SPQ Module 5 – Fueling the Fire

"Adventure is just bad planning."

- Roald Amundsen

Polar exploration involves traveling great distances. Everyone who sets out on a polar expedition must consider what source of fuel they will use to power their transportation and keep warm. If you travel to the Pole by snowmobile then gasoline is your fuel of choice. If you are kite skiing then wind power and food will fuel your progress. The task Ray, Richard and Kevin face is to haul sledges weighing 160 pounds each over a distance of 1130 kilometers and to a height of almost 10,000 feet. It will take a great deal of energy to accomplish this goal. Choosing and carefully apportioning the fuel that will provide the necessary energy for the expedition is a critical task. In their case, given that they will be using human power to transport themselves to the South Pole, food alone is the fuel of choice.

The difficulty with travelling great distances by human power through an environment like Antarctica is that should you run short of food you have no means of replenishing your stores. As such, you are obligated to carry all the food you require for the entire journey. If you happen to miscalculate the amount you require the consequences can be very dire. As we have learned, Scott and his men froze to death, in large part because they ran out of food.

Figure 1: A butter, peanut butter and macadamia butter sandwich made for the South Pole Quest Expedition. There is an eighth of a pound of butter in each sandwich (photo: Ewan Affleck).

Roald Amundsen was a master planner and never found himself in such dire straits. He had an ingenious - although some may say cruel - approach to the use of fuel and transportation during his successful bid for the South Pole in 1911. Amundsen carefully arranged that the means of transportation he was using to get to the Pole would also serve a source of fuel and warmth for himself and his four colleagues. Amundsen set out for the South Pole by dog team with 52 dogs, four sledges and five men. As their journey proceeded they ate stores and stashed provisions in depots for their return journey. This meant that the weight of their sledges grew lighter requiring fewer dogs to pull the load. Ever practical, Amundsen sacrificed dogs as they proceeded, feeding them to the living dogs and saving the best cuts of dog-meat for himself and his men. Upon his return from the South Pole, he and his four men travelled with two sledges and only 11 dogs, almost all the others having been used for food. This proved a remarkably efficient way to travel.

All living organisms depend on an external source of energy to live and reproduce. Plants harvest energy from sunlight, while animals use the chemical energy trapped in food. The food energy that humans eat is measured in calories. A calorie is defined as the amount of food energy that will raise the temperature of 1 kilogram of water by one degree C. The daily energy requirements of an average adult human are 1500 to 2500 calories a day. Ray, Richard and Kevin estimate they will require about 7,000 calories a day to sustain themselves on their trip.

Scott and his men provided for a diet of only 4,500 calories a day, and unlike Amundsen, they hauled virtually all the food stores they required as dried food, eating only a little fresh meat in the form of ponies they sacrificed toward the start of their expedition. It is now clearly understood that they underestimated their caloric needs and gradually starved to death. Without adequate caloric intake they began to burn their own fat and protein stores as manifested by the marked weight loss they experienced.

Mealtime during the Scott expedition. From left to right: Evans, Bowers, Wilson and Scott (Source: Lawrence Oates)

The current consensus is that sledge-hauling expeditions in the Antarctic require a caloric intake of about 7,000 to 8,000 calories a day. Their energy needs are very high, not only because of the strenuous exercise required to pull a sledge, but also because human beings have increased caloric needs in response to colder temperatures and higher altitudes. In fact, a good proportion of the energy human beings capture by breaking down food is converted to heat, essential to keep body temperature in a normal range.

Scott's diet for the duration of the 160 days they survived consisted of pemmican, butter, biscuits, cocoa, sugar, and tea. One can imagine growing tired of this diet. Ray, Richard and Kevin will enjoy a more varied diet very rich in low weight fats that provides a high daily caloric content. Table 1 outlines the diet for a segment of the South Pole Quest expedition. The food is carefully planned and prepared by weighing all items before packaging and loading onto the expedition sledge.

Table 1: List of daily diet on South Pole Quest 2008 with Caloric & Weight estimates

Item	Calories / 100 gm	Grams	Total Calories	Days	Men	Total Weight gm
Breakfast						
Coffee Instant / Tea	100	6	6	9	3	162
Multi – vitamin	0	2	0	9	3	54
Fiber	400	12	48	9	3	324
Muscle Milk	428	38	162.64	9	3	
Cream, dry	500	20	100	9	3	540
Pemmican	644	100	644	9	3	2700
Rice	363	50	181.5	9	3	1350
Cheese, Cheddar, dry	666	50	333	9	3	1350
Macadamia butter	718	10	71.8	9	3	270
Sucarie	420	20	84	9	3	540
Butter	716	30	214.8	9	3	810
Peanut butter	667	40	266.8	9	3	1080
Subtotal		378	2112.54			
Lunch						
Butter	716	57	408.12	9	3	1539
Bacon, double smoked	650	50	325	9	3	1350
Nuts	661	125	826.25	9	3	3375
Zero Bar	600	0	0	9	3	0
Chocolate Truffle with M?	650	200	1300	9	3	5400
Exped. Fruit Cake	500	50	250	9	3	1350
Herb Tea	1	3	0.03	9	3	81
		485	3109.4			
Supper						
Milk, dry	600	55	330	9	3	1485
Maple Sugar	350	15	52.5	9	3	405

Whisky	231	25	57.75	9	3	675
Pemmican	644	100	644	9	3	2700
Coconut Milk	650	33	214.5	9	3	891
Pasta	383	80	306.4	9	3	2160
Cheese, Cheddar, dry	666	50	333	9	3	1350
		358	1938.15			
		1221	7160.09			

Pemmican has long been the staple of Antarctic exploration. Amundsen as well as Scott used it, and Richard, Ray and Kevin are packing a daily ration of pemmican. Pemmican is a dense mixture of fat and protein that is very high in calories. The native peoples of North America invented pemmican, a term that is derived from the Cree word pimî, meaning fat or grease. The South Pole Quest team pemmican is made of pork, lamb, chicken, vegetable fat, dried apples, pine nuts, wheat germ, wheat kernels, semolina, cherries, cranberries, herbs and salt.

Figure: Vacuum packed bacon, pemmican and chocolate truffles for the South Pole Quest Expedition (photo: Ewan Affleck)

Food energy comes in three major forms: protein, fat and carbohydrates. The amount of energy or calories these forms of food contain is not equal. Fat has the most calories per unit of weight at 9 calories per gram, whereas protein and carbohydrates contain only 4 calories per gram. What this means, in practical terms, is that to obtain the same amount of food energy from proteins or carbohydrates one requires twice as much food in weight compared to fat. In other words if Ray, Richard and Kevin decided to take all the food for their expedition in the form of carbohydrates and protein rather than fat that they would have to pull twice as much weight for their food. Furthermore, the body can digest

fats and feed this energy to muscles more rapidly than protein and carbohydrate during endurance activities. For these two reasons protein and carbohydrates are felt to be an inferior source of calories or energy for Antarctic explorers.

Even when careful plans are laid however, Polar exploration is a very risky business, and running out of food can lead to desperate acts. During the Franklin expedition of 1845, and the Greely expedition of 1881 – 1884 critical shortages of food arose when both expeditionary teams were stranded in the High Arctic. While everyone on the Franklin expedition perished, 6 of the 25 men on the Greely expedition were ultimately rescued. There is compelling evidence that men on both expeditions resorted to cannibalism in their effort to survive.

Did You Know?

Most Polar explorers attempt to fatten up prior to setting out on an expedition by eating excess calories to store fat. This fat can then be burned as fuel during the course of their expedition. Carrying extra fat is a very efficient fuel source.