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Mapping a pathway through the digital age.

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Staff Reporters

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Bill Rankin's Radical Cartography



Maps created by history professor Bill Rankin

It was the mid-1990s. Stacey Maples, a Southern Methodist University student at the time, was researching a multitude of archaeological sites in the rough and mountainous high desert surrounding Albuquerque, New Mexico. He was studying the anthropological remains of diverse villages and settlements, including those of hunter-gatherer tribes and agricultural communities. Traveling from site to site, Maples began to question a possible geographical pattern.

He wondered whether there might be a relationship between the location and environment of the sites — some underlying trend. For instance, were there more sites near rivers or waterways, or were these typically located in drier areas? Were they buried in valleys or did they sit atop elevated plateaus?

But Maples didn't immediately address his curiosity — work in the field precluded intense technical analysis for the time being. Some years later, once Maples and his archaeological cohorts had left the

tasks of digging and examining behind, Maples returned to these questions.

Maples had migrated from the arid New Mexico terrain and found himself a master's student at the University of Texas at Dallas. He began plotting.

Dot after dot, he placed each site onto an old United States Geological Survey topological map. But, again, he was left with dangling question marks. The points on paper did not suffice.

So Maples started learning to use Geographical Information Systems (GIS), a computer program that allows users to plot a wide variety of information — from census data to industrial development to air pollution — against maps in order to observe correlations and trends.

With the help of GIS, he reached a surprising conclusion. He was able to show that hunter-gatherer tribes settled in areas with panoramic views: in other words, in locations where they were able to see out onto surrounding lands. Agricultural communities, on the other hand, showed no such discriminatory trend based on visibility.



Today, Maples sits nestled within the neo-Gothic walls of Sterling Memorial Library. He is Yale's GIS specialist and he is in high demand. Working in the three-person Map Department, a department within the Yale University Library, he trains students and faculty in the use of the arcane computer program. He helps professors in areas from history to public health, in such projects as diverse as mapping correspondence networks and placing photographic collections in a geological context. He is adamant that geographical data is relevant to all academic endeavors.

"Everything is somewhere, and that somewhere matters," Maples declared.

"With the advent of web mapping services like Google Earth and Bing, the ability to sense geographical position in real time via the Global Positioning System (GPS), and the opportunity to place this sort of magic quite literally into the hands of anyone with a smart phone, there is no question that the world at large is already well beyond the point of no return in terms of making routine use of geographical data in digital form," Dana Tomlin FES '78 GRD '83, who is now a professor of landscape architecture and the co-director of the Cartographic Modeling Laboratory at the University of Pennsylvania, told WEEKEND in an email.

Though GIS has emerged from a childhood of uncertainty as a program with immense potential, it is extremely difficult to use. It's often easy to convince faculty of its importance, but convincing them of the need to learn the program is another matter altogether, as Maples elaborated.

THE QUESTION OF 'WHERE?'

As Maples propounds, everywhere is indeed somewhere. The importance of that somewhere, however, is often far from obvious.

History professor William Rankin, who uses GIS in his research and wrote his graduate dissertation on cartography, said it is easy to fail to realize what GIS can do for academia. He believes that academics outside the hard sciences often have a very simplistic view of the system, thinking that it can only be used to create pretty maps to supplement their research.

"Deciding to learn GIS to make a single map would be kind of like saying you want to learn Excel to make one graph," he quipped.

Rankin said that GIS can be used for complex statistical work. With the help of the software, researchers can search for elaborate correlations between geographical data and other information. A scientist could, for example, place data concerning the prevalence of depression onto a topographical map and investigate whether altitude has any effect on mood — something that would be next to impossible without a program as powerful as GIS.

Indeed, many researchers are already delving into the unconventional uses of GIS.

It was 2005 when the Indian government approached University of Cambridge research scholar Mark Turin, who now conducts research at both Cambridge and Yale, with a formidable task. He was asked to lead the first phase of a linguistic survey of Sikkim, an Indian state. The region, nestled in the Himalayas with a population of 600,000, is highly multilingual: 40 languages, of which at least 10 are indigenous, are spoken in the state.

It was up to Turin to devise a survey that would investigate children's language use in Sikkim. To do so, he presented public and private high school students with a set of questions ranging from "If you could study only one language, which one would you choose?" to "If you have to write a shopping list, which language do you write it in?"

Altogether, his team visited 105 schools, spoke to 16,500 students and collected half a million data points. The project could easily have produced broad statistics with little nuance. For instance, the team could have investigated the percentage of participants speaking nontraditional languages like English, and how many students preferred these new languages to those their parents and grandparents were more comfortable with.

But Turin is taking a very different approach. The question of location — where schools are positioned in relation to major roads, sea level and other such environmental components — is an important one for Turin.

Over the course of the study, his team took down geographical coordinates for each school surveyed. Though he characterized the geographical information as "thin," Turin's coordinates will allow him to plot the data he found in his survey against concrete space. Each school will be associated with a real physical location and compared against publicly available information. The goal is to analyze whether a relationship exists between specific geographic location and language use, Turin said.

"You can add layers of complexity and layers of texture to something that is otherwise very flat," he said.

He will be able to search for correlations in extremely unlikely places. For example, he will investigate whether elevation has any correlation with a person's tendency to retain his or her mother tongue.

When asked how his research would be different in a world without GIS, Turin said that tracing each individual geographic correlation would take a tremendous amount of work. It would be almost impossible, he said.

"There are all kinds of things that you can do [with GIS] because you can see the data visually, on a screen," he explained. "You could never have imagined it without GIS — or you'd have to be a genius for the numbers to sing to you."

Indeed, GIS's innovation lies in this very ability to provide a visual representation of the abstract by laying data points into a concrete geographical framework. Just as simple correlations between two variables don't become apparent until data is thrown onto a scatter plot, trends connected to geography don't become apparent until information is plotted on a map.

THE HISTORY

GIS has a very extensive history, spanning many different college campuses across roughly half a century. Maples said that many universities in the “Cambridge area” are often credited with pioneering the development of GIS.

“When people talk about the history of GIS, they always talk about the Harvard design labs,” Maples remarked. “To be fair, all of [Yale’s GIS developers] came from the Cambridge area, so its certainly a circular group of people who helped develop these things.”

But Maples was quick to argue that Yale’s contributions to GIS are not to be ignored. He noted that the University’s pioneers are not “spotlight seekers” — they don’t look for the recognition they are due.

Don Cooke ’63, a former Yale researcher who now works at a GIS software development firm called Esri, is credited with having created a technique called Dual Independent Map Encoding (DIME). Maples said the fundamental principles underlying Google Maps’ ability to locate specific addresses on maps relies on the principles of DIME.

Additionally, Tomlin’s doctoral dissertation developed Map Algebra, a computational language used in most modern GIS software.

Still, despite its extensive history, the existence of GIS support units — specialized departments within universities that assist students and faculty with technical GIS issues — is far more recent.

As many of the nation’s elite universities began offering GIS as a resource in the 1990s, it opened academic doors previously not known to exist. Peter Bol, the director of the Center for Geographic Analysis at Harvard University, argued that institutions not using GIS by 2003 “were already behind the curve.”

With the growing relevance of GIS to research came the increased need to offer support services for the program’s use.

Many of the nation’s elite universities began incorporating such “support units” into their regular operations around the turn of the century.

The Massachusetts Institute of Technology hired its first GIS specialist in 1999 because “a few strategic faculty members felt strongly about” bringing GIS support to campus, Lisa Sweeney, the head of GIS services at MIT libraries explained. At Stanford, GIS support became a part of the map collection in 2000.

At Yale, Maples was brought to the Map Department to serve as the University’s second GIS specialist in 2005, just as GIS was rising in prominence and demand. He now runs the training workshops his department offers, while also assisting students and faculty with their technical needs.

THE USE OF GIS

The critical measure of GIS's newfound popularity is not to be found among professors — it lies in the growing number of students, both undergraduates and graduates, who see GIS adding new value to their work.

Max Lambert FES '13 said that he found the tool “invaluable” in his work on ponds across the state of Connecticut for the help it afforded him in relating vast quantities of data. And, just as professors across disciplines have adopted the technology, Vanessa Lamers FES '13 MPH '13, who is pursuing degrees at both the School of Forestry and the School of Public Health, attests that GIS has proven to be “highly useful in both disciplines” with which she's involved.

Lamers added that her peers in the public health program, an arena that lacks the traditional GIS linkages of the Forestry School, are “really starting to find [the tool] very helpful for public health.” Projects that have made extensive use of it include investigations into food deserts and the ties between chemical exposure and health problems.

Beyond the tangible appeal of setting data within a novel framework, GIS has also proven to attract students for other purposes. Lambert says that “a lot of [its] use is just for aesthetic appeal — [it] represents data better.” Another factor is the way maps make quickly grasping data easier, according to Lamers, who says the use of GIS can help graduate students “create an image everyone will understand.”

For undergraduates, the split between departments is more evident. Of 10 undergraduates surveyed across various majors, only three had even heard of GIS — all within the Environmental Studies major.

This may be due to a policy decision from higher up. Lamers says that “there is more of a [push to promote GIS] by the Forestry School” than exists in other departments. This surely extends beyond the graduate setting as well.

Within the Environmental Studies major itself, enthusiasm for the tool varies. A junior seminar, taught by Tomlin himself, is among the major's course listings. Jimmy Murphy '13 claimed that “your use of GIS depends on your concentration.” Because of his interest in urban studies, Murphy does not think GIS is vital to his studies.

But undergraduates across the board are not unaware of the tool's potential. “I understand that GIS is a really useful skill,” Environmental Studies major Andrea White '13 said. She learned about the program outside Yale, when she interned with the U.S. Forest Service in Montana. Much like the professors Maples speaks of, she evidently recognized the value in GIS only once she saw it applied.

Different schools are employing similar strategies to try to cater to such growing demand. The GIS support teams at both Stanford and Harvard conduct regular open workshops, much like their counterparts at Yale. Having GIS software installed on all or most campus computers is also a common attempt at accessibility.

Still, some plans get even more ambitious. Sweeney described an experiential class at MIT called Periscope, which offers freshmen a chance to solve what she called “a problem bigger than anyone could solve, say, deforestation in the Amazon.”

Graduate students have varying opportunities to learn GIS depending on their program. “There are tons of classes [that teach people how to use GIS],” Lamers said. She added that many students who are likely to use the tool in their field of research already have experience in it, thanks to jobs or teaching commitments prior to entering graduate school.

EXPLORING A COMPLEX PROGRAM

But all capabilities aside, GIS is an incredibly difficult program to use.

Turin, whose project relies on an ambitious use of GIS, has never used the program himself and does not know how to use it. Steven Wilkinson, a political science professor using GIS to map the locations of Hindu-Muslim riots during the 1947 partition of India and Pakistan, said that he leaves the geographical aspect to a research partner who is a “GIS guru.”

According to Lamers, other research programs led by esteemed professors also depend on GIS specialists.

“The professor is probably not sitting down with GIS data,” she said.

The difficulties that scare professors off are immediate.

Rankin said many who would like to use GIS open the program on their computers expecting a map to materialize before their eyes. But this is not the case. GIS itself is devoid of data — everything, from the data points to the maps, must be supplied by the user.

In this sense, GIS is the Microsoft Excel of the future: Excel has lots of possibilities, but if you don’t have any actual information to input, it’s useless.

Stanford’s Patricia Carbajales, who heads the GIS staff at the university’s Branner Library, speaks of such difficulties too. She argues that GIS is “not user-friendly; it can be very overwhelming.”

For a researcher whose area of study is far from the realm of geography, finding the right map and investing the necessary time into plotting the data-points is a heavy burden to assume, especially if the benefits are not immediate.

But Maples insists that, each time he sits a professor down at one of his computers, he is able to convince them of GIS’s importance to cutting-edge research.

Still, professors are often unwilling to face the monster head-on and, while Maples spends a great deal of time holding workshops to help Yale affiliates confront GIS, his schedule becomes over-filled with one-on-one consultations.

“I help people answer their spatial questions — if they have a ‘where?’ component to their research, I help them leverage that component,” he said.

And while hurdles might exist in the present, the field is constantly changing, often making the software more accessible, as MIT’s Sweeney reminded WEEKEND.

“Two aspects have changed a lot: GIS today is more user-friendly, and computers are more powerful. It used to be that your computer would crash every day and you would be chopping up files to save them. Now, online mapping is constantly becoming easier to do,” he explained.

IS IT WORTH IT?

Professors who use GIS are convinced of its necessity. As Harvard’s Bol said: “If you want to publish competitive research today, you have to have GIS.”

This may be something of an overstatement. Stanford’s Carbajales says the use of GIS is spreading by word of mouth: “If one biology student starts using it, 15 more will [be using it] tomorrow.”

But the fact remains that an immediate name recognition of the software has yet to develop.

There are naysayers even among those who are aware of GIS’ potential. Murphy said he sees no value in taking a course in the tool; even his peer, White, who is considering taking the Environmental Studies department’s junior seminar in GIS training, sees it as an opportunity more than a compelling need.

Lambert concurs — he says that “it is definitely not a necessity” for all researchers.

Specialization, then, may be the future for the program. It is conceivable that GIS might one day become as ubiquitous within academia as Google Maps is within the broader population. If departments integrate GIS into their own teaching, the role that Maples and other specialists play is likely to diminish. Graduate students in fields employing GIS are expected to understand the program and its functionalities, according to Lamers.

Meanwhile, academics who only rarely use GIS might consult specialists if and when necessary, while remaining blissfully oblivious of the program’s nitty-gritty.

Today’s graduate students are tomorrow’s professors. And, if the trends hold true, at least a significant proportion of them will soon be using GIS technology to gain deeper insight into diverse fields of study for decades to come. So map on, Maples.

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