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CARTOGRAPHIC TRANSFORMATIONS FOR INFORMED DECISIONS

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The discipline of cartography can be conceived in a number of ways. The organization of this conference emphasizes the visualization aspects ahead of the analytical approach to cartography. Yet, the big story over the past forty years has been fuelled by what has been termed a "revolution" at meeting after meeting (for example, Morrison 1989), a revolution of analytical means and digital technologies. After a few decades of this brute force work we ended up with warehouses of spatial data infrastructures, an advance, but hardly as revolutionary as desired. In principle, these developments were meant to deliver results to society, usually formulated as decision-makers, rather than the public at large. Many important advances have been made; some of them indeed may count as revolutionary. Yet, the present is not entirely the future we had imagined.

In the early period of geographic information systems, the technical emphasis was placed on a few tools, such as polygon overlay (Chrisman and others, 1992). This massively geometrical procedure provided the means to integrate information from different sources and thus, it was presumed, to support decision making practice. Around 1980-85, the acid test in evaluating software was the speed of the overlay engine (Tomlinson and Boyle, 1981). A whole host of other transformations (such as buffers, point-in-polygon, and conversion of raw digitizer input) were executed by common overlay engine (or planar enforcer as some came to see it). No matter whether working from a vector concept or a raster concept, the issue of collocation (overlay) was seen as the base (Tomlin 1993). This architecture provided some coherence, since there was a single main processor to ensure interoperability.

Alongside this effort, the field developed prototype spatial data infrastructures oriented toward content that would be used by the public (National Research Council 1993). The same logic applied to the data, one system to serve all needs. The presumption was that we needed lots of different layers for each environmental discipline so that we could support an integrated analysis for issues like facility siting, inside of a single common architecture. We started the eternal quest for the Holy Grail of interoperability standards. Groups like the US Federal Geographic Data Committee divided up the work by theme, calling upon each discipline (and agency) to contribute to a larger whole. Some of the presumptions have turned out to be correct, but many of the expectations turn out to be misplaced. Data layers that were originally considered to be a background (like air photography) have taken much higher priority than the analytical resources required for environmental analysis. The base layer of transportation continues to attract more and more sophistication, far beyond the traditional requirements of cartography. Even more so, the idea of a few producers distributing common layers to many users has been shattered by the bottom-up citizen sensor (Goodchild, 2009).

The profession of cartography and GIS has to come to terms with a reality different from the one we imagined originally. Cartographic transformation is a part of the consumer toolkit openly available to web users, but the transformations are different from the ones we expected. Some of them are limited, placing much more emphasis on visual interpretation. Others, like route planning functions and shortest path algorithms, are computationally quite demanding. Consider the computational power to take a whole continent's road network and recalculate the shortest path as the user drags a point to another road segment. Inside a city, this is not very exotic, but over thousands of kilometres, it is a sign that computing speed is no longer an issue. Our browsers have become portals to all kinds of data services and transformations. Despite this raw power, the projections available on the web cartography engines are pretty poor, with continued reliance on versions of the Mercator even in the northern regions where we know too well the huge distortions involved. What passes for projection is a form of fly-over video game that moves from global view down to the imagery in greater detail. Much is precomputed and cached, out in vast warehouses of queries past and future. Did we ever imagine this?

This is an appropriate moment to reflect on forty years of innovation in cartography, particularly with a sense of our limitations in making predictions about the future. Our crystal balls were rather cloudy, or we chose to see what we wanted to see. The various points of origin for GIS include McHarg's (1969) multi-layer approach to suitability. It was popularized in the Whole Earth Catalog (Brand, 1968) by 1970; a publication of huge mass appeal and the social network of its time in many ways. Steve Jobs in 2005 called it precursor of the web. For those who might vaguely remember, it was the big telephone book ‘resources for the Planet’ with the picture of the Earth from space on the cover in some of its earlier editions. There was a section on Shelter and Land Use, it included a two-page spread on Design with Nature. The page after McHarg was the geodesic dome resource (Shelter), how to build one yourself. But this view of integrating all sources of information together has become nearly banal, expected. Mash-ups are exactly the result, the ability to relate anything with anything, though without really combining them.

How should we approach technological change in an era of mass markets and commodity services? It is no longer a matter of a few scientific groups dreaming up centralized solutions. Yet, we go on thinking that a portal of some flavour is what we need. Then we go create portals of portals. Our discovery process was conceived for scarce data, not huge warehouses of duplicative unevaluated resources. The structure of our solutions has long been unexamined, but for me it is not the major issue.

I return to the issue of transformations. What we built as GIS in the 1970s and 80s were all designed around a common understanding of a user community- typically land managers working in forestry or something similar. The toolkit still has some underlying flavour of this conception. ArcGIS still has a geometry engine that has origins in the polygon overlay problem. But for the mass market, things went in another direction. The connection of various items is more tenuous and implicit. We end up calculating proximity of points over and over as un-processed raw GPS signals from mobile devices send out their signals and tweets. This seems to serve immediate needs, but some of the earlier goals are simply left behind. Coherence and integration are harder and harder to ensure. If it is just a technical issue, perhaps we can solve it with more and more computers. However, that does not seem like a sustainable approach. The real question is to come back to the public vocation behind the spatial data infrastructure, how do we ensure that our efforts ensure an informed public?

In the long run, it seems better to ensure that public systems provide a complete range of functions, so that any form of measurement can be transformed to any other. Anything less than that ends up in a dead-end. The wisdom of the first round of analytical cartography was more to examine transformations that preserved information (Tobler 1969, 1979). This is a conservative approach to information content. An active approach expects to add information (Chrisman 1999), and that is certainly where the value is for the current generation of online map maker/consumers. There is much more that remains to do, in that just producing the information does not deliver it to decision-making processes, but as designers we must ensure that a complete set of transformations is available.

Once the challenge of providing a complete set of transformations is overcome, then the next challenge will be to document what happens as items are mashed up and restructured again and again. The metadata standards are already creaking under misuse and undercompliance, so it will not get any better. Yet in the long run we must find a way to trace submissions and transformations of these raw ingredients.

This then raises additional concerns about the social and institutional aspects of GIScience, in specific, the detection of a possible “data alignment” – the influence of pre-existing data sources on subsequent use. This effect can arise since it is substantially easier to put an existing data resource to use than to generate a new one. Our age of portals encourages this use. As it is explained in many circumstances, databases are a form of capital, either as a corporate resource, or as a public good. Data access policy frequently assumes that the value is always positive. Existence of a certain data resource creates an opportunity effect, making subsequent transactions cheaper, if all is well managed. This would apply to decision making applications, for example. The downside is that less suitable parameters will be used if they come from existing sources compared to those specifically tailored to the question at hand. It is easy to imagine that stakeholders in decision making might be tempted by some form of data alignment; it can reduce budgets, shorten times, and build coalitions of data users. Even more so, consumers on some web service are unlikely to know (or care) where the service is grabbing the data resources. The reasons to align with existing data sources are so varied, the effect is hard to detect. The next generation will not look like the centralized portals we built over the past twnty years. The world of distributed sensors requires transformations not just in one place but everywhere.

This sketch of a revised business model for simple sensors inverts the old hierarchy. The old GIS looks like a telegraph business with its bicycle messengers for the last kilometer. But like the anarchic and turbulent world of Web 2.0, it is not clear how we make the transition to the world of distributed sensor networks. There is a lot of programming to be done, and business models to be shredded by the competition. The sensors we currently have around the city and the environment are much more complicated than before. We have video cameras pointed at every public place. But, when London needed to trace backpack bombers, they resorted to brute force: people looking at videotape for hours looking for recognizable people. In George Orwell’s 1984, the cameras enforced the State’s will, but the 1944 author had people behind the screens. If it takes one policeman to watch each citizen, the overhead costs are pretty high. And, as always, who watches the watchers?

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