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Essay

A Reverence for Time: A Review of Land-Based Travel Calculations

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Abstract

How long will it take to get from "Point A" to "Point B"? Estimating the answer to this question is essential for outdoor leaders to accurately and safely manage their outdoor adventure education course. By being able to carefully estimate the amount of time needed to travel a particular route, over the course of a day or an entire expedition, outdoor leaders will be able to avoid unnecessary risk and provide ample time for other experiences and curricula. This paper describes several land-based travel calculation methods (including the less known Munter formula recently added to www.caltopo.com's mapping functionality) and notes why they are essential for leading successful outdoor expeditions. Far from an effort to micro-manage course schedules to the second, this paper offers recognized techniques that allow instructors (and students) to calculate the duration of travel, thereby protecting other pedagogical interests through "a reverence for time."

KEYWORDS: *Outdoor leadership, expeditionary learning, wilderness education, navigation*

Introduction

This thing all things devours:
Birds, beasts, trees, flowers;
Gnaws iron, bites steel;
Grinds hard stones to meal;
Slays king, ruins town,
And beats high mountain down.

From *The Hobbit* (Tolkien, 1994, p. 88)

Side-hilling along a steep alder-choked mountainside, without so much as a game trail to follow, the pod of students I (Nate) was instructing on day 20 of a mountaineering course with the National Outdoor Leadership School (NOLS) was behind schedule. Steady rainfall was relentless. Deep in Wrangell-St. Elias National Park, our re-ration was scheduled to be flown in the following day, but after 12 hours of hiking, we had only made two miles of progress, meaning the rendezvous point was another nine miles away. The pressure we felt to meet the airplane-assisted rendezvous, coupled with mounting fatigue, caused us to make riskier decisions than we might have otherwise. For instance, rather than accept the reality of getting "cliffed out" and backtracking to find a less hazardous route, we at times pushed through slippery third-class terrain, while wearing packs that weighed up to 40% of our body weight. We had not anticipated the difficulty of travel encountered that day, and experienced the uncertainty that often accompanies adventure in the outdoors.

Variations on this experience are a component of what makes Outdoor Adventure Education (OAE) a transformational experience for many. We seek the outdoors, in part, because of the unknowns. Such uncertainty surrounds navigation in particular where the "reality" we project from the map seldom perfectly matches the topography we encounter. While we welcome this challenge, the balance between having an adventure versus a misadventure—between making safe decisions or choosing amongst risk-laden ones—often comes down to a matter of time.

This paper is intended for outdoor leaders who have a pedagogical "reverence for time[1]." That is, they have a wish to facilitate and steward the opportunities they have to educate others in the outdoors. For, beyond the above noted safety issues, accurately estimating the time required for land-based (e.g., backpacking, mountaineering, climbing, etc.) travel helps educators retain opportunities for formal presentations, debriefs, course highlights, and needed down time. In sum, mismanaging time can lead to misadventure on the one hand, and miseducation on the other.

Note that we are not advocating for micro-managed expeditions that scrutinize schedules to the second. Instead, we enumerate recognized techniques that allow instructors and their students to anticipate the time necessary to travel a proposed route. In our experience, these techniques are often either unknown or underutilized by outdoor leadership instructors. This is not surprising as the techniques/formulas for calculating time are typically mentioned in brief and tucked away within longer accounts of navigational strategies. To address this challenge, we list a number of these techniques/formulas, including the Munter Method, more common to the guide community, which has recently been added to the mapping functionality within www.caltopo.com.

Expanding on our purpose here, timing calculations are important for several reasons. First, they allow instructors and program supervisors the opportunity to design for a successful course. A route shapes the educational experience of a trip or expedition, providing the curricular "story" in chapters of history, geology, and botany (see Henderson, 2005). The question of whether a route supports the curriculum and the participant ability level can be designed in advance. Second, time-distance formulas help set the stage for turning over the reigns of the course to students in "Leader of the Day" (LOD) curriculum. For expeditionary courses, both route planning and navigation (and we would therefore argue timing calculations) are foundational to LOD responsibilities and provide the opportunity for a wide variety of learning outcomes. Third, they provide a tool to address risk management concerns. It is a testimony to the power and variability of nature that many hazards dramatically increase or decrease throughout a 24-hour time cycle.

Careful time planning can minimize exposure to these hazards. For instance, snow conditions are often firmest in the morning and softest in the afternoon; firm snow may be quicker to travel through, but the consequence of a slip or fall is higher. In the late spring and early summer, avalanche hazard frequently increases in the late morning and early afternoon; thus, avoiding solar slopes where a wet avalanche may start is critical. Likewise, thunderstorm activ-

[1]This phrase is borrowed from Matthew Kelty (2015), a Trappist monk, who eulogized Thomas Merton, his novice master, observing that he had "a great reverence for time" and a profound wish to spend it well.

ity is often remarkably consistent in the early afternoon, so being down from mountain passes, off of ridgelines, and clear of slot canyons is important for avoiding lightning and/or flash-flood hazards. For backpackers, crossing mountain streams is frequently safer in the morning before snowmelt increases its volume throughout the day. Similarly, mountaineers on glaciers often try to finish their travel in the early afternoon before increased temperatures and solar radiation weaken snow bridges. And of course, nightfall brings with it a host of potential problems, such as cold, exposure, and the increased possibility of not finding camp and needing to suffer a "benightment." Such forced nights out might also have LNT implications (environmental risk) if a durable site cannot be found. Further, institutional risk management requires a course to camp and travel within the areas for which it is permitted. Thus, instructors must be able to estimate how long it will take to travel a route section, so as to ensure they remain within the confines of their permit. For all of these reasons, being able to make accurate time calculations is essential.

Time Control Plans and Time Calculation Models

Time Control Plans (TCPs) are frequently used as a teaching tool to assist students in learning map reading and time calculations (Drury et al., 2005, pp. 399–400). Typically, prior to a day of travel, and, as noted above, as part of the LOD's responsibilities, students will complete a TCP that includes origin, destination, route description, time-distance calculations, contingency plans, alternate campsites/rendezvous points, and potential causes for delay. While TCPs ought to include timing calculations, end-of-the-day fatigue or a discomfort with math may result in their omission. Although such omissions are forgiveable for experienced leaders who have developed an intuitive sense of how long a particular route will take, and therefore forego some of the granular details of a formal TCP, we recommend that novice/intermediate outdoor leaders continue making detailed calculations. As hazards increase, however, most outdoor leaders, including experts, will formalize all aspects of their TCP, to ensure that risk is kept to a reasonable level.

The following section describes the common time calculation models and divides them into two principal parts: (a) relatively straightforward time calculation formulas and (b) more involved time calculating formulas. To economize word count, we have assumed a high school level of math. Additionally, some formulas employ the imperial formula while others use metric. Since map reading for outdoor leadership requires "bilingual" ability, we've left the formulas in their typical units.

Time Calculation Formulas

Naismith's Law is a time calculation method common to the British hillwalking community (Long, 2004, p. 31). First espoused by W. H. Naismith in the late 1800s, the method employs a horizontal calculation added to an ascent/descent calculation. Horizontal calculations estimate the speed at which a hiker might travel through a given section (5km/h, 4km/h, etc.). Then, referring to the map's scale, this speed is multiplied by the distance of the section at hand. Thus, traveling at 5km/h for 800m yields ≅ 10 min. of travel time. To account for ascent, Naismith's Law adds an additional minute for every 10m of climbing. Similarly, a minute is subtracted from each 30m of descent. To make calculations more efficient, a "timing chart" can be created with distance on the Y axis (100m, 200m, etc.) and km/h along the X axis. As skill and craft improve, an outdoor educator becomes increasingly accurate in their projection of speed, which is dependent on a host of factors (e.g., terrain under foot, density of undergrowth, altitude, etc.). Likewise, through experience, the practitioner learns when to add more or less time to the vertical calculation, which also depends on a number of factors (e.g., heaviness of pack, steepness of grade, etc.).

Another British time calculation method, this one useful when calculating long uniform ascents, comes from Peter Cliff (2006, p. 30), an international mountain guide. When the ascending gradient is consistent, Cliff suggests that greater accuracy can be obtained by foregoing horizontal projection (noted above). Instead, he suggests simply adding 1¼ or 1½ minutes per 10m of gain. Again, with experience one will learn to estimate the appropriate time allotment per contour interval.

NOLS suggests a general standard, estimating that two miles on a flat trail with a heavy pack takes about an hour, which typically slows to one mile per hour off-trail (Gookin, 2006, p. 73). Additionally, each 1,000 feet of elevation gain is an additional hour. For instance, a 10-mile route that is on trail and has 3,500 feet of elevation gain is estimated at 8.5 hours.

Given their shared history, the Wilderness Education Association (WEA) unsurprisingly tracks quite closely to NOLS' figures, similarly suggesting the two and one mile per hour rates for trailed and off-trailed travel respectively (Drury et al., 2005, p. 400). However, the vertical numbers are more nuanced: for 1,000-foot ascents up to 7,000 feet of elevation, the WEA similarly suggests adding an hour, whereas for 1,000-foot ascents that occur between 7,000-11,000 feet of elevation, they suggest adding an hour and a half. The WEA additionally recommends adding 30 minutes for each 1,000 feet of descent.

An alternative WEA source suggests converting vertical gain and loss into "energy miles" (Jordan & Cashel, 2008, p. 88). Instead of adding a fixed portion of time per 1,000 feet gained to the horizontal calculation, this method converts the ascent to linear miles where 1,000 feet of climbing equals 3-4 miles on flat terrain, the variance depending on the steepness of the climb. In this WEA model, the effect of descent on timing is ignored. Thus, a short one mile hike to an alpine lake with 1000 feet of gain, converts to the amount of time it would take to hike 4-5 miles on flat terrain.

Outward Bound (Randall, 1998, pp. 30-31), again revealing a shared lineage with NOLS and WEA, references a similar model to those noted above, but importantly highlights that said model is a guideline only since myriad variables affect accuracy: fitness, load, slope angle (27 degrees being toward the upward end of what most participants can handle in heavy packs), geological formations (e.g., technical canyons), scrambly terrain (discussed below), depth and hardness of snow, mode of transportation (e.g., snowshoe or ski), and purpose of trip (e.g., wildlife viewing vs. summit attempt). In time, as an instructor becomes familiar with local terrain, they are able to make increasingly accurate calculations.

While we will discuss a technique common to the American Mountain Guide Association (AMGA) below, the Association of Canadian Mountain Guides has published the following timing formula (ACMG, 2004, p. 16). Good trails allow for travel speeds ranging from 2-5km/h depending on the degree of interruption. Travel speeds of 1-3km/h can be anticipated off trail depending on the terrain (e.g., open, dense, rough, wet). While the ACMG's vertical calculation is a standard hour/300 m, they include consideration not yet mentioned: adding 10 minutes per hour for rests, or, more for longer breaks like lunch.

Lastly, Burns and Burns (1999, pp. 66-67), authors for Seattle-based The Mountaineers, and long-term contributors to the *Freedom of the Hills*' navigation chapter, do not provide a formula for determining a time calculation but advise the following guidelines for estimating travel time. Hikers with a light pack will travel 2-3 mph on a flat trail. Hikers traveling with an overnight pack will average 1-2 mph in steep terrain. When traveling off-trail in moderate terrain with a day pack, estimate one hour for every 1000 feet of elevation gain. Traveling off-trail in moderate terrain with an overnight pack, estimate one hour for every 500 feet of elevation gain. They too caution that in heavy brush these rates of travel can drop by ½ or even ¾. By contrast if the descent is straightforward it would take half the time it took to ascend.

While readers may feel some dismay regarding the variations within and between the different formulas, such discrepancy serves to reveal the need for experience. Some users will swear by one formula, others by another. In time, you will determine what works best for you. While this subsection emphasized time calculation methods for non-technical terrain (e.g., where the risk and consequences of a fall are minimal), the next subsection emphasizes two methods suitable for technical terrain.

Guide-Based, Time Calculations Formulas: Munter and Chauvin

Travel through technical terrain is characterized by slower progress and exposure to a fall that may result in a significant injury. As noted above, this subsection introduces two relevant methods: the Munter and Chauvin methods. The Munter formula works equally well in non-technical terrain but, like the Chauvin formula, it too shines when applied to terrain that is snowy, scrambly, or steep, often requiring the use of ropes to arrest a fall. For a summary of the distinctions between technical and non-technical terrain, see Rose's (2013) treatment of the topic in *Terrain Classification, Climbing Exposure, and Technical Management*.

A timing formula more common to the mountain guide community is Swiss guide Werner Munter's eponymously named Munter method—yes, the same person who gave us the Munter hitch (Volken et al., 2007, pp. 111-113). Perhaps most frequently used in ski touring, the Munter method can also be applied to foot-based travel. To employ the method, break down a given route into a series of legs, noting the horizontal distance and vertical gain/loss for each. Leg termini are best determined by definable topographic points (e.g., a saddle) or places where a bearing changes. Greater numbers of legs are appropriate in unfamiliar areas or when whiteout conditions are a possibility. Conversely, fewer legs are necessary when one is familiar with the landscape or when the land features (e.g., either geomorphologically or a trail) make the route more obvious.

To perform the calculation, Munter "units" must be assigned: 1 horizontal km = 1 unit; 100 vertical meters = 1 unit. Thus, a 4km leg with 300m of gain equates to 4 horizontal units and 3 vertical units, equaling a total of 7 units. Then, divide the total units by a (sliding) specified number that pertains to the type of travel being used: for uphill travel, on foot or skis, divide by 4; for flat or downhill travel on foot, divide by 6; when bushwhacking, divide by 2; and when travelling downhill on skis, divide by 10 (Burk, 2019)[2]. The quotient (answer) gives the time in hours as a decimal. In the above example, we would divide 7 units by, say, 4 (for uphill travel on foot), which equals 1.75 hours, or 1 hour and 45 minutes. Note, this total represents time moving, not at rest. While the math is straight forward, in can be ponderous. Fortunately, Burk (2019) has created an app, *Guide Pace*, which automatically makes the calculation.

Using Munter calculations within a larger set of navigational skills, an outdoor leader can create a table (see Table 1) clearly delineating details for each leg within a route, including: the leg #, bearing, coordinates, elevation gained/lost, net elevation gained/lost, distance, net distance, specified Munter units, leg time, and net time. Formally a time-consuming process, www.caltopo.com (n.d.), an online mapping software used by many outdoor leaders, has recently added the Munter method to its feature set, and the "Trip Plan" tool will instantly generate a similar table.

Table 1
Sample Time Calculation for the Kautz Route on Mt. Rainier Using CalTopo's Trip Plan

Leg	Coordinates	Elevation'	Gain	Loss	Distance	Bearing	Leg Time	Total Time
0	10N 596441 5182170	5420'						
1	10N 594414 5187695	11514'	+6545'	-495'	4.01 mi	341° TN	6 hr 37 min	6 hr 37 min
2	10N 594507 5189575	14,401'	+3015'	-83'	1.29 mi	4° TN	2 hr 48 min	9 hr 25 min
Total			+9560'	-578'	5.3 mi			9 hr 25 min

[2]While these "specified numbers" may at first seem arbitrary, they have been determined to work with the Munter method and are based on "the average pace made by a party moving steadily at a medium exertion" (Volken, et al, 2007, p. 113).

A comparable formula has been designed for 3rd and 4th class terrain (e.g., scrambling and snow climbing). This "Chauvin" formula (named after its creator, international mountain guide, Marc Chauvin, see Burk, 2019), converts distance and elevation into 60m pitches. To use the formula, one must estimate a rate of 10 to 30 minutes per 60m pitch (a typical rope length). The equation works out to: Time in minutes = ((Distance in meters + Elevation in meters)/60m) x Rate in minutes per 60m. By way of illustration, a 3rd class ascent that takes place over a 1km horizontal distance and gains 300m at a rate of 10 minutes per pitch (i.e., ((1000m + 300m)/60m) x 10 minutes per 60m) equals, 217 minutes or 3 hours and 37 minutes.

In this section, we presented 10 different land-based travel calculation models. Although similarities exist between them, they each have their own distinctions. Before transitioning to the conclusion, we want once more to petition the reader to experiment with them in order to find the method(s) that consistently yields the most accurate results.

Conclusion

It is worth reiterating that all time calculations are only estimates. Real-world variables frequently alter—and sometimes shatter—the most carefully laid plans. Thus, educators are advised to use these estimates conservatively, and leave time for unforeseen problems (and solutions to them). With that said, we have found these techniques to be remarkably good starting points for planning. As a route is experienced the calculations' accuracy will inevitably vary depending on the human and environmental characteristics (e.g., physical condition, pack weight, undergrowth, precipitation, etc.) encountered.

In closing, we revisit the story that introduced this paper. The NOLS students and I (Nate) spent the night far from our intended campsite, and separate from the two other student groups. The next morning, we broke camp early and made quicker progress in the widening river valley. However, we did not make it to the rendezvous point in time to meet our aircraft and had to use a satellite phone to reschedule for the following day. After getting our re-ration, the weather broke and we spent a glorious layover day sunning ourselves and playing games on the banks of the Kuskulana River, gorging on what was now an extra day of rations and bonus moose meat kindly left by the pilot. The price of underestimating our travel calculations was a night of grumbling bellies, the additional fuel-use for the airplane's return trip, and the need to rely on obtrusive technology to make the call. While by no means devastating, the miscalculation did have physical, social, and environmental consequences, reinforcing our commitment to a reverence for time.

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