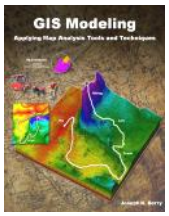
Beyond Mapping IV



GIS Modeling book

Introduction – Extending Basic GIS Concepts (Further Reading)

Is it Soup Yet? — *describes the evolution in GIS definitions and terminology (February 2009)*

What's in a Name — *suggests and defines the new more comprehensive term "Geotechnology" (March 2009)*

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Is it Soup Yet?

(GeoWorld, February 2009)

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In the forty-odd years of computer-tinkering with maps our perspectives and terminologies have radically changed. My first encounter was in the late 1960s as an undergraduate research assistant at the University of California, Berkeley. The entry point was through photogrammetric interpretation in the pursuit of a high resolution contour map for the school's forest. In those days one stared at pair of stereo-matched aerial photos and marched a dot at a constant elevation around the three-dimensional surface that appeared. The result was an inked contour line drawn by a drafting arm that was mechanically connected to the stereo plotter—raise the dot and re-walk to delineate the next higher contour line.

The research effort took this process to a new level by augmenting the mechanical arm with potentiometers that converted the movements of the arm into X,Y coordinates that, in turn, were recorded by direct entry into a keypunch machine. After several months of tinkering with the Rube Goldberg device several boxes of punch cards were generated containing the digital representation of the contour lines that depicted the undulating shape of the terrain surface.

The card boxes then were transferred to a guru who ran the only large-bed plotter on campus and after a couple of more months of tinkering the inked lines emerged. While far from operational, the research crossed a technological threshold by replacing the analog mechanics of traditional drafting with the digital encoding required to drive the cold steel arm of a plotter—maps were catapulted from drawings to organized sets of numbers.

In the 1970's **Computer Mapping** emerged through the efforts of several loosely allied fields involved in mapping—geography for the underlying theory, computer science for the software, engineering for the hardware and several applied fields for the practical applications.

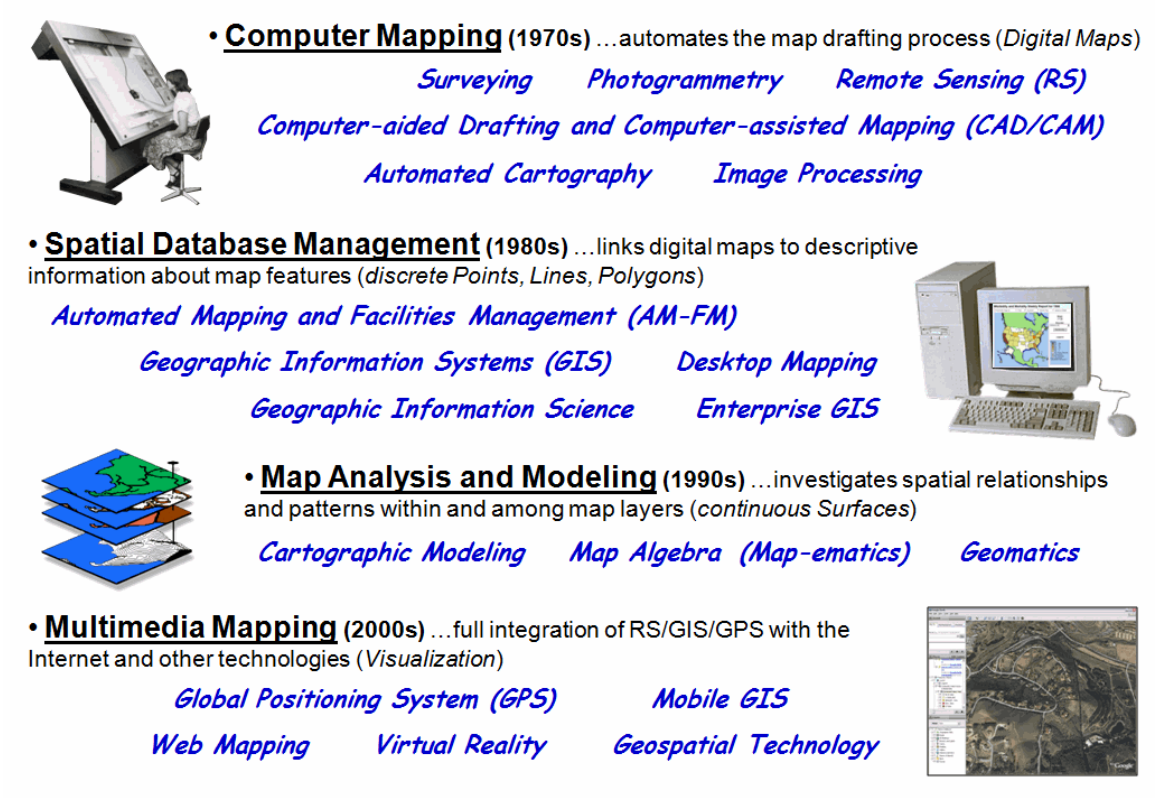

Figure 1. The terminology and paradigm trajectory of GIS's evolution.

As depicted in figure 1, some of the more important perspectives and definitions of the emerging technology at that time were:

- **Surveying** is the technique and science of accurately determining the terrestrial or three-dimensional space position of points and the distances and angles between them where these points are usually, but not exclusively, associated with positions on the surface of the Earth, and are often used to establish land maps and boundaries for ownership or governmental purposes. *(Wikipedia definition)*
- **Photogrammetry** is the first remote sensing technology ever developed, in which geometric properties about objects are determined from photographic images. *(Wikipedia definition)*
- **Remote Sensing** is the small or large-scale acquisition of information of an object or phenomenon, by the use of either recording or real-time sensing device(s) that is not in physical or intimate contact with the object (such as by way of aircraft, spacecraft, satellite, etc.). *(Wikipedia definition)*
- **Computer-aided Drafting and Computer-assisted Mapping (CAD/CAM)** is the mapping expression of Computer-aided Design that uses computer technology to aid in the design and particularly the drafting (technical drawing and engineering drawing) of a part or product. *(Wikipedia definition)*

- **Automated Cartography** is the process of producing maps with the aid of computer driven devices such as plotters and graphical displays. *(Webopedia definition)*
- **Image processing** is any form of signal processing for which the input is an image, such as photographs or frames of video with the output of image processing being either an image or a set of characteristics or parameters related to the image. *(Wikipedia definition)*

The common thread at the time was an inspiration to automate the map drafting process by exploiting the new digital map form. The focus was on the graphical rendering of the precise placement of map features—an automated means of generating traditional map products. For example, the boxes of cards containing the contour lines of research project were mothballed after the plotter generated the printer's separate used for printing multiple copies of the map. **Spatial Database Management** expanded this view in the 1980s by combining the digital map coordinates (*Where*) with database attributes describing the map features (*What*).

The focus shifted to the digital nature of mapped data and the new organizational capabilities it provided. Some of the perspectives and terms associated with the era were:

- **Automated Mapping and Facilities Management (AM-FM)** seeks to automate the mapping process and to manage facilities represented by items on the map. *(GITA definition)*
- **Geographic Information System (GIS)** is an information system for capturing, storing, analyzing, managing and presenting data which are spatially referenced (linked to location). *(Wikipedia definition)*
- **Geographic Information Science (GISc or GISci)** is the academic theory behind the development, use, and application of geographic information systems (GIS). *(Wikipedia definition)*
- **Desktop Mapping** involves using a desktop computer to perform digital mapping functions. (*eNCYCLOPEDIA definition*)
- **Enterprise GIS** is a platform for delivering organization-wide geospatial capabilities providing for the free flow of information. *(ESRI definition)*

Geo-query became the rage and organizations scurried to integrate their paper maps and management records for cost savings and improved information access. The overriding focus was on efficient recordkeeping, processing and information retrieval. The approach linked *discrete Point, Line and Polygon* features to database records describing the spatial entities.

Map Analysis and Modeling in the 1990s changed the traditional mapping paradigm by introducing a new fundamental map feature—the *continuous Surface*. Some of the more important terms and perspectives of that era were:

- **Cartographic Modeling** is a process that identifies a set of interacting, ordered map operations that act on raw data, as well as derived and intermediate data, to simulate a spatial decision making process. *(Tomlin definition)*
- **Map Algebra** (and **Map-*ematics***) is a simple and an elegant set-based algebra for manipulating geographic data where the input and output for each operator is a map and the operators can be combined into a procedure to perform complex tasks. *(Wikipedia definition)*

- **Geomatics** incorporates the older field of surveying along with many other aspects of spatial data management which integrates acquisition, modeling, analysis, and management of spatially referenced data. *(Wikipedia definition)*

While much of the map-*ematical* theory and procedures were in place much earlier, this era saw a broadening of interest in map analysis and modeling capabilities. The comfortable concepts and successful extensions of traditional mapping through Spatial Database Management systems lead many organizations to venture into the more unfamiliar realms of spatial analysis and statistics. The emerging applications directly infused spatial considerations into the decision-making process by expanding "*Where* is *What?*" recordkeeping to *"Why, So What and What If?"* spatial reasoning—thinking with maps to solve complex problems.

Multimedia Mapping in the 2000s turned the technology totally on its head by bringing it to the masses. Spurred by the proliferation of personal computers and Internet access, spatial information and some "killer apps" have redefined what maps are, how one interacts with them, as well as their applications. Important terms and perspectives of the times include:

- **Global Positioning System (GPS)** is the only fully functional Global Navigation Satellite System (GNSS) that enable GPS receivers to determine their current location, the time, and their velocity. *(Wikipedia definition)*
- **Mobile GIS** is the use of geographic data in the field on mobile devices that integrates three essential components— Global Positioning System (GPS), rugged handheld computers, and GIS software. *(Trimble definition)*
- **Web Mapping** is the process of designing, implementing, generating and delivering maps on the World Wide Web. *(Wikipedia definition)*
- **Virtual Reality** (**VR**) is a technology which allows a user to interact with a computer-simulated environment, be it a real or imagined one. *(Wikipedia definition)*
- **Geospatial Technology** refers to technology used for visualization, measurement, and analysis of features or phenomena that occur on the earth that includes three different technologies that are all related to mapping features on the surface of the earth— GPS (global positioning systems), GIS (geographical information systems), and RS (remote sensing). *(Wikipedia definition)*

The technology has assumed a commonplace status in society as people access real-time driving directions, routinely check home values in their neighborhood and virtually "fly" to anyplace place on the earth to view the surroundings or checkout a restaurant's menu. While spatial information isn't the driver of this global electronic revolution, the technology both benefits from and contributes to its richness. What was just a gleam in a handful of researchers' eyes thirty years ago has evolved into a pervasive layer in the fabric of society, not to mention a major industry.

But what are the perspectives and terms defining the technology's future? That's ample fodder for the next section.

***Author's Notes**: a brief White Paper describing GIS's evolution is posted online at www.innovativegis.com/basis/Papers/Other/Geotechnology/Geotechnology_history_future.htm . An interesting and useful Glossary of GIS terms by Blinn, Queen and Maki of the University of Minnesota is posted at www.extension.umn.edu/distribution/naturalresources/components/DD6097ag.html.*

What's in a Name

(GeoWorld, March 2009)

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The previous section traced the evolution of modern mapping by identifying some of the more important labels and terminology that have been used to describe and explain what is involved. In just four decades, the field has progressed from an era of *Computer Mapping* to *Spatial Database Management*, then to *Map Analysis and Modeling* and finally to *Multimedia Mapping*.

The perspective of the technology has expanded from simply automated cartography to an information science that links spatial and attribute data, then to an analytical framework for investigating spatial patterns/relationships and finally to the full integration of the spatial triad of Remote Sensing (RS), Geographic Information Systems (GIS) and the Global Positioning System (GPS) with the Internet and other applied technologies.

While the evolution is in large part driven by technological advances, it also reflects an expanding acceptance and understanding by user communities and the general public. In fact, the field has matured to a point where the US Department of Labor has identified Geotechnology as "one of the three most important emerging and evolving fields, along with nanotechnology and biotechnology" (see Author's Notes). This is rare company indeed.

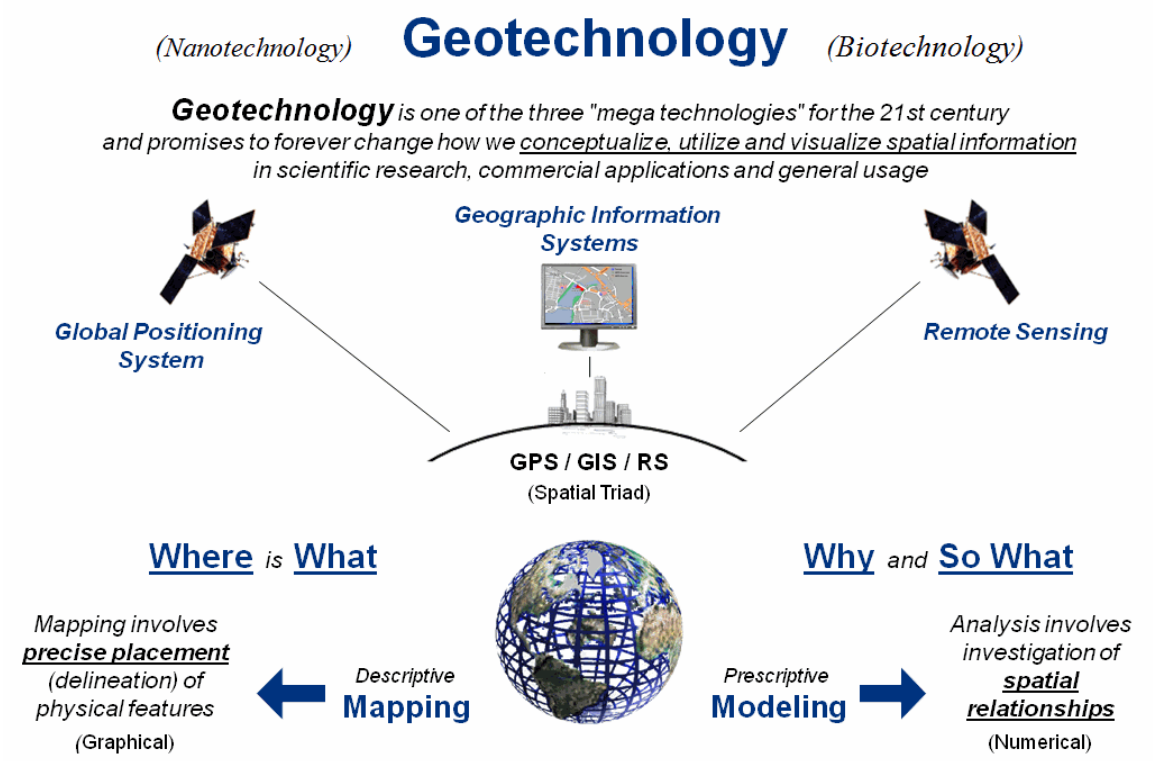
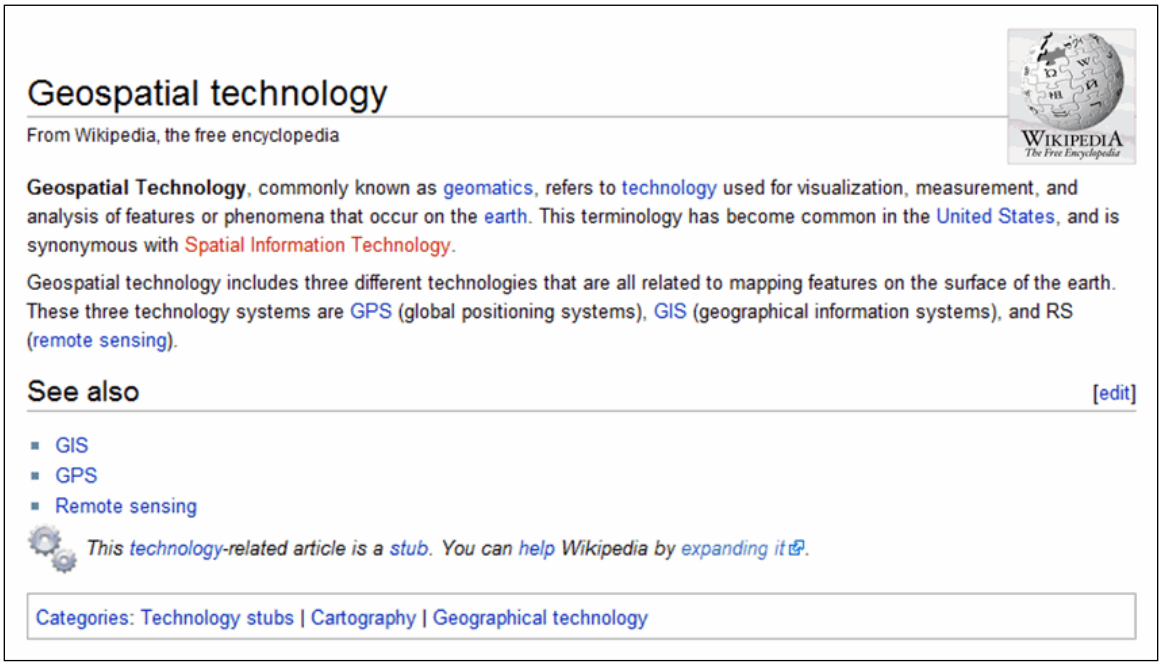


Figure 1. Conceptual framework of Geotechnology.

The Wikipedia defines *Biotechnology* as "any technological application that uses biological systems, living organisms, or derivations thereof, to make or modify products or processes for specific use," and *Nanotechnology* as "a field whose theme is the control of matter on and atomic and molecular scale." By any measure these are sweeping definitions that encompass a multitude of sub-disciplines, conceptual approaches and paradigms. Figure 1 suggests a similar sweeping conceptualization for *Geotechnology*.

The top portion of the figure relates Geotechnology to "spatial information" in a broad stroke similar to biotechnology's use of "biological systems" and nanotechnology's use of "control of matter." The middle portion identifies the three related technologies for mapping features on the surface of the earth— GPS, GIS and RS. The bottom portion identifies the two dominant application arenas that emphasize descriptive Mapping (*Where* is *What*) and prescriptive Modeling (*Why* and *So What*).

What is most important to keep in mind is that geotechnology, like bio- and nanotechnology, is greater than the sum of its parts—GPS, GIS and RS. While these individual mapping technologies provide the enabling capabilities, it is the application environments themselves that propel geotechnology to mega status. For example, precision agriculture couples the spatial triad with robotics to completely change crop production. Similarly, coupling "computer agents" with the spatial triad produces an interactive system that has radically altered marketing and advertising through spatially-specific queries and displayed results. Or coupling immersive photography with the spatial triad to generate an entirely type of "street view" map that drastically changes 8,000 years of analog mapping.



Geospatial technology

From Wikipedia, the free encyclopedia

Geospatial Technology, commonly known as geomatics, refers to technology used for visualization, measurement, and analysis of features or phenomena that occur on the earth. This terminology has become common in the United States, and is synonymous with Spatial Information Technology.

Geospatial technology includes three different technologies that are all related to mapping features on the surface of the earth. These three technology systems are GPS (global positioning systems), GIS (geographical information systems), and RS (remote sensing).

See also [edit]

- GIS
- GPS
- Remote sensing

This technology-related article is a stub. You can help Wikipedia by expanding it.

Categories: Technology stubs | Cartography | Geographical technology

Figure 2. Wikipedia Definition of Geospatial Technology.

To this point in our technology's short four decade evolution it has been repeatedly defined from within. The current "geospatial technology" moniker focuses on the interworking parts that resonates with GIS specialists (see figure 2). However to the uninitiated, the term is as off-putting as it is confusing—*geo* (Latin for the earth), *spatial* (pertaining to space), *technology* (application of science). Heck, it even sounds redundant and is almost as introvertedly-cute as the terms *geomatics* and *map-ematics*.

On the other hand, the use of the emerging term "Geotechnology" for the first time provides an opportunity to craft a definition with a broader perspective that embraces the universality of its application environments and societal impacts along the lines of the bio- and nanotechnology.

As a draft attempt, let me suggest—

> ***Geotechnology*** *refers to any technological application that utilizes spatial location in visualizing, measuring, storing, retrieving, mapping and analyzing features or phenomena that occur on, below or above the earth. It is recognized by the U.S. Department of Labor as one of the "three mega-technologies for the 21st Century," along with Biotechnology and Nanotechnology. There are three primary mapping technologies that enable geotechnology—GPS (Global Positioning System), GIS (Geographic Information Systems) and RS (Remote Sensing).* *...etcetera, etcetera, etcetera… to quote a famous King of Siam.*

As with any controversial endeavor, the devil is in the details (the *etcetera*). One of the biggest problems with the term is that geology staked the flag several years ago with its definition of geotechnology as "the application of the methods of engineering and science to exploitation of natural resources" (yes, they use the politically incorrect term "exploitation"). Also, there is an International Society for Environmental Geotechnology, as well as a several books with the term embedded in their titles.

On the bright side, the Wikipedia doesn't have an entry for Geotechnology. Nor is the shortened term "geo" exclusive to geology; in fact just the opposite, as geography is most frequently associated with the term (*geo + graph + y* literally means *"to write the descriptive science dealing with the surface of the earth"*). Finally, there are other disciplines, application users and the general public that are desperate for an encompassing term and succinct definition of our field that doesn't leave them tongue-tied, shaking their heads in dismay or otherwise dumbfounded.

Such is the byzantine fodder of academics …any inspired souls out there willing to take on the challenge of evolving/expanding the definition of Geotechnology, as well as the perspective of our GPS/GIS/RS enabled mapping technology?

Author's Notes*: see www.nature.com/nature/journal/v427/n6972/full/nj6972-376a.html for an article in Nature (427, 376-377; January 22, 2004) that identifies Geotechnology by the US Department of Labor as one of the three "mega technologies for the 21st century" (the other two are Nanotechnology and Biotechnology).*

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