

CHANGING BORDERS AND SHIFTING FRONTIERS: CARTOGRAPHY FOR THE NEW MILLENNIUM

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WHAT'S HAPPENING?

Today we read about the "Global Paradox". "The bigger the world economy, the more powerful its smallest players". (Naisbitt, 1994, p.5). Futurists, like Naisbitt, are telling us that two trends, that on the surface appear to be contradictory, are in fact rapidly changing how humans work and live on the Earth. On the one hand we see a homogenization of lifestyles worldwide. Consumer tastes are converging on such things as Levis, soccer, chopsticks, karaoke bars, and even wearing baseball hats backwards, as global television conveys lifestyles that are being replicated worldwide. On the other hand local differences and unique characteristics are being emphasized. Trade barriers are being removed creating potentials for smaller businesses to compete internationally with large corporations. Deregulation and the globalization of finance is making capital available to many more local entrepreneurs.

Today quality can be realized in all manufacturing pursuits so that the economic advantage lies with those manufacturers who can speed products to the market. Established name brands are no longer certain to be winners. In the United States major national beer brands, like Miller, Busch, or Coors, are fighting for market shares not with each other but with many local mini breweries. The obtaining of patents and copyrights slow down the product distribution process to an extent that they are becoming ignored. The half-life of most products that make a profit can be measured in months not years. If you withhold the product from the market awaiting a patent, you have lost most of your profit. Additionally, many products are being marketed such that they can be customized to the user at the time of purchase. Small firms rather than multinational corporations are becoming more attractive to individuals as places to work. But perhaps the most important of all of these trends is the rapid rise in the use of computers and telecommunication. This has enabled small corporations to vie with big companies. This allows for the individual to work with other individuals without the encumbrance of hierarchical management overheads. This has enabled the breakdown of large corporations into smaller firms and according to Naisbitt, eventually, will lead to the disintegration of large ethnically diverse national states into many smaller nations. (Naisbitt, 1994, p.34-5).

The fact is that as the global economy gets larger (welcome the former communist nations of eastern Europe, China and other Asian nations into the global economy) each component part becomes smaller. Strategic alliances are becoming more numerous than mergers, both corporately and politically. Competition and cooperation are existing side by side not in opposition to one another, as fierce competitors may sign a strategic alliance to cooperate on one product of their business so as to meet the demands of the world economy, while still competing in other product areas. Due to the introduction of electronic technology, global financial institutions are now in place that make it possible to transfer currencies instantaneously. ATM machines and VISA and Master cards are replacing cashiers checks, travelers checks and ordinary cash transactions. Tourism is becoming a second global industry. Already according to Naisbitt one in nine employed people in the world work to support the tourism industry. (Naisbitt, 1994, p.132). Tourism makes the local differentiation of space a marketable commodity for a global industry.

So what do these trends have to do with cartography in the 21st century? Simply put, cartography is rapidly evolving in the midst of this global paradox and we as cartographers must understand what that means for our future. I would like to make the case that cartography has a support role in both the global collection and standardization of spatial data and in the local use of that data. Clearly the same technological shift, that is so important in aiding the creation of the global financial economy, and the expansion of global tourism, is radically changing cartography. This technological revolution is allowing the individual to access spatial data and to perform spatial analyses which cartographers have traditionally performed for the map users during the map making process.

The technological revolution is forging a shift in the underlying paradigm of the cartographic discipline. I am excited about the potentials for society of these paradigm shifts taking place in the use of spatial data. We are in a period of the "democratization" of the use of spatial data by the individual and a renaissance in geographic thinking by the general public, and I doubt if any of us has a completely clear vision of what our field will encompass even ten years from now.

We must continually remind ourselves that two fundamental changes are occurring simultaneously, not sequentially. Technology and its instrumentation are changing, and also an intellectual paradigm shift is occurring. The two are not the same although the technological change is speeding the paradigm shift. Innovative uses and different modes of thinking and communicating spatial data need to be the items capturing a cartographer's interest. These changes enable the user, i.e. every individual, to easily produce a visualization that is freed from the necessity to also accurately and precisely render the spatial data. Future users, the citizenry at large, having direct access to a database containing accurate data; rather than having to depend on the cartographer to interpret and then render that accurate data as part of a visualization and then, as a user extract data from the visualization for use in subsequent analysis; will directly produce analyses and visualizations from the database. This will precipitate major structural changes in our institutions and lead to a profound increase in the use of spatial data for all types of decision making. In effect, electronic technology has taken one tightly controlled multiuse product, the printed map, converted it into a digital database and thereby created the capability to produce two outputs: the accurate analyses of spatial data, and the creation of visualizations of that data which support an analysis. This implies major changes that most cartographers have not yet fully understood.

Currently our field of cartography is primarily organized as it was when analog technology was the only technology which we used. We need to let our field evolve into a modernized state completely based upon electronic technology. Institutional vestiges of analog technology are everywhere and we "establishment" cartographers are perhaps more guilty than others of holding onto the status quo. For example, national mapping organizations as we knew them under analog technology, are obsolete. The copyrighting of digital data to such institutions as the Ordnance Survey is a desperate attempt to maintain that organizational vestige in the United Kingdom. We need to think of another institutional structure for cartography. Is the ICA helping the field of cartography to evolve? Or is ICA placing the field in a straight jacket that was defined long ago when a different technology was prevalent?

ENABLERS

There are at least two primary enablers that are helping our field rapidly evolve: electronic technology and a renaissance in geographic thinking. The larger and stronger of these enablers in the short run is electronic technology. Cartography now has two primary products: *precise analyses* of digital data residing in our databases, and *visualizations* of those data and the analyses. To perform precise analyses we need a methodology and accurate data. Fortunately electronic technology has increased our capabilities for obtaining accurate data. The global positioning system, GPS, has made the accurate determination of positions of points on the surface of the earth commonplace. These positions form the foundation for a global spatial data infrastructure which along with a framework of digital base data consisting of transportation routes, hydrography, and boundaries, allow for the collection and use of an indeterminable number of data attributes possessed by positions and areas on the earth's surface. Electronic technology also has enabled us to more easily capture data remotely, to relate those data to one another spatially and to increase our capabilities to display or visualize the results of our precise analyses.

The renaissance in geographic thinking and the advent of easy-to-use geographical information systems, GIS, can be viewed as mutually reinforcing and they constitute a second enabler. Without GIS, people could not adequately analyze spatial data and answer their geographic questions. With GIS it is possible for people to answer questions that they have always wanted to be able to answer, and this capability provides a platform that leads to other, even more involved, questions which require additional and more precise spatial data. Thus with GIS, geographic thinking can progress beyond those questions which the analog map could answer. We can posit that at the intellectual level, the paradigm level, our discipline has risen to a new plateau that accommodates greater intellectual complexity.

Together the enablers enhance our capabilities to realize the benefits of the paradigm shift which the electronic technology has brought to cartography. If Naisbitt is correct in his assessment that tourism is the second industry, after financial systems, to become globalized; geography and cartography, which should play a fundamental role in global tourism, need to throw off any shackles of their analog pasts and fully concentrate on changing the borders and shifting the frontiers of their disciplines as we enter the 21st century.

CHANGING BORDERS

I have mentioned several changing borders in our field already. To systematically look at cartography's changing borders I will use an old manufacturing model as an organizing principle. Perhaps this will prove to be the Achilles heel of my speculation since using an industrial age model to discuss an information age phenomenon may render the discussion ill-structured. My chosen model separates cartography in the information age into its raw materials, technology and processes, products, and institutions.

Before starting the discussion, I raise one caution: in the electronic technology dominated information age, we must realize that more and more non-cartographically trained individuals will be using images and making maps. Therefore, I would like to repeat one of the basic tenets of maps which cartographers so often take for granted that they often fail to appraise non-cartographers of it. That basic tenet is the difference between a recorded image and a map. We often forget that a map is on a different intellectual plane than an aerial photograph or a satellite image. The latter two simply record what their respective emulsions or electronics allow them to record. On the other hand a map displays the results of some human intervention and interpretation with the recorded data. Some conscious intellectual generalization, using that term in its broadest sense, has taken place in the creation of a map. Most often some data have been deleted and other data have been emphasized or exaggerated. The texture of the image has been radically altered in making a map. Therefore a strict comparison of maps to imagery is

not relevant. They are two different spatial displays aimed at different purposes. The general public needs to be reminded often of this distinction to avoid making the ridiculous mistake of expecting a map to do what an image can do or vice versa.

Raw Materials:

Since the advent of returnable space flights in 1957, highly precise repeatable observations of the surface of the Earth have been possible and have become commonly accepted as an available data source for cartographers. Photographs from German rockets during the second world war pretold of things to come, but systems such as LANDSAT, beginning in 1972, really represent the beginning of the systematic mining of this new source of raw materials for cartographers. Today cartographers rely on directing electronics aboard highly stable platforms in space to record digits which are converted almost instantaneously to images. The fact that the data arrive on earth in machine readable form, i.e. digitally, is a major advantage over older aerial photography which had to be developed, most often with a wet process, and then the image had to be converted to digits. Both in terms of accuracy and speed, the electronic capture and processing of digital data is a vast improvement over the older air photograph.

This raw material is limited however to sensor observable Earth. Unfortunately many data sets which cartographers could and should work with are simply not recordable by electronics aboard satellites. The availability of sensor derived data which constitutes the foundation and part of the framework of a global spatial data infrastructure, which combined with non-sensor observable data which the cartographer can collect using GPS technology will provide a complete global spatial data infrastructure. Although this latter data collection is more expensive and human intensive, it is a vital part of the support for the paradigm shift which allows greater intellectual complexity in terms of questions asked and analysis performed on spatial data. In fact, derivative data sets will play an increasingly important role as society utilizes spatial analyses and visualizations to better understand both global and local contexts. This in turn ensures an increased demand for data which are not recordable by sensors. My prediction is that the foundation and framework layers of a global spatial data infrastructure will be in place very soon, perhaps by 2000. This global infrastructure will need continuous update and maintenance. This will be cartography's contribution to the global homogenization of spatial data and it should be freely available to all potential users.

Cartography's contribution to the local component of Naisbitt's global paradox will consist primarily of the creation and maintenance of derivative data sets relating to local areas and points which will be referenced to the global foundation and framework. Some of these data sets will be free and others will be proprietary. Concentrating on both the global and local components of database creation and maintenance constitutes a border that cartographers need to cross. This border shift raises important new and reformulated questions such as the value of copyright of spatial data, the confidentiality of spatial data, the management of spatial databases, and liability issues stemming from the use of spatial databases.

Technology and Processing

To date cartographers have been incredibly successful in using the new technology to replicate analog processes. Although this is to be expected when a new technology enters a field, the time is now past when we should expend our energies on the further refinement of digitally replicating analog processes. We need to take advantage of new techniques and process which were not possible in the analog cartography era. For example, the use of exaggeration as part of generalization should now be a standard operation. We can and should utilize data sets of differing resolution to create any map visualization. In analog days our axiom was "always compile from a larger to a smaller scale". Today that axiom is obsolete. Today we need to model spatial features. Resolution of the data is more important than scale of the visualization. A stylized model of a well-defined geographic feature or system is appropriate for

certain visualizations. Fractals (Lam and DeCola, 1993) can help us and examples of the use of fractals to create coniferous or deciduous forests, or dendritic stream networks, or generalized or exaggerated coastlines are appropriate in tomorrow's visualizations. Economists and sociologists have modeled their subjects for years and have not concerned themselves with the true complexity of the real world in their models in an attempt to increase understanding. Cartographers/geographers need to do the same. There is a great need for the visualization of the many potential different spatial outcomes of political, social, and economic decisions.

We do this by fully utilizing the new processing techniques which GIS make available to us. The user no longer is limited to a small finite number of printed maps or images created by unknown individuals. With the new technology, the user can modify and create, in real time, potential outcomes which can be visualized. Cartography has only begun to realize the potentials of electronic technology in this arena. If we are to survive as a vital profession we need to spend less time on replicating past processes and systematize new processes that electronic technology has made possible. This border which cartographers need to change is to explore to the fullest the capabilities which electronic technology allow for abstracting and modeling human and physical processes and their interactions in earth space, and for displaying the potential outcomes. This changing border calls for the greater use of cartography for modeling, planning, and predicting future habitats and less for accurately rendering the current or past conditions of the earth.

Products

As I suggested earlier: (1) the paradigm shift has separated our products into two sets: precise analyses and visualizations; (2) both are derivable from digital databases; and (3) these databases have both a global and a local component. To date cartographers have concentrated on the replication and production of our standard cartographic products. This is a border we need to change.

Future cartographic products, whether precise analyses or visualizations will be situation and user specific. Individual users will create these products. Cartographers will not reproduce multiple copies of printed maps under tightly controlled conditions. When using analog technology, scale was often predetermined by the final size of the output, the area to be covered, and sometimes the size of the available printing press. The cartographer working within those constraints created the best compromise map which accurately portrayed the data or the results of the analysis. Today's technology allows much more flexibility; the ability to zoom in or out on a visualization, and the ability to pan a wide area of coverage, viewing at larger scale only a portion at any one time. Resolution of data is more important than scale.

As computers become hand held and more lightweight, fewer and fewer hard copy maps will be necessary. Demand for our cartographic products will change. For example, in terms of navigation systems, a spoken triptych may be an alternative to a visualization. This would simply speak a driver or pedestrian from one point to another. The necessary components to create this flexibility will be standards, accurate data, and precise feature definitions. Rules for accessing and using digital databases and for creating products are also needed.

The border we need to change is to begin concentrating and exploring new products and de-emphasizing standard cartographic products. This border change may be harder for the individual cartographer to accept. In one sense it appears to be necessary to give up some of the freedoms which the cartographer has enjoyed in the past. Standards and rules might appear to some to stifle imagination and creativity. I do not believe this to be the case. Certainly in comparison to the freedoms which a cartographer had in creating a printed map, electronic technology presents a greatly expanded range of media and products which a cartographer can use to create a visualization. Softcopy maps have color as a given, time sequences and animation are now routinely possible, and multimedia can be used to enhance the impact

of a visualization. In one real sense cartography has become multidimensional in its tools. This presents far more freedom for the cartographer than was enjoyed using analog technology. The use of electronic technology in cartography represents the end of three hundred years of stove pipe thinking which always resulted in the creation of a printed map.

Institutions

With the global paradox and the technological and paradigm shifts, cartographers must look closely at their existing institutions. Institutions that wish to survive must take deliberate actions to ensure that survival. It will not happen automatically. I mentioned earlier that the national mapping organizations as we have known them are obsolete. Look at what has happened in the United Kingdom, Canada, and Australia; and now somewhat radical changes are taking place in the United States. National mapping organizations were convenient when analog technology was our only choice. The need to cover the territorial limits of a nation with a precision that could insure its defense and at the same time be useful to the citizenry at large, the high cost of capitalization, and the need for highly skilled artisans to make the maps were elements dictating the need for a national mapping institution. Further, considering that in most nations the population was not evenly distributed over the surface area controlled by the nation, meant that the cost of consistent and complete analog mapping of the nation had to be subsidized by the government.

Today we have the same concentrated population distributions, the same need to defend the territorial limits but we have low cost capitalization of equipment which can be used by any unskilled individual. The result is more visualizations, more analyses without the need for visualization, and everyone fulfilling personal needs almost instantaneously. The citizenry is no longer dependent upon the "one-size-fits-all" products of a national mapping organization. What should a national mapping organization do in the 21st century?

We also have vestiges of cartographic publishing houses that since the time of the Dutch Atlas makers of the sixteenth century have created products much in demand by people. Do people want hard copy books of small scale static maps? New companies are creating selected databases and devising simple analytical tool kits that enable each individual to create the equivalent of a personal atlas. In fact I do not know what constitutes an "atlas" today. Perhaps the concept of "atlas" needs redefinition.

One can speculate with a large degree of certainty that a hierarchically organized large institution like a national mapping agency that creates consistent topographic coverage for a nation will be replaced with a flatter organization that forms opportunity driven strategic alliances with private corporations and academic researchers to create the databases and tool kits which individual citizens will need to satisfy their desires for spatial information derived from the spatial databases of the future. In effect teams of individuals, each drawn from a different agency, university, or corporation will work on the creation of a given product or process. Such strategic alliances appear to offer one method of transitioning from the present institutional structure to a future team-based institutional structure. Both competition and cooperation will be needed; not as opposites, but as partners, to get a task accomplished. In a global economy it is not unreasonable to expect that a private firm in partnership with a governmental agency from one nation will bid on cartographic work to be done in another nation. This is already happening. This may appear strange to some but I believe that today's competitors will find it necessary and desirable to join forces to create and market a specific new product while continuing to compete with other products. ESRI and Intergraph will continue to have competing GIS software tool kits but the two firms might find it desirable to jointly agree to a standard format for metadata statements and for data exchange and to a standard set of feature definitions for database creation and geographic analysis.

The United Kingdom is experimenting with granting the Ordnance Survey data copyright privileges and asking the Ordnance Survey to more fully recover its costs. The Institut Geographique National in Paris has been given more freedom to operate like a private corporation by competitively bidding on contracts

for its services. I view these experiments as only the first in a long series which will result in an evolved institution that is in harmony with the new electronic technology. I can not describe that institution today, it must evolve. This border must change.

New institutions in addition to reconstructed existing institutions will be created. It is conceivable that a whole new layer of cartographic corporations may come into existence. This layer may be described as data wholesalers or re-packagers. The global databases in the global infrastructure may need to be packaged in a variety of different ways for efficient input into general circulation models, traffic flow models, or to analyze specific effects of predictable earth events like hurricanes, tornadoes, floods, earthquakes, volcanoes, migrations, and wars under differing conditions or constraints. Individual users may welcome spatial data packagers much as we welcome the preprocessing of food, fast food restaurants, and news and weather summaries.

The technology which we now employ does not work well with a management hierarchy. It does work well by enabling all interested individuals to communicate directly via electronic mail with one another. The low capital requirement does not require elaborate laboratories or printing facilities which in the past could only be agglomerated at a few locations. The low capital requirements do allow for many distributed workplaces. These factors will determine the type of institution that cartography will need in the future.

The role of the ICA in this changing situation must be studied carefully. What type of international organization is needed? Is one needed? Has ICA outlived its usefulness? We need to ask these questions and the ICA Executive Committee needs to be concerned with the answers. Is it time for the ICA to become an individual membership organization? Does the ICA need to have a "home page" on the Internet? If so, what does the home page direct the "surfer" to? What should ICA's role be with respect to the United Nations? to the International Standards Organization? to the creation of a global spatial data infrastructure? I believe that ICA must now be studying these questions. Otherwise not long into the next century ICA may find itself an anachronism. National mapping organizations and national societies of cartographers will both change. Will their changed identities still wish to pay dues to an unchanged ICA? Clearly there are institutional borders to be changed.

SHIFTING FRONTIERS

Finally I want to discuss some shifting frontiers in cartography. I think that we are moving in many directions at the same time, and I hope that by outlining some of these directions, trends may become more evident. I want this discussion to point out the edges of the potential exploitation of cartography of the future. Some of you may think that the ideas which I mention are not part of cartography. That is precisely my reason for mentioning them. I think that we have to question our currently established frontiers.

For example, what role should cartographers play in real estate transactions, if any? It is already commonplace for multiple listing services to use videos of the homes which they have listed, particularly the larger more expensive homes. These videos provide the potential buyers, whom often are currently living and working miles from their new location, with the opportunity to walk through and around the house they are considering. By perusing a number of videos, when the buyers do arrive at their new location, they already have narrowed the choices under consideration and this saves both the real estate agent and the buyer considerable time. Is there a role for cartographers here? Is there a need for simulations of neighborhoods in a city so that potential buyers can select the neighborhood in which they may wish to locate prior to viewing real estate videos of specific properties? Could the cartographer not provide an extended service for realtors? One could easily envisage starting with a city street map and expanding it into a multimedia presentation of the different neighborhoods of a city. This would involve letting the user "drive" from a neighborhood to the new place of work. It could also include advertisements by stores and malls in the city. A new cartographic product which presents an animated three dimensional frame of reference using vector data, raster images, sound and color is possible and could be a great addition to a national real estate sales marketing campaign or to local Chambers of Commerce.

A second frontier in which cartographers are and should play an important role is intelligent vehicle navigation. This area has already collected a substantial amount of digital networked data. There exist several competing comprehensive highway networks of the United States in digital form. Each has a different set of attributes and each is being used to route trucks or service repairmen, to systematically load delivery vehicles, and in general to minimize the amount of unproductive time in the transportation by road of goods and services. The cartographer can enhance both the spatial analyses and the visualizations of these analyses. Should a delivery person not experience a full visualization of the trip to the delivery point? Interactive electronic connections between a service repair person and the office should allow for much more efficient use of the repair person's time. There is no excuse for not being able to find a given address or for becoming lost. As with real estate, the cartographer has the skills to turn the planimetric display of a calculated route into a full multimedia visualization for the user that ends with an image of the targeted destination. Some users will want this capability and will be more efficient by using such displays.

Traffic control is another area where new tools can play an important role. Especially important would be an interactive capability that would allow motorists to input traffic accident locations so that other motorists could be given alternative routes within seconds of an accident and thus avoid major traffic snarls. What role can the cartographer play in interactive traffic information? Should we not be exploring this?

Other travel related frontiers include guided armchair tours of most major tourist sites. How often have you rented or bought an audio cassette and listened to a description of a tour through a museum or through the gardens of an estate? Should these audio tours not be accompanied by video tours? And of course a well done, interactive video tour could then substitute for the actual tour for those unable to navigate due to physical disabilities or age, or simply due to the economics of traveling to the site itself. I can envision a travel service with which I can interact to select exactly where my vacation will be. I want to be able to preview, that is walk through and see, different hotels. To discover the neighborhoods in proximity to each hotel etc. There are many opportunities for cartographic/geographic products which have not been marketed before.

Another area for potential products using cartographic skills is in the simulation of spatial displays for other disciplines. Within the last year weather reports on television in the United States have included, not only a dynamic visualization of the day's cloud cover, but also a fly-through, over and under the clouds, including simulated rain and bolts of lightning where present. Can these visual displays be even more effective with the skills of a cartographer?

Remember that I have suggested that in the future cartographers will work in teams with others. Should the tools of the landscape architect and the cartographer working in a team be made available in software for all individuals to design their lots and neighborhoods? Should the processes and tools of the cartographer and geomorphologist be made available for individuals to simulate and better understand earth crustal movements, lava flows, ground water seepage, or mass creep? Should the epidemiologist and the cartographer combine forces to illustrate and predict how a disease will spread in a locale? Medical science and medical illustration are other areas in which the skills of cartographers coupled with those of medical illustrators could be combined in a team to enhance visualizations of medical problems, or even medical norms.

I think that we can expect to see much greater use of spatial data in news media in the near future. Every report, war, auto accident, fire, tornado, etc. can make use of electronic mapping to enhance a visualization and understanding of the event. In the United States some of the large news media conglomerates have purchased firms which are collecting and constructing large spatial databases. In the future when I log onto my interactive television to scan the latest news reports at my convenience, I should have the option to request a cartographic product that allows me to visualize where an event has taken place and to aid me in understanding how the event has happened.

Advertising will soon follow in the paths of the news media. Some of the innovative uses of advertising will quickly replace the home shopping channels currently on television in the United States with interactive shopping for groceries, clothes, other necessities, and luxuries. Some of you may not think that cartography has a large role in these future endeavors. I disagree and posit that the only reason that cartographers will not play a role in these events will be due to the reluctance of the cartographers to join teams that create user oriented products with these capabilities. We know that on-line clothing stores will make it possible for an individual to interactively input his bodily measurements, including facial features, and then display different clothes on the body image so that the individual can visualize how he/she will look in each piece of clothing. This may trigger an end to ready-made clothing manufacturing, as it will be possible to custom tailor each garment as it is ordered. Imagine that when dialing the telephone and ordering a ticket to a concert that you also dial the clothing store and select your clothes for the concert. These clothes will be manufactured within hours to your exact specifications. In the future it could be possible for the theater to keep track of the concert goers, and especially for gala events, it should be possible to insure that no two people show up in exactly the same costume.

Other major changes using cartographic principles and techniques will be forthcoming in the advertising area. It has been suggested that each seat on a city bus be equipped with a television screen that would display a dynamic map of each area between bus stops. Such maps would show the location of retail establishments and within each establishment show the location of various goods and services offered by that establishment. The bus rider could therefore decide exactly which stop to disembark and exactly where to go within a given store on that block. This could be extended to museums, governmental offices etc. If this is done in buses, it can also be done on trams, trains, airplanes and in individual automobiles. To limit accidents and to allow the user maximum time to consult this information, we will have to have self driving and directed vehicles. These vehicles of course will require a spatial database to direct them through an area like the "smart weapons" of today's military. In June of this year it was announced that a new sports arena would be built in Washington, D.C. that would include seat back television monitors that would allow sports fans to request instant replays from their favorite angles. Spectators would be able to ask on-line questions about each player and receive statistics of the in-progress game, or order refreshments. Also in June of 1995, United Airlines became the first airline to fly the new Boeing 777 commercially. This airplane provides the potential for individual interactive electronics for each passenger. All of these analytical techniques should be of interest to cartographers.

Finally, we have all heard of, and some of us have experienced, "virtual reality." What role can and should cartographers play in future virtual reality scenarios? We have obvious skills in abstracting features from three dimensional reality. Is this not what "virtual reality" is composed of? How can we avoid being involved?

Are we ready for these shifting frontiers? Cartographers must explore them and decide the relevant frontiers for cartography. We must position ourselves to accept the new frontiers and to maximize their benefit to cartography. The user is in control of what is analyzed and visualized. The cartographer however makes it happen. We either play a central role, or someone else will. If cartography has something to contribute to human society in the electronic age we should be willing and eager to make that contribution. We should be doing it now.

CONCLUSION

The entire world and its predominant technology is radically changing. The long-term survivors of this revolution will accept change and adapt to it. Each discipline must make the choice. Each discipline must have the internal confidence to "sell" humanity its products and services. Cartography is no different. Even with a new prevailing electronic technology, there will still be boundaries to map, wars to fight, and tension for living space as our population continues to increase while the available land area remains constant. Cartography does have a role. That role will produce different products and different analyses, in effect

alternative futures. I think that cartographers are ready for the challenge and I think that in many respects we will be able to experience the thrills which European map makers must have experienced during the Age of Discovery. It is an exciting time. I look forward to this conference to learn how our cartographic colleagues from the nations of the world are meeting these challenges. Let's take advantage of changing borders and shifting frontiers to create an exciting and rewarding 21st century for cartography.

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