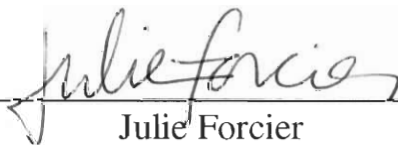Interactive Qualifying Project
Zürich, Switzerland
B Term 2001

Experience the Mountains
of Switzerland

Submitted by:

Greg Tremelling
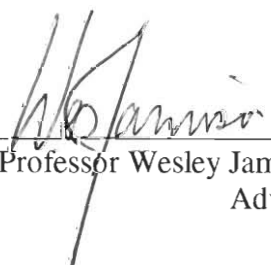
Greg Tremelling

Julie Forcier

Julie Forcier

Oleg Rekutin

Oleg Rekutin

Submitted December 18th 2001

Presented to: _Wesley Jamison_

Professor Wesley Jamison
Advisor

Abstract

This document, prepared for the Swiss Federal Institute for Snow and Avalanche Research of Davos, Switzerland (SLF), is a detailed compilation of the necessary research and methods used to build and test a web site that features images from mountain web cameras and detailed information on various aspects of Swiss mountain environments. By using focus group testing, we arrived at the conclusion that the final revision of the International Year of Mountains sub-sections, "Webcam" and "Enzyklopädie," are intriguing, usable, comprehensible, and above all, educational.

Executive Summary
Creating a Web Site that Highlights the Swiss Mountains

Introduction

This document summarizes the results of research within the areas of web site design, early history, and natural phenomenon within the alpine regions of Switzerland. Conclusions were derived from over seventy-five scholarly publications and numerous conversations with experts in relevant fields. This summary concludes that through the use of digital cameras, focus groups, and interviews, a comprehensive, clear, and easy to use web site was designed and implemented.

Approach for Designing the Web Site

Three linguistic regions of Switzerland contain a remotely controlled digital camera that takes snapshots of alpine landscapes at defined intervals. The fourth camera assembly will be installed in January due to reasons beyond our control. Equipment was installed at three camera sites to facilitate the transmission of data to a central server where it is collected, organized, and refined. The web site content includes detailed information about landscapes, forestry, botany, wildlife, people, climate, hazards and alpine history. Along with the web cams, these topics are the focus of the site because they are the most interesting topics that we could offer our audience. Along with providing the opportunity to read about these subjects, over 180 pictures provide the reader with a visual experience of the Swiss mountains. Essentially, the goal was to present the content in an interesting as well as educational context.

To expand the content of the web site, we conducted interviews with knowledgeable experts of the relevant fields. This allowed us to obtain further detail within selected subject areas. When the design of the web site was completed, we tested it by conducting two focus groups at SLF with adults between the ages of 23 and 29. The results of the first focus group were analyzed and implemented prior to the commencement of the following group. Utilizing this method of testing narrowed the gap between the user and the designer, thus increasing usability and comprehension.

Outcome

After creating a network that linked digital cameras to a main server, we created an encompassing web site that is interesting, educational, usable, and comprehensible. In an effort to fine-tune our web site, we used focus groups to test the levels of usability and comprehension, while interviews allowed us to add specialized information. Therefore, this web site is usable, visually attractive and informational.

Acknowledgements

Table of Contents

1.0 Introduction

The mountains of Switzerland are fragile environments characterized by steep slopes interrupted by valleys, lakes, and rivers. Home to a rich variety of plants and animals, these regions are also subject to harsh climatic conditions, such as extremely cold temperatures and high winds. Natural occurrences such as flooding and avalanches cause the soil formation and vegetative growth to be a slow process. These factors contribute to the fragility of the mountain environments.

As the population of the world increases, the demand for more land and resources has put pressures on the mountains and the life they support. Because the United Nations General Assembly (UNGA) feels that we must ensure the availability of resources for future generations, they want to promote sustainable development of the mountains. Consequently, the UNGA declared the year 2002 as the International Year of Mountains (IYM) (Food and Agriculture Organization of the United Nations (FOA), 2000).

Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Another commonly used definition is "development which improves the quality of life, within the carrying capacity of the Earth's life support system." This definition was accepted by three of the major international organizations working in the field: United Nations Environment Programme (UNEP), WWF (formerly known as World Wildlife Fund) and the World Conservation Union (IUCN). By declaring 2002 the International Year of the Mountains, the UNGA hopes to promote sustainable development and raise awareness of the significant role that mountainous environments play in daily life (FOA, 2000).

This Interactive Qualifying Project (IQP) involved working with the Institut für Schnee- und Lawinenforschung in Davos (SLF, or Swiss Federal Institute for Snow and Avalanche Research). Up until now, people did not have a way to learn and interactively experience the Swiss mountains without actually traveling to them. Thus, the goal of our IQP was to provide the means for people around the world to experience the mountains of Switzerland.

To ensure that their message reaches as many people as possible, the UNGA created a web site for the IYM. We designed the "Enzyklopädie" and "Webcam" sections of this site, which deliver an experience of the Swiss mountains in two different ways. The "Enzyklopädie" section provides information on the wildlife, plant life, physical phenomena such as glaciers and avalanches, and historical information concerning the people inhabiting these mountains. Because we wanted to give people an interactive experience of the Swiss mountains, we installed web cameras in three of the four linguistic regions of Switzerland: the Italian site is in the canton of Ticino, on top of Monte St Giorgio; the Raeto Romansch site is located in the Engadine region on top of Diavolezza; and the German site is in canton Schwyz and focuses on the Mythen peaks. In January the installation at the French site, located in the Jura on top of La Dôle, will be completed. These images are featured in the "Webcam" section of the IYM site. By exploring these sections, viewers have the opportunity to experience the Swiss mountains without leaving their homes or offices.

This project entailed researching many aspects of the Swiss mountains, such as wildlife, plant life, alpine hazards, and climate. Data was collected from reading literature as well as conducting interviews with experts who are currently researching the topics of interest. The two sections created for the IYM web site were tested for usability and comprehension using focus groups. This social science method allowed

us to efficiently determine areas for improvement with respect to usability and comprehension. After making the appropriate adjustments, this site was loaded onto a web server, where it was linked to the Internet to be accessed worldwide.

The goal of this project was to create an experience of the Swiss mountains for the public via the Internet. This has been accomplished by installing web cameras and linking them to a web site that highlights various aspects of the Swiss mountains. Still life photos have been used to illustrate the topics that were discussed in the "Enzyklopädie" section. The photos on the web site are intended to simulate what people would see if they actually traveled through these mountains. Therefore, the web site is dedicated to forestry, wildlife, and physical phenomena, such as glaciers and avalanches.

2.0 Literature Review

2.1 Vegetation

People have inhabited the forests of Switzerland for many centuries. Over this time, the early mountain inhabitants removed approximately half of the forest area in the Swiss Alps. Currently, the forests have expanded back to their original cover of 30% of the country's total surface area, with the largest share found in the Alps. This transition from deforestation to reforestation has significantly affected the biodiversity of the Swiss Alps (Mather & Fairbairn, 2000).

The history of the Alps shows a trend of deforestation, beginning with the first major phase in the settlement of the Alemanni, which occurred around the 5th century, A.D. Because there is limited historical data, researchers do not have specific information on these early mountain people, but they do know that the second major phase of deforestation began in the Medieval Period. This phase was characterized by clear-cutting the forests to make areas for grazing and agriculture (Mather & Fairbairn, 2000).

As the population increased during the 18th century, a direct relationship between population growth and deforestation occurred. Many of the mountain forests surrounding the villages had already been overexploited, causing increased pressure to find new sources of timber. The people then turned to the resources of neighboring regions. One area in particular, the pre-alpine region, served as a reserve timber supply for the nearby economic and industrial centers. The
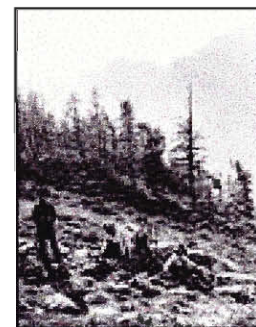
surrounding areas also used this area as a land reserve for the expanding agriculture, specifically for cattle breeding (Schuler, 1988).

In this context, the term "pre-Alps" applies to the transition zone between the Plateau or Mittelland and the Alps. For the purpose of this discussion, the valleys of the Alps are also considered to be part of this region because the forests of these lowland alpine settlements have similar histories. The pre-alpine region was located relatively close to the villages of the Mittelland and alpine valleys, allowing easy access to timber. Also, the region's rivers made the transport of the timber quite simple. After cutting down the trees, the villagers slid them down the slopes, sometimes even on tracks that they built. Once the timber reached the rivers, they dumped the logs in and floated them down stream to their village (Schuler, 1988).
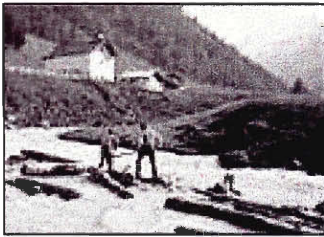
Combined with cattle grazing, clear cutting of forests lead to increased erosion of the land. The soil became more compact and water logged. Ultimately, this had a negative effect on the villages of the Plateau as the number of floods increased. These floods often resulted in damage to the villages and landscapes, and even caused some casualties (Schuler, 1988).

Originally, the control of the forests was left up to the surrounding villages. As the pressures of increasing population growth mounted, the existing ruling systems could not control the demand for wood. Once people realized that overexploitation was occurring, some villages appointed councils to set restrictions on forest use. However, this did not help because the villages continued to experience increased flooding, particularly during the 1830's and again in the 1850's (Mather & Fairbairn, 2000).

The second half of the 19th century showed a transition in the way the Swiss regulated their forests. The Swiss Forestry Society linked flooding to the forest conditions and summoned the President of Switzerland, Professor Elias Landolt, to look at the condition of the forests. After a major survey in 1862, Landolt concluded that the problem of deforestation was not just a local problem, but also one that affected the whole nation. The results of the survey were that deforestation caused irregular river discharge, lowered the upper timberline by 150-300 meters and reduced the resistance to avalanches and rock falls. Landolt also found that the rate of tree removal was greater than tree regrowth (Mather & Fairbairn, 2000).

Improved forest management was crucial. Local and cantonal authorities were obviously no longer in a position to control the mounting crises. As a result, regulation increased from the communal to the federal level when the Swiss federal government issued the Forest Policy Law of 1876. This law widened the area of concern from deforestation to include reforestation. Reduction in forest area was prohibited and before one could cut down a tree, a special permit was required. Also, in the removed tree's place, a new tree had to be planted (Mather & Fairbairn, 2000).

The Forest Policy Law of 1876 marked the starting point of reforestation. However, it was not the only factor that brought about the phase of an increase in forest area. An important aspect was the changing structure in agriculture, mainly, the introduction of dairies. These dairies led to the abandonment of many alpine pastures. Because of this reduction of pressure on the forests, the trees started to reclaim the lands, from which they were cleared (Schuler, 1988).

Most reforestations occurred between the years 1880 and 1920. In some areas, reforestation was not possible without the use of anti-avalanche constructions. Villagers built terraces made of stone and dirt to protect the young trees from getting

trampled by the force of avalanches (A. Schuler, personal communication, November 27, 2001).

As the forests grew back to cover their original surface area, they became increasingly important for recreation, especially for tourism. At the beginning of the 20th century, the forestry service realized the importance that tourism played on the economy and proposed a management plan to establish better hiking trails. Even though the economy of Switzerland greatly relies on tourism, the main objective of the forestry service is qualitative forest conservation. This means that the forestry service must protect the forests from environmental degradation. Although they must take into consideration the interests of the public, the preservation of the forests is their main priority (Gordon, 1994).

The forests have reverted to their original coverage area; however, human impacts are still evident. As a result of the past, biodiversity has declined in some areas of the Swiss Alps. Many animals of the lowlands were forced out of their natural habitats or have become extinct. Also, since the reforestation projects began, forest composition has changed. The replanted areas are now forests of even-aged, same-species trees.

One area that has been affected by humans is the Upper Engadine region, which is located in the Rhaeto-Romanic language region of Switzerland. The trees in this region prefer shady locations and usually live at heights of 2,200-2,300 meters above sea level, with the highest peaks reaching 4,000 meters. The Engadine is dominated by the European larch (*Larix deciduas*) and the cembra pine (*Pinus cembra*) also known as the stone pine or the arolla. Separately, the larch can be found on the easily accessible slopes exposed to the south, while the cembra pines mainly

7

spread over the steep, inaccessible, northerly-exposed mountainsides   (Holtmeier, 1994).

The distribution of these trees is mainly attributed to human influences. Cembra pines used to exist on the gentle, accessible slopes. However, the early mountain people cut them down because they obstructed the growth of grass and herbs on the forest floor. It was also a common practice for shepherds to burn alpine pastures to remove weeds. Sometimes, these fires got out of control and ended up damaging large portions of the cembra pine-larch forests.

Because of the larch's corklike bark, which can be up to 30 centimeters thick, it was not always affected by these fires and grew at the cost of the cembra pine. The cembra pines ended up being restricted to the steep inaccessible slopes (Holtmeier, 1994).

The European larch does not like fog or humidity, which is why it grows best

in the dry climate of the Engadine region. A typical feature of the Engadine is the larch-meadow forest, which would have been cembra pine-larch forest, had the cembra pines not been cut down so long ago. However, if the Engadine forests are not specially managed, they will continue their natural succession from larch to cembra pine forests that had been interrupted by human disturbances so many years ago. Eventually, the larch will be overtaken by the cembra pine because of the different reproduction processes of the two species (Holtmeier, 1994).

During autumn, the needles of the larch turn a golden-yellow color, and in November, the needles are shed. The seeds,

like those of the Norway spruce, are dispersed by the wind. However, the larch grows best in less dense forests and open areas because larch seeds require a significant amount of light for germination (Swiss National Park, 2001). Because the forest floors of the cembra pine-larch forests are usually covered by thick alpine vegetation, larch seeds may be prevented from getting into the soil, inhibiting germination. In contrast, the regeneration of cembra pines has a higher success rate. These trees are naturally better adapted because of their unique regeneration relationship with the nutcracker bird (Holtmeier, 1994).

The nutcracker (*Nucifraga caryocatactes*) is a member of the crow family Corvidae. In the Swiss Alps, this bird can be found in the well-developed parts of cembra pine forests. Nutcrackers are dark brown with white speckled plumage and possess a sharp bill that may be up to four centimeters in length (Swiss National Park, 2001).

Without the nutcracker there would be no cembra pine forests in the Alps. The important tasks of the bird start when it begins collecting and transporting the cembra pine nuts in September. Because the seeds of the cembra pine are protected inside of pinecones, the nutcracker must pry them out. The bird holds the pinecone with its toes and uses its bill to extract the seeds. After examining the seed for quality, the nutcracker places the seed in its pouch, which can fit up to 134 cembra pine seeds (Mattes, 1994).

The nutcrackers transport their collected seeds back to their territory to hide them in places that are sheltered from the snow, such as in the canopies of trees or in layers of lichens. Throughout the winter, the bird relies on these hidden collections as its primary food source for itself and its brood, or young. By observing these birds,

researchers have come to the conclusion that they not only remember where 80% of their caches are, but they also remember which ones have been used up. This is astonishing, considering that each winter, the bird usually stores more than 100,000 cembra pine seeds in an area over several square kilometers. These cached seeds can only be found by the bird that hid them (Mattes, 1982).

Because the next generation of birds must be ready for seed harvesting in September, breeding starts in March. Winter breeding has adapted these birds to build their nests with an insulating layer of dried wood. After the young have hatched, the parents take care of them until mid-June. Without their help, the brood would not be able to survive because of the scarcity of food. Once the young are able to leave the nest, the parents provide training for extracting the seeds from the cones, hiding them, and also digging for the hidden seeds (Mattes, 1994).

The regeneration strategy of the cembra pine is a symbiosis between the tree and the nutcracker. When the nutcracker collects the seeds and buries them, some of the seeds get the chance to germinate. If the nutcracker does not collect the seeds, the cembra pines will not germinate. Unfortunately, people used to shoot this bird, thinking that the bird was harming the tree by eating all its seeds. People finally realized that the cembra pines rely on these birds for the creation of new trees and now protect this bird and its habitat (F. Gugerli, personal communication, November 5, 2001).

Snow cover is another factor that affects the success of the cembra pines. The trees depend on the snow cover for insulation from the extreme mountain temperatures. However, if the snow cover stays too long, the trees will be infected by a snow fungus (*Phacidium infestans*). For this reason, the cembra pines need to grow in places where snow melts relatively early in the spring. Exposed ridges or southerly

exposed slopes are optimum places for these cembra pines. Like the cembra pine, the larch is another tree species that is affected by snowmelt (F. Gugerli, personal communication, November 5, 2001).

The larch and the cembra pine are two types of trees that are able to survive the harsh weather because they possess a special defense mechanism. This defense is the resin found within the tree. Acting as a bond, the resin protects the tree by creating a denser core. The increase in density guards the lifeline of the tree and keeps it from freezing. Also, because the resin is carbon-based, it is a non-conductor of heat. The trees are able to survive because the carbon does not allow heat to escape (Maeder, 1975).

The Norway spruce (*Picea abies*) is another type of tree in which humans have influenced the distribution patterns. This tree can be found mixed in with the cembra pine and larch in the Endagine region. Originally, the tree only occurred in subalpine areas. By looking at the genetics of the tree, researchers found that the spruce immigrated from the south across the Maloja Pass and Sils, in the Upper Engadine
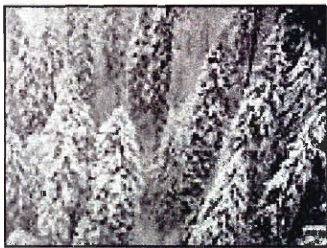
region. It is evident that this is due to human influences, because the tree is missing in between the Maloja Pass and the Sils (F. Gugerli, personal communication, November 5, 2001).

Normally seen in the northern Alps, the spruce takes on an adapted form in areas where the snowfall is great. Because of the harsh conditions at high altitudes, this tree does not grow as fast, causing the trunk to be slightly thinner. Also, the branches are shorter, which helps the tree when snow accumulates on it (Swiss National Park, 2001).

The dark evergreen needles of the Norway spruce are arranged individually around the branches; after six years, they fall off and are replaced. Norway spruce, like many other conifers, have cones, which serve to house the spruce's seeds. Before the seeds can be dispersed by the wind, they must ripen inside these cones. During autumn, the seeds are spread by the wind and the cones fall to the ground. Like the cembra pine, the seeds of the Norway spruce require very little light for germination and growth (Swiss National Park, 2001).

The spruce has now become one of the more important trees in the Alps. These fast-growing trees have been planted near alpine villages and roads to help prevent the formation of avalanches (F. Gugerli, personal communication, November 5, 2001). Also, because Norway spruce grow relatively straight and have a fast growth rate, they are often used for timber (Swiss National Park, 2001).

The mountain pine (*Pinus mugo*) is another tree that has successfully populated the land that was once scarred by the numerous clear cutting activities of the past. Mountain pine is an interesting species because it has two growth forms. One form is the erect mountain pine, a straight tree that is more prominent in the western Alps. Their hook-shaped branches easily distinguish this

type of mountain pine from the cembra pine (Swiss National Park, 2001).

Moving east, the mountain pine transitions to a reclining form. This tree's size

ranges from a bush to a normal tree, and grows at a bend. The branches are close to the ground and curl upward towards the ends. In the west-east transition zone, it is common to see a reclining pine that suddenly shoots upwards, taking the shape of the erect mountain pine (Swiss National Park, 2001).

The reclining mountain pine is an especially important tree species, because it grows on the steep slopes of avalanche regions. This type of tree is the perfect growth form for avalanche zones because its style enables it to survive. Instead of being ripped from the ground like erect trees, the snow goes over their tops, increasing their chance of survival (F. Gugerli, personal communication, November 5, 2001).

Another form of vegetation that can survive in avalanche regions is the green alder (*Alnus viridis*). Unlike the spruce tree, the stem of the green alder is very flexible which allows them to bend under the forces that avalanches can exert. Spruce trees are more competitive than green alders, but the green alder will dominate the spruce tree within active avalanche zones. This is because the spruce trees are continuously destroyed. The stem of spruce trees is very stiff, and thus easily broken by avalanches. Over time the spruce trees will take over the green alder if they are not destroyed by avalanches (F. Schweingruber, personal communication, November 11, 2001).

After an avalanche has taken place, there is a tremendous amount of pressure exerted on the surviving trees. Some trees can be knocked over and still survive. When this happens, the lower side of the trunk forms extremely dense wood as a result of being pushed over during an avalanche. This type of wood is called compression wood. A cross section of a tree that was partially knocked over in an avalanche would show that compression wood is the dark brown area that is formed on the lower side of the trunk. We can date avalanche events by counting the number of rings between the bark and the first ring of compression wood. The cell walls within the compression wood are much thicker than the cell walls of other trees,

and as a result this dense wood is much stronger than many other types of trees (F. Schweingruber, personal communication, November 11, 2001).

Hazards such as avalanches are just one of the conditions that alpine forests must face. Hazards can govern where specific species are located within the alpine forests. The specific traits of individual species help them endure these harsh conditions.

Frost is capable of damaging wide spread areas of vegetation. Depending on the time of year and the magnitude of the frosting, new growths as well as established growths are susceptible to being damaged by frost. Full-grown trees and small bushes alike must be able to deal with this demanding condition (F. Schweingruber, personal communication, November 11, 2001).

Frost usually damages vegetation in spring. This damage goes unnoticed, for the most part, because the damage is on a microscopic level. Frost can cause a discoloration similar to other colors that can be seen in springtime. Only a trained eye can tell the difference between frost damage and new spring colors. Because new growth is far more sensitive than established growth areas, frost typically damages and kills the younger sprouts. By looking at a microscopic view of tree cells that have been damaged by frost we can see that the new softer cells have been crushed after they died. The new growth that dies is typically replaced within the same vegetation period. This means that the frost has not prohibited the growing organism to produce new growth within the same season (F. Schweingruber, personal communication, November 11, 2001).
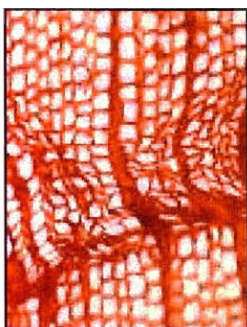
On a greater scale, heavy winter frosts can cause trees to split all the way up the side of their trunk. This type of damage is far more noticeable to the naked eye because it alters the permanent physical structure of the tree. Sometimes the frost actually makes its way into the center of the trunk. After a heavy winter frost has damaged a tree, the scar can be seen for many years (F. Schweingruber, personal communication, November 11, 2001).

The Alps create many landscapes where falling rocks have a considerable impact on their surroundings. Because the main shoots are continuously destroyed, the types of trees that can survive in rock fall zones are small and have small bush-like forms. The shoots that get destroyed are replaced by numerous secondary shoots (F. Schweingruber, personal communication, November 11, 2001).
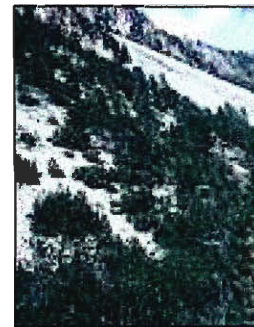
Full size trees are able to grow where rock fall is present but not frequent. The trees in this region cope with falling rocks differently. When a rock hits a tree the cells located at the point of impact die. This makes the tree vulnerable to becoming infected by fungi present in the environment. The tree defends itself against fungi
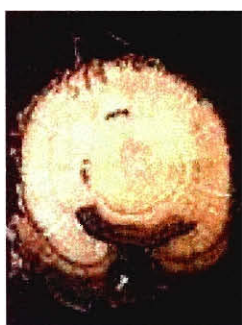
using chemical barriers. These chemical barriers do not kill the fungi but prevent it from spreading into the sides and middle of the tree. New growth is able to grow around these dead cells and eventually completely encompass the dead region. It may take many years for a damaged tree to fully recover. By looking at a cross section of a tree and counting the rings, we are able to determine when it was hit by the rock, and how long it took for the tree to fully recover (F. Schweingruber, personal communication, November 11, 2001).

In an effort to emphasize the beauty of these environments in our web site, we are featuring some alpine flowers. Alpine flowers are unique due to their ability to thrive not only in special soils, but also at high altitudes. Approximately one third of all alpine plants grow only in basic soil, which contains high levels of limestone rock. Another third of all alpine plants grow only in acidic soil, which contains silicates (F. Schweingruber, personal communication, November 11, 2001).

The Edelweiss (*Leontopodium Alpinum*) can be found on rocky limestone hills in the alpine regions between 1800 and 2500 meters. The Edelweiss is a small white flower that is about 3 to 20 centimeters tall. For the most part, this flower is symmetrical and has between 5 and 15 white leaves. The leaves of this plant have a very distinct look and shape. The entire plant is covered by tiny hairs, which can be seen around the edges of the white leaves. These hairs prevent the flower from drying out. The green leaves are about 8 millimeters wide and 5 centimeters long. The flowering center of the plant is yellow in color having a 1-millimeter long fruit (W. Frey, personal communication, November 18, 2001).

The Gentian family has a brilliant blue color that makes it stand out where

ever it is. The *Gentiana kochiana* can be found in meadows or pastures in the sub-alpine to alpine regions, which is an altitude between 1800 to 2500 meters, where there is no limestone. The green leaves of this plant grow at the base of the stem in the shape of a teardrop. The bell of this flower has green dots and stripes along the sides, which differentiates it from its close neighbor, the *Gentiana clusii*. It can be seen blooming in the middle and southern regions of

Switzerland from May to August (W. Frey, personal communication, November 18, 2001).

The major difference between the *Gentiana clusii* and the *Gentiana kochiana* is that the *Gentiana clusii* grows only where there is an abundance of limestone, which is completely opposite of its close neighbor. *Gentiana clusii* also blooms from May to August in sub-alpine and alpine altitude regions. A closer look at this flower reveals the flowering center and the depth of the bell. Unlike the *Gentiana kochiana*, this flower does not have the olive colored stripes and dots near the top (W. Frey, personal communication, November 18, 2001).

Another flower in the Gentian family is the *Gentiana verna*. The name of this flower translates to Spring Gentian. The *Gentiana verna* is a delightfully colorful member of the Gentian family. Like the *Gentiana kochiana*, it is abundant in areas with a high concentration of limestone. The *Gentiana verna* can be found in clusters all over Switzerland in the montane and subalpine altitudes. This flower blooms between April and July, which is slightly earlier than the rest of its relatives (W. Frey, personal communication, November 18, 2001).

The *Ranunculus glacialis* translates to glacier buttercup. This flower is able to grow in the alpine region above 2300 meters in regions of heavy snowfall. This flower generates 1 to 5 stems per plant and grows between 5 and 15 centimeters tall. It can be found on the side of glaciers where all of the rocks have been deposited. The *Ranunculus glacialis* can be seen in bloom between July and August. The blossoms start white and then often turn a pinkish-red color as they get
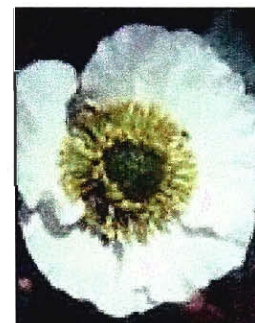
older. The width of this bloom is about 2-3 centimeters (W. Frey, personal communication, November 18, 2001).

The Latin name *Rhododendron hirsutum* translates to hairy alpine rose. This plant likes to grow in regions that are rich in limestone above 1500 meters in montane to subalpine altitudes. The leaves are green on both sides, but happen to be lighter on the topside. The bright red flowers can be seen from May until July in the central alpine region of the Switzerland. A closer look at this plant reveals that there are small 1-millimeter hairs at the edges of the leaves, with longer hairs at the base of the flower (W. Frey, personal communication, November 18, 2001).

The *Rhododendron ferrugineum*, rusted leaf alpine rose, is very similar to the hairy alpine rose. This plant gets its name from the rusty brown color on the underside of the leaves. The leaves of the *Rhododendron ferrugineum* have small brown dots on the underside of them. The topside of the leaves are shiny and do not have any hairs. The rusted leaf alpine rose differs from the hairy alpine rose because it does not grow where there is an abundance of limestone, and grows slightly taller than the hairy alpine rose. This plant can reach a height of 1 meter, where as the *Rhododendron hirsutum* does not grow as tall. This flower blooms from June to August, which is slightly later than its close relative (W. Frey, personal communication, November 18, 2001).

The *Soldanella alpina* can be found in mid to southern European mountains, in the sub-alpine to alpine altitudes. This plant grows only where there is plenty of moisture. The

Soldanella alpina is a special alpine flower because it is one of the few flowers that can be seen blooming within a couple of days after the snow completely melts. The *Soldanella alpina* develops 2 to 3 violet colored blossoms per stem growing to a typical height of 4 and 10 centimeters. These blossoms are usually 1 to 1.5 centimeters long with slits that run up the side of the blossom (W. Frey, personal communication, November 18, 2001).

Soldanella pusilla translates to delicate Soldanella. This flower will not grow where there is an abundance of limestone due the rock's chemical influence on pH of the soil. This flower can be found in the sub-alpine and alpine altitudes where snow covers the ground for long periods of time. The *Soldanella pusilla* has 1-2 blossoms per stem and is slightly smaller than its close relative the *Soldanella alpina*. The *Soldanella pusilla* is capable of sprouting even before the snow cover has completely melted. One of the major differences between the *Soldanella pusilla* and the *Soldanella Alpina* is the blossom. The *Soldanella Pusilla* has much shorter slits in the side of it. The blossom has more of a long bell shape as a result of these shorter slits (W. Frey, personal communication, November 18, 2001).

2.2 Wildlife

By clearing the land of forests, humans also affected the wildlife that lived in these regions. One animal that suffered greatly from this deforestation was the lynx (*Lynx lynx*). During the 19th century, the lynx became extinct in Switzerland. Clear-cutting of the forests took away the natural habitat of the lynx and

also the habitats of its prey, the roe deer and chamois. Because the numbers of roe deer and chamois were also declining, the lynx started preying on the sheep of the villages. As a result, the sheepherders hunted these lynxes because they considered it to be a competitor, preying on the same things that the villagers needed (Swiss National Park, 2001).

Although the lynxes became extinct in the Switzerland, they did exist in the western regions of the Alps, which helped during the reintroduction projects of the 1970's. During this time, several lynxes were released into the Swiss National Park; however, since 1982, there has been no evidence of their existence in this region. Through observations, researchers have found that these lynxes migrated to the forests of the neighboring Engadine Valley and Val Müstair (Swiss National Park, 2001).

The lynx is an animal that belongs to the cat family. Because of their alpine habitat, they have become well adapted to their environment. Lynxes are approximately 1 meter long, from the head to the beginning of the tail and 55 centimeters from ground up to the shoulder. Their long legs help them to run in deep snow and their light brown, spotted fur helps them to blend in with trees and bushes when they are hunting (Swiss National Park, 2001).

When on the hunt, the lynx will sneak around behind trees or wait in tall grass for the right time to jump out. To prevent their prey from escaping, the lynx will first aim to bite the animal's neck. This animal consumes about 1.5 kilograms of meat per day, which is equivalent to about 60 roe deer or chamois per year. Occasionally, they will eat sheep, which causes a problem for the farmers. Even though the lynx is a protected species in Switzerland, poaching is still widespread (Swiss National Park, 2001).

Residing in an area of approximately 100-400 square kilometers, the lynx is only territorial within its boundaries, which are usually anywhere from 50-200 square kilometers. In this territory, they live alone. However, sometimes the territories between males and females overlap. This allows them to meet for possible mating. In Switzerland, there is usually about one lynx per 100 square kilometers (Säugetiere der Schweiz, 1996).

Mating takes place in the beginning of March, and ends in early April. About 70 days later, between one and four kittens are born in a secure, hidden place, such as under a fallen tree or near rocks. When the kittens are 10 months old, they leave their mother's territory and look for their own. At this time, the kittens are in a sensitive state because they usually walk up to 100 kilometers before they find an unoccupied territory. During this journey, it is common for these sub-adult lynxes to die, for example, either because they are hit by an automobile or because of starvation. Usually, only one out of ten young lynxes finally succeed in establishing its own territory (Säugetiere der Schweiz, 1996).

Like the lynx, the bearded vulture (*Gypaetus barbatus*) was another animal that people ceaselessly hunted. The bearded vulture was originally located throughout the mountainous regions of Europe, Africa, and Asia; however at the beginning of the 19th century, it became extinct in the Alps (Pachlatko, 2001).

Bearded vultures are quite large, weighing between 4.5 and 7 kilograms. With

a wingspan between 2.3 and 3 meters, the largest bird in Europe was known as the "Lämmergeier" which translates to "the lamb vulture." According to historical documents, the early mountain people believed that the birds stole their sheep and carried them off to devour them. People also believed that these birds were

kidnappers of their children. These stories are doubtful because the bearded vulture can hardly carry more than 2.5 kilograms (Pachlatko, 2001).

The bearded vulture disappeared from the Alps mostly due to human influences. People would hunt the bird and make them into prized trophies. As the population of bearded vultures declined, the price that people would pay for the trophies increased. Also, because the forests were hunted and cleared for farm and pasture lands, the populations of other species were affected as well. The bearded vulture suffered because its food supply became scarce as the numbers of ibex, chamois, and red deer declined (Pachlatko, 2001).

The bearded vulture still existed naturally in the Pyrenees, as well as in parts of Africa and Asia; however their numbers were declining there as well. During the 1920's, some people advocated for a reintroduction; however, a project did not start until the 1970's. Specialists from Germany, France, Italy, Austria, and Switzerland came together with the WWF (formerly known as World Wildlife Fund) and IUCN (The World Conservation Union) to reestablish the bird in the Alps. The release of these birds into the wild has been a success and is something that has gotten quite a bit of media attention (Pachlatko, 2001).

It is easy to distinguish the young from the adults; however, males and females generally look the same. The young are a brown-gray color from head to tail and as they mature, their head and chest become paler. Because the birds bathe in pools rich in ferric oxide, adult bearded vultures eventually develop a reddish color on the neck and under parts of their plumage (Swiss National Park, 2001).

The bearded vulture is not adapted to catching prey; rather it feeds on carcasses of ungulates, particularly the bones. These birds prefer the bones because of their high fat and protein content. The bird's gastric juices are able to dissolve the bones, allowing them to swallow bones up to the size of cow vertebra. However, if the bones are too large, the bearded vulture will fly 50 to 80 meters above flat rocks and drop the bones, causing them to splinter (Swiss National Park, 2001).

The forests are also home to one of Switzerland's most fascinating animals, the chamois (*Rupicapra rupicapra*). Although they resemble the alpine goat, the chamois possess many characteristics that allow them to traverse mountain environments that are inaccessible to goats.

The chamois are characterized by a white 'face-mask' and relatively thin

horns, which curve backwards at the tips. It is not easy to distinguish the female chamois from the males, because both have horns. However, the horns of the females are somewhat thinner and not as curved compared to the males. Unlike the antlers of animals such as the red deer, the horns of the chamois grow continuously (R. Fankhauser, personal communication, November 26, 2001).

Strong legs, good-gripping hooves and very good eyes are adaptations to the mountain habitat. Combined with muscular strength and agility, chamois possess extraordinary jumping capabilities. They can reach elevated grazing beds, and ascend steep cliffs (Maeder, 1975).

The chamois are also well adapted to the changing seasons. In the summer, their coat is light brown to yellow-gray. As winter approaches, their coat turns dark brown. However, there are stripes of fur on the animal that do not change with the seasons. Stripes from the mouth to the ear, on the back, tail, and legs, remain dark

brown to black all year round (R. Fankhauser, personal communication, November 26, 2001).

Around the months of May and June, the female chamois gives birth to one or two young. Just a short time after birth, the young chamois are able to follow their mother even in steep terrain. The young and mother live in groups of changing size and composition. These groups consist mainly of the females, yearlings and kids. Normally, the kid will closely follow its mother; however, when in these groups, it is almost like 'kindergarten.' A group of kids stay and play close to one female while the other mother chamois graze at a slight distance (R. Fankhauser, personal communication, November 26, 2001).

While young males often live in small groups during summer, the older males normally live alone. In order to communicate with the other males, the chamois uses his scent. By rubbing his horns on branches and twigs, the male deposits a musk-smelling secretion from glands situated behind his horns. The purpose of the scent is to allow individual recognition by other males (Swiss National Park, 2001).

During the rutting season, which usually occurs in November and December, the males join the female groups. By showing off, they try to get the females to leave the group. However, their impressive behavior may lead the chamois to attack intruding males. The fights among males often look fierce and dangerous, but these interactions usually do not cause serious injuries to the opponents (R. Fankhauser, personal communication, November 26, 2001).

The ibex (*Capra ibex*), like the chamois, is also an ungulate that lives in the Swiss Alps. However, at one point in history, this species became extinct in Switzerland. Thanks to reintroduction projects, the ibex once again inhabits the Swiss Alps.

Human influences caused both the extinction and the reintroduction of the ibex in the Swiss Alps. Early mountain people used to hunt the ibex because the horns and flesh were used for medicinal purposes. The ibex were fiercely hunted and by 1650, they had been exterminated from the Canton of Graubünden (Swiss National Park, 2001).

At the beginning of the 20th century, some Swiss took it upon themselves to reintroduce the ibex in the Swiss Alps. They stole two ibex from the last remaining colony, which existed in the Gran Paradiso resort supervised by the Italian king, Vittorio Emmanuele. These ibexes were successfully smuggled through the mountains into Switzerland. From the two, a successful breeding occurred in 1906 at the wildlife enclosure "Peter and Paul," near the city of St. Gallen (K. Hindenlang, personal communication, November 27, 2001).

The first ibexes descending from this breed were released in 1911 in the federal hunting resort, Graue Hörner, located in the canton of St. Gallen. Further releases occurred in 1914 and 1921 in the canton Graubünden. A successful breeding from the wildlife zoo, Harder, in the Bernese Mountains were released into the Swiss National Park in 1920. As a result of these releases, many ibex colonies developed in the cantons of St. Gallen, Graubünden, Berne, and Valais. This reintroduction can be judged as a success because over 14,000 ibex currently exist in Switzerland (K. Hindenlang, personal communication, November 27, 2001).

From the head to the beginning of the tail, the ibex measures between 115-170 centimeters long and weighs 35-150 kilograms. Generally, the females are smaller and lighter than the males. Like the chamois, the ibex have horns that grow throughout their entire life; however, growth slows after they are 4 or 5 years of age.

The horns of the males are up to 1 meter long, and every year, 1-3 new knots form. By examining the rings on the back of the horns, it is possible to determine the age of the ibex. Because females only have horns up to 35 centimeters in length, it is more difficult to determine their age because the rings are closer together (Säugetiere der Schweiz, 1996).

During the mating season, which is in December and January, the ibex live in mixed groups; however, throughout the rest of the year, the males usually live alone or with other males. These male herds consist of a hierarchy dominated by the strongest ibexes. The status of the male depends on age; the older, more dominant males possess bigger horns, and therefore lead the group and also mate with the females. To determine their status, they fight with each other. Because these fights are a ritual, the ibex rarely get hurt. When fighting, they stand on their hind legs, bashing their horns into each other until they fall back to the ground (Säugetiere der Schweiz, 1996).

When courting, the male will sniff the air to pick up the female's scent. Because his horns are very intimidating, the male must tilt his head back so his horns lie flat. About 170 days after mating, the pregnant females retreat to the steep, rocky terrain and give birth to one, rarely two young. Shortly after birth, the young ibex follow their mother through the rough terrain of the mountains (Swiss National Park, 2001).
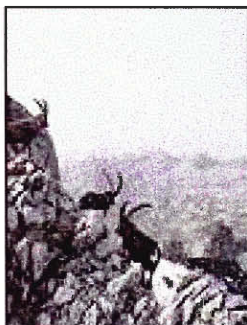
The ibex live in steep, rocky terrain usually between 1,600-3,200 meters. They feed mainly on grass and during the winter, they must dig or find places that are free of snow. Avalanches expose possible grazing areas; however, if the ibex are digging on a snowy slope, they have the potential to cause an

avalanche. During February of 1999, several dozen ibex were the victims of an avalanche in Trupchun Valley of the Swiss National Park, which is located in the canton of Graubünden (Swiss National Park, 2001).

Like the chamois and ibex, the red deer (*Cervus elaphus*) is another hoofed animal that resides in the mountainous regions of Switzerland. Before humans inhabited the Swiss Alps, red deer used to live in forests along the flood plains of the rivers, moving to the higher alpine regions during the summer. However, as more humans came to live in the Alps, the red deer were forced to leave their natural habitats. By 1850, they were almost extinct, but reimmigrated from Austria to the eastern parts of Switzerland through the Canton of Graubünden. Although the majority of red deer reside in the eastern regions of Switzerland, reimmigration is continuing to expand the populations to other areas of the Swiss Alps (Säugetiere der Schweiz, 1996).

The red deer is called the king of the forests because of its large size and strength. Its height, from the shoulder to the ground, ranges between 1 to 1.5 meters and its length is 1.9 to 2.5 meters from the head to the beginning of the tail. Males usually weigh around 200 kilograms, while the females weigh approximately 100 kilograms (Säugetiere der Schweiz, 1996).

Like the ibex and chamois, the red deer live in herds. Theses herds usually consist of the mothers, calves and yearlings. From generation to generation the herds can grow; however, they do not have to stay together. The stags, especially the younger ones, live in so called "bachelor herds." In winter, stags and hinds are often seen together in one herd (B. Schielly, personal communication, November 26, 2001).

27

The male deer or stag has antlers. At the end of each winter, their antlers fall off and regrow between March and July. During this time, a velvet-type substance covers the new antlers, which is a soft, blood-filled, bone-forming tissue. Once the antlers have grown to their full size, the velvet sheds. The deer help facilitate the shedding by rubbing against trees and bushes, which often gives the antlers a brown tint (Swiss National Park, 2001).

The antlers of the stags form during the second year of their life and serve both to impress and fight. During rutting season, which occurs during the months of September and October, the older males separate themselves from the rest of the bachelor herd. Fighting takes place between the stags to claim their hinds, or to defend their mate from other males. These fights are not often real fights with injuries and deaths; rather the purpose is to cause the rival to run away. The winner is not necessarily the stag with the bigger antlers, but rather the one that is more fit. During rutting season, the males collect as many females as possible and try to impress them by making loud noises. They compete against each other, because mating is only possible if the female agrees (B. Schielly, personal communication, November 26, 2001).

The red deer is well adapted to its living space in the Alps. Because of these different adaptations, they are able to survive the harsh winters of the Alps. They migrate from their higher, summer habitats to the milder valleys where they spend their winters. During this season, their coat is twice as long as their summer coat. Also, because they eat almost every kind of plant, grass and leaves, it makes it easier for them to find food. Nevertheless, there have been winters in the past when even the red deer, Switzerland's largest ungulate species, struggled for survival (B. Schielly, personal communication, November 26, 2001).

One example is the harsh weather that occurred during the winter from 1998 to 1999 in the canton Glarus of eastern Switzerland. Many red deer individuals died in massive avalanches. Also, because of the significant amounts of snow, many got stuck and almost starved to death. Fortunately, game wardens rescued many of the weakened deer. The wardens fed the deer and cleared paths to guide them to better places. Through this, we can see that in such harsh weather, even the red deer with its great adaptability can be overtaken by the harsh conditions of the Swiss Alps (B. Schielly, personal communication, November 26, 2001).

Up on the highest alpine slopes, where trees and brush no longer grow, one may find a short-haired furry animal called a marmot (*Marmota marmota*). Resembling a squirrel, this animal is Switzerland's largest rodent. Depending on the season, marmots weigh between 3-6 kilograms. The body is approximately 45 to 58 centimeters in length, while the tail is between 14 and 20 centimeters (Säugetiere der Schweiz, 1996).

During the summer months, the marmot survives by eating grass and blossoms of small alpine plants, particularly the alpine clover. Because there is only a short time period in which they can feed, it is essential for the marmots to eat food that has a high content of unsaturated fats, allowing them to build up their reserves for the winter. During this time, they eat between 1-1.5 kilograms per day and usually gain about 25 grams of body weight per day (Säugetiere der Schweiz, 1996).

Often, the marmots have one burrow for the summer and one for the winter. The summer burrow is used mainly for protection from their foes, such as the golden eagle. The moment they sense danger, they quickly scurry to the confines of their

burrow. It is not unusual for the marmots to have burrows that are up to 20 meters long and 3 meters deep (Swiss National Park, 2001).

In the winter, the marmot lives an underground life. For six months, they hibernate in a deep hay-lined burrow, which protects them from the harsh weather. According to an old fable, the marmots load the hay on the belly of one and then another marmot drags it by the tail into their winter home. Supposedly, this is what causes the marmot to have rough, coarse hair on its back. When their hibernation ends, the marmots come out of their burrows, look around, and do a few somersaults to stretch after their long winter rest. Through this fable, the Swiss can explain what they have witnessed in the mountains (Maeder, 1975).

Hibernation begins when the marmots' instincts take effect, which is independent of weather conditions. In general, they hibernate as a family to share body warmth because the young would not have enough energy to hibernate alone. During hibernation, the animal looses up to 30-50% of its weight. Hibernation ends in mid-April, when mating season begins. After about 34 days, between 2 and 7 marmots are born per litter. The litter stays in the den for 40 days until they are no longer blind, naked, and deaf (Säugetiere der Schweiz, 1996).

One important social aspect for the marmot is family, which consists of a

mother, father, and several young from previous litters. Mutual sniffing and play-fighting are forms of social contact between the family members. With the aid of scent glands in their cheeks, they can recognize one another, and also use their scents to mark their territory. If an outsider's scent is smelled, the intruder is quickly chased away (Swiss National Park, 2001).

When the marmot is not hibernating, it serves as a source of food for one of the largest birds of the Swiss Alps, the golden eagle (*Aquila chrysaetos*). With a wingspan of approximately 2.2 meters, the king of the air originally populated the central European region. However, because of its size and beauty, humans hunted the bird for many generations. At the beginning of the 20th century, the number of golden eagles was so low that they were on the verge of dying out. With the help of strict protection measures, the golden eagle was able to escape extinction (Swiss National Park, 2001).

Today, these magnificent birds can be seen particularly in the Swiss National Park. These birds are extremely territorial and often times they will have several nests within its territory, which is on average, about 50 square kilometers. Although the golden eagles no longer have any natural enemies, researchers have found that their numbers have not increased. This is due to the fact that the territories of the birds are so large. If the numbers were to increase, it would mean that there would be a greater number of birds soaring through the available airspace, causing an increase in competition. The adult golden eagle would have to leave its nest to protect its territory, which has a negative effect on the bird's young (Swiss National Park, 2001).

The golden eagles mate during January, and the eggs are not laid until April. After the chicks hatch in May, the stronger one ends up throwing his sibling out of the nest. This is nature's way of ensuring a back up, should something go wrong with the first (Swiss National Park, 2001).

The golden eagle mainly preys on marmots but will also strike grouse and mountain hare. Just before the eagle attacks, it gets into position by downwardly

extending its talons, or claws, and quickly swoops in to grab its prey. During the winter months when the marmot is hibernating, the eagle mainly feeds on ungulate carcasses; however, the bird will also prey on weak and insecure animals, such as the young of the capercaillie (Swiss National Park, 2001).

The capercaillie (*Tetrao urogallus*) is a bird that requires a large, uninterrupted habitat. Because of their high ecological demand, the coniferous forests that these birds inhabit must be well structured. Coniferous trees of all ages scattered with open spaces as well as a lush ground covering of ericaceous shrubs is the ideal habitat of the capercaillie. This environment provides the bird with protection from predators as well as an ample source of food (R. Graf, personal communication, November 23, 2001).

The male capercaillie appears to be a large turkey-sized, dark slate-gray bird; however a closer look reveals much more detail. The chest feathers have a hint of

metallic green, while the backside, wings and tail are chocolate colored. Along with a crimson color above the eyes, the male capercaillie also has some white markings on its wings and tail. The male is actually the largest member of the grouse family, weighing 4 to 5 kilograms (Trees for Life, 2001).

In comparison, the female is much smaller, weighing about half the weight of the male. The hen's dark brown plumage mixes with reddish brown feathers that blend with a chestnut

breast dotted with white. Although she is less colorful than her mate, her camouflage helps her to blend in with the surroundings when sitting on her eggs or looking after her brood, or young (Trees for Life, 2001).

The plumage of the capercaillie allows them to survive through the harsh winters. On the backside of each feather, smaller feathers exist, which insulate the bird. They also have feathered nostrils to warm the air as they breathe and feathered spikes on their feet to act as snowshoes (R. Graf, personal communication, November 23, 2001).

During the mating season, the older male capercaillies display themselves to defend their territories from the other males. Depending on the weather conditions and the height above sea level, the time of display normally takes place in March and lasts until May. While chanting, the male lifts and spreads his tail into the air, slightly lowering his wings and his neck. He then sticks out his breast feathers, exposing his white shoulder patches. This special behavior also serves to impress the hens (R. Graf, personal communication, November 23, 2001).

Between early May and June, the female capercaillie lays between five and twelve eggs in a nest on the ground. The nest is usually surrounded by vegetation, which offers protection from predators, such as the golden eagle, that might be lurking from above. Once hatched, the chicks can only fly over short distances, making them easy prey. Because the male does not help the hen during this time, the hen must be very protective of her chicks. She keeps the chicks close to her, making muted contact calls. If a predator is near, the hen will draw attention to herself and pretend to be hurt. This will lead the predator away from her chicks (R. Graf, personal communication, November 23, 2001).

Chicks mainly feed on insects such as the caterpillars of moths and sawflies. After their first two weeks, they switch to the adult's herbivorous diet. The chicks live in flocks with their mother until autumn (Trees for Life, 2001).

During the winter season, the capercaillies feed exclusively on the needles of conifer trees, consuming approximately 110 grams of needles per kilogram of body weight. A male weighing 3 to 5 kilograms has to collect 400 to 500 grams of needles per day in order to have enough food to survive. This winter diet is very hard to digest. As a result, the digestion system of these birds is specialized. Strong stomach muscles along with grit serve to grind the food. They also possess very large intestines as well as a large appendix, which help them to get the most nutrition out of their food (R. Graf, personal communication, November 23, 2001).

The capercaillie is a highly endangered species in most areas of its central European range. During the transition from the 19th to the 20th century, a large number of capercaillie still existed in Switzerland. However, the last fifty years have shown a decrease in the number of capercaillie cocks, from about 1100 to 650-550. This trend is still continuing and the species has disappeared from several parts of its former distribution area. The capercaillie has become a highly endangered species in most areas of it Central European range (R. Graf, personal communication, November 23, 2001).

There are several reasons for this decline however the most important is the loss of suitable habitats. Many of the Swiss forests stem from lands that had been reforested and are now even-aged, dense forests. These environments cannot support the needs of the capercaillie. Additionally, most forests have been interrupted by forestry service roads. Over the last fifty years, there has been an increase in road building. This has provided easier access to the forests, resulting in an increase of human disturbances. Mountain biking, hiking, and snowshoe hiking are activities that can have a negative impact on the capercaillie population and habitat (R. Graf, personal communication, November 23, 2001).

The capercaillie acts as an umbrella species. An umbrella species needs a large expanse of habitat and can therefore be seen as a surrogate for many other species. When the capercaillie's habitat is protected, many other species benefit because they reside in the same habitat. Capercaillies are a good umbrella species for mountain birds such as the three-toed woodpecker, the Pygmy owl, and the woodcock. Like the capercaillie, these birds are rare and have a place on the Red List of threatened animals in Switzerland (R. Graf, personal communication, November 23, 2001).

2.3 Mountain Environments

The wildlife that live in these mountainous regions are greatly affected by the mountain climate. One factor of climate that plays an important role is precipitation. Precipitation is the most important element of the hydrologic cycle, which is the transport of water between the earth, atmosphere, and the seas. The amount of precipitation in the Alps effects the vegetation cover, the shape of the landscape due to erosion, is the cause of natural disasters such as flash floods and landslides, and also provides people with freshwater resources from runoff and snowmelt (Frei & Schär, 1998).

When analyzing the Alps, climatologists usually look at the mountain range as a whole. This range has two precipitation bands, which extend along the northern and southern edges of the Alps, while the drier conditions exist in the middle of the mountain range. By looking at the maps of the different seasons of these regions, we can compare the differences of these wet bands (J. Schmidli, personal communication, November 5, 2001).

The northern alpine regions usually have the most precipitation during the summer months as a result of convection. As the air is heated by the landmass, it

becomes unstable, resulting in thunderstorm activity. Thunderstorms are much more frequent in summer because the landmasses are much warmer. Acting as a mixer, the warm air near the earth's surface rises and condenses, while cold air rushes down to replace the warm air that has risen. Also, because air temperatures are high in the summer, the atmosphere can hold much more moisture. When there is enough moisture in the air, precipitation occurs. For these reasons, summer is the season with the most precipitation (J. Schmidli, personal communication, November 19, 2001).

In contrast, the winter months have below average levels of precipitation. This occurs because in winter, the Alps lie under a high-pressure system for several weeks. This high-pressure system blocks the airflows from getting to the Alps; the airflows are redirected to go around the Alps. Also,

because the winter air is much colder, it can hold less moisture. As result, there is less precipitation during this season (J. Schmidli, personal communication, November 19, 2001).

The southern regions experience maximum precipitation during spring and

autumn due to moisture advection and convection from the Mediterranean Sea. The warm Mediterranean water, located south of the mountain range, evaporates into the air. Atmospheric airflows carry this moisture to the Alps,

causing heavy rainfall on the southern edge of the Alps during spring and autumn (J. Schmidli, personal communication, November 19, 2001).

Originally, it was thought that an increase in height implied an increase in precipitation. The research of climatologists shows that a simple precipitation-height relationship does not exist in the Alpine region. The weather system of the Alps is actually a complex interaction between the mountain range and how the air flows in the atmosphere. Data shows that precipitation levels depend on mountain topography, specifically the slope and the shielding effects that the mountains have (Frei & Schär, 1998). When there are atmospheric flows towards the Alps, the air is forced to rise or flow around the mountain range. When the air rises, condensation occurs, increasing precipitation. However, once a certain altitude is reached, the cold air has already lost a certain amount of water vapor. This decreases the amount of precipitation at these high altitudes (J. Schmidli, personal communication, November 19, 2001).
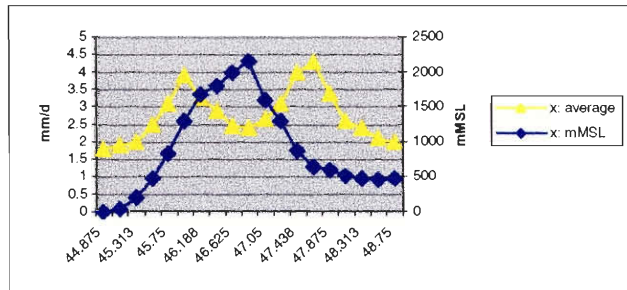
Acting as a climatic divide, the Alps also protect the southern regions from the cold air coming from the north. The shielding affect explains why there is a significant difference between the southern and northern regions of the Alps. The south resembles a Mediterranean climate, which is characterized by significantly higher temperatures and greater amounts of precipitation. On the other hand, the north is more of an alpine climate, with short, cooler summers and long, harsh winters (J. Schmidli, personal communication, November 5, 2001).

37

The presence of snow is fundamental at high altitudes and provides the essential ingredient for glaciers and avalanches. These three interrelated phenomena contribute much to the distinctiveness of the mountain landscapes. Snow is precipitation in a solid form and results from the freezing of super-cooled water around tiny particles of foreign matter in the air, such as clay particles. The principle form of a snowflake follows a hexagonal pattern and can be grouped into ten main types, which only apply to falling snow. When first formed, snowflakes are generally small and simple but can change and grow as they fall through elevations where temperatures are higher, thus providing more moisture. Once they hit the ground, their individual shape is lost as they become packed together. As a result, snow that is found on the summit of a mountain will be different from snow that has accumulated in the lower slopes (Price, 1981).

Snow that accumulates in alpine regions above 3000 meters will often form glaciers. At this altitude the temperature year round is almost always below freezing. This allows snow and ice to build up and compress into a moving block of ice, also known as a glacier. As the snow and ice ages, it becomes more compact. Eventually, all of the air is pushed out from in between the particles of snow, giving it a blue or greenish tone. This process takes several years, but once this compact stage is reached it is considered to be glacial ice (Price, 1981).

Alpine glaciers are an important part of mountain environments because they have a significant influence on their surroundings. As well as supporting various types of ponds, lakes, and rivers, glaciers greatly affect the earth that they traverse. Glaciers in the Ice Age are responsible for creating

many lakes, rivers, and geological features. As glaciers slowly slide along, they wear away at the earth (M. Latersner, personal communication, November 18, 2001). For example, small cirque glaciers, which once occupied isolated depressions in mountain slopes, leave behind semi-circular or bowl-like depressions. Where cirque glaciers existed on both sides of a mountain ridge, the glacial erosion created saddles and notches. This headward erosion is largely responsible for the rugged topography of glaciated mountains. Headward erosion of cirque glaciers on all sides of a summit results in a pyramidal peak called a horn. An example of this is one of the most famous peaks in the Swiss Alps, the Matterhorn (Price, 1981).

Because glaciers have many of the same properties as fluids, the speed of different glaciers can vary greatly. In Switzerland the slowest moving glacier is about 2-3 meters per year and the fastest moving glacier moves up to 150 meters per year. When glaciers are retreating, a lake is often formed between the end of the glacier and the pile of debris that the glacier has scraped up. (M. Latersner, personal communication, November 18, 2001).

As a result of different forces within the glacier V-shaped clefts, also known as a crevasses, are formed to relieve internal pressures. A crevasse zone in a glacier is also known as an icefall. Glaciers tend to move faster in steeper sections, so the ice becomes stretched and fractures, forming these crevasses (M. Latersner, personal communication, November 18, 2001).

Another example of a glacier is a valley glacier. A valley glacier is a massive stream of ice that extends down-valley for some distance. As a result of their great mass and erosive capacity, the glaciers deepened and widened the valleys causing

them to be U-shaped. People visiting the Swiss Alps can see the effects of valley glaciers in Lauterbrunnen, Switzerland (Price, 1981).

Along with glaciers, avalanches affect the shape and characteristics of the Swiss Alps. Switzerland is the home of many snowy peaks that create the perfect conditions for avalanches. Features such as slope angle and aspect, precipitation (snow and rain), wind, temperature, solar radiation, snow depth and snow layering all contribute to the formation of avalanches (J. Schweizer, personal communication, November 15, 2001).

Over the course of the winter, the type of snow that falls can vary as a result of the changing weather patterns. Each snowstorm creates a different layer within the
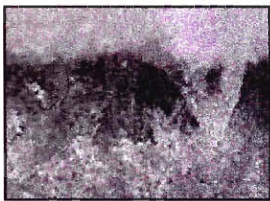
snow pack. After a layer is deposited, it begins to settle and transform. The speed at which these transformations take place can vary depending on the current weather conditions. Accordingly, different types of snow crystals that evolve within the snow cover have different mechanical properties. Large faceted crystals typically have a lower coefficient of friction than small rounded snow crystals, causing there to be very distinct layers within the snow pack. As a result, weaknesses about 1 centimeter thick form within the snow pack. Large surface frost crystals (in the middle) form a fragile connection between two snow layers. The interaction between these layers is crucial for understanding how avalanches are created (J. Schweizer, personal communication, November 15, 2001).

The two general types of avalanches that occur in the mountains are called loose snow avalanches and slab avalanches. Loose snow avalanches start at a single point with a small amount of snow. The snow starts rolling and as it continues down the mountain, it gains speed and size, spreading outward from its original path.

40

Because these types of avalanches usually involve a smaller amount of snow, they only scratch the surface of the snow cover (McClung & Schaerer, 1993).

The slab avalanche tends to be a more dangerous form of avalanche, affecting a much greater path on its way down the mountain. Slab avalanches develop due to a combination of high stresses and weaknesses located within the snow pack. When the force pulling the snow down (stress) exceeds the force of static friction holding the snow in place (strength), an initial failure forms. The failure might propagate and eventually the whole slab is released. An unsuspecting skier can unintentionally cause an existing weakness to fracture and release. Avalanches can involve massive amounts of snow that flow downhill like rivers, particularly if the snow is moist or wet. These kinds of avalanches, occurring mainly in the spring, can run for long distances. This deposition of a wet snow avalanche looks like it would consist of snowballs (J. Schweizer, personal communication, November 15, 2001).
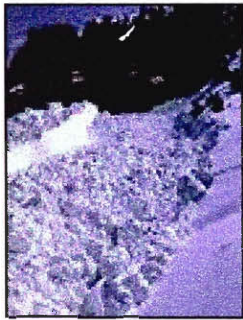
Avalanches can be dangerous to backcountry skiers who like to ski in fresh snow. In ski areas, particularly after any major snowfall, avalanches are triggered by explosives to prevent them from occurring while people are skiing.

The harsh alpine climate, avalanches and other physical aspects of the Alps make this a difficult environment for living things. The mountains are not only home to plants and animals, but also the home of human beings. For many centuries, people have inhabited the Alps and have used the resources that these mountains provided them. However, not everyone has always viewed these mountains in a positive light.

41

2.4 Early History

Over time, peoples' views have governed how they interact with the mountains. The early mountain dwellers relied on the resources that the mountains provided to aid in their survival. People could not import materials from the Mittelland, so they used the available material to build their houses. Because the people relied on the resources that the mountain regions provided them with, these settlements developed according to what the mountains limited them to.

There is evidence that the first shelters in the mountains were established approximately 6,000 years ago. These shelters are considered to be semi-permanent because the inhabitants had to relocate approximately every twenty years to avoid using up the resources in that area. However, permanent settlements can be traced back to 1,000 A.D., when there was alpine population growth. Since then, the Alps have become the most populated major mountain range in the world (J. Mathieu, personal communication, November 6, 2001).

Up until and all the way through the French Revolution, mountain people used the available resources near their villages to build their homes. Many homes were made of wood and stone. Because stone was durable and more luxurious, it became a desired material. Stone houses were a symbol of status, a sign of power and money. Over the years, more stone houses were built. These stone houses had to be built in the right places to ensure that the moisture and temperature were not at extreme levels (J. Mathieu, personal communication, November 6, 2001).

The locations of almost all early alpine settlements were quite specific. Because of the harsh winters, people relied heavily on the sun for warmth. As a result,

many settlements developed on the south-facing slopes, where the snowmelt was considerably earlier than the opposite mountainsides. These slopes were warmer because they received greater sun exposure, as a result of the Alps being located in the Northern Hemisphere. Alpine villages were also located part way up the foothills and mountains to avoid the swamps that formed as the snow melted in the spring. The highest settlement prior to the 19th century was recorded to be 2,000 meters, although it was unusual to find one above 1,500 meters (J. Mathieu, personal communication, November 6, 2001).

Depending on which mountainous region these settlements were founded in affected how the people lived and how they built their houses. Very high mountains and deep valleys characterize the inner Alpine region. Because of the topography, traveling to outside villages was difficult, which limited trade. As a result, the farmers had to grow many different things at the same time. In the valleys there would be vineyards, the cattle would graze in the forests, and the wheat would be grown on the slopes that were cleared of the forests (A. Schuler, personal communication, November 27, 2001).

The Engadine valley is part of this inner Alpine region. Originally, people built houses of wood with little stables next to the house. Because many people that lived here often went to Italy, they were influenced by the styles of the Italian houses. While in Italy, they learned how to make walls and other structures. When they came back to the Engadine, they built walls surrounding their already existing houses and stables. The designs seen on the front are a type of graffiti, with ornamental decorations and sometimes even elaborate paintings of mythical animals (A. Schuler, personal communication, November 27, 2001).
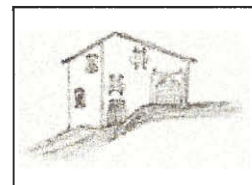
The inhabitants of the Engadine herded goats, cows, and sheep. They also grew cereals and rye on their terraced farmland. Because this was not a suitable environment for vineyards, they had to import wine from the southern valleys as well as from Italy (A. Schuler, personal communication, November 27, 2001).

Many "lombardia" houses characterize the southern Alpine region. This type of house refers to those that have sections, each with a distinct purpose. The different sections all come together with a courtyard in the middle. The buildings were usually made of stone, such as chalk (A. Schuler, personal communication, November 27, 2001).
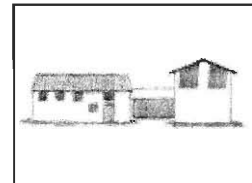
These groups of buildings were scattered throughout the village and were the homes of more than one family. Because farming was an important aspect of village life, the employees of the farmers may have lived with the families as well. One part of the complex would house the families. There was also a stable, which is where the families kept their cattle. Another building was used as an area to dry cereals and tobacco. These buildings had special openings to let the air flow in, which helped in the drying out process. The people in this region also grew chestnuts and had vineyards (A. Schuler, personal communication, November 27, 2001).

Houses in the northern alpine region were built of both wood and stone; the foundation was stone and the upper part of the house was wood. Originally, the roofs
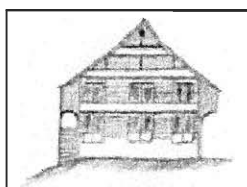
were made of overlapping wooden plates. The people would put stones on top of the wooden plates to make the roof sturdier. When the people wanted to make the house bigger, they just added onto the top. Usually, only one level was added, which gave the house a steep, sloping roof. Because the existing roof was relatively flat, a new roof had to be added

on. Eventually, new materials, such as brick and tile, made it easier to build these new roofs (A. Schuler, personal communication, November 27, 2001).

The villages in the valleys of this region received a lot of precipitation. Because of this, many soil nutrients were washed away, causing this to be an unsuitable region for farming. As a result, the villages relied greatly on cattle. From the cattle, they were able to export milk and cheese and import cereals from the Mittelland. In the fall, herders would travel to the Mittelland to sell large groups of cattle (A. Schuler, personal communication, November 27, 2001).

The Jura mountain region has an abundance of chalk, a geological formation. This stone was plentiful and many people built their houses from this material. Because there was not enough precipitation in this area, the houses were built with long, gently sloping roofs. When it rained, the people could collect the rainwater by means of collection basins. The people would store the water that they did not use (A. Schuler, personal communication, November 27, 2001).
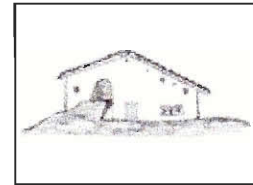
The early alpine villages did not have connections to the outside world. Modern transportation systems, such as the railway, did not yet exist, limiting trade between villages. Because of this, mountain people were very self-sufficient, producing mostly everything they needed to live (A. Schuler, personal communication, November 7, 2001). Subsistence farming enabled the people to live off a simple diet that consisted of bread, cheese, and potatoes, while meat was a rarity. With the help of trade, they were able to export mountain cheeses while importing iron, salt, wine, and clothing (Küchli, Stuber, & Zaugg, 2000).

The educational structures of these developing mountain communities can be first linked to the churches. It was common for the churches to require that everyone

be able to read the Bible. To facilitate this, reading and writing classes were offered within these churches. However, the Bible was not the only factor that influenced education; migration also helped educational structures to develop. If one wanted to move to a larger city, e.g. Milan, that person needed to be educated if they wanted to be successful (J. Mathieu, personal communication, November 6, 2001).

The first schools that did exist were held in low esteem. According to the primary school code for the canton of Bern, a survey in 1835 showed that school attendance was extremely low. Teachers were not well educated and could not be effective in the classroom. Also, the children had to complete their farm duties, which often took precedence over schooling. (Küchli, et al., 2000).

In order to enhance the teaching profession's credibility, the canton of Bern passed an education requirement for teachers. The law, passed in 1856, ordered that teachers could not be hired unless they were trained at a teacher training college. By also requiring them to pass a state examination, the education system was given a significant boost. This greatly improved the respect for the education system and also created more opportunities for women (Küchli, et al., 2000).

In general, a lack of education was the main factor that led to economic instability for some villages. People wondered how industry was to be promoted among an uneducated population. With the help from the law passed in 1856, improvements in the education system significantly impacted the economy. Dairy and trade schools opened, allowing the opportunities for apprenticeships to increase (Küchli, et al., 2000).

As the 19th century progressed, the railroad developed, creating a rapid growth within the consumer and commercial markets. The railroad allowed grain from America and Russia to be brought to Switzerland. Even though grain from these

countries needed to be imported, it was still cheaper to do so because these countries had much more available land. After a few generations, the Swiss mountain people ceased to produce grain because it was no longer worth the time and money (J. Mathieu, personal communication, November 6, 2001).

However, as these settlements were developing, the rest of Europe was developing as well. From settlements to towns to large industrial centers, populations increased at alarming rates. Throughout history, Europeans' views of the Swiss Alps changed from a lack of understanding and respect, to one of admiration and a feeling of exploration.

2.5 Historical Views

Unlike the early mountain inhabitants, outsiders, those who did not live in the mountains, possessed fears towards the Alps. Even during the times of the Roman Empire, people tried to avoid traveling in the Alps by going around them. People knew that traveling through the mountains was dangerous and even life threatening if unfamiliar with the terrain. Many people did not know for certain what existed in the mountains. The cloud-hidden peaks stirred mysterious feelings that caused people to create superstitions and myths. By telling these stories, people tried to explain what they did not know about the mountains.

No one explored the Alps for pleasure and understanding until the beginning of the Renaissance. People feared the mountains because they did not know enough about them. Mountains were viewed negatively and generally associated with storms, snow, strong winds, and the cold. Because clouds usually hid the peaks, a mysterious feeling of uncertainty was stirred. Travel in the mountains was difficult, unpleasant

47

and often avoided if possible. The medieval people paid little attention to the grander aspects of nature and had few favorable references to the mountains in either their art or literature. The favorable references that do exist are distorted by these negative views. For example, in many paintings of these times, the mountains are portrayed as dark mounds or wastelands (Price, 1981).

The mountains were a dangerous place. Medieval Europeans disliked traveling through them not only because of the risk of death, but also because of its unfamiliarity. This lack of knowledge facilitated many to believe the myths and stories that were told about the mountains.

One such tale is about King Peter III of Aragon (born 1236) who set out to prove it was possible to climb Pic Canigou – 2,785 m (9,135 ft.) – then believed to be one of the highest peaks in the Pyrenees. Resting by a small lake near the summit, he absently threw a stone into the water. Suddenly, "a horrible dragon of enormous size came out of it, and began to fly about in the air, and to darken the air with its breath" (Gribble, 1899). The full account may be found in Gribble's *The Early Mountaineers* (1899, p.16-17). Gribble concludes: "For many centuries after Peter's death, men of enlightenment believed in dragons as firmly as they believed in God."

There are many other popular myths that were considered to be common truths. One man claims that he witnessed hundreds of souls chanting and drumming as they marched through his small village in the middle of one winter night. The man claimed that the march lasted for an hour and that the participants ranged from skeletons to glowing figures. There were reports of lanterns lighting by themselves, blowing out, and then mysteriously re-lighting (Gos, 1926).

The intimidating Mount Pilatus, 2,129 meters (6,985 feet) has haunted the minds of locals for centuries, causing it to

the subject of many myths and legends. The most often told legend, and the source of the mountain's name, says that the infamous Pontius Pilate was buried on the mountain (Griffin, Kinen, Meyer, & Moreno, 2001). As the story goes, Caesar was angry with Pilate for crucifying Jesus, so he had Pilate brought to Rome to be put to death. His body was tied to a stone and dropped into the Tiber River, where it caused a great commotion. The body was therefore retrieved, and was eventually placed near a small lake on Mount Pilatus, in the Swiss canton of Luzern (Gribble, 1899). According to Griffin, et al. (2001):

> It was believed that every Good Friday, Pilate would emerge form the grave to wash his bloodied hands in the lake below. According to legend, any attempts to challenge Pilate's dominion over the mountain brought storms of fury, so climbing the mountain was prohibited. In 1585, a priest and a few townsmen decided to test the story by going into the foothills and creating a ruckus.

Because there was no retribution, the spell was considered to be broken (Griffin, et al. 2001).

Many people that lived in Europe were uneducated about the nature of the Alps. They created myths to illustrate the fears that they held towards these mountains. Instead of finding out for themselves, they believed stories that had been passed down from previous generations. However, not everyone shared these common beliefs. People began to explore the mountains because they were curious. Once exposed to the natural beauty of the Alps, they gained a respect for the mountains. Two spiritual movements awakened this enthusiasm for the mountains: the Renaissance and the Enlightenment.

Previously, during the Middle Ages, scholars had been guided by the teachings of the Church. Thought revolved around the idea that good deeds and actions led to heavenly rewards. However, the Renaissance and the Enlightenment opened the doors for new ideas and thoughts. A new philosophy emerged as the

scholars of the Renaissance, known as humanists, studied the works of ancient writers of Rome and Greece. They were influenced by the emphasis that these ancient writings placed on Man, his intellect, and his life on Earth (Annenberg/CPB Resources, 2001).

The humanists took it upon themselves to open their minds to the ancient ideas. Lifted from the suppression that the Church had put on them for so long, the humanists turned away from a life that revolved around spirituality. Instead, they focused on gaining knowledge and spreading their ideas. The ancient literature that they read gave the humanists new ideas about human rights, liberty, and life on Earth (Annenberg/CPB Resources, 2001).

The humanists were also explorers. Faced with uncertainty, the humanists set out to understand the mountains and test the mythical legends, which were believed by many. Once they discovered the true beauty that the mountains held, they were compelled to search for an understanding of nature (Price, 1981; Maeder, 1975).

In 1555, Zürich scientist Konrad Gessner completed an expedition up Mount Pilatus. Gessner not only confirmed the absurdity of the Pilatus legend, he became enthusiastic about the beauty of the mountains and had an urge to climb them. He set out to explore the Alps, with a goal to climb one peak per year. He often took many of his Renaissance friends along, awakening their interests to the splendors of the mountains. Konrad Gessner was one of the great humanists of his time, and is the person usually credited as being the first to appreciate and love the mountains for their own sake (Price, 1981; Maeder, 1975).

However, mountains were still not generally appreciated for their beauty. Although many writers published books and journals describing their tours through the Alps, people were reluctant to accept these new ideas. One humanist, Jean-

Jacques Rousseau, had an almost revolutionary impact. In his writings, he described how mankind's goal was to get "back to nature." These ideas awakened and challenged people to act. His numerous disciples wanted to become familiar with the scenery that he described in his Confessions: "They do not know what I mean by beautiful scenery. I need brooks, rocks, pine trees, dark forests, rough winding paths and abysses" (Maeder, 1975). His expressions awakened a way back to nature and greatly increased popular appreciation of Switzerland as a place of beauty (Price, 1981).

The Renaissance and Enlightenment could be thought of as the root cause for some of these new attitudes. The Enlightenment reached many places in this region of the world and in each region it took on a different form. From poetry to mountain climbing, these time periods had a sizable effect on how people viewed the mountains. Appreciation spread throughout Europe and as more people became educated on the many splendors of the mountains, exploration increased. This set the stage for the birth of the sport mountaineering.

The English Victorian era was a time of exploration and invention. Increasing power and wealth gained by the English middle class resulted in prosperity and caused these people to spend more of their money on books (Deanna's World, 2001). This worked to the advantage of Albert Smith, a journalist who wrote about his early adventures of mountaineering. In his journal of his ascent to Mont-Blanc, Smith encouraged his audience to imagine themselves making their own ascent (Hansen, 1995).

Albert Smith's amusing narrative transformed the commonly held views of the mountains. According to Hansen (1995)

> The invention of mid-Victorian mountaineering demonstrates that middle-class men were not co-opted, nor did they passively receive an

older, gentlemanly culture, but instead they actively constructed an assertive masculinity to uphold their imagined sense of Britain's imperial power.

During this era, England was developing into the most powerful, modern, industrial country in the world (Deanna's World, 2001). These accounts were very exciting and appealed to many, particularly to the men of the English middle class. Growing bored with their mundane lifestyle, these men became intently interested in Smith's accounts of exploration (Maeder, 1975; Hansen, 1995).

Smith's accounts popularized climbing for athletic activity, which led to the Golden Age of mountaineering. Men with money, time, and an adventurous spirit came to the Alps to experience the feelings of conquest and adventure that they read about (Maeder, 1975). They supported these adventurous feelings by forming Alpine Clubs, which were exclusively for people interested in playing this game of mountain climbing (J. Mathieu, personal communication, November 6, 2001). Because these clubs were not formed to popularize alpinism, only tested mountain climbers of high social standing were invited to join. The clubs gave the men a place to exchange experiences with each other and enjoy the challenges that the mountains presented (Maeder, 1975). The game of mountaineering was a brand new concept for most people. Because these English aristocrats were the first people who published books about their trips into the Alps, they claimed that they were the first to discover mountaineering (J. Mathieu, personal communication, November 6, 2001).

The pioneers of alpinism had climbed the peaks, but most importantly, they overcame the wall of misunderstanding and fear that surrounded them for so long. The literature that the English produced after climbing these peaks caused more attention to be directed towards the Alps. The English were definitely not the first people to climb the alpine peaks; they were just the first people to officially publish

books about their mountain experiences (J. Mathieu, personal communication, November 6, 2001).

The English did not climb the mountains all by themselves. Often times, villagers who were familiar with the terrain, mountain guides, took part in almost all of their excursions (Maeder, 1975). Although it was a risky job that took great levels of courage (Gos, 1926), the guides knew that outsiders would pay for a tour up into the mountains (Coolidge, 1908). The first organized and guided trips were not until the later half of the 1800's (Herold, 1948), when the snowy peaks became worth gold to the people that lived beneath them (Coolidge, 1908).

As time went on, more people learned about the Alps and wanted to see the splendors for themselves. After 1875, the Swiss mountain railroads started operating, allowing for easier travel. The many tourists that came supplied a basis for the developing economy. As economic growth continued, many technological innovations were made. The ability to transfer electric power over long distances and the improvements in transportation, such as the rack-railway and cable cars, provided tourists with easy access to the Swiss Alps (Pfister & Messerli, 1990).

Tourism provides a basis for the Swiss economy. These people are drawn to the Alps because the mountain environments are fascinating. They offer adventure, recreation and nature. Like the tourists, the Swiss also enjoy the Alps.

In a recent survey done by the Swiss Agency for the Environment, Forests, and Landscapes (SAEFL), the majority of the Swiss people visit the forests for recreational purposes and to enjoy the cool, fresh feeling that nature brings them. In connection with the word "forest", what most often sprung to the minds of the Swiss interviewed were "fresh air" "good air" and "recreation." The Swiss often walk through the forests to enjoy the coolness, stillness, and pleasant smells and feelings

that the forests evoke. Approximately 44% of those interviewed use the forests once or twice a week (Swiss Agency for the Environment, Forests, and Landscapes, 2000).

The Swiss are knowledgeable about the degradation that is taking its toll on their forests. 63% of those interviewed felt that there has been a deterioration of forest health and 66% believed there has been a reduction in the number of plants and animals over the last 20 years. The Swiss associate these problems mostly with air pollution. More than 70% of the interviewees hold protection of the ozone layer, climate protection, and air pollution to be very important. Their opinions on biodiversity and forest health show us that they are concerned about their forests (SAEFL, 2000).

Data collected by SAEFL identified the major environmental problems that currently plague the forests. For example, excessive inputs of acids and nitrogen absorbed into the forest soil and the direct effects of air pollutants cause an upset net balance in the forest. In the long run, this will ultimately lead to a deterioration in the health of the forest ecosystem because the critical loads that the forests can handle have already been greatly exceeded. Ozone is one pollutant that has greatly exceeded its critical load. The photochemical product of compounds directly enters the leaves and needles of the plants, impairing the metabolism and straining the plant (Limacher, Kubler, Kissling-Naf, & Zimmermann, 1999).

This background information supports our web site's focus on nature and mountain phenomena. Because we want to give people an experience of the mountains, this site contains many pictures of mountain landscapes, forests, and wildlife. The digital cameras we installed were used to attract people to the site. This technology allowed us to capture the landscapes and showcase these pictures on the Internet. By delivering up to date images of the mountains, visitors of the site can get

an impression of being in the mountains. By combining explanations with pictures of these mountain phenomena, we hoped to create a visual as well as educational platform to facilitate an enjoyable experience.

2.6 Web Camera Setup

The process of delivering Swiss landscapes into a web browser begins with the camera and ends with the picture on the site. This process must take into consideration five factors. First is the choice of the camera itself. Second is the protection of the camera from the elements. The next consideration was the supply of power to the camera and also the style of mounting apparatus. Lastly, we had to find a way to transmit data from the camera to the web site. These parameters became increasingly important when the camera was installed in areas where winds can exceed 80mph, temperatures are sub-freezing, and there are no telephone line communications. The different conditions that the assembly is exposed to played an important role in the selection of components.

The camera is the first component of the image capturing process. Possible choices included analog and digital cameras; within the latter, there were video and snapshot cameras. Because the web camera pictures were to be displayed on a web site, images captured had to eventually exist in a digital format. Another major guideline that affected camera selection was our preference for a higher quality image. Because the mountain landscapes change by days or weeks at a time and not minutes, the delivery of full motion real-time video was not important.

Like any analog electronic device, analog cameras output a continuous signal representing the captured light. The formats in which analog cameras output their

signal are severely limited in their resolution. For example, standard VHS has only 280 vertical lines of resolution, while the output of most commercially available video cameras is limited at 480 lines of vertical resolution. (Panasonic Security Systems Group, 2001). Furthermore, in order to be presented on the web site, the camera's analog signal has to be digitized, a process which requires the use of a separate video digitizer component (Hardaway & Will, 1997). The conversion from analog to digital would result in a degradation of the signal (Um & Wright, 1999).

Digital cameras, on the other hand, output the captured signal from the camera sensor immediately in a digital format. Because the processes of digitizing and synchronizing the video to a consistent timing source are performed simultaneously and immediately, using a digital video camera results in no conversion from analog to digital domain and hence no signal degradation (Um & Wright, 1999). However, the synchronization to a constant timing source is less important, because our intended application has a very low frame rate and does not need the stable synchronization that is required for full motion video.

Within digital cameras, we had to choose between a digital video or a digital snapshot camera. The former and the latter illustrate the trade-off between quality and quantity, which occurs because the digital information has restricted bandwidth. Digital video cameras sacrifice image quality for higher frame rate video, while digital still cameras transmit high quality images at a much slower pace. Because the bandwidth is determined by the available means of communication, the choice of transmission of data further influenced the choice of video versus still.

The bandwidth available at the camera sites was very limited. Three out of four camera sites lacked traditional phone lines, let alone high-speed network access. Thus, the only means of communication available at those sites was cellular

communication via the European GSM network. The bandwidth of the data transmission over the GSM network is restricted at 9600bps, which is approximately five times slower than a typical modem and about a thousand times slower than a local area network (Degermark, Engan, Nordgren, & Pink, 1997). Transmission of real-time video over this speed was simply not feasible, as some of the lowest quality compression algorithms require approximately fifty times the bandwidth available at our camera sites (Gall, 1991).

Consequently, digital snapshot cameras were our choice for higher resolution images. Although this choice prevented fast frame rates, we did not need those capabilities, since we were taking only about five pictures per day. Digital snapshot cameras provide resolutions ranging from 768 to 1536 vertical lines, exceeding the pixel area of common analog and digital video formats by four to twenty times (Canon U.S.A., 2001, Image sensor device section). Furthermore, to obtain the best possible picture, the cameras have time to take longer exposures and properly focus the image.

Low cost, in addition to high image quality, was yet another factor that effected the selection of cameras. J. A. Orr (personal communication, October 15, 2001) pointed out that off-the-shelf, consumer digital snapshot cameras would support computer-requested image capture. Some manufacturers provide ready-made software that allows such image capture (Canon U.S.A., 2001, PC-connected shooting section). The increased availability and lower cost, as well as high image quality made these consumer-level digital still cameras our choice.

Protection of our chosen web cameras became very important because the apparatus has to withstand harsh conditions, including temperatures below negative 20 degrees Celsius. When camera enclosures were researched, it was found that

moisture-tight, self-regulating, self-mounting, store-bought units were available. Because the lower end of the outside temperature was below the web camera operating temperature, such units also needed to provide heating. The remaining question was whether or not the enclosure was made big enough to house the desired camera (Monacor Intl., 2001).

When powering the camera was researched, it was determined that solutions other than direct line power would be costly and time consuming. The decision was made to overlook camera sites where direct power was unavailable.

The transmission of data from the camera to the local computer needed to be via USB cable (Canon U.S.A., 2001, Interface section). The USB cable provides a fast as well as reliable connection from the camera to the computer. The transmission distance from the camera to the local computer varied between 2 and 6 meters. Because a standard USB cable from the camera did not exceed 1 meter, active USB extensions were needed. The active extensions were able to relay the signal quickly without compromising signal quality. The transmission of data from the local computer to the web server was determined to take two forms, conventional and wireless. Internet access via a conventional modem would be used were available, and a mobile network kit would be used elsewhere.

The hardware we chose to capture images from the mountains was just one part of the web site's content and design. It was of great importance that we understood how to properly design an easy to use, easy to navigate, and clearly comprehensible web site. Usability, page design, content design, and information architecture were among the many factors involved in creating our web site. Since our web site is the only channel through which the users can experience what we have

to offer, it was important that we designed this channel to be easily accessible, usable, and comprehensible.

2.7 Web Site Design

One of the most apparent features of our web site is its visual appearance, including graphics, icons, and color palettes. Simplicity, design quality and pleasantness are all aesthetic notions, which are often implicitly mentioned in related literature, but are not emphasized or given significant attention. At the same time, overall satisfaction is a common factor in usability studies. Karovnen (2000) then asked rhetorically whether there could really be satisfaction without the beauty element and aesthetics in the first place (Karovnen, 2000).

The few studies that have examined the impact of simplicity of visual design on the users' satisfaction have found that design quality and proper aesthetics often increase the visitor's perception of a web site, instilling trust. Studies of Swedish and Finnish users have found that the participants tended to "appreciate 'clear' or 'clean' design, as they defined it, and since the design was pleasing to them, they were also ready to trust it more easily" (Karovnen, 2000). Nielsen (2000) indeed confirmed, "Good-looking visuals are a major opportunity for establishing credibility." While our web site did not require the kind of trust level that electronic commerce sites desire, increased credibility is still important, as it is a factor in the users' perception of the quality of our site's content. Unmarred by overcomplicated or poorly done graphics, the high quality of content is one of the key factors that keep visitors coming back.

Mullet and Sano (1995) noted, "Because complex designs rarely seem elegant, simplification is an important step in the development of any elegant solution." They went on to suggest other techniques for elegance, such as regularity. It reduces information by repeating elements according to a discernible rule, principle or rhythm (Mullet and Sano, 1995). Quite often referred to as consistency, this concept is universally regarded as a tenet of good user interface design.

Graphic design encompasses more than elegance. Mullet and Sano (1995) indicated that, "scale, contrast and proportion are among the most subtle aspects of design." Weinman (1999) stressed the contrast and value of a graphic, which involves choosing colors in which the gap between lights and darks is not too close. Weinman (1999) identified a problem with color computer screens: there are few monitors calibrated accurately to one another. Although there is no solution for this problem, we can take certain steps to increase our awareness of the problem. However, this is not easy. Mullet and Sano (1995) described a number of useful techniques, such as the squint test. Reduced amount of light achieved through squinting of one's eyes mimics low levels of illumination as well as low-contrast situations, quickly exposing potential problems as well as the overall visual structures of an interface.

Design of icons and graphics of the site also involves cognitive and cultural aspects. Icons are small graphics that visually represent a concept and are often used not only in computer interfaces, but also in real life to compactly convey a concept. Difficulties arise when images are used for abstract concepts, as opposed to concrete objects that have a direct visual relationship. Imagery with cultural or language dependencies, that is, those that rely "on inside jokes, figures of speech, slang, or other terminology that is well-known only within a particular substructure" are to be avoided (Mullet and Sano, 1995). As we designed the web site, we needed to avoid in

our writing and graphics cultural references that are specific to America, such as baseball. While apparent to us, such references will confuse those unaccustomed with the culture, especially during explanations of natural phenomena.

In the end, aesthetics stretch beyond visual appeal. Rosenfeld and Morville (1998) pinpointed the spirit of the term:

> An attractive site is distinguished by a cohesive and consistent look that presents a unique identity for the site and, ideally, for its sponsors. These sites' graphics and page layouts are integrated with their other features, such as navigation systems, custom applications, editorial style, and so forth. Therefore, the user doesn't notice the individual images so much as he or she enjoys the overall atmosphere and experience created by the site.

Following graphics, layout of a web site is the second most visible aspect of a site's design. The objective of a layout is to present content and provide navigation to other pages of the site. Discussing the concept of screen real estate, Nielsen (2000) argued that content should dominate a web page, with other elements taking up a minimum amount of space. This is because web sites are visited for their content, and not navigational links, which Nielsen described as a necessary evil. One technique to maximize space for the content is to try removing design elements of a web page one by one. If, upon informal inspection by a designer, the design does not lose apparent usability or usefulness without a particular element, then remove it, suggested Nielsen, reiterating, "simplicity always wins over complexity, especially on the Web," where download time counts. Since high-bandwidth Internet access is not as proliferated in Switzerland as it is in the United States, download time of web pages remained an important measure to track.

In relation to page layout, above the fold defines the area until the point at which the user has to scroll down to get more information (Spool et al., 1999). Despite the conventional notion that users do not like to scroll and thus all

information should be in the first screenful, Spool claimed that the study did not show any user frustration with scrolling and that users were just as likely to click above the fold as they were to click below it. However, Nielsen (2000) suggested that it is important to have as much useful information in the first screenful as possible, so that users can start acting quickly on the already-downloaded information. He points out that "it matters less if it takes longer to load the full page and all its illustrations if the user can start acting on some information quickly." Thus, the time spent loading a page can be divided into two stages: the time when useful information first fills the screen and the time when everything else is loaded, with the first time point being the most important issue (Nielsen, 2000). Since this project's web site is graphic-intensive in a number of pages, careful layout of content provided a way to minimize the impact of the download time.

Apart from the location of individual elements on a page, we also had to consider the content of the navigational sections of the page's layout. The navigation system of a web site is a set of links to other parts of the site, placed on each web page. Nielsen (2000) says that navigation needs to help users answer three questions: where they are, where they have been and where they are going.

Indicating the user's current location is important because users do not always enter the web site through its front page and thus may not always remember their location relative to the web site's structure. Such location is usually given by highlighting the current link from a list of links within the site structure. Identification of the entire site and links to its front page should also be provided, as well as a clear headline or title for the current web page (Nielsen, 2000).

To allow the user to locate similar resources or backtrack steps, the navigation system needs to indicate where the user has been. A few methods, such as the

breadcrumb path, exist. The breadcrumb path method shows a list of pages, which the user needs to follow from the web site's top, in order to get to the current page (Nielsen, 2000). Links that have already been followed are usually indicated by a "visited link color," and help the user to determine which pages are still unexplored. The standard link colors are blue for an unvisited link and violet for a visited one. Nielsen (2000) warns against using link colors that significantly deviate from the de facto standard to avoid misunderstanding whether a particular link has been visited.

A navigation system also links to other parts of the site, providing the user with an overview of further destinations. Though such navigation links originate from the site's structure, Spool et al. (1999) found that general navigation to the entire web site, constant from page to page, is not as effective as customized navigation. Such navigation adapts to the content being shown, offering links more related to it, and reducing the clutter of the navigational system. Other ways of reducing such clutter include summarization of unrelated links and truncation of information (Nielsen, 2000).

A separate, layout-related concern is the front page of the web site. "The most prominent design element on the home page should be the name of the company or the site," claimed Nielsen (2000). The front page should provide a general overview of the site, including its purpose, to accommodate first-time visitors, as well as highlight changes and news for the returning visitor. Key content areas should be featured on the home page as well (Nielsen, 2000).

Designing information architecture also involved choosing what content to present, organizing this content using appropriate hierarchies, navigation, labeling and searching systems, and determining "how the site will accommodate change and growth over time" (Rosenfeld and Morville, 1998). Thus, information architecture

underlies the navigation system, the site's layout and the content's design. After all, the purpose of our web site was to present information, with layout, appearance and accessibility built around the site's content, ensuring maximum usability.

Another task that was focused on early in the process was organizing information. This was especially important when we were creating labeling systems. The goal of a label is to communicate information efficiently; that is, without taking up too much of a page's vertical space or a user's cognitive space. Labeling involves categorizing the information in a way that avoids ambiguity. Consideration from the user's point of view is apt: how does the user see the information? What types of labels would the user use? (Rosenfeld and Morville, 1998). Answering these questions helped us organize the layout of the page.

"Web sites should make the main things users want to do very simple. Other actions and advanced features can certainly be possible, but simple things should be simple to do," underscored Nielsen (2000). Thus, we produced an easy-to-use, aesthetically pleasing web site, with clear navigation and a sensible organization of information that delivers a satisfying experience of the Swiss mountains to the visitor.

3.0 Methodology

The sections "Enzyklopädie" and "Webcam" of the International Year of the Mountains web site were created to deliver an interactive experience of the Swiss mountains. To expand the information that was gathered for the content portion of the web site, we conducted interviews. Once the web site was completed, we tested it by using focus groups.

To expand our knowledge on topics that were covered in our web site, we conducted interviews with experts from the Swiss Federal Institute for Snow and Avalanche Research (SLF). We used these interviews to obtain quantitative information to expand the content section of the web site. By questioning experts that study the subjects of glaciers, avalanches and alpine environments, we obtained a better understanding of the specific mountain phenomena and ecology that we featured in our web site. This permitted us to provide the user with a greater level of detail.

The first interviews were conducted with our sponsors at SLF to unify their expectations with our goals. During these interviews, the sponsors were asked to create lists of experts within the proposed subjects of interest. The potential interview respondents were faculty members from the SLF, WSL, and ETH institutes. After a comprehensive list was finalized, interviews were then scheduled with the proposed respondents. Because the purpose of these interviews was to expand the information that we already gathered, the questions asked were based on our current level of knowledge within the selected fields of study. The interviewees were able to supply us with extensive information on the subjects we intended to feature in the site.

Evaluation of the web site's usability could have been done via empirical methods (i.e. gathering feedback from actual users via focus groups, interviews), or by applying usability inspection methods (i.e. without the users' involvement). According to Desurvire's study on the effectiveness of usability inspection methods (in Nielsen & Mack, 1994):

> ...the main advantage of laboratory and field testing is the realism of the tasks and users who perform those tasks. The results are going to be most representative of real users of a proposed system, especially from field studies. Usability inspection methods, however, do not address this realism.

It then follows that to maximize the usability of our web site, we needed to perform focus group testing on the prototype and final versions of the web site. Focus groups are an efficient method of extracting an accurate opinion from a selected group of people with common interests. We used this method to evaluate the effectiveness of our web site. To uncover specific information about our web pages, we needed to carefully design the questions and the groups. By conducting focus groups with people that use the Internet on a regular basis, we were able to improve the organization and usability of our web site.

Usability measures the ease of locating desired information within a web site. The speed at which users can locate desired information was an important issue for the development of our site. Furthermore, focus groups were useful in testing levels of personal interest as well as comprehension. The perception of the site's user-friendliness was yet another factor that was investigated, as it directly affected the user's interest in the site. In order to effectively investigate these areas, we had to understand more about why people respond the way they do to given situations. Social exchange theory helped us to accomplish this.

We used social exchange theory to help plan a successful and effective focus group. Social exchange theory explains how and why people respond the way they do to different situations involving other people. At some point during every interaction with another person we experience social exchange (Dillman, 1978).

Unlike other exchanges we experience, social exchange is far more ambiguous. For example, a customer in a super market will complete an exchange by trading money for food. The transaction is understood and agreed upon prior to the exchange of goods or services. The same customer of the super market is now walking home when approached by a stranger who would like directions to the nearest interstate highway. After a short pause, the customer takes a few minutes of their time to give the stranger directions. The stranger expresses their gratitude and drives away.

The hypothetical situation that was just described was a social exchange. In this social exchange there were no prior agreements, nor were there official terms of exchange of any kind. In a more conventional type of exchange, there are terms and conditions that are mutually agreed upon before the exchange takes place. The difference between the two types of exchanges becomes obvious when they are compared.

By taking a closer look at the concepts of social exchange, we can reveal exactly what has been exchanged and why. The basic principle of social exchange is the concept of cost versus benefit. Decisions are made based on whether or not the benefits are greater than the costs. The supermarket customer thought that the cost of giving a stranger some information was outweighed by the benefit that would be received by it. In this situation, the benefit to the supermarket customer was a feeling they got as a result of helping the stranger, while the cost was a few minutes of their

time. The comparison between these two factors is called a cost versus benefit analysis. If the costs had outweighed the benefits, no exchange would have taken place. This same principle of social exchange was applied to attract people to come to a focus group. By making the assumed costs less than the assumed benefit, people took time out of their day to attend a focus group.

When trying to recruit respondents for a focus group, it was important for us to make the costs as low as possible. There are a few ways in which we lowered the costs that our subjects incurred. One way was to reduce the time commitment required by the respondent. People are busy and their time is valuable; by reducing the time that was required, we lowered the respondents' costs. Another method was to acknowledge and address the fact that costs may take the form of personal feelings such as inferiority and anxiety. If respondents are asked sensitive or tough questions, they may feel intimidated, greatly increasing their costs. People are also sensitive to a feeling of power, or rather the lack of, when weighing costs versus benefits. If a respondent feels that they have nothing to offer to the group, they feel useless. Ultimately, this feeling diminishes their willingness to participate.

An increase in benefits is also an acceptable method of closing the gap between cost and benefit. In some situations, telling someone that their time was appreciated can be sufficient payment for their effort. Other ways that were used to increase benefits included allowing respondents to support their own values, giving tangible rewards, and creating a situation where the respondent felt that their time investment directly benefited them. The key to achieving attendance in a focus group was to make it worth their while. By initially offering participants a reward for their participation, the chances of them actually participating become significantly higher (Krueger 1994).

Of the many parts involved in conducting successful focus groups, planning is one of the most important. Without proper anticipation and planning, the focus groups would be useless. Some factors involved in planning a focus group range from financial issues to the style of questions that will be asked.

It is important not to lose meaning or purpose while planning a focus group. By reflecting on various questions, we easily pinpointed our purpose. "Why should such a study be conducted?," "What types of information are of particular importance?," "How will this information be used?," and "What kinds of information will be produced?" are questions that were suggested by Krueger (1994).

The nature of focus groups leaves room for many variables that must be accounted for in advance. One of these factors is the facility in which the focus group is held. The location of the focus group must be close to the respondents so that their time commitment is minimized. The room itself must be free of visual distractions. Visual distractions are an open invitation for a respondent to wander off (Greenbaun, 1998). Background noise must be eliminated to ensure that respondents remain focused on the conversation at hand. Also, the temperature and overall quality of the facility itself can play a role in the types of responses given (Morgan, 1994). In our case, it was imperative that the computers used were up to date, standard models that everyone knew how to use. If the respondents were unfamiliar with the computers, it would have affected their ability to accurately evaluate our web site.

The next task was selecting people for the focus groups. The process of selecting a small portion of the larger group that one seeks to obtain feedback from is called sampling. Because we were only testing the web site for usability and comprehension, we did not have to concern ourselves with sampling methods. Although sampling techniques were not necessary, there were other selection methods

that were used in recruiting respondents for focus groups, such as our screening process (Appendix A) (Krueger, 1994). A screen is an initial questionnaire given to potential respondents to identify whether or not their involvement in the focus group would be beneficial. Because respondents feel more comfortable sharing opinions when they can identify with others in the group, it was important that the screening process eliminated participants who:

1. did not know how to use the Internet,

2. were not between the ages of 21 and 29.

3. were not excessively proficient in using the Internet (were not "gurus")

4. did not speak/read English

Although a group that is perfectly homogeneous can limit the types of responses generated, creating similarities within the groups encourages discussion. The group setting must invite individuals to share their honest opinions. People that share the same education level and age will be more likely to actively participate in a focus group. Once homogeneity is established, the subjects would feel more comfortable in participating (Krueger, 1994).

We conducted two focus groups and a pretest using employees from SLF. The objective of the pretest was to obtain feedback on the focus group process, whereas the actual usability findings were not the priority. Pretesting uncovered most of the flaws in our focus group test process. These flaws had to do with the length of the test, style of questions, and difficulty understanding English. After the pretest, the number of questions were significantly reduced and the questions that were not discarded were rephrased. Pretesting the focus group process with a participant unfamiliar with the project enabled us to fine tune our test, which resulted in successful focus groups.

The focus groups we conducted are called mini groups because they involved four respondents. As the group arrived, they were greeted with friendly conversation to make them feel welcome and comfortable. The setting was a low-pressure forum where people could share their ideas and thoughts (Krueger, 1994). The testing was conducted in a conference room where each participant was given a computer with the web site already loaded onto the hard drive. After getting acquainted, participants were given ten minutes to answer a questionnaire which involved finding ten specific things located within our web site. We purposefully created the questionnaire to be lengthy and time consuming to encourage the respondents to rush. By hurriedly navigating through our web site, even the smallest misunderstandings and usability problems would become obvious.

After the ten minutes were up, the questionnaires were collected and the discussion began. The mediator proceeded by asking a few un-cued, open-ended, "icebreaker" questions to initiate some discussion within the group. The mediator remained neutral, avoiding responses such as "good" or "excellent" in order to avoid reinforcing responses given by respondents. After the initial discussion, we moved to questions like "If you could improve one thing what would it be?," and "If you could tell me one word that represents this web site what would it be?" These questions were useful because they addressed the issues that concerned us.

After the discussion segment, the sentence completion part of the focus group began. The sentence completion segment involved filling in sentences that were started for the respondents. These sentences read as follows:

1. After my colleague had used this web site during his/her lunch break, she/he told me that the material on the web site was organized in a way that…
2. I asked my friend if they had found what they were looking for after they had looked at this web site. They told me that…
3. When I was searching for new things on this web site, I had trouble finding information because…

Sentences one and two were designed to give the respondent the chance to project their feelings onto a friend or colleague, while sentence number three aimed at obtaining negative information about the web site. Projection allowed us to cut back on the normative response biases present in group situations. Normative biases in these situations stem from individuals feeling self-conscious about their peers' perception of them. For example, a respondent might have had trouble navigating the web site, but would neglect to admit so in front of their peers to avoid feeling dumb. Because their answers to the sentence completion worksheets were not privy to the rest of the group, we were able to obtain accurate and useful information (Krueger, 1994).

After the sentence completion sheets had been collected, the two dimensional mapping technique commenced (refer to Appendix D). The respondents were asked to compare usability to comprehension on a two dimensional grid using a scale from one to ten. This written method avoided normative biases and provided us with another angle for analysis. When the respondents were finished with the two-dimensional grid, it was collected.

Before the close of the session, the mediator summarized the main ideas of the session in an effort to minimize miscommunications between the mediator and the group. After the summary was clarified and the group had no further comments, the session was closed and the respondents were free to leave. Immediately after the focus group session finished, the mediator and the assistant had a debriefing to solidify the key attitudes and topics (Krueger, 1994).

When the group session ended, there was a large amount of information to be analyzed. To minimize error during the analysis process, a recording device was used to tape the focus group conversation. After the focus group ended, we listened to the

recording and typed up a complete transcript, which can be found in Appendix G and H. This allowed us to complete the most accurate interpretation of the focus group session. We believed that this method was the most accurate because of its concrete nature (Morgan, 1993).

One analysis technique that we used is called code mapping. This style is used to identify different topics during group sessions. The basis for code mapping is assigning numbers or codes to the different topics that come up during discussion. By combining all like codes or numbers, we were able get a better feel of the actual responses to the specific questions. This was extremely useful because all comments made in focus groups cannot be taken for face value. Seeing comments lumped together with their context can clarify what was actually meant. Code mapping is a useful first step in constructing an overview grid (Morgan, 1993).

Comparisons and overview grids were also effective methods of content analysis. The overview grid is a process of organizing inter-group similarities. The different groups are displayed on one axis while the topics are displayed on the other. This interpretive method shows congruent themes and differences between focus groups. The overview grid, which can be found in Appendix F, was a very helpful tool in finding trends between groups (Morgan, 1993).

Team analysis was used to minimize interpretation error. This simply means that more than one member from the team, usually the mediator and the assistant, participated in the interpretive part of the analysis. The team members started the analysis independently and then brought their results together in an effort to discount incongruent data. This was useful when qualitative information was being collected because this type of data has a higher probability of being distorted by subjectivity

(Morgan, 1993). The analysis was systematic, verifiable and focused, which produced results in a timely and effectively manner (Krueger, 1994).

The focus groups were scheduled so that after the results had been summarized, we were able to make the appropriate changes to our web site before the commencement of the next focus group. This process ensured that the second focus group had a chance to confirm the changes made to the web site. Staggering the groups in this fashion enabled us to maximize the useful information extracted from focus group testing.

We felt that two non-pretest focus groups were sufficient because the second focus group was extremely positive and successful. The respondents could only come up with minor issues and had trouble finding anything negative about the web site. Because of the neutral content of our web site, we did not expect any particular group of respondents to be significantly biased towards or against the various topics of the web site. Using this information, we were able to polish the web site.

Through focus group testing, we were able to ensure that the public will be able to navigate and understand the site. By utilizing the two methods of interviewing and focus groups, we were able to create a usable and educational web site that provides an interactive experience of the Swiss mountains.

4.0 Results

4.1 Interviews

In an effort to deliver an experience of the Swiss mountains, it was decided that information about various alpine phenomena would be presented in an interesting as well as educational format. A section titled "Encyclopedia" was created to organize and display the information that was collected during interviews. Interviews were used to help gather the large amounts of information required to support the encyclopedia section of the web site. Using these interviews, we were able to gather and choose from over 300 pictures, as well as enough information to give a description of each picture. The information was hierarchically organized into levels and categories. Each picture used in the encyclopedia section was annotated with a brief paragraph. Using interviews were able to gather a massive amount of information in a timely fashion.

4.2 Focus groups

After the web site had been created, it was tested for usability and comprehension using focus groups. Two focus groups were conducted to highlight issues that would have otherwise gone unnoticed.

Focus group one

The first focus group was conducted on December 10th at 11:00 am in Davos Dorf at the Institute für Schnee- und Lawinenforschung (SLF). Unfortunately, it was not emphasized enough at the outset of the group that the respondents were only

looking at a section of a larger web site. This miscommunication resulted in one of the respondents taking links that brought them to pages outside the scope of the test. However, once this respondent figured out where the desired information was located, they were able to concentrate on the questionnaire. During the focus group, this respondent was reluctant to actively participate in the topics discussed. It is not a coincidence that after the group had established an attitude of high usability this respondent became quiet. This clearly illustrates the concept of normative response bias. This respondent felt that sharing their experience of being lost would have made them look dumb in front of their peers. Despite this minor miscommunication the respondents of focus group one were able to provide us with valuable feedback that was used to improve the site prior to the commencement of the second focus group.

This focus group indicated that although the web site was interesting, usable, and understandable, it could use improvements in certain areas. Refer to Appendix G for the complete transcription and unedited comments from this focus group. Suggestions for improvements were made with respect to location, an active search engine, and text length.

Individuals found that they had trouble determining their current location within the web site. As mentioned in the literature review, knowing the current location is an essential part of useful navigation. At this point, the web site used a breadcrumbs style of indication, which indicates the user's current location using a hierarchical path. This indicator was placed at the bottom of every page. Because the placement was at the bottom of the page, the focus group had trouble noticing it. It was suggested in the focus group to display the current location at the top of every page, to make it more visible. The users suggested that this would improve the

usability of the web site, and as a result this change was implemented before the second focus group.

The respondents of the focus group agreed that some type of internal search engine would be useful when looking for specific bits of information. Although the entire IYM web site has a search engine, the focus group could not use it because the test computers were offline. However, the disabled search engine helped our study, because it forced the user to manually navigate through the site, allowing them to more accurately talk about the site's organization and usability.

The focus group illustrated that some sections of the web site had large amounts of visually uninterrupted text. During discussion, the focus group agreed that when browsing web sites, finding pages full of text is undesirable. The users indicated that after discovering this type of page, they became uninterested and left. The suggested improvement was to use sub-headings, and more pictures to visually break up the text. Because the effectiveness of the web site is directly related to users' interest, pictures and sub headings were added where appropriate.

This directly relates to another point that was mentioned in this focus group. The respondents indicated that they would prefer to use navigation within the page instead of the navigation that is provided by the web browser. When the respondents came to a page full of text and wanted to go back, they found it undesirable to use navigation outside of the page. The respondents indicated that a back button or some sort of link within the page would help the usability of the web site. Unfortunately, we were not allowed to make this change before the second focus group. The web designers responsible for the home page deemed this change silly and unnecessary, and because they were the primary authority in this matter, they had the final say.

The focus group talked about some issues within the "web camera" section of the web site. The validity and importance of these comments is debatable and will be discussed in the analysis chapter. The more valid points had to do with the map for the web camera locations, a dead link, and the web camera heading itself.

The web camera selection page features a map of Switzerland with 4 Swiss flags placed on it to represent the location of each web camera. It was not clear to the respondents that the flags were clickable and that they represented web cam locations. The suggestion was to change the Swiss flags to the local cantonal flag of the specific region, showing that there is a difference between the markers on the map. This might spark the idea to click the icons because the difference between these flags would suggest that there is more to the story than just a map. This idea was considered and implemented to improve the usability of this web site.

Although the pretest focus group highlighted many issues with the focus group test, it was not able to uncover everything. It was observed during the first focus group that some of the English terms that were used in the questionnaire confused the respondents.

The decision was made to give the same questionnaire to the second focus group, despite the anticipated problems with English. We intended to analyze focus groups by comparing one against the other. Altering the questionnaire between groups would prevent us from accurately making the comparisons between them. The one change that was made to the test allowed the respondents an additional 10 minutes to look at the web site, after the questionnaire was taken from them. This allowed us to accurately compare the results of the questionnaires, while increasing the validity and value of the following discussion that would follow.

Focus group two

The second focus group was conducted on December 12th at 11:00 am in Davos Dorf at the SLF. During the introduction, to avoid any miscommunication, the exact sections of the site that were to be explored were clarified.

The discussion of this focus group uncovered some reoccurring themes as well as new areas for improvement. Generally, it was difficult for the respondents to come up with negative comments. The main ideas for this group included praise of the layout and balance of the pages, easy navigation and compliments with regards to the pictures used to illustrate points of interest. The suggested topics for improvement had to do with the heading "Webcams," color of the links, current location, and picture descriptions. The transcript and comments can be found in Appendix H.

Comments from the session were very positive with respect to the sites attractiveness and organization. For example, one respondent said "yea, I think it would be a site that people would really like to surf.....when they find the site they will stay there for 10 or for 15 minutes because there is much information and nice pictures and the web cam, ya know, I think they like this". The context of this statement can be seen in Appendix H line number 169.

One respondent brought up the fact that the black text and the blue color of the link were very similar. This resulted in the respondent missing a few of the links when skimming through the text. They said that a possibility could be "...another color or its bold or italic or..." making a change to this effect. Other respondents agreed that more attention could be drawn to the links.

The "breadcrumbs" style of identifying current location was removed after the first focus group and replaced with a two level hierarchy, in which the second level changes as a function of the first. The link currently under navigation becomes highlighted to show the user's current location. The respondents seemed to

understand this style of addressing better. Although this change was perceived to be an improvement, one respondent became confused when looking at the hierarchical levels. The only distinction between hierarchical levels in this system is the horizontal space between the first line and the second line. The respondent thought that the second level should be set apart from the first level in some way. This suggestion will be given to the web designers, but as of right now it remains unchanged.

Pictures on the web site are initially presented in a "thumbnail" format, which means that when they are clicked it enlarges to show the full size version. The suggestion was made to include names of glaciers on the glacier pictures, as well as including the names of places or valleys at the bottom of the pop up picture window. Although this might be a good suggestion, it happens to fall outside the interest of this focus group. The intent of this focus group was to uncover specific usability and comprehension problems, not to discover additional areas for expansion.

5.0 Analysis

The style of the test given to participants, combined with their limited English vocabulary played a role in the types of responses that were generated. The focus group respondents where given 10 minutes to answer 10 difficult questions; for someone who has trouble with English, this task became increasingly harder. Therefore, the test that was conducted was made extreme to intentionally uncover usability and comprehension issues. We needed to exercise caution when considering the suggestions from the respondents, keeping in mind the nature of the test.

Although a screening questionnaire (Appendix A) was used to help maximize group performance, the English skills seemed to be a problem for some respondents. The screen for the focus groups excluded people that did not speak English; however, it did not exclude people who had trouble reading English, but were capable of everyday English conversation. English skills seemed to be an important issue that affected this study.

The effects of poor English skills in this analysis are worthy of discussion. An example of this was when one of the respondents did not understand the directions
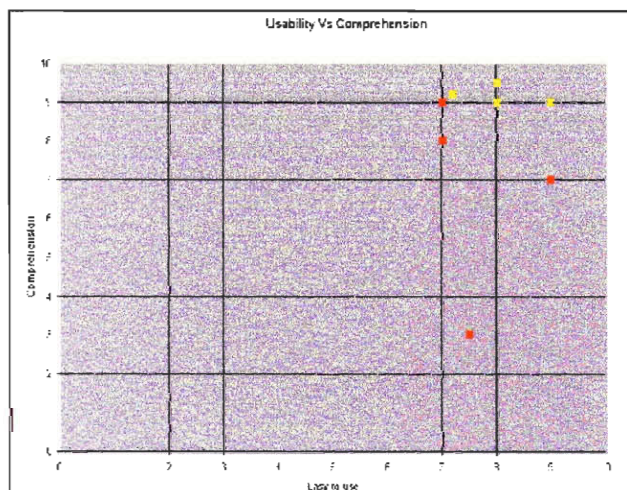
given to them and started looking at sections of the web site that were unrelated to the project. The respondent became slightly frustrated that they did not understand what to do. As a result, comprehension received a 3 out of 10 in the two-dimensional mapping technique (above) also shown in Appendix D.

Poor English skills also illustrated that this web site was easy to use. Notice that respondents were still able to answer the questions even though they had problems with English. One of the respondents was able to say that the information on the site "was quite easy to find" even though they said, "I had problems understanding you English questions." This information was taken from the projection part of the focus group, sentence completion questions 2 and 3, which can be found in Appendix C. There is another example within the same appendix where they admitted to having poor English skills, and was still able to quickly and easily find what they were looking for. The answers from these sentence completions are as follows:

1. It's easy to find all the information (about mountains and forests…) I was looking for.
2. Yes. It's a very good web site. It was not difficult to find most of the informations.
3. I had problems with the English.

This evidence shows that even people with less than perfect English skills were still able to say that the information presented in this web site is organized and usable.

It can be seen in the overview grid, (below) transcripts, and sentence completions (Appendix F, Appendix H, Appendix C respectively) that the only problem areas that resurfaced in the second focus group had to do with the heading "Webcam," English skills, identifying current

location within the site, and the need for additional attention to be drawn to the links.

In retrospect, the problem related to the web camera heading can be dismissed because it was a direct result of the test administered. At the time the test was created, vague questions were included to challenge the respondents. To be more specific, question number 1 from the questionnaire asked for the temperature in the canton of Ticino. Respondents felt that they could have answered this question faster if they had known that within the web cam section there was weather data.

We believe that weather data within these pages complements the webcam picture, and should not be the focus in any way. Furthermore, we feel that people on the Internet that are looking for weather data in Ticino will not end up at the Berge Erleben section of the IYM homepage. People who are interested in finding the temperature in Ticino might go to a search engine or http://www.weather.com to look it up. It is unrealistic to think that users interested in the webcam section of this site will be unhappy when they discover that there is more to the story than webcams. Therefore, it is completely logical to overlook these comments because they are a direct result of accidentally simulating unrealistic searching conditions. The heading "Webcam" will remain because that is exactly what we want people to visit that section for.

With regard to the number of questions answered, the second focus group answered fewer questions from the questionnaire than the first group, shown left. (Group #2 with red bars) Because some questions were harder than others, and naturally required more time to answer, it can be stated that the number of questions answered

Questions Answered
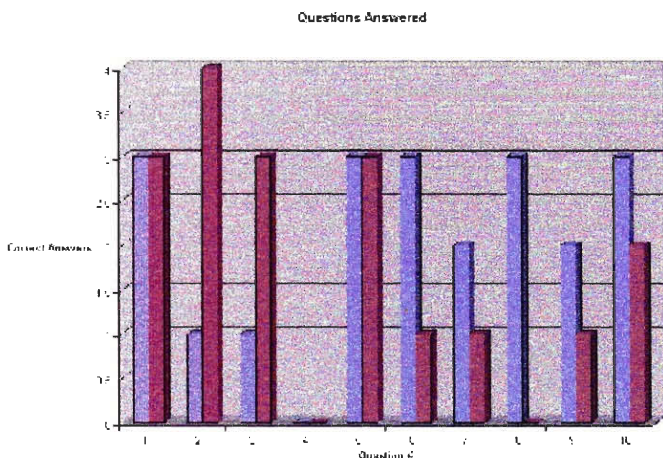
is not an indication of how easy the site was to navigate. The previous graph, which can also be found in Appendix E, shows the distribution of questions answered between the two groups. Notice that every respondent from focus group two answered question #2 correctly and only one respondent from the first group was able to correctly answer the question.

It was observed during the second focus group that the two groups had different approaches to answering the questions. Group one scrambled and answered the easier questions first. Group number two seemed more insistent that an answer be found prior to moving on. Notice in Appendix E that compared to group one's distribution, group two completed more questions in the beginning to middle of the questionnaire and fewer towards the end of the questionnaire.

Also notice that not one respondent from either group answered question number 4. Question number 4 was mentioned by the respondents in lines 125-127 of Appendix H as being the most difficult question. The fact that respondents could identify this question as being difficult means that time was spent trying to answer it. It is impossible, without discussion, to tell how much time was actually spent on each question. Because time did not permit discussion in this area, comparing the number of questions answered between groups would be inconclusive. Therefore, the number of questions answered will not carry any significance in this report.

The suggestion for a search engine was proposed to improve usability. This would have been a convenient way for the respondents to overcome their problems with English. Even under pressure, the respondents felt they had no major problems with navigation. Therefore, we do not believe the suggestion for a search engine carries any importance.

The transcripts from the first focus group, lines 225-230, summarizes that the respondents felt there was a need for a clear indication of their current location within the site at all times. Supposedly, this would have allowed the respondents to navigate the site more easily. Looking at the first two sentence completions shown in Appendix C, the respondents answered:

Responses to 1st Question
"Made it easy to find specific information," and "You can chose what you want with pictures."

Responses to 2nd Question
"They had found it quickly," and "You can easily find information about the animals..."

We see that two respondents showed a strong indication of high usability. Looking at the responses to the last question, we see that the two people that were raving about the site's usability were also lost.

Responses to 3rd Quesiton
"I was not always 100% sure what sub section I was currently navigating in," and "He didn't know in which chapter searching."

Feeling lost is something associated with poor usability, but for some reason the respondents were able to feel lost and then complete a sentence with "made it easy to find specific information." Perhaps because of their limited vocabulary, they neglected to accurately describe their feelings in writing. As a result, within the sentence completions, the word 'easy' should not be taken for face value.

Despite the contradiction, the "breadcrumb" style of indicating the user's current location was replaced with the newer hierarchical style prior to focus group number two. The effect of this modification in the second focus group can be seen in the transcript lines 120-124 of Appendix H, and the overview grid located in Appendix F. Lines 120-124 read: "(Moderator) You always had an idea of where you were and where to go? (Respondents) Yes, Yes, Yes, Yes."

Although the respondents from group two had a suggestion regarding our new addition, they never felt lost. The moderator specifically looked at each respondent to encourage a reply to the question asked in line 120 of Appendix H. It is clear that although feeling lost might not prohibit one's ability to browse a web site, it can still affect the user's opinion. By looking (left) at the 2-D mapping technique also in Appendix D, the respondents from the second focus group (yellow) rated the comprehension and usability higher and more consistently than the first group. Because the sentence completions of the two groups are similar and positive, 2-D mapping, combined with the overview grid, helped graphically clarify the overall satisfaction of the web site. By reviewing the transcription of the second group, 2-D mapping, and the overview grid, we are able to prove that the web site's usability had improved from the initial design.
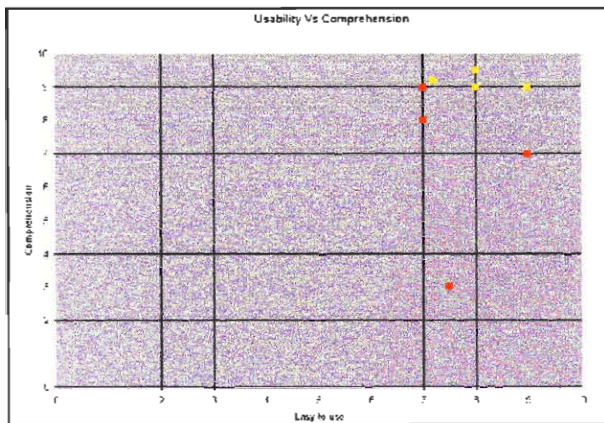
One area that was not addressed before the commencement of the second focus group was the attention drawn to the links. A respondent from the first focus group, line 179 from Appendix G, clearly states that they had no trouble identifying a link as a link. "(Respondent) Nah, you could definitely identify the links as links…"

The only suggestion for improvement was the addition of an underline to any clickable link. However, the second focus group, lines 99-102 from Appendix H, illustrates that the color of the link was a problem for one respondent. "(Respondent) Ok, perhaps, it's a question of the screen or my eyes, but I can't or I have difficulties

to see the blue and black..." The contradiction between these two focus groups suggests that the color of the links is an issue. If we are trying to design a web site that is usable, the fact that this issue is even debatable is unacceptable. Individuals with compromised eyesight should be able to clearly identify where the links are.

The literature review discusses visual inspection methods in the web site design section 2.7. It states that squinting at the screen to examine the contrast between colors is a valid way to determine whether or not the colors used provide the necessary contrast. The color scheme used for this web site fails the squint test described in the literature review. Although a respondent from focus group one admitted that they had no problem identifying a link as a link, they did suggest in lines 179-181 of Appendix G to "...I don't know, underline them..."

Although the respondents have not described the links as a major problem, they suggested that improvements could be made. Acceptable improvements could include underscoring linked text, bold type font, or some other change that would result in more attention being drawn to the links. Because navigation is so important, we feel that this issue needs to be addressed. Unfortunately, we were only responsible for a sub-section of the larger whole, which means that we have no control over the color or style of the links. SLF hired web designers to make these important decisions, and as a result we were unable to make the appropriate changes to our portion of the web site.

Shown left, we compared the responses of the discussion questions asked in the focus group. The reoccurring themes that appeared, shown in the overview grid, also in

Appendix F, include good organization, interesting subject matter, effective text length, and nice visual layout. It is clear that the respondents from both focus groups felt that even though there were minor areas for improvement (that have since been fixed) the site is usable and understandable.

When probing for things to improve on the web site, it was hard for the respondents to come up with anything substantial. The worst thing they could say about our web site was that the links could use an underline or we could create a greater distinction between the two navigational hierarchical levels. These focus groups played a key role in the development of the website. As a result of these focus groups, we can say with confidence that usability and comprehension are more than acceptable.

6.0 Conclusions

6.1 Conclusion

Increasing public awareness of mountain environments is a key goal of the United Nations General Assembly's (UNGA) International Year of Mountains. This IQP promotes such awareness by focusing on delivering an experience of the Swiss mountains via the World-Wide Web. This experience is based on over 180 pictures combined with the images from web cameras around Switzerland. Along with the images, there is interesting as well as educational information about the nature and phenomena of Swiss mountain environments. Finally, the quality and effectiveness of this experience was ensured through focus group testing.

The web camera section of this web site provides views of the Swiss Alps and Jura mountains. Apart from the images showcasing the regional landscapes, each camera site also features current weather conditions. The climate measurements not only include the temperature and wind speed, but also values such as snow height and hours of sunshine. Finally, each camera site features a monthly picture that refers to some of the "Enzyklopädie" topics that are relevant to the region.

Interrelated ecological systems of the mountain ranges are highlighted in the "Enzyklopädie" section. The information on topics such as wildlife, avalanches and history is not presented as separate pieces, but as pages linked across categories and topics. These pages highlight the symbiotic relationships between animals, trees, history's effect on present day biodiversity, and nature's adaptation to avalanches. Together, the interlinked pages allow the site's visitors to explore a wide variety of interrelated pages.

Conducting focus groups permitted us to ensure that the web site was organized and easy to use. The analysis of the focus groups and their results show that the web site is logical, easy to use, comprehensible, and interesting. However, the focus groups also brought up a number of problems within the site, especially in the areas of navigation, link colors and text length.

The navigation bar, which always shows the user's current location at the top of each page, has been perfected and implemented. At the same time, the ineffective "breadcrumb"-style path was removed from the bottom of the pages. The focus groups showed that the users' awareness of their current location was an integral factor in the site's usability.

It was also shown in the focus groups that uninterrupted paragraphs of text caused some respondents to leave the page after a brief visual inspection. Consequently, the lengthy sections of text have been broken up into smaller pieces. Pictures have been inserted where applicable and sub-headings have been applied to areas without pictures. Problems discovered by the focus groups were fixed, while the issues beyond our control were listed as recommendations.

6.2 Recommendations

Although the analysis shows that our sections of the IYM web site are highly usable and comprehensible, there are some issues beyond our control that would improve the site even further.

The web site's color scheme offers the user a visually appealing blend of blues, purples, and greens. The drawback is that the color chosen for the links is soft and blends into the page, making it difficult to distinguish the links. To enhance the links' distinction, we recommend making the links underlined. Because underlines are strongly associated with web page links, they would greatly increase the visibility of the link.

An alternative to underlining links is changing their color to create a stronger contrast. Although this is less desirable, it is still an improvement over the low-contrast, non-underlined links.

Finally, we recommend that when new content is added to the site during its stay on the web, the guidelines and format that we established for the content pages are followed. These include varying the text with pictures or sub-headings, as well as writing concise and clear text.

APPENDIX

<div style="text-align: right">

A

</div>

Screen

1. Choose the phrase below that most accurately approximates your attitude towards the Internet.
    a. I think the Internet is not very useful and I do not use it.   (Dismiss)
    b. I use the Internet occasionally to check my emails.   (Pass)
    c. I think the Internet is useful and I use it regularly.   (Pass Good)

2. Do you have access to a computer at home or at work?   (NO = Dismiss)

3. Does you job or profession involve web design, web maintenance, or other types of software engineering?   (Yes = Dismiss)

4. Have you participated in a focus group within the last year?   (Yes = Dismiss)

5. Choose the category below that includes your age.
    a. 19 → 33   Ok
    b. 34 → 60   Dismiss
6. Do you speak English well enough to have an intelligible conversation with a native English speaker?

Dismissal = Ok, Thank you for your time, unfortunately, we will not able to use your help in this project.

If individuals get to this point then say:

We would like to invite you to SLF in Davos Dorf to discuss your opinions about a new non profit web site that was made as a part of the international year of mountains home page. This section of the web site was designed to create an experience for anyone who wishes to explore the Alps from their home or office. The discussions last less than one hour and will be held on Dec, 10th and 12th from 11:00AM → 12:00Pm. Would you be willing to participate in a group discussion on this topic?

If yes then say:
I would like your name and home mailing address so that I can mail you a reminder for this group discussion.

Appendix

<div style="text-align: right">

B
</div>

Questionnaire

1. What temperature is it in Ticino right now? _____^{0}C

2. What myth do we talk about in our web site?

3. Young Bearded Vultures have a brown-gray color. What color do the feathers change to as the bearded vulture gets older?

4. How can you determine the age of a scar within a tree?

5. How far does the fastest glacier in Switzerland travel in one year?

6. Why do rhododendrons grow where they do?

7. Why can some trees survive in avalanche zones?

8. How did the Ibex reappear in Switzerland after it had become extinct in this region?

9. How tall is the peak (meters) shown on the Mythen web camera?

10. The two types of mountain pines are_____and_____.

Appendix

Sentence Completion

- Group 1
- Group 2

1.) After my colleague had used this web site during his/her lunch break, she/he told me that the material on the web site was organized in a way that
- It was easy for her as a non-expert to find what she was looking for.
- Made it easy to find specific information
- Looks interesting but not finished.
- You can choose what you want with pictures.
  - You quickly find your special pints of interest.
  - She/he could find a lot of info and nice pictures so that she/he sent this link to lots of friends. ☺ (← That's what they did.)
  - I can find the information
  - It's easy to find all the information (about mountains forests…) I was looking for.

2.) I asked my friend if they had found what they were looking for after they had looked at this web site. They told me that
- They found some good very general information on the topic.
- They had found it quickly.
- It was a hard way, because the navigation was ambiguous.
- You can easily find information about the animals……
  - They needed some minutes to get an overview. Then they found things easily.
  - Was quite easy to find.
  - The information and the pictures are very well. It is a good mix of pictures and information.
  - Yes. It's a very good web site. It was not difficult to find most of the informations.

3.) When I was searching for new things on this web site, I had trouble finding information because
- There was no search engine
- I was not always 100% sure what sub section I was currently navigating in.
- There was no working search point
- He didn't now in which chapter searching.
  - At first look I couldn't recognize the blue color of the links in the text.
  - I had problems understanding you English questions.
  - No trouble. The website is very good organized
  - I had problems with the English

Appendix

D

Usability Vs Comprehension

E

Appendix

<div style="text-align:right">F</div>
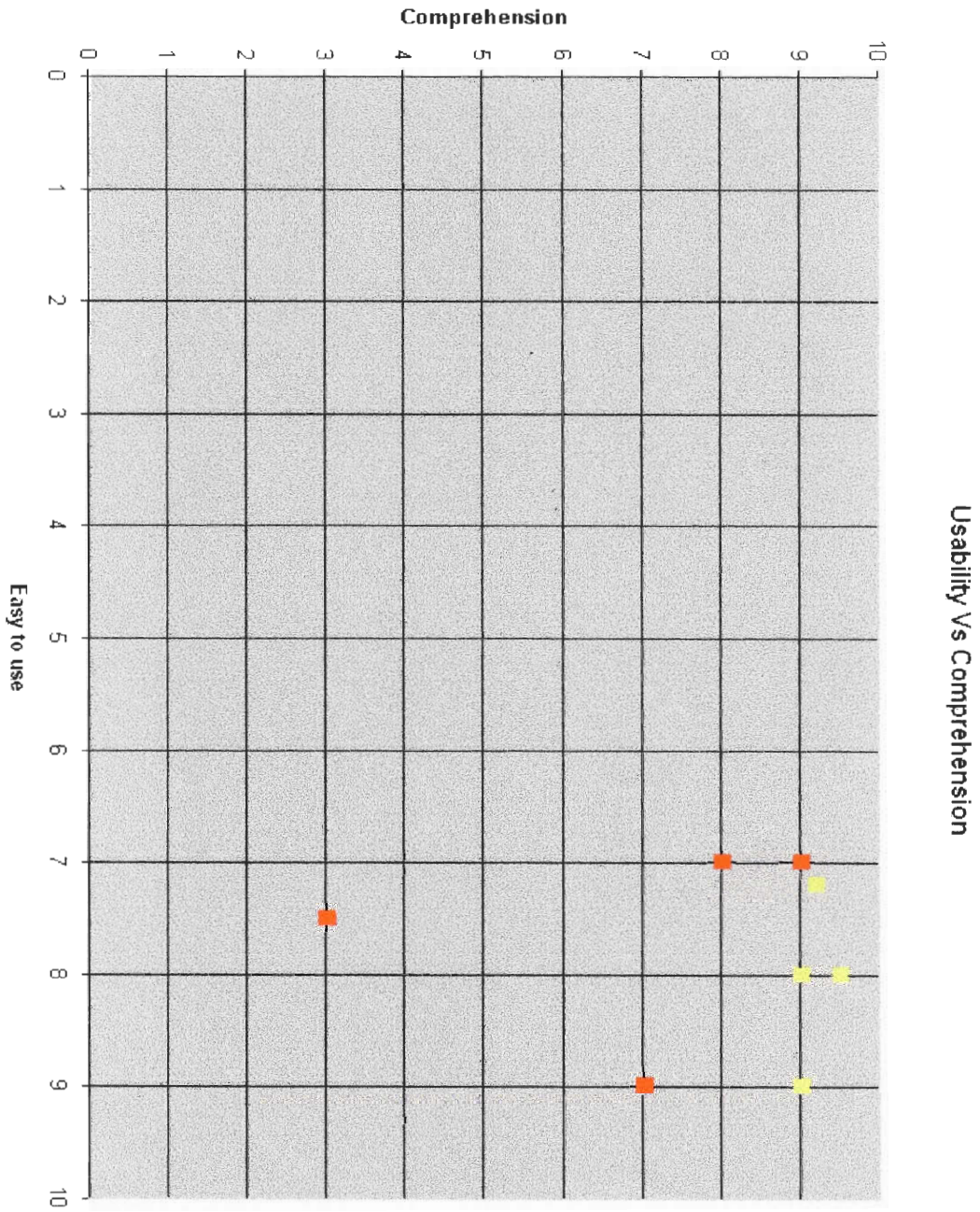
Overview Grid Comparison of Major Topics
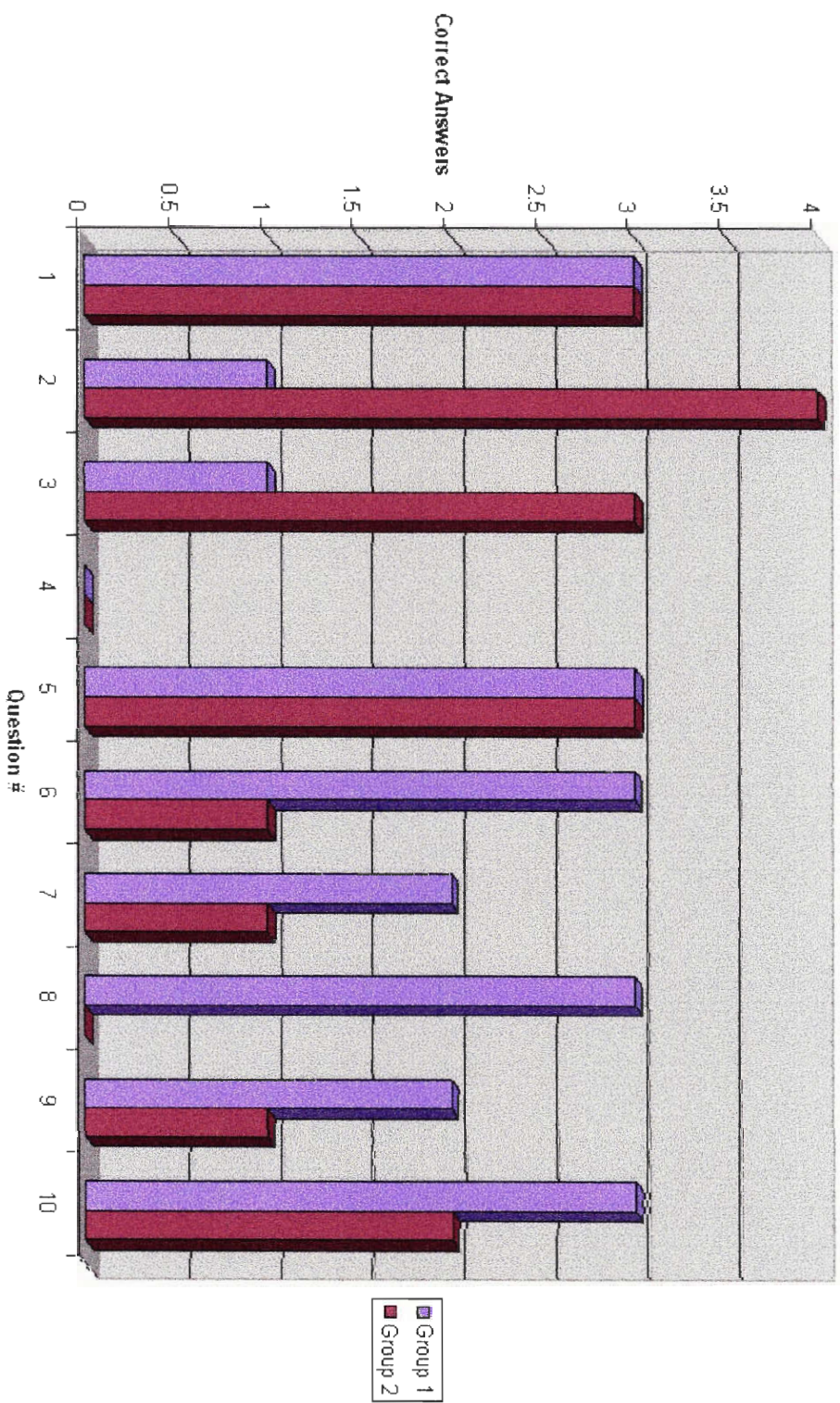
	Focus Group #2	Focus Group #1
Link Style (W R T attention of)	■	■
Lenth of text too long		■
English Problems	■	■
Miscommunication of instructions		■
Need for Search Engine		■
Feeling lost		■
Webcam location markers		■
Webcam Heading too Vaugue	■	■
Positive visual layout	■	■
Logicly Structured	■	■
Interesting	■	■
Text lenth Good	■	■
Organized	■	■

1 **Appendix**

2

3 **Focus group #1**

4 **M = Moderator   R = Respondent**

5 **Monday, 10 December 2001**

6 Start: 11:09

7 **M:** Hello, thank you for showing up. Please take a seat at the computer with your

8 name tent on it. [respondents coming in]

9 **M:** I would like to start by saying thank you for choosing to participate in this group.

10 The discussion today is confidential. Your name is in now way connected to any of

11 the reports or papers that are produced from this meeting.

12 **M:** I will now distribute to you a worksheet with questions. You will have 10 minutes

13 to look around the site and answer these questions.

14 **R:** Yeah, sure.

15 **M:** Whenever you're ready, you can start answering the questions.

16 [respondents answering questions]

17 [small, unintelligible conversations in German between participants to clarify

18 meanings of English words on the question sheet]

19 (10 minutes later)

20 **M:** Okay, time's up. Alright, so what did you think about the worksheet, did anybody

21 finish? I made it long on purpose.

22 **R:** No, I'm missing two.

23 **M:** Missing two? Yeah, I made it long on purpose to help figure out the organization.

24 Let's talk about the links. Does anyone find the links easy to find or hard to find?

25 **R:** [confused looks]

26 **M:** The connections, the organization of the site.

27 **R:** Can I just say something? Some of the links go to the same place and they're all in

28 Italian.

29 **M:** So where, where's that?

30 **R:** Um, quiz, statistics, postcards.

31 **M:** Oh, yes. That's when we join our portion of the web site with the web designer's

32 part, that will all be taken care of. Our two parts are the webcam and the

33 encyclopedia.

34 **R:** Okay, did you say that in the beginning and I missed it?

35 R: [Laughter]

36 M: So what did you think overall?

37 R: I was confused about the navigation. The navigation, because it's in German and

38 then the text was in, I don't know, French. And the navigation is not completely

39 working.

40 M: Where, where is that?

41 **R:** [unintelligible foreign language conversation between respondents]

42 **R:** It was a problem for me, because first I want to get an overview of it. And then the

43 most wasn't working.

44 **R:** I think you have to make it clear, this is not a criticism of the site, but of the test.

45 You have to make it clear that there are only two links working. [M: On the left] In

46 fact, it would be the best if you could get rid of the others. People are gonna get lost.

47 **M:** Yeah.. How much time did you actually spend on the questions? Did you find

48 where the questions were?

49 **R:** Yeah, I figured out very quickly, I spend most of my time on the questions.

50 **M:** Did you guys get a chance to look at [cut off]

51   **R:** I was only, uhh, only encyclopedia. So the webcam questions I didn't get.

52   **M:** Oh, that's okay, it's okay. Did you, did you get [cut off]

53   **R:** Oh the most time I was looking at the navigation.

54   **M:** [Repeat back] So more than half the time you weren't even [cut off]

55   **R:** No, maybe the half. Four minutes or so.

56   **M:** Okay, alright, well of the time that you did spend within the pictures and the

57   encyclopedia... Once you were inside, how was it?

58   **R:** I think it was fairly logically structured. Um, I mean you've got, living, non-

59   living... and everything underneath that fits those categories. [unintelligible] I mean, I

60   was looking for trees, so I would go to the trees. So yeah

61   **M:** Yeah

62   **R:** So it's nice like this...

63   **M:** Anyone else... Olivia?

64   **R:** Yeah, I mean.... As soon as you're the one looking for specific topics...

65   **M:** Uh huh.

66   **R:** [unintelligble, fades into silence]

67   **M:** So what question would you say was the hardest to answer? Of the ones that you

68   looked at?

69   **R:** None of them, I just didn't have enough time.

70   **M:** You just needed more time.

71   **R:** Oh, oh, I'm quite sure within three minutes, I would've been able to answer the

72   last two. Oh possibly the myth... I'm not sure, no, that would be within people.

73   **M:** Okay, Yannick?

74   **R:** I only answered... five questions.

75   **M:** But with the questions [cut off]

76   **R:** It was just a question of time.

77   **M:** So the organization did not affect your ability to answer the questions?

78   **R:** In the beginning I didn't understood how it works. But uhhh.. In the next,

79   encyclopedia, you got the... the page and that's okay.

80   **R:** I couldn't find the temperature.

81   **M:** Okay.

82   **R:** I... uhhh... right... that's because I just went thru all the different web cams,

83   because Ticino is not actually listed. It is ... you have to manually go through each

84   web cam to find it, 'cause it's not one of the headings.

85   **R:** There's one link that says current temperature or something...

86   **M:** [speaking over] Is there, is there a flag?

87   **R:** ... in the avalanche section.

88   **R:** Because you've got, you've got, Mythen, Diavolezza, Monte San Salvatore, La

89   Dole.

90   **M:** So it's not clear that Monte San Salvatore is in Ticino?

91   **R:** No, not if you don't know [giggle]

92   **M:** Okay. That's good to know.

93   **R:** There's this one link in the avalanche section that says current conditions and it's

94   not leading anywhere.

95   **M:** Where does that bring you?

96   [Moderator gets up to look at respondent's screen.]

97   **M:** Interesting... Okay.... We'll fix that. If you could improve one thing within the

98   webcam and encyclopedia sections, what would that be?

99   **R:** What's improve?

100   **M:** Make better.

101 **R:** Some sort of search engine, where you just type in the words that you're looking

102 for. So if you're looking for specific animal, you just type in the word and it finds it

103 for you.

104 **M:** And it searches the web site for you? Brings you to the page?

105 **R:** Yap. This is [unintelligible].

106 **M:** Like the SLF homepage.

107 **R:** Yeah, well, there is a search, but it must not be online.

108 **M:** No, I don't think so. No, that's... No that's the web designers... section. So, as a

109 whole, how did you find the text itself, when you were reading through the text? Did

110 you see anything that was confusing or worded funny or spelled?

111 **R:** Well, the problem with this is that you're scanning the text for the information,

112 you're not paying any attention to how it's written [cut off]

113 **R:** I didn't really. I only was just, only was looking for the words...

114 **M:** Specific words?

115 **R:** You may have to design a different test if you want someone to check out...

116 **R:** In general, I think the length of the text is really good for people just looking at the

117 basic information.

118 **M:** So that the short paragraphs next to the pictures [cut off]

119 **R:** Yeah, that's okay.

120 **M:** Did any of you click on the pictures?

121 **R:** [heads shaking, laughter]

122 **M:** They all get bigger.

123 **R:** Oh yeah, I did, on the web cam pictures.

124 **M:** Oh that's alright, I was sending you on a goose chase anyway. So what did you

125 think about all the pictures? Were the pictures not clear, or fuzzy or shady?

126   **R:** [shakes head]

127   **M:** So as a whole, you would say, the site was usable or user-friendly or what... come

128   up with, tell me one word that describes the web site?

129   **R:** I think it's well structured. Logically structured...

130   **M:** Logically structured, anything else?

131   **R:** Yeah, that's interesting, if you want to know.. to know a lot of things in few times.

132   Because you can ... yeah.. quickly... yeah... [cut off]

133   **R:** Find information.

134   **R:** You have the pictures for each paragraph. That's... a good thing. Because.. aah...

135   when you show it you look at the pictures and click on which ones are very

136   interesting.

137   **M:** So you really searching for pictures?… That you like? And when you find the

138   picture you like, you read about it?

139   **R:** Exactly. Uhh. That's for the subject... Because, uuh, you have the pictures, you

140   find them... (changes topic) they are not really... that's not really nice.

141   **M:** Not nice or is nice?

142   **R:** Uh that's not really good one. [turns laptop to moderator] That one's lovely, but

143   the quality is...

144   **M:** So the picture itself is not very exciting, but...

145   **R:** Uh, the little ones, but uhhh... But I...

146   **M:** Hmm. So would you like to see them bigger or smaller?

147   **R:** For me I like when you've got a really big picture. Perhaps,..

148   **M:** So the thumbnail pictures, when you make them blow up bigger...

149   **R:** Not bigger, but a bit best resolution [cut off]

150   **M:** Better quality?

151   **R:** Yeah... I just show in this one but perhaps....

152   **M:** Yeah, that picture is not a nice one. Okay. So what did you think of the way that

153   some pictures were left on the left side and some were on the right side? Would you

154   like to see it better all left, all right, alternating, two to one, one to two? How's that,

155   how's that organization? The visual organization?

156   **R:** Well, one thing I noticed was that there was not many pictures in the people

157   section. It's a lot of text.

158   **M:** Hmm-hmm.

159   **R:** Very few pictures.

160   **M:** And that makes it?

161   **R:** Well, it just doesn't break it up much, you just see a page of text, it may scare

162   people away. The other things, you have a picture and a bit of text beside it. Maybe it

163   was saying...

164   **M:** Okay, as far as pictures on the left, pictures on the right, does anyone have a

165   comment?

166   **R:** I think's good, yeah

167   **R:** I think it's good.

168   **M:** The two to one?

169   **R:** Yeah. If you put all on the left, it's like enumeration [German], [cut off]

170   **R:** Enumeration.

171   **R:** Yeah, you've got that, that that, but that's not really quite pretty. I think that's

172   good.

173   **M:** Mmm-hmm.

174   **R:** It breaks it up a bit.

175   **M:** It sounds like you found the headings accurate, living, non-living, hazards,

176   people.. Those were straightforward?

177   **R:** Yep.

178   **M:** Okay. Did anyone think the color of the links or headings were a problem?

179   **R:** Nah, you could definitely identify the links as links. I mean, you know that if the

180   individual words are highlighted in the text are fine. Might want to, I don't know,

181   underline them.

182   **M:** Underline would help?

183   **R:** People are used to links being underlined, I guess.

184   **M:** Right.

185   **R:** To an extent.

186   **M:** Benny, what did you think?

187   **R:** Yeah, the links, it's good when you draw over it, that they underscore. And some

188   of the pictures, when you drive the cursor over it, you can't see that it's a link for a

189   bigger picture.

190   **M:** Is that in the flowers?

191   **R:** Yes. I don't see it here [goes to a different page on the computer]

192   **M:** Yeah, I need to fix that.

193   **R:** And it really makes.. if you take picture.. big ... when you get the little.. make it a

194   little under text. Not so much text as you have here inside.

195   **M:** Less you mean?

196   **R:** So when you were only just looking for specific... uhh.. maybe animal... and

197   you're there.. and you click here. I think that here you have the text [cut off]

198   **M:** Oh okay, pop up .. with the picture.

199   **R:** So the text [unintelligible]

200   **M:** So it pops up and says this..

201   **R:** When it pop up...

202   **M:** Okay, that's a good idea. Itching to say something? (Olivia)

203   **R:** Maybe you could have with... uhh.. this Renaissance page.., a picture of a guy,

204   with a beard and such. And glasses.

205   **R:** I also would take the navigation at the bottom and take it ...

206   **M:** Put it at the top?

207   **R:** So that you always see where you are.

208   **M:** Mmm-hmm. (nod)

209   **R:** Because if you click click click and you don't know about where I am. So that the

210   first time I click on Encylcopedia and I was in the beginning. Then I have to go ahead

211   and click the navigation. This navigation bar.

212   **M:** So you're more likely to see...

213   **R:** Maybe.

214   **M:** Anyone else agree with that?

215   **R:** And here you can't really go to the first page. Okay, that's this one. Instead I was

216   back back back back to the first page.

217   **M:** Okay. So make it easier to get to that page right there?

218   **R:** Yeah, exactly... [unintelligible]

219   **M:** Just say Encyclopedia or Home...

220   **R:** But you've got this... here.. but I didn't find it. ... I didn't know.

221   **M:** Does anyone else agree with the problem of going backwards? Did anyone have

222   trouble going back? Because that's been mentioned before, when it's been shown to

223   other people before today. They also said that we needed to have something else to go

224   back, to make it easier [cut off]

225   **R:** What.. I think the problem is a combination of what Benny and Yannick was

226   saying. That you don't really know where you are. Or what subsection you're in.

227   You've gone like three levels or something, you wouldn't know which link to click to

228   go back one level, as opposed to two or three. You've got... you've got.. it's like the

229   address bar at the top. It tells you which subsection you're actually in, it may make it

230   easier. For people to realize... or just put in a back button on the actual page.

231   **M:** Okay.

232   **R:** But that's an always easy solution too. For people on that don't know how to use

233   browsers.

234   **M:** Alright, I have a couple of sentences that I would like you to fill in. I started them

235   and then you fill in the rest of the sentence however you see fit.

236   [papers distributed]

237   **R:** What do you mean by these things [referring to questions on sheet]?

238   **M:** Information.

239   **R:** New information?

240   **M:** Like if you had something you wanted to find.

241   **R:** [conversation in German across participants to clarify meaning of new things]

242   **R:** So when I search for new things..

243   **M:** New things

244   **R:** New things in meaning, uhh, it was last Monday or for me new things?

245   **M:** New things, like I had you searching for, like if you had something you wanted to

246   find about an animal. That would be new information to you. Searching for something

247   you want to find.

248   **R:** [nods]

249   **R:** What happened to Diavolezza?

250   **R:** The picture, it looks like it was at night or something.

251   **M:** Yeah, that was last night's picture.... Is everybody finished with the sentence?

252   **R:** One more thing, on the web cams, yeah? On the site... You have four Swiss flags...

253   why don't you put the flags of the regions or something?

254   **M:** Oh, the cantonal? That's a good idea.

255   **R:** Yeah. You can't really distinguish between.. especially somebody outside of

256   Switzerland. Like, I didn't, I didn't realize at first that they had any meaning at all.

257   [Laughter] Being four Swiss flags.

258   **M:** So as a summary, it sounds like, overlooking the trouble in the beginning finding

259   out the part that we actually worked on, the site was for most part organized and

260   logical. The people section we could break up with pictures, or any section that has

261   text break up with pictures. Uhh and navigation with respect to going backwards...

262   needs to be a little improved.

263   **M:** On some of those longer pages of text, what did you think of subtitles to sort of

264   section off the different subjects? What do you think of the effectiveness of that?

265   Would that help?

266   **R:** I think it would definitely help, yeah. When looking for specific information, it

267   would make it easier, it would just visually break it up as well. Without being put off

268   by three or four paragraphs of text. It's a visual thing, I mean, it's kind of scannability

269   thing as well.

270   **R:** For the question about trees in the avalanche... I didn't know.. I searched

271   something in the forest path... and uhh it was long text and without subtitles, so I just

272   passed it and searched the avalanche. And it was the same, so I didn't find it.

273   **M:** Okay. One last thing, I have a little grid, on one axis, it's comprehension, which

274   means how well you understood the information presented. On the other axis is how

275   easy it was to use. Now if you could make an X somewhere on the grid, that

276   represents how you feel about the site's usability, compared to its comprehension.

277   **R:** By comprehension you mean [cut off]

278   **R:** Understanding...

279   **M:** The information that you saw, how much of it did you understand? When you saw

280   a picture and text, did you understand what it said? However much you understood.

281   **R:** Just put one, one [cut off]

282   **M:** One X that represents where the lines cross.

283   **R:** 10 means good and 0 means bad.

284   [papers distributed]

285   **M:** Thank you, that's all I had, thank you for coming over. As soon as you're done

286   looking around, feel free to leave.

287   [as respondents are leaving]

288   **M:** Thank you, thank you for showing up... You are really helping our project...

289   Thank you for your time. Bye, thank you. Bye. We appreciate your participation. See

290   you later.

291   **M:** This will be at berge2002.ch.

292

293   End.

1   # Appendix

H

2

7   **M:** To start out I would like to say thank you for taking some time out of your day to

8   come and look at our web site. Everything we talk about today is not going to be

9   printed anywhere, it's just for my own improvement of the web site. Don't worry

10   about saying anything that could get you into trouble, because I am looking for things

11   that need to be improved, so I am looking for the bad things. I mean good things are

12   nice to hear as well but I am looking for ways that I can improve, so with that in mind,

13   **R:** Um

14   **M:** yes

15   **R:** my laptop switched into standby mode,   (laughing)

16   **M:** (Restarted the comp)

17   **M:** Just to explain a little about the site….. we designed a part of it, not the entire

18   web site, so the links for the different languages don't work. The two folders that you

19   need to look in are encyclopedia and web cam sections. All of the other links wont

20   take you anywhere because they were not done by us and we are testing our part.

21   (Now looking at questions for 10 min)

22   **R:** Um,….for all of the names of the flowers…… they all have Latin names next to

23   them and the edelweiss has a German word next to it.

24   **M:** What was the question?

25   **R:** The word next to the name of the flower?

26   **M:** Oh ok,….. We will look into that. That's good to know.

27   **R:** I wonder, actually I'm on the page forest history, is there a back button? I want to

28   go back?, I could take the return button, but is there something in the page to go back?

29   Or is that not a possibility?

30   **M:** At the top of the page, where you are is highlighted,… to show you where you

31   are.

32   **R:** ok

33   **M:** You can use those links to stay within encyclopedia. But there isn't a specific

34   button within the page.

35   **R:** Greg, on the top of hazards there is another German word, frost

36   **M:** Frost? F R O S T, ?

37   **R:** yea

38   **M:** That's English too.

39   **R:** really?

40   **M:** yea.

41   **R:** ok

42   **R:** (German gibberish being mumbled amongst themselves, from what I could tell it

43   was to clarify English words and questions,)

44   **R:** Pictures of avalanches are very good.

45   **R:** (mumbled to self, SU-PER)

46   **R:** Greg, um, only an idea, but you could I though it would be good if you say the

47   name of the picture, or avalanche or something. If you say the name of the place.

48   **M:** ok

49

50   Browsing on own for 10 min

51

52 **R:** um, because I think if the people look at the home page and say oh, I was there,

53 huh, then,......

54 **M:** ok, the name of the place the picture was taken.

55 **R:** yup

56 **R:** mumbles about web camera

57 **M:** There are only two web cams that are installed at the moment, number 3 is being

58 installed today.

59 **R:** mumbles

60 **R:** If I click on the current weather conditions link in the avalanche page it brings me

61 here (points to page with folders displayed)

62 **M:** ok, I will fix that.

63 **R:** wow, These good pictures

64 **R:** yup, …. Yup…..

65 **R:** (clicked on link that brought her outside of local page and became confused when

66 it didn't work)

67 **M:** Oh, the computer is reading this web site of the hard drive so you are not actually

68 on line.

69 **R:** AHHH ok

70 **R:** ok

71 **M:** Well, we should probably move on with the rest of it. Do you think you have had

72 enough time to look at it or…..I can give you another 5 min in you like? If your

73 enjoying yourself I can give you more time. But if not I would like to ask you a few

74 questions. That we could maybe talk about as a group.

75   **M:** did you think you had enough time to feel comfortable with how the site was laid

76   out?

77   **R:** ummm hmmm

78   **M:** ok, so the work sheets were long.   That was on purpose… When you were

79   looking for the things on the worksheet…. When you were looking for something,….

80   was the link that you were looking for easy to find? Was it obvious where you needed

81   to go?

82   **R:** With the web cameras, I thought that the web cam is just a picture. It is not a

83   picture its just now picture of how it is, but ok, It is more…. I did not think I would

84   geological (information) here.

85   **M:** So, the heading web cam is too vague?… it's not descriptive enough, it doesn't

86   tell you enough about what's underneath it?.

87   **R:** for example, web cam and explanations or web cam and….. (more)

88   **M:** something is missing there?

89   **R:** yea, I cant say what but I think it should give more of an idea that can find

90   information about meteorological, on webcam, or info.

91   **R:** When I was searching for question number 4 on the scars,…..

92   **M:** ok….

93   **R:** I would have looked under forests.

94   **M:** umhmmm

95   **R:** but ok, forest trees, but not rockfall.

96   **M:** Very understandable, if I had not designed the test myself I would have done the

97   same thing. That was one of the harder questions. (Laughter)

98   **M:** any other things you noticed about the organization and the links?

99   **R:** Ok, perhaps, it's a question of the screen or my eyes, but I cant, or I have

100   difficulties to see the blue and black. (link color) ya know, people in the alps, then you

101   have links like early mountain dwellers, but I cant recognize it as a link, or now I can

102   but perhaps another color or its bold or italic or …..another color.

103   **R:** Maybe, also, when you click the first line, living, non living, hazards, people (click

104   on people) and then after you click on one of these you have a second line with early

105   inhabitants, views and so on. Maybe you can spend half an hour looking at these

106   pictures and then coming back, then you want to go back to the first choice but here

107   you 5 choices, its not… uh….

108   **M:** doesn't let you go back far enough?

109   **R:** just to make more understandable that the second line is linked to the first choice

110   people. Because then you look at these five together and think I am in people now.

111   But they are not on the same level.

112   **M:** There different levels I understand.

113   **R:** and here you don't understand it. You think they are the same level

114   **R:** (indistinguishable)

115   **R:** If you go on hazards there is a free line between the first and second level… I

116   think that is a little better because you see some difference between them. But on

117   people or the other links without any space…

118   **M:** Did everyone know where they were, did you ever feel lost in the levels?

119   **R:** (silence and shaking head no)

120   **M:** You always had an idea of where you were and where to go?

121   **R:** yes

122   **R:** yes

123   **R:** yes

124   **R:** yes

125   **M:** What was the hardest question to answer?

126   **R:** Rockfall, #4, the scar

127   **M:** The scar of the tree?

128   **R:** yea

129   **R:** I stilldont know how to get the altitude of one of the mountains?

130   **M:** ok

131   **R:** Im not sure,…. Do I go to one of the web cams?

132   **M:** yes

133   **R:** What was it again…. Mythen?

134   **M:** yea

135   **M:** at the top… under description. It's a description of what the camera is looking at.

136   **R:** oh, ok

137   **M:** So If you could tell me one word that represents this web site, one thing, one word

138   that comes to mind after using this web site? What would it be?

139   **R:** Thinking?

140   **R:** Nice pictures.

141   **M:** Stefi?

142   **R:** yup….. yup…..I like it yup,…. Only one word is difficult.

143   **R:** much information.

144   **R:** It's a good mix of pictures and information.

145   **R:** Well balanced

146   **M:** Well balanced?

147   **R:** yea

148   **M:** That brings up an interesting question that I had…Balance of the page…. Does the

149   page look balanced….you say it does, does anyone else agree or disagree with that?

150   With two pictures on the left and one on the right? Does that need to be different or

151   improved in any way?

152   **R:** no this is good, its ok

153   **R:** its good.

154   **M:** If you could tell me one thing to improve what would that be?

155   **R:** So specific?

156   **R:** The color of the links.

157   **M:** Color of the links…..

158   **R:** Names of the places (on the pictures)

159   **R:** also names of the glaciers.

160   **M:** Oh, the name of the glacier?

161   **M:** ok

162   **R:** What is this picture at the top, … the resolution is not so good.

163   **M:** What page is that?

164   **R:** (Shows me the page)

165   **M:** Unfortunately we did not get to design the colors and that fuzzy mountain at the

166   top.

167   **M:** That was beyond our control.

168   **R:** ok

169   **M:** Would it be safe to say that this site is user friendly? Some who didn't know

170   much about computers could come here and learn about different things. Or do you

171   think they would have some trouble?

172   **R:** I think it's a site that if you had no special aim you could look around and then you

173   find allot. That's really good.

174   **M:** So, its more set up you mean for just looking around casually

175   **R:** yea, I think It would be a site that people would really like to surf.....when they

176   find the site they will stay there for 10 or for 15 minutes because there is much

177   information and nice pictures and the web cam, ya know, I think they like this.

178   **M:** it is an attraction.

179   **R:** yup

180   **M:** ok, I have these sentences, I started them and if you could just finish the sentence

181   for me… I started it, and then you can make up the ending however you like.

182   **R:** Are you a physiologist also? Its not easy find a way to understand if its good or

183   not

184   **M:** that's part of the project.

185   **R:** What if the only problem I had was English?

186   **M:** No that's ok, If that your only problem you can write that.

187   **M:** write anything you want.

188   **M:** this is the easy part. (handing out 2d map)

189   **M:** This is a graph with two axis. The one on the bottom represents how easily you

190   were able to use the site and the vertical one represents how well you understood the

191   information you saw. 0 is bad and 10 is good, 10 would be the best, and 0 would be

192   the worst. Make one x where the lines would cross.

193   **R:** (joking about how their poor English was their own problem and they didn't know

194   how to rate the site because if they spoke better English they would have more easily

195   used and understood site)

196   **M:** Ok, while your thinking about that I just wanted to repeat back what heard in our

197   little meeting. It sounded like there was lots of good information, you liked the

198   pictures and it was good for casual browsing. And it was fairly well laid out and

199   organized. And we could improve the color of the links, or draw more attention to

200   them, explain were pictures were taken and the web cam heading should be more

201   encompassing. It should hint that there is more to the story than just a web camera.

202   Did I miss anything? Were there any key points that I overlooked?

203   **R:** No

204   **R:** no

205   **R:** No it was very good

206   **M:** Would you say that that was an accurate summery?

207   **R:** yea (Pause)

208   **R:** yea

209   **R:** yea

210   **R:** yea

211   **M:** (pause)

212   **M:** Thank you all for coming, that's all I had, no more worksheets, no more questions,

213   (laughing)

214   **R:** Is there coffee?

215   **R:** (Laughing)

216   **End**

Appendix

<div align="right">

I
</div>

Technical Notes

Technical notes on the hardware and software used in the WPI/SLF Web

Camera IQP project.

Troubleshooting

Possible problems that can be encountered in the web camera setup.

Symptom: Web camera image not updated.

Possible problems:

1. Digital camera lost connection to server and became powered down.

    Diagnosis: The server's RemoteCapture application shows "Disconnected

    from camera."

    Solution: Power cycle the server and the camera. To power cycle:

    a. Turn off the power to both camera/enclosure and the server by either

    removing the plug from the wall socket or using a power switch.

    b. Wait approximately 30 seconds.

    c. Turn on power to both camera/enclosure and the server by plugging

    the power cord back into the wall socket or using a power switch.

    Note: It is not necessary to power down or up the camera and the

    server simultaneously. There can be a delay of up to a minute between

    the two.

2. The server has become powered down, but fails to turn back on by itself.

   Diagnosis: The server is not turned on, even though the power is being supplied.

   Solution: Power cycle the server and the camera, starting the server manually upon resumption of power.

3. The mobile network connection is failing.

   Diagnosis: The LED indicator on the mobile modem is blinking rapidly, with equal lengths of "on" and "off" lights.

   Solution: Verify that the mobile account associated with the SIM card is still valid. Verify that there is sufficient connection signal present by issuing AT+CSQ command to the mobile modem. Verify that the correct PIN is specified in the computer's configuration (SIM card may require PUK code to be entered before PIN can be sent).

Symptom: Weather data not updated.

Possible problems:

1. Database on the web host is failing.

   Diagnosis: Accessing http://www.iym.ch/processing/dbtest.php displays *Problem*.

   Solution: Report the database problem to the technical support staff of the web hosting company and ask for a resolution.

2. wdata@slf.ch e-mail account is not operating properly.

   Diagnosis: Sending an e-mail to wdata@iym.ch bounces OR http://www.iym.ch/processing/poptest.php displays *Problem*.

Solution: Report the database problem to the technical support staff of the web hosting company and ask for a resolution.

3. Weather data for Mythen site is not being sent from WSL.

   Diagnosis: http://www.iym.ch/processing/wdatalast.php?site=ge shows an old, not updated date.

   Solution: Contact Bruno Fritschi at WSL (bruno.fritschi@wsl.ch) to ensure that the weather data update batch file is scheduled and being run correctly from the data logging application.

4. Weather data for Diavolezza site is not being sent from SLF.

   Diagnosis: http://www.iym.ch/processing/wdatalast.php?site=ro shows an old, not updated date.

   Solution: Contact Urs Stöckli at SLF (u.stoeckli@slf.ch) to ensure that the weather data updates are scheduled and are being sent from SLF.

5. Weather data for La Dôle site or Monte San Salvatore site is not being sent from MeteoSchweiz.

   Diagnosis: http://www.iym.ch/processing/wdatalast.php?site=it or http://www.iym.ch/processing/wdatalast.php?site=fr show an old, not updated date.

   Solution: Contact Christian Schuler (scc@meteoswiss.ch) to ensure that regular weather updates are being sent from MeteoSchweiz to wdata@iym.ch.

Web Camera Setup

At each site:

- the web camera is mounted inside a camera enclosure;

- the camera enclosure is mounted to buildings using different kinds of mounting armatures;

- power and data cables from the enclosure are ran into the building with the server;

- the server inside the building transmits the data using a land or a mobile modem.

Camera

The digital snapshot camera used for the webcams is *Canon Powershot A20*. Each installation uses a *Canon AC Adapter Kit ACK600* to supply power from a 230V source.

USB cable is used to transmit data from the camera. Type mini-B to type A USB cable, included with the camera, is connected to the camera with the mini-B end. The mini-B connector has the plastic casing stripped from the sides, in order to allow it to be inserted through the enclosure's cable ports.

Because the distances between the server and the camera sometimes may be as long as 15 meters, but the maximum allowed physical length of a USB connection is 5 meters, the data cable is extended to necessary length using *5-meter active (single-hub) USB extension cables*. Attempts were made to minimize the length of the data cable present outdoors. The connections to the active USB cables that are located outdoors need to be protected from moisture. One way to implement such protection is to apply flexible plastic casing to the connection and use electrical tape to secure the casing to the cable. This also firmly holds the connection together, protected from disconnection by wind.

Before the camera is installed, it should be turned on and configured via the on-display menu. The configuration option "Auto Power Shutdown" should be set to

Off. The rest of the setup, which consists of the camera's time and date, and the ownership identification is performed via the settings dialog in the RemoteCapture application.

One of the cameras uses wide angle lens and lens adapter *Canon WC-DC52* and *Canon LA-DC52*.

Enclosure and Camera Mounting

The enclosure used to protect the cameras from the elements and provide heating during cold months is *Monacor TVG-400*. This enclosure is mounted to various walls and supports using the mounting arm *Monacor TVH-600*. Each enclosure is covered with *Monacor TVG-404* sun roof, for added protection, reduced internal heating from direct sun exposure and reduced amount of precipitation on the front window.

The camera is mounted inside on a guiding support. This support is attached to the camera enclosure rail via two screws. The camera is screwed on a third screw, using the camera's tripod mount, rising from the front right of the guiding support.

The guiding support also hosts a security support, using two screws. The security support flushes firmly with the camera, depressing the power button at all times. This ensures that the camera is turned on automatically in the event of power failure.

The enclosure contains a silicon bag, supplied with the enclosure, to eliminate the possible moisture inside.

Camera and Enclosure Power

The camera is powered using the ACK600 AC adapter. The adapter is placed inside the enclosure, with the camera end of the DC power cable attached to the camera's DC in. The AC power cable is trimmed to about 15cm from the end that plugs in to the AC adapter. The wires at the trimmed end and stripped. The stripped wires are inserted into the "AC out" part of the camera enclosure's electrical distribution board.

The power cable to the enclosure has a poly-plastic coating, for environmental protection. The power cable is inserted into one of enclosure's cable ports, with its wires stripped. The wires of the power cables are then connected to the "AC in" part of the enclosure's electrical distribution board.

The power cable is then ran into the building with the server. The power cable is then terminated with a power plug and is ready to be connected to a power outlet.

Mounting the Enclosure

On three out of four sites, the enclosure is attached to the TVH-600 mounting arm. The mounting arm is attached to a wall or another vertical surface.
One of the four sites uses a completely custom mount, due to the unusual mounting location of the camera.

Camera Server

The camera server regularly captures the image from the camera using the Canon RemoteCapture software, supplied with each Powershot A20 camera. The

custom applications on the server process the captured images and transmit them via Internet to the web server.

The server is a low-end machine, powered sufficiently to deal with the task of regularly downloading and processing images. The specifications for the servers used are as follows:

- Compaq EN, small case

- Pentium III 350MHz

- 128MB RAM

- 6.4GB hard drive

- CD-ROM and floppy

- Ethernet card on board

- Windows 2000

The Mythen camera server uses an Acer 56k modem to transmit the data over a plain phone line. The rest of the camera servers use a Siemens TC35 mobile terminal (along with the antenna and the power supply) from *MobileSolutions Siemens TC35 Starter Kit* to transmit the data over a mobile phone network.

Transmission of Captured Images

The captured images are transmitted to the central web server via the Internet. The connection to the Internet is achieved through an Internet Service Provider. In order to dial up these providers, access to a phone network is gained via either a plain modem or the mobile GSM network.

Before the images are transmitted to the server, they are broken into chunks. Should the upload of a chunk stall or fail, the camera server will attempt to retry

sending the unsuccessful chunk. Upon the receipt of the final chunk by the central web server, the image is reassembled and posted on the web site.

However, only the images with sufficient visual content are posted for public viewing by the central web server. This is achieved by posting pictures only above a certain size. Such an algorithm works because the JPEG compression used on the images tend to produce much smaller images if there is almost no contrast in the image. This mechanism prevents the uninteresting pitch black web camera images from appearing on the server.

Weather Data Setup

The weather data for all camera sites is received in three different ways, from three different weather data suppliers. The weather data for each site are provided by the following organizations:

Camera site	Organization
Mythen	WSL
Diavolezza	SLF
Monte San Salvatore	MeteoSchweiz
La Dôle	MeteoSchweiz

Upon receipt of a weather data update, the new information is stored in a climate values database on the web server. This is a MySQL database with the following schema:

```
CREATE TABLE weather (
  weather_id int(11) NOT NULL auto_increment,
  site enum('ro','ge','fr','it') NOT NULL default 'ro',
  sampletime datetime NOT NULL default '0000-00-00 00:00:00',
  temperature double(5,2) NOT NULL default '0.00',
  humidity double(4,2) NOT NULL default '0.00',
  snowheight double(5,3) NOT NULL default '0.000',
```

```
    precipitation double(5,3) NOT NULL default '0.000',
    pressure double(6,4) NOT NULL default '0.0000',
    winddirection double(4,2) NOT NULL default '0.00',
    windspeed double(5,3) NOT NULL default '0.000',
    sunshine double(6,4) NOT NULL default '0.0000',
    PRIMARY KEY  (weather_id)
) TYPE=MyISAM;
```

As the visitors of the site access the camera site pages, the latest weather data is
fetched from the database and displayed to the user. The embedding of the fetched
weather data in the web page, as well as the database access itself, are implemented
using the PHP scripting language.

Weather data via web: Mythen

The weather data is sent to http://www.iym.ch/processing/mythenweather.php,
by WSL, with a file attached via the HTTP file upload mechanism. This file contains
the information for the latest weather data update, with each value separated by
commas. Here is a sample Mythen weather data file:

```
2,2001,340,1700,.899,-1.189,15,0,42.27,4.261,0
```

The meanings of each values break down as follows:

```
2,              Logging file identification number
2001,           Year
340,            Julian day
1700,           Time, HHMM
.899,           Air temperature, in C° averaged over 3 hours
-1.189,         Dew point, in C° averaged over 3 hours
15,             Snow height in cm
0,              Wind direction in degrees
42.27,          Wind speed, maximum m/s in last 3 hours
4.261,          Sun shine, minutes in the last 3 hours
0               Precipitation, in mm averaged over 3 hours
```

Weather data via web: Diavolezza

The weather data is sent to
http://www.iym.ch/processing/diavolezzaweather.php, by SLF, with a file attached
via the HTTP file upload mechanism. The file contains the information from the latest

128

weather data update, with values annotated with headings on one line, and separated

with commas on the other line. The format is similar to that of Mythen weather data

updates.

Weather data via e-mail: Monte San Salvatore and La Dôle

The weather data is sent to wdata@iym.ch, by MeteoSchweiz. It arrives in the

following format, with annotated headings:

```
Automatic generated mail by WeatherMan

001
VPAA06 LSSW 141009
MeteoSchweiz

Stundenwerte

Stat    Temp    relF    Nieder    Druck    Windg    Windr    Sonne
Schnee    Datum/Zeit
        Grad C    %        mm        hPa      m/sec    Grad     min
mm
DOL    -11.8    69.5      0.0      826.7    12.5     101       23
-    20011214094
0
LUG     -1.4    71.2      0.0      996.6     0.9     150       60
-    20011214094
0

Routed by WeatherMan System at MeteoSwiss
```

The units and climate values are indicated in the headings.

Appendix

J

Programming code

```php
<?php
// weatherutil.php
// Weather utilities - WPI/SLF IYM 2002 Web Camera Project
// Version: 1.0
// Author: Oleg Rekutin, uksi@wpi.edu

// Database Connectivity
require_once('/raid/virt-server/slf/processing/dbconfig.php');

// Generalized weather updates
function addweather($site, $when, $wdata) {

    global $DB_HOST, $DB_USER, $DB_PASS, $DB_DB;

    $db = mysql_connect($DB_HOST, $DB_USER, $DB_PASS);
    mysql_select_db($DB_DB, $db);

    $sql = 'INSERT INTO weather '
            . 'SET sampletime=FROM_UNIXTIME(' . $when . '), '
            . 'site=\'' . $site . '\', '
            . 'temperature=' . $wdata['temperature'] . ', '
            . 'humidity=' . $wdata['humidity'] . ', '
            . 'snowheight=' . $wdata['snowheight'] . ', '
            . 'precipitation=' . $wdata['precipitation'] . ', '
            . 'pressure=' . $wdata['pressure'] . ', '
            . 'winddirection=' . $wdata['winddirection'] . ', '
            . 'windspeed=' . $wdata['windspeed'] . ', '
            . 'sunshine=' . $wdata['sunshine'];

    $result = mysql_query($sql, $db);
    if ($result === false)
        user_error('Cannot insert data into database: ' . mysql_error(),
E_USER_ERROR);

    if (mysql_affected_rows() == 0)
        user_error('No data inserted into database: ' . mysql_error(), E_USER_ERROR);

    mysql_close($db);

}


// Retrieve most recent weather for a particular site
function recentweather($site) {

    global $DB_HOST, $DB_USER, $DB_PASS, $DB_DB;

    $db = mysql_connect($DB_HOST, $DB_USER, $DB_PASS);
    mysql_select_db($DB_DB, $db);

    $sql = 'SELECT sampletime, temperature, humidity, snowheight, precipitation,
pressure, '
            . 'winddirection, windspeed, sunshine FROM weather '
            . 'WHERE site=\'' . $site . '\' '
            . 'ORDER BY sampletime DESC LIMIT 1';

    $result = mysql_query($sql, $db);
    if ($result === false)
        user_error('Failed to fetch weather data: ' . mysql_error(), E_USER_ERROR);

    $wdata = mysql_fetch_array($result, MYSQL_ASSOC);
```

```php
    // Now we get cumulative stats

    $sql = 'SELECT SUM(sunshine) AS sunshine_today FROM weather '
         . 'WHERE site=\'' . $site . '\' '
         . ' AND TO_DAYS(sampletime) = TO_DAYS(\'' . $wdata['sampletime'] . '\')';

    $result = mysql_query($sql, $db);
    if ($result === false)
        user_error('Failed to fetch weather data: ' . mysql_error(), E_USER_ERROR);

    $extra = mysql_fetch_array($result, MYSQL_ASSOC);
    $wdata['sunshine_today'] = $extra['sunshine_today'];


    mysql_close($db);

    return $wdata;

}


// Varied weather utilities

function dewpoint2humidity($temp, $dew) {

    $mid = (112-(0.1*$temp)+$dew)/(112+(0.9*$temp));
    return pow($mid, 8) * 100.0;

}


function bearing2dir($bearing) {

    if ((($bearing >= 0) && ($bearing < 22.5)) ||
        (($bearing >= 337.5) && ($bearing < 360))) {
        return 'N';
    }

    if (($bearing >= 22.5) && ($bearing < 67.5)) {
        return 'NE';
    }

    if (($bearing >= 67.5) && ($bearing < 112.5)) {
        return 'E';
    }

    if (($bearing >= 112.5) && ($bearing < 157.5)) {
        return 'SE';
    }

    if (($bearing >= 157.5) && ($bearing < 202.5)) {
        return 'S';
    }

    if (($bearing >= 202.5) && ($bearing < 247.5)) {
        return 'SW';
    }

    if (($bearing >= 247.5) && ($bearing < 292.5)) {
        return 'W';
    }

    if (($bearing >= 292.5) && ($bearing < 337.5)) {
        return 'NW';
    }

}

?>

<?php
    // imgreceive.php
    // Camera Site Image Reception - WPI/SLF IYM 2002 Web Camera Project
    // Version: 1.0
    // Author: Oleg Rekutin, uksi@wpi.edu
```

131

```php
// configuration
require_once('siteconfig.php');

// get params
$site = $HTTP_POST_VARS['site'];
$passwd = $HTTP_POST_VARS['pass'];

// security & param check
if ($passwd != 'duncecap')
    user_error('Banned incoming IP address', E_USER_ERROR);

if (($site != 'ro') && ($site != 'fr')
     && ($site != 'it') && ($site != 'ge'))
    user_error('Invalid camera site', E_USER_ERROR);

$STORAGE_SITE_PATH = $STORAGE_PATH . $site . '/';


// get the image info
$imgname = $HTTP_POST_FILES['image']['name'];
$imgpath = $HTTP_POST_FILES['image']['tmp_name'];
$imgsize = $HTTP_POST_FILES['image']['size'];


// validate image
if (!is_uploaded_file($imgpath))
    user_error('No image submitted for upload', E_USER_ERROR);

if ($imgsize > $MAX_CHUNK_SIZE)
    user_error('Maximum image chunk size exceeded (uploaded size: '
               . $imgsize . ')', E_USER_ERROR);

$chunknum = substr($imgname, -3);

if (!is_numeric($chunknum)) {
    user_error('Unable to determine chunk number from ' . $imgname, E_USER_ERROR);
}

$name = $site . '-chunk.jpg.' . $chunknum;

// first chunk kills existing chunks
if ($chunknum == '001') {
    system('rm -f ' . $STORAGE_SITE_PATH . substr($name, 0, -3) . '*');
}

print "Saving $name...<br>\n";

// move the image into storage
move_uploaded_file($imgpath, $STORAGE_SITE_PATH . $name);

// merge all chunks if we received the last one
if (@$HTTP_POST_VARS['chunk'] == 'final') {
    chdir($STORAGE_PATH);
    $today = getdate();
    $finalname = $site
                 . '_' . $today['year'] . '-' . sprintf('%02d', $today['mon'])
                 . '-' . sprintf('%02d', $today['mday'])
                 . '_' . sprintf('%02d', $today['hours'])
                 . '-' . sprintf('%02d', $today['minutes'])
                 . '-' . sprintf('%02d', $today['seconds'])
                 . '.jpg';
    $finalpath = $STORAGE_SITE_PATH . $finalname;
    print "Merging image: " . $finalname . "...<br>\n";
    system('cat ' . $STORAGE_SITE_PATH . substr($name, 0, -3) . '* >'
           . $finalpath);
    system('rm -f ' . $STORAGE_SITE_PATH . substr($name, 0, -3) . '*');
    system('chmod a+w ' . $finalpath);

    // At this point, the image from the camera site has been completely
    // received and stored on the server. Now the script will prepare
    // versions of the images for public view on the site, but only if
    // they contain useful content. This is to avoid pitch black or
    // all-single-color images.

    // Useful content is detected based on the size of the image. If
    // the final image is smaller than $MIN_PUBLIC_SIZE, it is not put up
    // for public view.
```

```php
        // verify public suitability
        $fileinfo = stat($finalpath);

        if ($fileinfo[7] < $MIN_PUBLIC_SIZE) {
            print "Image not put up for public view.<br>\n";
            exit();
        }


        // create thumbnail
        $thumbpath = $STORAGE_PATH . $site . '_current_thumb.jpg';
        system("cp $finalpath $thumbpath; chmod a+w $thumbpath");
        system("$MOGRIFY_PATH $THUMBNAIL_MOGRIFY $thumbpath");

        // create midsize w/ annotation
        $midsizepath = $STORAGE_PATH . $site . '_current_midsize.jpg';
        system("cp $finalpath $midsizepath; chmod a+w $midsizepath");

        $note = $today['year'] . '-' . sprintf('%02d', $today['mon'])
                . '-' . sprintf('%02d', $today['mday'])
                . ' ' . sprintf('%02d', $today['hours']) . ':' . sprintf('%02d',
$today['minutes']);
        $midsizenote = $MIDSIZE_NOTE_BEFORE . $note . $MIDSIZE_NOTE_AFTER;

        system("$MOGRIFY_PATH $MIDSIZE_MOGRIFY $midsizenote $midsizepath");

        // copy full-size
        $fullsizepath = $STORAGE_PATH . $site . '_current_fullsize.jpg';
        system("cp $finalpath $fullsizepath; chmod a+w $fullsize");
        // no transmogrifying the full size image
        // system("$MOGRIFY_PATH $FULLSIZE_MOGRIFY $fullsizepath");

    }

?>

<?php

// zoomlocator.php
// Zoom and pan locator generation - WPI/SLF IYM 2002 Web Camera Project
// Version: 1.0
// Author: Oleg Rekutin, uksi@wpi.edu

// configuration
require_once('siteconfig.php');

$LOCATOR_X = 80;
$LOCATOR_Y = 60;

$cluster_x = $HTTP_GET_VARS['x'];
$cluster_y = $HTTP_GET_VARS['y'];

if (!is_numeric($cluster_x) || !is_numeric($cluster_y)) {
    user_error('Cluster coordinates not specified.', E_USER_ERROR);
}

$pos_x = $LOCATOR_X * (((((float)$cluster_x) - 1) / $CLUSTER_RES / $CLUSTERS);
$pos_y = $LOCATOR_Y * (((((float)$cluster_y) - 1) / $CLUSTER_RES / $CLUSTERS);

$gif = ImageCreate($LOCATOR_X, $LOCATOR_Y);
$bg = ImageColorAllocate($gif,0x66,0xcc,0xff);
$tx = ImageColorAllocate($gif,0x00,0x00,0x00);
$hi = ImageColorAllocate($gif,0x00,0x66,0xcc);

ImageFilledRectangle($gif, 0, 0, $LOCATOR_X - 1, $LOCATOR_Y - 1, $tx);
ImageFilledRectangle($gif, 2, 2, $LOCATOR_X - 3, $LOCATOR_Y - 3, $bg);

ImageFilledRectangle($gif, $pos_x, $pos_y,
                            $pos_x + ($LOCATOR_X / $CLUSTERS),
                            $pos_y + ($LOCATOR_Y / $CLUSTERS),
                     $hi);

header("Content-type: image/gif");

ImageGif($gif);
```

```php
?>

<?php

// zoom.php
// Zoom and pan around an image utility - WPI/SLF IYM 2002 Web Camera Project
// Version: 1.0
// Author: Oleg Rekutin, uksi@wpi.edu

// configuration
require_once('siteconfig.php');

$site = $HTTP_GET_VARS['site'];

if (($site != 'ro') && ($site != 'fr')
    && ($site != 'it') && ($site != 'ge'))
    user_error('Invalid camera site', E_USER_ERROR);

switch($site) {
    case 'ro':
        $sitename = 'Diavolezza';
        break;
    case 'it':
        $sitename = 'Mt San Salvatore';
        break;
    case 'fr':
        $sitename = 'La Dole';
        break;
    case 'ge':
        $sitename = 'Mythen';
        break;
}

$cluster_x = $HTTP_GET_VARS['x'];
$cluster_y = $HTTP_GET_VARS['y'];

if (!is_numeric($cluster_x) || !is_numeric($cluster_y)) {
    user_error('Cluster coordinates not specified.', E_USER_ERROR);
}

?>

<html>
<head><title>Zoom and pan on <?php print $sitename; ?></title>
<link rel="stylesheet" href="http://www.iym.ch/iym.css" type="text/css">
</head>
<body>

<table width="350"><tr><td>

<table width="100%">
  <tr>
    <td width="*" valign="top">
      <b>Zooming in on</b> <span class="highlight"><?php print $sitename; ?></span>
    </td>
    <td width="96">
      <img src="http://www.iym.ch/processing/zoomlocator.php?x=<?php
                print $cluster_x ?>&y=<?php
                print $cluster_y ?>&site=<?php
                print $site?>" width="96" height="72" align="center">
    </td>
  </tr>
</table>

<table align="center">
  <tr>
    <td> </td>
    <td>
      <center>
<?php if ($cluster_y > 1) { ?>
  <a href="zoom.php?x=<?php print $cluster_x?>&y=<?php print $cluster_y-1?>&site=<?php
print $site?>"><img src="uparrow.gif" border="0"></a>
<?php } ?>
      </center>
    </td>
    <td> </td>
  </tr>
```

```
    <tr>
      <td>
        <center>
<?php if ($cluster_x > 1) { ?>
  <a href="zoom.php?x=<?php print $cluster_x-1?>&y=<?php print $cluster_y?>&site=<?php
print $site?>"><img src="leftarrow.gif" border="0"></a>
<?php } ?>
        </center>
      </td>
      <td><img src="http://www.iym.ch/processing/imgpart.php?x=<?php
            print $cluster_x ?>&y=<?php
            print $cluster_y ?>&site=<?php
            print $site?>" width="256" height="192"></td>
      <td>
        <center>
<?php if ($cluster_x < ((($CLUSTERS-1) * $CLUSTER_RES)+1)) { ?>
  <a href="zoom.php?x=<?php print $cluster_x+1?>&y=<?php print $cluster_y?>&site=<?php
print $site?>"><img src="rightarrow.gif" border="0"></a>
<?php } ?>
        </center>
      </td>
    </tr>
    <tr>
      <td> </td>
      <td>
        <center>
<?php if ($cluster_y < ((($CLUSTERS-1) * $CLUSTER_RES)+1)) { ?>
  <a href="zoom.php?x=<?php print $cluster_x?>&y=<?php print $cluster_y+1?>&site=<?php
print $site?>"><img src="downarrow.gif" border="0"></a>
<?php } ?>
        </center>
      </td>
      <td> </td>
    </tr>
</table>

</td></tr></table>

</body>
</html>
```

sendimage.php

```php
<?php

$CONFIG_DIR = '/WPISLF/config';
$dir = opendir($CONFIG_DIR);

$result = array();

while (false !== ($file = readdir($dir)))
    if (preg_match('/^config[0-9]*.php$/', $file))
        $result[] = $file;

closedir($dir);

sort($result);

include($CONFIG_DIR . '/' . $result[count($result)-1]);

// lists the chunks of the captured image
function FindChunks() {

    global $CHUNK_STORE;
    global $IMAGE_NAME;

    $dir = opendir($CHUNK_STORE);

    $result = array();

    while (false !== ($file = readdir($dir)))
        if (preg_match('/^' . preg_quote($IMAGE_NAME) . '\.[0-9]*$/', $file))
            $result[] = $file;

    closedir($dir);
```

```
    return $result;

}

$retval = -1;

if (!$NO_DIALUP) {
    // Initialize the mobile configuration
    if ($MOBILE) {
        print "Initializing mobile config...";
        passthru("$ESTPIN_PATH $MOBILE_PORT $MOBILE_PIN", $retval);
        print " return value: $retval.\n";
    }

    // Obtain dial-up connection
    $attempts = 0;
    do {
        print "Dialing up $CONNEXION, attempt #" . ($attempts+1)
              . "...";
        passthru($DIAL_PATH . ' ' . $CONNEXION, $retval);
        print " return value: $retval.\n";
        $attempts ++;
    } while(($retval != 0)
            && ($attempts < $MAX_CONN_ATTEMPTS));

    if (($retval != 0) && ($attempts == $MAX_CONN_ATTEMPTS)) {
        $fp = fopen("/WPISLF/capture/error", "w");
        fputs($fp, "maximum number of connection attempts exceeded");
        fclose($fp);
    }

}


// Split
print "Chunking image in $IMAGE_CHUNK_SIZE" . "kb pieces...\n";
$old_dir = getcwd();
chdir($CHUNK_STORE);
passthru($SPLITS_PATH . ' ' . $IMAGE_PATH . ' ' . $IMAGE_CHUNK_SIZE);

$chunknames = FindChunks();

print "Sending image (in chunks)...\n";

for ($i = 0; $i < count($chunknames); $i++) {

    $cmdline = "$CURL_PATH -v -F image=@$CHUNK_STORE" . '/'
               . $chunknames[$i] . " -F pass=duncecap -F site=$SITE ";
    if ($i + 1 == count($chunknames))
        $cmdline .= "-F chunk=final ";
    $cmdline .= "--connect-timeout $CONN_TIMEOUT -m $MAX_TIME "
         //      . "-y $SPEED_TIME -Y $MIN_SPEED "
               . "$SERVER_URL";
    print "$cmdline\n";

    $attempts = 0;
    do {
        system($cmdline, $retval);
        $attempts ++;
    } while(($retval != 0)
            && ($attempts < $MAX_UPLOAD_ATTEMPTS));

    if (($retval != 0) && ($attempts == $MAX_UPLOAD_ATTEMPTS)) {
        // Failed to upload the image
        // what to do here?
    }

}


chdir($old_dir);

print "Requesting configuration update...\n";

$fd = fopen($UPDATE_URL, 'r');
```

```php
$buffer = fgets($fd, 4096);

print "Received: '$buffer'\n";

if (strstr($buffer, 'UPDATE') != FALSE) {
    // updating configuration!
    // next line contains file name
    $filename = fgets($fd, 192);

    $configout = $CONFIG_DIR . '/' . trim($filename);

    $cfd = fopen($configout, 'w');

    while (!feof ($fd)) {
        $buffer = fgets($fd, 4096);
        fputs($cfd, $buffer);
    }

    fclose($cfd);
}

fclose ($fd);

include('/WPISLF/updateschedule.php');

print "Hanging up dial up connection.\n";

system($HANGUP_PATH);

?>



<?php

  // Expects to be inserted/called during an active Internet connection,
  // Expects site configuration to be available during use.

print "Requesting schedule update...\n";

$fd = fopen($SCHED_UPDATE_URL, 'r');

$buffer = fgets($fd, 4096);

print "Received: '$buffer'\n";

if (strstr($buffer, 'UPDATE') != FALSE) {
    // updating configuration!
    // next lines contain hour/minute combinations, separated by space,
        // one per line
        system($SCHED_KILL_PATH);
    while (!feof ($fd)) {
        $buffer = fgets($fd, 4096);
                system($SCHED_UPD_PATH . ' ' . $buffer);
    }

}

fclose ($fd);



?>
```

capture.bat:

```
@echo off

c:
cd \WPISLF\Capture

echo Preparing...

echo y | del *.*
```

```
echo Capturing image.
\WPISLF\forcerelease.exe
if ERRORLEVEL 1 GOTO capturefailure

echo Waiting for capture to finish...

\WPISLF\sleep.exe 250

echo Captured.

ren *.jpg cap.jpg

echo Processing image...

rem \WPISLF\imagemagick\mogrify -quality 67 -crop 10% -geometry 75%%
\WPISLF\capture\cap.jpg
\WPISLF\imagemagick\mogrify -quality 67 -geometry 64%% \WPISLF\capture\cap.jpg

echo Sending image...

php -q \WPISLF\sendimage.php

echo Archiving image...
\WPISLF\datefile.exe cap.jpg

move *.jpg archive

:success
IF EXIST \WPISLF\capture\error GOTO end
echo image capture success > \WPISLF\capture\success
goto end

:capturefailure
echo image capture failure > \WPISLF\capture\error
echo Failed to capture the image...
:end

cd \wpislf

echo Done.
```

estpin.c:

```c
#include <windows.h>
#include <stdio.h>

#define BUFFER_LEN 4096
#define PINID_CMD  "AT+CPIN=%s\r"


int comwrite(HANDLE comm, char *buffer) {

    DWORD bytes = -1;

    printf("Writing\n    %s\n...", buffer);

    if (WriteFile(comm, buffer, strlen(buffer), &bytes, NULL) == 0) {
        printf("Failure writing to the %s port (error: %d).\n",
                comm, GetLastError());
        return 3;
    }

    if (FlushFileBuffers(comm) == 0) {
        printf("Failure flushing the %s port. (error %d).\n",
                comm, GetLastError());
        return 3;
    }

    printf(" written.\n");

    return 0;

}

char *comreceive(HANDLE comm) {
```

```
    DWORD        bytes = 0;
    DWORD        count = 0;
    static char  buffer[BUFFER_LEN];

    printf("Reading from port... ");

    while (1) {

        if (ReadFile(comm, buffer + count, BUFFER_LEN - count, &bytes, NULL) == 0) {
            printf("Failure reading from the %s port (error: %d).\n",
                   comm, GetLastError());
            return NULL;
        }

        count += bytes;

        buffer[count] = 0;

        if (strstr(buffer, "OK\r") != NULL) {
            break;
        }

    }

    printf("received: %s\n", buffer);

    return buffer;

}

int main(int argc, char** argv) {

    HANDLE  comm;
    char    *port, *pin;
    DCB      dcb;
    char    *str;
    char    *substr;
    DWORD    tmp;
    char     pincommand[200];

    if (argc != 3) {
        printf("Usage: comm <comport> <sim pin>\n");
        return 1;
    }

    port = argv[1];
    pin  = argv[2];

    printf("Opening port %s...", port);

    comm = CreateFile(port, GENERIC_READ | GENERIC_WRITE,
                      0, NULL, OPEN_EXISTING, FILE_ATTRIBUTE_NORMAL,
                      NULL);

    if (comm == INVALID_HANDLE_VALUE) {
        printf("Failed to open the communications port (%s).\n",
               port);
        return 2;
    }

    printf(" opened.\n");

    if (!SetupComm(comm, 128, 128)) {
        printf("SetupComm failed (%s).\n", GetLastError());
        return 2;
    }

    if (!GetCommState(comm, &dcb)) {
        // Handle the error.
        printf ("GetCommState failed with error %d.\n", GetLastError());
        return (2);
    }

    GetCommModemStatus(comm,  &tmp);

    printf("Received modem status: %d.\n", tmp);
```

139

```
    // Fill in the DCB: baud=57,600 bps, 8 data bits, no parity, and 1 stop bit.

    dcb.BaudRate = CBR_57600;        // set the baud rate
    dcb.ByteSize = 8;                // data size, xmit, and rcv
    dcb.Parity = NOPARITY;           // no parity bit
    dcb.StopBits = ONESTOPBIT;       // one stop bit
    dcb.fAbortOnError = TRUE;

    if (!SetCommState(comm, &dcb)) {
        // Handle the error.
        printf ("SetCommState failed with error %d.\n", GetLastError());
        return (2);
    }

    COMMTIMEOUTS timeouts;

    timeouts.ReadIntervalTimeout = 20;
    timeouts.ReadTotalTimeoutMultiplier = 10;
    timeouts.ReadTotalTimeoutConstant = 100;
    timeouts.WriteTotalTimeoutMultiplier = 10;
    timeouts.WriteTotalTimeoutConstant = 100;

    if (!SetCommTimeouts(comm, &timeouts)) {
        printf ("SetCommTimeouts failed with error %d.\n", GetLastError());
        return (2);
    }


    if (comwrite(comm, "AT+CPIN?\r"))
        return 3;

    if (!(str = comreceive(comm)))
        return 4;

    if (!(substr = strstr(str, "+CPIN: "))) {
        printf("Failed to receive a valid PIN response.\n");
        return 5;
    }

    substr += 7;

    if (strncmp(substr, "READY", 5) == 0) {
        printf("No PIN entry required.");
        return 0;
    }

    if (strncmp(substr, "SIM PIN", 7) != 0) {
        printf("Unknown response or non-PIN1 authentication required.\n");
        return 0;
    }

    sprintf(pincommand, PINID_CMD, pin);

    if (comwrite(comm, pincommand))
        return 3;

    if (!(str = comreceive(comm)))
        return 4;

    if (!(substr = strstr(str, "OK"))) {
        printf("Failed authenticate the PIN number.\n");
        return 5;
    }

    CloseHandle(comm);

    return 0;

}
```

rasdial.c:

```
#include <windows.h>
#include <ras.h>
```

```c
#include <raserror.h>
#include <stdio.h>
#include <string.h>
#include "rasutil.h"


int DialConnection(LPRASENTRYNAME target) {

    DWORD result;
    RASDIALEXTENSIONS ext;
    RASDIALPARAMS params;
    BOOL passwd;
    HRASCONN conn = NULL;
    RASCONNSTATUS status;

    status.dwSize = sizeof(RASCONNSTATUS);

    ext.dwSize = sizeof(RASDIALEXTENSIONS);
    ext.dwfOptions = RDEOPT_IgnoreSoftwareCompression
                   | RDEOPT_SetSoftwareCompression;
    ext.hwndParent = NULL;
    ext.reserved = 0;
    ext.reserved1 = 0;
    ext.RasEapInfo.dwSizeofEapInfo = sizeof(RASEAPINFO);


    params.dwSize = sizeof(RASDIALPARAMS);
    strcpy(params.szEntryName, target->szEntryName);

    result = RasGetEntryDialParams(NULL, &params, &passwd);
    if (result != 0) {
        printf("RasGetEntryDialParams error: %d.\n", result);
        return 4;
    }

    printf("Dialing %s as %s...\n", params.szEntryName,
            params.szUserName);

    result = RasDial(&ext, NULL, &params,
                     0, NULL, &conn);
    if (result != 0) {
        printf("RasDial error: %d.\n", result);
        if (conn != NULL)
            HangUp(conn);
        return 5;
    }

    result = RasGetConnectStatus(conn, &status);
    if (result != 0) {
        printf("RasGetConnectStatus error: %d.\n", result);
        HangUp(conn);
        return 5;
    }

    if (status.dwError != 0) {
        printf("Error in connection: %d.\n", status.dwError);
        HangUp(conn);
        return 5;
    }

    if (status.rasconnstate != RASCS_Connected) {
        printf("Not connected, current state: %d.\n", status.rasconnstate);
        HangUp(conn);
        return 5;
    }

    printf("Connected via %s (%s).\n", status.szDeviceType,
            status.szDeviceName);

    return 0;

}



int main(int argc, char** argv) {
```

```
    LPRASENTRYNAME lpRasEntryName;
    int nRet, i;
    DWORD cEntries;
    DWORD cb = sizeof(RASENTRYNAME);
    LPRASENTRYNAME targetEntryName = NULL;

    // Ensure that a parameter was provided
    if (argc != 2) {
        printf("Usage: rasdial <connection name>\n");
        return 2;
    }

    printf("Looking for dialup connection %s...\n", argv[1]);

    lpRasEntryName = (LPRASENTRYNAME)GlobalAlloc(GPTR, sizeof(RASENTRYNAME));
    lpRasEntryName->dwSize = sizeof(RASENTRYNAME);
    if ((nRet = RasEnumEntries(NULL, NULL, lpRasEntryName, &cb, &cEntries))
        == ERROR_BUFFER_TOO_SMALL) {
        lpRasEntryName = (LPRASENTRYNAME)GlobalAlloc(GPTR, cb);
        lpRasEntryName->dwSize = sizeof(RASENTRYNAME);
    }

    // Calling RasEnumEntries to enumerate the phone-book entries
    nRet = RasEnumEntries(NULL, NULL, lpRasEntryName, &cb, &cEntries);

    if (nRet != ERROR_SUCCESS) {
        printf("RasEnumEntries failed: Error %d\n", nRet);
        return 1;
    }

    printf("Phone-book entries in the default phone book:\n");
    for(i=0;i < cEntries;i++) {
        printf("  %s",lpRasEntryName[i].szEntryName);
        if (0 == strcmp(lpRasEntryName[i].szEntryName, argv[1])) {
            printf(" <-- target");
            targetEntryName = &lpRasEntryName[i];
        }
        printf("\n");
    }

    if (targetEntryName == NULL) {
        printf("Could not find entry %s.\n", argv[1]);
        return 3;
    }

    // Dial the found connection
    return DialConnection(targetEntryName);

}
```

rashang.c:

```
#include <windows.h>
#include <stdio.h>
#include <string.h>
#include "rasutil.h"


int main(int argc, char **argv) {

    // Find an existing connection
    RASCONN * lpRasConn;
    DWORD     lpcb;
    DWORD     lpcConnections;
    int       nRet, i;

    lpRasConn = (LPRASCONN) GlobalAlloc(GPTR, sizeof(RASCONN));
    lpRasConn->dwSize = sizeof(RASCONN);
    lpcb = sizeof(RASCONN);

    nRet = RasEnumConnections(lpRasConn, &lpcb, &lpcConnections);
    if (nRet != 0) {
        printf("RasEnumConnections failed: Error = %d", nRet);
    } else {
        printf("The following %d RAS connections are currently active:\n",
```

```
                lpcConnections);
        for (i = 0; i < lpcConnections; i++) {
            printf("    %s ", lpRasConn[i].szEntryName);
            printf(" (hanging up...");
            HangUp(lpRasConn[i].hrasconn);
            printf(" done)\n");
        }
    }

    // Kill it

    return 0;

}
```

rasutil.c:

```
#include <stdio.h>
#include <string.h>
#include "rasutil.h"

void HangUp(HRASCONN conn) {

    RASCONNSTATUS status;
    status.dwSize = sizeof(RASCONNSTATUS);

    printf("Hanging up...");

    RasHangUp(conn);

    // FIXME: Warning, potential infinite loop.
    while (RasGetConnectStatus(conn, &status) == 0) {
        if (status.dwError == ERROR_INVALID_HANDLE)
            break;
        printf("  connection status: %d, dwError: %d\n",
               status.rasconnstate, status.dwError);
        Sleep(1000);
    }

}
```

rasutil.h:

```
#include <windows.h>
#include <ras.h>
#include <raserror.h>

void HangUp(HRASCONN conn);
```

forcerelease.cpp:

```
#include <windows.h>
#include <iostream>

#pragma hdrstop

using namespace std;

int main() {

    HWND captWnd;

        captWnd = FindWindow(NULL, "RemoteCapture");

        cout << "RemoteCapture window handle:" << captWnd << endl;

        if (captWnd == NULL) {
            cout << "Can't find RemoteCapture window. Aborting." << endl;
            return 1;
        }


        HRESULT res;
```

```
        res = SendMessage(captWnd, WM_SYSCOMMAND, SC_HOTKEY, MAKELONG(captWnd, 0));

        cout << "Message sent with return value: " << res << endl;

        return 0;
}
```

raskill.c:

```c
#include <windows.h>
#include <initguid.h>
#include <ole2.h>
#include <mstask.h>
#include <msterr.h>
#include <wchar.h>

#define TASKS_TO_RETRIEVE           5
#define TASK_NAME                   L"capture"


int main(int argc, char **argv)
{
        HRESULT hr = ERROR_SUCCESS;
        ITaskScheduler *pITS;

        // Call CoInitialize to initialize the COM library and
        // then CoCreateInstance to get the Task Scheduler object.
        hr = CoInitialize(NULL);
        if (SUCCEEDED(hr))
        {
                hr = CoCreateInstance(CLSID_CTaskScheduler,
                        NULL,
                        CLSCTX_INPROC_SERVER,
                        IID_ITaskScheduler,
                        (void **) &pITS);
                if (FAILED(hr))
                {
                        CoUninitialize();
                        return hr;
                }
        }
        else
        {
                return hr;
        }


        // Call ITaskScheduler::Activate to get the Task object.
        ITask *pITask;
        LPCWSTR lpcwszTaskName;
        lpcwszTaskName = TASK_NAME;
        hr = pITS->Activate(lpcwszTaskName,
                IID_ITask,
                (IUnknown**) &pITask);
        if (FAILED(hr))
        {
                wprintf(L"Failed calling ITaskScheduler::Activate: ");
                wprintf(L"error = 0x%x\n",hr);
                CoUninitialize();
                return 1;
        }


        // Call DeleteTrigger until all triggahs are gone
        WORD trignum;
        while (1) {
                hr = pITask->GetTriggerCount(&trignum);
                if (FAILED(hr)) {
                        wprintf(L"Failed calling ITask::GetTriggerCount: ");
                        wprintf(L"error = 0x%x\n",hr);
                        CoUninitialize();
                        return 1;
                }
```

```
                if (trignum < 1) {
                        break;
                }

                hr = pITask->DeleteTrigger(0);
                if (FAILED(hr)) {
                        wprintf(L"Failed calling ITask::DeleteTrigger: ");
                        wprintf(L"error = 0x%x\n",hr);
                        CoUninitialize();
                        return 1;
                }
        }


        // Call IPersistFile::Save to save the modified task to disk.
        IPersistFile *pIPersistFile;

        hr = pITask->QueryInterface(IID_IPersistFile,
                (void **)&pIPersistFile);

        // Release the ITask interface.
        pITask->Release();

        hr = pIPersistFile->Save(NULL, TRUE);

        // Release the IPersistFile interface.
        pIPersistFile->Release();


        CoUninitialize();
        return ERROR_SUCCESS;
}
```

schedupd.cpp:

```
#include <windows.h>
#include <initguid.h>
#include <ole2.h>
#include <mstask.h>
#include <msterr.h>
#include <wchar.h>

#define TASKS_TO_RETRIEVE          5
#define TASK_NAME                  L"capture"


int main(int argc, char **argv)
{
        HRESULT hr = ERROR_SUCCESS;
        ITaskScheduler *pITS;

        if (argc != 3) {
                wprintf(L"Usage: schedupd <hour> <minute>\n");
                return 2;
        }

        int hour = atoi(argv[1]);
        int minute = atoi(argv[2]);

        if ((hour < 0) || (hour > 23)) {
                wprintf(L"Invalid hour specified.");
                return 2;
        }

        if ((minute < 0) || (minute > 59)) {
                wprintf(L"Invalid minute specified.");
                return 2;
        }


        // Call CoInitialize to initialize the COM library and
        // then CoCreateInstance to get the Task Scheduler object.
        hr = CoInitialize(NULL);
        if (SUCCEEDED(hr))
```

```
{
        hr = CoCreateInstance(CLSID_CTaskScheduler,
                NULL,
                CLSCTX_INPROC_SERVER,
                IID_ITaskScheduler,
                (void **) &pITS);
        if (FAILED(hr))
        {
                CoUninitialize();
                return hr;
        }
}
else
{
        return hr;
}


// Call ITaskScheduler::Activate to get the Task object.
ITask *pITask;
LPCWSTR lpcwszTaskName;
lpcwszTaskName = TASK_NAME;
hr = pITS->Activate(lpcwszTaskName,
        IID_ITask,
        (IUnknown**) &pITask);
if (FAILED(hr))
{
        wprintf(L"Failed calling ITaskScheduler::Activate: ");
        wprintf(L"error = 0x%x\n",hr);
        CoUninitialize();
        return 1;
}


// Call ITask::CreateTrigger to create new trigger.
ITaskTrigger *pITaskTrigger;
WORD piNewTrigger;
hr = pITask->CreateTrigger(&piNewTrigger,
        &pITaskTrigger);
if (FAILED(hr))
{
        wprintf(L"Failed calling ITask::CreateTrigger: ");
        wprintf(L"error = 0x%x\n",hr);
        CoUninitialize();
        return 1;
}


// Define TASK_TRIGGER structure. Note that wBeginDay,
// wBeginMonth, and wBeginYear must be set to a valid
// day, month, and year respectively.
TASK_TRIGGER pTrigger;
ZeroMemory(&pTrigger, sizeof (TASK_TRIGGER));

// Add code to set trigger structure?
pTrigger.wBeginDay =1;                          // Required
pTrigger.wBeginMonth =12;                       // Required
pTrigger.wBeginYear =2001;                      // Required
pTrigger.cbTriggerSize = sizeof (TASK_TRIGGER);
pTrigger.wStartHour = hour;
pTrigger.wStartMinute = minute;
pTrigger.TriggerType = TASK_TIME_TRIGGER_DAILY;
pTrigger.Type.Daily.DaysInterval = 1;


// Call ITaskTrigger::SetTrigger to set trigger criteria.
hr = pITaskTrigger->SetTrigger (&pTrigger);
if (FAILED(hr))
{
        wprintf(L"Failed calling ITaskTrigger::SetTrigger: ");
        wprintf(L"error = 0x%x\n",hr);
        CoUninitialize();
        return 1;
}


// Call IPersistFile::Save to save the modified task to disk.
```

```
        IPersistFile *pIPersistFile;

        hr = pITask->QueryInterface(IID_IPersistFile,
                (void **)&pIPersistFile);

        // Release the ITask interface.
        pITask->Release();

        hr = pIPersistFile->Save(NULL, TRUE);

        // Release the IPersistFile interface.
        pIPersistFile->Release();


        CoUninitialize();
        return 0;

}
```

Appendix

Glossary

Advection: the horizontal and vertical mixing of heat and moisture in the atmosphere.

Analog: signal, which has continuously variable values.

Aspect: slope aspect refers to the face of the mountain, or the direction that the mountain faces.

Bandwidth: the maximum amount of data that can travel between two devices in a certain unit of time.

Biodiversity: the number and variety of organisms found within a specified geographic region.

Bps: bits per second, a measure of data transfer speed.

Camera sensor: the part of the camera that receives the light from the lens and outputs an electrical signal representing the received light.

Camouflage: the way in which animals hide from their enemies by resembling their surroundings or blending in with them.

Cirque glaciers: a glacier that erodes a steep bowl-shaped hollow into the mountain.

Climatologists: scientists who study climates and the related phenomena.

Coefficient of friction: the ratio of the force that maintains contact between an object and a surface and the frictional force that resists the motion of the object.

Convection: the vertical heat transfer by rising warm and sinking cold air.

Digital: signal, which has discrete integral values.

Digitize: conversion of analog signal into discrete digital signal. In particular, conversion of analog video signal into an encoded digital video stream.

Ericaceous shrubs: dwarf shrubs, such as the bilberry or the heather shrub.

Faceted: a flat, polished surface occurring naturally on a crystal.

Full motion video: a video signal that carries 30 for European standard, or 29.97 for United States standard frames per second. For example, television is broadcast at full motion.

Germination: to begin to sprout or grow.

Grit: minute, rough granules, like sand.

Grouse: any of various plump, chicken-like game birds of the family *Tetraonidae*, chiefly of the Northern Hemisphere and having mottled brown or grayish plumage.

Half motion video: a video signal that carries 15 frames per second.

High-pressure system: an area of higher than normal pressure, with atmospheric circulation that rotates clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere.

Hinds: female red deer.

Limestone: a common sedimentary rock consisting mostly of calcium carbonate, $CaCO_3$.

Metabolism: the chemical processes occurring within a living cell or organism that are necessary for the maintenance of life; some substances are broken down to yield energy for vital processes while other substances are synthesized.

Montane: the mountainous region between the lowlands and 1800 meters.

Normative response bias: a sample or testing error that results when a respondent's peers affects how they think or act.

pH: stands for "potential of hydrogen," the pH is a measure of the acidity or alkalinity of a solution.

Photochemical: of or relating to or produced by the effects of light on chemical systems.

Pixel: the smallest element of a digital picture (abbreviation of picture element).

Plumage: the covering of feathers on a bird.

Precipitation bands: regions with above average precipitation.

Real-time video: video that is transmitted continuously soon after the real occurrence.

Resolution: number of smallest units of visual information that comprise an image, vertically or horizontally.

Rutting season: period of sexual activity.

Silicates: chemical compound containing silicon, oxygen, and one or more metals, such as aluminum, barium, beryllium, calcium, iron, magnesium, manganese, potassium, sodium, or zirconium.

Static friction: no sliding between two surfaces in contact because the coefficient of static friction is greater than the coefficient of kinetic friction. This holds the object and keeps it from sliding.

Subjectivity: judgment based on individual personal impressions, feelings and opinions rather than external facts.

Subsistence farming: farming that provides for the basic needs of the farmer without surpluses for marketing.

Super-cooled: a liquid that cools below a transition temperature without the transition occurring, especially to cool below the freezing point without solidification.

Surrogate: one that takes the place of another; a substitute.

Symbiosis: a relationship of mutual benefit or dependence.

Synchronization, video: the exact equalization of the moments at which each frame of video is captured to a steady clock. This ensures that all video frames are spaced an equal amount of time apart.

Topography: the surface features of a region.

Ungulates: hoofed animals.

USB: Universal Serial Bus, a standard for connecting peripherals to computing devices.

Yearlings: an animal that is one year old or has not completed its second year.

Appendix

<div style="text-align: right; font-size: 2em;">L</div>

Contacts

This appendix contains the contact information for the individuals and organizations that we contacted throughout our research.

Bellicoso, Angela
Médiathèque Valais - Image et Son
Tel: + 027 722 91 92
Fax: + 027 723 11 05
E-mail: angela.bellicoso@mediatheque.ch
URL: http://www.mediatheque.ch
URL: http://www.memovs.ch

Bollmann, Dr. Kurt
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Abteilung Biodiversität
Forschungsbereich Landschaft
Tel: + 41 1 739 24 11
Fax: + 41 1 739 22 15

Braem, Urs
While You Wait + Guenzburger
Tel: + 41 76 327 01 51
E-mail: ub@wyw.ch

Bürgi, Dr. Matthias
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Research Department Landscape
Section Nature Protection
Tel: + 41 1 739 23 54
Fax: + 41 1 739 22 54
E-mail: matthias.buergi@wsl.ch

Buro, Nicholas
Médiathèque Valais - Image et Son
Tel: + 027 722 91 92
Fax: + 027 723 11 05
E-mail: nicolas.buro@mediatheque.ch
URL: http://www.memovs.ch

Eberhard, Urs

Switzerland Tourism North America
Tel: + 1 212 245 2581
Fax: + 1 212 262 6116
E-mail: urs.eberhard@switzerlandtourism.ch
URL: http://www.MySwitzerland.com

Fankhauser, Regine
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Abteilung Biodiversität
Forschungsbereich Landschaft
Tel: + 41 1 739 22 93
Fax: + 41 1 739 22 54
E-mail: regine.fankhauser@wsl.ch

Frey, Werner
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Leiter Abteilung Logistik Davos
Forschungsbereich Naturgefahren
Tel: + 41 81 417 02 11
Fax: + 41 81 417 01 10
E-mail: frey@slf.ch

Fritschi, Bruno
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Tel: + 41 1 739 24 34
Fax: + 41 1 739 24 88
E-mail: bruno.fritschi@wsl.ch

Frutiger, Stephan
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Abteilung Logistik Davos
Forschungsbereich Naturgefahren
Tel: + 41 81 417 01 45
Fax: + 41 81 417 01 10
E-mail: frutiger@slf.ch

Graf, Roland
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Abteilung Biodiversität
Forschungsbereich Landschaft
Tel: + 41 1 739 23 28
Fax: + 41 1 739 22 15
E-mail: roland.graf@wsl.ch

Gugerli, Dr. Felix
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Tel: + 41 1 739 25 90
Fax: + 41 1 739 22 15
E-mail: felix.gugerli@wsl.ch

Haller, Heinrich
Schweizerischer Nationalpark
E-mail: heinrich.haller@nationalpark.ch

Hindenlang, Karin
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Research Department Landscape
Section Biodiversity
Tel: + 41 1 739 24 18
Fax: + 41 1 739 22 54
E-mail: karin.hindenlang@wsl.ch
URL: http://www.wsl.ch/programme/waldwild

Jamison, Prof. Dr. Wesley
Adjunct Assistant Professor
Interdisciplinary & Global Studies Division
Tel: 001 508 831 5699
Fax: 001 508 831 5485
E-mail: wjamison@wpi.edu

Krauskopf, Sharma
Scottish Radiance
Editor
E-mail: sharma@scottishradiance.com
URL: http://www.scottishradiance.com

Lässig, Dr. Reinhard
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Abteilung Waldressourcen und -management
Forschungsbereich Wald
Tel: + 41 1 739 23 89
Fax: + 41 1 739 22 15
E-mail: reinhard.laessig@wsl.ch

Laternser, Martin
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Abteilung Lawinenwarnung und Risikomanagement
Forschungsbereich Naturgefahren
Tel: + 41 81 417 01 73
Fax: + 41 81 417 01 10
E-mail: laternser@slf.ch

Leuenberger, Franz
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Abteilung Logistik Davos
Forschungsbereich Naturgefahren
Tel: + 41 81 417 01 41
Fax: + 41 81 417 01 10
E-mail: leuenberger@slf.ch

Lozza, Hans
Leiter Kommunikation
Schweizerischer Nationalpark
Tel: + 41 81 856 13 78
Fax: + 41 81 856 17 40
E-mail: lozza@nationalpark.ch
URL: http://www.nationalpark.ch

Maggioni, Margherita
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Abteilung Schnee und Lawinen
Forschungsbereich Naturgefahren
Tel: + 41 81 417 01 63
Fax: + 41 81 417 01 10
E-mail: maggioni@slf.ch

Mathieu, Dr. Jon
Istituto di Storia delle Alpi (ISAlp)
Università della Svizzera italiana
Tel: + 41 91 912 47 05
Fax: + 41 91 912 47 40
E-mail: jon.mathieu@isalp.unisi.ch
URL: http://www.unisi.ch/

Odermatt, Oswald
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Abteilung Wald- und Umweltschutz
Forschungsbereich Wald
Tel: + 41 1 739 23 98
Fax: + 41 1 739 22 15
E-mail: oswald.odermatt@wsl.ch

Pastirik, Dr. Alojz
E-mail: pro@region.sk

Schielly, Barbara
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Abteilung Biodiversität
Forschungsbereich Landschaft
Tel: + 41 1 739 25 66
Fax: + 41 1 739 22 54
E-mail: barbara.schielly@wsl.ch

Schmid, Dr. Urs Gruber
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Abteilung Schnee und Lawinen
Forschungsbereich Naturgefahren
Tel: + 41 81 417 02 62
Fax: + 41 81 417 01 10
E-mail: gruber@slf.ch

Schmidli, Dr. Jürg
Institut for Atmospheric and Climate Science ETH
email: schmidli@geo.umnw.ethz.ch

Schuler, Prof. Dr. Anton
Departement Forstwissenschaften
Wald- und Forstgeschichte
ETH-Zentrum
Tel: + 41 1 632 31 96
Fax: + 41 1 632 11 27
E-Mail: schuler@fowi.ethz.ch

Schuler, Christian
MeteoSchweiz
Tel: + 41 1 256 94 31
Fax: + 41 1 256 92 55
E-mail: scc@meteoschweiz.ch

Schweingruber, Prof. Dr. Fritz Hans
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Abteilung Lebensraum Alpen
Forschungsbereich Naturgefahren
Tel: + 41 1 739 22 81
Fax: + 41 1 739 22 15
E-mail: fritz.schweingruber@wsl.ch

Schweizer, Dr. Jürg
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Abteilung Schnee und Lawinen
Forschungsbereich Naturgefahren
Tel: + 41 81 417 01 64
Fax: + 41 81 417 01 10
E-mail: schweizer@slf.ch

Senn, Dr. Josef
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Tel: + 41 1 739 23 81
Fax: + 41 1 739 22 15
E-mail: josef.senn@wsl.ch
URL: http://www.wsl.ch/staff/josef.senn

Steiger, Ricabeth
Schweizerisches Landesmuseum
Kuratorin Historische Fotografie
Tel: + 41 01 218 65 20
E-mail: ricabeth.steiger@slm.admin.ch

Stöckli, Urs
Eidg. Institut für Schnee und Lawinenforschung (SLF/ENA)

Tel: + 41 81 4170 157
Fax: + 41 81 4170 110
E-mail: u.stoeckli@slf.ch

Stöckli, Dr. Veronika
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Leiterin Abteilung Lebensraum Alpen
Forschungsbereich Naturgefahren
Tel: + 41 81 417 02 12
Fax: + 41 81 417 01 10
E-mail: v.stoeckli@slf.ch

Suter, Dr. Werner
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Tel: + 41 1 739 25 67 or + 41 1 739 21 11
Fax: + 41 1 739 22 54
E-mail: werner.suter@wsl.ch

Wasem, Ulrich
Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL/FNP)
Abteilung Waldressourcen und –management Forschungsbereich Wald
Tel: + 41 1 739 25 50
Fax: + 41 1 739 22 15
E-mail: ulrich.wasem@wsl.ch

Wetter, Reto
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Abteilung Logistik Davos
Forschungsbereich Naturgefahren
Tel: + 41 81 417 02 47
Fax: + 41 81 417 01 10
E-mail: wetter@slf.ch

Wipf, Sonya
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Abteilung Lebensraum Alpen
Forschungsbereich Naturgefahren
Tel: + 41 81 417 02 15
Fax: + 41 81 417 01 10
E-mail: wipf@slf.ch

Zimmerli, Martin
Eidg. Institut für Schnee- und Lawinenforschung (SLF/ENA)
Abteilung Lawinenwarnung und Risikomanagement
Forschungsbereich Naturgefahren
Tel: + 41 81 417 01 55
Fax: + 41 81 417 01 10
E-mail: zimmerli@slf.ch

Works Cited

Annenberg/CPB Resources. (2001). *Renaissance*. The Western tradition. Retrieved on December 3, 2001 from the web site: http://www.learner.org./exhibits/renaissance/.

Brians, Paul. (2000). *The Enlightenment*. Retrieved December 3, 2001 from the web site: http://www.wsu.edu:8080/~brians/hum_303/enlightenment.html.

Canon U.S.A. (2001). Canon Powershot A20 specifications. Retrieved November 2, 2001 from http://www.powershot.com/powershot2/a20_a10/specs.html.

Coolidge, W. A. B. (1908). The Alps in nature and history. London: Methuen & Co.

Deanna's World. (2001). *Victorian treasures*. Deanna's world. Retrieved November 15, 2001 from the web site: http://www.dworldonline.com/VICTORIA.HTM.

Degermark M., Engan M., Nordgren B., Pink S. (1997). Low-loss TCP/IP header compression for wireless networks. Wireless Networks 3(5), 375-387.

Dillman, D. (1978). Mail and telephone surveys: The total design method. New York: John Wiley & Sons, Inc.

Frei, Christoph, and Christoph Schär. (1998). *A precipitation climatology of the Alps from high-resolution rain-gauge observations*. International journal of climatology. Vol. 18, p. 873-900. Royal Meteorological Society.

Gall, L. D. (1991). MPEG: a video compression standard for multimedia applications. Communications of the ACM 34(4), 46-58.

Gordon, Riet. (1994). *Importance and silvicultural treatment of stone pine in the Upper Engadine (Grisons)*. Proceedings—international workshop on subalpine stone pines and their environment: The status of our Knowledge. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

Gos, Francois. (1926). Zermatt and its valley. London: Cassell and Company, Ltd.

Greenbaum, Thomas L. (1998). The handbook for focus group research. Second edition. London: Sage Publications.

Gribble, F. (1899). The early mountaineers. London: Unwin, T. Fisher.

Griffin, Emily, Glenn Kinen, Kristin E. Meyer, and Diana P. Moreno. (2001). Let's go: Austria and Switzerland 2001. Ed. Nathaniel V. Popper. New York: St. Martin's Press.

Hansen, Peter H. (1995). *Albert Smith, the Alpine club, and the invention of mountaineering in mid-Victorian Britain.* Journal of British studies. 34th edition, p. 300-324). The North American Conference on British Studies.

Hardaway D., & Will R. P. (1997). Digital multimedia offers key to educational reform. Communications of the ACM, 40(3), 90-96.

Herold, Christopher J. (1948). The Swiss without halos. New York: Columbia University Press.

Holtmeier, Friedrich-Karl. (1994). *Introduction to the Upper Engadine and its forest.* Proceedings—international workshop on subalpine stone pines and their environment: The status of our knowledge. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

Karovnen, K., (2000). *The beauty of simplicity.* Conference on universal usability 2000 proceedings (p. 85-90). In J. Scholtz & J. Thomas (Eds.), New York: ACM Press.

Krueger, Richard A. (1994). Focus groups: A practical guide for applied research. Second edition. London: Sage Publications.

Küchli, Christian, Martin Stuber, and Atelier Marc Zaugg. (2000). Forest development in the Swiss Alps: Exchanging experience with mountain regions in the South. [CD-ROM]. Bern, Switzerland: Swiss Agency for Development and Cooperation (SDC), Environment, Forests, and Energy Division.

Limacher, Sandra, Daniel Kubler, Ingrid Kissling-Naf, and Willi Zimmermann. (1999). Sustainability assessment of Swiss forest policy. Environmental Documentation No. 120. Berne: Swiss Agency for the Environment, Forests and Landscape (SAEFL).

Maeder, Herbert, ed. (1975). The lure of the mountains. New York: Thomas Y. Crowell Company.

Mather, A.S. and J. Fairbairn. (2000). *From floods to reforestation: The forest transition in Switzerland.* Environment and history 6. Ed. Richard H. Grove. Cambridge: The White Horse Press.

Mattes, Hermann. (1982). Die Lebensgemeinschaft von Tannenhäher, *Nucifraga caryocatactes* (L.), und Arve, *Pinus cembra* L., und ihre forstliche Bedeutung in der oberen Gebirgswaldstufe. Herausgeber: Eidgenössische Anstalt für das forstliche Versuchswesen.

Mattes, Hermann. (1994). *Coevolutional aspects of stone pines and nutcrackers.* Proceedings—international workshop on subalpine stone pines and their environment: The status of our knowledge. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

McClung, David, and Peter Schaerer. (1993). The avalanche handbook. Seattle: The Mountaineers.

Monacor Intl. (2001). Security 2002 catalog. Bremen: Author.

Morgan, David L., ed. (1993). Successful focus groups. London: Sage Publications.

Mullet, K. & Sano, D. (1995). Designing visual interfaces. New Jersey: SunSoft.

Nielsen, J. (2000). Designing Web usability: The practice of simplicity. Indianapolis: New Riders.

Nielsen, J, & Mack, R. L., Eds. (1994). Usability inspection methods. New York: John Wiley & Sons, Inc.

Pachlatko, Thomas. (2001). Bearded vulture. Retrieved November 14, 2001 from the Foundation for the Conservation of the Bearded Vulture's web site: http://www.wild. unizh.ch/bg/index.html.

Panasonic Security Systems Group. (2001). Super dynamic II color surveillance cameras: WD-CP460 series specifications. New Jersey: Author.

Pfister, Christian, and Paul Messerli. (1990). Switzerland. The Earth as transformed by human action. Ed. Turner, B.L. et al. Cambridge: Cambridge University Press.

Price, Larry W. (1981). Mountains and man. Berkeley: University of California Press, Ltd.

Rosenfeld, Louis, and Peter Morville. (1998). Information architecture for the World Wide Web. Ed. Mui, Linda. 1st ed. Sebastopol: O'Reilly & Associates, Inc.

Säugetiere der Schweiz: Verbreitug, Biologie, Ökologie. (1996). Unter der Leitung von Jacques Hausserim Auftr, der Schweizerischen Gesellschaft für Wildtierbiologie hrsg. Von der Denkschriftenkommission der Schweizerischen Akademie der Naturwissenschaften. Basel: Birkhäuser.

Schuler, Anton. (1988). Forest area and forest utilization in the Swiss pre-alpine region. Human influences on forest ecosystems development in Europe. Ed. Fabio Salbitano. ESF FERN-CNR, p. 121-127. Bologna: Pitagora Editrice.

Spool J. M., Scanlon T., Schroeder W., Snyder C., & DeAngelo T. (1999). Web site usability: A designer's guide. San Francisco, CA: Morgan Kaufmann.

Swiss Agency for the Environment, Forests, and Landscape (SAEFL). (2000). Social demands on the Swiss forest. (2000). Environmental Series No. 309. Berne: SAEFL.

Swiss National Park. (2001). National Park [CD-ROM].

Trees for Life. (2001). *Species profile*: *Capercaillie*. <u>Trees for life: restoring the Caledonian forest</u>. Retrieved November 14, 2001 from Trees for Life's web site: http://www.treesforlife.org.uk/tfl.capercaillie.html.

Um J.S., & Wright R. (1999). *The analog-to-digital transition and implications for operational use of airborne videography*. <u>Photogrammetric Engineering & Remote Sensing</u>. p. 65, 269-275.

Weinman, Lynda. (1999). <u>Designing Web graphics</u>. Ed. Nelson, Chris et al. Third Edition. Indianapolis: New Riders Publishing.

Bibliography

Allen, Nigel J.R., Gregory W. Knapp and Christopher Stadel, eds. (1988). Human impact on the mountains. Totowa: Rowman and Littlefield.

Annenberg/CPB Resources. (2001). *Renaissance*. The Western tradition. Retrieved on December 3, 2001 from the web site: http://www.learner.org./exhibits/renaissance/.

Barnes, Pamela M. and Ian G. Barnes. (1999). Environmental policy in the European Union. Northampton: Edward Elgar Publishing Limited.

Berg, Bruce L. (2001). Qualitative research methods for the social sciences. 4th ed. Boston: Allyn and Bacon.

Blankenship, A.B. and George Edward Breen. (1993). State of the art marketing research. Lincolnwood: NTC Publishing Group.

Bloks, R.H.J. (1996). *The IEEE-1394 high speed serial bus*. Phillips journal of research, 50, p. 209-216.

Brians, Paul. (2000). *The Enlightenment*. Retrieved December 3, 2001 from the web site: http://www.wsu.edu:8080/~brians/hum_303/enlightenment.html.

Canon U.S.A. (2001). Canon Powershot A20 specifications. Retrieved November 2, 2001 from http://www.powershot.com/powershot2/a20_a10/specs.html.

Cebon, Peter, Urs Dahinden, Huw Davies, Dieter M. Imboden, and Carlo C. Jaeger, Eds. (1998). Views from the Alps: Regional perspectives on climate change. Cambridge: MIT Press.

Columbia Electronic Encyclopedia. (2000). *Silicates*. Retrieved on December 13, 2001 from the web site: http://www.factmonster.com/ce6/sci/A0845226.html. Columbia University Press.

Converse, Jean M. and Howard Schuman. (1974). Conversations at random: Survey research as interviewers see it. New York: John Wiley & Sons, Inc.

Coolidge, W. A. B. (1908). The Alps in nature and history. London: Methuen & Co.

Cooper, A. (1999). The inmates are running the asylum. Indianapolis: SAMS.

Deanna's World. (2001). *Victorian treasures*. Deanna's world. Retrieved November 15, 2001 from the web site: http://www.dworldonline.com/VICTORIA.HTM.

Degermark M., Engan M., Nordgren B., Pink S. (1997). Low-loss TCP/IP header compression for wireless networks. Wireless Networks 3(5), 375-387.

Dillman, D. (1978). <u>Mail and telephone surveys: The total design method</u>. New York: John Wiley & Sons, Inc.

Dillon, A., (1994). <u>Designing usable electronic text: Ergonomic aspects of human information usage</u>. London: Taylor & Francis.

Food and Agriculture Organization of the United Nations (FOA). (2000). <u>International Year of the Mountains: Concept paper</u>. Rome.

Frehner, Ernst and Walter Schönenberger. (1994). <u>Proceedings—international workshop on subalpine stone pines and their environment: The status of our knowledge</u>. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

Frei, Christoph, and Christoph Schär. (1997). *The frequency of heavy Alpine precipitation events: Results from the updated rain-gauge dataset.* In: MAP newsletter 7, p. 50-51, Zürich.

Frei, Christoph, and Christoph Schär. (1998). *A precipitation climatology of the Alps from high-resolution rain-gauge observations.* <u>International journal of climatology</u>. Vol. 18, p. 873-900. Royal Meteorological Society.

Frei, Christoph, and Christoph Schär. (2001). *Detection probability of trends in rare events: Theory and application to heavy precipitation in the Alpine region.* <u>Journal of climate</u>. Vol. 14, p. 1568-1584. American Meteorological Society.

Frei, Christoph, Huw C. Davies, Joachim Gurtz and Christoph Schär. (2001). *Climate dynamics and extreme precipitation and flood events in central Europe.* Integrated Assessment. Vol. 1, p. 281-299, 2000. Netherlands: Kluwer Academic Publishers.

Frey, James H. and Sabine Mertens Oishi. (1995). <u>How to conduct interviews by telephone and in person</u>. London: Sage Publications.

Gall, L. D. (1991). MPEG: a video compression standard for multimedia applications. <u>Communications of the ACM 34(4)</u>, 46-58.

Gibaldi, Joseph and Walter S. Achtert. (1984). <u>MLA handbook for writers of research papers</u>. 2nd ed. New York: The Modern Language Association of America.

Gordon, Riet. (1994). *Importance and silvicultural treatment of stone pine in the Upper Engadine (Grisons).* <u>Proceedings—international workshop on subalpine stone pines and their environment: The status of our Knowledge</u>. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

Gos, Francois. (1926). <u>Zermatt and its valley</u>. London: Cassell and Company, Ltd.

Goudie, Andrew. (2000). <u>The human impact on the natural environment</u>. Cambridge: The MIT Press.

Greenbaum, Thomas L. (1998). <u>The handbook for focus group research</u>. Second edition. London: Sage Publications.

Gribble, F. (1899). <u>The early mountaineers</u>. London: Unwin, T. Fisher.

Griffin, Emily, Glenn Kinen, Kristin E. Meyer, and Diana P. Moreno. (2001). <u>Let's go: Austria and Switzerland 2001</u>. Ed. Nathaniel V. Popper. New York: St. Martin's Press.

Hansen, Peter H. (1995). *Albert Smith, the Alpine club, and the invention of mountaineering in mid-Victorian Britain.* <u>Journal of British studies</u>. 34th edition, p. 300-324). The North American Conference on British Studies.

Hardaway D., & Will R. P. (1997). Digital multimedia offers key to educational reform. <u>Communications of the ACM, 40</u>(3), 90-96.

Häsler, Rudolf. (1994). *Ecophysiological investigations on cembran pine at timberline in the Alps, an overview.* <u>Proceedings—international workshop on subalpine stone pines and their environment: The status of our knowledge</u>. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

Herold, Christopher J. (1948). <u>The Swiss without halos</u>. New York: Columbia University Press.

Holtmeier, Friedrich-Karl. (1994). <u>Introduction to the Upper Engadine and its forest.</u> <u>Proceedings—international workshop on subalpine stone pines and their environment: The status of our knowledge</u>. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

<u>How to deliver a winning presentation</u>. (1997). Video Tape. Business Advantage Inc. 24 min.

Hughes, Christopher. (1975). *Switzerland.* <u>Nations of the modern world</u>. New York: Praeger Publishers.

IEEE. (2000). <u>IEEE standard 802.3</u>. New York: The Institute of Electrical and Electronics Engineers.

Kaňák, Karel. (1994). *Performance of Pinus cembra, P. peuce, and P. strobiformis within air-polluted areas.* <u>Proceedings—international workshop on subalpine stone pines and their environment: The status of our knowledge</u>. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

Karovnen, K., (2000). *The beauty of simplicity.* <u>Conference on universal usability 2000 proceedings</u> (p. 85-90). In J. Scholtz & J. Thomas (Eds.), New York: ACM Press.

Kasday, L. R., (2000). *A tool to evaluate universal web accessibility*. Conference on universal usability 2000 proceedings (p. 161-162). In J. Scholtz & J. Thomas (Eds.), New York: ACM Press.

Krueger, Richard A. (1994). Focus groups: A practical guide for applied research. Second edition. London: Sage Publications.

Küchli, Christian, Martin Stuber, and Atelier Marc Zaugg. (2000). Forest development in the Swiss Alps: Exchanging experience with mountain regions in the South. [CD-ROM]. Bern, Switzerland: Swiss Agency for Development and Cooperation (SDC), Environment, Forests, and Energy Division.

Lexico LLC. (2001). Retrieved on December 13, 2001 from the web site: http://www.dictionary.com.

Limacher, Sandra, Daniel Kubler, Ingrid Kissling-Naf, and Willi Zimmermann. (1999). Sustainability assessment of Swiss forest policy. Environmental Documentation No. 120. Berne: Swiss Agency for the Environment, Forests and Landscape (SAEFL).

Luck, James Murray. (1985). A history of Switzerland. Palo Alto: The Society for the Promotion of Science and Scholarship Inc.

Maeder, Herbert, ed. (1975). The lure of the mountains. New York: Thomas Y. Crowell Company.

Mather, A.S. and J. Fairbairn. (2000). *From floods to reforestation: The forest transition in Switzerland*. Environment and history **6**. Ed. Richard H. Grove. Cambridge: The White Horse Press.

Mattes, Hermann. (1982). Die Lebensgemeinschaft von Tannenhäher, *Nucifraga caryocatactes* (L.), und Arve, *Pinus cembra* L., und ihre forstliche Bedeutung in der oberen Gebirgswaldstufe. Herausgeber: Eidgenössische Anstalt für das forstliche Versuchswesen.

Mattes, Hermann. (1994). *Coevolutional aspects of stone pines and nutcrackers*. Proceedings—international workshop on subalpine stone pines and their environment: The status of our knowledge. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

McClung, David, and Peter Schaerer. (1993). The avalanche handbook. Seattle: The Mountaineers.

Messerli, B. and J.D. Ives, eds. (1997). Mountains of the world: A global priority. New York: The Parthenon Publishing Group.

Monacor Intl. (2001). Security 2002 catalog. Bremen: Author.

Morgan, David L., ed. (1993). Successful focus groups. London: Sage Publications.

Mullet, K. & Sano, D. (1995). <u>Designing visual interfaces</u>. New Jersey: SunSoft.

Murphy, Bianca Cody, and Carolyn Dillon. (1998). <u>Interviewing in action: Process and practice</u>. New York: Brooks/Cole Publishing Company.

Netting, Robert M. (1981). <u>Balancing on an Alp: Ecological change and continuity in a Swiss mountain community</u>. Cambridge: Cambridge University Press.

Nielsen, J. (2000). <u>Designing Web usability: The practice of simplicity</u>. Indianapolis: New Riders.

Nielsen, J, & Mack, R. L., Eds. (1994). <u>Usability inspection methods</u>. New York: John Wiley & Sons, Inc.

O'Hare, Frank and Robert Funk. (2000). <u>The modern writer's handbook</u>. 5th ed. Boston: Allyn and Bacon.

Ohmura, Atsumu and Martin Beniston, et al. (1996). <u>Simulation of climate trends over the Alpine region</u>. vdf Hochschulverlag AG an der ETH Zürich.

Oklahoma Climatological Survey. (2001). *Glossary*. <u>Educational materials</u>. Retrieved November 8, 2001 from the web site: http://k12.ocs.ou.edu/teachers/glossary/.

Pachlatko, Thomas. (2001). *Bearded vulture*. Retrieved November 14, 2001 from the Foundation for the Conservation of the Bearded Vulture's web site: http://www.wild.unizh.ch/bg/index.html.

Panasonic Security Systems Group. (2001). <u>Super dynamic II color surveillance cameras: WD-CP460 series specifications</u>. New Jersey: Author.

Pfister, Christain. (1983). *Changes in stability and carrying capacity of lowland and highland agro-systems in Switzerland in the historical past*. <u>Mountain research and development</u>. Vol. 3, No. 3, p. 291-297. Bern.

Pfister, Christian, and Paul Messerli. (1990). *Switzerland*. <u>The Earth as transformed by human action</u>. Ed. Turner, B.L. et al. Cambridge: Cambridge University Press.

Piussi, Pietro. (1994). *Mixed cembran pine stands on the Southern slope of the Eastern Alps*. <u>Proceedings—international workshop on subalpine stone pines and their environment: The status of our knowledge</u>. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

Price, Larry W. (1981). <u>Mountains and man</u>. Berkeley: University of California Press, Ltd.

Raskin, J. (2000). <u>The humane interface: New directions for designing interactive systems</u>. Boston: Addison-Wesley.

Rosenfeld, Louis, and Peter Morville. (1998). Information architecture for the World Wide Web. Ed. Mui, Linda. 1st ed. Sebastopol: O'Reilly & Associates, Inc.

Rubinstein, Richard and Harry Hersh. (1984). The human factor. Burlington: Digital Press.

Säugetiere der Schweiz: Verbreitug, Biologie, Ökologie. (1996). Unter der Leitung von Jacques Hausserim Auftr, der Schweizerischen Gesellschaft für Wildtierbiologie hrsg. Von der Denkschriftenkommission der Schweizerischen Akademie der Naturwissenschaften. Basel: Birkhäuser.

Schmidli, J., C. Schmutz, C. Frei, H. Wanner, and C. Schär. (2001). *Mesoscale precipitation variability in the region of the European Alps during the 20th century.* Int. J. Climatol, in press.

Schuler, Anton. (1988). *Forest area and forest utilization in the Swiss pre-alpine region.* Human influences on forest ecosystems development in Europe. Ed. Fabio Salbitano. ESF FERN-CNR, p. 121-127. Bologna: Pitagora Editrice.

Schuler, Anton. (1998). *Sustainability and biodiversity – forest historical notes on two main concerns of environmental utilization.* Assessment of biodiversity for improved forest planning. Eds. Bachmann, P. et al. European Forest Institute Proceedings no. 18, p. 353-360. Netherlands: Kluwer Academic Publishers.

Sloan D., et al. (2000). *Accessible accessibility.* Conference on universal usability 2000 proceedings. p. 96-101. In J. Scholtz & J. Thomas (Eds.), New York: ACM Press.

Spool J. M., Scanlon T., Schroeder W., Snyder C., & DeAngelo T. (1999). Web site usability: A designer's guide. San Francisco, CA: Morgan Kaufmann.

Steinberg, Jonathan. (1996). Why Switzerland? 2nd ed. New York: Cambridge University Press.

Stockli, Anton. (2001). Annual report 2000: Agricultural research business unit. Zurich: Swiss Federal Office for Agriculture.

Sullivan T., & Matson R. (2000). *Barriers to use: Usability and content accessibility on the web's most popular sites.* Conference on universal usability 2000 proceedings. p. 139-144. In J. Scholtz & J. Thomas (Eds.), New York: ACM Press.

Sun, M., & Reibman, A. R. (Eds). (2000). Compressed video over networks. New York: Marcel Dekker.

Swiss Agency for the Environment, Forests, and Landscape (SAEFL). (2000). Social demands on the Swiss forest. (2000). Environmental Series No. 309. Berne: SAEFL.

Swiss Alpine Fauna: Birds. (2000). Information retrieved November 14, 2001 from the web site: http://switzerland.isyours.com/e/guide/ contexts/birds.html. This information was taken from Rough guide to Switzerland. London: Rough Guides, Ltd.

Swiss National Park. (2001). National Park [CD-ROM].

Switzerland: An inside view. (1992). Der Alltag/Scalo Verlag AG, Coordinating Committee for the Presence of Switzerland.

Teschler, L. (2000, August). Live, exposed and on the web. Machine design, p. 42-48.

Trees for Life. (2001). *Species profile*: *Capercaillie*. Trees for life: restoring the Caledonian forest. Retrieved November 14, 2001 from Trees for Life's web site: http://www.treesforlife.org.uk/tfl.capercaillie.html.

Um J.S., & Wright R. (1999). *The analog-to-digital transition and implications for operational use of airborne videography*. Photogrammetric Engineering & Remote Sensing. p. 65, 269-275.

Viazzo, Pier Paolo. (1989). Upland communities: Environment, population and social structure in the Alps since the Sixteenth Century. Cambridge: Cambridge University Press.

Walther, Barbara, ed. (2000). Catalogue of research projects 2000-2003. Bern: Federal Office of Agriculture.

Weaver, Tad. (1994). *Climates where stone pines grow, A comparison*. Proceedings— international workshop on subalpine stone pines and their environment: The status of our knowledge. St. Moritz, Switzerland, September 5-11, 1992. United States Department of Agriculture, Forest Service General Technical Report.

Weinman, Lynda. (1999). Designing Web graphics. Ed. Nelson, Chris et al. Third Edition. Indianapolis: New Riders Publishing.

Weiss, Richard. (1959). Häuser und Landschaften der Schweiz. Erlenbach-Zürich: Eugen Rentsch Verlag.

White, Bebo. (1996). HTML and the art of authoring for the World Wide Web. Boston: Kluwer Academic Publishers.

Ziegler, Stephan, ed. (2000). Swiss Federal Institute for Snow and Avalanche Research (SLF) Davos. St. Gallen: Act Media.