Computers and Cartography: For Better or For Worse?

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Abstract: In the civil engineering field, the computer has revolutionized the way maps are created, viewed and printed. GIS technology has taken this even further by allowing municipal users to access tabular and geographic information simultaneously. Software programs, such as ArcView, have become easier to learn, so that even the occasional user is assured of remarkable results. But the ease of use and high quality of the end product are often a double-edged sword. Many people in the engineering industry are looking at cartographers and GIS professionals as little more than data processors or printing clerks these days. The artistry and awe formerly associated with the mapmaking craft seem to have vanished in the face of Internet mapping websites and desktop GIS. Can we enjoy the benefits of GIS while still giving the mapping profession the respect it deserves? This paper will explore the challenges and possibilities.

Computers Have Changed Everything: More than half of all American households now own computers, up from a meager 8.2% only twenty years ago. Computers have changed the way we access information, receive mail, conduct business, and even pay our bills. Entirely new professions have been created that could never have been conceived of without computers. Data processing, software design, information technology, and even GIS have their roots in the digital age. The college syllabus of today includes a plethora of coursework and degree programs our parents and grandparents probably wouldn't even recognize.

In the writing profession, computers have taken us from pen-and-ink and portable typewriters to word processors. Research material is no longer confined to the library, but literally there at our fingertips on the worldwide web. Instead of packing up a manuscript and sending it in heavily stamped packages through the postal service, we attach the whole thing electronically to an e-mail and it's off to the editor's desk in a matter of minutes. Many publications are becoming available right over the Internet, providing an entirely new marketplace for the written word.

But computerizing the writing process does not seem to have adversely affected the public's image of a writer. Instead of being bowed over a typewriter staring at a blank page until inspiration strikes, we imagine the writer of today staring at a blank computer screen awaiting the same muse. No one seems to believe that a writer can simply press a button on a word processing program and instantaneously produce a bestseller. There is something more to the process that is universally understood. Writing is still an art form, whether it is jotted down by hand like Lincoln's Gettysburg Address, pounded out on an old Royal typewriter like a Hemingway novel, or downloaded to the Internet by the burgeoning authors of today.

The cartographic profession, on the other hand, seems to have fared quite differently during the digital revolution, in spite of the many new and exciting professions that have been created through the advent of CADD and GIS technologies. The romanticized image of a struggling writer sitting alone in a garret somewhere while turning out beautiful poetry is still evocative and believable, even in the digital age, while the romanticized image of a cartographer struggling along on a Lewis-and-Clark-style expedition to map uncharted continents seems hopelessly outdated. After all, we've sent astronauts to the moon, and we have robotic probes hurtling into the farthest reaches of outer space. We even have satellites orbiting overhead, streaming back aerial imagery of every inch of our planet that is as detailed as it is awe-inspiring. What is left, then, in this day and age, for the poor cartographer to explore and document?

A Proliferation of Maps: Most people have a sense of what writing entails. From earliest grade school, we have been asked to write essays, or to report on books that were written by others. But our experience with maps is very different. We may have been asked to write an essay about what we did on our summer vacation, but we were probably not asked to draw a map to illustrate it.

For many of us, our earliest recollection of a map is something made out of paper and impossibly folded, with a gas station's logo emblazoned on the front cover. It was generally stuffed into the glove compartment of the family car until our parents were either lost or embarking on a long road trip. No one seemed particularly concerned if the map became lost or dog-eared, or if baby brother spilled milk all over it. Another copy could be easily obtained from any gas station along the way.

In school, we learned about maps through globes, atlases and geography books. Before the advent of computers, if we needed a map as part of a school project, it was traced or copied from an existing map in a textbook, or an outline map was given to us by the teacher to be colored or annotated by hand. Unlike writing projects, maps always seemed to come to us more or less ready-made.

The myth of the ready-made map has been exacerbated over the past few decades by the proliferation of digital mapping software products and Internet mapping sites. The gas station maps we once relied on have been largely replaced by countless websites offering instant maps and travel directions to destinations throughout the country. Just type in any two addresses, and out comes a customized map of the best driving route between the two points, and a turn-by-turn set of directions to go with it.

GIS software packages generally come pre-loaded with worldwide mapping data and related attributes tables. Even a novice can make recognizable maps, charts and tables using these products without ever creating or incorporating original data. Once again, everything is right there. The innate ability of GIS software to recycle existing mapping data in a variety of ways for different projects has simultaneously helped and hindered the cartographer's image.

Municipal Mapping Woes: Civil engineers design the transportation corridors; water and sewer services; mechanical, electrical and plumbing systems; structural elements; and environmental management facilities that touch our everyday lives. Something as outwardly simple as turning on a faucet for a glass of water is a product of countless hours of design by skilled engineering professionals. Many civil engineering firms provide dedicated services to local municipalities, assisting them with projects such as road construction, utility infrastructure improvements, hazardous waste disposal, and municipal mapping services. Tax maps, zoning maps, land use maps, election district maps and GIS implementation services are among the products most frequently requested by municipal mapping clients.

The cartographic professionals providing municipal mapping services through civil engineering firms have also suffered in the digital translation, and not just in terms of their clients' perceptions. Although various CADD programs may assist in the design of a new bridge, no one seems to doubt that the civil engineer plays a critical role in the overall process. There are simply too many variables involved to truly imagine a "bridges are us" software program capable of prefabricated bridge designs at the touch of a button for a variety of span lengths and purposes. But these same engineers who have so successfully made the transition between slide rule and computer without sacrificing their prestigious image do not always extend this respect to their cartographic peers. It is not uncommon to have civil engineers approach their computer cartography counterparts, ask them to "punch up" a new map for a particular client, and then literally stand there and wait as if the new map will appear automatically after a few simple keystrokes.

The same perception often extends to the civil engineering client in need of municipal mapping services. Most municipal mapping projects are based on existing hardcopy maps, such as tax parcel maps. For example, by scanning and vectorizing a municipality's existing hardcopy tax maps, the same geographic information regarding streets, waterways and individual property boundaries can become the digital foundation for a variety of municipal mapping projects. Incorporating related tax assessment data about each property into the GIS attributes table provides comprehensive analytical capabilities that might otherwise require hours of cross-referencing to achieve.

But once again, the end product is created using pre-existing resource material. This often makes it difficult for the cartographic professional to justify the costs involved, at least from the municipal client's perspective. *I'm already giving you the bricks and mortar,* the client seems to say, *so why are you charging me so much to build the house?*

Changing Perceptions: Today's municipal cartographer is not usually required to survey or explore the area being mapped, at least not in the traditional sense. But there is a great deal more to the art of digital cartography than just scanning an existing set of tax maps "as-is." Part of the marketing process today for most digital cartographic services must necessarily include some type of client education to justify the time and expense involved.

A completed GIS database has some of the same characteristics for many people as today's videogames. It's colorful, it's interactive, and learning to master it can be very challenging. But playing a pre-packaged videogame and creating maps from a completed GIS database have another, more critical similarity that is generally overlooked. The end product enjoyed by the user is the result of many unseen hours of labor by skilled digital technicians in a particular industry. The off-the-shelf qualities that most people relate to are only an illusion.

In the videogame industry, there will likely be millions of customers worldwide for each new game created. Therefore, most videogame aficionados aren't particularly concerned about the cost determination factor, since the massive customer base involved keeps the individual impact to each user to a minimum. With municipal GIS projects, however, the time and skill involved in each project must generally be absorbed by a single client, making the overall costs appear much higher by comparison. The client needs to understand that they are not paying for a pre-packaged database suitable for the masses, but for a digital mapping product created by highly trained professionals and carefully customized for their individual applications.

In the municipal mapping arena, the accuracy and currency of available resource data are the most crucial concerns when estimating the costs involved in a new GIS or digital mapping project. A municipality's existing hardcopy maps are often tremendously out of date, and considerable research must be performed to compare conditions on the existing maps with the actual conditions in the municipality today. Parcels of land may have changed hands many times during that time period. They may have been subdivided or consolidated, which means their dimensions will have changed. Entire developments may have been added where a farm or open space once existed. The only way to verify the correct information about each parcel of land within a municipality may be through deed and filed plan research. Although some of this information is available over the Internet, it is more often necessary to sort through vast quantities of hardcopy files at either the local or county level in order to resolve each issue. The research hours alone are a major contributor to overall costs.

Other issues with available hardcopy mapping include differing map sizes, scales, projections and formats. The infrastructure data created at a scale of 1"=100' is obviously not going to be compatible with or possess the same level of accuracy as a base map created at a scale of 1"=50'. Some amount of digital manipulation and photo interpretation techniques will be necessary to ensure that the infrastructure features from the first map ultimately line up in relational aspect to the streets and other locations depicted on the base map. It is also necessary to determine if the State Plane Coordinate System used to create available GIS data was based on North American Datum of 1927 or 1983. The two systems are not compatible without some type of data conversion process. The same is true when trying to incorporate raster data into a vector database, or vice versa. The cartographer must become something of a mapping tailor at this point, making the necessary alterations to the materials at hand in order to custom fit them to the municipal GIS applications needed by the client.

Unlike the old gas station map, which is complete as it stands, a digital map consists of many layers of information that can be interchanged as needed for a variety of different applications. For municipal mapping purposes, one layer could contain all the roadway lines in the area, another could represent all the property lines, and yet another could contain the utility infrastructure system. In essence then, creating a GIS database is not just about making one map, but many, and doing so in such a way that each map will work as well separately as it does collectively.

In addition to creating and linking the individual mapping layers in a GIS database, it is also necessary to create and link the in-depth tables of information that make GIS so beneficial to municipal applications. This often begins in the municipal Tax Assessor's office. For tax assessment purposes, each parcel of land is assigned a unique property identification number that distinguishes it from all other properties, not only in the municipality, but in the entire State. The information associated with the physical property location, such as block and lot number, street address, exemption status, assessed value and land usage, is stored and accessed in the tax assessment database by property identification number. This process is repeated for each of the hundreds or even thousands of properties that may be located in a particular municipality. Anyone who has ever typed, even on a computer, should understand the time involved to manually key in these property identification numbers on both the graphical and tabular interfaces of the GIS database in order to link the two together. Unless this is done accurately, the image of 123 Main Street on the GIS map may incorrectly reflect property data for 321 Main Street or 123 Elm Street instead.

A GIS database can also be used to create buffers around all properties adjacent to or within a specified distance of a particular property. For municipal purposes, this is necessary when zoning changes or related activity involving one or more parcels of land may ultimately impact the surrounding parcels of land as well. Notification to the surrounding property owners must be made based on an Abutters List. This GIS function is very useful for Tax Assessors, Planning Boards and Zoning Boards, among others, and can only be done accurately when municipal tax assessment data has been properly incorporated into the GIS database.

There is a variety of mapping data available through State, County and regional websites that can be incorporated into municipal GIS projects. More and more municipalities are becoming aware of what's out there and where to get it, which tends to reinforce the myth of the ready-made map that only needs to be downloaded and printed before delivery to their door. Aerial photography, in particular, is often made available through larger organizations for use at the municipal level, and offers an old-fashioned "lay of the land" perspective that is very appealing. Maps have been created in this way for a number of years, even before the advent of aerial and satellite photography. The ability to look down on a place from above, even from a mountainside, provides a powerful visual reference in establishing the relational aspects of one location to another. But it's not quite as ready-made as it may seem.

The aerial photography generally comes in tiles, like pieces of a larger puzzle. The cartographer must choose the correct puzzle pieces to display the municipality in question, and then join them together as seamlessly as possible to create an overall view. And an aerial photograph is exactly that – just a photograph taken from the air. Without the cadastral data needed to anchor it, the patchwork quilt of rooftops, parking lots, shoreline and roadways comprising the aerial photography can be very confusing, and so may have limited value for many municipal GIS applications. The cartographer needs to add street names, property lines, municipal boundaries and other important information to the acquired aerials in order to create the necessary perspective for GIS use. This cadastral data also needs to be linked to the aerial data in such a way that it does not become dislodged or distorted when the GIS user zooms in or pans across the aerial imagery in search of a particular feature.

Perhaps the best analogy of the municipal GIS process is that it is less of a ready-made product than it is a kit requiring expert assembly. Many of the pieces may be readily available, but the quality of the final product will ultimately depend on the cartographer's proficiency in locating, evaluating and assembling them.

Maintaining the Balance: Public education on a client-by-client basis will be a long and arduous process. What else can the cartographic profession do as a whole to debunk the myth of the ready-made map when there is so much evidence out there to support it?

Take that gas station map, for example. It bears the gas station's name and logo, as if the gas station itself went out to make the map. With municipal mapping projects, the mapping firm's name appears on the map where the gas station's logo would be. The same is true of most street map atlases. What happened to the human factor in cartography?

Maybe some of the blame for this misconception is founded in the maps themselves. The individual artistry that was once so prevalent in the cartographic profession seems to have been overshadowed to at least some degree by the cookie-cutter precision of the digital age. The ability to reuse the same base map foundation for a variety of GIS and other mapping products works very well from an analytical perspective, but often detracts from the overall appearance of the finished product, and encourages the image of a push-button, assembly line map. It is not uncommon to see a hand-drawn parchment or linen map proudly framed and displayed in someone's home or office because of its unique or artistic qualities. It is far less common to see today's digital counterparts revered in this same manner.

Although largely responsible for creating the myth of the ready-made map in the first place, the computer may be versatile enough to come to its own rescue by adding color, graphics and other stylistic touches that can make those cookie-cutter maps seem as distinctive and appealing as their hand-crafted predecessors. It may be wise for the cartographer to take a step back from that computer screen during the digital mapmaking process, just for an instant, and to look at the finished map the way the public will

ultimately see it. If cartography is truly to remain an art form, even in the digital age, the end product must look as much like fine artwork as it does a depiction of place.

Restoring a Critical Link: When a book is published, there is generally a dust jacket to refer to with some kind of personalized information about the author's name and background. This factor alone lends an element of soul to a mass-produced book that a mass-produced map will be lacking. Even a cheap print made from a fine painting is still regarded as art, and the concept of the artist/creator remains intact.

The dust jacket around the book and the artist's signature on the print also create a jumping off point from which to acquire additional information about the writer, the artist, or the creative process itself. If anything, the computer has enhanced this connection by making the search for biographies, time periods, and story and artwork settings easier and more gratifying. Making that same connection between today's cartographers and the digital mapping products they create can be more difficult.

For example, when visiting a website offering maps and step-by-step driving instructions, the available links are often to discount airfare and hotel bargains. Apparently, if people want maps and directions, they must want to travel, and if they want to travel, they must need a way to get there and a place to stay when they do. This is understandable, perhaps, but it doesn't shed any light on the mapping itself. Worse yet, the website may advertise a home edition of its mapping software, which further accentuates the public's map-in-a-box mentality.

There is no denying the incredible convenience and usefulness of these mapping websites for the general public. It is a marvel of modern technology to be able to type in two diverse street addresses that may be on opposite ends of the country and receive a customized map and in-depth driving directions between the two in a matter of seconds. The kaleidoscope of maps is generally stamped with the host website's name and logo, but there is little information there about how the website was created in the first place, or the digital mapping technology that supports it. How many people did it take to develop the maps and the tabular data that appear so effortlessly on screen with just a few keystrokes? What kind of time factor was involved? What type of ongoing maintenance is occurring to keep the data current and the website running smoothly? There is a great opportunity here to enhance the public's perception of cartography and the cartographic process that seems, so far, to have been entirely overlooked.

Why not establish a link between the standard mapping websites offering travel directions and the venerable cartographic websites, such as ESRI and GIS.com, that explain the actual technology? Not everyone would use the links, but the subliminal value alone could be enormous. And for those who do use the links, an important education, and perhaps even some well-deserved respect for the cartographic profession, would be waiting.

Conclusion: In the civil engineering province, a movement is currently underway to present engineering in all its aspects to children as young as elementary school age,

hoping to inspire interest in the profession. It may be time for the cartographic industry to move in a similar direction.

From apprenticeship to internship, mentoring has always been an important means of passing on the art of craftsmanship from one generation to the next. Although GIS is being used more and more frequently in the classroom to teach children about geography, the cartographic aspects of it often take a back seat. It's one thing to for a child to master the fundamentals of GIS, or even to create digital maps for a school project using pre-existing mapping data. That's all part of the videogame society children have grown to expect. It's another thing for a child to understand how that pre-packaged mapping data was compiled in the first place. When all is said and done, this may be the most important means of all to restore the human face to the digital mapping industry.

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