EARLY NAVIGATION

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Have you ever been lost? I mean really and truly lost; the kind of lost that puts a lump in your throat and makes your hands sweat. Whenever you travel to a new place, be it a different part of your own town or to an entirely different country, navigation is critical. You need some way of translating what you see around you to a larger picture of where you are, relative to certain landmarks so that you may travel from point A to point B. Your method of navigation may be something as rudimentary as verbal directions ("travel down this road two blocks and take a left") or something as complicated as translating latitude and longitude coordinates to plot your location on a map. Modern technology has made navigation a very simple task under most circumstances. Ships traveling across the vast open reaches of the Pacific and Atlantic Oceans no longer need to use the stars and a sextant to successfully traverse between continents. Modern ships are equipped with GPS locators that allow them to revisit exact locations for fishing or travel along busy shipping lanes. Traveling across the country by car is now exceedingly simple with a GPS unit in your vehicle. They come as built-in equipment in some cars and some units will even give you verbal turn-by-turn directions as you move along the road at highway speeds. You would have to try to get lost with one of these functioning in your vehicle.

Once you begin to wander off the paved roads however, modern technology starts to break down. Two-track, dirt, oil roads, and ranch roads are not on GPS units, not to mention if you decide to get out of your vehicle and hike. Before roads and signs, people used the sun, stars, rivers and landmarks to navigate. Eventually enough maps were available for easier navigation, but mapping the western US was a large and arduous process. See Manz, 2013 for insight into early mapping and surveys of the western United States.

Arguably the oldest method of navigation is something called dead reckoning. This is a process of navigation best described as a "best guess." It is still used today, although those that use it might not know that their method of navigation even has a name. For example, one might travel to the western United States by simply following the setting sun, knowing they would eventually encounter the Pacific Ocean. A very famous example of dead reckoning is Charles Lindbergh using it to cross the Atlantic Ocean on his solo flight in 1927. On his famous flight, Lindbergh flew the Spirit of Saint Louis between New York and Paris, and successfully navigated across more than 1,800 miles of open ocean between Newfoundland and southern Ireland simply by taking compass readings every hour (Lindbergh, 1953). He was traveling at approximately 100 miles per hour, meaning he flew for at least 18 hours without any kind of land or physical marker to help him navigate.

Figure 1. Reconstructed map showing stops along the transcontinental airmail route. Each city named would be a temporary stop for the pilots. Individual arrows and beacons would be dispersed between each stop.

During the early days of flight navigation, pilots navigated in the same way that weather men predicted the weather during the early 1900s, they looked out the window. Pilots would fly just a few hundred feet off the ground navigating by sight of landmarks, buildings, and roads. Nighttime and inclement weather forced many aviators to fly only a few dozen feet off the ground or be grounded unless it was daytime with good visibility. Crashes during poor weather were common. In 1918 Congress appropriated money to start the United States' first air mail service between Washington D.C. and New York (Anonymous, 2007). In 1921 a series of marker beacons for airplanes was established between New York and San Francisco (fig. 1). These

Figure 2. Google Earth view of one transcontinental airmail arrow southwest of Salt Lake City, Utah. The arrow is approximately 65 feet long.

Figure 4. Photograph of one transcontinental airmail arrow in Nevada. Photograph courtesy of BLM.

beacons opened up night flying and flying during bad weather situations, increasing the speed with which mail was able to traverse the country. Mail was now taking a measly 25-35 hours to travel from New York to San Francisco, when it was previously taking more than 100 hours to travel by train (Anonymous, 2007). The marker beacons consisted of a large concrete arrow and a tower, placed on the ground every 10 miles or so. The concrete arrows were very large, most of them reaching 70 feet in length (fig. 2). On top of that arrow was a generator station and a tower with a rotating light to serve as a beacon (fig. 3). These beacons were spaced in such a way that as the plane passed over one beacon, the next beacon was visible. The beacons were to be used by pilots during bad weather or during the night and greatly reduced the number of crashes (Anonymous, 2007). By July of 1922, the Air Mail Service had gone one full year without a fatal accident (Anonymous, 2007). Used mostly by the US Post Office, these large arrows became known as transcontinental air mail arrows and some can still be seen today (fig. 4). This system of beacons and arrows, with its greatly decreased travel time for mail, made the US airmail the envy of many nations across the world. Although long since decommissioned, the remains of these concrete arrows and metal beacon towers can still be seen in a few places today.

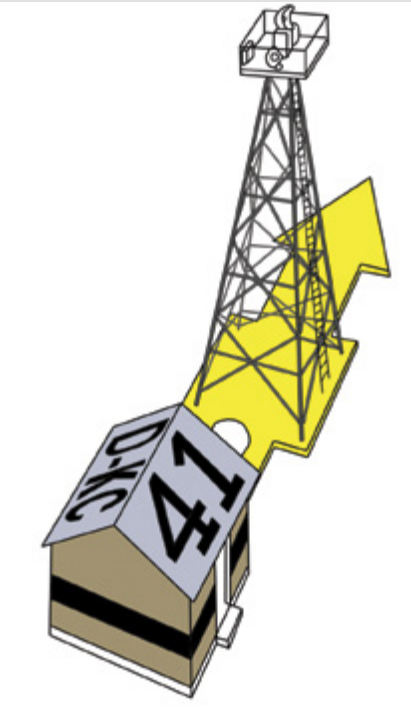

Figure 3. Drawing of an arrow with generator and tower with rotating light.

Carl Ben Eielson was a famous pilot and navigator from Hatton, North Dakota. Known as the "father of aviation" in Alaska, he flew mail between towns in Alaska in 1924, and made landmark flights over both the Arctic and Antarctic in 1928. Although he most likely did not use the transcontinental air mail arrows, he was part of the group of pilots pioneering air mail in the United States. He was awarded the Harmon trophy (an award given to the outstanding aviator of the year) by President Hoover in 1929, and was posthumously awarded the Roughrider Award in 1997 (North Dakota blue book, 2011). A middle school in Fargo proudly bears his name (fig. 5).

Figure 5. Carl Ben Eielson middle school in Fargo, ND.

Figure 6. A cairn in southwestern North Dakota. An important fossil locality is nearby.

The use of rock piles or cairns as markers is another, much earlier, method of navigation. Cairns can be made of many materials, but often they are a large pile of rocks situated in a position so as they are easily viewed from distance. These may be small or large, but their main function is to mark specific locations or help to mark a larger, otherwise unmarked, "roadway" (fig. 6). Cairns are also often used to mark important or significant locations. They are generally distinct enough from the surrounding terrain to not be mistaken for anything but what they are.

Paleontologists and geologists spend a lot of time off the beaten path so map reading is a skill that needs to be developed early. Navigation with, and locating your position on, geologic maps is a complicated skill and those who do it best usually have had a great deal of practice at it. See Manz article in this issue for more on this subject (Manz, 2014, p. 8). Generally, a good familiarity with reading topographic maps and a compass is all that is needed to successfully navigate one's way around the "wilds" of North Dakota looking for fossils.

It is theorized that modern birds use Earth's magnetic field to navigate long distances, although the mechanism used is poorly understood (Lauwers et al., 2013). It is possible that fossil birds and even the extinct flying reptile *Pteranodon* (fig. 7) used a similar mechanism for navigation. Although the discovery of such a mechanism in fossil animals seems unlikely, it is not out of the realm of possibility.

Only recently has our ability to navigate taken a very large step forward with the implementation of satellite Global Positioning Systems or GPS. The first of these satellites was launched in the late 1970s but the system did not become fully operational until the early 1990s (NASA, 2013). Nearly every electronic device capable of tracking your movement or plotting your location on a map uses these satellites. In 1993, the North Dakota Geological Survey and the United States Geological Survey initiated an effort to establish a Global Positioning System (GPS) community base station (CBS) in North Dakota. In late 2001, the site was upgraded and became a member site of the National Geodetic Survey's Cooperative CORS (Continuously Operating Reference Station) network. The community base station, located in Schafer Hall, on the campus of Bismarck State College, is managed by the North Dakota GPS Steering Committee.

Hopefully the next time you decide to wander off the beaten path, you'll have some kind of tool to help you navigate your way to your final destination.

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Figure 7. The flying reptile *Pteranodon* in the Bismarck Airport.