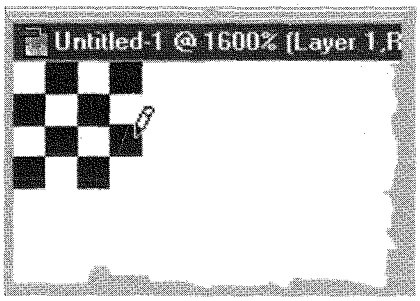
Creating manual dithers in Adobe Photoshop:

1. Create a new document using white for the contents and in RGB mode. Keep it small, maybe 64x64 pixels.

2. Add a new layer and zoom in to at least 400%. With the pencil tool set to the one-pixel brush, add a set of an even number of alternating pixels:



3. Make the background layer invisible and then select the new layer again.

4. Select just this group of pixels and from the Edit menu choose "Define Pattern."

5. Now select the entire area of the new layer, and from the Edit menu choose "Fill. . ."

6. In the Fill dialog, select "Pattern" from the "Contents" drop-down and click "OK."

7. The new layer should now be filled with an alternating pattern of transparent and non-transparent pixels. Deselect all.

8. In the layers palette, click on the new layer and check the "Preserve Transparency" checkbox. Make the background layer visible again.

9. Now to experiment with dithering combinations, just fill the background layer with one web color, and the new layer with another (the "preserve Transparency" option will allow you to color only the non-transparent pixels with the "Fill" command/

10. At 100% zoom, you should not see any pixels with a good combination of colors.

Concluding thoughts

At its most basic level, designing maps for computer screens is no different than designing for paper. There must be a well thought out plan from the beginning and a careful execution that considers all the limitations of the medium. Every design task has its restrictions and it is just a matter of learning how to work around those constraints. Dynamic mapping is a new way for people to use maps and therefore cartographic designers must incorporate new and creative design solutions to meet the needs of this new medium.

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MapPoint 2000 –
http://www.microsoft.com/mappoint
Streets & Trips 2000 –
http://www.microsoft.com/expedia
Expedia Maps –
http://www.expediamaps.com
Encarta Virtual Globe –
http://encarta.msn.com/evg

Map Design Enhancement for Terrain Visualization by Army Aviators

Wiley C. Thompson and
A. Jon Kimerling

Introduction

The objective of this study was to determine if a non-traditional relief shading method can be used to redesign a 1:50,000 scale military topographical line map (TLM) in a manner that allows the Army aviator to more easily "read" the terrain in "3-D" while viewing the map under Night Vision Goggle (NVG) compatible blue-green lighting. This study is not in response to a crisis, but rather an exploration into a possible cartographic solution to a problem perceived by surveyed Army aviators. The aviator is a highly skilled map reader, but any advance that can help reduce the stress of the task-intensive NVG cockpit (Figure 1) should be explored.

While conducting map navigation at night with NVGs, Army aviators, as navigators, must create a "3-D" mental image of the terrain each time they look at the map. The navigator will then match this image to the corresponding terrain seen through the NVGs. The aviator currently must build this image under dim, blue-green lighting on a non-shaded map. A method that allows the aviator to visualize the terrain on the map and more quickly return his attention outside the cockpit where he can scan for wires, enemy, and other hazards will enhance the safe operation of the aircraft. Even a tenth of a second reduction in the time required to visualize terrain and look back outside could be the difference between spotting a hazard and falling victim to it.

Figure 1. Army aviator in UH-60 Blackhawk helicopter cockpit. Pilot is wearing a liplight.

Background

There has been work in the past dealing with enhancing topographic map products through means of relief shading, layer tinting, contoured elevations and combinations of these methods. Various methods have been tested with regards to accessibility of information and visualization of terrain. These studies include: *Some Effects of Layer Tinting of Maps* (Kempf and Poock 1969); *The Effect of Shaded Relief on Map Information Accessibility* (Delucia 1972); *Some Objective Tests of the Legibility of Relief Maps* (Phillips et al. 1975); and *An Approach to Assessment of Relief Formats for Hardcopy Topographic Maps* (Potash et al. 1979).

While previous studies demonstrate that there are differences between time required to read the map and the accuracy of results when supplementing contour lines with other relief formats, the map scales, task conditions, and study populations have varied. It would be interesting to see the results of these studies if a population of aviators (experienced map readers) were tested, and darkened conditions with only monochromatic (blue-green) lighting were used.

Relief shading of terrain is an accepted method of increasing the map reader's ability to perceive terrain relief. Traditionally, cartographers have used gray scale values to shade their maps. This method works well in most situations, but reading maps in a dimly lit cockpit, with only monochromatic (blue-green) light available, is not a normal situation. Gray shading remains a constant "darkness" when illuminated with white or monochromatic light. This holds true regardless of lighting intensity and may not be desirable when a using a dimmer, monochromatic lighting source.

Since NVG flight created the requirement for a specific spectrum of supplemental lighting, aviators have experimented with using other contrasting colors to highlight features of importance on their maps. A popular method of highlighting features such as wires or aviation routes is the standard pink highlighter (yellow highlighters are also used). The highlighter shows up extremely well when illuminated with blue-green lighting and does not opaque background features. Drawing attention to a feature without opaquing the background information is the thought behind using colored, non-gray relief shading.

Concept

All colored light is lacking some portion of the visible color spectrum. If a green object is viewed under red light, it appears black, as its reflectance spectrum contains none of the wavelengths present in the red light source. Conversely, a red object when viewed under a red light source appears "white" as its reflectance spectrum contains all of the wavelengths present in the red light source (Erickson 1991).

The composite diagram (Figure 2) illustrates the interaction of the blue-green lighting, the reflectance of the spectrum of the colored shading, and the sensitivity of the eye as it occurs in the NVG cockpit. In the diagram, the blue-green light curve peaks in the blue portion of the visible spectrum and tapers towards the red portion. The shaded area, representing the blue and green portion of the relief shading color would, using Erickson's analogy, not be visible as its reflectance spectrum closely matches the spectral signature of the incident light. The red shaded portion of the relief color would show up in a dark, shadow-like manner, as the blue-green light source contains little red light and would therefore be mostly absorbed. The small amount of reflected red light would be perceived, as the red cone is the numerically superior cone in the retina (Hunt 1987). The net result is terrain enhancing relief shading with little of the user information being placed in the visual background. Under white light or day conditions, all relief shading colors would reflect their full spectrum of light - providing effective shading for day use.

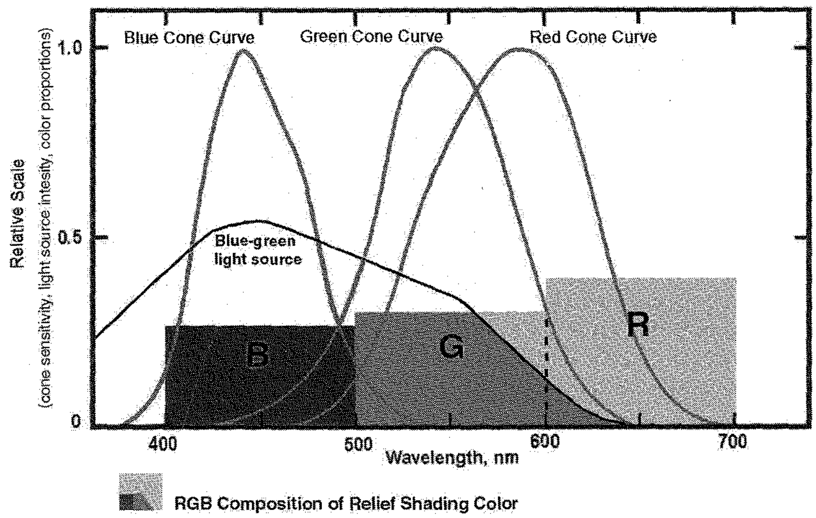

Figure 2. Composite of eye, blue-green light and shading interaction. (See http://terra.geo.orst.edu/users/kimerlia/pinkshad for a full color image)

A goal of this project was to create a relief shaded 1:50,000 scale military TLM from existing digital products, providing enhanced map terrain depiction under NVG compatible monochromatic light sources. Study maps of Stone City, Colorado and Ammonia Tanks, Nevada were created from National Imagery and Mapping Agency (NIMA) Compressed ARC Digital Raster Graphics (CADRG) CD-ROMs and United States Geologic Survey (USGS) 7.5 minute (30 meter) digital elevation models (DEM).

The base maps were created from the CADRG format using NIMAMUSE 2.1 software. They were saved as an RGB bitmap file. After importing the bitmap into an Adobe Photoshop™ layer they were converted to CMYK. The standard gray relief shaded DEM was contrast stretched (1%) to improve contrast and then also imported into Adobe Photoshop™. The relief shading was then multiplied by a magenta-yellow screen to create "pink". The yellow component was added to give the shading a browner, more natural appearance. This shading was layered over the base map to create a magenta, relief-shaded map (Figure 3).

The opacity of the relief shading (Figure 4) was varied to create a map with light shading (50% layer opacity), medium shading (75% layer opacity), and dark shading (100% layer opacity).

Evaluation

An evaluation procedure was developed to determine if the contour map with relief shading treatment as a method for enhancing the aviator's ability to visualize the terrain was an improvement over the contour-only base map. Additional information sought during the evaluation was which level of shading opacity the user preferred. The population for this survey consisted of volunteers from aircrews in Army rotary-wing (helicopter) aviation units.

Survey participants were asked if they were better able to visualize the terrain using the relief shading enhanced map product or the standard base map under daylight and NVG conditions. Each participant was given an evaluation folder with an instruction sheet, an answer sheet, and two sample maps. On each map sheet was an unshaded base map with three other shaded maps (See http://terra.geo.orst.edu/users/kimerlia/pinkshad for sample evaluation maps). The aviators were instructed to evaluate the map products in a darkened area, which closely matched ambient lighting conditions of the NVG aircraft cockpit environment. They were also instructed to illuminate the maps with whatever NVG compatible lighting device they normally used when flying with NVGs.

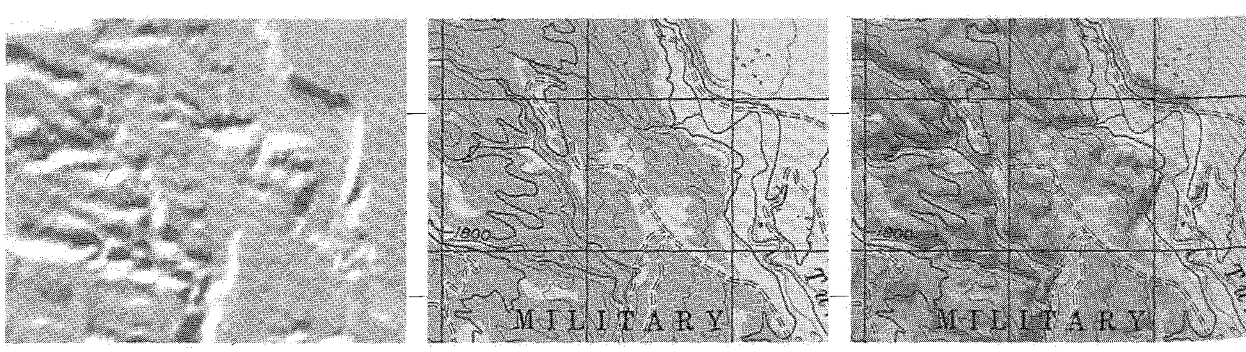

Figure 3. "Pink" shading, Un-shaded Base Map, and Composite Shaded Map (See http://terra.geo.orst.edu/users/kimerkia/pinkshad for color maps)

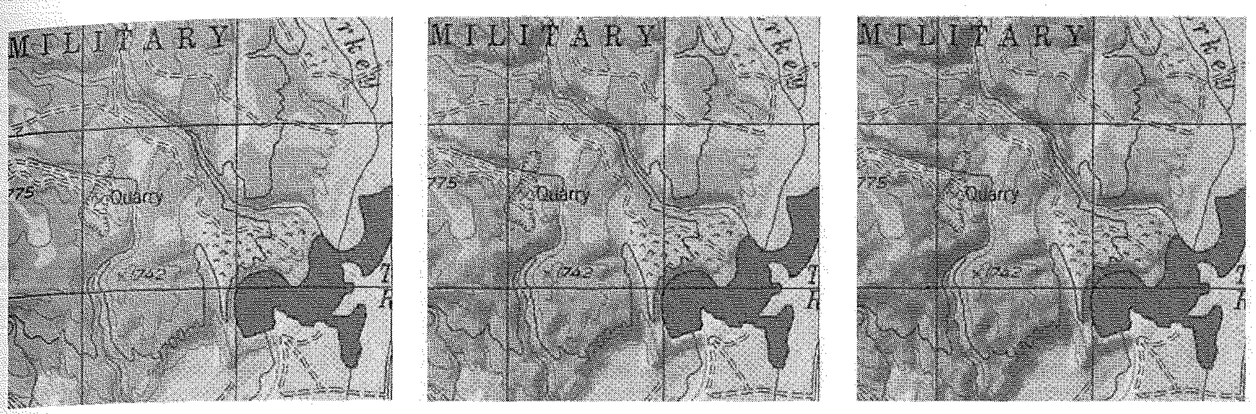

Figure 4. Shading at 50%, 75%, and 100% opacity (See http://terra.geo.orst.edu/users/kimerlia/pinkshad for color maps)

The survey results were positive in favor of the shading treatment being a method of enhancing the aviator's ability to visualize the terrain on the map (Table 1).

A general preference for the level of shading seemed also to be apparent. Responses generally appeared to favor the 75% or medium shading for both map areas (Table 2). One respondent made no choice, one other chose both 50 and 75%.

An initial hypothesized result of the shading preference was that aviators using the "dimmer" lighting devices such as the LED lip-light would prefer a lighter level of shading and that those using an brighter light source such as the Army flashlight with blue filter would prefer a darker level of shading. The evaluation results actually showed that mean lip-light preference was 78.4%. Those using the Army flashlight with blue filter had an 82.5% mean preference. Although this fits the initial hypothesis, the difference is not statistically significant.

Conclusion

This study confirms that enhancing or redesigning the relief shading holds promise to increase the aviator's ability to visualize terrain maps in 3D. The results of this study may prompt those concerned with aviation safety to further explore the study of enhancing the readability of maps or to even explore the feasibility of implementing the colored relief shading treatment examined in this paper. Additionally, this technique of relief shading may prove valuable to any user that required to read a map under non-white light conditions. Applications of this technique could find use in maritime operations, law enforcement or forestry service, to name a few.

	Significant Improvement	Improved	No Improvement	Worse	Significantly Worse
Stone City	10	9	0	1	0
Ammonia Tanks	7	12	0	1	0

Table 1. Survey Results (improvement)

	100%	75%	50%
Stone City	7	9	2
Ammonia Tanks	5	9	5

Table 2. Survey Results (level of shading preference)

The design techniques developed in this study are by no means intended to be a definitive solution to the problem of terrain visualization on TLMs. This study is intended to raise the consciousness of the aviation community to an often-neglected issue and suggest future work in that area. A review of known principles of visual cognition and cartography, combined with modern computing capabilities, have provided a promising solution for a unique application with important safety implications. Increasing efficiency of terrain visualization from maps is a critical matter to the Army aviator - it can be a question of life or death.

Acknowledgements

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The conclusions are based on the research conducted in a volunteer status by aircrews interested in improving cockpit map visualization, and do not represent the findings of any Department of Defense agency or contractor.

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online mapping

World Wide Web Mapping and GIS: An Application for Public Participation

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The World Wide Web (WWW) has garnered far ranging interest from those of us interested in the representation and analysis of geographic information. The WWW is seen as an exciting medium for numerous reasons: it can be accessed by a global audience, on almost every computer platform, and does not require expensive software nor specialist training to use. The multimedia capabilities of the WWW have made it a medium in which visual representations - images, maps, diagrams, graphs - are as easy to implement as text. Five or so years back, cartographers and others began using the WWW to display static maps, and some low levels of interactivity could be added to the maps by using 'image maps' - click-sensitive areas of the map which could hyper-link you to other maps or materials. Alas, this relatively low level of interactivity did not match the complex, interactive maps available in Geographic Information Systems (GIS) and geographic visualization software packages. This situation has, of course, changed. In the last few years a series of technologies has matured to the point where interactive, WWW-based mapping and GIS are now commonly found on the WWW.

Numerous different methods exist for providing more sophisticated mapping and GIS capabilities via the WWW. It is relatively simple to make spatial data and analytical software available over the WWW; users can download the software and data and perform their own analysis on their own computer. A more sophisticated method is to use a map generator, where WWW users set the parameters of a map or GIS analysis on a WWW-based form. This form is passed to a map or GIS server, which generates a map or series of maps, then posts the results on the WWW page. The U.S. Census Bureau's Tiger Mapping Service is a good example of this type of technology. Real-time map browsers, such as ESRI's Map Objects and Internet Map Server provide similar functionality in a package explicitly aimed at component- and WWW-based GIS developers. Map Objects (and other similar packages) are aimed at software developers who want to cobble together customized GIS packages for specialized uses. For example, a developer, using component GIS software, can create a GIS that includes the limited GIS and mapping functions necessary for realtors searching for particular houses for clients. This customized, component GIS can function on the WWW with the addition of Internet Map Server software.

My own experiment with Map Objects and the Internet Map Server was funded by a small grant which allowed me to pay a graduate student to develop an interactive mapping and GIS site aimed at enhancing public participation in issues concerning housing in an inner-city Buffalo neighborhood. The set of WWW-based maps generated in this project are prototypes with limited functions, intended to assess the capabilities of the software. The process behind this project has been described in the master's thesis of K. Chang and is available at the WWW site where the Public Participation mapping and GIS application is running. Other background information on the application and some of the conceptual and theoretical ideas are available at the site. From this page, a link takes you to a series of three Map Objects maps.

These options consist of three different map scales: a local, neighborhood scale map, a city of Buffalo map, and a US and World map. The focus of the project was the neighborhood scale map.

This map has a series of basic GIS functions, including zoom in and zoom out from map, re-center the map, and 'hot-links' to additional information. A park on the map may be linked to the appropri-