

The Use of Future Digital Data Sources in Land Use Planning Documents

Abstract

This paper describes the next ten to twenty years of collecting and managing planning information and planning documents. CAD drawings can be registered (geo-referenced or linked) to the GIS database so that the houses on the hills are really on the hills and walls do not cross property lines. Old drawings and maps, captured by scanning, can be updated using CAD vectors. A hypertext history of all planning document changes can be kept automatically. Stereo photo technology will migrate from airplanes to handheld cameras so that field inspections will produce 'as-built' drawings of buildings, substructures, and earthworks. Virtual reality can be used to create fly-over *and fly-under* tours of a city as well as tours that go backwards and forwards in time. And, these new systems can be made ADA (Americans with Disabilities Act) friendly. People who are colorblind will no longer have trouble with color images.

Introduction

As more and more processes are computerized, input to the planning process will increasingly be in digital form.

Another reason to look into future digital formats is that many public works structures have a design life of 100 years and the documentation for these structures must be kept for longer than 100 years. This documentation will reside in these future twenty-second century systems.

In designing a planning system, decisions must often be made between two approximately equal options. The option most consistent with future trends should be chosen. Finally, a description of the future is required to create a roadmap of future additions to planning systems. This will allow the addition of future capabilities in an orderly manner. It will also show that the more prosaic process of raster scanning documents is a consistent, first step in the creation of comprehensive citywide data repositories. The repositories can then be built using the most advanced tools and techniques available now and in the future.

Vector Updates to Raster Scanned Drawings

A planning database can be designed to store digitally locked raster images of each drawing produced by a public works department or submitted as building plans or subdivision plans. Because the drawings are locked, they can be used as a base for vector based CAD (Computer Aided Design) changes without a concern that the updates will change the original image. Because only the changed area of the drawings are modified, drawing cleanup costs are minimized. And, all vector-based changes can be manipulated using CAD systems in the future. No work

product is lost when CAD vector data is converted to a raster image for a paper-based printout of record.

Detection of Interferences

Geo-referencing CAD files is the process of establishing control points in a CAD file that match corresponding control points in a GIS (Geographic Information System) system.

Geo-referenced CAD files will allow the automatic detection of interferences between built structures constructed at different times by different city departments or other organizations. Interferences are where two structures are designed to occupy the same space, such as a pipe that passes through the foundation of a bridge.

Today, with a paper based planning database, an interference cannot be detected until the pipeline is laid right up to the bridge foundation and the interference is physically discovered. At that point an expensive redesign is required, usually requiring modification of previously built structures.

Eventually city planning departments will begin to scan, accept CAD files, and geo-reference the CAD files. At this point, all built structures in a city will be modeled on the same GIS (Geographic Information System) grid, and all interferences can be identified while structures are still in the design phase, before construction starts. In virtual reality fly-overs, the buildings on the hills will be CAD models of the actual buildings, as built. Virtual reality fly-unders will show the city substructure beneath the streets.

To support interference detection, the GIS system will have to support CAD tolerances over wide areas. The GIS system will evolve into a geographically extensive CAD model.

One of the important attributes of a GIS system is that all data in the GIS system is consistent with all other data in the system, no geographically located data point can have two locations or values. In the process of integrating CAD and GIS data inconsistencies can be eliminated in CAD and GIS data first, then inconsistencies can be eliminated in the data contained in the relational databases. This consistency will gradually extend to more and more city data over time, as all city data is combined in the planning database / GIS system.

GIS Data History

GIS data can be time stamped to deal with ground movement caused by earthquakes. Similarly, CAD data can be time stamped to show the construction and demolition of structures. Relational database fields can be time stamped when their value changes. In newer database, overwritten data values are not erased; they are time-stamped and pushed down on a stack for the data field. Thus, as the owner of a land parcel changes, the owner's name is always placed in the

same field, but the database automatically keeps track of all changes and provides a history of the name of everyone who has owned the parcel.

Certainly, in the next one hundred years, all information recorded in the planning databases will have had its consistency verified and will have been time stamped. The planning database GIS record will become the simulacrum described by Arthur C. Clark in his book *The City and the Stars* (New York, Harcourt, Brace & World, 1956) where the City's citizens can walk around a three dimensional holographic model of their city and modify the city model to see the results of their personal 'what-ifs'. The citizens will be able to select a portion of the city and move it forward and backward through time, to see how sections of the city evolved or are planned to evolve.

Data Input via Macro- and Micro-Remote Sensing

Inspection reports will be integrated with the design of build structures. When this happens, the inspection records will become part of the planning database.

Sewer inspection using CCTV is a very good use of a low cost technology. In ten to twenty years, still frame technology may supplant video technology for inspection. Cameras are very quickly gaining many new attributes to attach to the still frame photos: time and date are examples. With GPS base stations and miniature fiber optic based internal navigation systems in the cameras, each photo can be referenced by the lens setting, time and date, direction, and camera location. All photos can be part of stereo photo pairs. From these photos, surface maps of the photographed objects can be generated, either of the inside of sewers or of the exterior of buildings or earthworks.

Still cameras will be capable of creating panoramas automatically. As the still camera is panned across a landscape, the camera will take just enough still frames to generate a complete photomosaic of the landscape (or structure). Then, by moving a few feet, a second, stereo set of panorama still frames can be taken. Multi-spectral electronic images can also be added, including radar for viewing surfaces beneath dry sand and sonar for viewing surfaces below water covered areas.

These surface maps can then be compared to the planned structure exteriors, structure interiors, excavations, and fills using GIS systems linked to geo-referenced CAD designs. Differences can be shown as colored solids in the 3D displays. Similarly, damage to structures or earth movements can be shown as volumetric differences in 3D displays. The locations from which physical samples are taken can be marked and photographed, geo-referencing the samples to their location. An example of this technology is Apple's QuickTime VR (Virtual Reality) which can automatically create 3D images from stereo photo pairs.

While cameras with these capabilities may not be cost effective for one or two decades, these technologies can provide a context for planning future sewer and other inspection systems that could use still frame inspection techniques.

Hypertext

Hypertext links on the Internet are familiar to many people. Less well known is the attribute of hypertext that considers each letter of each word in a document to be a separate element, added, or removed at a specific time. From this comes the ability to fork, creating two documents with a common ancestor. Merging two documents, or parts of documents, is also possible. Finally, and operationally the most important, because hypertext builds documents one character, or object, at a time, hypertext supports an infinite number of un-do's. Typing errors, and command errors become impossible because the option of undoing the error is always available. GIS systems, which are both complex and designed to be used by many occasional users, could benefit greatly from the infinite number of un-do's available in a hypertext model for design and data entry.

Hypertext can extend the fully linked mesh of a comprehensive data repository to the creative process. Hypertext can add needed support to the planning database creation process by preventing the loss of the provenance (history) of stored information. The provenance of the information includes: where the information came from, was it valid, and how was it modified for incorporation in the Planning Database.

Environmental Impact / Remediation

A planning database can eliminate the need to copy information onto paper, saving trees, and reducing landfill requirements. It can reduce air pollution, as citizens will be able to search and receive information over the Internet without having to make a trip to the planning database.

Access by Physically Challenged Persons

Colors in system windows on PC's (Personal Computers) can be displayed in the individual color space visible to each colorblind person providing a full range color presentation. Sounds can be shifted to the individual audio spectrum of each listener providing a full range sound presentation.

Document and GIS features can be enlarged for use by persons with limited sight.

System pointing and data entry can be via spoken command, eye tracking, any physical motion, or direct neural pickup.

Because all system features will be available electronically, homebound individuals will be able to fully utilize all system features. Additionally, all system operation, maintenance (redundancy in hardware could allow scheduled physical maintenance), and training could be performed by homebound individuals.

These features can be incorporated at very little additional cost. Most computer system features have options for physically challenged individuals. All that is required is to make the options available on system menus. The system can incorporate what exists, and make requests in the appropriate forums for what cannot be found.

Finally, the resulting awareness of physical challenges to members of our society will allow system designers to create a diversity inclusive GIS system as an expected system design goal.

This greater spatial awareness and greater awareness of physical challenges, made available on a society-wide basis over the internet, may even result in unexpected benefits such as a decrease in the number of wheelchair ramps that are built with an imprinted notice of "Caution: Slope exceeds 12:1" which means the newly built wheelchair ramps are steeper than the steepest Interstate highways and are therefore unsafe for wheelchairs.

Sidebar: 64 Bit Computing

To support interference detection, the GIS system will have to support CAD tolerances over wide areas, requiring 64 bit vector values and helping to usher in 64 bit computing. 64 bit vector values have more binary positions and therefore have a greater precision.

The transition from 16 bit to 32 bit computing was difficult, the transition from 32 to 64 bit computing promises to be more-of-the-same.

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Note to Editors

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Steve Gilheany
Archive Builders
1209 Manhattan Ave., PMB C-14
Manhattan Beach, CA 90266
Tel: +1 310-937-7000 Fax: +1 310-937-7001
SteveGilheany@ArchiveBuilders.com

Bio

Steve Gilheany, BA in Computer Science, MBA, MLS Specialization in Information Science, CDIA (Certified Document Imaging System Architect), AIIM Maser, and AIIM Laureate, of Information Technologies, CRM (Certified Records Manager, ARMA) has seventeen years experience in document imaging and is a Sr. Systems Engineer at Archive Builders.

Author

Steve Gilheany is a Sr. Systems Engineer at Archive Builders. He has worked in digital document management and document imaging for seventeen years.

His experience in the application of document management and document imaging in industry includes: aerospace, banking, manufacturing, natural resources, petroleum refining, transportation, energy, federal, state, and local government, civil engineering, utilities, entertainment, commercial records centers, archives, non-profit development, education, and administrative, engineering, production, legal, and medical records management. At the same time, he has worked in product management for hypertext, for windows based user interface systems, for computer displays, for engineering drawing, letter size, microform, and color scanning, and for xerographic, photographic, newspaper, engineering drawing, and color printing.

In addition, he has nine years of experience in data center operations and database and computer communications systems design, programming, testing, and software configuration management. He has an MLS Specialization in Information Science and an MBA with a concentration in Computer and Information Systems from UCLA, a California Adult Education teaching credential, and a BA in Computer Science from the University of Wisconsin at Madison. His industry certifications include: the CDIA (Certified Document Imaging System Architect) and the AIIM Master, and AIIM Laureate, of Information Technologies (from AIIM International, the Association of Information and Image Management, www.AIIM.org), and the CRM (Certified Records Manager) (from the ICRM, the Institute of Certified Records Managers, an affiliate of ARMA International, the Association of Records Managers and Administrators, www.ARMA.org).

Contact:

SteveGilheany@ArchiveBuilders.com
Tel: +1 310-937-7000 Fax: +1 310-937-7001

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