intelligence to the MarketPlace