Short notes on the articles included in the first reference list by Dr. Montello.
By Marco Ruocco, 4-10-2001

(Brandes 1983) Provides several different examples of techniques to represent relief subdivided in morphometric analysis, point information, three dimensional diagrams and continuous surface flat maps. Morphometric analysis is used for a quantitative expression of relief to obtain information on terrain forms. Several representations of slope and relief, quantitative analysis seems to be based on the representation of slope. Aesthetical component in representation important to convey non symbolic information.

(Chang, Antes, Lenzen 1985) About the experience effect in topographic map reading. The experiment recorded eye movements and answers to questions on map heights. Experienced readers performed better, had less processing difficulty and greater attention level. Map reading can be improved through experience, and expert map readers visualize and interpret better the contours.

(Eley 1992). The experiment consisted in a series of tasks requiring a contour mapped land surface to be studied, the manipulation of its mental representation and the judgment of whether a provided representation matched the original. Other tasks results, concerning components of mental imagery processes, were then compared to the map visualization results to better describe the cognitive processes involved. Experiment used 52 spot heights sets, 7 renderings at different orientations (30 deg of altitude), and trials showing a map, a direction cue and the surface to be compared. The results show high inter-subjects variability indicating high variability in the strategies adopted, and a differentiation between consistent and inconsistent subjects can be traced across the different phases of the experiment (for example in map study phase a consistent subject prepares the rotation and proceeds to checking, while an inconsistent one have just time to prepare the rotation). As a conclusion contour training should be cognitive in nature.

(Griffin & Lock 1979) Comparison of contour with profile and block diagrams, with testing conducted at elementary level. The pattern of errors followed the presence of convex slopes and slope reversals. The results were due to 1) the test procedure, 2) conceptual error (understanding of contour) and 3) perceptual error. In particular 3) included the aspects of texture gradient (extraction of depth cues from series of lines, in contour it would cause errors in judgment) and figure-ground (emergence of an arbitrary figure over a base of ground separating otherwise uniform surfaces). The perceptual problem is then not dominant, but existent.

(Kinnear & Wood 1987) Processing of map information considered as chunking and subsequent reconstruction. Recognizes different degrees of visualization, from layout to full mental image of terrain. Experiment comprised several map tasks to be carried out. More efficient memory for those with tasks dealing with terrain. No education effect, no long term schemata (unlike chess players), especially remembered were valleys.

Visualization vividness varies, and depends on memory. Which representation method produces the most vivid images in memory?

(McGuigan 1957) Study on the effectiveness of method of teaching contour interpretation. From concrete to abstract, representations were terrain board, stereoscopic slides and 2D slides, while symbols (maps) were either 3D map (most concrete) or 2D map. The best combination for training was 2D slides-3D map. Difficult to rank the 3 representations, no linear concrete to abstract progression. Concrete symbol was preferred.

(Montello, Sullivan & Pick 1994). Two experiments to examine the recall of information from natural landscapes and topographic maps. In the first the subjects were exposed to pictures of landscapes which had later to recall from memory, after being influenced by a map matching task; experience was not influential. In the second experiment no scene matching was required and subjects had to recall verbally and in drawing a portion of a map; recall was also a function of experience with topographic maps. Natural landscape processing is the same for inexperienced and experienced users – they make use of naïve knowledge real world schemata. Landscape-to-map matching is instead a specialized task where experienced users recalled a higher proportion of terrain/valley/water versus vegetation/atmosphere. Specialized map reading knowledge takes over at first exposure to a topographic map, and therefore it had not to be activated by a map matching task.

(Phillips, 1979) Comparison between traditional contour and wedding cake representation, showing no significant difference. Contour versus tint layers results in a better performance of tint layers for height estimation, possibly because of the effects of peripheral vision: colors are better distinguishable than thin lines and therefore integration is facilitated.

(Phillips 1984) Summary on experimental research on relief maps. Investigates the limitations of the human visual system, distinguishing between raw information processing and the use of peripheral vision as a support to the inputs to the visual system. For example tint layers map allow for better recognition of certain terrain forms also because of the possibility of reading larger chunks of the map by peripheral vision alone. The construction of mental images is similar to the construction of an image from a landscape. 3D views are preferred to tints because they allow more vivid visualization of landscape, but the mental image is less detailed leading in the end to worse performance (static synthetic images less effective method of representation ?).

(Phillips, De Lucia & Skelton 1975) Comparison of four different types of relief maps (contours, contours with hill shading, layer tints, spot heights) using map reading tests including location, height estimation, viewshed. Tests grouped in terms of judging relative and absolute height, reading map base and visualizing. No single best map but

different maps performed differently for different tasks: tints best for visualization, spot heights for absolute height determination, equal performance in base map reading

(Pick, Heinrichs, Montello, Smith, Sullivan & Thompson 1995) Describes how experienced topographic map readers approach the drop-off problem, a difficult form of localization task. The strategies of the subjects were recorded in a talk-aloud format, whereby information and processes could be recorded and later analyzed. The features of topography were described qualitatively and the conclusion is that people are not sensitive to the metric characteristics of topographic features. Information processes included feature matching and reconnaissance, and strategies included the construction of relations between features, attention to local features and generation of multiple hypotheses about the location of the viewpoint. Subjects used a disconfirmation strategy, did not employ a global visualization strategy and did not use quantitative geometric reasoning.

(Shurtleff & Geiselman 1986). The first experiment defines a set of symbols for cartographic representation. The second experiment consists in tasks of localization and identification using the symbol set of exp 1. The experiments included geometric & derived symbols, and color and monochrome maps. Better performance with derived symbols rather than geometric. Color, thought to incremement redundant information, was the cause of delay, even if redundancy per se facilitates feature extraction.

(Taylor 1984). Study of interaction of map design variables: scale, complexity, generalization. Aimed at examining the separate effect of map scale and cartographic generalization on recognition performance. Best performance in recognition of map and photo pairs was obtained with the least generalization (reduction in detail) and an identity of scale between the map and the photo. This study results useful for designing an experiment based on the variation of the three design variables.

General comments:

The papers focus on the interpretation of relief maps and more specifically on contour lines and map and landscape visualization. My impression is that my research won't be exclusively centered on these topics, but several aspects have been worth exploring:

- For a hypothetical investigation of the cognitive processes behind visualization I would refer extensively to the paper by Eley (1992) because its design incorporates an explicit consideration of the process of visualization of landscape. I liked the methods in the experiment, using combinations of generated 3D views for producing possible terrains.

- I am more interested in the description of the mental image of terrain, to be then compared to the physical reality of the landscape. Pick et al. (1995) proposed the term global visualization for the production of a global image of terrain. It would be

interesting to know how terrain characteristics affect this image when it is formed. For example it would be worthwhile to see which method of representation produces the strongest images of terrain.

- I appreciate the difference between terrain perception and perception of represented terrain. In a hypothetical experiment aimed at finding the best method for terrain representation amongst animated views, static pictures and 3D models a linkage must be found between real world terrain perception and the perception of its representation.