ICA Commission III Panel

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Stine: The International Cartographic Association (ICA) was conceived at a conference on applied cartography in Stokholm in 1956. The proposal that international cartographic cooperation be investigated was re-emphasized by delegates to the Second International Cartographic Conference sponsored by Rand-McNally & Co. in 1958. The ICA statutes were formally adopted at the first general assembly in Paris in 1961.

The aim of the association is to advance the study of cartographic problems. In particular, the ICA is concerned with source material, compilation, graphic design, scribing, and reproduction of maps and associated forms of graphic representation. The coordination of cartographic research involves cooperation between different nations and different scientific groups: exchanging ideas of cartographic knowledge, organizing international technical conferences and exhibitions, participating in similar meetings, and establishing special commissions to work on specific problems. The ICA is affiliated with the International Geographical Union, and they hold joint assemblies every 4 yr. The ICA also holds technical conferences biennially.

Each nation can only be represented by a member of one organization, preferably a national cartographic society or committee. Individuals can not be admitted as members. The Cartography Division of the American Congress on Surveying and Mapping was designated the official organization to represent U.S. cartographic activities. The Fifth General Assembly of the Eighth Cartographic Conference of ICA will be held August 3-10, 1976, in Moscow, and the president, Professor Arthur H. Robinson of the University of Wisconsin, will preside. The themes of this meeting will be cartography as a service to public education; mapping of nature and natural resources for environmental protection; the cartographic application of remote sensing data; methods for utilization of maps for scientific research and application; international collaboration in the compilation of small-scale map series; and the development of cartography in Russia and the USSR. Technical exhibitions will include Maps and Atlases for Public Education; Natural Resource Maps and Atlases; Nature and Environmental Protection Maps; Charts of the Continental Shelves; Seas and Oceans Resource Maps; Maps Compiled on the Base of Remote Sensing Data; Maps Published with the Use of Automatic Means and Modern Technology; and Cartographic Literature.

At the Second General Assembly, London, 1964, three working commissions were established. The objectives of Commission I, Training of Cartographers, are (1) to collect information on the different systems of training cartographers, (2) to collate this information according to the various technical and professional levels and age groups of those in training, and (3) to make this information available in a concise and convenient form. The objectives of Commission II, Definition, Classification, and Standardization of Cartographic Terms, are (1) to make a list of terms designating the principal cartographic documents, (2) to make a list of the essential operations involved in the preparation of these documents, and of the terms designating such operations, (3) to prepare a short but sufficient definition of each term chosen for the documents and for the operations, (4) to prepare a classification of maps, charts, and cartographic documents, and (5) to prepare a simplified glossary of the corresponding terms in the principal languages. The objective of Commission III, Automation in Cartography, is to study and evaluate automated aids for the cartographer.

The first two commissions have progressed well in accomplishing their objectives. Commission I has completed two publications on education, and Commission II has published the Multilingual Dictionary of Technical Terms in Cartography with definitions in five languages and corresponding words in nine additional languages. Commission III has not been dormant: it has held a symposium or technical meeting each year since the first one in Frankfurt in 1966 and has published several volumes--Automation: the New Trend in Cartography, the final report on the ICA Commission III scientific working session held August 1973 in Budapest, and Automation Terms in Cartography, definitions of terms unique to automated cartography (copies may be obtained from ACSM). The latter has just been published, but Commission III is already reviewing it to include new terms and definitions. Although the objective of Commission III has been narrowed, its mission is dynamic and will never be completed. The next meeting of Commission III is a symposium to be held at The International Institute for Aerial Survey and Earth Sciences (ITC), Enschede, Netherlands. The topics for discussion are digitizing processing, output techniques, cartographic systems (configurations for all kinds of cartographic purposes), tests for hardware, and trends in hardware and software development. The ICA Working Group on Oceanographic Cartography will share one day of the meeting to discuss automation of marine cartography. It is probably too late to submit a paper for this meeting, but papers will be required for the Moscow meeting.

The most important current project of Commission III is the preparation of a universal test standard that could be used for testing all automated hardware and software. If a common test standard can be agreed on, then claims for digitizing, processing, and output speed and accuracy would be meaningful. Various systems for collection, processing, and output can be checked against known parameters or against each other. Members of the Commission are being supplied test samples so that they may perform the test, evaluate the concept, and recommend any revisions or additions for improving the interim standard. One session in the Netherlands will be devoted to the results obtained by the participating countries.

Over the years 3 additional commissions and 2 working groups have been formed: Commission IV, Thematic Cartography; Commission V, Communication in Cartography; Commission VI, Techniques in Cartography; the Oceanic Cartography Working Group; and the History of Cartography Working Group. The U.S. is represented in each commission and working group. The ACSM

Cartography Division has a U.S. National Committee for ICA responsible for U.S. participation in ICA. The chairman of this committee is Warren Schmidt, 11304 Fieldstone Lane, Reston, Va. 22091. Inquires about U.S. participation in ICA, Commission III should be addressed to Dean Edson, Western Mapping Center, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025. Edson reports that the published record of this week's meeting will be available for discussion and distribution at the Netherlands meeting.

Diello: We (RADC) still consider the test standard experimental. It has not been thoroughly assessed or used enough. However, we have constructed a test to encourage people to think about the uses of a test standard. At the ICA meeting in Madrid two members of Commission III began discussing the advantages and disadvantages of point and stream digitizing. At that time we offered any member of the Commission a copy of the test standard and instructions for compiling data streams in either a point or stream mode. Using our diagnostics at RADC, we promised to assess the test results and to determine which method is most effective from time and accuracy standpoints. We have six test data sets out now; a few more test packages are available. If anyone in the audience wants to participate in this small but meaningful test, we certainly want to hear from you.

Two members of my working group are Dr. Gottschalk from West Germany and Mr. Nardozza from the U.S. Nardozza was the project engineer on the cartographic test standard developed for the Air Force at RADC. I have asked each commission member to identify additional candidates for this working group. We hope to enlarge it to 8 or 10 members, to make it as international as possible, and to have something to report as early as the 1975 spring ITC conference in the Netherlands.

Government and private industry are working together to establish a realistic yet flexible cartographic test standard consistent with the existing and projected requirement of the various mapping and charting communities. The objectives of our working group are to design a standard capability of testing the accuracies, resolution, repeatability, and input/output rates of various graphic digitizing equipment and to intermediately manipulate digital records and ultimately convert them back into manuscript form.

The test standard should be composed of three basic elements. The first is a graphic manuscript exhibiting a wide variety, quality, and density of cartographic features, imaged on a dimensionally stable base material in a form suitable for reproduction. This manuscript should serve as a source bracket for input devices being tested and a reference bracket against which output test materials could be compared. The second element in the test standard is a magnetic tape or digital record containing all the graphic information (registration points, control points, and feature identification) portrayed on the stable base. The third element is analytical software for comparing the digital data with the test standard.

The first step in the development of a cartographic test standard is to develop a design that accommodates the conditions under which the cartographic test standard is to be used in both manufacturing and production. Most testing should be done at individual equipment levels. The cartographic test standard should be capable of determining general performance with defined specifications and required error budgets, lump parametric errors, and limited error diagnostics. It should also identify error budgets based on error threshold, and perform necessary measurements, reduction, and analyses by error analysis software, diagnostic graphics, or manual measurement techniques. Testing should be as simple as possible within normal operator measurement capabilities. The simplest test would probably be an error budget test which might be required for normal setup and checkout.

Periodic testing should be an integral part of the continuing quality control of a preventive maintenance program. Testing is also useful when excessive errors are observed in the normal operation of a device and when a new device is being assessed in comparison to other devices.

I welcome any contributions, ideas, comments, and criticism. For the working group to be effective we must represent the entire international cartographic community. The development of a cartographic test standard will take a few years, and before it is totally accepted, it will have to be thoroughly assessed and certified.

Nardozza: As Diello indicated, the experimental test standard developed at RADC 3 yr ago consists of a graphic portion, a digital portion on tape, and a diagnostic software package.

(Slide) (Editor's note: Slides not available for publication.) The test standard consists of a cartographic composite which was tailored to represent the standard 1:250,000 JOG charts. The features identified as below standard can be added in any of the boxes marked "blank." The basic format is 24 by 36 in, and there are 12 8- by 8-in blocks with a 6- by 6-in information area within each. These areas consist of features selected from the composites, such as nonintersecting features which eliminate software problems associated with scanning through intersections and vertical information which is more acceptable to the scanning devices. We did not want to be totally dependent on the linealization process as a criterion for evaluating the scanning systems.

(Slide) This fiducial construction gives an optical target for hand-held digitizing systems and a unique geometric pattern for recognition by the scanning systems.

(Slide) Our resident glass standard has a series of skewed lines which are not to be digitized but are used to optically evaluate plotted outputs. Most are angled from their center point on a 10 mil/in slope. The standard copy used for digitizing has straight lines between the fiducials. However, if you try to examine the output and distortion of the plotting system by overlaying straight line segments between the fiducials with the skewed lines, you create an optical vernier which gives 50:1 and 100:1 magnification. Thus with a pocket scale you can get an indication of distortions and discrepancies of 20 to 30 mil.

(Slide) One panel consists of a series of radial lines of 4-and 14-mil line weights, which indicate the errors of vector or angular dependence. This panel is useful on both scanning and manual digitizing systems. The 14-mil line weight is used because we feel it is typical of hand-drafted manuscripts.

(Slide) A series of resolution rulings--vertical, horizontal, and skewed--are located in one of the 6- by 6-in information areas. Again, these resolution rulings can be used to check high-speed scanning systems, manual systems, or semiautomatic line-following systems. A series of semicircles of various line weights allow us to obtain some indication of angular dependence and to accurately define the precise intersection of features that converge very slowly.

(Slide) This simple grid localizes any deformation within any one of the 8- by 8-in working blocks.

(Slide) This slide shows a composite that serves many purposes. Not only is it typical of the 1:250,000 but left, right, top, and bottom boundaries match. If you need repetitive information cells or an unlimited data base, you simply repeat and panel the composite as many times and in as many directions as desired. The composite cartographic panel is the test graphic to be used in the digitizing test that Diello mentioned earlier. Approximately 360 lineal inches of feature information are organized into 8 basic classes with 8 unique headers. RADC has used this cartographic portion extensively over the past 3 yr. We developed the standard in order to compare the results of high-speed scanning systems, semiautomatic line-followers, and manual digitizers. Within a working group we found claims of speed, accuracy, and rates that no one was able to duplicate. We use the standard to train operators and to monitor their progress. We can also check experimental devices, which are prone to failure. The test standard is flexible so that test results can be either detailed or cursory.

(Slide) This cartographic composite was digitized from a hand-drafted source. In testing plotting systems, you generate a plot format from the digital file on tape, output that data in graphic form, and compare it with the composite of the standard. You can move through this testing system in many ways, depending on your interest: you can make graphic to graphic comparisons and digital to graphic comparisons.

(Slide) The most important way in which we have used the test standard is to evaluate input digitizing systems.

(Slide) Two stages in our diagnostic software compare the test files with the stored standard file. This slide summarizes what we look for and what we can analyze from the first phase, i.e. Pass 1. The test sample of data obtained in point and stream digitizing modes may be compared to the standard file or to each other. The errors in x and y direction are presented as a collective mean and as orthogonal arithmetic averages which indicate bias. Thus this test can eliminate some machine errors.

(Slide) The significance of this histogram is to show error frequency. Range designates the error interval in 0.001-in steps, and frequency is a scaled representation of the number of errors in each interval.

(Slide) Pass 2 provides a listing from which we can analyze the data point by point. It also provides a line-printer plot of the reference data with the test data. The listing shows the interval between test points, the orientation of line segments between points, their relationship to the reference points, and the value of the x and y bias adjustment necessary to minimize the summary displacement errors generated in Pass 1.

(Slide) One transaction of Pass 2 will provide a line printer plot of a specific feature or portion of a feature. This transaction allows you to use your line printer to rapidly plot a comparison between the test data and the reference data. This capability is particularly useful in analyzing the raster to lineal conversion software that we are developing to support our color scanning system. The succeptability of the algorithms to highly convoluted lines is clearly demonstrated by the Pass 2 output.

(Slide) This slide shows what happens in stream digitization. If you are interested in what an operator is doing and what the data look like, you can specify an area or a portion of a feature and get a line printer output, which gives an all-points consideration of the rms deviation from the true reference point and the intended counterpart (test point) on the line.

The cartographic test standard has been very beneficial. It provides an appropriate way of gaging our progress and a method for assessing the relative value of high-speed scanning systems, high-speed line-following systems, and manual devices.

Gottschalk: Since automation was not used for production until now, sophisticated methods of testing cartographic equipment were not needed. People simply believed what the manufacturers said. With the installation of a system paid for by the German Counselor of Research, test methods were systematically developed.

Scribed words on a thin metal plate are used for testing digitizers. The grid is composed of holes produced by a high-precision tool machine. The grid constant is about 2 in. The coordinates of the grid points used for calibration of the digitizer are measured with a high-precision coordinatograph so that the grid points are known within an accuracy of about 30 µm. The coordinates of the grid points are compared with the readings of the digitizer by lining the metal plate on the digitizer table so that the x values of the map points at the extreme left line of the grid are 0. The y value of the grid point in the lower left corner is also set at 0. The differences between the digitizer readings and the known coordinate of the grid represent the errors of the digitizer. If systematic errors of the whole table are found (for example, different scales in x and y direction and deviation in the angle of the x coordinates from 90 degrees), they must be adjusted in the electronics of the digitizer. The metal plate must be as large as the digitizer table, and its temperature equation must be known.

Another method for testing digitizers is to use a glass plate and measure the coordinates of points of a 10-cm by 10-cm grid. The glass plate is moved systematically, and the measurements are repeated. The coordinates obtained by the different measurements are transformed into one coordinate system by a least-squares adjustment. The relative differences of the coordinates of the transformed measurements indicate systematic errors of the digitizing table. With this method no absolute scale of the grid on the glass plate is needed. The climate must be checked constantly during the test.

A simplification of this test is a test using points in a straight line on a piece of plastic. The coordinates of two points are measured on the digitizing table, and the distance between the points is calculated from coordinate differences in the digitizer system. After changing the direction of the line formed by the two points on the plastic, the measurement is repeated and the distance is recalculated. If the distance has not been changed critically, the difference between the two distances must be due to an error of the digitizer table. Systematic relative errors of the table can also be found by this method, but the absolute scale cannot be determined.

The accuracy of digitizers is also tested by other methods. Usually, correct values of coordinates are compared with the coordinates measured on the digitizer table. The direction of the movement of the cursor is considered. For testing drawing machines, the test of static errors is performed by using a laser and differometer, a rule, and fixed angles.

The main tests evaluate hardware and software. Digitizing is tested with a test pattern digitized from a typical topographic map. The lines are digitized point by point where convenient, elsewhere by stream digitizing. The point rate is about 30 points/sec if the time mode is used and about 10 points/mm if the distance mode is used. Alphanumeric input is generated by the keyboard or manual technique. The digitized data are transformed into a plane coordinate system (like the UTM system), displayed on a CRT, corrected interactively, and listed by the line printer. Many editing functions are used. The digitizing is made on-line and off-line, and the data are processed according to the required purpose. The digitized data are filtered so that only those points are left which are sufficient and necessary for drawing the line. The data to be drawn are optimized so that the drawing machine runs the shortest path. The drawing is done in ink with a scribing and light spot on the tangential control that includes automatic symbolization. Programing and real-time assessing is tested, such as on-line digitizing, drawing, teleprocessing, filtering, and editing at the same time. In addition batch programs are run in the background.

Restart and protection measures will be tested. For example, if there is a power breakdown in the system, the data bases must be protected or reconstructed if they are destroyed. The direction of the data bank in different stages of filing is tested by measuring the processing times. The capacity of the data bank is examined at different stages of solution. The reaction of the data bank to different densities of digitized points is tested too.

As test material, the 1:50,000 German topographic map is digitized in different color separations on film and on paper. The drawing data automatically generalized from 1:50,000 to 1:200,000 are used. The complete test of hardware and software requires 2 months. This test was developed by the Cartographic Research Group of the Institute for Applied Geodesy.

Hoinkes: A small system--hardware and software that includes a multi-activity operating system--will cost about $250,000. We plan to run up to 4 concurrent activities on one PDP 11/40 computer. We have included a variety of peripherals: 12-million 16 bit word disk, 9-track magnetic tape unit, cassette tape unit for smaller files, card reader, printer, and console. The graphic work stations included are two interactive digitizing and/or editing stations. One is equipped with a GRADICON high-precision digitizer for input of graphical data, a keyboard, and a special-function button keyboard where functions can be taught to the system by software. Visual feedback of all input goes to a Tektronix 4014 storage CRT. We will use this station for manual line-following digitizing or point-by-point digitizing. In any case we get an immediate feedback of what has been digitized, even though we may have to process up to 50 points/sec according to the current digitizer calibration derived from 2, 3, or 4 reference points. The points are digitized and transformed immeditately so that we get their transformed (and stored) positions on the CRT. However, x-y cursor lights can show the raw digitizer units, if we like. I call this station a digitizer-editing station because it allows us to use all the editing facilities available (and mainly used) on the other station--a smaller Tektronix 611 CRT with a tablet as a graphical input device (a smaller, less precise digitizer) and a keyboard. Finally, to get hard-copy verification of what has been done on these two stations, we have included a CalComp 936 drum plotter, also on-line, which may run as an independent third activity or in background with another activity. It gives sufficient line quality and precision for check-plots of all digitizing and editing work.

The main problem of computer-aided cartography is input of cartographic data. However, we do not intend to use the system for big digitizing jobs. For this reason, I'd rather call it a digitizer-editing system. We still think that manual digitizing will be used for quite a while, either in editing or generating new lines. When you generalize from an existing map image copied at reduced scale to a scribing sheet, you can not use a scanning or automatic line following device since the line you want is not yet there. It can hardly be generated automatically in the near future. Certainly, when one must input a great amount of graphical data (for example, all the 1:100,000 topographical map sheets of a small country like Switzerland), it won't be feasible to follow all these lines manually. In this case we will have to think big because the volume of the data is tremendous in terms of today's technology. Using many men on manually operated digitizers, as the Ordnance Survey in Britain intends to do, is like cutting trees with pocket knives. It can be done if you use enough people and the famous Swiss army knives, but it would be better to find two strong men with a big saw.

In our small cartography department we do not have this large-volume input problem. Therefore, we will experiment with such editing techniques in which future human judgement and digitizing will be necessary. On the other hand we will have access to off-line high-precision photoplot output (a British-made FERRANTI Masterplotter) in order to prove that the necessary quality for cartographic reproduction and printing can be obtained from a digital system. Actually, this plotter was bought together with the interactive system, but since it will be used only partly for cartographic applications, its price has not been included in the $250,000.

Another problem is the interfacing of an interactive software and hardware system. I stress software because I think interactive systems are basically software systems, although a minimum of suitable hardware must certainly be there with other data base systems on larger computers. For this reason we have also included software to write data on 9-track magnetic tape in ASCII or to read such data (if formatted according to a certain standard) into our interactive system.

The stand-alone interactive system will allow us to work quickly with large amounts of data generated on another computer system. After the tape is read to disk, even millions of data points (which one map sheet may contain) can be displayed on the storage tube in a reasonable time since data transfer rates up to about 100,000 baud are used within the system. After the editing and possibly the plotting have been done, the data can be fed back to the larger computing facility on tape.

Dunphy (Research Facility, Univ. of New Mexico): (To Nardozza) Have you found any trend differences between the distributions you've obtained with point and stream digitizing?

Nardozza: No, we have not attempted to analyze the difference on that basis. That program is just beginning, in fact about 3 wk old.

Dunphy: How many points do you anticipate having to look at to get an idea of the distribution limit?

Nardozza: Our basic manuscript will contain 360 linear in. We haven't identified any restraint in the point mode. Whether it is a random point mode or a time-dependent mode makes no difference; we will compare it to a 1-mil or 0.1-mil standard.