

Mara Cusker  
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## **Summary of notes from the Planning Workshop for the National Forum on Advanced GIS Applications for Civil Infrastructure Systems, April 24, 2000**

### **Opening and Introduction**

Tom O'Rourke opened the meeting and noted that it is meant to be a very interactive discussion focused on advanced technologies and their implications for infrastructure. Rae Zimmerman then introduced ICIS and its interests in GIS. Mike Rodgers, from Keyspan, noted that while Keyspan has been involved with mapping technologies and GIS since the 1970s, this is the first project where the company is looking outside its traditional utility scope and data and hoping to bring other people and issues together in order to improve customer service as well as operations and management. As the utility world is changing and becoming more competitive, he said, they are looking for more input from key leaders, customers, vendors and others.

O'Rourke discussed the purpose of the planning workshop. The goal, he said, is to identify: 1- the most important issues related to GIS and its applications in civil infrastructure; and 2-the direction of future technology and how it can be used most effectively in serving infrastructure and communities. The next step is to create an agenda for the forum, identify activities, invitees, speakers, the organizational format, and the timing of the event.

O'Rourke then defined Civil Infrastructure Systems as the physical facilities that provide resources and services to sustain and enhance modern communities and those activities in communications, education, and information which enable communities to make decisions about how best to manage these facilities and their future. He referred to the white paper written by Christine Uy and himself ("Advanced GIS Applications for Civil Infrastructure Systems," 4/7/00) as an initial discussion of some important issues for technology and civil infrastructure and as a working paper which is open to comments and revision.

O'Rourke showed a slide with a figure titled "Vision for Infrastructure Management in the 21<sup>st</sup> Century." This vision, he said, should be shaped and guided by effective graphical representation of complex systems, accurate network simulations, risk assessment (through software, modules, real-time representation), and graphical fusion of physical and social databases. Until now, people in infrastructure management have worked in a compartmentalized way, focusing on specific physical assets. We are moving now towards layering in the demographic and social issues, he said, through data fusion and data mining, and exploring the dynamics as they are unfolding in the real world, in real-time.

Achieving the full potential of GIS technology, O'Rourke said, requires creative thinking about: data fusion, selection and use of relevant social and physical databases, evaluation of spatial variability, and reduction of institutional barriers to common GIS use. We need to more effectively match databases. Currently, there is no GIS system which maps all utilities and infrastructure facilities because of the many concerns about competition, security, and jurisdiction. How can we encourage greater interactivity among all these sources of information? We need to identify opportunities to manage these systems and their data in common because they share space and problems. He noted the example of a water main break in the Garment District in NYC which knocked out electricity, the subway system, etc. showing the cascading effect of infrastructure disruptions.

O'Rourke briefly discussed the purpose of the National Forum on Advanced Applications of GIS for Civil Infrastructure Systems. The forum will bring together experts from industry, government, and academia to talk about the current status and the potential future uses of GIS in infrastructure and identify GIS applications to decision-making for civil infrastructure systems. The event, to be hosted by Keyspan at its Metrotech Center in Brooklyn, will take place in the Fall 2000. O'Rourke expects the forum to include four nationally prominent GIS experts to prepare papers, talks, and computer demonstrations of GIS applications. Among the key issues he hopes they will address are: data quality and availability, interoperability, integration of data, and effective community participation.

### **Planning Committee Introductions and GIS Concerns**

Each participant introduced his/her background and experience with and interests in GIS.

Zvia Naphtali, a sociologist who teaches GIS courses at NYU's Wagner School, does GIS consulting for various organizations, and is writing a GIS web course, has significant experience using demographic, economic, and public health data in GIS applications. She said that public access to data is a major issue, especially for public health data. She recommended Michael Goodchild as a speaker who could address the future of GIS and especially its real-time uses which are very exciting. She is currently working on collecting data for 31,000 non-profits in NYC to use GIS to illustrate equity issues, gaps in service and access.

Dennis Ulatowski, from the environmental planning firm of Allee King Rosen & Flemming, uses GIS in writing EISs and said that he sees advances in remote-sensing technologies for assessing land use as very important for infrastructure and environmental justice issues.

John Ziegler, from Spacetrack, said that he has seen huge changes in the way that data is provided by the private sector and that third-party data providers are becoming increasingly important. He noted that the availability of physical data is far behind that of socio-economic data because physical data is simply less documented, less cohesive. In NYS, for example, property tax data is available on CAD for only 20% of the State.

FEMA has managed to map only 30% of the floodplains in the US. He expects physical data to catch up with social and economic data within the next three years. But accessibility of data continues to be the most important issue and institutional barriers are important here. Users are also poorly educated in using, formatting, and accessing data. With regard to technical developments in GIS and use in infrastructure planning, the implementation and management levels of infrastructure will be the most important users of mapping technologies. Affordable and accurate (in timing and measurement) GPS, (RIDAR) 3D GIS, and other advanced technologies will be crucial to these new users.

Rodgers, from Keyspan, has seen GIS and modeling applications since the 1970s significantly improve the utility's business and operations. They have learned how difficult it is to bring data together and improve the accuracy of data. They have also realized that GIS can be used to see not just where leaks are but where they aren't. Keyspan has tended to focus strictly on operational needs but is now pushing towards more strategic applications of GIS, using it for marketing initiatives and understanding its territory in terms of demographics and diverse sets of customers with different service needs. GIS has become an important integration and strategic tool.

Zimmerman said that her work with GIS which involved looking at the demographics around Superfund sites for the EPA revealed the importance of locational data and GIS applications in planning.

Al Leidner discussed NYC's effort to build a mapping velcro system where the hooks are all the geographic markers (addresses, districts, street intersections, census tracts, etc.) and the loops are all the databases which have any of these geographic attributes as a field. The City is building a common map of velcro hooks with every kind of marker to align on a common base map all the data used in the City with any kind of geographic identifier. All agencies and the private sector will then be able to look at data in a common way and use it interactively. They are working to maximize the accuracy of their digital maps and relate block and lot maps, the Cogis file, and the City's Lyon files to the physical base map so that all property data in the City can be related and all critical physical layers and infrastructure can be integrated. They are also working with Keyspan and Con Ed to incorporate utilities into the base map. Utilities may be required to use the basemap for any submissions to the City to register their infrastructure layers with the city for planning and emergency use. The City's Department of Information Technology will have this central base map.

Ideally, the base map will be useful in emergency situations to identify what, where, and who (affected, responsible) much more quickly. The map should also be used to eliminate conflicts before they happen in construction and to encourage agencies to coordinate activities and decrease costs and disruptions. They plan to map the 5 and 10 year capital plans of every agency in the City to eliminate conflicts. The map is currently being used by the NYC DOH to map the West Nile virus strategy and by fire departments and the Office of Emergency Management for other things. There is a City Wide Strategic Plan for GIS available in draft. Funding for maintaining the base map comes from the DEP and DCP and the City is expected to eventually spend about \$100 million

on the effort. The map will be shared with the Federal government to advance the City's place at the table in terms of mapping efforts. Other local mapping efforts in the NY Metro Region are also advanced—Westchester, Nassau, and Suffolk counties—so there is potential for a very large contiguous area to be mapped, making the region a great test bed.

In response to a question from O'Rourke about federal and state participation in advanced mapping, Leidner said that because local data is more likely to be reliable and accurate, the state and federal governments should and have begun to support local efforts. He said that the USACE and FEMA are both using NYC's data and maps.

Rock Miller, involved with the use of GIS in the MTA's capital planning, said that he is impressed with the capacity of GIS as an integration tool. In order to improve this integration, we need to take a broader view of GIS not just as a technology but also as a part of a wider information technology problem which is that the geographic technology side is moving far ahead in terms of integration but there is little integration among agencies. He is also impressed with the capacity for mapping technologies to make the complexities of infrastructure systems and problems clear for a wide variety of stakeholders and to make these issues more accessible to the public. There are many problems in data warehousing and data modeling which make data hard to read and use. How will the ordinary citizen see the data and use it to make decisions?

Randolph Franklin, a computer scientist at RPI and a program director at NSF implemented the first triangulated GIS network in 1973 and is interested in how advances in computing technology, communications, and free information on the web will jumpstart new businesses and affect the use of GIS. He noted that while Moore's Law means that computers speed up and improve every year, user interfaces have not been improving—the Windows mouse interface, for example, has not improved for 30 years. This affects the usability of GIS.

Wendy Dorf has worked on mapping water mains in NYC at the DEP. The project has been completed in a CAD platform and will be converted to a GIS platform. She said that GIS advancements require tenacity and commitment to making data and maps usable by everyone. Fundamental issues are accuracy, accessibility, and massaging data. A map's use for infrastructure is to improve maintenance (especially preventive maintenance) and speed up response to breaks/incidents. The City's base map effort involves a Citywide Steering Committee which includes mostly infrastructure agencies. Issues about distribution and security are important because everyone, not just private utilities, is nervous about things like terrorism. Data quality assurance is also an important issue. Modeling issues are fairly minor but getting data and using it are not. In government agencies, needs assessments approaches are not always possible right away; often they have to just jump in when they can get the money for something and later refine the work or the process (e.g. CAD programmed to migrate to GIS).

Liebner said that the costs of using GIS applications will eventually be very low and the benefits very high. Because every City agency is getting tremendous value from the

integrated work, they are willing to fund more. In response to Miller's question about whether the NYC base map is a public document or whether there are intellectual property issues, Liebner said that this is a major area of debate. While they are considering putting the map up on the web, there are a number of policy issues to consider because federal, state, and local agencies, as well as contractors and private utilities are all supplying the data.

Harvey Simon, the Chair of EPA's GIS work group, from EPA Region 2, said that EPA's original approach to data was like an engineering firm's in that it was very limited in scope and use. He said that the technology generally has not been there to allow decision-makers to use georeferences in a good way. Now, a number of key groups are coming together to produce good data for spatial analysis, like the Census. At the same time, the telecom infrastructure and software technology is advancing to provide real impetus for new and better applications of geospatial analysis. The EPA recently reorganized and formed an information systems office and an information integration initiative which integrates air and water quality data etc. for assessments of facilities, chemicals, regulations, risks. A useful system for putting all this together is necessary. Another important advancement is the transition from paper to electronic data streams with supporting documents which are much easier to access and use. GPS units using wireless technology will be very useful for field work—will allow workers to submit data in real-time from the field and have it immediately codified. The question will become, he said, How can you afford not to have the data? Data will become essential and will be a tiny cost of what infrastructure owners and managers do. The EPA is working on prototyping spatial enabling data over the web where facilities with all their relevant data attached will be available via one connection (vs. all data on separate servers). EPA's Enviromapper allows users to map without actually using the data itself.

Liebner said that there is a need for a national demonstration of the ways in which the federal and local governments can interact to share and maximize a database.

In response to O'Rourke's question about the Open GIS Consortium and Ex order 12906, Simon said that while Open GIS is moving in the right direction to develop practical standards, the current focus is on clearinghouses that point to data but don't make connections immediately and thus cause friction and disincentives to accessing data. The new file formats have been developed so that they don't have to deal with data transfers.

Liebner added that while Open GIS and FGDC are making some progress, the problem is that the federal government doesn't understand local governments. The local governments are the ones who are investing in these technologies, but because the federal government deals with states over local governments, they miss out on these local achievements and exclude the local governments from the deliberations on building data structures (FGDC). This conference must address this problem.

Franklin noted that the relative roles of industry and government are important and that the tension between the two is necessary. Industry gets things done in R&D but doesn't do anything with a long time-frame. Most research is being done by small start-ups and

then big firms buy up those ideas. The government, meanwhile, is also funding related research at NSF and DARPA, but has a more long-term focus.

Christine Uy, a graduate research assistant at Cornell, wrote the white paper on GIS applications in infrastructure and has experience using GIS. She said that data formatting and usability issues are extremely important.

Kathy Stein, from Howard Stein Hudson, emphasized the need to overcome the institutional constraints on both GIS and infrastructure and the need to encourage different jurisdictions and the public and private sectors to work together on competitive issues, legal issues, mutual dependence, and cost sharing issues. She is also interested in public access to data as she sees the private side limiting it and the public side protecting it. While there are practical reasons for barring access to some information, these issues are often used to mask issues of turf and control. We need to sort out real issues of national security and issues of power and control.

Salem Syed, from Keyspan, said that the company is rapidly expanding and needs better tools for information analysis and to improve day to day operations. Keyspan is working to centralize information and use data to make decisions about infrastructure investments and effective management. He is concerned about the accuracy of data in general and especially about integrating outside data with Keyspan data. He suggested Jury Konga as a possible speaker for the forum as he heard him at a GIS 2000 conference in Toronto.

## **Identification and Discussion of Major Issues**

O'Rourke listed the issues he felt came across as the most important in the discussion so far. This provoked further discussion of these and other issues.

### **1. Accessibility**

- policy for data access; decisions have not yet been made on this
- linking the presence of infrastructure and social and demographic data bases and the cost of property
- problems with information distortion

Liebner said that governments are clearly already spending a lot of money to maintain their departments and maintain geographic data just to fuel agency operations. Since the money is being spent regardless, the key, he said, is for agencies to do it more efficiently, more intelligently. In response to Tom's question about whether cities talk to each other about their GIS, Liebner said that Public Technologies Inc (PTI) is one example of a nonprofit association of cities using GIS.

Simon noted that secondary use of data is part of the initial capital investment. Most of the time, data is already paid for because it is necessary just for operations. When organizations charge for data, people complain and/or don't use it. It makes more sense to provide it free because it is then used.

Naphtali brought up the issue of metadata which is also important but often difficult to understand. O'Rourke agreed that the standards for metadata are impossible to understand and use. Liebner said that it is important to put the right people together to create these standards, i.e. people who actually use the data in real life for real purposes.

## 2. Advances in IT and CS

- remote sensing
- real-time GIS representation

Franklin said that it is very difficult to make valid predictions about how technology is going to evolve, develop. The NSF Presidential IT Advisory Committee does make predictions about technology. But we can't really say what is going to happen in ten years (consider email, computer use in general). We can say that new businesses will start and that things will become cheaper.

Rodgers suggested that there will be advances in intelligent structures and remote sensing (sensors in pipes which record data, for example).

In answer to O'Rourke's question about how much information the government should provide in terms of the sensitivity of information and the local community, Simon said that this is a vital issue which will work itself out over time as the applications determine what information is made available. Most information does not have security sensitivity but the 5-10% that does tends to halt the availability of all information. Instead, Liebner said, we should go ahead and put out that 97% of information that is non-sensitive and then focus policy decisions on the remaining 3%.

## 3. Federal/state/local government interaction

Liebner talked about an article by Bruce Kahan (Urban Logic) in NYC (an advisory to DOC, USGS, FGDC) in which he addresses how to create a common data infrastructure using a Lego analogy: if every local government built a lego-type piece according to some standards, then all the pieces could fit together and produce a common system. Federal and state aid to local governments to build these lego pieces would benefit all levels. But there are no such funding mechanisms in place. Instead three or four companies dominate the market and are creating the standards.

Simon said that there is tension between the different levels of government who are waiting on each other for data, working on similar projects etc. A common data framework would be helpful. The National Hydrographic dataset is a good example of a cooperative effort (USGS website). Joint funding is also becoming more common as various agencies try to fill in the data gaps. USGS, for example, has a process to develop digital orthophotography and EPA and other agencies have chipped in. Liebner said that at the PTI conference, there was talk of doing a survey of local governments to see the status of GIS across the country.

Rodgers added that is important to have a set of standards of maintenance for data in terms of updating data and reliability issues. O'Rourke said that the Jan 2000 Exec 12906 is to establish a process for data maintenance. Liebner said that NYC will have its own maintenance standards based on the needs of its users but that a national set of standards is needed. Simon noted that there is also potential for technology that will update spatial databases in all transactional/operational systems so that one update would change the data wherever it is being used.

#### 4. Community Uses

Simon said that we should be providing not just the data but a tool that goes deeper.

#### 5. Education

Liebner said that the Board of Ed should bring GIS into the classroom and make mapping part of the curriculum to train kids to learn about their communities, analyze their neighborhoods.

#### 6. Public Proprietary; Sources of Information

Ziegler said that there is no central place to obtain data, proprietary information. There are some clearinghouse web sites but no central yellow pages. Census tiger mapping has its own format.

#### 7. Data Management

- creating data about data
- data quality

Liebner noted that the people who are actually making the de facto standards, in lieu of anyone else trying, are the consulting firms, the industry leaders who are often working for local governments.

### **After Lunch: Organization of National Forum**

Time Frame: Thursday all day with dinner, Friday morning session, adjourn early afternoon on Friday

Possible dates: Oct 19-20, Oct 26-27, Nov 9-10, Nov 16-17

People need to run calendar checks and web-checks for conflicting meetings, conferences (URISA, Oracle conference, ESRI etc.) It may be good to have it in the same week as something else related to GIS.

Place: Keyspan auditorium, Metrotech Brooklyn—very high-tech, comfortable; and break-out rooms.

Plan: Want to break the days up into 2-3 sessions where the first part would involve 1-2 speakers addressing the whole group and then have smaller breakout sessions which will be facilitated.

Opportunities: Speakers could combine several topics, integrate issues. This would be a good chance to showcase a successful public-private partnership.

#### Tentative Agenda of Talks/Topics and Potential Speakers:

- Thurs a.m.: A1- Information sources, local databases and access (Kastas Taragas, PTI)  
A2- Societal data (Marty Richie, previous director of Census Bureau to set strategic goals)
- Thurs p.m.: B1- Standards and interoperability; data management (including CAD) (Jurie Konga); advanced GIS applications (Jack Dangermond)  
B2- Advanced technologies (3D, real-time, remote sensing) (Michael Goodchild, UC Santa Barbara)  
B3- Systems engineering and assessment (Malczewski)
- Fri a.m.: C1- Community use and education (Edward Tufte, Cheshire Press)

#### Other potential speakers:

- Bruce Babbitt
- Consultants (Convergent Group, Plan Graphics etc.)
- Industry reps (Parsons Brinkerhoff, Bechtel etc.)

#### Logistics:

- Want to start by 9 am, so we should have an 8 am registration. Plan to end by 3 pm.
- Want to distribute materials on presentations beforehand. Miller suggested putting briefing materials on the web (papers, websites etc.), possibly attached to the agenda.
- May want to have the breakout sessions focus on the specific topics/issues rather than wed the main speakers to them.
- Space and time constraints would probably make a controlled trade show difficult. But we could have computers and places for people to set up and give demos.
- O'Rourke suggested that the viewing audience could be larger, include students and others with more general interests, and then the breakouts would be limited to a core group.
- The total audience will probably be around 150 with 30-50 in each core discussion group with professional facilitators (Kathy Stein and her colleagues could facilitate). The auditorium can hold about 250-300 people.
- Miller suggested the possibility of broadcasting the talks over the internet through NYU.