

# Whither Where? Remarks on the Future of our Profession

By  
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When Professor Kainz asked me to deliver this speech, I was a little reluctant. As he and I discussed via e-mail the nature of the conference and the potential attendees, I became more interested. My interest was peeked by two things: (1) the overwhelming changes that technology has brought to our fields and (2) the difficulty that active professionals have in taking a long term perspective of these changes when daily events force their attentions, primarily yours now that I am retired, on continuous operational changes. I came to realize that in my retirement, I may be in a better position to contemplate the meaning of this period of revolution in our field than would you who must actively make daily decisions on incorporating change into your various modus operandi.

So I would ask you this morning to sit back and take a few deep breaths, relax, and listen. I do not seek either your agreement or disagreement with what I say. I only ask that you listen and think long term for a few moments. Hopefully later at those odd moments of quiet that you may experience, you can contemplate some of the points I will make and decide for yourself what “feels right” for your future professional activities.

Today we hear all sorts of hype designed to gain our attention and to evoke our reactions. “Cartography is Dead”, blares a headline appealing for a reaction directly to those of us who think of ourselves as cartographers. “Should current curricula be revised and renamed Geographic Information Science or Geoinformatiks?”, again is designed to get a reaction. Often these statements have political overtones, either governmental or academic. Similar derivative statements like “maps are obsolete” or “place is no longer important” are made to elicit reactions from the professionals who hold a deep reverence for our science. My conclusion is that these comments, when one takes a long term view have both positive and detrimental effects on our profession. And they are probably necessary.

Within our profession, these statements are necessary to make us think and rethink about our field. As I alluded to earlier, time found to contemplate our future profession is rare given the pace of change that we are experiencing, but a limited amount of time spent contemplating these statements is healthy. At the

point an individual becomes obsessed with changing the name or declaring that part of the field is obsolete or dead, it becomes detrimental to the individual involved and to the profession itself. Within the profession we should not spend a lot of time reacting to these statements. We should be doing good solid research and promoting it for the betterment of humankind.

On the other hand, these same statements outside of our profession may grab the attentions of groups of individuals. These groups may be either desirous of undercutting our profession for their own benefit, or may simply think that the statements make for eye-catching headlines. For this later group the attention generated is transitory and to the extent that the only point remembered is that there is disarray in our profession, it is not generally a positive idea to be implanted in the minds of others. To the extent it signifies new and innovative contributions that we can make to society, it is positive. For those who seek self promotion by undercutting our profession, I have little time or give little consideration.

In general, I think that much of the time spent reacting to hype could be better spent in working toward the realization of the new potentials of our field and in developing new capabilities and methodologies for use in our science. I have no problem with up-dating curricula which is a necessity, but I question whether it is necessary to elevate the up-dating to a level that brings into question the very existence of the discipline by those outside of the discipline.

Enough introductory remarks, again I would ask you to bear with me and take a long term view of what is happening in our field. To do this I am going to try to avoid the use of labels and names and will start by reminding you what we are about by stating an over simplified philosophy of human knowledge and our professional role relative to it.

### **Infrastructures**

I like to think in terms of infrastructures and especially on the fundamental infrastructures that all humans must rely upon to coexist on this planet. Each of us must learn four fundamental infrastructures that usually form the core of our basic education. I will call these infrastructures the WHAT, HOW MUCH, WHEN, and WHERE infrastructures. With data and basic information in these infrastructures we are then equipped to approach the HOW and WHY questions which are fundamental to science and engineering, and to philosophy and religion.

Clearly this audience is concerned with the WHERE infrastructure. In fact we are the individuals that society has entrusted to define, nurture, expand, and evolve the WHERE infrastructure. We are the experts. We are directing the future of the WHERE infrastructure for mankind. It is truly a very important responsibility because the infrastructure is so basic. We often overlook the fact that some

things have existed for years and that they are vital to man's continued existence. For me, the WHERE infrastructure is one of these long term vital items. For this reason alone, I have no fears that our profession, whatever we call it, will survive. Furthermore however we choose to subdivide our profession, i.e. according to the prevailing paradigm of the time, worthwhile work can and will be accomplished.

Most people probably never explicitly think about these four basic infrastructures which underlie all human abilities to communicate and co-exist. We, in this room, do think about them. In whatever language we use for verbal and written communication, we are familiar with the question words: What? Where? When? And How Much? We use them daily. Each of these word questions rests on a basic infrastructure that is the fundamental subject of a discipline that we all study in schools and which forms the basic core of our education. For example, the infrastructure supporting what? is language and I am using English today. That infrastructure prescribes a grammar, and creates a vocabulary of agreed upon groups of letter symbols that stand for entities and actions about which humans wish to communicate. Humans have codified their verbal and written communication to a relatively few major languages which are maintained, changed, and expanded as necessary. Most of these languages use a similar basic infrastructure which is characterized by a sequential placement of symbols that usually have associated sounds, and are used to represent and define entities, actions, and concepts. Each language has rules for the correct use of its symbols. A set of professionals is designated as guardians of these WHAT infrastructures.

The How Much infrastructure is the province of Mathematics. Fortunately, mathematics does not support as large a variety of systems as does language. It is more universal. Again though, the mathematics infrastructure has a set of definitions and rules that are standardized for a given number set. Mathematicians expand the HOW MUCH infrastructure making advances that are useful to other basic infrastructures in the solution of HOW and WHY questions.

The WHEN infrastructure is supported by the discipline of History. Very simply, the WHEN infrastructure is dependant upon agreement on time. The infrastructure fundamentals are based on physical properties of the universe. Like language, the WHEN infrastructure is sequential and gives humans the ability to create such concepts as day, season, duration, era, before, after, until, soon, later, etc. The infrastructure itself is but a small portion of the discipline of History. Most of the discipline concerns itself with events and temporal relationships that rely on the WHEN infrastructure for understanding and the creation of knowledge from data and information to aid in answering HOW and WHY questions.

Finally, our infrastructure, WHERE, is the province of Geography. The concepts that form the bases of the WHERE infrastructure are really very simple, and like the WHEN infrastructure is to the discipline of History, constitutes but a minor part of the discipline of Geography. Our earth-based WHERE infrastructure relies on four basic concepts: the shape of the Earth, the size of the Earth, and a method for specifying location on the surface of the Earth. For that, the concepts of latitude and longitude suffice. Ancient Greek scholars can be credited with defining all four concepts for us and thus for initially establishing the WHERE infrastructure. For at least the past 2300 years learned scholars have accepted these concepts and have expanded upon them and improved upon their measurement. These advancements have recently culminated in the availability to all of us of GPS, Global Positioning System, receivers that can record digitally where you, or some object of interest, is located on the Earth's surface to a precision that is most often more accurate than you need.

Our earth-based WHERE infrastructure is simple and everyone in this room learned it in primary school. It enables us to define concepts like East, West, North, South, up, down, over, under, above, beneath, near, far, inside, outside, adjacent, between, close, contiguous, etc. Clearly all of these concepts have definitions that employ the WHERE infrastructure and many have more precise definitions employing the HOW MUCH and WHAT infrastructures.

The WHERE infrastructure is critically necessary for geographers to use to create geographic knowledge. We provide the infrastructure, basic data, primitive information and the infrastructure methodology that is vital to enable Geography to create complex geographic information and knowledge. We, the people in this room, are the ones who expand the WHERE infrastructure by making advances that enable geographers to more usefully and effectively offer information and knowledge solutions to HOW and WHY questions that have a spatial component.

We also must realize that this earth-based WHERE infrastructure is but one possible WHERE infrastructure. We can and do generalize this useful infrastructure to other milieus which enable scientists to investigate the structures of cells, the organs of a human body, the interactions of humans in social settings, plants and animals in regional settings, the networks involved in a communications system or to help define a culture. Any systematic employment of an agreed upon size and shape plus a method of determining position within that size and shape allows us to communicate and study the spatial relationships of the entity.

Our WHERE principles are universal: not dependent upon language or time. Whenever the spatial dimension is needed to answer HOW and WHY questions that arise in their work, scientists must employ a where infrastructure. With the increasing interactions of these four basic infrastructures, all humans can use the data and information defined by the infrastructures to ask HOW something occurs and scientists and engineers can help to explain, thereby creating

knowledge. Similarly, WHY questions can be posed and scientists, engineers, philosophers, and religion can offer explanations creating further knowledge. This is all so very basic, and I suggest to each of you that it is one of your fundamental responsibilities to nurture the basics of the WHERE infrastructure and to improve upon its use.

I have dwelt on this infrastructure to remind you how basic our work is and to convince you that it is not going to become obsolete or lost. Therefore Cartography, surveying, remote sensing, or photogrammetry by any name, are not dead and we can call the curricula for educating professionals whose job is to nurture the WHERE infrastructure anything we wish. Preferably something that attracts the brightest students and maximizes the availability of research funding.

### **The real question for you is where is the WHERE infrastructure going?**

We as the professionals in charge of the WHERE infrastructure must carefully adopt and adapt the revolutionary electronic technology to support the needed WHERE infrastructures that are vital to our future. How do we accomplish this continuing evolution of the WHERE infrastructure?

There are numerous aspects of the WHERE infrastructure with which we must work. On the earth based WHERE infrastructure we work mainly with physical entities, but also with abstractions. Some of the entities and abstractions of our interest are capable of movement and others are static. We have coordinates that define a place for these entities to various degrees of accuracy and precision, and we have different scales of measurement upon which to record attributes for entities identified at these coordinate locations. From these data we create and deduce relationships among and between entities and information and knowledge about entities. Hopefully humankind can use this newly created knowledge to attain the ultimate goal of bettering our existence.

A basic WHERE infrastructure allows us to perform three activities: (1) to create syntheses of positions having selected attributes and relationships, (2) to perform analyses of both the attributes and the positions selected, and (3) to create a visualization of a situation. All three activities have been greatly affected by the revolution in technology. Electronic technology has expanded our capabilities in each of these to a point that at times they appear to be separate fields of endeavor.

The need for these three activities has been with humankind forever. At the most primal level, individuals have needed to perform analyses to know where to obtain food, water, and shelter in their locale. They have needed to analyze the conditions under which each need is usually found and to synthesize learned attributes of entities and their locations on the earth to enable them to know where to hunt, or find shelter. To communicate these primal needs to other individuals, both aural and symbolic means have been employed. Verbal and

gesticulated means were followed quickly by graphic visualization means. But the overall number of users and the sophistication of the products remained primitive. It is only in the past 500-600 years that the sophistication of these means of communication has been enhanced by technology. Related to the WHERE infrastructure, two major technological revolutions have occurred. The first is the introduction of printing technology around the middle of the 15<sup>th</sup> century in Western Europe, and the second is the introduction of electronic technology in the latter half of the 20<sup>th</sup> century.

Before the middle of the fifteenth century all communications between individuals employing the WHERE infrastructure were verbal, gesticulated or temporarily sketched on some easily disposable medium. The only permanent WHERE infrastructure communications were manuscripts, most of which we would consider to be maps. Each was individually prepared, and a very small number of individuals on the earth possessed or even had seen a manuscript map. For the most part we operated one-to-one that is one manuscript map created for one person or use. There were few map makers; few map users, and few maps.

After the introduction of text printing into Western Europe, engraved maps with embedded text were made in multiple copies. This changed our normal operation from one-to-one to one-to-many, that is, one map, many copies for several people and perhaps multiple uses. It greatly increased the number and hence the availability of maps. This increased number of products allowed for increased numbers of users, but still a small minority of individuals on earth possessed or had seen a map. A condition that may exist even today. For the past five hundred years we perfected these communication products working with improved media, improved data capture mechanisms, and improved printing processes. It is important to remember that we spent five hundred years improving on the technology of printing, our first technological revolution. After five hundred years we still were characterized as a small profession. The number of persons involved in creating multiple copies of similar products for an increased number of users was not large.

During the past fifty years we have been experiencing our second technological revolution, the electronic revolution. This revolution changes our operation from one-to-many to many-to-many that is many maps for many uses involving many people. Everyone is now a map maker as well as a map user. In so doing this revolution promises to make the analyses, syntheses, and visualizations of the WHERE infrastructure ubiquitous. I think that it is entirely possible that this will happen. This is very significant for us as it opens the use of the basic WHERE infrastructure to every human on the planet to become a creator of tangible geographic information and knowledge for themselves and for others.

Even though we can label the change in technology as revolutionary, the professional responsibility to nurture and enhance the WHERE infrastructure is our long term job. It is not revolutionary. The revolution has taken place in

technology; we have an evolutionary task to perform using electronic technology in our disciplines. We must watch over it and direct its future. This is a long term task, it does not matter what we call it today, or what “new” name we may call it tomorrow.

But what should our profession be concerned with today? I have alluded to three major areas—analyses, syntheses, and visualization. Electronic technology offers us major changes in each area. Perhaps in the area of analyses, electronic technology offers our greatest chances for both immediate theoretical and practical advancements and improvements to the methods we have been using. There are two important reasons for this: (1) Our colleagues, those entrusted with the HOW MUCH infrastructure, now sense the possibilities of working with data tied to place, and are finding the challenges interesting, and (2) The market for such analytical information already exists. Consumers have accepted what I will call very imprecise results in the immediate past and will be only too ready to accept more precise and refined analyses in the future.

Just remember that to routinely invert a matrix larger than 3x3 was simply not done before the availability of electronic technology. That is less than 50 years ago. The rapid advancement in analytical tools made possible by electronic technology presents to us many expanded capabilities. We are only starting to recognize this, build on it, and oversee the production of reliable data for input to the new algorithms that are available for the processing of accurate spatial data into new and useful information and knowledge. I urge you to establish working relationships with mathematicians and computer scientists to create useful analytical techniques. Is this Analytical Cartography or Geographic Information Science, or Geoinformatiks? I do not think that the user cares, provided we produce the precise information and useful knowledge required

Easy linking together of the results of increasingly precise analyses into a synthesis for a prescribed region is also a benefit from the revolutionary technological changes. Precise, rigorous, and complex synthesis of spatial data was one of the hardest tasks for us to accomplish before the electronic technological revolution. We spoke of overlaying layers of attributes defined at locations of interest, but the syntheses themselves were imprecise and primarily visual. This left decision making in the gray area of personal perceptions of visual displays, not unlike the determination of the “best-of-show” judging of entries at an art show.

Using electronic technology, more rigorous syntheses are now possible. To the more casual user these changes may be subtle but I think that in the long term the effects of more rigorous syntheses will be more profound for society. An example from transportation will serve to illustrate what I mean. With increased use of embedded sensors in road networks, spatial data along a given road segment can be collected and synthesized into meaningful information. Say a vehicular accident occurs on Highway A. The traffic backup begins, the need to

get emergency equipment to the scene quickly, and precise knowledge of the location and scale of this incident for other drivers in the vicinity are all needed in real time. Being able to know the precise location of the accident and drawing on a synthesis of the normal traffic flow along Highway A allows us to predict the impacts of the accident on the traffic in the entire region. Synthesizing this one incident on one highway segment with on-going analyses of other unimpeded highway segments nearby that feed or link to the highway segment experiencing the accident allows information to be created that could be transmitted to drivers in the entire geographic region. This is but one example of the fundamentally different geographic syntheses of data and information that are now possible. This synthesis needs no visualization, yet could have one. It could be embedded in instrumentation currently available, and transmitted to a user verbally or visually. The complex use of the WHERE infrastructure would be invisible to the user.

Another example is of a military engagement. Analytical processing of near real-time spatial information from a large number of sensors could be synthesized into spatial information and knowledge that could be transmitted to an active user in the form of directions or battle plans. The resulting electronic battlefield is an example of the use of spatial analyses followed by syntheses to direct military operations. Is this military operations or geographic information science?

These advances are only now coming on line as a sufficiently installed base of data sensors and the widespread availability of the spatial data analytical capability that make the syntheses possible are being built. There is a large need for education of the user in this arena. In other words I think that the market does exist, but it does not as yet know that it needs the information that is possible. It is only a matter of time until this is corrected.

These examples of analyses and their synthesis can be communicated aurally and/or visually through dynamic displays. But our tradition has been for a reliance on static visualization. Already electronic technology has expanded the area of static visualization and has created a large market for push button map production. Look at the success of Mapquest and Google Maps. In a very real way these readily available products are beginning to grow a market for more sophisticated map uses in the future. Google Earth is a start with the incorporation of dynamic visualization.

Increasing rapidly in number are in-car navigational systems. These dynamic systems, in addition to being examples of the display of new syntheses are also forerunners of the development of the talking map. Our old static visualization is not only dynamically enhanced but audio information has been added. Although limited today, there is no reason why audio additions to all maps will not be the norm in the future. Whether the map is viewed on a mobile telephone, a desktop computer, or on an in-vehicle screen, it makes sense to have the ability to query



the map, to receive audio responses in real time, and to easily flip between registered images and maps.

The imbedding of tiny displays in the corner of eyeglasses that enable the wearer to see the results of spatial analyses and syntheses can simultaneously input into our ear an audio transmission. The potentials for further advances are enormous. Think of the other senses that we have not even begun to explore like smell and feel. Then think of the possible virtual realities. These are the maps of the future, the uses of an expanded WHERE infrastructure.

## **Conclusion**

In conclusion, although it is fun to speculate and dream, I do have some joys and concerns to share with you.

### **Joys:**

Among my foremost joys is the fact that the use of the WHERE infrastructure is being embedded in more and more activities. Even though it may not be noticeable to the user, we have moved from involving a small percentage of the people on earth in activities dependent upon the WHERE infrastructure to near total reliance upon it. Just consider the rapid rise in the dependency on spatial information in the delivery services and utility maintenance industries.

Secondly, the potential for research and associated funding for research has never been greater. Increasingly funds not only from governments and institutions, but also from the private sector of our economies are being used for research in our fields. Training of our professionals has likewise never been more robust. Increasingly I see young professionals in our field who are highly knowledgeable in mathematics and computer science. This ensures future scientific collaborations that will enhance the uses of the Where infrastructure. We are creating the ability for humans to experience a virtual existence while remaining within the real world. This is exciting even if its ultimate result may be unpredictable.

When I think that we are only fifty years into this second technology revolution, I become excited about our future. I would ask you to examine the maps printed around 1506 versus those manuscript maps produced around 1456, i. e. fifty years into the first revolution. Then compare what we consider to be the best maps printed in 1956 to the array of cartographic products available in 2006. Also consider the time it took to produce each of those products. Consider the time it would take today to change the colors, scale, or names on a visualization versus making the same changes on the 1956 printed map. What will the next 450 years bring?

I am also excited when I attend conference like this one where I meet the guardians of the WHERE infrastructure. I realize that the future is in your capable hands. It is a tremendously exhilarating and exciting time to be in this profession. As I look around, I sense that the experts in this room are both prepared and excited about the tasks ahead.

### **Concerns:**

At the same time I do have a few concerns. One very important item that we may be overlooking today, or at least paying too little attention to, is documentation of the present. We desperately need to be documenting what is taking place as we more fully exploit the use of this revolutionary technology. Today I can walk into a major map library and look at the collection of extant maps that will detail for me what I can learn about the conditions on earth and of mankind at a previous time. Fifty years from now if you were to walk into the successor of today's map libraries, what would you want to find about conditions in 2006? Would you expect CD-ROMS, would you expect manuscript printed maps or images? Would you expect software programs that allowed the creation of 2006 products? Please give this some thought. Remember we are the people responsible for the WHERE infrastructure. We are also responsible to see that its history is preserved. This means working closely with librarians and historians.

A second concern is that there will exist a time gap between expectations in others created by the new technology and our capabilities to deliver the products. I think that there is little we can do about this and would urge you to err on the side of lengthening the gap to create a more robust product than to attempt to rush a poor product to the market.

My final concern I have voiced throughout this presentation. Overall I will accept this concern as the paranoia that accompanies change. The involvement of many more people in our work can be frightening to some established professionals because it may seem that they are "losing control" over their own profession. At the same time I decry the lack of time that you have in your professional lives to enable you to take a long term view of your activities. I know of no solution. This has always been a problem for those on the forefront of scientific discovery, but I feel that this new technology has exacerbated our problem since it has so quickly and fundamentally changed our operations.

Hopefully this is a temporary situation and one that simply will not continue in the long term. Any such evidence of historically comparable periods in our profession's history illustrate that this feeling of losing control is only of a temporary nature, provided that we have done our work in the past and are continuing to do our research and development thoroughly. I am certain that some manuscript map draftsmen of the fifteenth century felt threatened by the growth of new map printing establishments, but did that result in an end to our profession? So again I would urge you to ignore sensational statements like

“Cartography is Dead” “Maps are Obsolete” or “Place is no longer important”. They make good cocktail talk but should not intrude on your professional time.

This leads directly to my stated concern about wasting time internally within the profession arguing over names. Yes, in many senses we have a new baby and we as proud parents want to select an appropriate name for it. Our field has its traditional names like geography, cartography, surveying, photogrammetry, remote sensing and its new names like geographic information systems, geographic information science, geoinformatiks, visualization, data mining, etc. These new names can serve two purposes: one political and one promotional. It is well known that politicians will respond to new ideas and new innovations. Those that are catchy and fresh will get the attention. IED, not car bomb, UAV, not unmanned aircraft, command attention today. In our field, data integration, visualization, uncertainty, semantics and ontologies are newly minted areas of our research. I submit that there is an appropriate time and place for level headed discussions and a need for both political and promotional terms. Are they long term for our field? If the past is any indication, the answer is no. Geography and Cartography have been around for over 2000 years. So I urge you not to get hung up over the names used today. Instead spend your time on thorough research about your professional interests. In the long term, I do not think that the name matters. The soundness of our research does matter.

### **Future of Where**

What is the Future of Where? I think that we have an incredible future as a profession. Employing electronic technology, it is evident that there is greater potential for change, even radical change, to our professions than we have ever before experienced. The technology has opened the profession to many more people. This will result in a more stable profession as it directly affects the lives of more of humankind. In addition, the value of our contribution has already been proven in the marketplace. We need only worry about meeting the increased demand for our products and services. I urge you not to neglect these opportunities. I wish you good luck and thank you for your kind attention.