Computers redraw the map

What's new in cartography: a computer’s experimental perspective map of the San Francisco Bay Area

By David Lore

Astronomy Reporter

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ice Shi-Ning Lam loves those 15th-century maps in which serpents slither through uncharted seas and devils tease the sails of foolhardy mariners. But such artistic fantasies are ages behind the work being done at the newly dedicated Ohio State University Cartographic Laboratory.

Here, Lam and his colleagues are armed with computers, not compasses, and they create maps that are mediums for social research.

The broadest definition of cartography is the art, science and technology of designing, analyzing and producing maps, explained Harold J. Moellering, OSU associate professor of geography.

Today that means data analysis as well as drawing. In the OSU laboratory, computer terminals are used more often than mapping boards.

"I LIKE to draw, but I just don't have time," said Lam, an assistant professor of geography and a specialist in such subjects as numerical cartography, geographic information systems and quantitative analysis.

These are serious credentials for a field in which sea monsters and stern gods once footnoted the unknown.

The science of cartography first flourished on the sea, Daniel Boorstin, the librarian of Congress, wrote in his 1961 book, "The Discovery of America." He wrote: "Christian geography had become a cosmic enterprise, more interested in everyplace than in anywhere, more concerned with facts than with faiths. Cosmographers confirmed Scripture with their graphics, but these were no use to a sea captain deliveries a cargo of olive oil from Naples to Alexandria."

Ship pilots began keeping notes on coastal features at least as early as the 5th century B.C. Cartographic historians believe maps first appeared around 1300, according to Boorstin.

BACK THEN, the map-makers had to be talented artists.

Today, it still takes a bit of the artist to make a good cartographer, said John Bayley, chairman of OSU's geography department. But most of the draftsmen at the analytical lab are rendered on keyboards.

And because of the new technology, a map no longer is just a flat sheet of paper.

Traditional maps, such as sheet maps, were tangible objects with visible graphic images, said Moellering. These are now supplemented by new "virtual" maps, which may be neither tangible nor visible.

A U.S. Geological Survey computerized data bank, for example, may contain millions of bits of information about topographic and man-made features in our world, but that map isn't in tangible or visual form until converted.

"The key to a map is information," said Moellering. "It's taken cartographers a long time to realize this. Cartographers always thought they were dealing with fixed maps, but they're really dealing with information."

And computers offer an efficient way to present that information, Lam said. A sheet of paper no longer dictates how much information can be included in the map because the computer can give a large-scale, bird's-eye view and then plunge down into smaller-scale detailed segments.

"The key to a map is information. It's even taken cartographers a long time to realize this. They always thought they were dealing with fixed maps."

An aerial survey map of Mt. St. Helens in 1980
IN MANY CASES, maps are easier to handle and read on a computer terminal than they are in bulky paper form. Airplane pilots and motorists probably will use computer-display maps in the future, for example, because punching a few buttons is easier and safer than folding paper maps. In fact, Moeller-ing said, cassette maps will probably be on the market in several years.

Map readers also will have access to more types of information when the graphic display is tied to computer data banks.

On the computer, for example, one map can tell you the route to Cleveland as well as the city’s population, crime rate, traffic trouble-spots and distribution of income.

"Thematic” maps now give us a geographic perspective on issues as varied as the economy, population increases and the spread of disease. With a computer, thematic maps can offer a snapshot of current social conditions and a moving picture of changes over time.

And map data can more easily be kept up to date when it is stored and displayed by computer.

Today, Rayner pointed out, some brand-new sheet maps from the U.S. Geological Survey actually display terrain features last surveyed in 1908.

MAP SURVEYING remains a slow process, even in urbanized regions such as Ohio. The last full-scale revision of Ohio topographic maps, for example, was completed in the early 1960s, said Ohio Geological Survey chief Horace Collins. Photo revisions are made in areas of rapid change, such as cities or mining sites. But even in Columbus, where most map sectors were revised in 1982, there remain map areas unchanged since 1973.

Once new surveys are completed, computer maps can be updated more quickly than sheets and atlases.

But the big roadblocks to compiling vast map data banks, said Moeller-ing, are the lack of standard, uniform techniques for coding and storing terrain features and other map data, and the lack of compatible computer programs for using this data.

Today, for example, the OSU lab can get tapes of map data by mail but it cannot electronically pull in map data by mail, but it cannot electronically pull in map data through computer terminals.

Moeller-ing, as chairman of the National Committee for Digital Cartographic Data Standards, is working to develop such standards so all university, government and commercial map-makers will be on the same electronic wavelength. It’s a significant step, and an expensive one. The computerization of the U.S. Geological Survey mapping effort alone is expected to cost in excess of $500 million, he said.

IN THE MIDST of all this, the artistic aspect of cartography seems as remote as those ancient mariners.

But what we’re seeing, said Moeller-ing, is a blending of the two aspects of a good map. "From the analytical point of view, we see more science and not as much art, but that doesn’t push the artistic part out,” he said.

Computer graphics offers entire new vistas for artistic expressions in cartography. A mountain, for example, is no longer just a whorl of lines but a range of peaks that can be seen on three-dimensional computer maps from many different angles and perspectives.

And today, more than ever, Rayner said, map-makers can be storytellers, "telling us not only where we are, but who we are."
COLUMBUS, Ohio -- Ohio State University's department of geography has named its cartography and climatology laboratories for two former professors distinguished in these respective fields.

The department recently dedicated the Guy-Harold Smith Cartography Laboratory in room 158 of Derby Hall, 154 N. Oval Mall, and the Eugene Van Cleef Climatology Laboratory in room 100 of Derby Hall.

Cartography is the art of mapmaking and climatology is the science of dealing with the weather and climate.

Professor Smith died in 1976, 11 years after his retirement from Ohio State's faculty. He had joined the geography faculty in 1927 and in 1933 began a 29-year span as chairman of the department.

Professor Van Cleef served for 36 years on the geography faculty, retiring in 1957. He died in 1973.

John N. Rayner, professor and chairman of geography who also serves as state climatologist, says facilities of the newly-named laboratories are in several different locations.

The cartography laboratory is equipped with special desks for drawing maps and with a series of computer terminals linked directly to one of the university's main computers, providing the
capability for interactive graphics -- a technique for modifying maps as they are being drawn.

Facilities also include digitizers and plotters. A digitizer is a device which records map information for creating map-like displays on a video screen. A plotter transfers graphic material from a video screen back to a hard copy.

The laboratory also makes available an enlarger and reducer, as well as a printer for lettering of different sizes.

One of the laboratory's current projects is the establishment of national standard guidelines for storing digital data. The project is under the direction of Harold Moellering, professor of geography. Work of the National Committee for Digital Cartographic Data Standards is supported by a grant from the U.S. Geological Survey.

The laboratory's cartographic equipment, used in conjunction with the facilities of the university's department of geodetic science and surveying, provides a strong resource for attracting personnel from various government agencies, Rayner says.

"We have about a dozen graduate students specializing in cartography under special arrangements with the Federal Defense Mapping Agency, as well as with other agencies. "Under this program the agencies send employees to Ohio State for a year or more of training in conjunction with the department of geodetic science and surveying."

The climatology laboratory is equipped with a facsimile machine which receives current weather and prognostic data for general weather forecasting.

Other equipment includes a receiver for weather radar and a
satellite receiver for cloud images and maps. Instruments mounted on the roof of Denney Hall relay wind speed, atmospheric pressure, temperature and humidity readings to the laboratory.

The laboratory's micrometeorological instruments measure transfers of heat energy, water, and air momentum near the ground. Equipment also includes sensors of solar radiation, terrestrial radiation, and wind velocities at six levels.

As state climatologist, Rayner receives and stores all of Ohio's climatological records on campus, but he says there currently are no funds available for cataloguing and analyzing the data.

"We should be publishing regularly, and I hope that we will be able to do some of that in the future," he says. "We need to put these records on tape as well."

Up to 10 graduate students are taking courses in climatology, in which specialists train mostly for government agencies or for teaching. Rayner says the trend is for government agencies to require advanced degrees for employment. "Agency people get academic credit for courses they take. Some also come in for advanced degrees."

In addition to Moellering, Siu-Ngan N. Lam, assistant professor of geography, is associated with the cartography laboratory, while A. John Arnfield, associate professor, and Jeffery Rogers, assistant professor, join with Rayner in working with the climatology laboratory.

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Cartography at Ohio State University

Harold Moellering

Academic Setting at OSU

The Ohio State University (OSU) was established in 1870. It has 16 colleges and more than 100 academic departments that offer courses in almost every area imaginable. The university has about 4,500 faculty members, 13,000 full-time staff members, and 54,000 students on the main campus, which makes it the largest single university campus in the United States. OSU also has four branch campuses in Lima, Mansfield, Marion, and Newark with a total of 6,000 students.

The academic study of cartography originated in the Department of Geography in the 1920s, and is currently shared with the Department of Geodetic Science and Surveying. In general, course work in the geography department is oriented toward thematic, numerical, and analytical cartography, while the course work in the geodetic science and surveying department focuses on topographic and general cartography. The geodetic science and surveying department shares surveying with the Department of Civil Engineering; while remote sensing and terrain analysis are taught by the civil engineering department. Geodesy and photogrammetry are taught in the geodetic science and surveying department; courses in geographic information systems (GIS) are offered by the geography and geodetic science and surveying departments, and the School of Natural Resources.

Historical Overview

OSU originally was chartered as Ohio Agricultural and Mechanical College in 1870 as a land-grant college under the Morrill Act of 1862. In 1878 the name was changed to The Ohio State University. Academic work in geography has been offered since 1873, when the university began to offer classes. In the early days before departments and colleges were defined, cartography may have been taught on an informal basis.

The geography department was established in 1924 in the College of Commerce and Journalism. The study of cartography has been closely associated with the geography department since. From the 1920s to the 1970s, cartography was taught exclusively in the geography department, and now its teaching is shared with the geodetic science and surveying department.

As nearly as can be determined, the first cartography course began in 1925 as Map Construction and Interpretation, offered by Fred Carlson. Earlier, students had taken courses in engineering drawing in the Department of Engineering Graphics and topographic drawing in the civil engineering department. A few years before, the geography department began to offer a course, Fieldwork in Geography and Commerce, that specifically included the making of maps, diagrams, and a final typewritten report.

In 1927 Guy-Harold Smith was appointed to the geography faculty. Smith, with a Ph.D. from Wisconsin (A.K. Lobeck was his advisor), took over the cartography courses. Except for the academic year 1928-29, Smith offered cartography courses continuously until his retirement in 1965. He was appointed department chairman in 1934, and was promoted to full professor in 1937. Smith dominated OSU cartography for four decades.

During the Depression, university programs, including those in the geography department, faced financial problems. From 1930 to 1934, university faculty faced three salary reductions; some salaries were cut by as much as a third. Student enrollment fell, and class sizes and teaching loads were increased for all faculty members.

During this period the faculty continued to produce research and publications. In 1931, 11 of Smith’s physiographic maps were included in Nevin Fenneman’s famous textbook on the physiography of the Western United States. Smith produced his spherical symbol population maps of Wisconsin and Ohio during this period, and in 1934, the first version of his physiographic map of Japan was published.

By 1935 the geography department offered four cartography courses. F. Webster McBrayne, who had a Ph.D. from Berkeley, was hired in 1937 to share the departmental field course with Smith, but later resigned in 1942 to join the war effort in Washington. McBrayne became well-known for his contributions to the field, and his work on the U.S. Geodesic Survey in 1945, as well as for several projections he developed in the 1970s. He invented more than 10 map projections, including the 1977 S3 projection for which he was granted a U.S. patent.

Arthur H. Robinson also figures prominently in the history of OSU cartography. He began his Ph.D. program in 1938 with Smith as his advisor, and finished his course work by 1941. That year Richard Harshbarger was coordinating an intelligence organization for the war effort. During a stopover in Columbus, he asked members of the geography department whether any geographers with knowledge of cartography would be interested in joining this endeavor. Robinson saw this as an exciting challenge and opportunity to serve his country and build his career. He moved up rapidly in the organization, and by 1945 was chief of the Map Division of the Office of Strategic Services in Washington, D.C.

Many OSU faculty members assisted in the war effort. Smith helped organize the Army Specialized Training Program on campus with geography faculty and 11 faculty members from other departments. Area studies with geography, and perhaps some cartography, were emphasized. Several thousand people were trained at the university during this period.

Harold Moellering is a professor in the Department of Geography, Ohio State University, Columbus, OH 43210.

From 1943 to 1944 Smith produced his famous physiographic maps of Japan from indirect sources because it was impossible to conduct field work at the time. A map of Hokkaido was prepared in 1943 and the map of Japan was completed in 1944 for the Topographic Branch, G 2 General Staff of the U.S. Army. In 1949 he prepared a physiographic map of Iran and later of Soviet Central Asia. Because these maps were classified until the early 1960s, Smith has not received full scientific and professional recognition for them.

After World War II, veterans returned to the OSU campus. In 1947 Robinson completed his doctorate degree under Smith’s tutelage. Robinson’s dissertation, “The Fundamentals of Cartographic Method,” was expanded and published in 1952 by the University of Wisconsin Press as The Look of Maps. This work began the philosophical paradigm of cartographic communication that has had a tremendous impact on cartography.

Robinson went to the University of Wisconsin as a faculty member in 1945, and built its famous cartography program. He has served in many capacities including president of the International Cartographic Association. In 1984 OSU awarded Robinson an honorary doctor of science degree to recognize his outstanding work and role as a world leader in the field of cartography. In June 1984 he was on hand to dedicate the geography department’s cartography teaching laboratory in the name of Guy-Harold Smith.

The Mapping and Charting Research Laboratory was founded on the OSU campus in 1947. The laboratory conducted contract research in geodesy, photogrammetry, and cartography. By 1950 the Institute of Geodesy, Photogrammetry, and Cartography was established as an academic unit of the university. Courses in geodesy and photogrammetry were offered through the geography department.

By 1955 these cartography courses were offered by the geography department: Introduction to Cartography (510), Cartography and Map Interpretation (611), Map Projections (612), Fieldwork in Geography (700), Special Problems in Cartography (702), Cartography and Map Intelligence (812), Seminar in Geography (850), and Research in Geography (950).

The Division of Geodetic Science in the Department of Geology was converted into a full department in 1960 and began offering courses in geodesy and photogrammetry. It was named the Department of Geodetic Science, and in 1964 Urho Uotila became department chairman.

In 1983 Robert Basile was hired as an assistant professor to help Smith. Smith retired from the university in 1965 after 37 years of distinguished service to his department, the university, and the field of cartography. About this time, the map projections course was taken over by the geodetic science department. During the late 1960s the geography courses in the department were reorganized and renumbered in accordance with a new university plan.

Edward Taaffe was appointed the geography department’s new chairman in 1983. He set the department on a course of quantitative methods and spatial analysis. In 1970 the department tried to blend this new thrust with the rich history of cartography by hiring Carl Youngmann, who had recently received his Ph.D. from Kansas, to replace Basile who had left in 1969. Youngmann reoriented the cartography courses toward digital cartography; in 1972 he installed the course, Computer Cartography (683). Youngmann took a faculty position at the University of Washington in 1973.

In 1972 the geodetic science department hired Harry Steward, with a recent Ph.D. from Wales, as an assistant professor. He developed cartography courses oriented toward general cartography and scribing. One of his first Ph.D. students was Joseph Loon who did his conventional work with Steward, and learned numerical cartography from Harold Moellering.

In 1973 Moellering, who had recently received his Ph.D. from the University of Michigan, was hired to take over Youngmann’s cartography position. Moellering got permission to include GIS course work in the geography department’s cartography courses. He continued Youngmann’s work by orienting the cartography courses toward numerical and analytical cartography with an emphasis on thematic cartography. That year there was one new graduate student and a partially equipped, traditional cartography teaching laboratory. Moellering immediately began to write proposals and specifications in hopes of building a numerical cartography laboratory.

Moellering and Steward worked to increase enrollment in graduate and undergraduate courses in their respective departments. They encouraged their students to take cartography courses with each faculty member, and coordinated the content and timing of their respective courses. Moellering began offering course work in GIS in 1975 by alternating the content of Seminar in Cartography (880) with a topic in interactive cartographic systems. This was the first course work in GIS offered at OSU.

By 1975 the following courses were offered in the two departments: Geography—Elements of Cartography (580), Cartography (681), Individual Studies in Cartography (682), Computer Cartography (683), Seminar in Cartography (880), Fieldwork in Cartography (885), and Interdepartmental Seminar (899); and Geodetic Science—Cartography I (555), Cartography II (635), Mathematical Cartography (636), Introduction to Advanced Cartography (637), Applied Cartography (735), Advanced Cartography (835), Research Principles and Techniques (885), and Interdepartmental Seminar (899).

Steward left OSU in 1978 for a position at Clark University. Temporary appointments filled his position for the next several years. Meanwhile, the cartography specialization continued to flourish in the geography department. The Defense Mapping Agency began sending graduate students for long-term training at the master’s level. By 1978 the load from the growing cartography course work was overwhelming Moellering. A departmental self-study in 1979 recommended creation of a second faculty position in cartography, that the course in computer cartography be split into two courses, and that an introductory course in map reading and interpretation be implemented.

In fall 1980 the cartography department hired Nina Lam, with a Ph.D. from Western Ontario (Michael Goodchild was her advisor) to fill this second faculty position. The Computer Cartography course was split into Numerical Cartography and Analytical Cartography, following Waldo
Tobler's suggestion concerning the half-life of theory versus the half-life of technique. By this time the graduate program had increased to 10 resident cartography graduate students, 25 percent of the department total, and a growing number of undergraduate majors declared the cartography track as their specialization. Also, the undergraduate cartography and climatology tracks were converted to bachelor of science degrees, primarily at the urging of recent graduates and students in the track. Not long after, the GIS course became a departmental course. Moellering and Lam shared teaching of the lower-level courses; Moellering covered analytical cartography and interactive cartographic systems and Lam covered the GIS course.

In 1981 the geodetic science department hired Joseph Loon to take over the position vacated by Steward. Loon increased enrollment that had slipped after Steward's departure. In 1985 Lam accepted an offer from Louisiana State University for a cartography position. This left a gap in the geography faculty that, with the scarcity of qualified applicants, became difficult to fill. The position was open for a year, but in fall 1986 Michael DeMers was hired for the cartography position and to cover two GIS courses.

In spring 1986 a group of faculty members in the spatial sciences wrote a proposal for a National Aeronautics and Space Administration (NASA) solicitation for a real-time satellite mapping center. Moellering was the representative from geography and Ivan Mueller was the representative from geodetic science and surveying. Eight of 10 faculty members from various university departments participated. In fall 1986 the group learned that NASA was awarding a five-year grant to OSU for the center. The next year John Bossler was hired as the administrator and director of the NASA Center, and what later became known as the Center for Mapping.

Also at this time, the National Science Foundation (NSF) announced a competition for the National Center for Geographic Information and Analysis. OSU was among many universities competing for the center. As part of the overall strategy, the university announced that four senior faculty positions would be made available to support the proposal for the NSF center. The faculty positions were to be allocated among the major participating departments.

The geography department was allocated one position, and subsequently hired Duane Marble from the State University of New York at Buffalo. The natural-resources school hired Dana Tomlin part-time; the geodetic science and surveying department hired Grenville Barnes, who had recently received his Ph.D. from the University of Wisconsin. Later, natural resources hired Earl Epstein from the University of Maine. Po-Chin Lai was hired in fall 1989 by the geodetic science and surveying department as an associate professor for its second cartography faculty position, to work with Loon.

OSU's geography department began granting master's degrees in the 1920s and doctoral degrees in the 1930s with a concentration in cartography. In the 1970s when the geodetic science department began offering cartography courses, it also began to offer master's and doctoral degrees in the specialization. Since 1986, the geography department specialization has been named analytical cartography and GIS. These departments provide a strong offering in cartography with additional work in GIS. Many faculty members hold courtesy joint appointments in other departments.

As of 1990-91, the following cartography courses are listed in the OSU catalog. This offering of courses in the cartography specialization is one of the strongest in the United States: Geography—Map Reading and Interpretation (280), Elements of Cartography (580), Numerical Cartography (680), Individual Studies in Cartography (682), Analytical Cartography (780), Interactive Cartographic Systems (782), Seminars in Cartography (880), Interdepartmental Seminar (899), and Special Topics in Geography—Analytical Cartography (983); Geodetic Science and Surveying—Fundamentals of Computer-Assisted Cartography (630), Large-Scale and Topographic Mapping (632), Digital Surface Models (633), Digital Mapping Systems (634), Map Projections (636), Topics in Mapping (637), Group Studies in Cartography (694), Generalization of Topographic Maps (732), Advanced Cartography (835), Research Principles and Techniques (885), Interdepartmental Seminar (899); and Natural Resources—Cartographic Modeling (745).

General Nature of OSU Cartography Specializations

The two major areas offering work in cartography are the geography department and the geodetic science and surveying department. In both cases cartography is viewed as a subfield of the main disciplines.

The cartography specialization in the geography department is named analytical cartography and GIS because there is a large overlap in basic theory used in these two areas. At the undergraduate level, the cartography track begins with a basic core of courses and branches into a choice of three courses oriented toward cartography or GIS. Both undergraduate branches of the cartography specialization result in a bachelor of science degree in geography with a specialization in analytical cartography and GIS.

At the master's and doctoral levels, analytical cartography focuses on theory and cartographic practice with an emphasis on understanding and working with the expanding body of analytical theory in the field. The GIS side of the specialization tends to focus more on applied work, using spatial concepts in an applied setting. Course work in cartography tends to be oriented toward numerical, analytical, and interactive cartography with an orientation toward thematic cartography because it meshes best with the wide variety of conceptual and applied work in the discipline of geography.

The cartography specialization in the geodetic science and surveying department is in one of four major areas: geodesy, photogrammetry, computer-assisted mapping, and land information management. Work is offered at both the master's and doctoral levels in all four areas. The cartography work in the department is primarily oriented toward topographic and general cartography because it blends with the work offered in the other three specializations. At the undergraduate level, the geodetic science and surveying department offers bachelor of science degrees in surveying, mapping, and land information science.
At the master’s and doctoral levels of the cartography specialization, courses in the other department are generally required along with a list of cognate areas. This means that master's degrees specializing in cartography in each department are somewhat different in character and orientation. At the doctoral level this difference is more pronounced because the dissertation research topic is specific to the individual. Hence, the mix of elective courses beyond the core is linked directly to that individual’s dissertation.

Cognate Areas
GIS is widely offered at OSU. In the geography department GIS is an integrated specialization of analytical cartography and GIS. In the geodetic science and surveying department the specialization of land information management is separate, but the specializations in that department seem to be more tightly bundled together than in geography. The 1990-91 OSU course catalog lists one course in GIS offered in the natural resources school. Because the growth in GIS is recent, new courses are still being defined and links to home departments and other departments in the area are still being refined.

Other cognate areas, such as remote sensing and terrain analysis, are offered by the civil engineering department with these courses cross-listed in the geodetic science and surveying department. These courses form the core of a remote sensing and terrain analysis master’s and doctoral specializations in civil engineering. This type of cross-listing has been used in other areas to connect the offerings of one department with those of another.

At OSU, surveying is offered as a separate program linked to the geodetic science and surveying department, although there are also connections to the civil engineering department. It is possible to get a bachelor of science degree in surveying in the geodetic science and surveying department and a bachelor of science degree in civil engineering with a concentration in surveying in the civil engineering department. Geodesy and photogrammetry are offered exclusively by the geodetic science and surveying department.

Enrollments
With such a varied set of programs, shared specializations, and interlocking courses, specific enrollment figures are not calculated easily. The geodetic science and surveying department now has about 20 cartography graduate students in residence. Cartography graduate enrollment in the geography department is more difficult to estimate because analytical cartography is integrated with GIS. In that specialization there are about 20 graduate students in residence, with a third estimated to be interested in analytical cartography. Together, the departments have about six cartography doctoral students in residence. If one added the graduate students enrolled in cognate areas, there would be more than 60; therefore, it is estimated that there are more than 100 graduate students enrolled in the cartography and cognate graduate programs at OSU. This number is still growing.

Coordination and Cooperation
With such a cornucopia of cartography courses offered in two major departments and at least six major cognate areas, coordination and cooperation are challenges. There are four faculty positions dedicated to cartography and 12 devoted to the other cognate areas, bringing the total faculty members involved to 16 from four main departments. This does not count about six more faculty members interested in this area, who are housed in such departments as landscape architecture, city and regional planning, and geology.

Coordination and cooperation are accomplished through courtesy joint appointments of faculty members, requiring or strongly encouraging graduate and undergraduate students to take courses in cartography in both departments and additional cognate areas, and coordinated research work of faculty members in various areas of the spatial sciences.

Conclusions
OSU offers a rich set of specializations in cartography and other cognate areas. This is true in terms of the specializations and programs offered, as well as the quality of the faculty members and their teaching and research. OSU is a world leader in cartography and spatial sciences.

ACKNOWLEDGMENTS
Many individuals provided assistance in gathering information. Bertha Ihnot of University Archives provided valuable time and assistance to locate important documents on the history of the specialization. Jana Drvota of University Photo Archives located the photograph of Guy-Harold Smith that is used elsewhere in this issue. Charles Summerson of the geology department and John Randall of the geography department provided interesting insights. Additional information has been provided by Barbara Skunza of the geography department and Robert Canegali of the geodetic science and surveying department. Comments on the manuscript were made by Edward Taaffe, John N. Rayner, Henry Hunker, and S. Earl Brown of the geography department, and Joseph Loon of the geodetic science and surveying department.

REFERENCES
OSU may try hand at maps

Researchers take to the road, use satellite in project

By Tim Doulin
Dispatch Higher Education Reporter

Ohio State University finds itself in uncharted territory as it considers going into a for-profit cartography business.

OSU researchers have invented a mobile mapping system that uses satellite technology to chart the location and condition of roadways more quickly and accurately than standard methods.

Researchers who developed the system considered starting a for-profit business. But, because the system was invented on university time, they can't market the technology themselves without violating state ethics laws.

The university is considering ways around the problem, including opening such a business for itself.

"If our employees were major shareholders in a spinoff company and were negotiating a contract with the university with respect to royalties from a university invention, then we would have a situation where we would be in conflict," said Edward F. Hayes, OSU vice president for research.

"Essentially, a university employee would be selling something back to the university."

OSU believes it can establish a university-owned company and assign the researchers to work for the company, Hayes said.

"If we go down that road, you could basically make your product, train a new cadre of people and sell the company at the appropriate time, if it is of value."

And OSU believes that the technology has some value.

A receiver mounted on a van traveling at legal highway speeds picks up satellite signals.

As the van travels down a road, the Navigation Satellite Timing and Ranging Global Positioning System marks the location, and video cameras record the view. Information is processed and entered into a database.

The location of everything from signs to bridges is mapped. The system has proven accurate within 100 feet.

The information has the potential to help transportation agencies in many states and other countries design more accurate maps, make better use of road signs and determine sections of road most in need of repair, the researchers say.

Many states have inaccurate inventories of tunnels, bridges and intersections because older maps were improperly scaled, OSU officials said.

"There are people all over the country and the world who want to know where their highways are and what is around them," said Paul G. Lafayatis, director of technology transfer at OSU.

"Having surveyors go out with equipment and figure out where things are can be a relatively tedious job. This is a quick way to map the highways and their conditions."

The university does not have a patent, which would protect its property rights and allow royalty agreements with a company or companies that would market the technology.

Researchers contacted several investors about setting up a company but had no takers.

"There is no group out there that has said, 'We think we can take your technology and run with it on our own without your help,'" Hayes said.

In the meantime, the non-profit OSU Research Foundation, which helps the university obtain grants to support research, plans to market the technology temporarily.

Private companies interested in the technology will contract with the foundation. Researchers will build vans on request, refining the hardware and software. The university will have a chance to test the marketplace and determine costs of a business venture. The first van cost about $200,000.

"This will allow us to better assess whether there is a sound business plan for setting up a wholly owned company by the university," Hayes said.
CARTOGRAPHY
IN THE GEOGRAPHY DEPARTMENT
AT OHIO STATE UNIVERSITY

The Department of Geography has offered M.A. and Ph.D. programs with a specialization in cartography for many years. The specialization emphasizes thematic cartography, numerical and analytical cartography, interactive graphics in cartography, and geographic information systems. It concentrates on the theory and analysis of cartographic data as well as the concepts and techniques of producing machine generated cartographic displays in static, interactive and dynamic settings.

FACULTY

Harold Moellering, Ph.D., University of Michigan, 1973, Associate Professor, thematic cartography, numerical and analytical cartography, interactive graphics in cartography. Director of Numerical Cartography Laboratory.

Nina Siu-Ngan Lam, Ph.D., University of Western Ontario, 1980, Assistant Professor, numerical cartography, geographic information systems, quantitative analysis.

FACILITIES

The Department of Geography cartographic facilities includes a well equipped conventional teaching laboratory and support facilities as well as a numerical cartography research laboratory. The numerical cartography laboratory contains several Tektronix and Hewlett-Packard graphic CRT terminals which are interfaced to the main university Amdahl 470 V6 computer. The terminals have peripheral support equipment such as plotter, graphic printer, graphic tablet, and hard copy unit interfaced to them. The laboratory also jointly owns with the O.S.U. Computer Center a Bendix Datagrid II large bed digitizer for use with large format maps or high volume digitizing.

The University Library system has a large collection of thematic maps, topographic sheets and atlases in the Map Room of the Main Library and in the Geology Library. It also offers a computerized book checkout system and computerized bibliographic reference service.

CORRESPONDENCE

For further information please write:

Dr. Harold Moellering
Department of Geography
100C Administration Bldg.
Ohio State University
Columbus, Ohio 43210
COURSES OFFERED

580 - Elements of Cartography
An introduction to the theory and methods of thematic cartography. 5 credits

680 - Numerical Cartography
A detailed survey of the theory and methods of machine-oriented numerical cartography. 5 credits

682 - Individual Studies in Cartography
The individual study of various topics in cartography. 2 - 5 credits

780 - Analytical Cartography
A detailed survey of the theory and methods of analytical cartography. 5 credits

795 - Seminar in Geography
A thorough introduction to computer applications in geography. The course includes lectures as well as an emphasis on worked problems. 5 credits

880 - Seminar in Cartography
1) Geographic Information Systems - an examination of the theory and techniques of the design, data structures, building and operation of such a system.
2) Interactive Cartographic Systems - an investigation of the theory and methods of the design and implementation of interactive cartographic systems. 5 credits

RECENT PUBLICATIONS, MASTERS PAPERS AND DISSERTATIONS


1. **Field of Specialization:** Cartography
   **Faculty:** N. Lam
   H. Moellering

2. **General Description:** The specialization in cartography is oriented towards thematic cartography with an emphasis on numerical, analytical and computer methods. The program concentrates on theory and analysis of cartographic data as well as the concepts and techniques of producing machine generated cartography displays in static and interactive settings.

   Cartographic facilities include a conventional teaching laboratory and support facilities as well as a numerical cartographic research laboratory. The Numerical Cartography Laboratory contains several state-of-the-art graphic CRT terminals and peripheral support equipment such as plotter, graphic printer, graphic tablet and hard copy unit. The laboratory also jointly owns with the O.S.U. Computer Center a Bendix Datagrid II digitizer for use with large format maps or high volume digitizing. The university library system has a large collection of maps, topographic sheets, and atlases in the Map Room of the Main Library and in the Geology Library.

**Masters and Ph.D. Minor Course Sequence:**

1) The student is expected to have a comprehensive knowledge of the theory and methods of cartography and reasonable acquaintance with the cartographic literature especially as it applies to his/her major.

2) It is presumed that the student will take some cartography courses offered in the geodetic science department.

   The student is expected to fulfill all of the departmental requirements. In addition, the following courses are required:

   **Year 1**
   **Autumn**
   Geog. 795
   580 or equivalent
   Geog. 889
   **Winter**
   Geog. 883.01
   795 Programming
   680 Cartography
   Geog. 889
   **Spring**
   Geog. 883.02
   780 Cartography
   880 Seminar
   Geog. 889

   **Year 2**
   **Autumn**
   880 Seminar
   Research Paper
   Elective
   **Winter**
   899 Seminar
   Elective
   **Spring**
   G.S. 635 Cart. II
   Elective

*** Students with prior cartographic backgrounds who are considering work in cartography towards a major or a minor may be excused from some of these courses.
Cartography Ph.D. Major

1) The student is expected to have a comprehensive knowledge of the theory and methods of cartography and a thorough knowledge and understanding of the cartographic literature.

2) It is expected that a Ph.D. student would take 899 Joint Seminar in Cartography each year.

3) Advanced tools and techniques:

   Each student is expected to complete either of the following:

   a) Pass an examination in technical translation in a language in which there is a substantial literature in the field of cartography such as Russian, French or German. (other languages may be substituted if special needs are demonstrated.)

   b) Further work in mathematics/computer programming.

4) It is presumed that the student will take several of the cartography courses offered by the Geodetic Science department.

   The student is expected to fulfill all of the departmental requirements. In addition, the following courses are required:

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<th>Year 1</th>
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<tr>
<td></td>
<td>Geog. 795 (Quant.)</td>
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<td>Geog. 883.02</td>
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<td>580 or equivalent</td>
<td>795 Programming</td>
<td>780 Cartography</td>
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<td>Elective</td>
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<td>882 Geographic Thought</td>
<td>Other cartography courses</td>
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The following is a brief synopsis of the courses concerned:

580 - Elements of Cartography 5 credits
2 hours lecture and 4 hours laboratory per week. An introduction to the theory and methods of thematic cartography

680 - Numerical Cartography 5 credits
Two 2 hour lectures per week. A detailed survey of the theory and methods of machine-oriented numerical cartography. Prerequisites: Geography 580 or equivalent; Mathematics 150 or equivalent. Computer programming recommended.

682 - Individual Studies in Cartography 3-5 credits
The individual study of various topics in cartography. Prerequisites: permission of instructor.

780 - Analytical Cartography 5 credits
Two 2 hour lectures per week. A detailed survey of the theory and methods of analytical cartography. Prerequisites: Geography 680; and 795 or equivalent, Mathematics 152 or equivalent.

795 - Seminar in Geography (Winter) 5 credits
A thorough introduction to computer applications in geography. The course includes lectures as well as an emphasis on worked problems.

880 - Seminar in Cartography 5 credits

1) Geographic Information Systems
An examination of the theory and techniques of the design, data structures, building and operation of such a system. Prerequisites: Geog. 780, Geog. 795, permission of instructor.

2) Interactive Cartographic Systems
An investigation of the theory and methods of the use of an interactive CRT terminal in a geographic/cartographic setting. Prerequisites: Geog. 780, Geog. 795, permission of instructor.

899 - Interdepartmental Seminar
An advanced research seminar in cartography given cooperatively with the Geodetic Science Department. Prerequisites: Permission of the instructor.

Cartography courses offered in the Geodetic Science Department.

GS 635 Cartography II
GS 636 Mathematical Cartography
GS 735 Applied Cartography
GS 835 Advanced Cartography