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Insights

Published by the CADD/GIS Technology Center for Facilities, Infrastructure, and Environment

Fall 2001 Vol. 01-2

From the Center

It is difficult for us to perceive the shocking reality of the attacks on the World Trade Center and the Pentagon. We commemorate those who lost their lives, those who were injured, and those who answered the call to duty. At this time of tragic loss, we dedicate ourselves to responding to our daily duties from a renewed perspective.

As General Robert Flowers, Chief of Engineers, stated, "The events of this week have tested our generation in ways that were unimaginable before Tuesday."

Let us never forget to appreciate our freedom, and let us all strive to make our country proud of us.

--The Staff of the CADD/GIS Technology Center

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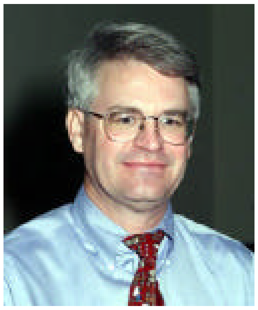

From the Center Chief

by Harold L. Smith, Center Chief
The CADD/GIS Technology Center for Facilities, Infrastructure, and Environment

On September 5, 2001, the Center's Board of Directors (BOD) held its semi-annual meeting to review the completion of the FY01 Work Plan and consider new directions and goals for the coming year. I would like to thank the BOD for their continuing guidance and support. I especially thank Mr. Gary Erickson, U.S. Air Force, who served as the BOD Chair this past year, and welcome Mr. Dwight Beranek, U.S. Army Corps of Engineers, who will serve as the new Chair. Thanks are also extended to the outgoing Corporate Staff Chair, Ms. Jean McGinn, Headquarters, U.S. Army Corps of Engineers, and to the incoming Chair, Mr. Paul Bouley, Headquarters, U.S. Marine Corps. Their leadership has been invaluable in the accomplishment of the Center's mission.

The past year has been a productive one for the Center. To name a few of our accomplishments, we--

- Held 30 Web Conference meetings covering a wide range of topics with a total attendance of 202 people. We found the technology to be highly effective for audio and video conferencing, saving money in travel expenses and allowing for better participation from Headquarters, field offices, and other agencies.
- Trained Jacksonville and Louisville District personnel in the A/E/C CADD Standard and held two SDSFIE Implementation Workshops for 73 attendees.
- Developed the Chief of Engineers' Design and Environmental Awards Program Web site for automated submission and judging of projects.
- Assisted with the deployment of an enterprise GIS for the Mississippi Valley Division.
- Published the first HTML-version of the *CADD/GIS Insights* (formerly the *CADD/GIS Bulletin*) to enhance viewer accessibility of the newsletter.
- Converted the National Guard Bureau's existing data flat files into an object-relational database, enabling improved analysis of different data into a comprehensive enterprise system for Environmental Programs.
- Established a hosting service for Electronic Bid Solicitations.
- Created the SDSFIE object-oriented Geodatabase model.
- Developed an Interior Design Resources Web site prototype supporting our DoD customers that provides links to design information, related associations, vendor sources, and references.
- Distributed via our Web site a Web-based Global Positioning System tutorial that was developed at Patuxent River Naval Air Station.

One of the tasks of the BOD at the September meeting was to consider and finalize the FY02 Work Plan, developed and proposed by the Corporate Staff. This approved Plan sets the pace for the upcoming fiscal year and helps us stay focused on our customers.

The Center received 79 project proposals totaling over $6 million dollars in proposed projects. After review by the Field Working Groups, the Corporate Staff selected 31 projects for the FY 02 Work Plan. The Center Staff, Corporate Staff, and BOD appreciate everyone who took the time to prepare and submit a project proposal.

Finally, do not forget this year's Symposium and Exposition. The Center is looking forward to co-locating with the Air Force's Joint Services Pollution Prevention and Hazardous Waste Management Conference in San Antonio, TX -- more exhibitors, more technical tracks, and more chances to meet your counterparts in the other services and agencies. The Symposium is scheduled for the week of August 19, 2002. Watch for updates and a call for papers in the coming months.

This will be a challenging year for the Center, but one that holds the promise for many good things. We in the Center commit ourselves to making this one of the best years possible.

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The CADD/GIS Technology Center for Facilities, Infrastructure, and Environment
FY02 Projects

Project No.	Title	PI
Core Mission		
96.013	Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE)	Bobby Carpenter
96.015	Facility Management Standard for Facilities, Infrastructure, and Environment (FMSFIE)	Bobby Carpenter
96.017	Maintenance, Revision, and Implementation of A/E/C CADD Standard	Toby Wilson / Stephen Spangler
96.003	Federal Geographic Data Committee (FGDC) Participation	Laurel Gorman
96.055	Support of National Institute of Building Sciences (NIBS) Facility Information Council	Dave Horner
1.044	Consolidated Object Strategy	David Johnson / Warren Bennett
Mission Related		

98.190	Continued Support of Electronic Bid Solicitation (EBS) Project and Implement Web-Based Bid Submittals	Elias Arredondo
96.023	Generic Details Library Updates and Revisions	Stephen Spangler
99.030	Library of CADD Designs	Elias Arredondo
1.037	Dredging-Related Standards and Application Interfaces to Support Enterprise-Wide Dredging Software, Phase 2	Laurel Gorman
1.039	Development of an FMS Entity Set for Work Execution for Assets, Phase 2	Denise Martin
2.013	GeoRender Update	Milton Richardson
2.030	Airfield Management Suite	Bryan Perdue
2.026	Evaluate Current Business-to-Business Enterprise Solutions	David Johnson
2.046	Automated Forest Management Information System (FMIS), Phase 1	Laurel Gorman
2.042	Spatial Data Standard for Historic Buildings and Structures	Laurel Gorman
2.043	Electronic Deliverables Guidance	Ken Cook

1.040	Use of GIS to Simplify Environmental Impact Analysis Process	Bobby Carpenter
2.018	Assessment of ESRI Object-Oriented Models and National Integrated Land System Application Effects on SDSFIE and GIS Real Estate Activities	Nancy Towne
98.125	Integration of CADD and GIS Standards and Digital Data	Denise Martin
98.045	Continued Development of a Data/Project Management System for Survey Engineering	Dr. V. Danushkodi
1.016	Expand SDSFIE/FMSFIE to Meet Clean Air Act (CAA) and SARA Title III Regulations and Data Reporting Requirements	Bobby Carpenter
2.020	Web-Based Standards and Workspace Training	Drew Anderson

Mission Support

96.001	Publishing the CADD/GIS Insights (Web Bulletin)	Laurel Gorman
96.011	Center Internet and Intranet Technology	Drew Anderson
96.150	Marketing	David Johnson
96.200	Support of Board of Directors, Corporate Staff, and Field Working Group	John Hood

96.210	Equipment (Maintenance Support)	Milton Richardson
99.021	Foundation Knowledge Web Portal	Denise Martin
99.035	Balanced Scorecard	Bryan Perdue
2.050	Symposium and Exposition 2002	Toby Wilson

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GIS: Expensive Toy or Effective Technology?

by Ayman S.A. El-Swaify, P.E.
Navy Public Works Center, Yokosuka, Japan

This paper is based on a presentation I delivered at the ESRI User Conference, July 2001. I received a very positive response from the audience and would like to share it with the CAD/GIS community at large. The intent is to communicate some useful information about potential costs, benefits and pitfalls to those organizations that are in the initial stages of implementing GIS technology.
--Ayman S.A. El-Swaify

Implementing GIS technology is not a "one size fits all" proposition. Therefore, the information in this paper must be understood in the context of our particular operating environment. The mission of Public Works Center Yokosuka (PWC) is to provide maintenance and repair, utilities, transportation, engineering, and planning to the military (primarily Navy), shore establishment and other Federal agencies. Our customers expect us to provide these services in a responsive, high-quality, and cost-effective manner. Therefore, the PWC initiated a program in 1995 to begin implementing GIS technology throughout the Command.

The Japanese islands of Honshu and Kyushu are home to numerous U.S. military installations. The various Naval installations are clustered into Naval Complexes (NCs). As a result of our GIS successes during the first couple of years, PWC Yokosuka was asked by other NCs to implement the technology in like manner. In 1998, PWC began its current role as a GIS service provider to the Japan Navy Region. The region's GIS implementation now consists of 21 sites organized into four NCs (Figure 1).

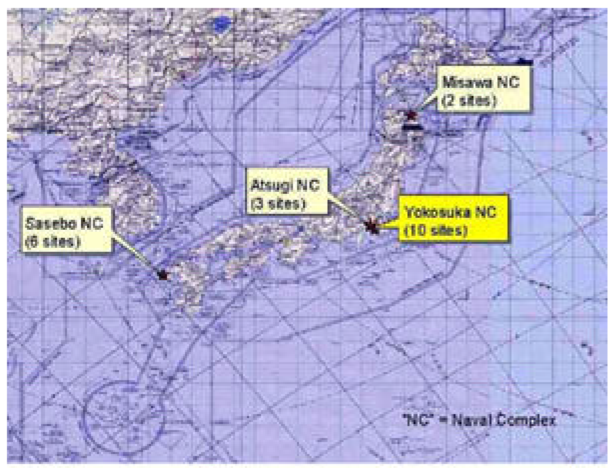


Figure 1. U.S. Navy Japan Region

The objective behind the GIS technology is integrated installation management, which involves enabling many diverse functions to work together, sharing data and maps (Figure 2).

Regional Support Structure

The full-time regional GIS support staff resides in Yokosuka and consists of a U.S. Civil Service (USCS) manager and two (soon to be four) Japanese national employees. The remote NCs designate a primary GIS point of contact (POC) with whom the regional staff can coordinate their implementation. All NCs designate departmental POCs throughout their respective organizations. GIS and departmental POCs perform their functions as collateral duties. The regional support staff coordinates all data development, training, etc., for the NCs.

In terms of equipment, the Yokosuka NC hosts a master GIS data server, an Oracle/ArcSDE server and an ArcIMS server. The remote NCs each manage a local GIS data server for direct query and editing of their data. These remote data are periodically reconciled back to the master data server in Yokosuka. The ArcIMS server serves as the regional map server for all NCs and provides basic functionality to all users in the region (Figure 3).

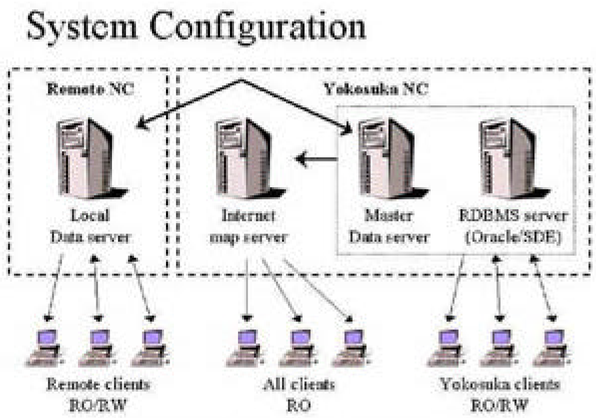


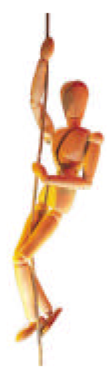
Figure 3. Regional system configuration

Counting the Costs

Before making a commitment to implement GIS technology, you must answer the following questions to get to "Level 1":

- ***Do you need GIS technology?*** This is the most basic question. How will the system be used? What problems will it help solve? Are these practical uses? Have you seen others using the technology in this manner? Who are the potential users and viewers in your organization? Who needs it most?
- ***Is management committed to this?*** Without solid upper management commitment for at least 2 to 3 years, you risk having the plug pulled on the implementation before it can get going. Management needs to understand that results will take some time.
- ***Is adequate funding available?*** Later in this paper, I will lay out some guidelines for estimating your startup costs. You must have money available to invest.
- ***What is the staffing plan?*** Will GIS support be a full-time or collateral duty? Will your organization re-allocate positions or hire onsite contract support? You should be aware that some sort of full-time commitment is essential. GIS implementations with only collateral staffing move very slowly and risk being crowded out altogether by the normal urgencies that fill people's workday.

If you are able to answer these questions and the picture looks encouraging, then consider the following questions to get to "Level 2":



- ***Do you have a suitable map?*** If one is not available, it will take longer to get started (and cost more money). However, almost every site is lacking in some respect. There are six criteria I use in answering this question:
  - **Up-to-date.** The map should be reasonably accurate or else a lot of manual effort will be required up front to make the updates. This could take just as long as creating a new map.
  - **Spatially accurate.** Maps developed from scanned drawings can exhibit spatial distortion due to the warping introduced during the scanning process or poor digitizing practice (re-positioning the source document while digitizing).

    - **Geo-referenced.** It must be tied to the appropriate coordinate system and projected accordingly.
    - **Topologically correct.** This is usually a problem with CAD maps. Building features should be drawn as closed polygons; utility features should be digitized in the direction of flow and should have precise coincidence between related features.
    - **Spatially contiguous.** The map should be seamless, not broken out into tiles.
    - **Spatial Data Standards (SDS) compliant.** This is particularly important for DoD users. These standards are maintained and published by The CADD/GIS Center for Facilities, Infrastructure, and the Environment (http://tsc.wes.army.mil).
- ***What data formats will be used?*** This may depend on your current digital editing environment, if any. If your organization has strong CAD expertise, you may wish to keep most of your data in CAD format and convert only certain features to GIS formats (shape, coverage, etc.) as necessary. Otherwise, you may wish to begin right away with ArcInfo and the geodatabase format.
- ***What software will be used?*** There are many choices, and they depend mostly on the capabilities that users require and how you will maintain your mapping layers.
- ***How will viewers ("low-intensity" users) get to the information?*** Will you set up a Web service to make it widely available? Or will you create a smaller portable application using MapObjects? Or you could deploy the ArcExplorer or ArcReader tools, which are free of charge. It is best to simplify the strategy in the beginning; try not to roll out too may different tools at once.
- ***Where should we start ("quick kills")?*** Based on the GIS capabilities you have seen, where can your organization benefit the most right away? In our case, we started with an adequate map, linked property record information, floor plans, and photographs. This is our most basic level of functionality, and it brings tremendous benefit immediately.
- ***How will we keep the data current?*** Normally, the best approach is to push data maintenance out to the end users that are the natural data owners. This way, your GIS staff can focus more on the technology, new functionality and data improvements rather than being consumed with trying to keep data up-to-date. However, keep in mind that end users will require training, or they will likely become frustrated.
- ***How much emphasis should be placed on custom coding?*** There is a delicate balance between using straight commercial software (out-of-the-box) capabilities and writing your own code. Unless a function is immediately required, it may be best to defer it and see if the software manufacturer is willing to add the functionality to the commercial product. Also, any coding should conform to sensible development practices. This will be discussed more under "pitfalls."
- ***Can we partner with other sites?*** If you know of other sites with similar requirements, you can learn from them and save yourself a lot of time and trouble during what I call the "figuring out" process. Also, it is often possible to jointly fund initiatives that will benefit two or more sites at once.

Initial Startup Costs

If after considering these issues you are ready to seriously consider an implementation, it is time to start considering the actual costs that will be incurred. The following discussion focuses on the most significant cost factors. However, remember that these numbers may vary greatly depending on your particular situation.

- *Staffing.* Does it make sense to devote in-house personnel to the implementation? Can someone be transferred to this function, or should you hire someone new? I will discuss staffing options in further detail below.
- *Equipment.* Is your existing network capable of supporting GIS data traffic? Are your workstations capable of running the software? How should you license your software?
- *Training.* Who needs training? Should you bring an instructor onsite or send people to a central training facility? Can you partner with other sites in providing training?
- *Consulting and support services.* This will almost always be necessary to some degree, especially if you do not maintain contractor personnel onsite at all times.
- *Data development and cleanup.* This is a guaranteed requirement. Most GIS implementations do not consider the poor state of their data in the beginning and end up being surprised at what it takes to organize and clean it. Without good data, a GIS can be rendered practically useless no matter how much money you spend elsewhere.
- *Application development.* As mentioned, this involves balancing commercial capabilities and additional functions you may need. Also remember that anytime an application is developed, you are assuming an associated maintenance cost - you will likely be required to use additional funds to maintain and enhance the capabilities over time; or even port it to a new platform.
- *Survey monuments.* This is often overlooked, but it is best to consider it up front. In order to maintain your data over time, you will need a sufficient number of monuments for using field surveys to update and add new layers to your GIS database.

Staffing Options

There are three basic approaches to staffing. You can use in-house resources for 100 percent of the requirements, hire contractors for 100 percent, or settle on some combination both. One-hundred-percent contract staffing normally implies that one or more contractors will remain onsite at all times. A combination effort normally implies that a contractor will be brought onsite a few times a year for a couple weeks at a time and will be "retained" for various tasks in between the site visits. The relative advantages and disadvantages of each staffing option are given in Table 1:

Table 1. Advantages and Disadvantages of Staffing Options	
Advantages	**Disadvantages**
100% In-House	
Less expensive and more flexible.	Must establish positions and find people.
Familiar with the organization; can push for progress.	Difficult to terminate if it does not work out.
Can continue to operate on a limited basis in periods of "lean" funding.	Will likely have limited access to broader resources and technical expertise.
100% Contract	
No need to establish permanent positions.	More expensive, especially for simple tasks.
The burden of finding capable people is placed with the contract firm.	Unfamiliar with the organization; limited authority to drive the implementation.
Usually has access to broader resources and technical expertise.	Risk of discontinuity if funding becomes a problem or the assigned person leaves the

	company.
Combination In-House and Contract	
The in-house staff can drive the implementation and stay actively engaged with the contractor's efforts.	Same issues with in-house staffing.
Smaller tasks can be handled in-house; larger or more complicated ones can be passed to the contractor as necessary.	Can be more expensive for smaller implementations.
Lower cost for broad implementations.	Must be more proactive in tracking and managing the contractor's tasks remotely.

Estimating Startup Costs

Here are some very rough guidelines that you can apply to determine what it might take to implement a long-term GIS solution (Table 2). Again, please keep in mind that these costs can vary widely depending on the approach taken and the particular operating environment.

Table 2. Guidelines to Determine Costs

Cost Factor	Estimate
Staffing (annual costs)	$100K/year per position for in-house support. About twice as much for full-time contractor support.
Equipment startup (assuming a suitable network is already in place)	For advanced users, $10K/person. For viewers, $2K/person.
Equipment maintenance and upgrades (annual costs)	$1K/person per year.
Training (annual costs)	For advanced users, $5K/person. For viewers, $1K/person.
Consultation and support (annual costs)	About $200K/year (about 1/2 for contract staff full-time on-site).
Data development and/or cleanup.	To create a new base map from aerial photography, assume $400/acre for installations at least 200 acres in size. For adding legacy layers from existing CAD or hardcopy documentation, estimate about $150/acre.
Application development (annual costs)	About $100K/year (about 1/2 for contract staff full-time on-site).
Survey monuments	Estimate one monument required for every 10 acres of developed area @ $6K each.

Potential Pitfalls

Unfortunately, there are many ways to waste money during the course of a GIS implementation. Here are some common pitfalls to watch out for:

- Related to planning and oversight.
  - *Poor planning; unclear objectives.* Consider all Level 1 and Level 2 questions before starting. Be sure management understands the plan, the time it will take, and what results to expect. Lay out a plan of action and milestones.
  - *Lack of organizational commitment.* This applies to end users as well as management. The benefits of GIS will not be realized if users are not willing to use the system. Spend time demonstrating the technology and explaining the benefits to them well in advance of installing the software on their computers.
  - *Failure to guide contractor efforts.* Do not let the contractor work in a vacuum - work together in setting goals and objectives. Communicate regularly to ensure that assigned tasks are on-track and meet your requirements.
  - *Shooting for flash (short term) versus substance (long term).* Although demonstrations of advanced GIS capabilities are often helpful in gaining upper management approvals, it may lead to unrealistic short-term expectations. Be sure to focus on the foundational things in the beginning - good data, data maintenance, basic functionality.
  - *Failing to regularly evaluate progress and adjust course.* It is almost certain that priorities or objectives will change as the implementation progresses. Technical decisions made in the beginning may have proven too expensive or unrealistic. Do not be afraid to adjust course as long as the destination is still in front of you.
- Related to data development.
  - *Failing to start with a suitable land base.* It is rare that an organization has a suitable map in the very beginning. It is usually necessary to develop a new one that meets the six criteria outlined earlier. Because this requirement could delay the implementation, it is tempting to skip this step. Sometimes it may be possible to obtain a land base through means other than aerial photography. Just realize that as time passes, it may become apparent that a new map is necessary.
  - *Failure to consider the big picture (all potential functions using the system).* This comes into play when you are concerned about satisfying many functional requirements with your implementation. A big picture mentality is required when you are formatting data and writing applications that will potentially be shared by different departments.
  - *Spending time and money to add or clean data that are not useful.* During a GIS analysis, data are found tucked away all over the place. It is tempting to try to add everything to the system. However, the expense in re-formatting data or adjusting users' work processes may not be justified by the potential benefit to be gained. Do not add data simply because they are there.
  - *Failure to consider existing work processes and data maintenance considerations.* Another important consideration when adding data is to think about it long-term. Will users naturally keep it up-to-date? For this to happen, you must tie the maintenance to their existing process somehow. Double-entry data maintenance will not help your users - try to avoid it.
- Related to poor coding practice.
  - *Duplicating commercial features.* The advantage of purchasing commercial software is that the vendor has taken the time to build the functionality. You are paying for this! Most times it is better to leverage what is already there even if it is not the most convenient approach for your users. Provide feedback to the vendors if usability is an issue and urge them to make improvements to their product.
  - *Creating applications that look cool but are not of practical use.* Again,

sometimes it is necessary to do this on a limited scale in order to help upper management see the potential benefits. But these types of applications often end up as "throw-aways."
    - *"Stovepipe" coding (platform or function-specific).* This relates to not keeping the "big picture" in mind. For example, why develop a different document retrieval (hotlink) function for different departments? If this is necessary, code it in such a way that it works for any potential user for any feature on any layer.
    - *Failure to consider future software compatibility.* The ArcView Avenue language has become a classic example of not supporting new software versions. It does not make sense to invest much more in these applications unless you plan to be committed to that platform for a long time.

What are the Benefits?

With all this said, what can you realistically expect to gain? I have compiled a short list of gains that can be expected in the near-term. While I stopped short of applying dollar values to these, you can think of them in terms of your organization to determine potential savings over time.

- Data improvement.
    - GIS forces good data management practices, thus instituting a framework for continuous data improvement over time. All organizations have information scattered all over the place in diverse formats. Because GIS can relate this information together and make it more usable by others, it naturally forces a manageable schema and rules for organizing data.
    - Ongoing data collection efforts can be captured for future use. Many one-time data collection efforts are conducted in response to data calls. This is often thrown away when the need has passed. Then a year or so later, it is done again from scratch. If the users know how to capture and store the data in the new GIS schema, it can be easily retained and retrieved by others as necessary.
    - GIS facilitates data upkeep by making it easier and more systematic and by simplifying the validation process. Better than most any other tool, GIS technology helps point out data deficiencies. There is thus an incentive to correct errors or complete missing information because more people now notice these problems.
- Information efficiency.
    - Data are more accessible, thus they are leveraged among a broader user base.
    - Data repetition and data redundancy will decrease. A good GIS schema partitions the data and places their maintenance with the true owners (those that know them best and have a vested interest in their accuracy).
    - Users can focus on their own data. Users often spend time keeping data that they need but are not actually responsible for. Once the owner's version of the data is accessible, those users can focus on keeping their primary information current.
    - Decisions can be made quicker and more accurately. The natural outcome of this geospatial automation is that information is more accurate and immediately accessible to those who require it.
- Other benefits:
    - The quality of your products and services will greatly improve. What report or diagram is not enhanced by the inclusion of a color map? These types of

enhancements all reflect positively on your organization.

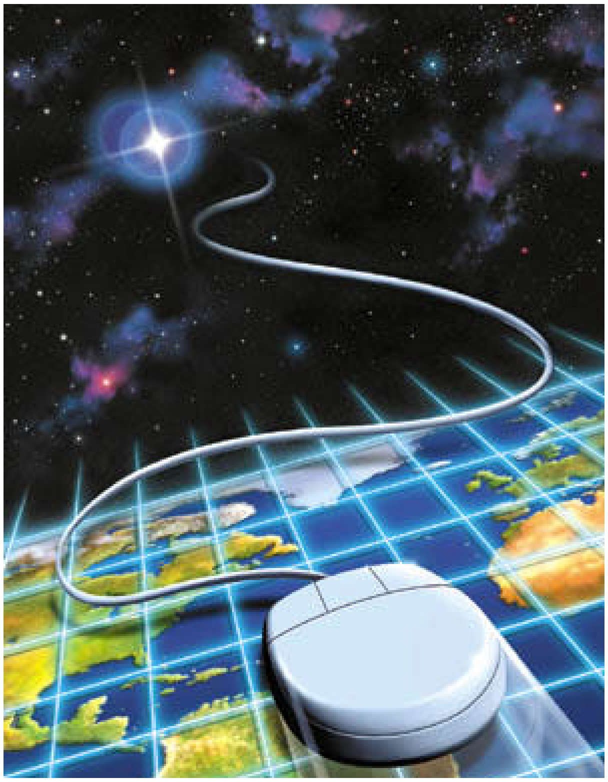
- Users' morale will improve as certain aspects of their jobs are simplified and they work with state-of-the-art tools. Users opposed to these types of tools in their work are diminishing. Most users now welcome them and enjoy the new capabilities. They will find themselves more productive.
- New types of analyses are available that were previously not possible. Being able to relate information across functional areas, overlaying layers that were previously on separate drawings, and performing buffer analysis are a few of many examples.

Conclusion

GIS is an effective technology, but it is definitely expensive. Before starting on the "road to GIS," it is essential to realize and accept the commitment that is required. In many cases, about 2 to 3 years is required to start seeing significant results.

Management often wants to know the return on investment (ROI) in real dollars. However, most benefits are intangible and hard to quantify. What I have found is that "seeing is believing" and typically speaks louder than ROI numbers. This is the dilemma faced by most. If you can get far enough along to show basic functionality with your organization's data, you will be almost over the hump.

You should also realize that this is a great time for implementing GIS technology. Costs are lower than ever, the technology is much more mature and intuitive, standards are better defined, and it is highly likely that you can find other organizations that are already doing what you want to do. You can learn from them without having to reinvent the wheel. Good luck!



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Object Relational Databases: Oracle Spatial

by Rita Massey
The CADD/GIS Technology Center for Facilities, Infrastructure, and Environment

Object Relational Database Management Systems are defined by their data types and objects and are fully compatible with relational databases. An object is defined as a person, place, or thing that knows something about itself and performs actions. This allows the incorporation of spatial data into a relational database.

Object relational databases provide the first unified, in-depth treatment of special techniques for dealing with spatial data, particularly in the field of geographic information systems (GIS). Spatial databases offer significant advantages compared to the proprietary GIS products traditionally used for such tasks, in that they allow the integration of spatial data with enterprise-wide tabular data. The usage of the same open interface, with Standard Query Language (SQL) and abundant programming features, enables management of spatial and tabular data types.

There are three types of spatial data: (1) GIS (mapping) data, (2) computer-aided drafting and design (CADD) data, and (3) computer-aided mapping (CAM) data. In order to work with all of these spatial data, an object relational database must be able to deal with the following:

- Geometrical data elements, such as points, lines, polygons, arcs, and more-complex elements created by combining these simpler elements.
- Spatial relationships (such as connection and overlap) and operations (such as determining the intersection of two objects or the distance between them).
- Spatial queries (often requiring large amounts of memory) to test for particular spatial relationships among specified objects (for example, the query: find all the radiant arcs from all street lights that are taller than 20 feet).

The use of an object relational database does not eliminate the need for GIS software applications. The primary use of GIS software is to perform analyses, geo-reference, and solve queries. By combining object relational databases with GIS software, the representation of spatial features (points, lines, or polygons) is stored in a single field within a database table. These spatial data need to be geo-referenced to be fully utilized by GIS. The spatial basic building blocks of geometry are illustrated in Figure 1.

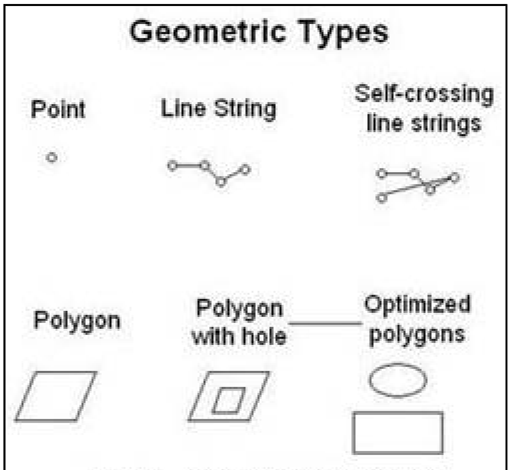

Figure 1. Geometric element types

Attribute data for spatial data are stored within columns of a table in the database. Access to the data for processing and manipulation is accomplished through extensions to SQL. Most geospatial data are complex, heterogeneous, and incompatible, and that is why the users must possess considerable expertise and special software to overlay or otherwise combine different map layers of the same geographic region. Common interfaces are one way to enable overlays and combinations of complex and essentially different kinds of geographic information.

The OpenGIS Consortium (OGC) provides a common interface (Figure 2). OGC is an organization that manages consensus processes that result in interoperability among diverse geoprocessing systems. The access to heterogeneous geodata and geoprocessing technology that users work with should be transparent. The OGC enables vendors of GIS software, earth imagery, database software, data integrators, computer hardware, and other technology to reach agreement on the technical details of open interfaces that allow these systems to work together. The OGC goal is to provide a comprehensive suite of open interface specifications that enable developers to write interoperating components. Some of their specifications with regards to geospatial information are:

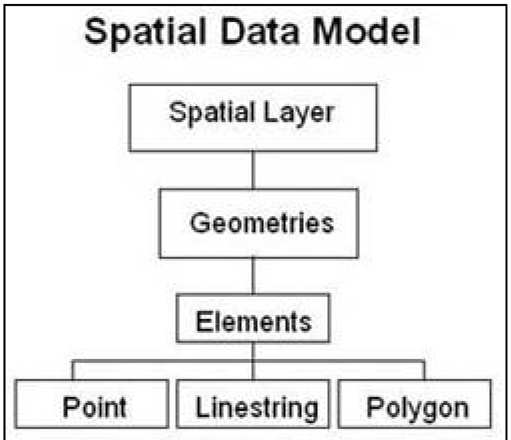

Figure 2. Geospatial data model

- Easy to find, without regard to its physical location.
- Easy to access or acquire, once found.
- Easy to integrate, combine, or use different sources in spatial analyses, even when sources contain dissimilar types of data (raster, vector, coverage, etc.) or data with disparate feature-name schemas.
- Easy to register, superimpose, and render different sources for display.
- Easy to generate special displays and visualizations, for specific audiences and purposes, even when many sources and types of data are involved.
- Easy, without expensive integration efforts, to incorporate into enterprise information systems geoprocessing resources from many software and content providers.

A section of the OGC is the Oracle Spatial Research Laboratory (SRL) in Nashua, NH. Oracle has recently opened the SRL to provide a non-commercial computing lab dedicated to advanced spatial application development. Object relational, databases with an extension to the relational model with a set of functions and procedures that allow storage of geospatial and multi-dimensional data are opening doors for spatial data applications. SQL queries and spatial operations can be performed on these data.

- Enhance object-relational database applications by allowing users to incorporate location information directly into their application and services.
- Provide spatial object type storage, SQL access, spatial operations, fast R-tree and quadtree indexing, linear referencing, and projection and coordinate transformation support.
- Object relational databases support commonly used mapping coordinate systems as well as user-defined coordinate systems.
- Support storage of "measurement" information as part of linear geometry.

There are several good publications relating to object relational databases. One of these is *Spatial Databases with Applications to GIS* by Philippe Rigaux, Michel Scholl, and Agnes

Voisard, published by Morgan Kaufmann, May 2001. This publication covers:

- The strengths of various query languages and approaches to query processing.
- The use of computational geometry in GIS and spatial databases, providing necessary background and an in-depth look at key algorithms.
- Spatial access methods, including the R-Tree and several space-driven structures.

The next issue of the *CADD/GIS Insights* will describe how GIS vendors are integrating Object Relational Databases into their products.

For additional information, contact Rita Massey at 601-634-4396 or Rita.F.Massey@erdc.usace.army.mil.

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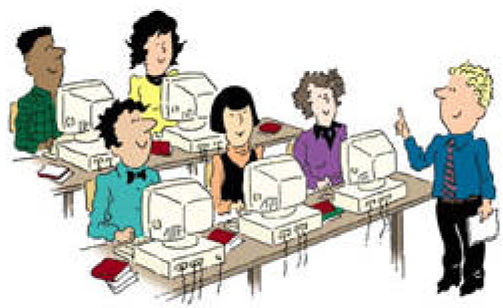
The A/E/C Standard/Workspace Assistance Team (SWAT)

by Stephen C. Spangler
The CADD/GIS Technology Center for Facilities, Infrastructure, and Environment

When Engineering Circular (EC) No. 25-1-243 (July 1998) rescinded the former Corps of Engineers' Computer-Aided Drafting and Design (CADD) Standard in favor of the Center's Architect/Engineer/Construction (A/E/C) CADD Standard, personnel at Corps sites were reluctant or unsure how to move to the new standard. To address these concerns, the Corps' Systems Field Action CADD Group (SFAC) decided that a team was needed to visit sites and introduce the A/E/C CADD Standard to the staff. The result was the formation of the Standard/Workspace Assistance Team (SWAT), composed of SFAC group members who have successfully implemented the Standard at their own sites and CADD/GIS Technology Center personnel. The SFAC SWAT members are responsible for providing implementation tips, and Center personnel teach introductory classes on both the Standard and the Workspace tool.



In support of this effort, Corps Headquarters sponsored two SWAT site visits in FY01 - one to a District performing Civil Work (Jacksonville) and one to a District performing Military Work (Louisville). The Jacksonville District class occurred in March, and the Louisville District class occurred in July. The first day of both classes involved bringing in various disciplines and teaching users how to implement the A/E/C CADD Standard. File naming techniques were demonstrated, and the students were taught how to use the A/E/C Workspace tool for MicroStation. At both sites, the students were impressed that they never had to refer to the A/E/C CADD Standard document to set the proper symbology for levels when using the Workspace.

The second day of each site visit was spent interviewing different design branch staff members to determine what standard they currently followed and how they shared CADD files with other branches. Most branches did follow a loosely defined standard, whether it be the former Corps standard or an in-house standard. They were receptive to using the A/E/C CADD Standard provided management would allow them a "honeymoon" period to become accustomed to the document and to be properly trained on the Workspace. All branches agreed that the adoption of the A/E/C CADD Standard would result in consistent drawing files and reduce the time in determining where items had been placed in CADD files.

The final days involved gathering the key personnel from cooperating branches together in the same room and letting all groups hear how other branches were working. This resulted in other branches understanding the way their associates work, and allowed them to provide constructive feedback on how problem areas could be resolved. The SWAT then presented their findings to the Chief of Design Branch and provided the System Administrator with a CD containing the training materials and the SWAT's findings for that week.

For FY02, it will be up to other sites to determine whether they want to fund a SWAT visit. For those sites having difficulty implementing the A/E/C CADD Standard, the funds used to bring the SWAT to the site would be money well spent. The Center definitely appreciates the efforts of the following SWAT members:

- **Jacksonville District SWAT**
  - John Kincaid (Rock Island District)
  - Glen Kato (Seattle District)
  - Steve Hutsell (Fort Worth District)
  - Scott Flanagan (New England District)
  - Toby Wilson (CADD/GIS Center)
  - Stephen Spangler (CADD/GIS Center)
  - Edward Huell (CADD/GIS Center)
  - Debbie Solis (Jacksonville District host)
- **Louisville District SWAT**
  - John Kincaid (Rock Island District)
  - Glen Kato (Seattle District)
  - Mary Diel (Sacramento District)
  - Stephen Spangler (CADD/GIS Center)
  - Edward Huell (CADD/GIS Center)
  - Ed Mathison (Louisville District host)

For further information on the SWAT, please contact John Kincaid at (309) 794-5492 or by e-mail to John.A.Kincaid@mvr02.usace.army.mil.

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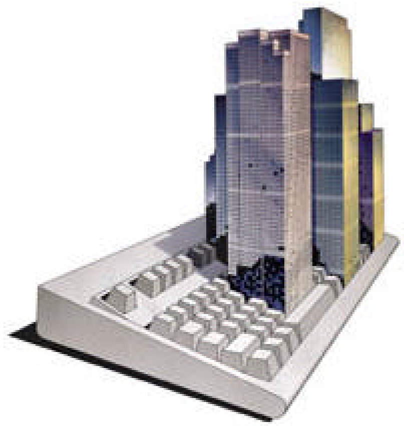
Sheet Files - To Scale or Not to Scale?

by Stephen C. Spangler
The CADD/GIS Technology Center for Facilities, Infrastructure, and Environment

When Release 1.8 of the A/E/C CADD Standard was released in October 1999, little did I know that one paragraph I wrote in the Standard would spark such an intense maelstrom of communication. It seemed that whether I was visiting a site, or participating in a conference, I was cornered and quizzed about this paragraph. The paragraph from page 8 read (with the controversial part highlighted):

> A sheet file is synonymous with a plotted CADD drawing file. A sheet file is a selected view of the model file(s) within a border sheet. **Sheet files are usually plotted at full scale (1=1)**, since the model files are referenced into the sheet file at a particular scale ratio. In other words, a sheet file is a "ready-to-plot" CADD file.



When the architect or engineer is creating a sheet file, he/she references together various model files (such as floor plans, site plans, piping plans, lighting plans, etc.) and a border sheet model file. While researching the Standard by visiting various sites, I found that people created sheet files in three different ways. While all three ways are feasible, there are disadvantages to some. The intent of this article is not to advocate one method over another (if a particular method has worked for you for many years, keep on doing it!), but to explain why a particular paragraph in the A/E/C CADD Standard will change for Release 2.0.

Method 1 - maintaining various scaled border sheets: For this method, various types of border sheets (ANSI D or E, ISO A1 or A0) are sized to the various possible scales (e.g., 1/4" = 1'-0", 1/8" = 1'-0", 1" = 100'-0"). When the sheet file is created, the needed model files (floor plan, site plan, etc.) are referenced into the active file (without scaling), and the desired plot scale border sheet is referenced into the drawing (without scaling, since it has already been sized for the particular plot scale). The file would be plotted at the plot scale.
Disadvantage: Requires maintenance of multiple border sheets.

Method 2 - scaling model files down to fit into a 1:1 border sheet: This method was the one mentioned in the controversial paragraph. For this method, the border sheet is referenced in at full size (e.g., an ANSI D size sheet would measure 22" x 34") and the other model files (floor plan, site plan, etc.) would be scaled **down** to fit into the border sheet. The file would be plotted at 1:1.
Disadvantage: Introduces the opportunity for scaling errors. Also, if the user tries to dimension the model file, a dimension scale factor has to be applied to make sure that dimensions are correct. AutoCAD users adept with

paperspace and modelspace can easily overcome this obstacle.

Method 3 - scaling the border sheet up to match the other model files' plot scale: This method is the most common in use at sites. When the sheet file is created, the needed model files (floor plan, site plan, etc.) are referenced into the active file (without scaling), and the border sheet is referenced in and scaled **up** to match the plot scale of the other model files. If the model files in the border sheet need to be dimensioned, a dimension scale factor does not have to be applied. The file would be plotted at the plot scale.
Disadvantage: None.

Based on discussions with site personnel, Method 3 is used the most. So for Release 2.0 of the A/E/C CADD Standard, the paragraph above will be revised to read:

> A sheet file is synonymous with a plotted CADD drawing file. A sheet file is a selected view or portion of the model file(s) within a border sheet. **Sheet files are usually plotted at a particular scale, since the border sheet is scaled up to fit around the full-scale model files.** In other words, a sheet file is a "ready-to-plot" CADD file.

For additional information, contact Stephen Spangler at 601-634-3104 or by e-mail to Steve.C.Spangler@erdc.usace.army.mil.

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GIS: More Than Pretty Pictures

by Theresa A. Dawson, Huntington District

Ms. Dawson is a hydraulic engineer with the Huntington District. She describes her experiences as part of the Corps of Engineers team deployed to West Virginia in the aftermath of the July 2001 flood.

On Sunday, July 8, 2001, heavy rains and strong winds caused extensive flooding in six West Virginia counties. By July 11, a state of emergency was declared, and a FEMA (Federal Emergency Management Agency) Disaster Field Office (DFO) was established in Charleston, WV. The Corps of Engineers was assigned three missions -- debris removal/demolition, organization of temporary housing, and installation of generators.

We immediately began using GIS once the Charleston field office was set up. At first, there was only a stack of CDs with base maps for the entire State of West Virginia, including DRGs (digital raster graphics), DLGs (digital line graphics), GDT (geographic data technology) data, DEMs (digital elevation models), and orthophotos. Terry Siemsen of the Louisville District had already converted these to UTM (Universal Transverse Mercator) Zone 17 as part of his efforts to get a base map for the entire Great Lakes and Ohio River Division. Because of his work, we were able to hit the ground running.

Devastation from flooding in West Virginia

Terry first set up the mapping for debris removal. He then began to support the temporary housing mission by finding photos and maps of possible sites. Because he is also part of a team that works on hurricanes, he was able to deploy for only a few days. I had about three days to work with him, and it was a real learning experience.

From the DFO, we were able to provide maps of debris sites, track debris hauling tonnage, work with the National Guard to keep things organized, help coordinate payments to the contractors hauling the debris to landfills, give the landfill owners estimates about how much debris they could expect, and provide some very good estimates about how much debris was left to haul.

The majority of the temporary housing work was completed at the District office using CADD technology. Once the DFO received the files, we were able to plot the proposed sites on orthophotos, add floodplains, roads, oil and gas wellheads, coal mines, and superfund sites in the vicinity. After NEPA

(National Environmental Protection Agency) learned we had these data, they regularly asked for this information and other data related to the temporary housing sites, including soils, wetlands, endangered species habitats, and maps. We also provided information to the FEMA office on floodplains, bridges, and roads.

As the fire marshal condemned structures, we maintained the list. The information was transcribed from GPS (global positioning system) units, and many times they were in error. At one point, we had a house in southwest West Virginia that showed up as being in southern Ohio (right over my house, as a matter of fact, which cheered my husband up enormously. He though he'd get out of finishing the renovations).

Much of the existing data came in huge Excel spreadsheets with the pertinent information often buried in the comments section. A student aide converted the information into a usable format from which we developed country maps of the condemned structures. We also developed maps of the landfills showing the best locations to take debris, based on the fire marshal's report of how much debris we could expect from each condemned structure.

Once that was done, I was temporarily replaced by Heather Henneman of the Chicago District. She put everything into databases, automated a lot of the bookkeeping and mapping, and updated maps every morning. She used Access to make the operation look very professional.

I know there can be a lot of snickering from engineers about "pretty GIS pictures," but when you do not have the time to internalize large quantities of information, it is easier to see relationships and understand overall ideas from graphics than from written reports. The graphics were a tremendous help in letting people who were not intimately familiar with the area get an overview.

As for my lessons learned:


West Virginia Soil Conservation Agency is working to restore streams

- I cannot stress how important it is to know where the background data are located before the disaster. When they are all in one place, it is easy to grab a computer and CD case and go. If it had not been for Terry, we would not have been as successful.
- Do not be afraid to start with "ugly" maps. "Pretty" can come later. The faster things get up, the faster people can start understanding the situation. Get a plotter and a color laser printer. They are not luxuries -- they are necessities for displaying the information in a comprehensible way. Do not forget paper and extra ink cartridges. You will go through them fast!
- Many people do not understand how much GIS can be used to support Emergency Operations Centers. Be prepared to explain to others how you can help them, and be prepared to go to them. They may not know how you can help.
- GPS is valuable. It may not replace conventional survey equipment in the hands of professional surveyors, but it will let you get rough positions of the things you need to be able to locate -- either on a map or in the open field. On the other hand, GPS in the

hands of the untrained can be a bad thing. You must keep in mind that the data may be in error.

- No matter how many times your supervisor asks you (in my humble opinion), the GIS cannot be supported completely from the District office. There are too many lines of communication that come together at the DFO.
- About 98 percent of what I did was mapping, not analysis, but it still required someone who was familiar with the programs and the theory to merge maps in order to create new ones.

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Team Approach in Action -- Dredging Standards Project

by Laurel Gorman
The CADD/GIS Technology Center for Facilities, Infrastructure, and Environment

In support of Center Project 01.037, Use of Dredging-Related Terms, Standards, and Concepts for the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE), a team approach was used to develop a core set of dredging standards as part of the SDSFIE. Diverse viewpoints from Headquarters, U.S. Army Corps of Engineers (HQUSACE), Districts, the Engineer Research and Development Center (ERDC), contractors, and consultants were captured during bimonthly Placeware Web conferences hosted at ERDC. At the conferences, standards were discussed and reviewed online using PowerPoint slides, existing dredging databases, and the SDSFIE application. During the meetings, real-time meeting notes were recorded, and proposed terms and definitions were searched by the SDSFIE browser application for all participants to view.

These meetings were led and supported by James Clausner, Tim Welp, and Doyle Jones from the Coastal and Hydraulics Laboratory, ERDC, and Laurel Gorman and Chip Fleming from the Center, ERDC. We would like to thank everyone in the Corps field group who participated in this effort. Special recognition goes to:

- Scott Leonard, New England Division
- Ginny Pankow, Institute of Water Resources
- Jenny Darnell, Rock Island District
- Tom Verna, HQUSACE
- Doug Wall, Wilmington District

Discussions on the methods, templates, and polygons used to quantify and qualify dredging information will culminate in an SDSFIE-compliant, dredging standard. A hierarchal approach and identification of applicable Civil Works databases were used to organize geospatial dredging terms. The standards will be linked to several existing waterway projects, including the Federally Authorized Navigation Project, Civil Works Project Information, the Civil Works Identification System, and the Intercoastal Waterways GIS Data Model (Wilmington District effort). Additionally, the data were also classified into SDSFIE-format geospatial features, attributes, and domain values. The proposed dredging terms encompass dredging events, channel-cut configuration, placement sites, and beneficial uses. A draft set of dredging terms will be available in November, from the Center's Web page located at http://tsc.wes.army.mil. This draft set completes Phase1 of the Dredging Standards Project. During FY02, Phase 2 will continue to develop dredging standards related to detailed beneficial uses, geotechnical classification, nearshore placement, dredged volumes, contract/contractor information, and facility management tables.

For more information about this project, please contact Timothy.L.Welp@erdc.usace.army.mil or Laurel.T.Gorman@erdc.usace.army.mil.

Related Links

Site Name	Description	URL Address
SAME	A professional engineering association focused on current and emerging capabilities and needs of government, military, and private sector engineers.	http://www.same.org/
Foundation Knowledge Portal	Site dedicated to Facilities Management and Information updates.	http://www.foundationknowledge.com/
Federal Geographic Data Committee	Promotes data sharing, standards, data documentation, and maintains a national clearinghouse for geographic data.	http://www.fgdc.gov
Corps of Engineers Geospatial Data Clearinghouse	Central Site for the Corps with links on policy/documents, POCs, and research and development.	http://corpsgeo1.usace.army.mil
GeoBase	GIS resources site supporting U.S. Air Force installations.	http://geobase.org
Integrated Training and Management GIS	GIS resources site to support the Army military training and testing mission	http://www.army-itam.com/gis/page1.asp
Navy/Marine Corps GIS Network	Serves as a communication and collaboration tool for GIS.	Subscribe at: http://www.navy-mc-gis.org

GIS Café	Commercial, online site featuring latest news, articles, resources, jobs, and free downloads	http://www.giscafe.com/
Corps of Engineers Knowledge Base CADD	Supports the Corps design, engineering, and construction missions using state-of-the-art CADD systems and one industry-wide, National CADD standard.	http://ckb.wes.army.mil/
Interior Design	Provides links to various Interior Design, Corps of Engineers, and Department of Defense sites	http://tsc.wes.army.mil/ID_Resources_DoD/index.htm
Virtual Center of Expertise from Civil/Site Design	A one-stop site for locating resources that may assist Civil/Site engineers in their design tasks	http://cadlib.wes.army.mil/CivilSite/index.asp
Open GIS Consortium	Builds consensus on interoperability of GIS software and related technologies.	http://www.opengis.org/
Electronic Cultural Atlas	An interactive electronic atlas of the world from which selected data from regions, eras, and disciplines can be instantaneously accessed.	http://www.ecai.org/
TimeMap Project	A methodological approach to recording cultural data in time and space.	http://www.archaeology.usyd.edu.au/research/time_map/tmoverview.htm
Object Management Group	Establishes industry guidelines and detailed object management	http://www.omg.org

	specifications to provide a common framework for application development.	
International Alliance for Interoperability in North America	A global standards-setting organization, promoting effective means of exchanging information among all software platforms and applications serving the AEC+FM community.	http://www.iai-na.org

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The CADD/GIS Technology Center for Facilities, Infrastructure, and Environment

Harold L. Smith, Center Chief

Laurel Gorman, Outreach Coordinator

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