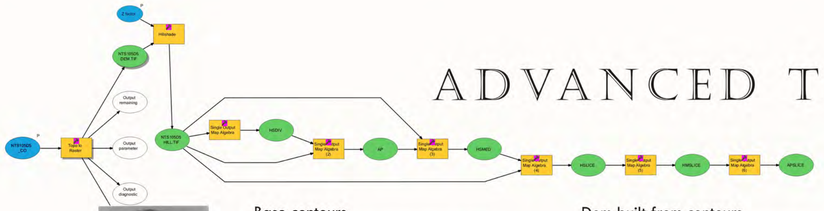
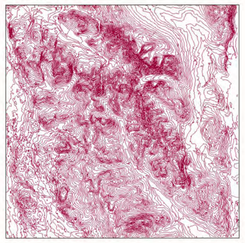
ADVANCED TERRAIN VISUALIZATION TECHNIQUES



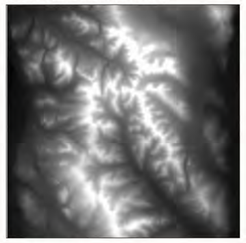
THE IMHOF MODEL

Base contours



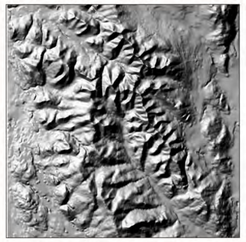
Topo to Raster
Cell size: 25

Dem built from contours



Azimuth: 315, Altitude: 45, Z Factor: 1
Cell size: 25

Hillshade built on DEM



HSDIV.img

HSDIV = [NTS105DHS.tif]/5

AP.img

AP = [HSDIV] - [NTS105DHS.tif]

Eduard Imhof was a master of shaded relief; his artistry and understanding of complex mountainous representations made his work iconic. As such, this effect has been similarly replicated in ArcMap through a sequence of altered hillshades.

This version is based on a model David Barnes of ESRI created in 2002.
In his words this procedure 'emphasizes the major geographic features, minimizes the minor features, smooths irregularities on the slopes, but maintains the rugged characteristics of ridge tops and canyon bottoms...you can simulate an aerial perspective that makes the higher elevations lighter and the lower elevations darker.'[1]

HSMED.img

HSMED = focalmedian([NTS105DHS.tif],circle,4)

HSLICE.img

HSLICE = slice([NTS105DHS.tif],eqinterval,128,127)

HMSLICE.img

HMSLICE = slice([HSMED],eqinterval,170,85)

APSLICE.img

APSLICE = int(slice([AP],eqinterval,128,127)

IMHOF.img

IMHOF = int([APSLICE] * .4 + [HMSLICE] * .3 + [HSLICE] * .3)

Landsat Imagery

Bands 1, 2, and 3

This particular technique redefines a smooth uninterrupted surface with an uneven pattern that and gives the object texture.
By doing so it can make features and object's appearance more realistic and add contrast to surrounding elements.

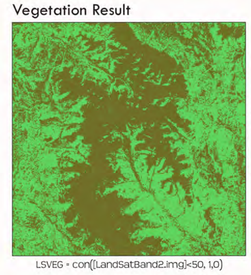
In order to apply this method to a map, to a vegetation layer for instance, it was necessary to obtain a landsat image of the selected area.
This particular one was downloaded from GeoGratis located in the CanImage folder.

Extracted Band 2

Exported with: Extent: Raster Dataset, Spatial Reference: Raster Dataset Output Raster - Use Renderer, Cell size: 15x15, Pixel Depth: 8 bit, saved as .img

Next, the second band of the image was individually selected [used to extract low values as vegetation] and exported with the parameters listed below.

Vegetation Result



LSVEG = con([LandSatBand2.img]<50, 1,0)

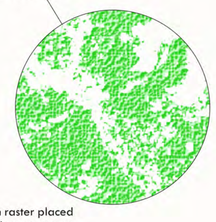
Once brought back into the data frame the following function was undergone to extract the values.

BUMP-MAPPING EFFECT

Bump-mapping texture

(abs(eucdistance(con(($$rowmap mod int(normal() * 1 * 5) eq 0) and ($$colmap mod int(normal() * 1 * 5) eq 0),255),*,*,75,*)- 75) * (80 / 30)) * setnull([LSveg] eq 0,[LSveg])

The Vegetation layer made, the bump texture calculation needed to be built: the 'normal' function 'creates a raster of random values with normal distribution cell by cell.' This process can be altered and tweaked by the use of the CON function; this will adjust the standard deviation.
The MOD function 'finds the remainder of the first raster divided by the second on a cell by cell basis.'



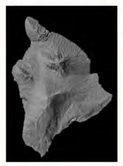
Merged result

This result is the combination of the initial DEM and the bump mapping equation. The two merged together give a more even and realistic effect.

The bump map calculation raster placed above the hillshade itself does not create a very even or probable looking result, as such, the original DEM and the bump calculation are merged to create the final raster.

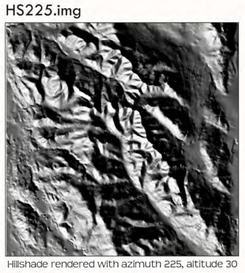
Alternatively, the textured vegetation can be extracted and re-coloured to give more definition between itself and the hillshade.

THE ROBERT MARK MODEL



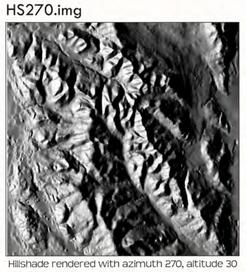
This effect generates more detail in portions of the image that in single illuminated situations would be left in darkness. By extracting illuminations from different elevations and angles, the combined result allows for more depth.

HS225.img



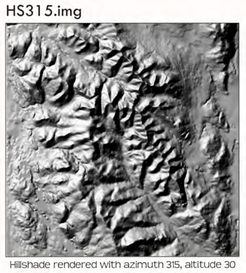
Hillshade rendered with azimuth 225, altitude 30

HS270.img



Hillshade rendered with azimuth 270, altitude 30

HS315.img

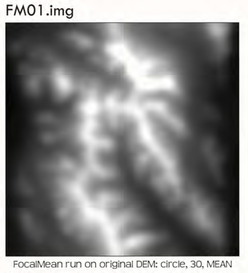


Hillshade rendered with azimuth 315, altitude 30

HS360.img

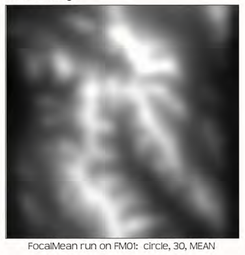
Hillshade rendered with azimuth 360, altitude 30

FM01.img



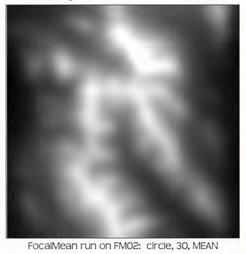
FocalMean run on original DEM: circle, 30, MEAN

FM02.img



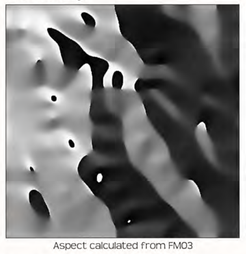
FocalMean run on FM01: circle, 30, MEAN

FM03.img



FocalMean run on FM02: circle, 30, MEAN

ASP01.img

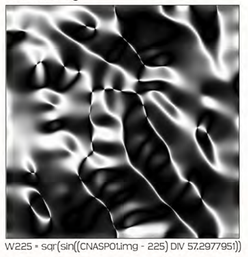


Aspect calculated from FM03

CNASP01.img

CON using IsNull raster with Constant Value 293

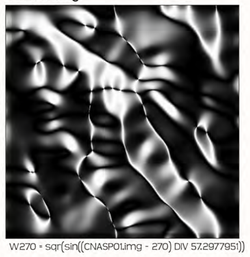
W225.img



W225 = sqr(sin((CNASP01.img - 225) DIV 57.2977951))

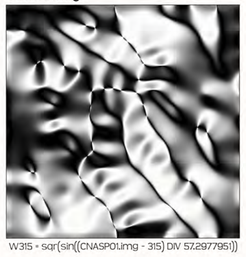
IsNull computed on Aspect

W270.img



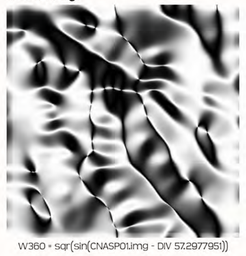
W270 = sqr(sin((CNASP01.img - 270) DIV 57.2977951))

W315.img



W315 = sqr(sin((CNASP01.img - 315) DIV 57.2977951))

W360img



W360 = sqr(sin(CNASP01.img - DIV 57.2977951))

RobertMarkFinal.img

int([W225.img * HS225.img + W270.img * HS270.img + W315.img * HS315.img + W360.img * HS360.img) DIV 2

R. MARK AND IMHOF TOGETHER

nscc
Centre of Geographic Sciences

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CanVec data:
NTS 105/D15 mapsheet

Imhof image obtained from
www.lokalnamen.ch/

[1] Barnes, D. 2002. "Using ArcGIS to Enhance Topographic Presentation", Cartographic Perspectives 42: 5-11