Professional Implications of Automation Panel

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Morrison: The professional and educational events happening in cartography today are inevitable and would have occurred without automation, but automation has hastened these developments, making a revolution out of the cartographic evolution. Automation has changed almost every cartographic problem.

First, automation has relieved the cartographer of the time-consuming work of sitting at a drafting table. I'm not saying that using some automated equipment does not involve time-consuming work, but the cartographer now has more time to concentrate on what he is doing rather than on how he is doing it. As a result the cartographer can pay more attention to the design of cartographic products than ever before.

Second, the purpose of the map can be more specific. Maps made with a large investment of time have to be used for years. Now maps can be produced for more specific uses and less longevity. With automated equipment it is no longer necessary to print a map or even to have a hard copy map.

Since automation allows cartographers to spend more time designing special-purpose maps of less longevity, cartographers must carefully define map purpose. In other words perhaps the most important long-term effect of automation on professional cartography will be to hasten the development of a theoretical structure for the field. The structure is developing around the map as a communications medium. I will not say that without automation cartography would never have developed this theory, but automation has definitely advanced it. This theoretical structure gives cartography a completely scientific base, maybe for the first time in its history.

Previously the geodetic and projectional aspects of maps had a scientific base, while cartography was thought of as an art. Now cartographic art and technology are recognized as tools in a scientific field. The recognition of cartography as a science has caused a proliferation of professional cartographic societies and journals. Since 1961 at least five international journals were started, all are devoted to our field alone. The International Cartographic Association has been active only in the last 20 yr. Now undergraduate and graduate programs in cartography are available at colleges and universities, and there are positions with the title "cartographer." Although some people have distinguished between mapmakers and cartographers for many years, the distinction is now clearer than it has ever been. The cartographer who directs a mapmaker or a draftsman is a professional, and he must have a broad education to prepare him for this position.

The goal of educating the professional cartographer must be to create a generalist in one sense and a specialist in another. The cartographer must understand the computer and its peripheral equipment; he must be able to state clearly what he wants done in terms that a programer can understand. It would be useful for the cartographer to be a programer, but I doubt that all the requirements on his time would allow him to be a skilled programer. In most automated cartographic work, the cartographer himself is not the programer, but he directs the programer, who is a member of his support staff.

The cartographer must also know something about the perception of the map reader. If his aim is to communicate to map readers, then the cartographer must know how they will react to each option in the automated system.

A knowledge of statistical processing of data is also necessary in this day and age where we are flooded monthly with statistics from our Government and daily with statistics from news reports and papers. But because cartographic data generally require enhancement and/or generalization and because repeatable generalization schemes rely heavily on statistically processed data, the cartographer especially needs a basic understanding of statistical processing.

Finally, a professional cartographer must have some knowledge and ability in management and budget operations. He must be able to efficiently operate both equipment and personnel.

Ward: We are witnessing the most revolutionary cartographic development since the invention of the aerial camera. The effects of automation on mapmakers are enormous. I am not referring to the prospects for unemployment, which may or may not exist, but to the different tasks that cartographers will perform in the future. We know that automatic plotters will do the work of cartographic draftsmen. But what about the professional, the person who conceives the map? How will his life be affected?

Although design is basic to every map, the word design repels those who think of design as merely esthetic. If someone says that the London taxicab is a superbly designed vehicle, he does not mean that it is the most beautiful thing on four wheels, but that it is maneuverable, comfortable, safe, and durable. It's also rather ugly. I accept the premise that a map can be well-designed and ugly at the same time.

While the London taxicab design recognizes the needs of the users, cartographic designs reflect the tastes and prejudices of the designer. Cartographers seem to perpetuate archaic methods of portrayal. Are these methods adequate for today's customers whose association with graphic information is for the most part through television commercials? We must cater to the American people, and they have no patience with tedious maps. We must stop making maps for each other and start making maps that people will want to use. Automated methods will not only enable us to process data and to construct lines and symbols, but will also free us from the tedious parts of our jobs and allow us to spend more time designing appealing cartographic products.

In 1966 a landmark article entitled "Graphicacy Should Be the Fourth Ace in the Pack" appeared in The Cartographer. The writers contended that formal education stresses three aces--articulacy, numeracy, and literacy--but leaves out the fourth ace, graphicacy. If that fourth ace ever gains

equal status in American education, perhaps we will become even more map conscious than our European friends.

We have an enormous challenge to shape our maps to public taste and to bend the public mind to understand the importance of comprehending spatial relationships. Automation will help us do a better job more cheaply and more quickly than we have in the past. In short, we can achieve volume production on a quality scale.

Cartography is in a stage comparable to the automobile industry in 1910. Motorcars of that day closely resembled the horse-drawn carriages that they replaced, sometimes even to having a whip socket on the dashboard. It took a Henry Ford to understand the needs of the mass market and a decade of design innovation to achieve a unique look. Maps produced in 1984 will probably be quite different from those produced today. Gradually we will rid ourselves of such archaic notions as north orientation, geographic grids, precise shorelines, and verbose legends and footnotes, and we will focus our attention on the spatial relationships of features important to man.

How do we achieve this goal? First we must experiment with design, and automation makes such experimentation possible. In my organization, we have a data bank and a plotting system. We can design alternative cartographic displays, produce and evaluate each, and then make a final decision on scale, size, content, and specification. Second, we can use the results of studies in visual perception. With a plotter we can generate a variety of symbol gradations within a few hours and make a test map for its gestalt effect, before choosing the final design. Third, we can stop designing maps for posterity. We can solve today's problems now and generate a whole new map for tomorrow's problems more cheaply than revising an existing map. Finally, professional cartographers will have to be imaginative. They will have to be in tune with user needs as never before, and they will have to understand the problems of visual perception. I will know that we have won the revolution when I ask my local sports-shop clerk for the Appalachian Trail Map, fall-colors version, and he says, "Do you want the normal vision edition or the bifocal edition?"

Devine: In 1972 the question at the 32d Annual Meeting of ASCM was whether automation would survive? Now the question is how fast can we automate? In 1972 I said that the new cartographer would be a cross-breed of the old cartographer and the computer scientist. I advised the cartographer to promptly study as much computer science as possible. Recognizing the fact that some of us have been in the field many years and are not about to go back to school if we can help it, we should try to learn as much as we can in order to communicate with the computer scientist. We must depend on him to do the programing because even though we might study programing, unless we do it every day, we won't retain the skill.

Two years ago I was involved in the Association for Computer Machinery, which was also concerned with educating the computer scientist. A task force was formed to develop a curriculum, headed by Professor Atchison (Univ. of Maryland). According to the resultant curriculum, prerequisites for courses computer graphics or information retrieval systems included an introduction to computing, programing, data structures, programing languages, and systems programing. Assuming that each course was 3 credit-hours, the cartographer would have to take 8 courses or 24 credit-hours, the equivalent of a master's degree in computer science,

to be independent of the computer scientist. The courses required today are introduction to programing, FORTRAN for computations and projections, and COBOL for state structures, data banks, and computer graphics.

At the same time we have the opposite side of the coin. Computer science has entered the field of cartography, and I welcome all the computer scientists into the field. But they should learn about cartography so that they can communicate with cartographers just as cartographers are learning to communicate with them.

When Professor Campbell, Chairman of the Geography Department at George Washington University, was asked to establish a course of study for a Bachelor of Arts in Cartography, he organized a team that consulted various government agencies and private industries for requirements. They decided on 189 absolutely necessary credit-hours which had to be condensed into a 4-yr course of 120 credit-hours. Courses include photogrammetry, geodesy, geomorphology, projections, map construction, map compilation, and map reproduction. Through such courses the computer scientist could also become familiar with cartography. When the cartographer and the computer scientist become one person, we will have the new cartographer. And the communication problem will disappear because he can have a chat with himself without any problems.

Cuff (Temple Univ.): I agree with the concern for design, but I am not really sure how automation is encouraging this concern or improving design. The very process of learning about automation distracts some designers from design. I hope that this distraction is just temporary. Also, installing and experimenting with a new system takes time, and sometimes we become so enamored with the system that we are completely sidetracked from design work.

Some computer-aided techniques are used when they are neither appropriate nor design-effective. For instance, some atlases are not designed to convey certain themes effectively, but to use a technique just because it exists; these atlases are really a collection of SYMAPS. A similar technique, frequently used but not ideal, is SYMVU. This technique is fine for smooth surfaces, but the three-dimensional choropleth map is done more effectively by hand, although the process is slower; production time, however, depends on the individual. Would you elaborate on how automation is improving design?

Morrison: What you say is true in the short run, but in the long run automation will affect design. In Ward's shop they do not make final design decisions until they have studied 3 or 4 possibilities. When you make maps manually, as we have for so many years, you must have a final design from the beginning. Ward is saying that with automation he can carry three designs almost to completion before making his final decision. This ability gives great flexibility. Granted, in the transition to automated techniques, it can be frustrating for organizations with limited automated facilities and trained personnel.

Ward: In a production shop, after a map is made, it has a shelf life of a week to 20 yr. When the map comes up for revision, it is almost never thrown away, regardless of how good or bad it is, because it is cheaper to revise it. With automation, however, it can be cheaper to make a new map than to make corrections. Thus you can constantly work on innovations and improvements and keep the map in tune with the times.

Thompson (U.S. Geological Survey): The real issue is not how automation

can improve map design, but how map design will accommodate automation. For example, if an automated system can produce contour lines, but not numbers, then numbers can be omitted at least in the first compilation. We need to be flexible in our current standards and designs so that we can make such changes and so that automation techniques will be easily compatible with our final product.

Morrison: We haven't really designed our maps today to fit the machines that are producing them. We are designing the machines to do what we have been doing manually. Therefore we are not taking full advantage of the possibilities of progressing in our field.

Rhind (Univ. of Durham): As someone involved in education, I am well aware of the grave difficulties of balancing oneself between revolution and reaction. Not only are we automating existing products, but we are thinking about how maps are made in the same way that we did in the past. For example, one can argue that the term "map projection" is redundant now. "Map projection" is an example of one type of spatial transformation; rectification of sheets to make sure that they are square is yet another type of map projection, and interpolation to contour surfaces might be another. In essence, we must acquire a different concept of the subject, but we won't get it overnight. However, we must think in new terms rather than taking a clay brick out of cartography and replacing it with a plastic one.

Finnie (Private consultant): With all the expenditures for automated equipment, we are still spending 80 percent of our mapping resources for people. There are many different concepts of training, organization, and utilization of people in the various organizations of the U.S. However, the majority of the mapmakers are professionals. The Defense Mapping Agency Aeronautical Center in St. Louis--probably the largest single map/chart organization in the U.S., with almost 4,000 people--has about 2,000 professionals, people with bachelor's degrees and often advanced degrees. Considering the kinds of systems that they operate ($250,000 to $1-million computer-driven systems), it is probably advantageous that they are well-educated. Most scientific computer operations, including special purpose operations, in that same organization are performed by cartographers who were hired as cartographers and then retrained as computer scientists. ACSM and other organizations should spend more time studying the use and development of these resources that represent 80 percent of mapping cost.

Bie (Soil Survey Institute): The systematic, general-purpose geologic and soil maps of the last 100 yr have rather limited use for the more intensive purposes for which maps are now requested. One result of automated cartography has been the invention of two very expensive methods, line-following and scanning. With the ability to make special-purpose maps by computer, soil scientists and geologists in many countries have re-evaluated their methods of collection. They are moving away from the fuzzy human algorithms used in the field for delineating different mapping units, toward point data and mathematical interpolation algorithms linked with automated cartography.

Moellering (Ohio State Univ.): Usually people use maps to analyze a spatial problem. With automated cartographic techniques, it is easier to digitize displays. Automation has also affected geographic analyses and data bases. We should bring these two together so that when we study a problem we will have an analysis of the geographic data and a cartographic display.

Morrison: The Special-Interest Group in Graphics of the Association for Computing Machinery is sponsoring a second symposium on computer graphics and interactive techniques this summer (1975) that will include a session on cartography.