ABSTRACTS
2023 ICA Mountain Cartography Workshop

Alphabetical by last name of primary presenter

AITKEN, GEOFF NewTopo NZ Ltd
Cartographic Communication: Text Variables on maps

Our focus in cartography is on communication, usually in a geo-related context. Text plays a major part in the attraction, and distraction, of the effectiveness of this communication, adding names identifying features, and information on themes. Graphic templates are easy to design on simple backgrounds; but design becomes difficult on the visually complex backgrounds of mountain topography. A wealth of digital fonts is available, many with more variables than are practical for mapping, and some with distracting characteristics. Bertin's Visual Variables aid selection by providing a structure for design.

It is hoped that this paper will stimulate critical appraisal of our work, and personal experimentation and discussion.

ALLEN, BRAD Independent scholar
Crossing Cochetopa: Time Travel, Exploration and Discovery Across the Continental Divide

Research Questions:

• What strategies and digital mapping and visualization tools can a 21st Century investigator employ to better understand and depict mid-19th Century exploration across the Continental Divide?
• Which approaches bring 165-year-old maps, journals and lithographs alive as an immersive and engaging experience for a 21st Century audience of students, public historians, historic trails custodians, recreational hikers and an interested general audience?
• What are the limitations and potential untapped opportunities these approaches present?

Background:

In the effort to find a rail route to the Pacific, no trail across the Continental Divide was more intensely investigated than Cochetopa Pass in the San Juan Mountains. Largely due to Cochetopa's location midway between St. Louis and San Francisco, all three points lying near the 38th parallel, proponents argued that this "natural central route" offered the most direct straight-line connection between the Mississippi River and the Pacific. Between 1848 and 1853 four expeditions tested this hypothesis, with deadly consequences. A total of a dozen men perished in the San Juan mountains (Frémont, 1848-49 and 1853-54) and another eight

died in Utah Territory after passing through Cochetopa (Gunnison, 1853), arguably making exploration of the 38th the costliest in terms of human life.

Poster Content:

This poster describes my efforts retracing the Pacific Railroad Survey expedition led by John Williams Gunnison through Cochetopa Pass. I georeferenced a scan of the original map and traced Gunnison's route, which then was revealed on the base map. I also transcribed both Gunnison's track and my own onto Google Earth. I identified the locations of specific POV's (points of view) from which the expedition's artist/illustrator Richard Kern made sketches posthumously published in the PRRS Reports.

Visual content will include both contemporary and 165-year-old maps, Google Earth and topographic maps of the trails across Cochetopa, Kern lithographs and my photographs of the same POVs. Text will describe the expedition background, my mapping process, tools and sources. I'll compare maps, describe challenges and limitations in attempting to retrace Gunnison's route and make observations about 19th Century depictions of western landscapes. In addition, I plan to have a live screen Google Earth tabletop display as well as background on the "natural central route," the Pacific Railroad Surveys and a bibliography as handouts.

BROWN, LELAND
Weighted Median Filtering for Terrain and Contour Generalization

Median filtering is a common technique in image processing for smoothing data or removing noise. It differs from linear filtering techniques like Gaussian blur by its ability to smooth while retaining edges in an image. When applied to terrain elevation data, this means that median filtering can better preserve steep slopes and cliffs while otherwise generalizing the terrain.

However, median filtering as typically applied can also introduce new artifacts, such as lopping off the tops of peaks and ridges to create flat plateaus that don't exist in the original data. A lesser-known technique, a weighted median filter, can reduce or eliminate these artifacts. This method shows promise as a way to generalize digital elevation models as well as their associated contour lines. It can also be used to smooth hillshaded images, preserving the sharp transition in shading that occurs across ridges. And due to its ability to retain discontinuities in the data, it can be used to locate latent terracing effects hidden in elevation data, which may represent real terrain features or may indicate artifacts of the processing methods used to generate the data.

While a straightforward implementation of weighted median filtering would seem to be computationally expensive, there is a radix-based median algorithm that can be easily extended to compute weighted medians of floating-point data with only a few extra steps. No sorting is required. The algorithm can be implemented efficiently and succinctly in the C language and is fast enough for practical use.

BUCHROITHNER, MANFRED
Big-Scale High-Mountain Orthophoto Maps. The Example of the 1:20,000 Map of Nevado Chimborazo, Ecuador

Using a set of give-away map copies for the workshop participants the author wants to briefly talk about the production steps and to discuss the pros and cons of image maps in comparison to "classical" topographic mountain maps.

BUCKLEY, AILEEN Esri
Terrain Revelations

Terrain Revelations is a series of blog posts in which I provide descriptions of strange and wonderful places on our earth and tips on how you can map them yourself. All the maps were created using nothing more than a single elevation dataset and the raster capabilities of ArcGIS.

Sometimes, the visualizations and analyses of elevation data can reveal landscapes and phenomena that are not visible or easily visible to the eye. Using but one multiscale, multiresolution elevation dataset, I demonstrate how symbolizing and processing the Terrain layer (https://www.arcgis.com/home/item.html?id=58a541efc59545e6b7137f961d7de883) from the ArcGIS Living Atlas of the World (https://livingatlas.arcgis.com/en/) can unveil hidden treasures and expose surprising features and phenomena on the earth's surface.

Terrain, a dynamic world elevation imagery service, is actually a repository of the best and most current terrain data from providers worldwide. It provides numeric values representing ground surface heights, based on a digital terrain model (DTM) in which above-ground features, such as trees and structures, have been removed. Heights are orthometric (sea level = 0), and water bodies that are above sea level have approximated nominal water heights. The ground heights come from multiple sources in multiple resolutions from less than a meter to almost 1000 meters (see the coverage and resolution of the datasets comprising the service here:
https://www.arcgis.com/home/item.html?id=3af669838f594b378f90c10f98e46a7f). The image service, which is continuously updated, combines all the datasets and resamples them dynamically to the user's desired projection, spatial extent, and pixel size.

Working with the layer in ArcGIS Desktop affords users control over visualization of the Terrain layer and its derivatives, such as slope, aspect, hillshades, and contours. For Terrain

Revelations, ArcGIS Pro was used to process and render the Terrain layer in various ways. New capabilities in ArcGIS Online also show promise for working with terrain data.
My global terrain explorations began on New Zealand's North Island with Mount Taranaki, also called Mount Egmont. Standing at 2,518 meters (8,261 feet) high, Mount Taranaki is unusual because the cone of the volcano has collapsed at least five times, an event that few volcanoes have undergone more than once. Associated with Taranaki's eruptions, historical landslides, lava, and pyroclastic flows have extended from 7 to 40 kilometers from the cone, reaching as far as the present-day coastline on three sides. To explore this terrain, I created a series of maps using a variety of techniques, including aspect-slope, contours, profile lines, slope, and hillshades.

Emboldened by the mapping possibilities and mesmerized by the results, I used similar approaches to explore and reveal surprising terrain features in other places on earth, including the floodplain of the Ob River in Russia; missing lake MegaChad in the southern Sahara Desert, the mysterious creeping sand dune of I-N-Salah; the monster mole holes in southern Iran; wild and wonderful wind waves in the Sahara;; the Gulf Coast salt domes; and the Richat Structure, also known as the Eye of the Sahara. My quest for strange landforms using elevation data and GIS continues and never disappoints.

CARPENTER, MARGOT DALE Hartdale Maps

Salt River from Summit to Seafloor: A Study of Shaded Relief Techniques for Coastal Environments

Coastal areas are among the most dynamic places on Earth. Creating a map of this area in the United States usually requires working across terrestrial, shallow-water, and deepwater datasets from different sources, with varying quality, and patchy availability. Using a recent map—*Salt River from Summit to Seafloor*—as a departure point, this paper presents options for creating a cohesive shaded relief map from these datasets. Salt River Bay is located on the north shore of St. Croix, USVI, and is home to the Salt River Bay National Historical Park and Ecological Preserve. *Salt River from Summit to Seafloor* is a large-scale shaded relief map that places the reef-protected, mangrove-edged bay in its topographic context, from the 270-meter hilltop to the 1200-meter seafloor below. I briefly describe options for downloading and preparing the relevant digital elevation models and spend more time describing the shaded relief techniques. I use Adobe Photoshop to render the hillshades and hypsometric tints, and Adobe Illustrator to layer the map elements and reinforce a visual hierarchy. The shaded relief images include a combination of hillshades for terrestrial elements, habitat-specific coastal details, and an arc of shadow-based tints for the sunless seafloor. While these methods require a custom approach, they are simple to replicate and can provide a template for working with the data.

CHURCHILL, CARL The Wall Street Journal
A Defense of Dedicated Terrain Work in Graphics Journalism

Newsrooms in recent years have moved away from terrain as the demands of digital media have made it difficult to produce shaded relief that meets news deadlines and does not get in the way of readers attention. This is to the detriment of the stories themselves, as terrain is a integral feature of every aspect of life on the surface on the earth, whether its identified as such or not. This presentation will go over examples of how shaded relief can work in a tight modern media environment, and argue a defense of dedicated terrain work in graphics journalism.

COE, DANIEL Washington Geological Survey
Using Lidar to Reveal the Natural Hazards and Landforms of Washington State, USA

The Pacific Northwest region of North America has a fascinating array of geologic landscapes. Along with these comes a variety of potential natural hazards. In the past two decades, the increasing prevalence of lidar data has allowed geologists in this region to map landslides, faults, volcanoes, and other geologic features with much greater detail and accuracy than with previous technologies.

Airborne lidar (light radar or light detection and ranging) systems collect billions of elevation measurements that are processed to create extremely detailed three-dimensional models of the Earth's surface. Vegetation and structures can be digitally removed to create a "bare earth" surface (also known as a digital terrain model) that reveals a very intricate representation of the ground.

For cartographers, lidar-derived models can often be too detailed, particularly for small-scale mapping projects, where data generalization is required for clarity and simplicity. However, in large-scale terrain mapping, the detail that lidar provides can be useful to show specific landforms, particularly when they reveal natural hazards or geomorphic processes.

I will show different ways that the Washington Geological Survey has used lidar to map geologic hazards and landforms, particularly in places where vegetation would traditionally obscure these features. I will also give examples of how we are using these techniques to interpret the natural history of our region and to tell the geologic story of our State.

FRIES, ALEX US National Park Service

Mapping the Alabama Landscape: A Retrospective

In 2018, I made and presented Alabama: Its Landforms and Natural Features, a map intended to vividly highlight my home state's wide and varied terrain, from its Appalachian ridges and peaks in the north to the coastal marshes and beaches along its southern Gulf Coast. Though it was my first true foray into the broader field of mountain cartography, to my surprise the map received an extremely warm reception at that year's NACIS meeting, ultimately being voted as the winner of the conference's Best Student Design competition. While the map retains a special place in my heart to this day, four years' worth of hindsight have allowed me to understand and appreciate the map with a more objective, if not critical, eye. This talk will serve as a reflection on that map, going over my reasons and inspirations for making the map; the general mapmaking process employed at the time; and, as someone now mapping professionally for the US National Park Service, the many things I would do differently if (or when!) I decide to altogether remake the map from scratch.

GAMACHE, MARTIN National Geographic Society
Relief for the 2023 NGS Ukraine Reference Map

In compiling a new map supplement of the Ukraine to document the ongoing Russian invasion of that country we have compiled relief at approximately 1:2 million and 1:10 million scale. We will discuss and demonstrate our approach to render both planimetric relief using Eduard software and Oblique relief using Natural Scene Designer. Our relief layers will be shown in combination with both land cover, detailed vector data and other thematic layers. Design choices will be discussed as well as techniques for reproducing landcover with modern relief rendering. For the medium scale 1:2 million reference map, relief depiction created using Eduard will be compared and evaluated against two other standard relief rendering applications: ARCGIS Pro and Natural Scene Designer. Evaluation will be based largely on aesthetic considerations of the cartographers as well as the overall accuracy of the depiction and how successful the software is at generalizing for a medium scale map.

GILGEN, JÜRG swisstopo
A Portrait of Alfred Oberli

Alfred Oberli, 1916–2005, was a copperplate engraver, and later on cartographer specialist in rock depiction at the Swiss Federal Office of Topography, artist, map collector, alpinist and honorary member of the Swiss Alpine Club SAC.

GUILFORD, SAM National Geographic Society
A Few Considerations Regarding Field Data Collection in Mountain Environments

A few considerations regarding field data collection in mountain environments National Geographic Society provides funding and support to scientists around the world. This support includes GIS and mapping solutions, data analysis, and assistance with data collection methods and technology. In this presentation I will discuss a few examples of scientific research projects taking place in mountainous and remote environments to which our team has given geospatial support. In particular I will note some considerations for collecting field data in these environments, including optimizing site locations for placing weather stations around Mount Everest, navigating mountainous terrain and researching Andean bears, and encouraging local support for tracking elephants in the Angolan highlands..

HAMPTON, MATTHEW Cascade Cartographics
Colorado - Pictorial Planimetric Oblique Cartography from 1894: A Review and Explorations of Reproductions with Digital Tools

Pictorial cartography has been used for centuries to depict areas for increasing trade and development - they are visually appealing and enhance features to provide familiarity. Often used at oblique angles with an emphasis on artistic representations of commercial districts, their use as cartographic mountain references in the US has been primarily focused on ski areas. This presentation will review an historic pictorial planimetric oblique cartography from 1894 from the home state of the 12th Mountain Cartography Workshop— Colorado.

Colorado is a state map created by illustrator Francis Pezolt and published by Caxton Maps in 1894 for the McConnell School Supply store in Denver. This exquisitely illustrated map portrays an early planimetric-oblique shaded map with a very detailed set of annotations for the rivers, mountains and multitudes of small settlements there were developing around the state at the turn of the century.

This isolated work from a single cartographer is profoundly unique in its early demarcation of historic settlement in Colorado as well its cartographic form. The author explores the use of modern techniques that reflect the stylistic generalization of Pezolt's cartography by applying machine learning to landscape generalization and planimetric oblique shading.

A review of the 1894 map and the techniques used will be visually portrayed along with examples of digital experiments using modern software to replicate the style.

HOLDHUSEN, BECCA US National Park Service
Remapping Hawai'i Volcanoes National Park

I will be presenting about the process of creating a new planimetric map for visitor use at Hawai'i Volcanoes National Park. This map presented a unique set of challenges because of the subdued topography of Mauna Loa (a shield volcano), the dynamic and ever-changing nature of volcanic landscapes, and a tight project timeline. I will touch on my process of representing Mauna Loa's relief through a combination of automated and manual terrain shading techniques. I will also cover the process of getting to understand a park, landscape, and cultural history through mapmaking from afar.

HOWARTH, JEFF Middlebury College
Transects of Japanese Mountain Cartography

In this paper, I report on preliminary investigations of indigenous mountain cartography in Japan. I explore how these patterns have changed since the 19th century and compare these changes geographically across the different islands of Japan. How did Japanese cartographers represent mountains during Sakoku, the policy that isolated Japan from foreign influence between 1603 and 1868? How did Japanese mountain cartography change after this period of isolation? How did cultures of mountaineering influence mountain cartography before and after the second world war? How do cartographic representations of mountainous terrains differ across the four main islands of Japan? Drawing on maps from national archives and libraries in addition to field investigations, I present preliminary answers to these questions.

HUFFMAN, DANIEL somethingaboutmaps
Finding the Voices that are Missing

Though I greatly enjoyed my time at the 2014 Mountain Cartography Workshop in Banff, I was struck by one thing: the lack of diversity. Attendees were almost exclusively white men who were well-established in their careers. This was a contrast with how I'd experienced other cartographic gatherings, such as NACIS. Certainly, cartography is not the most diverse discipline, and many organizations are working to change that. But, the MCW appeared to me to be particularly constrained, and did not reflect the diversity found even within the field of cartography. This pattern appears anecdotally to have held through the next two Workshops,

as well. I want simply to draw our attention to this issue in this talk. I do not offer concrete solutions, but I instead ask us to join together and start discussing why our gathering does not look like other gatherings of mappers. Finally, I ask us to think about ways we can actively work to bring in more voices, so that the MCW remains a robust and valuable organization in the coming decades.

ILIES, GABRIELA Babes-Bolyai University Cluj-Napoca
Re-tracing the Long-Forgotten Salt Road in Maramures (Romania)

The identification of old roads in a natural evolving landscape is not an easy task and that makes it interesting from cartographical and touristic point of view. Usually, the salt was transported towards the markets and destinations by large rafts on the Tisza River from the main extraction centers in Maramures (Ocna Sugatag, Costiui and Solotvyno), but due to certain historical context a mountain salt road was developed across the Ignis Mountains westwards. This salt road was functional during the Middle Ages, old documents mentioning some clues about its trajectory without maps or other details. The present research is approaching the long-forgotten salt road in Maramures (Romania) in order to discover the most likely path, its logistical infrastructure (linked to the salt trade) and the correlation with the existing communication infrastructure. The aim of the re-tracing is to implement a new tourist product which consists in re-enacting of the two-day movement along the salt road. We created several types of maps: a tourist map with the specifics of the landscape, a vintage looking map and a tourist product map which will be used during the training and management activities by the operational crew.

KENNELLY, PATRICK Central Oregon Community College
Maximizing Variance of Relief Shading

Gray tones vary across shaded relief maps, and this study looks to maximize the variance of these shades of gray. Using principal component analysis (PCA) and realigning x, y and z axes with the resulting eigenvectors, it is possible to create PCA images with a relief shaded appearance that maximizes variance among grid cells. Additionally, PCA images associated with the first three eigenvalues (PCA1, PCA2, and PCA3) can account for more than 99% of the variability found in relief shadings from all aspects and inclinations of illumination. PCA1 mimics relief shading from some aspect with intermediate inclination above the horizon. PCA2 appears to be illuminated from a direction separated from PCA1 by approximately 90 of aspect and also at an intermediate inclination. PCA3 is similar to slope shading or relief shading with lighting from the zenith direction. The first PCA can help to select an optimal direction of illumination to maximize variance, while the first three PCA could be combined to enhance areas of low contrast in relief shaded maps.

KNIGHT, ERIC
Tien Shan Panoramic Map

I'll bring along a large print and talk about a few of the background concepts and design considerations that go into panoramic oblique maps like this one. Possible themes include color gradients and interactions, depth and the illusion of distance, text placement and naming conventions, and composition and terrain adjustments that accentuate geography. This is not a how-to, but more of an exploration of why this map looks the way it does, and why it might draw you in.

KRIZ, KAREL University of Vienna
Rock Depiction for Large-Scale Topographic Maps Based on Open Geodata

Topographic mapping in high mountainous areas has a long history in Austria and Switzerland. In the course of time, special methods have been developed to better and more clearly depict the characteristics of mountain morphology. First and foremost, the depiction of rock and debris formations has become an indication of the quality of large scale topographic maps. Namely the freely drawn, artistic representations of rock such as by Leo Aegerter, the fine drawings of Ebster combined with contour lines and the geometrically bound rock depiction by Imhof, which give the Swiss maps of Swisstopo their unique three-dimensional clarity. However, these representations are all based on one method of production: drawing by hand.

Since manual drawing is hardly economically viable in today's cartographic production processes, automated methods must be found to integrate this form of representation. Methods for producing an Imhof-style rock depiction have already been implemented in previous work (see Geisthövel, 2017) as well as other similar approaches (see Grünwald, 2015).

In the course of this work, another method for creating rock and debris representations is considered, which is based on graphical filtering of high-resolution elevation models. The areas of rock and debris can be obtained by parameters such as slope and by information from remote sensing data. This contribution examines the process of implementing this method and the considerations in integrating rock and debris especially in the context of shading and contour lines. In addition, two scenarios from the Austrian Alps are used to examine the representation under different circumstances (high alpine glaciers and low alpine foothills) in order to gain insight for efficient map use.

KUMAR, SHEKHAR Government College, Hoshiarpur
Exposure to Climatic Variability and Associated Hydro-Meteorological Hazards in Beas River Basin of Western Himalaya, India

There is ongoing concern about current and potential climate change impacts on the Indian Himalayan Region from both a physical and societal perspective. The region is facing important challenges in view of coping with adverse effects of climate change. Thus understanding and anticipating the impacts of climate change on Himalayan mountain and the services it provides to people are critical. In this investigation, Beas river basin has been taken to measure the spatial pattern of exposure to climate change and associated hydro-meteorological hazards. Exposure was conceptualized as the sum of current state of various elements of climate, their changes in last 117 years, future climatic scenarios and extent of hydro-meteorological hazards. This approach allowed us to frame a climate change exposure index at basin scale integrating past and present. Exposure index has the potential to integrate different parameters representing climatic variability and associated hydro-meteorological hazards to guide preventive decision making. We integrated various such indicators in a single index to calculate the degree of exposure to climatic variability and associated hazards in the study area. It is noted that upper Beas basin is relatively more exposed to climatic change as compare to lower Beas river basin.

MARSTON, BROOKE US Department of State
High-Altitude Stakes in the Himalayas: China-India Boundary Dispute

The contentious boundary dispute between China and India–the two most populous nations and nuclear superpowers–is a fraught geopolitical conflict in one of Earth's most inhospitable landscapes. The decades-old boundary alignment disagreement extending across four distinct sectors remains unresolved and dangerous. Each side competes to build infrastructure in the hotly contested region which has led to deadly military standoffs. Political tensions shape, and are shaped by, the foreboding and treacherous terrain of the high-altitude Himalayan frontier. The unique mountain geography of this region defined the sectors outlined in 1961 and will likely contribute to climate conflict and regional insecurity going forward.

MEACHAM, JAMES University of Oregon
Mapping Carnivore Movement and Interactions in the Greater Yellowstone Ecosystem

Advances in location technology are giving biologists an unparalleled window into understanding new aspects of wildlife behavior. The detailed data collected from fitted GPS collars also presents cartographers many new mapping and data visualization opportunities. We are able to map the movement and activities of wildlife on time scales ranging from

minutes or hours, to the entire lifespans of individuals. This paper presents visualizations on movement patterns, activities, and interactions of individual carnivores, including cougars, grizzly bears, and wolves, with prey in the Greater Yellowstone Ecosystem. Through maps and data graphics, dramatic stories are unveiled. These stories are part of the new additions to the work in the second edition of the Atlas of Yellowstone, published in 2022 for the 150th anniversary of the establishment of Yellowstone National Park. This presentation will also include a brief overview of other mountain related topics found in the new atlas.

MESTRES, NOLAN Univ. Grenoble Alpes

Controllable Lighting Model for Designing Digital Panorama Maps in the Style of Novat

In Europe and North America, panorama maps are widely used by mountain operators to promote their resorts. They played an important role in the development of winter sport tourism. Panorama artists who have become prominent masters in the field all share a similar creative process while achieving different styles in the end. Stylistic studies have been published for the work of Heinrich C. Berann [Pat00], Heinz Vielkind [Pat00, KF19], James Niehues [Tai10, BFB19] and Pierre Novat [NNB13, Mes22].

Producing a hand-painted panorama map is a challenging task, involving a broad range of skills. Even for masters such as Heinrich C. Berann or Pierre Novat, the production time for large paintings can take up to several months. Panoramists, though experts at crafting beautiful aerial maps of the mountain, are now a dwindling profession due to these constraints. Indeed, ski resorts rely more and more on CGI to produce panoramas. Although fast, 3D rendering systems lack the editing tools to enable the creation of panoramas of similar artistic quality. Artists are often required to manually or digitally repaint parts of the rendered images to achieve the desired result.

For artistic reasons and relief depiction purposes, panoramists depart from the simplified hill shading models used in 2D mapping. A panorama map displays ideal weather conditions, at either sunset or sunrise. However, a realistic depiction of lighting effects caused by the illumination at these times can impair the readability of the map. Therefore, panoramists must invent new ways of shading the terrain surface, casting shadows, and depicting complex effects such as indirect illumination. A careful lighting design prevents shadows cast by the sun from masking important areas, and features parallel to the light direction from lacking contrast.

We propose a lighting model based on these observations and our stylistic study of Novat's artwork [Mes22]. Our lighting model takes advantage of the relative insensitivity of the human visual system to lighting inconsistencies [OCS05, WAM19]. We propose to modify the direction of light locally at each point of a surface, in a way that ensures a better shape depiction. We do that for both shading [Mes+21] and cast shadows separately and at multiple detail scales, so as to obtain a plausible while legible terrain depiction. Chamonix area.

MILBRATH, JOE US National Park Service
Mapping Glacier Peak: A 3D Oblique Tutorial Using High-Resolution Data

High-resolution data coverage for areas of the Pacific Northwest can be spotty at best. However, sometimes the stars align where compelling geography and adequate high-resolution data overlap allowing cartographers to unleash the full array of their tool box. This tutorial will walk through the process of compiling LiDAR, NAIP, and USGS hydrographic data for a remote area in the Cascade Range that contains an isolated stratovolcano, Glacier Peak. The presentation will touch setting up an optimal viewing angle to optimize light and shadow embedded in the imagery that work best with the terrain. I'll touch on techniques to add additional light and shadows including sun glints and golden alpenglow on high-elevation slopes. Finally, I'll walk through adding vector data including lakes, streams, and labels to the complete the cartographic process.

NELSON, JOHN Esri
Why Put Your Map in a Box?

A recent infatuation with the brilliant geographic cutaway illustrations of USGS cartographer, Tao Rho Alpha, led this map maker on a series of experiments in terrain diorama illustrations, with surprising results. Why is it that slicing away the margins of a geographic area captivates the imagination? How can this be leveraged to invite the uninitiated into becoming map makers and, interestingly, map sharers? In this presentation, we will discuss the merits of the cartographic diorama, conjecture at its allure, and demonstrate its construction.

PATTERSON, TOM US National Park Service (retired)
Malaspina Glacier Panorama

High, wild, remote, and icy—these are some of the words that describe the Saint Elias Mountains straddling the Alaska/Yukon border. They are the highest coastal mountains on Earth, boasting the second and third highest peaks in North America. Spilling out of the mountains is Malaspina Glacier, some 65 kilometers wide and 600 meters thick. It is a textbook example of a piedmont glacier and the main focus of my panorama. I started this project in 2017 and then put it aside for four years. However, accelerating climate change brought newfound urgency to my mapping. I wanted to showcase this magnificent glacier while it still exists. My talk will discuss the challenges of mapping a constantly changing landscape and harmonizing data sources obtained from two countries.

PETROVIČ, DUŠAN University of Ljubljana

Redefining Heights of Mountain Interesting Peaks and Other Characteristic Points in Slovenia

Slovenia is a popular touristic attraction thanks to its position and its diversity of the surface. More than 10,000 kilometers of marked mountain trails are known, which include peaks, saddles and starting points. To correctly record all the characteristic points is a big challenge for the Mountaineering Association of Slovenia (PZS). That is why PlanGIS, the Mountain Geographic Information System was established and where the spatial data of Mountaineering Association of Slovenia is kept. In PlanGIS, data of two heights are kept for each characteristic point. The source of the first height is not known, but it is probably taken from topographic and mountain maps, whereas the second height is determined from the data of the Digital Elevation Models (DEM) with a resolution of 1x1 meters, from National Lidar Survey data. Since the heights differ in many cases, even up to more than 10 meters, we determined the reasons for such differences within our research. The purpose of the task was to give PZS guidelines on which source of heights is the most suitable. We considered fourteen peaks, three parking lots, and two saddles, which represent a sample of characteristic points for research. These points were divided into 5 groups: peaks that are not overgrown or do not have a trigonometric point, peaks with trigonometric points, overgrown peaks, saddle and parking/starting point.

By measuring the heights, the ellipsoidal height is determined directly by GNSS. An ellipsoidal height is the geometric distance between a point on the surface and a reference ellipsoid, which is a mathematically determined smooth surface of the Earth's approximation. In Slovenia, the official vertical altitude system is marked SVS2010 (date Koper) and is based on the system of normal altitudes. The system uses the height reference plate SLO_VRP2016/Koper, which was established in 2016. SLOVPR2016/Koper is a quasi-geoid model that was included in the altitude system SVS2010 with GNSS/levelling points. In Slovenia, the national coordinate system is connected to the reference ellipsoid GRS80, which was adopted by the International Union of Geodesy and Geophysics (IUGG) in 1979. To compare the latest data, the ellipsoidal height had to be converted into altitude height. We did this with the Leica Infinity program, where we previously defined the coordinate system, ellipsoid (GRS80) and geoid (SLO_VRP2016/Koper).

Using static GNSS measurement, we determined the altitude of the selected points and used this data as a reference. In addition, we obtained the height from the terrain point cloud. In the group of peaks that are not overgrown and do not have a trigonometric point at the top, the largest difference between the heights in the PlanGIS is 29.1 m, which is due to an error in transcription from a topographic map or other used source. Of the nine peaks with trigonometric points, only two are those where the trigonometric point determines the highest point of the peak. The largest difference between the heights in this group was 15 m and is due to incorrect determination of the position of the point on the DEM.

PLEWE, BRANDON Brigham Young University
Mapping Visual Landscapes

What does it mean to be "in the mountains?" "in a valley?" "in canyonlands?" The visual landscape, our conceptualization of the visible environment around a place as a whole, is a fundamental part of our understanding of geography. One of our primary goals as cartographers is to represent the beauty and character of the landscape. Yet, it seems to have less of a conceptual framework, common terminology, and analytical methods than most of geographic discourse. Ironically, Landscape Ecology, despite its name, only partially helps.

We conducted a survey to better understand how people conceptualize the landscape; based on this, we are developing analytical techniques to classify visual landscapes, and are exploring how these may be used in cartography. For example, different landscapes may be best depicted by different terrain cartography techniques, and our analytical tools could be a first step toward automatically calibrating the relief representation to the relief.

PREPPERNAU, CHARLES Esri
Using Projection Distortion in Panoramic Maps

One of the inconveniences associated with making panoramic maps is managing elevation data. Depending on the software used, a panoramic map maker may need to use a single terrain tile that may be prohibitively high resolution in order to get adequate detail in foreground, and prohibitively large to accommodate the much wider view frustum in the background. This talk will describe how to design an oblique Mercator projection from which an optimized DEM can be extracted: a rectangular raster that closely fits the area covered by the frustum and has a smoothly increasing effective cell size from foreground to background.

RÄBER, STEFAN ETH Zurich
Swiss Authors and Producers Map Mountains Around the Globe

A small collection of well-known and lesser-known mappings of mountains (or mountain areas) outside the Alps is presented. The maps have one thing in common: they were produced or distributed by Swiss cartographers. The authors or producers of the presented documents are partly well-known cartographic publishers and state institutions, but partly also silent creators of the private trade, enthusiasts, adventurers or emigrants who sought their fortune in the distant world. The documents are current and historical productions. The oldest ones date back to the early 19th century. Not only topographical maps, hiking maps but also tourist bird's eye maps are part of this presentation. Each map is not only displayed, but also briefly explained. A complete historical classification and elaborate cross-references are not to be expected in this context. The compilation of the maps comes mainly from the

collection of the Zurich Central Library, from documents of map historians and conversations with map authors or their descendants themselves.

RILING, ANNA Four Corners Mapping & GIS
Geologic Trail Maps of the Grand Canyon

These maps were the recipients of the Best Data Driven Map award at the Arizona State University Mapping the Grand Canyon conference in 2019. Three maps were produced for three popular trails in the Grand Canyon. These maps combine a geologic trip log and guidebook with the utility of a topographic trail map. The concept is for anyone, regardless of geologic or navigational aptitude, to use the map on a hike and gain a deeper understanding of the Canyon's geology by pausing at each "Geology Stop" to read about and observe a geologic feature of interest, such as stream piracy, the Tanner Graben or the Great Unconformity. The map also contains trail info, including elevation profile, water sources, backcountry zoning, and history. On the reverse of each map is the map unit legend and a series of graphics, photos, and information about the geology of the Canyon. The color scheme from the rock units on the map is continued through to the graphics on the reverse, i.e. Proterozoic information is generally pink, Paleozoic is blue, and so on. Almost every feature on the map is data driven, including the Geology Stop info, trail stats, elevation profile, even the cover photo and trail name. The unfolded size is 18" x 24", and the folded size is 6.25" x 4". I produced maps for Hermit, Tanner, and Grandview Trails.

ROUSSEAU, GABRIEL Bureau of Land Management, Oregon
Custom Hypsometric Landscape Representation Interpretive Kiosk and Brochure Maps of Warner Wetlands & Hart Mountain

Bureau of Land Management (BLM) recently published two interpretive cartographic products of Warner Wetlands Area of Critical Environmental Concern (ACEC) and Special Recreation Management Area (SRMA), located in South Central Oregon. This two-pronged mapping project included the production of a folded brochure (Interpretive information Side A, Map Side B) and roadside interpretive kiosk map located at Hart Bar, the primary entry point of the ACEC. The brochure was printed on glossy stock and measures 20x27 inches, folded across 4x9 inch panels at a scale of 1:63,360. It focused on navigation while depicting access to public lands, recreation, transportation, and detailed topography.

During the last ice age, huge lakes filled Warner Valley. The remnants of Hart Lake today form a 40-mile chain of lakes which seasonally flood and recede, depositing sediment on their northeastern shorelines and creating a unique and beautiful series of bow shaped dunes. Sweeping vistas of sage brush roll across the high desert punctuated only by the serene lakes and the dominant Hart Mountain. The roadside kiosk was designed to capture the inspiring aesthetic of this rugged and remote landscape through a hypsometric tint derived from a 10-meter Digital Elevation Model (DEM) and judicious depiction of 1:24,000 National Hydrologic

Data. It measures 36x48 inches at 1:31,680 and was printed on UV resistant high-pressure laminate.

The interpretive kiosk sits at the base of Hart Mountain. A massive fault-block mountain that dominates the horizon just east of where the map sits. As viewers read the sign, the landscape before them sweeps westerly into the verdant Warner Valley with distant hills to the Northwest. Many visitors arrive in the spring when the Warner Lakes are flooded and snow caps Hart Mountain.

To capture a cartographic expression of this unique landscape a custom 31-class hypsometric tint was applied at specific elevation intervals across the DEM. Elevations ranged from approximately 4,450 feet to 8,000 feet. Colors of the landscape here change significantly across lower elevations as the valley begins to rise into distant hills and the base of Hart Mountain. The DEM reflects subtle changes in color in the valley through specific classifications between 4,450 feet and 4,600 feet. Above 4,600 feet color begins to change dramatically from green to brown. Between 4,600 feet and 5,000 feet classifications capture the more arid landscape of distant hillsides and the nearby slopes of Hart Mountain. Above 5,000 feet, color-classification subtly loses saturation until no color is applied at the highest elevations. A custom multi-directional hillshade was then applied to the hypsometric tint. The resulting map then captured a landscape many visitors will see before them. One of a green and blooming valley, with distant brown hillsides and a snow-capped horizon just to the east.

SAMSONOV, TIMOFEY Lomonosov Moscow State University
Topographic Hachures in QGIS

Hachuring was used for terrain representation mostly on 19th century topographic maps. Mountain cartographers are still fascinated by this spectacular technique, but it is quite hard to implement using a conventional GIS software. During my technical demo I will present the new software for depicting terrain with topographic hachures, which enhances the algorithm developed earlier (Samsonov, 2014). Hachure Builder generates vector layer with hachures from a raster digital elevation model and is implemented as a plugin for QGIS. Each hachure is a XYZ polyline enriched by average slope, aspect and elevation as attributes. Multiple hachuring styles can be implemented based on this information: traditional slope and shadow hachures, as well as more sophisticated techniques in which the color and width of each hachure is varied depending on the local slope, aspect and elevation. It is also possible to achieve hachure tapering in areas of low elevation gradient.

SIMMON, ROBERT Planet Labs
Off Kilter: The Assets of Oblique Satellite Views

Almost all satellite views of Earth share one thing in common—they're taken from directly above. But what happens when you image from an angle? Highly oblique satellite imagery provides a new perspective on our home planet, helping to bridge the gap between our

everyday viewpoint and the map-like data provided by common remote sensing platforms. In addition, since many very high resolution satellite images intended for orthorectification are acquired at angles up to 30˚ off nadir, there are opportunities for creating semi-oblique imagery that can help improve understanding of dynamic events like landslides, wildfires, and volcanic eruptions; while switching to a satellite-centric perspective minimizes distortions caused by orthorectification like smearing & occlusion.

STEINGISSER, ALETHEA University of Oregon
New and Improved (!) Terrain Representations in the Atlas of Yellowstone, Second Edition

Innovations in terrain representation methodology were incorporated to revitalize existing maps and create new maps for the Atlas of Yellowstone, Second Edition published in 2022. This presentation will showcase thematic maps from the atlas that highlight the variety of terrain representation techniques used including Blender-created terrain, illuminated contour shading, and the incorporation of satellite imagery to create more realistic representations of the landscape. Atlas topics include waterfalls, Yellowstone volcanics, historic development, wildlife, and more.

SWINEY, CHANEY Benchmark Maps
Mountains of Field Notes

As a cartographer and field checker for Benchmark Maps, I spend at least a month each year on the road in a continual quest to verify and improve our maps. When I sit down to plan out another season of field trips, I inevitably find my routes winding in and out of the mountains of North America. While our atlases include extensive swathes of non-mountainous terrain, the mountains are where public lands most often occur, where points of interest and access that matter most to many of our users are densely clustered, and where road statuses and classifications are so often in flux. In this talk, I'll provide an overview of my field checking process, from trip planning to the gear I use in the field and how we incorporate field findings into our updated maps. I'll also highlight experiences and observations that have defined my professional time in the mountains, noting the cartographic lessons learned while driving steep and scenic roads from the Southern Appalachians to the Canadian Rockies and beyond.

TAIT, ALEX National Geographic Society
A Climber's Map of the Heart of the Teton Range

There have been scores of maps made depicting the Teton Range in northwestern Wyoming. Most have been created for tourists and hikers and have been designed to show most, if not all of the Grand Teton National Park. Because of this, they are at a scale of between 1:40,000 and 1:100,000. They are effective at showing hiking routes and major mountain peaks but lack

higher resolution detail. Rock climbers and mountaineers require a map at a larger scale and with more intricate depiction of the geomorphology of the mountains.

I will present a brief review of the existing recreation maps of the Teton Range and a evaluate some of the techniques for showing alpine climbing and mountaineering routes. Using the latest detailed elevation data, I will explore a combination of terrain depiction and topographic map design techniques to best show mountain details on a planimetric map specifically created for climbers and mountaineers climbing in the Heart of the Tetons.

TYRRELL, ANDREW South Arrow Maps

Open Data, Open Source, Opening Opportunities: A Love Letter to Open Data and Open Source Software

I spent the first few years of my career working for a national mapping agency using proprietary software to create proprietary geospatial datasets. The software was fantastic, and the data was detailed and accurate. But both were expensive; prohibitively so for a wannabe freelance cartographer.

I now live on a different side of the planet, and I've been introduced to a different side of the geospatial industry. Over the last couple of years, I have experimented with all sorts of free and open source software, and discovered numerous high quality open datasets. The creative side of me I never knew existed is now set free. I am now happily navigating through the foothills of my freelance cartography career.

This presentation will be a tour of the open source software and open datasets that I have used to create a variety of maps of the mountains of Aotearoa New Zealand (and beyond), and kick-start my freelancing as South Arrow Maps.

TYSON, STEPHEN

Perspective Mapping Extreme Locations

Is not only challenging to live in extreme environments, mapping them come with their own unique challenges. Locations such as Nepal, the Saichen Glacier, and Antarctica are some of the most remote regions humans survive. In this technical demo, I will share my process for addressing some of the challenges I have faced creating 3D rendering of these regions. How I select a camera view based on map layout, handle harsh shadows in rugged terrain, and make adjustments to artifacts that dominate imagery with snow- and ice-covered terrain. Once the imagery and elevation data is prepared, I will break down my process for working back in details and texture that may have been lost and incorporating techniques such as sfumato and chiaroscuro used by classical painters to enhance depth and volume in the scene.