Highlight

Visions of the Information Industry - Dreams or Nightmares?

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"The new source of power is not money in the hands of a few but information in the hands of many," John Naisbitt (*Megatrends*, 1984). In 1985, Rutherford Rogers said in the *New York Times* "We're drowning in information and starving for knowledge."

Where are we today? Where might we be in the first half of the 21st century?

This leads to other, even more interesting questions: "What business opportunities does that suggest?" and "Where do we WANT to be ten or 20 years from now?" and "What can *I* contribute?" And, because of my role in ASPRS, I am also interested in the question "What will people want from their professional associations?"

I selected the following developments because I think they have a bearing on the information industry, and particularly on the industry that we are building around spatial information. Set your imagination to envision all sorts of possibilities for the 21st century; let your mind roam unconstrained.

To look at where we are today and where we might be in the 21st century consider this model — take data as a basic element; data plus processing yields information; the accumulation and processing of information leads to knowledge. And, we hope, the accumulation of knowledge leads to the application of knowledge for the benefit of all. We can envision this as a pyramid, with lots of data forming the base, then information, moving up to a smaller amount of knowledge, with benefits at the pinnacle. I see this progression as another way of stating the ASPRS Mission, which is "to advance knowledge and improve understanding of mapping sciences to promote the responsible application of photogrammetry, remote sensing, geographic information systems and supporting technologies." After reviewing some technology trends, I will present some ideas about what professional societies such as ASPRS can do to help our profession advance toward the peak of the pyramid.

Remote Sensing Trends

From the point of view of remote sensing, we are still in very early stages; in fact, we do not have nearly enough data. That will soon be changing, because more and more satellites are being planned, licensed, funded, and built. The number of Earth observation satellites being planned for launch in the next five to seven years is more than five dozen. Some of the satellites have several payloads, others focus specifically on oceans or agriculture. And, while some of the satellites are research oriented, a number of them are being developed for operational applications.

When data are plentiful, they will move through the economy like a commodity. Just as people consume wheat by buying bread or flour, but seldom by buying raw wheat, so too will people consume data by buying information, not raw data.

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What about the 21st century? Will there be constellations of satellites, so that every kind of data —panchromatic, multispectral (and hyperspectral), thermal, radar — can be collected every day over any place on Earth? And will the data be transmitted to hundreds or thousands of antennas, instead of just 20 ground stations? The trend toward personal computers for ground station use is in its infancy. So one possibility is that we each have our own antenna and ground receiving station. The increase in number of countries and companies launching Earth observation satellites raises the possibility that open architecture may be coming to the satellite control center market.

Or perhaps in the 21st century it will not be *data* that are transmitted at all.

At present, computer processing of remote sensing data uses the radiometric domain, and to some extent the spectral and temporal domains, with less use of the spatial domain. We can expect that advances in expert systems, neural nets, and fuzzy logic will enable us to have computers extracting much more information from the data. The prospect of repeat observations at any desired temporal frequency means

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that we will be able to analyze spatial patterns over time, which will help us better understand processes, so that remote sensing data will lead not just to information but also to knowledge.

We can also envision computers on future satellites processing data into information; perhaps in the 21st century on-board computers will not only process data into information, but compare new data to old and new information to old information, and by means of artificial intelligence generate *knowledge* to be transmitted to Earth instead of *data* or even *information*.

Trends in GIS

From a GIS perspective, we are further along the continuum from data to information, knowledge, and benefits, because a GIS helps us create information from data. While getting data into a GIS has been a bottleneck, the world is on its way to becoming more and more data-rich. For example, the columns in *GIS World* and *Geo-Info Systems* on new products report several new data products every month. What will happen in the 21st century? I can easily imagine that all maps are digital, and paper maps are rarely used. With 3-D visualization, I expect the kinds of information traditionally conveyed by maps will be much easier to understand.

Here are some other interesting developments: AT&T has introduced "500" area codes, a "follow-me anywhere" telephone number configured so that the computer will route the call to a series of numbers, e.g., office, then car, then home. You can change the order of the routing according to the time of day, and can enter new numbers remotely when you travel.

The Internet had more than 50 million users in 1996. In the last year or two, as the Internet has moved from being a government-financed tool for academics, to a source of entertainment

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ORGANIZATION OR COUNTRY	WHAT	WHEN
India	seven satellites	by 2004
European Space Agency	Envisat	July 1999
Canada	Radarsat-2, Radarsat-3	being planned
SPOT	SPOT 4	January '98
	SPOT 5	2002
Germany, Russia	MOMS 2P	
China, Brazil	CBERS, CBERS-2, two higher-resolution satellites after that	
Japan	ADEOS-2	1999
	ALOS	2003 or 2004
NASA	Lewis and Clark	1997
	LightSAR	concept studies
US, Japan	Tropical Rainfall Measuring Mission	1997
Russia	RESURS01-4	1997
	Almaz-1b	1998
	Almaz 1c and Almaz 2	being planned
Taiwan	Rocsat	April 1998 Korea
	MultiPurpose Satellite, Kompsat	1999
NASA	Landsat 7	1998
	the first of the many EOS satellites	1998
Argentina	SAC-C	1999
	SAC-D	2002
	Sacom	later
Italian Space Agency	Sky-Med Cosmos	2000
Australia et al.	ARIES-1	2000
Thailand		under contract
Malaysia	microsatellite (50 kg)	Sept 1997
Germany	microsatellite	1997
EarthWatch	EarlyBird	1997
	two QuickBirds	1998
Space Imaging EOSAT	the first one-meter satellite	Dec 1997
	one-meter satellite	Sept 1998
OrbImage	OrbView2	1997
	OrbView3	mid-98
GDE Systems	satellite with one-meter capability	has a license
GER Corporation	six to eight small satellites	starting 1998
Boeing et al.	Resource21, 4 satellites	1998

and information, the use of the Internet is growing faster than the number of subscribers: traffic through one of the main connection points has been doubling every six months, while the number of subscribers is doubling only every year.

Because it has become the "World Wide Wait," more and more users are bypassing the public Internet. Companies are setting up private "intranets" within single locations and "extranets" with branches and partners. A group of American research universities plan to build "Internet II", dedicated to academic traffic and free of commercial users, much as the Internet itself was just a few years ago.

In California, a company named Savi has used low-cost commercial cellular-telephone technology to develop a family of radio tags that comprise an ultra-low-power transceiver, a memory chip and a five-year battery. In combination with global positioning satellites, containers with these tags can know where they are. Using communication satellites in low orbits, the tags can tell people the position of the containers. This has great value to trucking companies, which estimate that normally 20-30 percent of containers are misplaced at any one time. UPS is testing these tags in Houston and San Francisco. It sounds conceptually like the Lo-jack, a device that can be installed in a car and activated to transmit the car's location to the police, if the car is stolen. With these technologies already available, what might be possible in ten or 20 years?

In other developments: a subset of MapInfo software is now available within Microsoft Office and Excel for Windows 95; Strategic Mapping Inc. has licensed Corel Corp to use SMI's technology in Corel's CD Office and CorelDRAW; SimCity has been so popular that Maxis developed SimTown for children. Now, children are gaining empirical understanding of spatial modeling, and soon mapping tools will be as readily available as word processing and spread-sheets are today. ERDAS is introducing a package that is totally compatible with Microsoft Office so that you can take a map from the ERDAS application into a Word document, work with tabular information in Excel, and return to your ERDAS application.

In an airline catalog last year, Timex and Microsoft joined to offer a Databank Watch which will do wireless transfers of phone numbers, appointments, and reminders from a PC to a wristwatch. Nokia now sells a device that is a combination personal digital assistant and mobile telephone. The handset opens to provide computer access to the Web and e-mail. And, if you've flown recently, you know that now you can not only make, but also receive, telephone calls at your seat. All these products and services are available today.

Surely in the 21st century geographic understanding will be more sophisticated than it is now. Young adults who grew up playing SimTown and then SimCity will feel at home using virtual reality to explore the interconnections of systems and the impacts of decisions.

In the United States, nearly 40 percent of homes already have a PC. Outside the United States, the PC market is growing more than 20 percent per year, with the European home-PC market growth estimated at 35 percent in 1996. PC sales outside the U.S. surpassed the U.S. market for the first time in 1996.

What about multimedia, combining the computer, telephone, and television? Ed McCracken, head of Silicon Graphics, believes 85 percent of multimedia users will interact with the information superhighway via television. Andrew Grove, head of Intel, on the other hand, envisions that PCs will play the leading role.

These visionaries may be unfamiliar with the findings of a survey by Apple, which found that 85 percent of those responding were terrified of computer technology.

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(Did you see the *Wall Street Journal* article about the new PC user who tried to use the mouse as a foot-pedal? And I've also heard that someone thought the CD-drive was a cup-holder!) My belief is that, to most consumers, the complexity of the technology is not yet sufficiently hidden. The complexity of an automobile or a fax machine or an ATM machine, in contrast, is hidden well enough. There is clearly a business opportunity in developing a simple user interface.

Johnston County, North Carolina offers public access to its GIS via cable TV. In Newport Beach, California, library patrons can easily maneuver through the city GIS, without realizing they are retrieving data from the municipal building across town. In Glasgow, Kentucky, the municipally-owned Electric Plant Board has been delivering high-speed Internet service since 1990 — on a network originally built for electric-facilities management. And these examples pale in comparison to Qatar's GIS, with 16 participating Ministries and publicly available kiosks. What all these cases have in common is that information technology is helping governments deliver services to citizens more effectively than ever before.

Digital agents are being developed to do our shopping, sort our e-mail, and accept or decline our appointments. I can imagine that in the early years of the 21st century, we can turn loose computer agents, not only to shop for us but also to request satellite acquisitions, assemble spatial data from various sources, analyze it, and call us on our 500-numbers to ring on our wristwatches to provide us the information we require.

The progression from information to knowledge is still in early stages. If we think of the "4 Ms" — mapping, measuring, monitoring, and modelling — the first two are primarily associated with processing data into information. The third "M", monitoring, involves comparing and processing information, and so moves in the direction of knowledge. It is the fourth "M", modelling, which presents the real opportunity to develop knowledge from information.

Modelling in GISs today is in elementary stages. One of the challenges is that some of the factors influencing processes are difficult to capture in quantitative spatial data; another challenge is that we do not yet know enough about cause and effect relationships in all sorts of interesting processes.

Or, as Joe Berry put it in his (March 1995) column in *GIS World*, perhaps we have the cart — the tools to characterize spatial relationships — in front of the horse — the scientific understanding of the relationships we wish to model.

Those of you who know me know I'm an optimist, so, of course, I expect this to improve! At least with these high-powered tools, we have the capability to develop empirical models. By studying these models, we can generate hypotheses and then predictive models. We can compare model outputs to observed and measured distributions, develop new hypotheses, and by this process improve our understanding.

On another front, I draw hope from the report in *Newsweek* (10 April 1995) on "behavioral economics." Some economists now incorporate such elements as the herd instinct, irrational fears, and poor self-control into their economic models. Traditional economic models based on "rational economic man" cannot explain real-world phenomena. By considering egotism, stubbornness and other such traits, economists can improve considerably the relationship between economic theory and actual human behaviors. In the 21st century we will probably better understand both the spatial and the psychological aspects of economic behavior.

What happens when we link GISs to virtual reality tools? When we get the horse of scientific understanding in front of the cart of spatial analysis, the two parts of virtual reality — simulation and interaction — will improve our understanding of the relationships between project plans and real-world consequences. Imagine that planners can enter a virtual reality, implement various plans, and compare the results. Or imagine funding agencies touring virtual realities shaped by different project plans, before they allocate the implementation funds!

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Computer Technology

Would ubiquitous computers make the world a better place, or not? One example of the power of computers to make the world a better place can be found in today's automobiles. Oldsmobile introduced a GuideStar option that includes GPS and a map database; you enter your destination and it signals as you approach turns and exit- and entrance-ramps you need to take. Some rental cars are now provided with this option.

The $2,000-worth of electronics in the average car today increases the safety of everyone on the roads. Anti-lock braking systems can pump the brakes 20 times per second, more than twice as much as a professional race car driver, let alone more ordinary folk. And by using the same monitors during acceleration, the result is electronic traction control, now available on Mercedes-Benz cars. All Greyhound buses are equipped with radar which signals if the bus is too close to the vehicle in front. So the vision for the 21st century? We will be able to safely put our cars on autopilot! And if your car has a Remote Emergency Satellite Cellular Unit (RESCU), available today, and you are in an accident that deploys the airbag, the car's computer uses GPS to determine location, then automatically calls an emergency service number by cell phone and reports the location of the accident.

Another example of the potential of computers to make the world a better place comes from the John Deere Precision Farming Group, which provides users access to a differential GPS correction signal and an array of crop-mapping and monitoring gadgetry in its "GreenStar" product. This allows farmers to map yield variation while harvesting, and then optimize seed and fertilizer inputs for that field the following spring. Such a capability will improve yield, reduce expense, and also reduce the environmental impact of excess fertilizer.

An example I recently learned about is a product called Strider, which puts a computer with voice synthesizer into a backpack. A blind person types a destination into the computer, shoulders the backpack, and the system provides directions to the destination. This product, being tested now, will be on the market soon. The initial price is around $1500 on top of the cost of the computer. The same capability could also be used by tourists once the price comes down.

Combined Trends

For remote sensing and GIS to move into the mass market as telecommunications and GPS have, we need to remember three things: simplify, simplify, simplify. Imagine a customer ordering spatial information without ever knowing the meaning of remote sensing or GPS or GIS, without ever using the words multispectral, kinematic or Boolean!

In the mass market, customers deal in one way or another with three variables: quality or features of the product, price, and time to delivery. Or to put it another way, we all recognize the reality behind the sign at the auto mechanic's shop: "We do good, cheap, and fast work. Pick any two." In the first scenario, the prospective customer needs a map of the Guthrie quadrangle with 1-meter contours and a specified map accuracy. Getting the map next week is worth paying a higher price.

In the second scenario, the prospective customer needs a map of the Clayton Forest, minimum mapping unit two acres, at least 80 percent accurate, and he has limited funds to spend, when could the map be ready?

In the third scenario, this prospective customer specifies both a deadline and an amount of money and inquires how accurate a map of the land use of Henry County he can get.

The Luddites of the 19th century, who took hammers and axes to machines in an attempt to prevent mechanization of jobs, have their descendents in the 20th century. For example, my local bookstore has such titles as *Silicon Snake Oil* (by Clifford Stoll), and *The Future Does Not Compute* (by Stephen Talbott). The technophobia suggested earlier by the results of the Apple survey, that 85 percent of the respondents are fearful of computers, coincides with predictions that information technology will destroy millions of jobs. (See for example Jeremy Rifkin's book *The End of Work.*) Historically, technological change has both destroyed and created jobs, and the growth in jobs has outpaced the loss. Is the change in information technology so different from past technological changes in its rate or kind that we should expect destruction to exceed creation of jobs?

First, note that the United States has invested much more

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heavily in computing and related technology over the last decade than has Europe, yet Europe has about twice the unemployment the U.S. has. If new technology reduces the labor required for a volume of output, then either the price of the product falls, or wages rise, or profits (and therefore money for investment) increase, or some combination of these three. In other words, there is an increase in consumer purchasing power. Whether that translates into increased demand for that product, or for other products, the economy as a whole sees growth. The 1994 OECD Jobs Study found that the U.S. and Japan, the countries most successful in creating jobs, are also the countries leading the shift in kinds of jobs, toward a high-tech, knowledge-based economy.

For people who are not Luddites, another question arises: will changes in information technology necessarily widen the gap in wages between the haves and have-nots? Given that some computer programs available today make medical diagnoses identical to those of qualified physicians, we may find that computers can lower wages for skilled work, not only for unskilled work. If computers take on such work as accounting and law, the result might be a lessening in the gap in wages! Another aspect of this is that information technology allows jobs to move more freely, so that the programmer or data entry person can live anywhere.

Benefits of Membership

This leads back to a theme raised earlier: What will people expect from their professional associations in the 21st century? And what can we do so that people continue to get value from belonging to the American Society for Photogrammetry and Remote Sensing? What will professional societies offer their members?

We need to sustain and enhance our efforts to be the authoritative source of information for photogrammetry and remote sensing, and their associated technologies. A significant challenge we must consider is how electronic publishing fits into our publications program. Ever since *USA Today* demonstrated that distribution could happen **before** printing, publications have become increasingly customized. For example, *Newsweek* no longer has a U.S. edition, it now has regional editions, each with several pages of ads for companies within that region.

Conventions and workshops are other ways we communicate the substance of our profession. And think of the possibilities created by the technologies that enable us to have electronic meetings. One scenario of the future is that we will become the "theres" and the "there-nots", meaning some of us will be able to do our work anywhere, and others will have to be "there" to do such things as physical labor, face-to-face service, or factory work. It is an interesting paradox that technologies which focus explicitly on spatial location may allow us to be "there-nots"!

Workshops and seminars help us as members to update our skills and broaden our understanding of the field. The National Research Council says that it used to take seven to 14 years for half of a worker's skills to become obsolete. Today it takes only three to five years for 50 percent of our skills to become outdated. With the pace of change in the technological aspects of our profession, and the trend of reduced employer support of employee career development, professional societies have an opportunity to expand their role in providing education and training as a service to members. Technological developments in telecommunications and computers will continually modify the options and redefine the competition in supplying tutorials and workshops to members.

Another important area for effort within professional societies is strategic planning: I see strategic planning as an on-going process in ASPRS which helps us communicate more clearly with each other and which helps us look at the relationships between our efforts, our results, and the world at large. As the environment in which we work continues to change, seemingly more rapidly all the time, we will need to identify ways to continually check our strategic plan against changing circumstances, and refine it as we go along. As Charles Darwin pointed out, "It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change."

Standards are another area presenting ASPRS and other professional societies an opportunity and a challenge. The importance of standards will increase dramatically as the use of geographic information systems continues its explosive growth. And as mapping tools move into the mass market, we will face increasing challenges in maintaining standards of scientific rigor.

In closing, I hope that this survey of developments and likely trends has stimulated your imagination, and that you are excited about the possibilities of the 21st century. If you want to shape the role of a professional society in the mapping sciences, I invite you to become more active in ASPRS.

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