Chapter 2
Exercises in Cartography

Ferjan J. Ormeling

Abstract By describing the scope and intent of contemporary cartographic exercises, the author pictures the changes that took place in cartography during the last 50 years in the format of an autobiography. Although these exercises changed from manual and repetitive ones towards digital and unique tasks, during this development some freedom of expression was lost, as current GIS-oriented software packages limit the design options. The author calls for exercises where the geographical insight of cartography students is strengthened, where they are made aware of the bandwidths of cartographic license and of the existence of many different but valid ways of rendering the same realities. Also, through exercises where they are addressed as map users, trainees may realise the map-use impact of the graphical decisions taken and the real challenges cartographers face in visualizing geospatial data for decision support.

2.1 Cartographic Apprentice

When I first started as an apprentice atlas editor, in 1961, I had to learn how to apply lettering to maps, and I spent many evenings just drawing the letter o. After a week I graduated to variations of o, such as a, b, d, g, q, c and e or p. Then I moved on to n, and varied it with h, u and m; the next month would be focused on i and l, f, j, t and odd letters like k, r, s, v, w, y and z. The next step would be to combine these letters and to get used to the differing distances between them. I did not feel particularly enriched by these long evenings and I merely wondered whether I had opted for the right profession. Fortunately, nowadays this lettering is done digitally and cartography students won't loose time in doing lettering exercises—at least not on lettering itself, but they still have to do exercises in the application of geographical names to maps.

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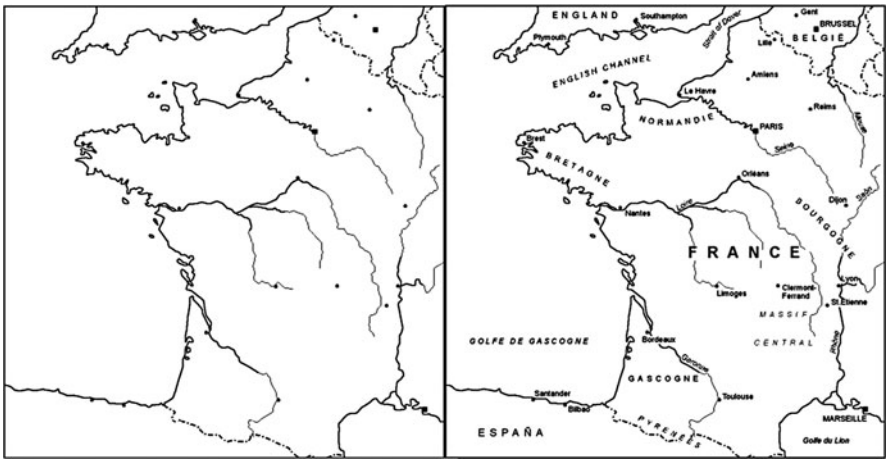


Fig. 2.1 Exercise in map lettering from the Basic Cartography Exercise Manual (1991)

Here they have to apply the theories of Imhof, Bonacker or Spiess to the map, in order to make sure that there is no ambiguity regarding the symbols a name refers to, to ensure the shortest possible time to find a name on the map, by using variations in type styles, sizes, boldness, spacing and colour (Fig. 2.1).

In my cartography classes at the university at the same time I had to be able to operate geodetical or photogrammetrical equipment, and map contour lines from pairs of aerial photographs, using both hands and feet. So I had to do mapping exercises with the equipment. Again, this was not particularly stimulating. As my main subject was geography we also had to engage in statistical exercises, do sums in order to compute the number of observations needed to end up with results that were 99% significant, or compute different kind of averages. The course in statistics was used as a threshold to keep out those without a head for mathematics although I never later on perceived any need why such a head was required in geography, nor in cartography. Fortunately for me, the looming onset of computers had obliterated—in the mind of the teaching staff—the need to do exercises in the plotting of map projections, with coordinatographs and the assistance of goniometric tables. As part of geography we also had to do geomorphology courses, and here we had to learn to draw all kinds of diagrams, cross sections, block diagrams and longitudinal sections. As we were interested in visualization we taught ourselves how to draw panoramic maps, based on topographic maps (Fig. 2.2).

2.2 Cartography Courses

But the real interest in cartographic exercises only started when I had graduated and, as a member of Utrecht university staff, helped to start up a Master's programme in cartography in 1971. Then we got to know a French publication called *La cartographie*

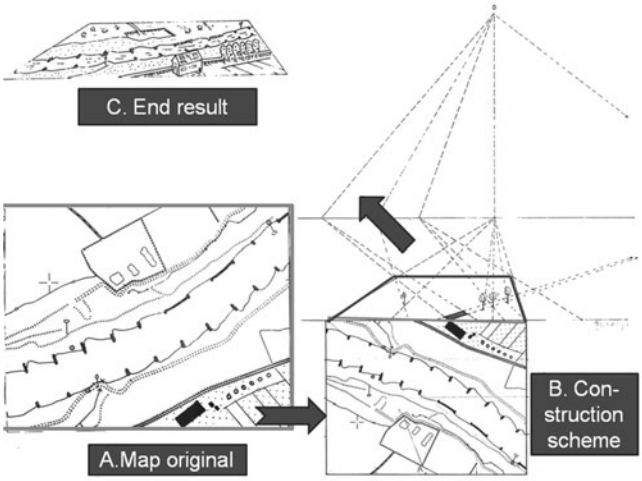


Fig. 2.2 Producing a panorama from a topographic map

thématique comme méthode de recherche, by Claval and Wieber (1969), which finally presented some intellectual challenge. It contained statistics on point, linear or areal data and base maps on which these data had to be visualized. Here at least there also was an opportunity to apply one's geographical knowledge, as doing these exercises frequently called for judgment regarding what was most important from a geographical point of view. As an example, in Fig. 2.3, I show an assignment to map statistical data on agriculture for Indonesia, where one has to pick the most important aspect of the table (based on one's geographical knowledge of the country) and visualize it.

The textbook by Claval and Wieber also showed us that—at least within Europe—there were different schools of cartographic design, using different mapping techniques. For instance, in France in the 1970s the areal cartogram method devised by Aimé Perpillou was en vogue. This was a quite elaborate method of showing different percentages of land use, per enumeration unit, by using coloured bands that together made up 100% (Fig. 2.4). The method called for extreme generalization of the data and the resulting images were not altogether straightforward. This method was never used in Germany or in the United Kingdom. In Germany, isoline maps were only used for physical phenomena, and the United Kingdom was an early advocate of anamorphosis maps, which were rather frowned upon in Germany. And it was only in Czechoslovakia that a particular time-related diagram type ever occurred.

2.3 ICA's Basic Cartography Programme

In the 1970s, there was already an ICA project under way to produce a textbook for cartographers. This endeavour was supported by UNESCO, and it resulted in the *Basic Cartography* manual series (Anson and Ormeling, 1984-2002), containing three

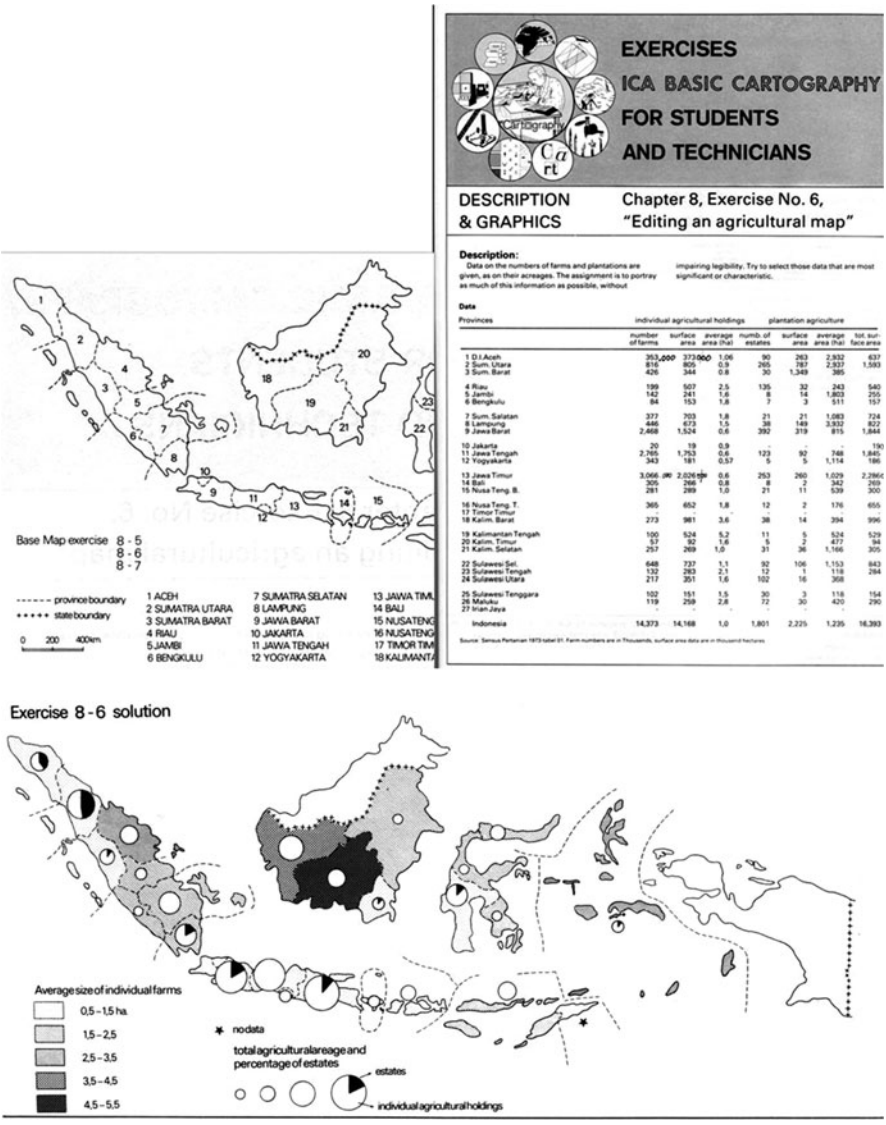


Fig. 2.3 Exercise on agricultural mapping with statistical data and base map (upper part). For solution see lower part. From the *Basic Cartography Exercise manual* (1991)

manuals (with contributions from France, FRG, GDR, Israel, Japan, the Netherlands, Nigeria, UK, USA and Sweden) and an exercise book. I travelled all over Europe to visit cartographic establishments in order to solicit 500 printed copies each of their best exercises, framed in a uniform ICA template and to put together this exercise manual, which finally consisted of contributions from, Austria, Belgium, Canada, France, Germany, Hungary, Israel, Japan, the Netherlands, Sweden and Switzerland.

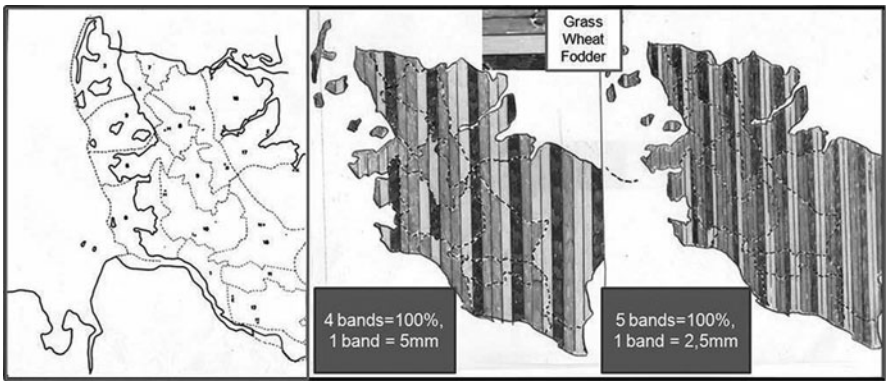


Fig. 2.4 Diagram map following the Aimé Perpillou method (From Claval and Wieber (1969))

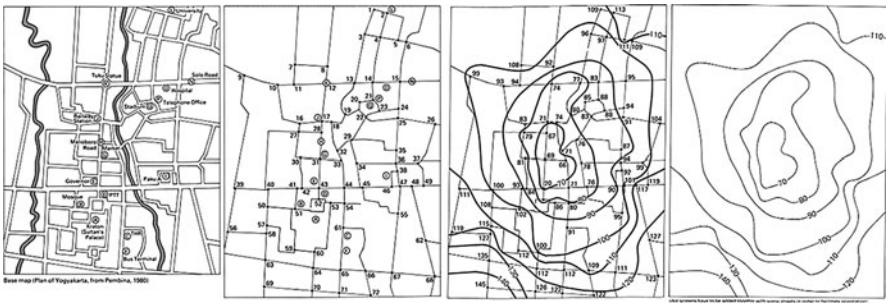


Fig. 2.5 Map exercise to assess the accessibility of urban services; the cumulative number of arcs it takes to get from each corner point to all public facilities is used as input for an accessibility isoline map (From Basic Cartography Exercise Manual (1991))

Apart from map construction exercises, the geographers in our faculty also had to do map use exercises, for analytical purposes, and these existed for instance of assessing accessibility, nearest neighbour values or quantifying patterns and shapes (see Fig. 2.5, for instance).

What is especially significant in doing most of these exercises is that the students see the effects of their design decisions by comparing their results with those of their colleagues and perceive how these differences affect or boost the information transfer: which method is best, pie graphs or columns to render absolute statistical values? Is it better to render the absolute values of the data or to link them to other data, so as to normalize them? (See Fig. 2.6). In a dot map exercise, where a base map and a description of the residential housing characteristics for a campus would be provided and the students asked to work out the best representative value and size of the dots with which to render the population distribution pattern, again comparing the results always was as much of an eye-opener to the students as doing the exercise themselves.

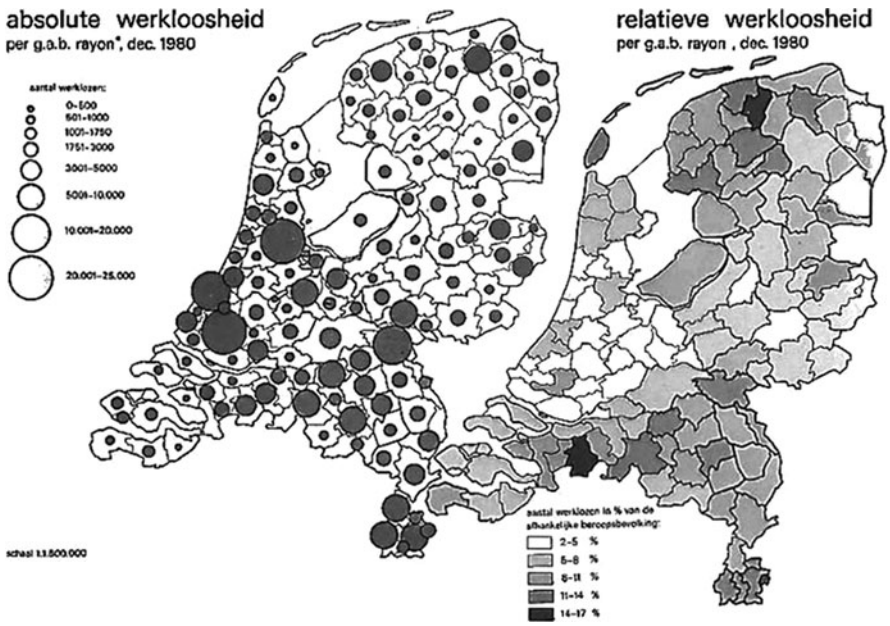


Fig. 2.6 Unemployment in the Netherlands, left rendered with proportional symbols, and at right normalized, i.e. expressed as a proportion of the total labour force

Next to map lettering, the most important exercises before the advent of the computer surely were those of rendering information according to a standardised legend, in which all the symbols and their measurements, and the various line widths were prescribed in a master legend. This part was rather repetitive, tiresome and disappointing, as the teachers always seemed to be able to discern who had drawn which map, in spite of us all adhering to the prescribed legend and specifications.

As my country is rather small there seemed not to be enough potential cartographic draughtsmen to start a regular cartography course for, so we opted for a correspondence course, in which the participants had to do exercises and had to send them in, and would receive them back within a week, annotated with the comments of the teachers (PBNA cursus, 1973-1976). On the exercise sheets the planimetry to be inked in was rendered in blue, and with special drawing pens and India ink the map detail had to be applied. In my first presentation to an ICA conference, in Moscow, in 1976, I reported on our experience with setting up this correspondence course.

2.4 Meta-exercises

Next to map drawing and map lettering came map generalization, and here it was again important that one developed a feeling of hierarchy, a feeling of what was important and should be retained, even if this activity was closely outlined as well,



Fig. 2.7 Generalisation exercise (by Prof. E. Spiess, *Basic Cartography Exercise manual*, 1991) with different results

so as to render the differences between the results of individual cartographers as small as possible. Legend-sheets with the exact dimensions of the symbols and lines to be used served as examples but, even when these specifications were adhered to as strictly as possible, students still ended up with a wide range of different results. When we confronted the students with the variation in their results, there was a meta-effect in this exercise—as the students could see that the results of their colleagues would deviate to some degree from their own, and this showed them a bandwidth of cartographic licence, it showed them that different results based on the same original data still were acceptable to a certain degree (Fig. 2.7).

Another drawing technique that had to be mastered through exercises where some geographic knowledge came in handy was hill-shading, which we would do with pencil, but which Swiss and Austrian experts would apply with airbrushes.

Picking the correct colour schemes or colour ramps is another item to do exercises in, in order to make sure that students see for themselves which colour combinations work or not, when diverging hues should be opted for, or how a colour ramp can be extended to accommodate a larger number of classes. Cynthia Brewer here helps students doing exercises on these items enormously with her Colorbrewer website (http://colorbrewer2.org).

For myself I have found much profit for the students in an exercise in which they are asked to render a same phenomenon, using the same figures in as threatening a way and in as inconspicuous a way, just by manipulating colours and class boundaries. By doing this exercise they realize the impact of their selection of class boundaries and colour schemes.

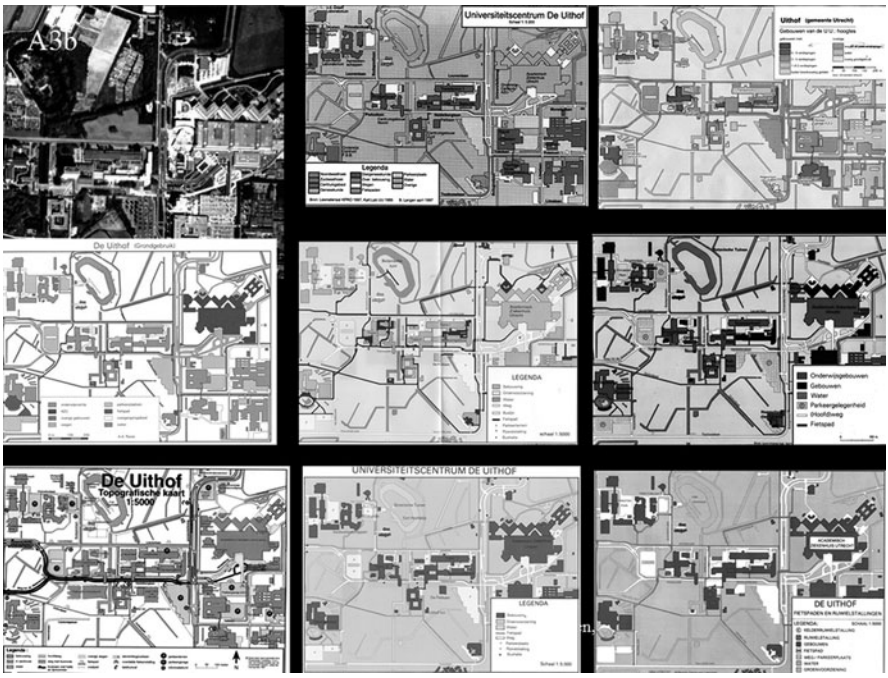


Fig. 2.8 Student maps of Utrecht University campus, based on aerial photograph (top left)

For the map reproduction classes we had in Utrecht University in the 1980s, prior to the advent of digital techniques, we did a simple exercise to produce a map of the university campus. Students could select their own target audience for this campus map, and customize the spatial information to convey accordingly. Here again the results are most instructive when compared. That is because they show how—even with very simple data, as on the function of buildings, their number of floors or the transport facilities—a host of different images will emerge, based on different decisions regarding information hierarchy, preferential colour schemes or student outlook—even differences between car-owning students and public transport advocating students would stand out on the maps (Fig. 2.8).

Part of the Utrecht cartography programme consisted of fieldwork, in France, where one of the assignments was to update an existing topomap, and another to do a land use survey of a small area. Apart from the generalization aspect, the results here provided another example of the impact of individual land use classification decisions, and of the generalization rules followed, even if the assignment—to produce a land-use based map 1:15.000 for the area for cyclists and hikers—would let us to expect rather homogeneous results. The realization that the same reality, to be mapped to the same specifications, could be reflected in so many different, but valid views of the same reality certainly was an eye-opener for the students.

2.5 Computer Classes

The map drawing exercises that replaced the manual ones took place on the computer, using specific drawing programmes like Aldus Freehand in the 1990s, and now perhaps Adobe Illustrator. I suppose every university cartography department would train its students with exercises to become familiar with these mapping packages, learn to deal with the various layers, at least before the advent of GIS software programmes, when boundary files could just be matched with statistical data sets, and many students do not get beyond learning how to combine data sets in EXCEL and deal with shape files in ArcGIS.

Of course the new digital environment also affected reproduction. The reproduction exercises contained in the ICA Basic Cartography Exercise manual, like those on the production of small-scale topographic maps, or of tourist maps no longer were relevant, and would have to be restructured. The same was valid for the production diagrams. A fair amount of time used to be spent on exercises on their compilation; I remember ICA workshops all over Asia where we trained students to find the least expensive ways of reproducing maps through these exercises that now had to be reworked, necessitating new sets of symbols for the new digital techniques required.

2.6 Atlas Production Exercises

Atlas production exercises simulate many aspects of the cartographic profession, as they would train both the design and the production planning aspects. I reported on them at the Tokyo ICA conference (1980). In Atlas production classes e.g. lay-out exercises were done, to establish a template for the individual atlas sheets, and for finding the best sequence of map subjects. An example here is the exercise how to structure a school atlas of Turkey, to be printed on both sides of a single printing sheet, one side in colour and the other in black and white. The sequence had to make sense and be thought logical; the most important maps would have to be coloured, but also the chorochromatic maps that would not be legible in black and white. For all individual atlas maps, preliminary drawings or mock-ups would be made, before starting with their digital production, in order to be sure all necessary elements would be incorporated (see Fig. 2.9).

Superior examples of atlas production exercises would be the atlases compiled at Oxford Brookes University where Roger Anson would take his students to the continent each year in order to gather the information to visualize in the next term.

Toponymy is another area of atlas cartography where exercises are used in order to speed up the student's grasp of the subject matter. We would ask them, for instance, to do an exercise in script conversion, or to compare geographical names on a map of Spain from a Spanish school atlas and from a British school atlas, and then ask them to work out the rules the editor of the British atlas would have followed in order to adjust the toponyms to his British audience. Production of a place names index and from a map would teach students how to deal with generic

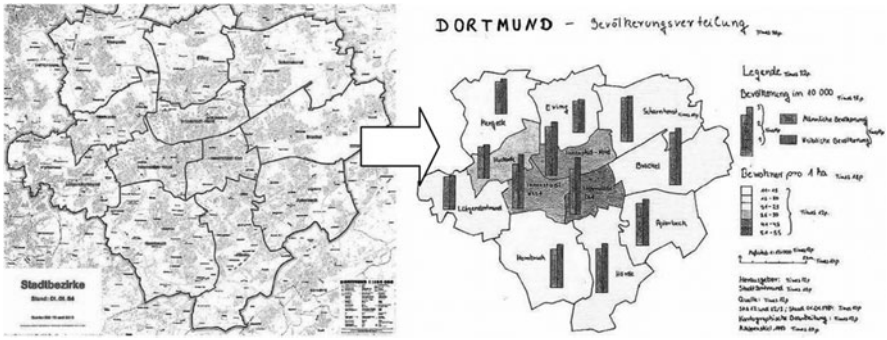


Fig. 2.9 Mock-up for an atlas map exercise, from 'Ausbildungsleitfaden' (2000)

name parts like Rio or Cape in a names index, and what to do with homonyms and allonyms. First they would have to copy all names from a map, identifying their object category and location, and then reordering them according to a specific alphabet.

A final aspect of map production would be an annotation exercise: how to prepare one's map or atlas in such a way—through adding marginal information—that an independent librarian would be able to list all the relevant information (impressum, publisher, author, date and place of publication) for a web bibliography or catalogue.

2.7 Map Use Exercises

Interpretation of maps or doing measurements on them is the other half of cartography, and although map use exercises are not primarily oriented at cartographers, they are still very suitable to increase the cartographers' awareness of how map users react to their products. Doing these kinds of exercises, they would for instance find out to which degree different measurement outcomes thought to be relevant by map users are just a consequence of generalisation.

Some examples of map use exercises are e.g. how to prepare a slope map (where, per grid cell the difference between the highest and lowest point is assessed first and then converted in a slope value, assigned to the grid cell centre, and followed by interpolation to produce an isoline slope map (Warn 1980)), drainage density assessment (here the length of rivers per km^2 grid cell would be computed, and the grid cell data categorized) or an exercise to interpret landforms from a contour line map (Schulz 1995).

2.8 Map Exercises for the Future

The framework of all these cartographic exercises described here has been different in scope—there were those meant for in-house training for apprentices, there were exercises that were part of the training of geographers and exercises meant for

cartographic draughtsmen. There were higher education or university cartography courses that had exercises in a classroom environment, and there were exercises that formed part of correspondence courses, or of manuals developed by cartographic societies or individual teachers. The Netherlands Cartographic Society used to invite foreign experts for its courses on specific techniques like map lettering or hill shading, for the benefit of their members who had to do exercises in order to master these techniques.

All of these exercises were meant to train, for the participants to practice the theoretical aspects, to pass on knowledge and experience. The ICA tries to continue this training work globally with the hands-on courses it has been organizing for some 30 years, not only through its Commission on Education and Training (CET) but also through the Commission on Management and Economics of Map Production and the Commission on Maps and the Internet, frequently also jointly.

As only a small audience can be reached, however enthusiast these commissions are, with lecturing teams only within the last 2 years (2009 and 2010) flying in into Central Asia, Iran, Indonesia or Vietnam, developing web courses are a way to reach larger audiences, even if interaction and feed-back still present problems. Already an enormous variety of cartography courses is being offered on the web, and the ICA Commission on Education and Training under Laszlo Zentai and David Fraser has selected the best ones and incorporated them on the CET website, a major job that deserves acknowledgement. The only aspect perhaps lacking in these web courses are exercises. I think the best and most challenging exercises that we have devised for our own students should be incorporated onto the CET website next to the current lessons or lectures that have already been stored there, just as we collected the best paper exercises in the past for the ICA Basic Cartography Exercise manual.

These best and most challenging exercises should show students how many-sided and intellectually stimulating cartography is, and they might thus be induced to follow a career in our discipline. With these exercises we would visualise the challenges of our profession, to adapt geospatial data to the objectives and the target groups of information transfer, to support spatial decision making now and in the future.

Annex 1: Overview of Cartographic Exercises

A. Map production exercises
A1. Information analysis
(1a) Establish information/parameter hierarchy
(1b) Establish parameter characteristics
(1c) establish rules for language-dependent toponymy
A2.Exercises in mapping technique
(2a) Map lettering
(2b) Hill shading
(2c) Generalisation
(2d) Drawing panoramic maps/block diagrams
(2e) Line drawing exercises

(continued)

A3. Exercises in design
(3a) Selecting map types
(3b) Classification/characterization
(3c) Classification/manipulation
(3d) Colour ramp/colour scheme exercises
B. Exercises in map reproduction
B1. Devise optimal reproduction method
B2. Construct reproduction diagrams
B3. Devise optimal atlas structure (Turkey)
B4. Prepare (atlas) map annotation to enable proper documentation
B5. Prepare map names index
B6. Produce standard lay-out and specifications
B7. Produce a mock-up of an atlas (sheet)
C. Map use/analysis exercises
C1. Recognise symbology
C2. Assess accessibility
C3. Determine patterns: nearest neighbour
C4. Recognise terrain forms (geomorphology)
C5. Working with grids
C6. Find position, in degrees, minutes and seconds or in decimal degrees
C7. Convert decimal degrees into degrees, minutes and seconds
C8. Establish directions, describe way points
C9. Assess network densities
C10. Assess terrain changes in-between successive map editions
C11. Assess slopes/gradients; describe expected relief on a route
C12. Establish distances and time needed to reach a destination
C13. Compute areas and distances
C14. Establish profiles, visibility analyses
C15. Establish spatial association (Spearman's rank correlation coefficient)
C16. Compute the map scale

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