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Alpine Trail Safety

An Interactive Qualifying Project Report

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Abstract

The goal of this project is to identify common factors between ski related injuries. This was done through a review of technical literature, distribution of surveys, mountain visits, and interviewing professionals within the ski industry. The scope of this project encompasses both equipment and trail design. Potential hazards were identified. It was found that many industry professionals have strong opinions regarding what is a hazard based upon their personal experience, though few have the data to back it up.

Acknowledgments

Due to the nature of our IQP we required assistance from many outside sources. Without their help, we would not have been able to gather enough data to make this project possible. Therefore, we would like to thank the following people and mountains who contributed their time and knowledge to help us attain our goals.

- Cannon - Bill Mead –Ski Patrol, Richard Andross –Mountain Manager, Entire Ski Patrol
- Wildcat - Jim Bilotta - Head of Ski Patrol
- Loon - Dan Healey Head of Ski Patrol
- Stowe - William Shaft - Head of Ski Patrol
- Wachusett - Mike Hallaren - Head of Ski Patrol
- Dr. Claire Wilmont
- Dick Penniman
- And all the others not mentioned who assisted us with this paper

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1.1 Objectives

The goals for our project consist of examining four main topics. Within each topic several factors need to ascertained.

The first goal is to determine common factors in ski and snowboard accidents.

- Common trail features including mergers, fall lines, obstacles, jumps, terrain parks, and trail difficulty.
- The different types of snow conditions, which are powder, soft, wet,
- hard, packed, and icy.
- How visibility, temperature, and other weather conditions play a role
- in accidents.
- The influence the time of day and fatigue has on accidents.
- How crowd levels effect accident rates?
- Who is responsible for such accidents?

The second goal is to establish current methods for preventing or reducing the risk of ski injuries, which includes:

- Determine how the risk of injury due to different aspects of trail design such as mergers, fall lines, and obstacles can be reduced.
- Determine how protective gear such as helmets, bindings, boots, wrist guards, and
- even types of clothing can reduce accidents.
- Determine how many skiers wear helmets and why some skiers do not wear helmets.
- Determine how ski patroller methods and numbers effect accident rates and severity.
- Determine the effect of skier conduct education programs, and lessons.

The third goal is to determine the tradeoffs mountains make in regards to trail safety and expansion in two areas:

- Environmental tradeoffs in trail design.
- How economics effects trail design?

And the fourth goal is to determine and evaluate the current role of government in ski safety.

1.2 Rationale

This paper has been done in part to help bridge the technical aspects relating to accident prevention with the social and economic need for them. Many of us have been skiing for a good number of years and felt this project presented an opportunity to help make the sport safer, especially for the growing number of families on the slopes. It is hoped that this paper might help in reducing the number and severity of ski related accidents. A long-term benefit of this might be the reduction in the legal and medical costs.

At present, there is no association that regulates issues relating to trail safety; the individual mountains control them. Because of this, concerns like hazard markings are different at each mountain. The industry itself is resistant toward changes or policy. It is therefore necessary for outside sources to take the initiative if changes are to occur. The technical knowledge to prevent some types of injuries is currently available but it is also important to compare their cost with social the demand for such changes. An evaluation such as this can help determine if changes are worth implementing or not.

Besides the faculty of WPI, it is hoped that members of ski patrols, officials at ski resorts, and other professionals involved with the ski industry will read this paper and take something away from it. Copies of this paper will specifically be made available to those resorts and individuals that have helped us in one way or another.

1.3 State of the Art and Background

1.3.1 Literature Review

Since skiing, and more recently snowboarding, have become popular researchers have been gathering and analyzing data to find out how dangerous skiing is and to try to find ways to make it safer. Some ski areas keep records of how many skier visits and how many injuries there are each day. These records help to determine injury trends and skier injury rates.

In a conference held at Wachusett Mountain, it was shown that there are an average of 35 deaths per year and that there has been no recent increase as the media has tried to portray. This is equivalent to .5 deaths per million skier visits. According to Shealy people are two to four times likely to die in a car or an airplane than skiing. Shealy also believes that snowboarders have a 40% lower death rate than skiers and are more likely to be hit by out-of-control skiers than skiers are to be hit by out of control snowboards. This trend occurs because when a snowboarder falls his board acts like an anchor and prevents them from sliding, while a fallen skier can continue to slide for many feet depending on the conditions and angle of the slope (Shealy & Thompson 1996).

1.3.1.1 Common Factors in Accidents

It has been found that there are usually a few common factors that lead to injuries. The most recognized are poor trail designs and poor obstacle marking techniques. The weather and crowds also play a key role in skiing accidents. It was clarified how both the weather and crowds play a role in ski injuries. The Sapporo ski area has been keeping records of temperature and crowd size since 1960 and this data was analyzed for this study. The researchers found out that there were two main types of ski seasons, hot and

cold. During cold seasons the researchers determined that there were fewer skiers, less injuries, and in a warm season people start skiing earlier in the day, they ski for longer. The weather is a major factor in determining crowd size, which can directly lead to more injuries (Serita 1987).

Another risk, which is a direct result of weather, is snow conditions. A study conducted in Sapporo, Japan defined the 6 main types of snow conditions and their threats. The 6 main types of snow conditions are powder, soft, wet, hard, packed, and icy. They determined that injuries occur the least on powdered and icy snow. They also found that sprains and lacerations occurred mostly in soft snow, dislocations occurred mostly in Hard snow, and that fractures occurred mostly in children and adults in soft, but that they occurred mostly in hard snow with adolescence (Sugawara et. al. 1987).

Skiers own fatigue can also play a direct role in the cause of an accident. There is a correlation between the time of day and period of time skiers have been skiing compared to when an accident occurs. It was found that before 1974 most injuries occurred towards the very end of the day, generally about 3 hours after people have been skiing. In recent years though, accident have been occurring sooner in the day. This is a result of technology allowing for more ski runs (Serita 1987).

1.3.1.2 Established Accident Prevention Methods

Accident prevention for skiers can be broke down into several categories. Penniman lays this all out in a hierarchy from which he bases his discussion. Potential solutions are given in five priority levels, with the "First Priority" level containing the most preferable of methods. The successive levels are each resorted to in turn if the previous levels do not adequately alleviate the danger. The priorities are as follows, First

Priority: Eliminate the hazard and/or risk, Second Priority: Apply safeguarding technology, Third Priority: Use warning signs, Fourth Priority: Train and instruct, and the Fifth Priority: Prescribe personal protection (helmets, wrist braces, etc.). There is no exact science to preventing accidents but only guidelines to follow which will help reduce accidents. An example prevention method is to reduce the angle at which trails merge, in order to reduce merger collisions (Penniman 1993).

Ski injuries can be closely related to ski equipment used, especially bindings, boots, safety brakes, and ski straps. The introduction of safety bindings has reduced the number of ankle fractures and knee sprains started decreasing rapidly. Then with the introduction of the plastic boot in 1972 fractures and sprains of the ankle started decreasing even more rapidly. As a result of releasing bindings, more injuries have been occurring to the head and upper extremities (Kuriyama & Fujimaki 1987). Another study found a decline in the number of injuries to the lower leg (esp. ankle), and a rise in the occurrence of injuries to the knee and thumb. These trends were more apparent in advanced skiers. This shift in the anatomical location of the injuries could be attributed to improvements in bindings, as well as attention to the proper adjustment of equipment (Young & Lee 1991).

1.3.1.3 New and Developing Accident Prevention Methods

There are not yet any adopted standards by U.S. ski areas for the identifying and mitigation of hazards on ski slopes. There is, however; a slowly developing common custom and practice for this. Many of the hazards in skiing, which were once considered inherent, are no longer acceptable. Improvement in equipment has reduced the number of injuries, and this is also true of the machinery used in the industry. The ski industry is

trying to reduce injuries in every aspect, yet there's no standardization in the dealings with hazards. Hazards differ greatly from mountain to mountain and even trail to trail, but there needs to be some sort of guidelines in place in order to properly identify and correct these hazards. Mountains have slowly over time developed there own practices, but generally it just comes down to a ski patroller's own judgment. Mr. Penniman gives lays out his own proposed guidelines for hazard mitigation, and hope for some standardization in the industry (Penniman 1993).

A new piece of equipment to the ski industry is the helmet. The U.S. Consumer Product Safety Commission (CPSC) has recommended the use of a helmet, to all skiers and snowboarders, in order to prevent head injuries. Helmet use by skiers and snowboarders could prevent or reduce the severity of 44% of head injuries to adults, and 53% of head injuries to children under the age of 15. In addition, about 11 skiing and snowboarding deaths a year could be prevented with helmet use. The news release also stated that in past years the numbers of injuries to the lower part of the body have been in decline, and this is due to equipment advancements (bindings, boots, ect.). Head injury statistics have been unchanged though, and hence the need for the helmet (CPSC 1999a).

A new solution to help skiers once they are injured was just recently put into place. This is a ruling by the FAA that allows private helicopters to make rescues without making a landing first. Although it may not directly prevent accidents on mountains, it will reduce the severity in some cases by allowing for quicker rescue times and faster delivery to the hospital. This practice has been in use by the Europeans for a long time, and was not allowed here in the states for the simple reason of the difficulty and danger involved in performing such a rescue (Reinfurt 1998).

One solution to skiing safety, which is in Europe and other countries, and is more in the developing stages for U.S. is the idea a Ski Safety Council that is backed by the government. In Sweden, a group got together and formed a ski safety interest group. After 6 years of work in the industry they contacted the government for support and backing. Government support for such a group means it would become an official government organization, which would mean more support and money. With government backing this allowed them to more easily attract the press' attention, and further spread their message. This has been proven to work in Sweden, Norway, and other countries. There's a similar need for such and organization here in the states. The ski safety council would be comprised of people in all aspects of the industry, and would allow for standardization and guidelines that would increase skiing and snowboarding safety (Eriksson 1993).

1.3.2 Legal background

Ski areas are shielded from liability for most accidents through inherent danger statutes in Massachusetts, New Hampshire, and Vermont. Inherent danger statutes protect ski areas from most natural and man made hazards such as trees, snow conditions bare spots, and snow making equipment that is marked or visible. In New Hampshire, no suit may be maintained against a ski area based on the condition of the slope unless the state board finds that the track at the time and place of the accident failed to meet the board's requirements (Title 19 NSA Section 225-A:24). Negligence on the part of a ski area must be clearly demonstrated by the plaintiff. Usually negligence is failure on the part of the ski area or employees to comply with the safety guidelines defined by the state tramway board and other regulatory agencies (MGL, NSA, and VSA). In addition to this

limited definition of negligence, statues of limitations restrict the time a skier has to collect damages. In Massachusetts, New Hampshire, and Vermont, a skier has 90 days to notify the area of damages. In Massachusetts, a suit must be filled with in one year of the injury (MGL Section 71P). In New Hampshire and Vermont, skiers have two years to file suit (NSA Section 225-A:25, VSA).

Ski areas often attempt to protect themselves from legal actions with releases, waivers and exculpatory agreements. Some wavers go well beyond telling people to ski at their own risk. Many of these wavers contain language that if enforced would prevent skiers from successfully making claims based on any negligence including violations of ski board safety protocols, or would allow parents to wave the rights of their children. Some waivers like the illegal Indemnification Agreement posted below allow the ski area to collect repayment from the parents for their own child's injuries.

> I therefore, for myself, the child, or respective heirs, successors and assigns, hereby knowingly and intentionally WAIVE AND RELEASE, AND AGREE TO INDEMNIFY, HOLD HARMLESS, AND DEFEND [THE SKI COMPANY] their respective owners, partners, agents and employees from and against any and all liability, claims, actions, causes of action, suits, expenses (including reasonable attorney's fees) and NEGLIGENCE of any kind or nature, whether foreseeable or not, arising directly or indirectly out of any and all damage, injury, paralysis, or death of the child resulting from the participation of the child in the program, any activity associated with the program or in any way related to the program, or the transportation of the child as provided herein, or to persons or property which child may cause or contribute to with another child in the

> program, whether such damage, loss, injury, paralysis or death results from the NEGLIGENCE of the [SKI COMPANY] their respective owners, partners, agents, or employees, or from some other cause (Chalat 1999b).

In Dalury v. S-K-I Ltd., the Vermont Supreme Court ruled that following waiver was invalid because it violated public policy by attempting to relieve the ski area of its safety obligations to the public and because a contract cannot leave a party at the mercy of another parties negligence.

> 1. I accept and understand that Alpine Skiing is a hazardous sport with many dangers and risks and that injuries are a common and ordinary occurrence of the sport. As a condition of being permitted to use the ski area premises, I freely accept and voluntarily assume the risks of injury or property damage and release Killington Ltd., its employees and agents from any and all liability for personal injury or property damage resulting from negligence, conditions of the premises, operations of the ski area, actions or omissions of employees or agents of the ski area or from my participation in skiing at the area, accepting myself the full responsibility for any and all such damage or injury of any kind which may result (Dalury v. Ski Ltd. 1999).

While the two waivers shown above might not have legal standing in court, they could have the affect of deterring skiers from filing legal actions in the first place.

When a skier collides with another skier, there is usually not liability assessed to either of the skiers involved. Although skiing is not a contact sport, skier to skier

collisions are still considered an inherent danger of skiing. While the uphill skier is often required to yield to a skier of the slope below him, a skier usually must demonstrate recklessness or malice to collect on this type of accident (ChalatA). Skiers involved in a collision have duty of care to leave their name and address to other parties involved and contact medical or rescue (MA Gen. L. ch. 143 Sections 71Q and Statute: 12 V.S.A. Section 1038(a)). The ski area owes the injured skier no duty to gather or preserve evidence against another skier for a future claim (OConnel v. Killington 1999).

1.4 Approach

In approaching the problem of furthering the state of the art in ski trail safety research, our first objective was to generate some data that, while original, could be used in conjunction with existing studies. The data we collected was designed in such a way that enabled us to observe trends and correlations between the published works we studied in our literature review and our data. Then additional considerations were made so that once our correlations were drawn, we had some additional data that could be used to develop our own hypotheses that were essentially an extension of the industry research we did.

1.4.1 Investigating Trail Features

The first, and most involved portion of our research dealt with the investigation of trail features, specifically the gleaning of both objective and subjective data regarding various trail features and conditions and how they relate to trail safety. To do this, we planned and developed separate questionnaires for distribution to skiers/snowboarders and ski patrollers. We also visited Snow Engineering; an engineering firm that deals specifically with the design and modification of ski trails, and a medical center in New Hampshire that deals with ski-related injuries. This approach was designed to gather opinions from skiers and assess industry sentiment towards different issues that have been studied statistically in previous studies.

1.4.2 Mountain Visits

Any project dealing with ski safety should involve visits to various resorts. Simply visiting a resort with the intention of gathering information about safety can be an invaluable tool in developing a well-rounded report on the subject. Our mountain visits

consisted of photographing relevant trail features and signs, and interviewing Ski patrol. This gave us a more hands-on investigation of the issues and attitudes relating to trail safety than most of the reports we found for references.

1.4.3 Photographs

One of the issues we encountered while developing our background section was a distinct lack of visual representations of specific dangers on ski trails. Most of the reference books we found in the library contained very few photographs and diagrams. Raw data, text and statistics can be a good way to convey a message, but we felt that the information presented in our project should use more photographs, annotated to add concrete examples and relate our experiences on the slopes. So, in our investigation of trail safety we have endeavored to create a project that presents not only hard facts, but also many photographs of relevant parts of ski trails with discussion of the feature and why each contributes or detracts from the overall safety of the trail, and how it affects the skier's experience in using the trail. These photographs are presented in Sections 3 and 4. The project is presented in uniquely visual fashion, making it an extension of the established state of the art.

1.4.4 Ski Patroller Questionnaire

Primary sources were major part of our research. Expert opinions about factors that contribute to injuries on the slopes were invaluable in the compilation of this report. We developed a questionnaire (survey) to give to patrollers at the resorts we visited (See Appendix I). The goal of our Ski Patrol Questionnaire was to gather information pertaining to trends and particular experiences of these people who have made a career of helping to improve the safety of the slopes. This data proved useful to provide a

counterpoint with which we could compare the statistical data gathered in the skier surveys, and illuminated skier and patroller opinions about safety on the slopes.

1.4.5 Skier Surveys

Another issue we encountered was that most of the background information we collected from books was not current, and most studies were specific to one particular mountain. In order to add credibility to the assertions taken from published studies anywhere from five to thirty years old, we compiled a skier survey. The survey's goal was to ask questions that would provide us with current data/opinions from a diverse population of skiers in the Worcester area. Once compiled, our survey information was compared to existing studies to see if the trends cited in resort-specific studies is representative of the overall skier population in the area (see section 3). To our knowledge, there has been no other study with this objective, making our study an extension of the "state of the art".

1.4.6 Massachusetts State Tramway Board

When investigating the existing laws governing ski areas, we found that we were unable to find sufficient information in the library. We were able to obtain a copy of the legislation, but little background information. Therefore, we approached this problem by contacting the Massachusetts State Tramway Board. Our queries were designed to glean information about the rationale behind the laws, and how such regulations are enforced.

1.4.7 The Vermont Coroner

A major obstacle to our research was gathering current information about specific incidents. To answer the questions: Why do accidents occur on trails? How do they happen? And Where? was an extremely important issue. On the advice of Professor

Brown, we attempted to contact his colleague Paul Morrow, the Vermont state coroner, as he visits each ski area death in the state. We attempted to contact him by email and phone, but were unable to get in touch with him until late in the project, and were unable to get the kind of information we requested of him in time for it to be included in the report.

1.4.8 Snow Engineering and Hospital Interviews

In addition to our interviews with resort ski patrollers, we also contacted an engineering firm called Snow Engineering; a New Hampshire firm that deals with the design and modification of ski trails. As they are the only firm we found in the area that does this sort of work, they were a good resource for information about the trail side of things. This gave us a base of knowledge about what sort of safety features are currently being implemented at resorts (See Appendix I).

To round out our ski patrol and Snow Engineering interviews, we arranged an interview with Claire Wilmot at the Littleton Hospital, Littleton NH (see Appendix I). The Littleton Hospital handles the majority of injuries sustained at Cannon Mountain, and Claire sees a side of alpine sporting injuries that the ski patrol does not. From this interview we gathered our only pro-helmet discussion; all of the patrollers and the majority of skiers we contacted were against mandatory helmets.

These two interviews provided us with a more well-rounded impression of trail safety issues, and gave us a better sense of the complexity of the issues of trail design and helmets.

1.4.9 Investigation of established methods of accident prevention

In order to extend the state of the art, it was important for us to investigate what measures ski areas already have in place to prevent accidents. We were able to collect much of this information while compiling our literature review, and the rest came from personal communication and the interviews described in the previous section.

2 Methods

2.1 Mountain Visits

To gain the necessary information needed to conduct our project we needed the support of the ski resorts to help us with our project. After the first couple of meetings, we decided that a formal letter outlining our project and asking them to assist us was the best way to approach the mountains.

When deciding when to send out the initial letters to the mountains we felt the earlier the better. This way we would have the letters hit the mountains before the first major snowfall because the mountains would have more time to dedicate to our project before they got too busy. With this in mind we sent out the letters on December 13, 1999. The next issue was, What Mountains do we send them to? We decided that the most effective method would be to sample a broad range of ski areas in New England. Table 2.1 shows what mountains we chose as well as their locations.

State Where Mountain is Located	Sent Letters To These Mountains
Massachusetts	Bousquets, Berkshire East, Wachusett
New Hampshire	Attitash, Bretton Woods, Cannon, Cranmore, Loon, Waterville Valley, Wildcat
Vermont	Killington, Mount Snow, Stowe, Stratton, Sugarbush

Table 2.1: Mountains that were sent letters

We felt these mountains were a representative sample that covered a broad range of characteristics that would be exhibited throughout the country. They were also selected in proximity to Worcester so we could visit them without costing too much.

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the letter that we sent to the mountains can be seen in Appendix A. Table 2.2 shows the rationale behind every phrase in the letter.

We wrote this in our letter...		To accomplish this...
1	Each year numerous people get seriously injured due to skiing and snowboarding accidents.	Have a opening sentence that will grab their attention
2	Even though recent studies have shown that in the past few years there has been a decline in the amount of these injuries, further reductions of these dangers would be desirable.	Show that we are looking to lower the injury rate (our objective)
3	We are a group of students from Worcester Polytechnic Institute (WPI) working on an Interactive Qualifying Project aimed at mitigating these risks.	Who we are, where we are from, and what we are doing
4	The IQP challenges students to investigate and report on a topic that interests them. This topic should examine how science or technology interacts with societal structures and values.	Explains what the IQP is
5	This IQP will attempt to bridge the technical and mechanical aspects of preventing ski injuries with the social and economic needs to prevent injury.	How the IQP interacts with our project
6	Currently we are involved in looking at past accidents and what has been done to avoid them	What we have been doing in the past
7	We will soon be reaching the next step in our project where we will be going out and determining what causes these accidents	What we are going to do
8	By doing this we can identify the most effective and practical methods to reduce these injuries. In order for us to meet these goals, we need your mountain's assistance.	Why we need their help and what we are going to do with the information that we receive
9	We are interested in any input that you would be willing to give us that could help our project, as well as allowing us to come up to your mountain for a visit	What we looking for from the mountain
10	With the help of your mountain, we can accomplish our goal of determining which factors are responsible for injuries and accidents. Because our IQP will be covering many of the ski resorts in New England, we can gather the information needed to develop strategies and conclusions that could be implemented at mountains across the	What their efforts are going to accomplish by helping us

	United States.	
11	We look forward to your ski resort joining our efforts in our IQP by helping us achieve our goal. If you can be of any assistance to our efforts, your ski resort will be recognized in our IQP report and published in May of 2000.	Emphasizing that we need their help and when our project will be open to the public
12	With experts in ski safety, faculty, and numerous students reading this report this could be a great opportunity for your mountain to show its efforts concerning the safety of the ski community.	What they can get from helping us
13	Thank you for your time and I look forward from hearing from you. You can contact me by phone at (508) 752-2307 ext.31, by email at fiona@wpi.edu, or by writing me at the address above	To thank them and how to contact us in the future.

Table 2.2: Mountain letter rationale

When we sent out the fifteen letters we were curious to see how many responses we would receive. On Tuesday, January 18, 2000, we got an email response from Cannon Mountain (Appendix B). With only one response from our original letter we had to find another way to gain the attention from the ski resorts. We felt that a well thought out follow-up call would be the most suitable way to contact the rest of the mountains. Table 2.3 illustrates the rationale behind each part of the follow-up call.

What we said to the mountain		The rationale behind each phrase.
1	Hi my name is _____ and I'm a college student working on a group ski safety project, can you please assist me in finding me someone who can answer a few of my question?	What to say to the operator
2	Hi my name is _____ and I'm a college student working on a group ski safety project. About three weeks ago we mailed a letter to your mountain And this is a follow-up call to see if you are interested in assisting us?	Let them know who I am, where I am from, why I am calling them. Also to see if they received our letter.
3	What we need from them • Visit any new prevention methods you have applied to your mountain • Visit locations where accidents occurred to see if there are any common factors • Set up a time to talk to a person on the ski patrol so we can ask a few questions	Tell them exactly what we are looking for from them if they already received the letter
4	Well let me tell you a little bit about it. The group consists of eight students from WPI that are currently working on a ski safety project. Our objectives are to reduce the number of serious injuries while keeping the cost economically viable for ski resorts. We plan on accomplishing this by looking at past accidents and where they occurred to see if there are any common factors that are involved. We are currently working with other ski resorts and we are wondering if you are willing to join our efforts?	If they did not receive the letter than tell them about the project, • Group • Objective • The past Also ask them if they are willing to help

5	Great, well with your help we can gather the necessary information needed to reduce the number of injuries that occur from skiing and snowboarding. We would like to visit your mountain and see these sites where the accidents occurred to see if there are any common factors. We would also like to look at any new prevention methods you have implemented to help reduce the number of accidents on your mountain. What would be a good day for a couple of us to come up?	What we are planning to do once we get to their mountain. Also to ask them if we can visit their mountain.
6	What would be a good day for a couple of us to come up?	Letting them know that we want to come up with more than one person
7	How would be the best way to visit these locations? (Snowmobiles, Skis)	How we are going to visit these location on the mountain. (Possible free lift tickets)
8	Great, I'll call you back with which we can come up. Well it's been great talking to you. Thanks for your time and I look forward to talking to you soon. Thanks again.	To thank them for their time and to let them know that I will be calling them back with a date in which we can come up.
9	Willingness to help (1-5)_____ Attitude I got from him/her On our project (1-5) _____	To rate them on the reaction that I felt and to document if they were really interested in the project or not. (Mountains that were given a high rating were first priority when deciding the order in visiting the mountains.)

Table 2.3: Follow-up call rationale

We made follow-up calls to the remaining fourteen ski areas to get an immediate response from the mountain. This way we would get a definite answer and could not be easily ignored. By creating a form for the callbacks we could say the same thing to every mountain that we talked to therefore the responses of the ski resort could be documented to compare one mountain to another. A sample of the form that we used when calling the mountains back can be seen in Appendix C. Figure 2.2 is a flow chart that illustrates

what we said when we called each mountain. By following this flow chart we knew exactly what to say depending on their response.

**Say this to the person who answers the phone:*

Hi my name is _____ and I'm a college student working on a group ski safety project, can you please assist me in finding me someone who can answer a few of my question?

*(*Be directed to either Ski Patrol or Mountain manager, or Director)*
Say this next:

Hi my name is _____ and I'm a college student working on a group Ski safety project. About three weeks ago we mailed a letter to your mountain and this is a follow-up call to see if you are interested in assisting us?

Yes **If they received our letter or not* ***No***

Well let me tell a couple of thing that we Are looking to do at your mountain

- • • **We would like to visit new prevention methods that they have applied to their mountains**
- • • Visit locations where accidents have occurred and see if there are any common factors involved
- • • Set up a time to interview a person on your ski patrol

Let me tell you little about it. The group consists of eight students from WPI that are currently working on a ski safety project. Our objectives are to reduce the number of serious injuries while keeping the cost economically viable for the ski resorts. We plan on accomplishing this by looking at past accidents and where they

occurred to see if there are any common factors that are involved. We are currently working with other ski resorts and we are wondering if you are willing to join our efforts?

If they Say **Yes, Then say This:*

If they say **NO, then say This:*

If they say **YES, then say this:*

Well it's been great talking to you Thanks for your time.

Great, well with your help we can gather the necessary information needed to reduce the number of injuries that occur from skiing and snowboarding. We would like to visit your mountain and see these sites where the accidents occurred to see if there are any common factors. We would also like to look at any new prevention methods you have implemented to help reduce the number of accidents on your mountain. What would be a good day for a couple of us to come up?

**Write down dates that we can come up and visit and say…*

Great, I'll call you back before we come up. Well it's been great talking to you. Thanks for your time and I look forward to talking to you soon. Thanks again.

Fig. 2.2: Flow chart used when calling mountains

After we got positive responses from the ski resorts we needed to set up dates that we visit them. By using the rating system from the follow-up calls, (Table 2.3, Section 9) we gave priority to those mountains we felt were the most interested in assisting us. We also wanted to visit as many ski resorts as possible without overlapping mountain

characteristics. We sampled small and large mountains, scarce and crowded mountains, family and skier orientated mountains and mountains with and without terrain parks. Then we decided who were the most qualified members of the group and called the mountains back with dates that we could go. Table 2.4 illustrates when we visited each mountains.

The Mountain	**Date Visited**
Cannon	February 11, 2000
Wachusett	February 17, 2000
Loon	March 14, 2000
Wildcat	March 15, 2000
Stowe	March 16, 2000

Table 2.4: Dates that we visited the mountains

When we visited the mountains we had a set of procedures and goals that we would set out to accomplish while we were there. These procedures tended to change from visit to visit depending on when we could interview the ski patrol. A typical days itinerary can be seen in Table 2.5.

Time	**What we Did**
Early as Possible. (Around 8 or 9am Depending on travel time)	Arrive at the mountain, change into skiing clothes and ask at the front desk for the contact that we had talked to before. Also receive lift tickets/passes from the front desk
Before Lunch	Interview Ski Personal with the list of Ski Patrol Questionnaire and go over any new prevention methods they have implemented. Then ask where the most common accident sites are so we can take pictures and document types of location on the mountain.
12:00	Have lunch and pass out skier surveys to people in the lodge.

1:00 to 4:00	Go around to the most common accident sites and any prevention methods implemented to their mountain. (In most cases we went around with a ski patroller or the mountain manager.)
4:00 to end of day	Pass out skier surveys to people in the lodge

Table 2.5: Itinerary of a typical mountain visit

Before we visited each mountain we knew a couple of different people that we could contact once we arrived there. We did this so we did not have to rely on our only contact person being there. Once we got to the mountain if our contact person was busy or not even there, we could rely on our next choices. During some of our mountain visits we were able and interview multiple sources. Table 2.6 shows our contacts and their jobs at each mountain.

The Mountain	**Who We Talked To**
Cannon	Bill Mead –Ski Patrol, Clare Wilmot, M.D., F.A.C.S. –First Aid and Surgeon at the Littleton Hospital, Richard Andross – Mountain Manager
Wachusett	Mike Hallaren - Head of Ski Patrol
Loon	Kevin Busby –Former employee, Dan Healey Head of Ski Patrol
Wildcat	Jim Bilotta - Head of Ski Patrol
Stowe	William Shaft - Head of Ski Patrol

Table 2.6: Our contacts at each mountain

2.2 Survey Methods

2.2.1 Method Overview

At the beginning of the project, it was decided that surveys would be a good tool to help find the answers to our research questions. The potential benefits of a survey would be that many people could be questioned and in the process a reliable amount of data could be collected, and could possibly be compared to industry research.

2.2.2 Question Rationale

A standard set of questions was devised for the survey. Each question of the survey had it's own rationale behind it. Figure 1 shows each individual question and the rationale.

Table 2.7: Rationale For Survey Questions

Question	Rationale
Sex?	Gender differences in injuries, etc
Age?	To see if age has an effect on the amount and types of injuries
What kind of equipment do you use?	To correlate common injuries for each type of equipment
How many times a year do you go skiing/snowboarding?	To make a correlation between the number of visits and the level of ability
How would you rate your level of ski/snowboard ability?	To find relationships between level of ability and quantity/types of injuries
Have you ever taken instructional courses? If you answered yes then how many have you taken?	To find correlations between level of skier/snowboarder education and injuries To find how many instructional courses have been taken
If you own your own equipment, how often do you have it checked and maintenance done?	To find any correlations between well maintained equipment and injuries
If you own your own equipment, how old is it?	To see if the advances in ski/snowboard design has an affect on the number and type of injuries
On average, how often do you fall on a given day?	To see if expert skiers/snowboarders who do not generally fall have more serious injuries than average
How would you rate your skiing/snowboarding style?	To see if skiing style has a correlation between the number and types of injuries
Do you normally wear goggles during harsh weather?	To see what affects visibility has on the number of injuries

Do you wear a helmet? If no, then why not?	To see what percentage of people wear helmets To find out why people don't wear helmets
Have you been injured while skiing/snowboarding? Briefly describe your injuries and what happened in your accident below	To see the percentage of people that have had injuries To find out what type of injury the person had
What type of equipment were you using when you got injured?	To find out if the person was using skis or a snowboard when injured
If you answered skis what type were they?	To see if shaped, normal, or race skis have different injury rates and types
If you answered snowboard then what type?	To see if downhill or freestyle snowboards have different injury rates and types
If you answered snowboard then what type of bindings?	To see if step-in or strap bindings have different injury rates and types
If you answered snowboard then what type of boots?	To see if hard or soft boots have different injury rates or types
What was your level of control?	To see if level of control has an affect on type and severity of injury
Your speed?	To see if speed has an affect on type and severity of injury
Your intensity?	To see if level of intensity has an affect on type and severity of injury
What were you doing on the trail?	To see if there are any correlations between what they were doing on the mountain and type and severity of injury
What level trail were you skiing on when you got injured?	To see where the majority of injuries happen
What were the trail conditions when you got injured?	To see what type of trail conditions affect different number and types of injuries
What time of day did your accident take place?	To see if there are any common times that injuries take place
What was the weather like at the time of the accident?	To see if there's a correlation between different types of weather and injuries
What was the temperature like at the time of the accident?	To see if the effect of temperature on snow and equipment causes more injuries
Was the trail too crowded when you got injured?	To see if accidents happen on crowded trails
Did ski patrol come to help you when you got injured?	To see how often ski patrol rescues an injured person
Who or what do you believe was the cause of your injury?	To see what people believe caused their injuries

2.2.3 Web Survey

After the questions were developed it was decided that the survey should be on the World Wide Web. The survey was posted on the survey hosting site

SurveyAnywhere.com. Putting the survey on the web allowed easy access and rapid dispersion. The web survey was limited to 20 questions, so the questions asked were selected carefully. An email was sent out to all WPI undergraduates, asking them to fill out the survey. Another limitation of the web survey was that the data could not be entered into a database, therefore all data could only be tabulated. Tabulation did not allow cross-referencing among survey submissions. The complete web survey form can be seen in Appendix D.

2.2.4 Handout Survey

Due to the limitation of the inability to cross reference data on the web survey, a paper handout survey was developed. Data from the handout survey could be entered into a database and cross-referenced easily. The two page survey was given out at the Wachusett Mountain lodge for one afternoon. Later, copies of the survey were left at the Strands' and Eastern Boarder stores in Worcester for a period of several weeks. The surveys were left with a drop box and sign, asking patrons of the establishments to complete the survey and insert it into the box when completed. Surveys were also handed out to friends and family of the people in the group. The two page handout survey can be seen in Appendix E.

2.3 Ski Patrol Questionnaire

When interviewing the ski patrol we wanted to look professional and organized. Therefore we planned out a set of procedures (as seen previously, in Table 2.5) while we arrived at the mountain. We also came with a prepared sheet of questions to ask the ski patrol and tape-recorded each interview. We did this for two reasons, 1) Get the whole interview documented (so we wouldn't miss any quotes) and 2) Create the image of acting professional and organized.

We achieved this image by creating a ski patroller questionnaire. People forgot that we were college students and took us seriously. People at the ski resorts even commented on our professional conduct. Figure 2.8 illustrates the rationale behind each question asked to the ski patroller.

Ski Patroller Questions		**Why we asked it (rationale)**
1	What are the most common injuries that you see? (For Skier's/Snowboarders)	To see what the most common injures are at that mountain
2	What trail features are the most responsible for accidents?	To see what common trail features play a role in accidents
3	What is the average ski patrol to skier ratio?	Find the average ski patroller to skier ratio is and see if that effects the accident rate at their mountain
4	Do you think making helmets mandatory would result in decreased head injuries?	See their opinion on if helmets would decrease head injuries
5	If so do you think it is feasible?	If they think it can be done
6	Are there any common factors involved in skiing/snowboarding accidents? (I.e. weather, experience of skier, time of day, conditions, features on the trail)	See what common factors are involved in the accidents at their mountain

7	How could most of these accidents been prevented? And would it be cost effective for the mountain?	Try to find if a way to prevent accidents and see if cost plays a factor in their decision
8	What actions has your mountain done to prevent accidents? And have you seen direct results from them?	See what that mountain has down to prevent accidents and if they were successful or not
9	What are the best and least expensive ways to prevent accidents?	See how that mountain prevents accident, and compare them to other mountains
10	What steps and procedures are taken when there is an accident on the mountain?	See different styles of handling accidents on their mountain
11	How often does mountain equipment contribute to accidents on the trails? (I.e. snow making machines, lift posts, trail groomers, snowmobiles)	To see if mountain equipment ever has an effect on accidents
12	Has the large increase in the number of snowboarders caused a proportionate increase in accidents and problems at your mountain?	To see if the increase in snowboarders caused more problems/accidents
13	Are you aware of alcohol and drugs playing a role in accidents?	See if drugs and alcohol plays a role in accidents
14	Does serving alcohol at mountain bars causes problems and if so what are your opinions on it?	See their opinion on having mountain bars causes problems/accidents
15	Other comments or Questions.	If they have any additional comments

Table 2.8: Ski patrol questionnaire rationale

By interviewing the ski patrol at each mountain we gathered the information needed to compare one mountain to another. Using a set of procedures when we went to each mountain, allowed us to conduct the same items at every mountain. One important part of visiting mountains was looking at common accident sites, good and bad trail features, and new prevention methods applied to their mountain. To document this information we felt a digital camera was the best and most economical way (the camera

was loaned to us by WPI). Then we could easily use them at our disposal and we didn't have to pay to get pictures developed. We also sent out thank you letters to everyone that helped us out during the mountain visits. (Appendix D)

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IQP/MQP SCANNING PROJECT

Two weeks later after a follow up e-mail was sent, the DPS representative requested that WPI make a formal request under the Freedom of Information Act. The information request was sent and we requested that the usual fees be waived.

The correspondence with the Tramway Board asked the questions listed in the table below:

Questions	Reasons for asking the Questions
What are the most common violations of board regulations found by or reported to your inspectors?	Helps establish how often the Tramway Board enforces each regulation.
How are these problems usually dealt with?	Shows how often each regulation is enforced.
Does the State Board collect statistical data on ski area accidents?	Shows what facts the boards collects in deciding how to develop or enforce regulations.
What role does the board play in accident investigation?	1. Determine if the board investigates accidents on their own or if and they rely on accident reports from ski areas and insurance inspectors. 2. Determine if the board investigates accidents that do not involve tramways.
Does the board use their findings to recommend or require trail modifications?	Determine how the board applies statistical data, and accident findings to public policy.

Table 2.9 Tramway Board Questions

These questions were submitted with an explanation of what information we were most interested in finding to the Tramway Board.

2.5 Claire Wilmot General Surgeon Littleton Hospital

2.5.1 Method Overview

In the beginning of our project we decided that one of the many ways we could find the answers to our research questions was to interview people who had knowledge in the Skiing/Snowboarding industry. This would include Ski Patrol, people in industry, safety experts, as well as other Mountain personnel. While at Cannon Mountain we interviewed a Dr. Claire Wilmot who worked in the first aide office that day. Dr. Wilmot is a General Surgeon at the nearby Littleton Hospital who volunteers one day a week to work at Cannon.

We devised a standard set of interview questions to ask her, somewhat like the ones we made to ask Ski Patrols. Doctor Wilmot was very informative not only answering our questions but also talking about many other interesting topics. Table 1 shows the individual questions as well as the rationale behind each one.

Table 2.10: Dr. Wilmot Interview Rationale

Question	Rationale
What are the most common injuries you see?	To see what the most common injuries are
What do you think about making helmets mandatory?	To see if mandatory helmets would result in decreased head injuries
Do you know of any ways to prevent accidents?	To see how most of the accidents could be prevented To see if it would be cost effective for the mountain

What are the best and cheapest ways to prevent accidents?	To see what the best and cheapest ways are to prevent accidents
Do you see drugs and alcohol involved with accidents?	To see if drugs and alcohol play a role in accidents
What is your opinion on alcohol being served at mountains?	To see if mountain bars cause problems/accidents

During the interview Dr. Wilmot mentioned a study on head injuries that she had been working on since 1996. But due to time restraints and the fact that she didn't have her research with her we were not able to get that information. The Dr. Claire Wilmot Interview at Cannon's First Aide on 2/11/00 can be seen in Appendix I.

On 03/15/00 we met Dr. Wilmot at her office in the Littleton Hospital for our second interview. While their Dr. Wilmot first showed us a study she had performed in conjunction with Cannon Mountain about the number of people wearing helmets and then explained their findings. After that she proceeded to show us her power point presentation on ski and snowboard Head injuries that she uses to educate people on the benefits of wearing helmets. With her permission we recorded the visit so we wouldn't miss anything. She gave us a copy of her power point presentation as well as other unpublished data for use it in our IQP. She did this in hopes that people would read our

IQP and spread the word on the benefits of wearing helmets on the slopes. The Dr. Claire Wilmot Interview at The Littleton Hospital in New Hampshire on 3/15/00 can be seen in Appendix I.

3.1 Mountain Visits

3.1.1 Trail Features

After visiting the 4 mountains that we were able to investigate first hand, it is clear that there are 3 major trail features that cause specific types of accidents. These features are merging trails, bad fall lines, and man made obstacles. Merging trails are when 2 or more trails merge into one at an intersection. A bad fall line is when the momentum of a skier or snowboarder that loses control, follows an unavoidable path that carries the person into a hazardous situation such as a falling into tree line or ditch. Man-made obstacles are objects that are not naturally part of the trail and are located in or to the side of the trail.

At one mountain that was investigated, a merging accident occurred and was documented. What caused the accident is that one skier had lost control and merged with another trail and collided with another skier who was traveling down the opposite trail. Fig 3.1 shows the actual merging trails at the site of the accident. The very short trail

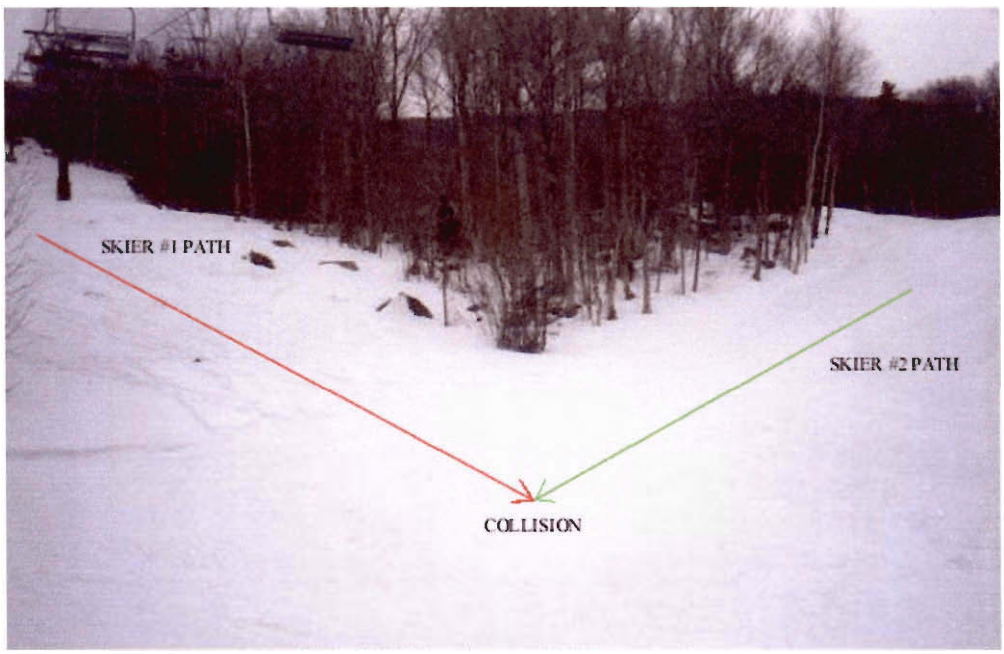


Fig 3.1 Merging collision paths

that skier #1 took is ungroomed and because it had rained the day before, the snow had a very thick icy crust over the powder. Not anticipating the crusty conditions of the trail the skier was unable to turn in the crust and lost control traveling down the red path marked in Fig 3.1 and collided with another skier who was traveling normally down the trail to the right, marked green in Fig 3.1. Upon collision, both skiers lost control completely, causing them to fall and their momentum carried them about 20 yards down the trail. Due to the nature of injuries sustained by both skiers, ski patrol was called to assist the fallen skiers. The entire scene of the accident can be seen in Fig 3.2. You can see the two merging trails to the left side of Fig 3.2 and where the two skiers

Fig 3.2 Panoramic view of accident

landed to the right. The skiers both sustained severe unknown injuries and had to be assisted by ski patrol and brought down the mountain, as seen in Fig 3.3.

Fig 3.3 Putting skier into sled

At another mountain, the site of a multiple skier death was investigated. The circumstances of the accident were that a skier was coming down a trail near the top of the mountain with his two companions and lost control. Because of the nature of the fall line of the trail, his momentum took him under a rope barrier and he slid down to the bottom of a closed trail. The closed trail was very icy and the fallen skier could not stop. The fall line eventually led him about 100 yards down the trail into the tree line where he suffered a traumatic injury. The fallen skier's daughter and daughter's fiancée stopped at the rope barrier at the top of the trail. The fiancée removed his skis and crossed the rope barrier, proceeding to go down the closed trail to assist the fallen skier instead of seeking help. On his way down the trail he slipped on the ice, falling down the same fall line of the other skier, hitting the same tree line where he also suffered a traumatic injury. The daughter of the first fallen skier took off her skis and went after her fiancée and father instead of seeking help and slipped and fell the same way her fiancée did, again sliding all the way down the trail in the same fall line, landing near her two companions, suffering her own traumatic injury. The three skiers were not discovered until some time later and only the female survived.

In Fig 3.4, the trail that the three skiers were skiing down and the where first skier lost control can be seen above the red line. The rope barrier crossed the trail on the ridge where the red line is and the trail flowed off to the right to detour the closed trail. Due to the nature of the fall line, it is assumed that the first fallen skier was traveling down the trail to the right of the lift tower in Fig 3.4, falling down and sliding underneath the rope barrier at the ridge. The skier slid down the trail, following the fall line marked in green in Fig 3.4. The spot where the other skiers stopped is at the ridge marked by

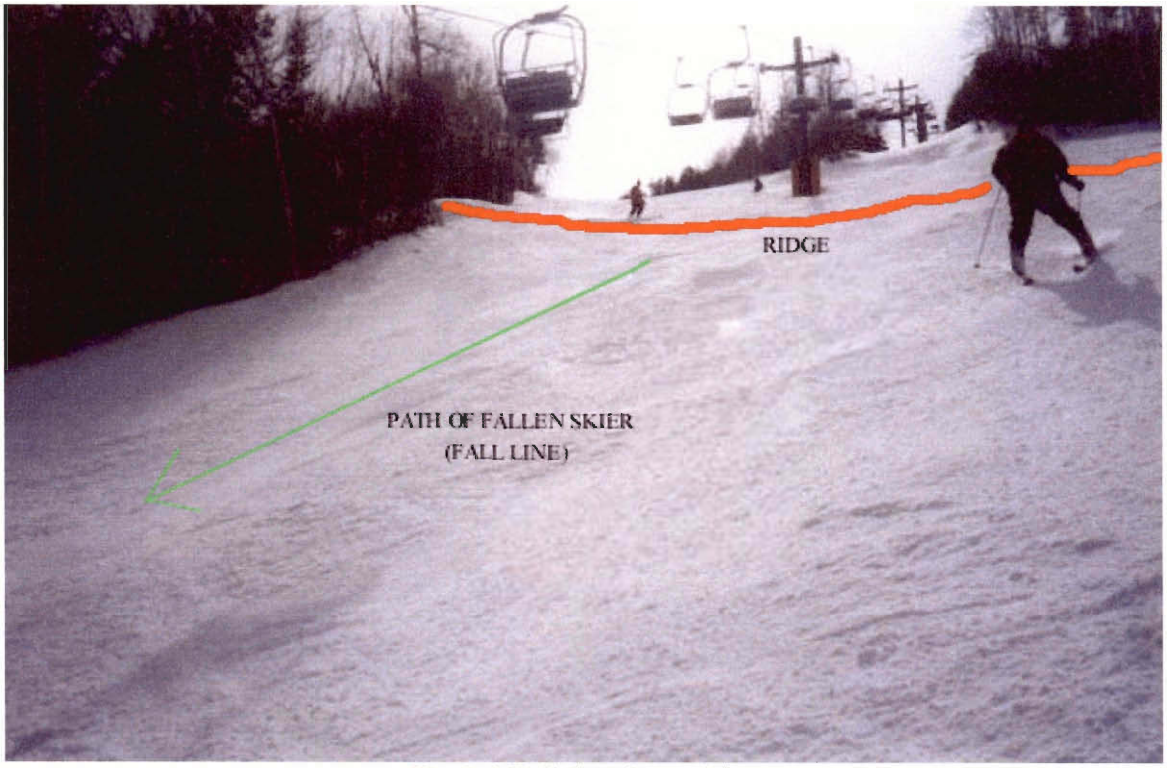


Fig 3.4 Fall line from ridge

the red line in Fig 3.4. If you follow the fall line in Fig 3.4, it continues down the trail marked in green in Fig 3.5. All three skiers landed in the tree line marked in red

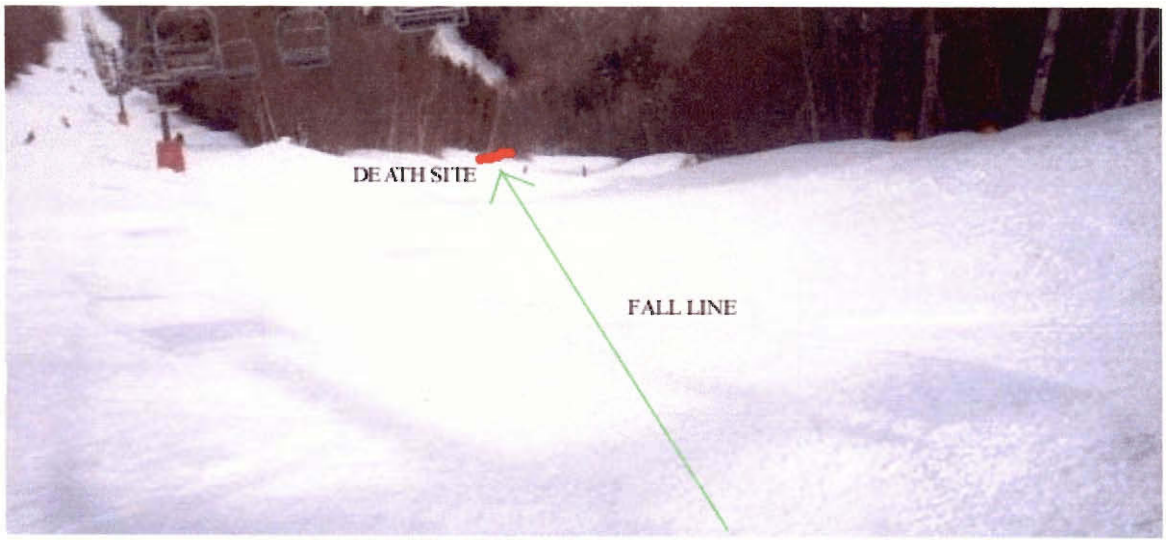


Fig 3.5 Fall line to death site

marked in Fig 3.5. A view of the bottom of the trail can be seen in Fig 3.6 and again the fall line is marked in green. In Fig 3.6, you can see how steep the trail is.

Fig 3.6 Fall line from bottom

Two more examples of bad fall lines were seen at two other mountains. In Fig 3.7, a snowboarder is seen losing control following the fall line and almost landing in the safety net. Another example of a fall line at another mountain is shown in Fig 3.8.

Fig 3.7 Fall line into net

Fig 3.8 Fall line into no net

Man-made obstacles are integrated into the trail and can sometimes pose a threat to any skier or snowboarder who may lose control and hit them. These obstacles were seen at all the mountains that were investigated. Obstacles placed in the middle of the

Fig 3.9 Wood Bridge

Fig 3.10 Padded lift pole #1

trail can be seen in Fig 3.9 and Fig 3.10. In Fig 3.9, a man-made bridge was constructed across a stream and the stream is protected by a wooden fence to prevent any skiers or snowboarders from falling into it. Fig 3.10 is an example of a chairlift pole placed in the middle of a trail. This trail feature is common among all the mountains that were investigated. Examples of man-made obstacles placed near the side of the trail are shown in Fig 3.11 and Fig 3.12. In Fig 3.11, a large wooden fence is in place to

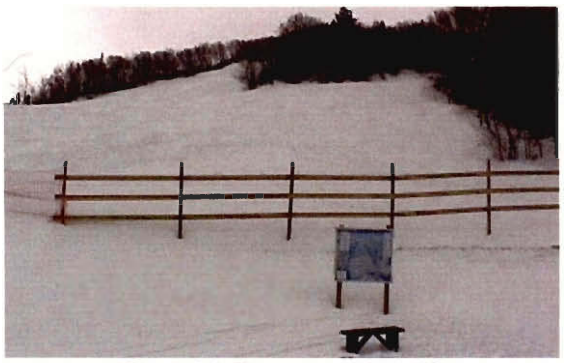


Fig 3.11 Fence at chairlift

Fig 3.12 Padded obstacles

prevent skiers and snowboarders from traveling directly into a chairlift drop off station which is located at the bottom of a trail. In Fig 3.12, a padded chairlift pole and metal box are placed to the side of the trail.

3.1.2 Trail Design

During the mountain visits, the investigation team documented trail design. At Wildcat Mountain, a spot was discovered where the characteristics of the trail caused numerous accidents and the mountain has plans to reconstruct the trail. Wachusett Mountain also has plans to reconstruct one of its trails because of a bad fall line. Cannon Mountain has already reconstructed one of its problem trails. Also, the designs of terrain parks on different mountains will be compared.

At Wildcat Mountain, the head of ski patrol, Jim Bilotta, showed the group's mountain investigators a problem spot on the Polecat trail. In the trail there is a rather large mound that is part of the mountain and extends more than halfway into the flat trail as seen in Fig 3.13. At the site, Jim Bilotta informed us that sometimes when people

Fig 3.13 Wildcat mound fall line

travel up on top of the mound they sometimes lose control and follow the path of the fall line, marked in green on Fig 3.13, and fall into the woods. The woods that the fall line leads to is a very steep hill with thick brush, as seen in Fig 3.14. This makes extraction of the injured skiers and snowboarders very difficult. Mr. Bilotta explained that he has

Fig 3.14 Wildcat mound fall line into woods

plans to reconstruct the trail in the following summer to remove the mound and flatten the trail completely, thus removing the fall line.

At Wachusett Mountain the head of ski patrol, Mike Hallaren, brought the investigating team to a site where a fall line on the trail causes problems with a tree line. You can see in Fig 3.15 looking down from the top of the trail the tree line

Fig 3.15 Wachusett tree line from distance

at the bottom. Mr. Hallaren explains that when people come down the trail and go over the ledge in Fig 3.16 they sometimes lose control going over the ledge, following the fall

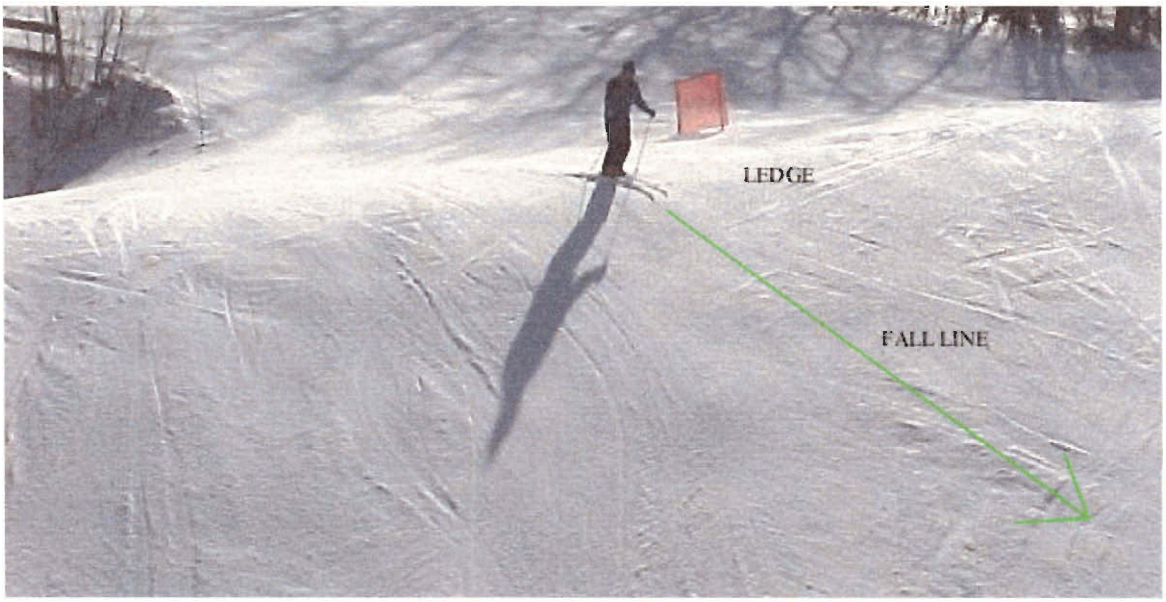


Fig 3.16 Wachusett fall line ledge

line marked by the green arrow and collide with the tree line marked in red in Fig 3.17. Mr. Hallaren explained that the mountain has plans to remove the tree line marked in red in Fig 3.17 to reduce the number of accidents on that trail.

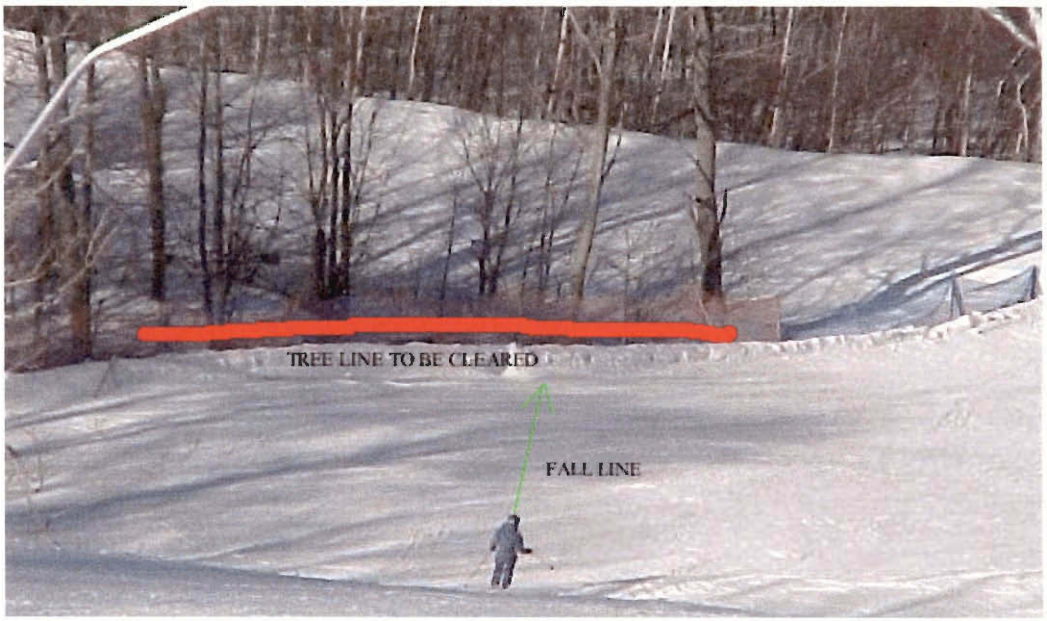


Fig 3.17 Wachusett tree line to be removed

Cannon Mountain has recently reconstructed a number of their trails. Bill Mead of Cannon Mountain explained that they widened the trail shown in Fig 3.18.

Fig 3.18 Cannon trail reconstruction

Before the reconstruction the trail was located to the right of Fig 3.18 up in the tree line. Due to a large number of accidents on that narrow trail from people going off the side of it into a large wooded hill, the trail was partially relocated and widened (Mead 2000). The drop off on the side of the new trail is not as steep as seen in Fig 3.19. Since the reconstruction, the trail has had significantly fewer accidents.

Fig 3.19 Cannon trail reconstruction ditch

At the 4 mountains that were investigated, 3 of them had terrain parks, which were Cannon, Wachusett and Loon. Terrain parks have a higher risk of accident on them because of their features (Mead 2000). Ski patrollers often call the terrain parks the "bone yard"(Mead 2000). Upon investigating terrain parks, the terrain park at Cannon Mountain is much narrower that the terrain parks at Loon and Wachusett. Fig 3.20 shows the width of the Cannon Mountain terrain park and Figs 3.21 and 3.22 show the width of the terrain parks at Wachusett Mountain and Loon Mountain respectively.

Fig 3.20 Cannon terrain park view

Fig 3.21 Wachusett terrain park view

Fig 3.22 Loon terrain park view

The most common features of all terrain parks are jumps and half pipes. Fig 3.23 shows the jumps at Cannon Mountain. If you look closely at Fig 3.23 you can see that the jumps are very close together and are one after another. The jumps at Wachusett Mountain and Loon Mountain are very spread out, as seen in Figs 3.24 and 3.25 respectively. While most of the jumps at the Cannon terrain park were rather small, the

Fig 3.23 Cannon terrain park jump

Fig 3.24 Wachusett terrain park jump

Fig 3.25 Loon terrain park jump

jumps at Loon and Wachusett were much larger. Examples of half pipes were seen at Wachusett and Loon. Fig 3.26 shows the half pipe at Wachusett and Fig 3.27 shows the half pipe at Loon. Cannon had an example of a quarter pipe as seen in Fig 3.28.

Fig 3.26 Wachusett half pipe

Fig 3.27 Loon half pipe

Fig 3.28 Cannon quarter pipe

3.1.3 Hazard Marking

Upon investigating the 4 mountains, we documented the ways that the mountains marked hazards was documented. The types of hazard markings documented were trail closing signs, terrain park signs, merging trail signs and markings, trail difficulty signs, obstacle signs and markings, fall line markings, courtesy signs and glade markings. Specific examples of each type of hazard marking will be presented.

By investigating the mountains, most trails were closed off with a rope and standard closed sign crossing the width of the trail, as seen in Fig 3.29. Other trails were closed with a rope and small flags and sometimes with an orange closed sign hanging

Fig 3.29 Standard closed sign and rope

from it and sometimes just a rope and flags but no sign. Fig 3.30 is an example of rope with flags and sign and Fig 3.31 is a rope with flags but no sign.

Fig 3.30 Rope with flags and sign

Fig 3.31 Rope and flags

One trail was seen closed with a freestanding closed sign, as shown in Fig 3.32.

Fig 3.32 Freestanding closed sign

Terrain parks at the different mountains had methods of marking hazards on their trails. Most mountains had disclaimer signs at the beginning of their terrain parks. Figs 3.33 and 3.34 show the disclaimer signs at both entrances of the terrain park at Loon, while Fig 3.35 is the disclaimer at the beginning of the terrain park at Wachusett.

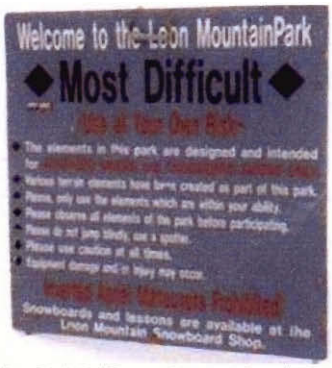


Fig 3.33 Terrain park sign #1

Fig 3.34 Terrain park sign #2

Fig 3.35 Terrain park sign #3

Dangerous terrain park features are often marked to make them more visible. The features include lips and the sides of jumps so help the skier or snowboarder to be more aware of the terrain. Fig 3.36 is the side of a jump at Loon and Fig 3.37 shows the end of the bowl of the Cannon terrain park marked with poles to warn people where it ends.

Fig 3.36 Markers on jump

Fig 3.37 Markers on bowl

There were many different ways in which mountains marked merging trails. At Loon and Wildcat, merging trails were often seen marked with merging and caution signs on the side of the trail up in a tree as seen in Figs 3.38 and 3.39 respectively. Merging

Fig 3.38 Merging and caution sign #1

Fig 3.39 Merging and caution sign #2

trail warning signs were often seen in the middle of the trail also. Fig 3.40 shows a caution sign in the middle of a trail that merges with another at Loon Mountain.

Fig 3.40 Yield sign

At Wachusett Mountain there were trail crossing signs sometimes seen in the trails, shown in Fig 3.41. In Fig 3.42, a merging trail intersects with a steep drop off,

Fig 3.41 Trail crossing

Fig 3.42 Poles on ridge

marked with poles running across the ridge. At Cannon Mountain there is an expert, high-speed trail, which intersects with an intermediate, low speed trail. The two trails are separated by orange netting to prevent the high-speed skiers and snowboarders from

colliding with the people on the low speed trail. Fig 3.43 shows the orange netting separating the two merging trails. At Loon Mountain the flow of traffic of some of the

Fig 3.43 Divided trail

merging trails are diverted using bamboo poles tied together with rope, seen in Fig 3.44. The rope in Fig 3.44 extends the tree line, allowing the flow of traffic to blend together more gently, instead of crossing perpendicular. It is also noted that the rope line allows the person coming down the trail to see the flow of traffic coming over from the adjacent trail.

Fig 3.44 Tree line rope extension

All the mountains that were visited used standard symbols to represent trail difficulty. In all instances the trail difficulty was marked on the trail name sign. Fig 3.45 is an example of trail signs marked with its difficulty. Sometimes the trail difficulty

Fig 3.45 Trail difficulty markings

was marked in the middle of the trail at its beginning. Often these signs were placed on expert trails that appeared easy at the beginning of the trail but got worse as the trail went on, to prevent novice skiers and snowboarders from going down the trail if they didn't notice the difficulty marking on the trail name. Figs 3.46 and 3.47 are examples of trail difficulty signs placed in the middle of the trail.

Fig 3.46 Not for beginners

Fig 3.47 Expert only

There are several different types of trail obstacles that were discovered that had hazard markings. These obstacles included spickets, lift poles, gondola towers, rocks, snow guns, pipes, chairlifts, fencing, fall lines, courtesy signs and glade skiing.

Spickets used for supplying air and water to snow guns were always found to the side of the trail, however the spickets were not always protected. Spickets were found

shielded and unshielded. Shielded spickets were covered with pads, barrels and shields. Examples of shielded spickets are shown in Figs 3.48, 3.49, and 3.50. Fig 3.48 is a spicket with a shield. Fig 3.49 is a spicket with a bucket over it and Fig 3.50 is a

Fig 3.48 Shield

Fig 3.49 Bucket

Fig 3.50 Pad

spicket with a pad covering it. Unshielded spickets are seen in Figs 3.51, 3.52, and 3.53. Fig 3.51 is an example of a spicket with a bamboo cross in front of it. Fig

Fig 3.51 Spicket and cross

Fig 3.52 Spicket and rope

Fig 3.53 Spicket and net

3.52 is a spicket with a rope and bamboo pole in front of it. Fig 3.53 is a spicket with a mesh and bamboo fence around it.

All mountains that were investigated had lift lines in their trails. Most mountains had padded lift poles. Fig 3.54 is an example of a lift line that is completely padded. There are different ways lift poles are padded. At one mountain, the lift poles were padded with thick yellow cushion pads and at another mountain, poles were surrounded

Fig 3.54 Padded lift line

with collapsible hollow cylinders with a cover sheet over them. Fig 3.55 is an example of a lift pole with thick yellow cushion pads and Fig 3.56 is an example of cylinders

Fig 3.55 Padded lift pole #2

Fig 3.56 Padded lift pole #3

with a cover sheet. At one mountain in particular, many lift poles were seen without any type of padding. Fig 3.57 is an example of a lift pole with no padding that is in the middle of a trail. Fig 3.58 is an example of a trail with a padded lift pole that is in the trail and an unpadded lift pole that is off to the side of the trail.

Fig 3.57 Unpadded lift pole

Fig 3.58 Padded and unpadded lift pole

One mountain that was investigated had very large gondola lift towers that were in the middle of the trail that were not padded or shielded in any way. Fig 3.59 is a view of a trail with these unshielded gondola towers. If you look closely at the picture you can see that the skiers near the center of the picture are in a direct fall line with the unshielded towers. Fig 3.60 is a close up view of an unshielded gondola tower.

Fig 3.59 Gondola tower trail

Fig 3.60 Gondola tower close up

At two of the mountains that were investigated, there were examples of large rocks near the side of the trail. At one mountain, a large rock is off to the side of a trail in a direct fall line. Fig 3.61 shows a very large boulder behind a closed trail rope.

Fig 3.61 Boulder and rope

While the photograph of Fig 3.61 was being taken, a skier coming down the trail had lost control and fallen down nearby the rock in Fig 3.61, note Fig 3.62. At the other

Fig 3.62 Boulder in fall line

mountain, a rock was seen to the side of the trail with no proper hazard markings around it. There was a mesh netting next to the rock but further down the trail, not up the trail. Fig 3.63 shows the rock with blue netting behind it.

Fig 3.63 Boulder and net

A metal pole was seen on the side of a trail at one of the mountain sites unmarked. It is not determined what its function is. The pole had no kind of padding or marking whatsoever. The pole is shown in Fig 3.64.

Fig 3.64 Black pole

Snowmaking equipment was also investigated during the mountain visits. Portable snowmaking machines were not seen at any of the mountains. Jim Bilotta of Wildcat Mountain explained that the portable snow guns are pulled off the mountain and put in storage when not in use (Bilotta 2000). Tower guns, which are permanent fixtures, were seen in many places. Tower guns were seen stored in an upright position, out of the

way on their posts. Tower guns were seen shielded and unshielded. Most of the shielded tower guns seen had padding on them. Fig 3.65 is a close up of a padded tower gun and Fig 3.66 is a view of a padded tower gun on the side of a trail. At Loon

Fig 3.65 Padded tower gun

Fig 3.66 Padded tower gun to side of trail

Mountain, some of the tower guns had braced shields on them, as seen in Fig 3.67. The head of ski patrol at Loon Mountain, Dan Healey, explained that the shields were part

Fig 3.67 Braced shield on tower gun

of a new experimental program (Healey 2000). Mr. Healey explained that the braced shields are very effective when the gun is in the storage position because the shield turns with the snow gun and when the tower gun is being used, the shield points sideways into the trail and the front of the tower pole is exposed (Healey 2000). There were also many examples of tower guns that had no shields on them but instead had just hazard markings. The hazard markings serve as a warning to the people on the trail, not as a barrier. The tower guns were seen marked with 2 different types of hazard markings. Fig 3.68 shows a tower gun with a bamboo pole and orange sign in front of it. A tower gun with several bamboo crosses in front of it is shown in Fig 3.69.

Fig 3.68 Tower gun and pole

Fig 3.69 Tower gun and crosses

In addition to snow guns and their spickets, the water and air pipes that supply them were often visible to the side of the trails. As shown in Fig 3.70, pipes were never seen with padding on them however if they were in the open and to the side of the

Fig 3.70 Pipes

trail, they were usually marked with bamboo poles.

At one mountain, the chairs on the chairlift at some points were dangerously low to the trail underneath it where if a person was coming down that trail they could get hit in the head by a chair passing above. To avoid this situation, the area was surrounded with orange netting to prevent people from skiing or snowboarding into that area, as seen in Fig 3.71.

Fig 3.71 Low chairlift

Usually wherever there is a ditch, fall line or other hazardous situation off to the side of the trail, it is blocked with some kind of netting. Loon Mountain had a good example of a drop off on the side of the trail. A large mesh net is put in place to catch skiers and snowboarders who may lose control and fall into it, shown in Figs 3.72 and 3.73.

Fig 3.72 Long fencing

Fig 3.73 View of ditch

Any fixed objects that are in close proximity to the netting have padding on them, shown in Fig 3.74.

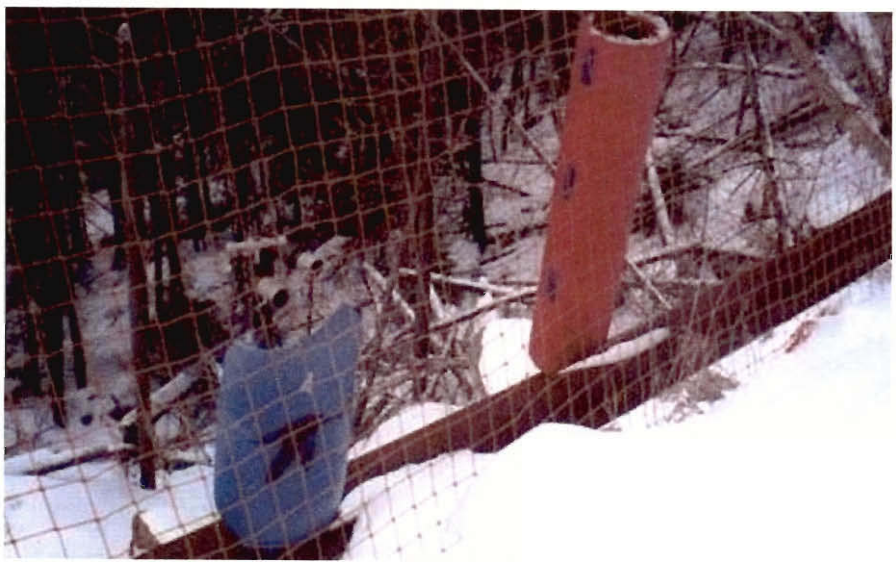


Fig 3.74 View of ditch with padded objects

At Loon Mountain there was a trail that had a water pool and parking lot adjacent to the trail. Both of these obstacles were marked with netting on a wooden frame, to protect skiers and snowboarders from entering these areas. Fig 3.75 is shows the wooden and orange netting fence that surrounds the pool and Fig 3.76 is a close up of the pool itself. Fig 3.77 shows the parking lot behind the wooden and green netting fence.

Fig 3.75 Pool fencing

Fig 3.76 Pool fencing close up

Fig 3.77 Parking lot fencing

The quad lift station at Wildcat Mountain was seen surrounded by orange mesh netting. The purpose of the netting is to keep out people who may lose control and fall into the hazardous area. Fig 3.78 shows people skiing by the orange netting, around the lift station and Fig 3.79 shows the orange netting surrounding the lift station itself.

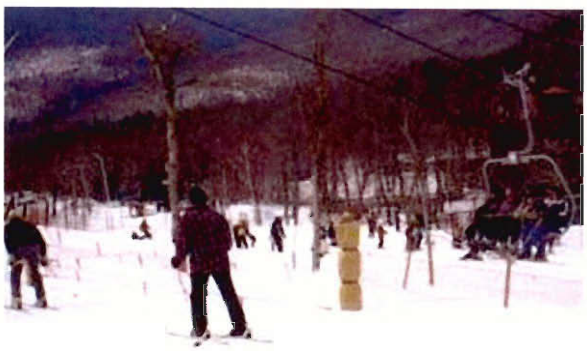


Fig 3.78 Quad station netting #1

Fig 3.79 Quad station netting #2

Fall lines on most mountains that follow into the woods are blocked with netting in the fall line's path. Fig 3.80 and Fig 3.81 are examples of mesh netting in the path of direct fall lines. One example of a wooded fall line not marked or netted is seen in Fig 3.82.

Fig 3.80 Fall line fencing #1

Fig 3.81 Fall line fencing #2

Fig 3.82 Fall line fencing #3

All the mountains investigated had courtesy signs on many trails to remind skiers and snowboarders of rules and hazards, and to provide direction. Fig 3.83 is an example of a slow sign near a lodge. Fig 3.84 is a trail crossing sign marking a fork in the trail.

Fig 85 is an "easiest way down" sign, to give direction to novice skiers. Fig 3.86 is a "family trail" sign, to remind people that small children will be present. Fig 3.87 is a sign reminding skiers and snowboarders of Massachusetts state ski law.

Fig 3.83 Slow sign

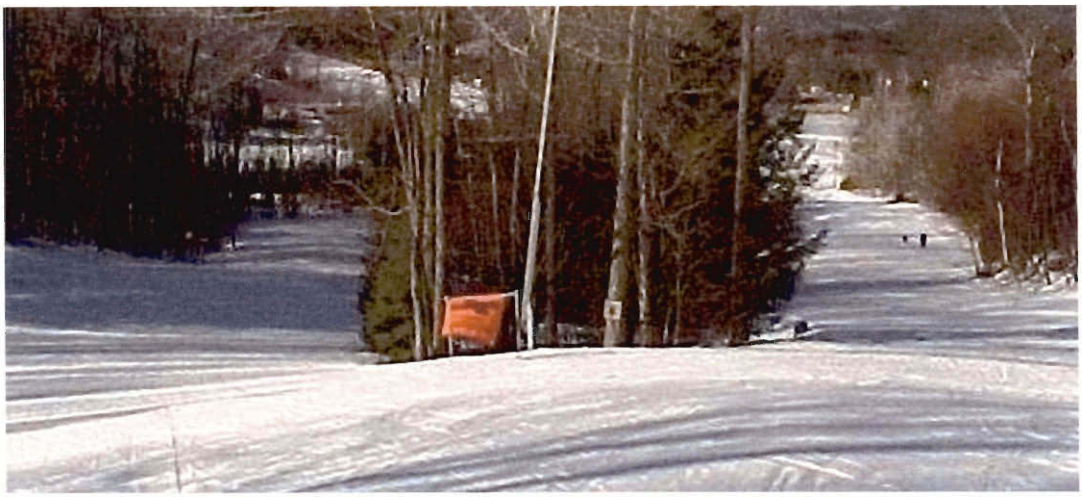


Fig 3.84 Fork in trail

Fig 3.85 Easiest way

Fig 3.86 Family trail

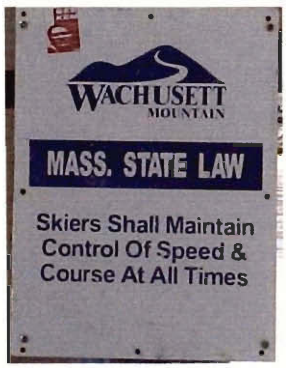


Fig 3.87 State law

At 2 of the mountains, there were trails for glade skiing, or sometimes called tree skiing. The trails span a vast wooded area with trees far enough to ski between, Fig 3.88. There were no hazard markings on each individual tree but at Loon Mountain there was a disclaimer sign at the top of the trail, Fig 3.89.

Fig 3.88 Glade skiing

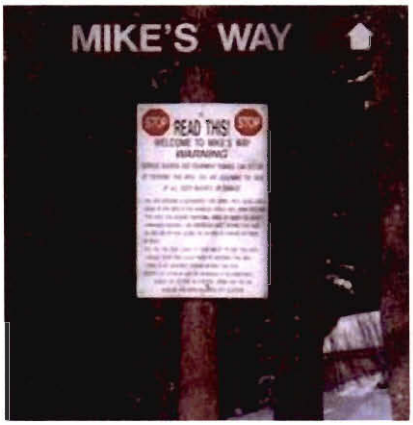


Fig 3.89 Glade disclaimer

3.1.4 Environmental Impact

At all of the mountains visited, the investigation team documented the impact of ski areas on the environment. At Loon Mountain, a proposed trail expansion was denied because of environmental activists. At Wildcat Mountain, people ski past the boundary marker into state forest. At Wachusett Mountain, activists have placed up fencing to protect trees.

At Loon Mountain, a trail expansion was proposed and was approved, then later revoked because of environmentalist protesting. The trails were partially built then sealed off and now law against trespassing protects the forest. Fig 3.90 is a sign placed near the partially constructed trails that explain the laws that protect the area.

Fig 3.90 Construction sign

Fig 3.91 shows the top of the partially constructed trail at Loon, which was closed by the courts.


Fig 3.91 Sealed off trail expansion

Dan Healey at Loon Mountain also explained the laws on cutting trees on the mountain. Since the mountain is on state forest, any tree bigger than 6 inches must have a permit to be cut down (Healey 2000). Smaller brush and trees smaller than 6 inches can be cut at the discretion of the ski area. Also dead trees bigger than 6 inches my be cut down without a permit (Healey 2000).

At Wildcat Mountain, people often tend to ski out of bounds. To the side of the ski area there are 3 entrances into the woods, all marked with boundary markers, shown in Fig 3.92. The woods past the mountain boundary marker is not owned by the ski

Fig 3.92 Boundary marker

area, it is state forest (Bilotta 2000). Even though there are state forest laws protecting the out of bounds territory, people continue to ski in there anyways. Since the out of bounds territory is state forest owned, the mountain is not allowed to expand.

At Wachusett Mountain, environmental activists have placed green fences along the side of a trail that contains some old growth forest. The green fences, shown in Fig 93.3, prevent people from going in the old growth forest and damaging the trees.

Fig 3.93 Green fencing

Wachusett Mountain also had plans to add some more trails but environmentalists would not allow it and the mountain was forced to expand only at the lower part of the mountain, where no old growth forest exists (Hallaren 2000).

3.2 Survey Results

3.2.1 Turnout

The surveys had a good response, even better than was expected. The web survey yielded 289 responses and the handout survey yielded 104 responses. The total number of surveys received was 393.

3.2.2 Data Summary

The areas of the survey that will be investigated will be helmets, goggles, level of ability, type of equipment, injury percentage, body part injured, speed, trail level, conditions, time of day, crowd, ski patrol, and fault.

3.2.2.1 Helmets

The majority of people that responded claimed that they do not wear helmets while skiing and snowboarding. Only 3% of those that responded acknowledged that they do wear helmets. Ninety-seven percent of those that responded do not wear helmets. When the people who don't wear helmets were asked to explain why they don't, most claimed that they do not think helmets were necessary. These results are from both the handout and web surveys. Fig 3.94 shows the distribution of responses on why people chose not to wear helmets.

3.2.2.2 Goggles

When asked if people wore goggles during harsh wear to aid their vision, 80% of those responded in the paper survey that they do wear goggles during harsh weather and 20% do not. Fig 3.95 shows the distribution of people of those who wear goggles during harsh weather and those who do not.

Fig 3.94: Why People Don't Wear Helmets

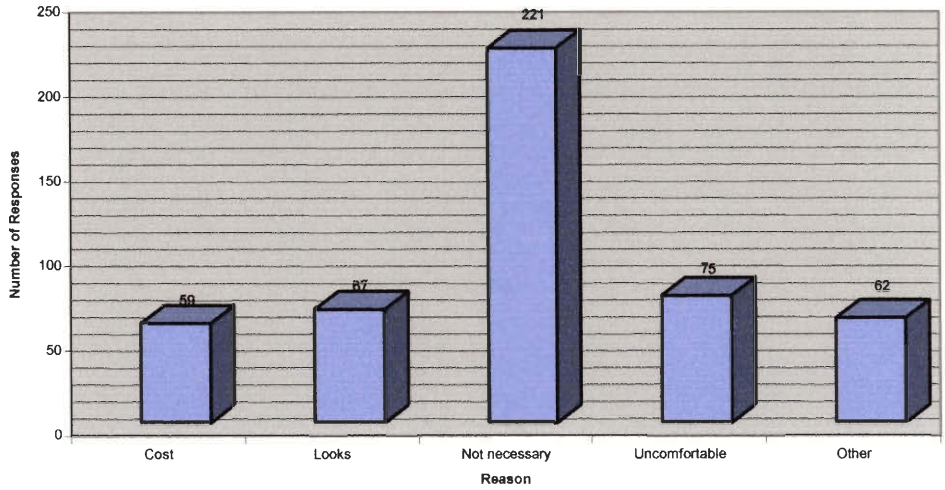
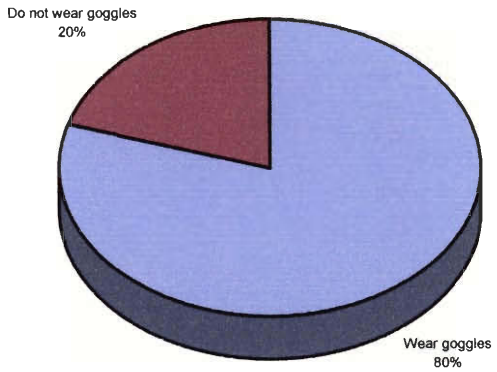


Fig 3.95: Distribution of People That Wear Goggles During Harsh Weather on the Slopes

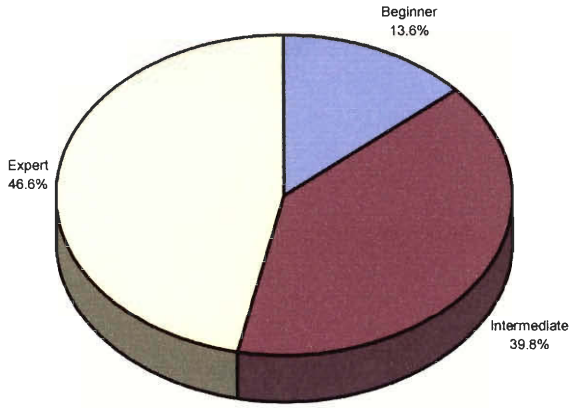


3.2.2.3 Ability Level

In the handout survey, people were asked to rate themselves on their level of skiing or snowboarding ability. The results show that 13.6% of the people that responded

were beginners, 39.8% were intermediates, and 46.6% were experts. Fig 3.96 shows the distribution of these self-rated ability levels.

Fig 3.96: Self Rated Ability Level of People Surveyed



3.2.2.4 Type of Equipment

In both surveys, people were asked what type of equipment they used on the mountain. Seventy-three percent of those responding were skiers and 27% were snowboarders. Fig 3.97 shows the ratio of skiers to snowboarders that were surveyed.

3.2.2.5 Injury Percentage

After combining the data from both surveys, a ratio of injured and non-injured skiers and snowboarders was determined. Overall, the percentage of injured skiers and snowboarders was 51%, while the percentage of non-injured skiers and snowboarders was 49%. Fig 3.98 shows the ratio of injured and non-injured skiers and snowboarders.

3.2.2.6 Body Part Injured

Near the end of both the web and handout surveys, people were asked to describe eir injury. Using these responses, the area of the body that was injured was

Fig 3.97: Ratio of Skiers to Snowboarders Surveyed

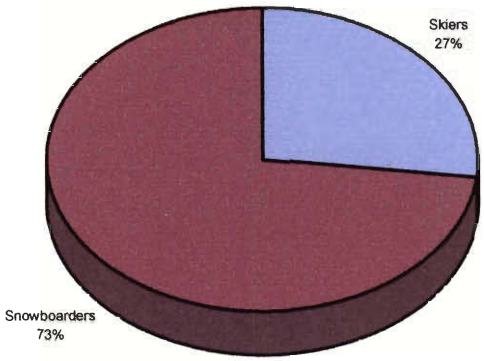
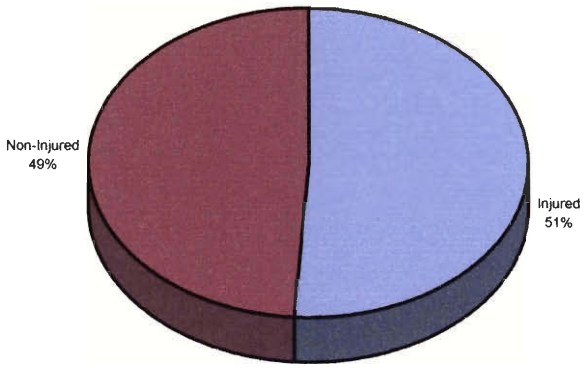


Fig 3.98: Injured vs Non-Injured Skiers and Snowboarders



categorized. The data results were separated based on the type of equipment used and gender. Fig 3.99 shows the distribution of body part injured for skiers and Fig 3.100 shows the distribution of body part injured for snowboarders.

Fig 3.99: Downhill Skier Region of Body Injury By Gender

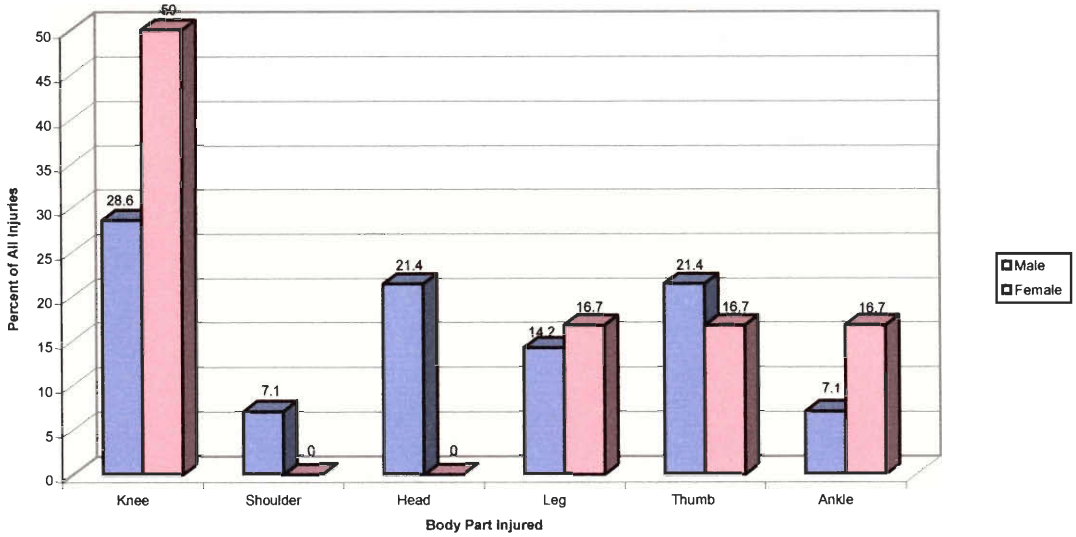
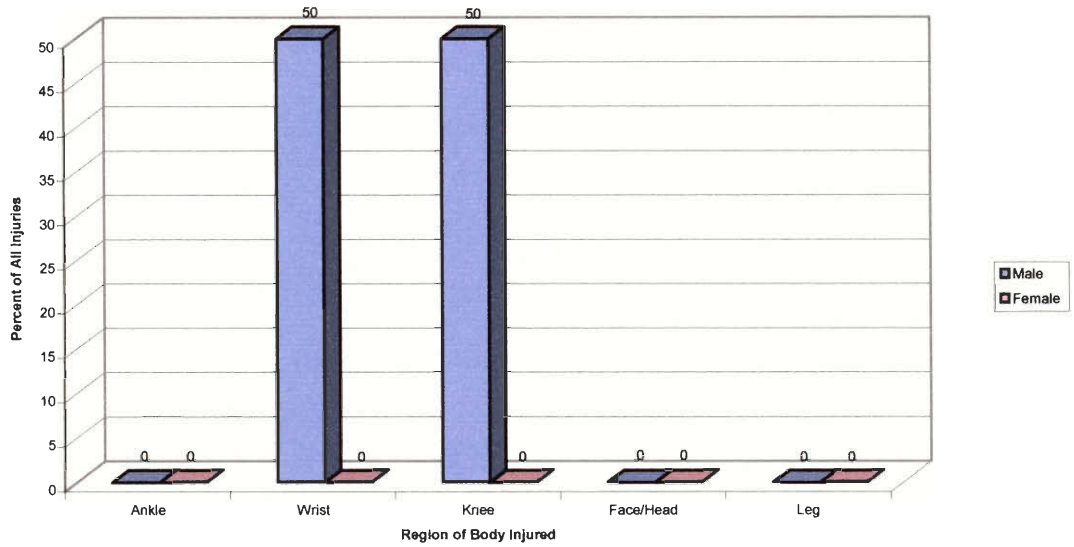


Fig 3.100: Snowboarder Region of Body Injury By Gender

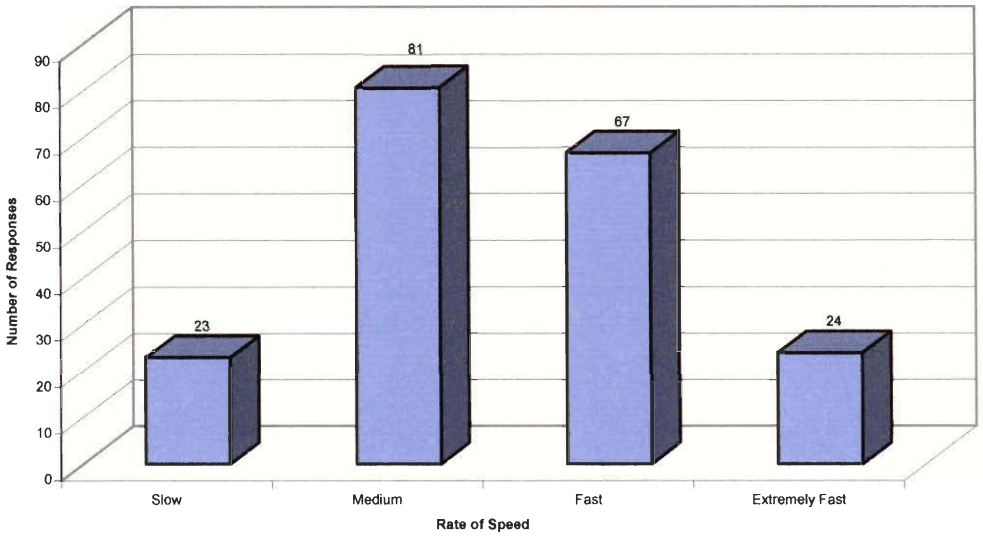


3.2.2.7 Speed

People that have been injured were asked in both types of surveys what their speed was at the time of their accident. After analyzing the data it was determined that

most accidents happened at a high rate of speed. Fig 3.101 shows the rate of speed of injured people questioned in our survey at the time of their accidents.

Fig 3.101: Rate of Speed During Accident



3.2.2.8 Trail Level

In both survey types, injured people were asked what level trail they were skiing or snowboarding on when they got injured. After data analysis it was determined that about 50% of all injuries happen on easier trails and the other 50% happen on expert trails. Fig 3.102 shows the trail level where injuries occurred.

3.2.2.9 Trail Conditions

People who have been injured in both survey types were asked what the trail conditions were at the time of their accident. The data showed that the majority of accidents happened during packed powder and icy conditions on the trails. Fig 3.103 compares the different trail conditions and how many accidents happened on each type

Fig 3.102: Trail Level Where Injury Occurs

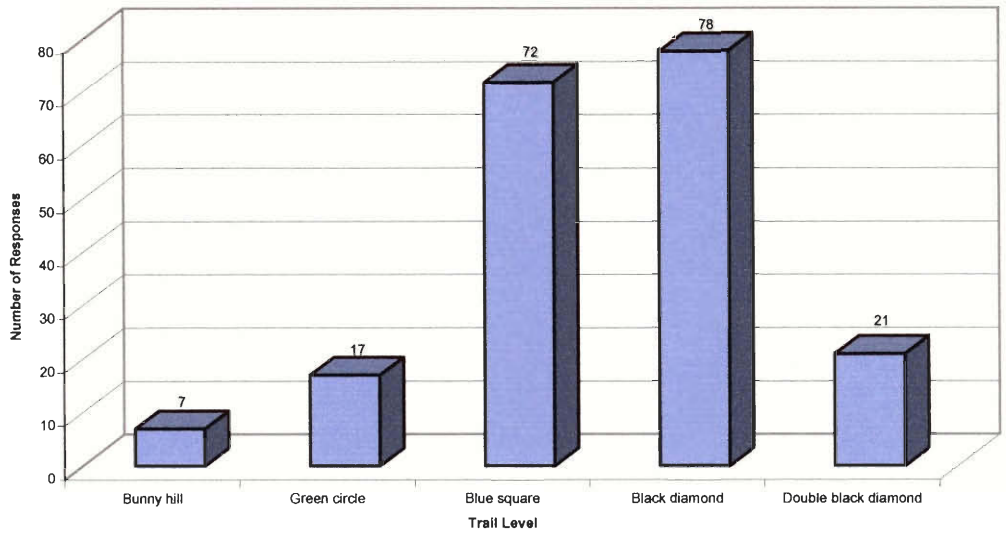
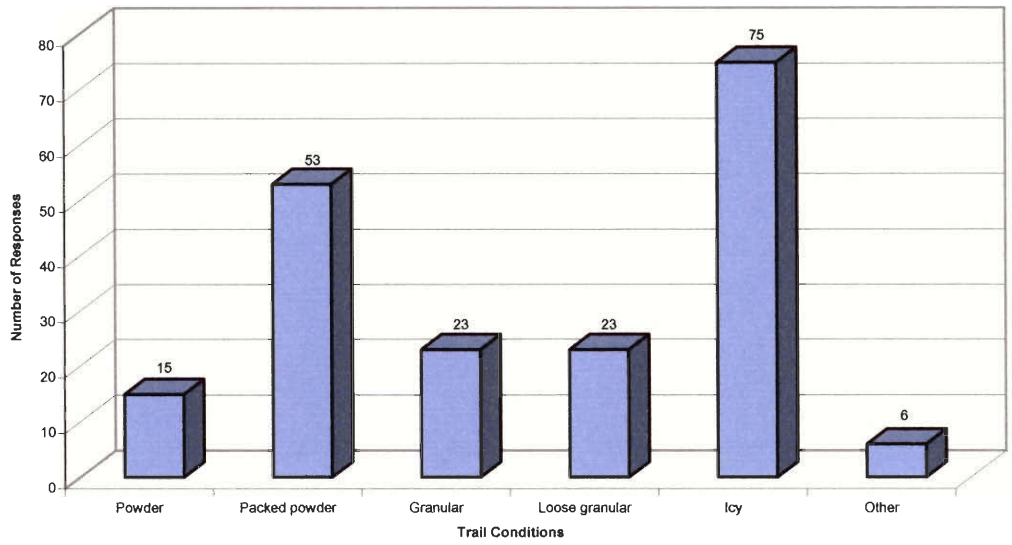


Fig 3.103: Trail Conditions at the Time of Accident

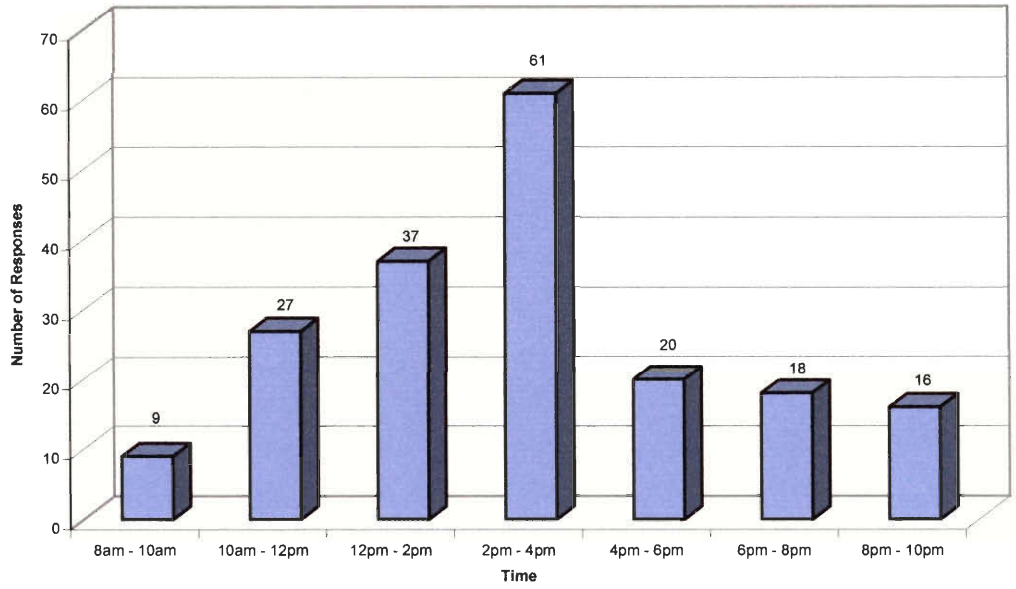


3.2.2.10 Time of Day

Injured skiers and snowboarders were asked what time of day their injuries occurred. Data analysis shows that injuries happened more frequently as the day goes on

until 4pm. The majority of accidents happened from 2pm - 4pm. Fig 3.104 shows the distribution of accidents vs. time on all surveys.

Fig 3.104: Time of Day When Accidents Occured



2.2.2.11 Crowd

In the web survey, people were asked if they felt the trails were too crowded at the time of their accident. Data analysis shows that only 16% of the time the trail was crowded and 84% of the time the trail was not crowded. Fig 3.105 shows the distribution of how crowded the trail was at the time of accident.

3.2.2.12 Ski Patrol

Ski patrol often rescues injured skiers and snowboarders that cannot make it down the mountain themselves by themselves due to their injuries. To see how often ski patrol rescues an injured skier, people that have been injured were asked in the web survey if they required the assistance of ski patrol at the time of their injury. It turns out that only 28% of the skiers and snowboarders surveyed required the assistance of ski patrol while

72% did not. Fig 3.106 shows what percentage of injured people surveyed required the assistance of ski patrol.

Fig 3.105: How Crowded the Trail Was at the Time of Accident

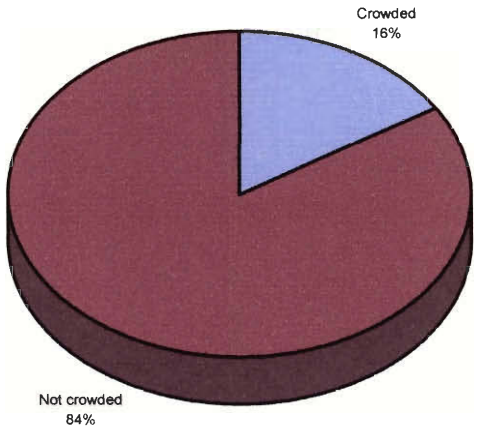
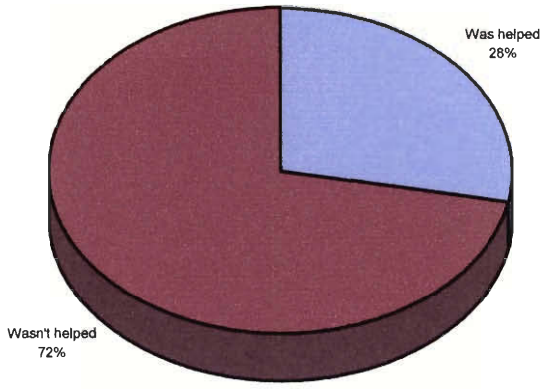


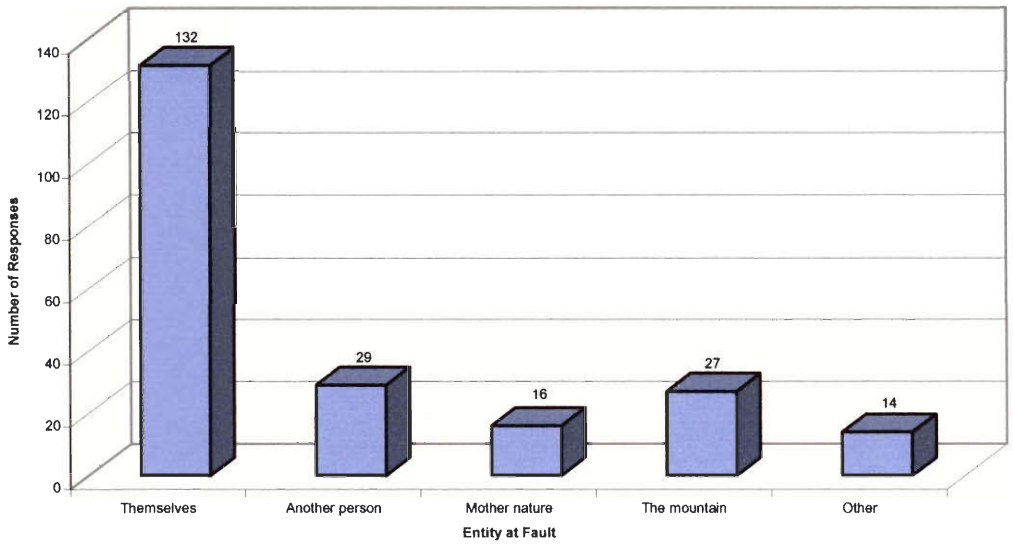
Fig 3.106: Percentage of Injured People Surveyed Helped By Ski Patrol



3.2.2.13 Fault

At the end of each survey, injured skiers and snowboarders were asked who they blamed for their injury. The data shows that very few people blamed the mountain for their injury, only 12% of those responded blamed the mountain, while 60% blamed themselves. Fig 3.107 shows the distribution of responses of who was at fault for the injuries.

Fig 3.107: Who Injured People Blame For Their Injuries



All survey web and handout survey data can be found in Appendix G and Appendix H respectively.

3.3 Ski Patrol Questionnaire Results

After conducting all of the ski patrol interviews we examined them to find the most common answers. Table 3.1 is the results from the ski patroller questionnaire that was documented during each mountain visit. The original transcripts of the interviews can be seen in Appendix I.

Ski Patroller Questions		Our Results
1	What are the most common injuries that you see? (For Skier's/Snowboarders)	• We found that skier's most common injuries are knees (ACL and MCL) followed by thumbs. The ligament that is usually torn is known as the "gamekeepers thumb" (Healey, 2000) • In snowboarding the most common injuries were wrists and shoulders.
2	What trail features are the most responsible for accidents?	• We found that it was not the trail features that were most responsible for accidents, they felt that it was more of a skier believing that he/she is better than they really are and then getting in over their head. *The only trail features that were mentioned were terrain parks (also known as the "bone yard") and little rises in the trail where you can't see what is on the other side.
3	What is the average ski patrol to skier ratio?	• We found that the ski patrol to skier ratio depends on how many acres the mountain has open and the number of lifts they have running. Therefore ratios vary from mountain to mountain.
4	Do you think making helmets mandatory would result in decreased head injuries?	• When we first asked the question the first response was yes it would help. But then when they thought about it the majority said that it would only reduce the number of common injuries and not serious injuries because the body tends to receive multiple traumas in serious injuries and the helmet could not prevent against that.

		*They felt that by educating the skier so they have "skier awareness", that in combination with helmets would be the best way to decrease head injuries.
5	If so do you think it is feasible?	• Many said it wouldn't be feasible. They said they would highly recommend them but don't infringe on their rights. • Also the cost of helmets being so high, it would make it very hard and expensive to make them mandatory.
6	Are there any common factors involved in skiing/snowboarding accidents? (E.g. weather, experience of skier, time of day, conditions, features on the trail)	• We found that many factors are involved in accidents such as weather and visibility. But the main factors were speed and time of day. *High speed was the key ingredient in serious accidents and the "Bewitching" hours between 1:00 and 3:00 was the most common time when accidents occur
7	How could most of these accidents been prevented? And would it be cost effective for the mountain?	• By educating the skier was the best way to prevent these accidents and they thought that is was cost effective for the mountain *Other ways of preventing accidents that were mentioned were: having slow banners in key locations on the mountain, proper signage/fencing, and padding fixed objects.
8	What actions has your mountain done to prevent accidents? And have you seen direct results from them?	• The most effective way that we saw was by educating the skier/snowboarder. This was done by passing out safety guides and by having clinics and contests about the code and teaching proper etiquette, these were all effective ways.
9	What are the best and least expensive ways to prevent accidents?	• They also felt the best way was to educate the skier/ snowboarder but they felt that the least expensive way was to have proper signage and marking on their mountain.
10	What steps and procedures are taken when there is an accident on the mountain?	• The steps were as followed: • Send a patroller down to find the accident. 2. Access the accident 3. Radio back and tell what emergency

		equipment and personal the patient needs.
11	How often does mountain equipment contribute to accidents on the trails? (E.g. snow making machines, lift posts, trail groomers, snowmobiles)	• We found that mountain equipment has no significant effect on accidents. *They added by saying that the accidents mainly contributed to skier-to-skier collisions and skier to fixed object collisions.
12	Has the large increase in the number of snowboarders caused a proportionate increase in accidents and problems at your mountain?	• It seemed that most of their first reactions was a tendency to say yes but when they thought about it most of the mountains accident rate has decreased in the last couple of years.
13	Are you aware of alcohol and drugs playing a role in accidents?	• There were a lot of different opinions on this but there was no significant evidence that concluded that alcohol and drugs play a factor in accidents.
14	Does serving alcohol at mountain bars causes problems and if so what are your opinions on it?	• Serving alcohol at mountains brings in huge revenue therefore they felt that if they don't serve alcohol on mountains then people will bring it so it does not matter whether they or they have bars or not.

Table 3.1: Ski patrol questionnaire results

The set of questions in table 3.1 were used during the interview but other questions came up while the interview was being conducted. These questions were not prepared before the interview took place but everything said was documented. Therefore the following section shows the significant results that were found during the ski patrol interviews but were not part of the ski patrol questionnaire.

- *Do you think trails can be designed that would lower the rate of accidents?*

"Yes, I do. If we didn't have such well-groomed trails, the speed would be down. Speed in the main factor in major injuries." (Healey 2000)

- *Have high-speed lifts changed anything in the last couple of years?*

"What happened years ago is that lifts were so slow that guys would drink beers, smoke a joint or something on the way up. Now they're so fast that they don't have time to finish a beer…so we don't really see a lot of it for the number of skiers we see"(Hallaren, 2000)

- *Do you see more injuries at night?*

"Well, there's definitely more at night because we have a lot of schools coming up, and they are minor injuries. I don't know that these kids have ever got hurt before. When I was a kid I was hurt all the time…didn't you ever play football, baseball…you get hit in the head with a bat, you know. Now, they bump their head they're in here…it's amazing. It's nice to be cautious, but I think some of these kids are a little bit overboard. I think they spend too much time with the computer or something." (Hallaren, 2000)

3.4 Massachusetts Tramway Board

3.4.1 Chapter 526 of Code of Massachusetts Regulations

The Massachusetts Tramway Board is responsible for licensing tramways and enforcing their regulations. A three-member subcommittee of the board serves as an examination board to certify Insurance Inspectors, Inspectors for the Division of Inspection, and Qualified Engineer or Qualified Specialist. The board may waive the examination if sufficient training or experience can be demonstrated in fields relating to the type of certification. To open a recreational tramway an application must be submitted to the board and may be accompanied by a report from an Insurance Inspector. The board has 90 days to grant or deny the application, and while the application is considered, the tramway may be operated. The board may elect to order the tramway closed while application is considered if it is decided that the tramway might be unsafe. If the tramway is considered unsafe or fails to conform to the specifications of the Board, then the license will be denied and the application fee refunded. The tramway manuals, schedules, and logbooks must be open to inspection by members of the board, inspectors, or the insurance inspector with jurisdiction. Detailed reports of all accidents involving tramways shall be sent to the board within four days from the date of the accident.

The methods the Board uses to adopt regulations are outlined in the second chapter of the 526 Code of Massachusetts Regulations. An interested person may petition the Board to adopt a new regulation, amend any regulation or repeal any regulation. The petition may be accompanied by supporting evidence or arguments. After receiving a petition, the Board will consider the petition at the next scheduled

meeting. The Board will notify the petitioner of its action within ten days after this preliminary hearing. During the preliminary hearing, written opinions may be submitted and the Board may listen to oral arguments. A list of regulation can be obtained from the Office of the Commissioner, Department of Public Safety, during normal business hours. The board also makes advisory rulings to apply the regulations to specific circumstances. The tramway board is responsible for setting standards for labeling Alpine and Nordic trails. The following pages are a listing of the sign standard as listed in the CMR (Massachusetts 1993).

526 CMR 8.00: SKI SAFETY SIGNS FOR DOWNHILL AND CROSS-COUNTRY SKIING

Section

8.01: Downhill (Alpine) Signs
8.02: Cross-Country (Nordic) Signs

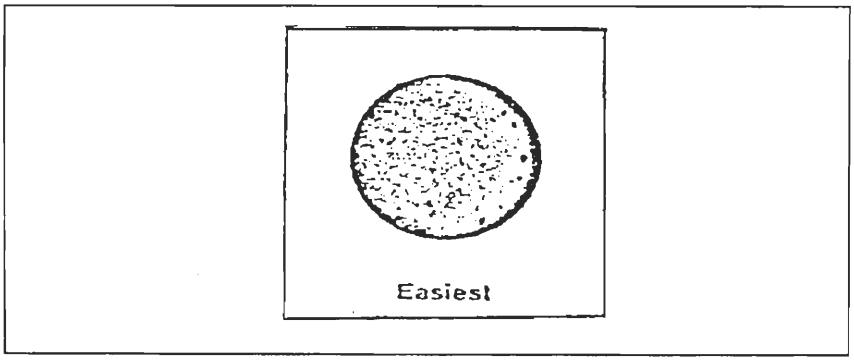
8.01: Downhill (Alpine) Signs

The signs shall indicate the difficulty of the terrain at each area and the appropriate sign shall be placed in a prominent position at the top or start of each trail.

(1) Downhill (Alpine) Degree of Difficulty. Signs shall be a minimum size of 14 inches by 14 inches and marked as follows:

(a) Easiest. A green circle on white background with the word EASIEST below the circle.

Figure 1



(b) More Difficult. A blue square on white background with the words MORE DIFFICULT below the square.

Figure 2

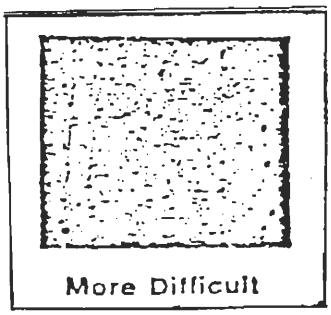
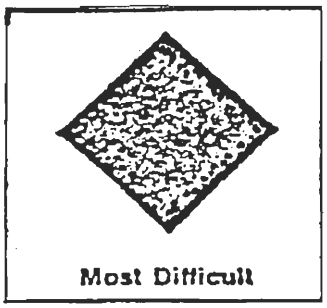


Fig 3.108 sign standards

8.01: continued

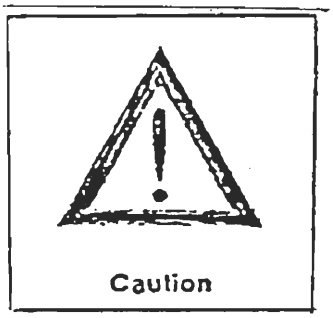
(c) Most Difficult. A black diamond on white background with the words MOST DIFFICULT below the diamond.

Figure 3



(2) TO ADEQUATELY ALERT SKIERS, the following signs shall be used:
(a) Caution. A 14-inch by 14-inch sign consisting of an orange triangle on white background, with an orange exclamation point on a yellow background within the triangle. The word CAUTION shall appear below the triangle.

Figure 4



Caution sign shall be posted where and when necessary to adequately alert skiers of known dangers of any slope or trail at ski areas, and it shall be posted uphill of any snowgrooming or snowmaking operation.

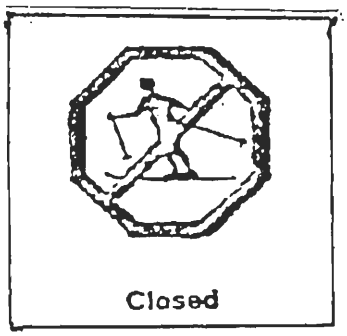
When the Caution sign is used with snowmaking or snowgrooming, the sign shall have fastened to the bottom a 4-inch by 14-inch white sign with contrasting color printing of either the words SNOWGROOMING or SNOWMAKING.

(b) Trail Closed. A 14-inch by 14-inch sign with a red octagonal shape on white background, with a black figure of a skier inside this octagonal shape, with a red diagonal stripe passing through the skier. The word CLOSED shall appear below the octagon.

Figure 3.108 sign standards (cont.)

8.01: continued

Figure 5



(3) Additional Requirements for Downhill (Alpine) Signs. There shall be a sign in a prominent place within the ski area containing the following:

(a) Map showing all trails and their degree of difficulty.

(b) Explanation and illustration of all signs and markers required by 526 CMR 8.00.

(c) Notice to skiers under M.G.L. c. 143 § 71P, as follows:

NOTICE TO SKIERS

M.G.L. c. 143, § 71P, provides, with limited exceptions that no action shall be maintained against the operator of this ski area for an injury to a skier unless the injured person shall, within 90 days of the incident, give to the operator notice by registered mail of the name and address of the injured person and the time, place, and cause of the injury. Any action to recover for injury shall be brought within one year of the date of injury.

(4) The color used in all signs shall be clear, contrasting, and well defined.

(5) Hydrant Markers. Horizontally or diagonally striped orange and black poles shall be used to mark snowmaking hydrants and obstructions. Markers shall be made out of slalom poles or other suitable material. These markers shall at all times extend above the snow a minimum of five feet.

8.02: Cross-Country (Nordic) Signs

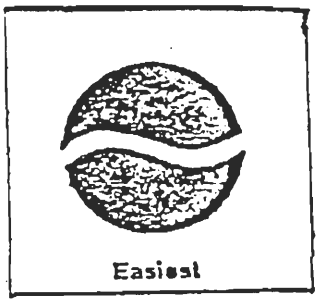
(1) Cross-Country (Nordic) Degree of Difficulty. Signs shall be a minimum size of 6 inches by 8 inches and marked as follows:

(a) Easiest. A green circle on white background, with a white wavy stripe bisecting the green circle, and the word EASIEST below the circle.

Figure 3.108 sign standards (cont.)

8.02: continued

Figure 1



(b) More Difficult. A blue square on white background, with a more pronounced white wavy stripe bisecting the square, and the words MORE DIFFICULT below the square.

Figure 2

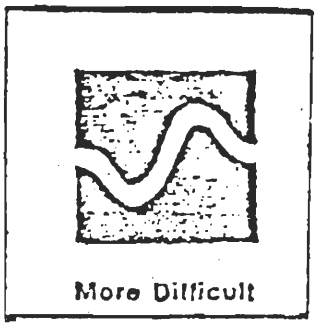
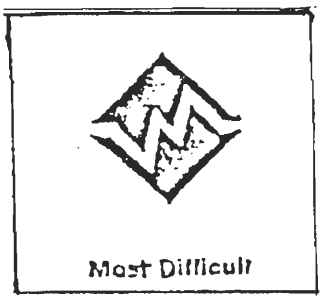


Figure 3.108 sign standards (cont.)

8.02: continued

(c) Most Difficult. A black diamond on white background, with a white zigzag stripe bisecting the diamond, and the words MOST DIFFICULT below the diamond.

Figure 3



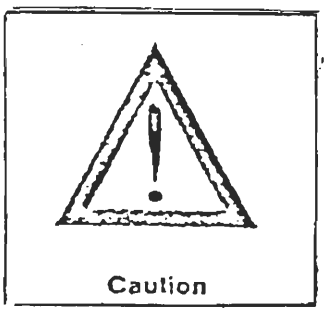
The above signs shall indicate the difficulty of the terrain at each area and the appropriate sign shall be placed in a prominent position at the top or start of each trail.

(2) Trail Markers, consisting of a blue diamond a minimum of four inches by four inches, shall be placed at appropriate intervals along each trail.

(3) To Adequately Alert Skiers, the following signs shall be used:

(a) Caution. A 6-inch by 8-inch sign consisting of an orange or red triangle on a white or yellow background with an orange or red exclamation point on yellow background within the triangle. The triangle shall be on a white or yellow background. The word CAUTION shall appear below the triangle.

Figure 4



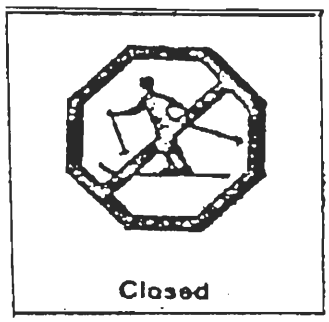
The Caution sign shall be used where and when necessary to adequately alert skiers of any known dangers of any slope or trail at ski areas. If used in conjunction with Trail Grooming, the Caution sign shall have fastened to the bottom a three-inch by eight-inch white sign with printing in contrasting color of the words TRAIL GROOMING.

Figure 3.108 sign standards (cont.)

8.02: continued

(b) Trail Closed. A 6-inch by 8-inch sign with a red octagonal shape on a white background, with a black figure of a skier inside this octagonal shape, with a red diagonal stripe passing through the skier. The word CLOSED shall appear below the octagon.

Figure 5



(4) Additional Requirements for Cross-Country (Nordic) Signs. There shall be a sign posted in a prominent place within the ski area containing the following:

(a) Map showing all trails and their degree of difficulty.
(b) Explanation and illustration of all signs and markers required by 526 CMR 8.00.
(c) Notice to skiers under M.G.L. c. 143 § 71P, as follows:

NOTICE TO SKIERS

M.G.L. c. 143, § 71P, provides, with limited exceptions, that no action shall be maintained against the operator of this ski area for an injury to a skier unless the injured person shall, within 90 days of the incident, give to the operator notice by registered mail of the name and address of the injured person and the time, place, and cause of the injury. Any action to recover for injury shall be brought within one year of the date of injury.

(5) The coloring used in all signs shall be clear, contrasting, and well defined.

REGULATORY AUTHORITY

526 CMR 8.00: M.G.L. c. 143, §§ 71H through 71S.

Figure 3.108 sign standards (cont.)

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3.4.2 Tramway Board Information Request

After sending an initial request for information and a follow up e-mail to the tramway officer at the Department of Public Safety, the officer requested that the request be made under the Freedom of Information Act. We sent the request under the Freedom of Information Act as the board specified, but they have not responded to it as of May 3, 2000

3.5 Dr. Clair Wilmot Results

3.5.1 Interview At Cannon Mountain

During our interview Dr. Wilmot answered some of our questions on her own and others we asked her directly. She was often interrupted by patients and mountain personnel so it was hard for her to comment on some things as much as she did on others. Fig 3.8.1 shows each of the interview Questions that we asked her, or that she answered on her own, as well as her response to it (Wilmot 2000a).

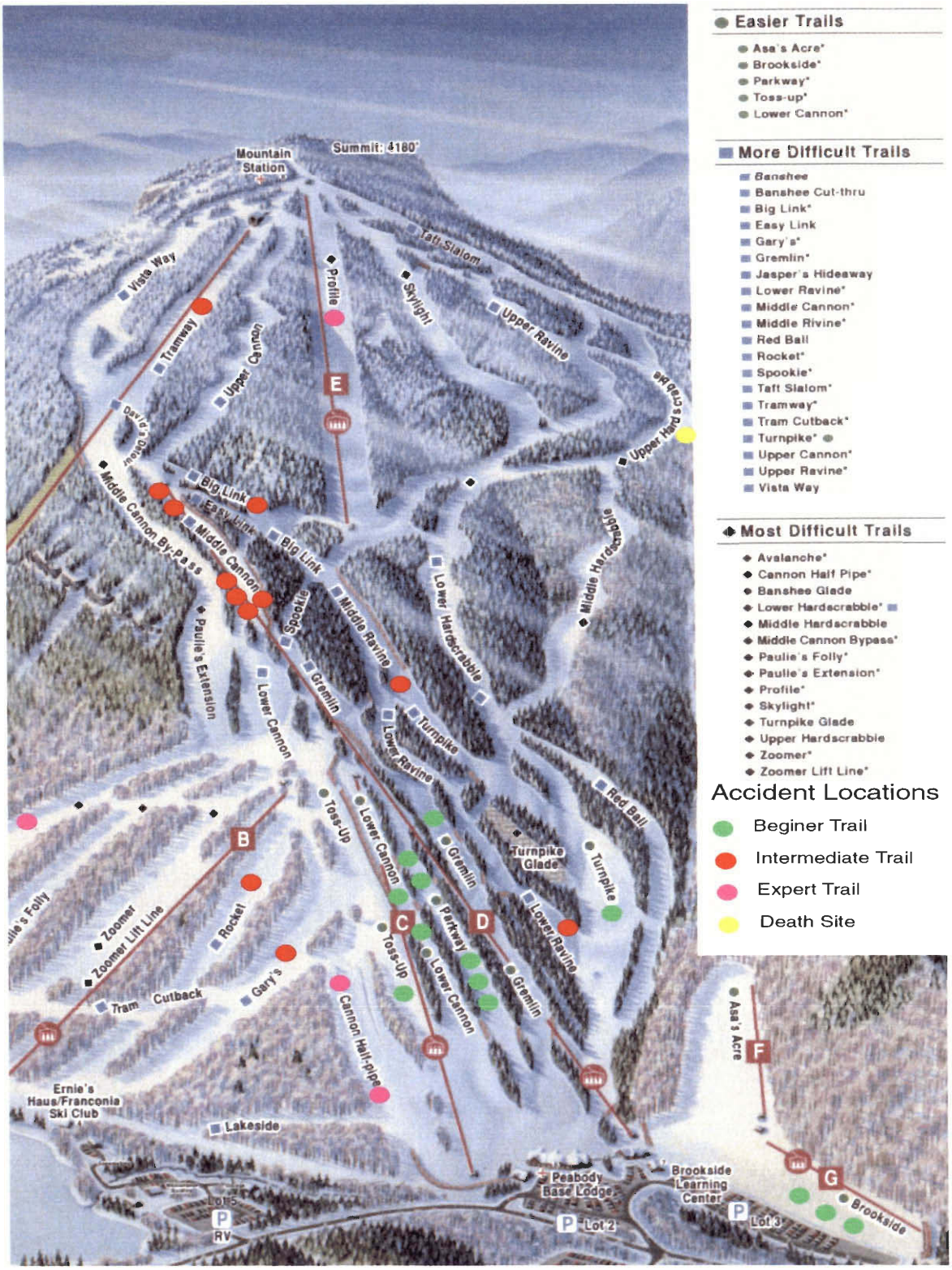
Table 3.2: Wilmot Interview (Wilmot 2000a)

Question	Answer
What are the most common injuries you see?	"With ski injuries you tend to get the knee, with snowboarding slow people get the wrist fast people get their shoulders and then the head and neck…" "…A lot of the snowboarders are taught to fall like this so that they don't hurt their wrists but they land and hurt their ribs and body…thumbs wrists and ski poles…."
If helmets were made mandatory would it decrease the number of head injuries?	"It would definitely decrease head injuries. I think that people have to, I mean skiing carefully is the biggest thing. People don't ski carefully when they wear helmets, they tend to think that they are invincible so they ski faster…"
What are the best and cheapest ways to prevent accidents?	"…So after lunch people are tired their bodies are worn out…push, push, push, I think they should have half day ski passes…"

Do you know of any ways to prevent accidents?	"...20 percent of the injuries that come thru the Littleton Hospital that have ski or snowboarding injuries 20 percent of them have an associated head injury, they are not all severe but I didn't brake up which were severe and which weren't, there were very few sever ones, in 1999 the same, with helmets the associated injuries were one in ten head injuries, so the helmets from my little tiny study cut the injury rate in half for head injuries."
Do you see drugs and alcohol involved with accidents?	"I think they should have half day tickets. I think they shouldn't serve alcohol and I think they should just really make people pay attention cause they really could get hurt..."
What is your opinion on alcohol being served at mountains?	"I think that it is a ridiculous idea...."

During our interview we asked Dr. Wilmot what level trails have the most injuries. She said that the majority of the injuries at Cannon come from the intermediate trails and the snowboard park. She then offered to go thru the injury reports from the last week and mark the location of the injuries on a trail map. She informed us that those injury reports were confidential but that she could give us the locations as long as we didn't look at the demographics of the injured. She also marked the location of the snowboarder that had a fatal accident in the 98/99 season. Fig 3.109 shows a trail map of Cannon Mountain with the locations of accidents for the week ending on 2/11/00. Each of the injuries is color-coded and represents the level of trail the injury took place on. The color codes are found in a key on the bottom left hand side of the Fig (Wilmot 2000a).

Fig 3.109: Cannon Accident Location Map (Wilmot &Cannon 2000)



Dr. Wilmot then mentioned that since 1996(excluding 1997), when all the Cannon Ski Patrol began wearing helmets, she has been studying the amount of head injuries as well as the head injury patterns relating to helmets at Cannon Mountain. She was not able to get into much detail because she said that she did not have he work with her, but she did briefly explain some of her major findings. She went on to say that in 1996 twenty percent of the ski/snowboard injuries that came thru the Littleton Hospital, were she works, had an associated head injury. While in 1999 only ten percent of the ski/snowboard injuries that had an associated head injury, a drop of fifty percent in only two years. She did not brake up the severe from the mild but she noted that very few were severe (Wilmot 2000a).

3.5.2 Interview at Littleton Hospital

We asked Dr. Wilmot about the study she had told us about when we first interviewed her back on 2/11/00. She explained that on seven test days lift attendants recorded during a set period of time if the people who rode up on their lift were male or female, if they were a skier or snowboarder, and if they were wearing a helmet or no helmet. Dr. Wilmot also recorded the total number of tickets sold on those days as seen in Fig 3.110. Dr. Wilmot then used this information to create graphs showing who was and wasn't wearing the helmets riding these lifts. Because she knew what level trails these different lifts serviced she could then use this data to see what level skiers/snowboarders were using helmets. She also used this data to come up with possible conclusions and ideas on why or why not the people were wearing helmets. Fig 3.110 shows the number of lift tickets sold on the days when Dr. Wilmot performed her study.

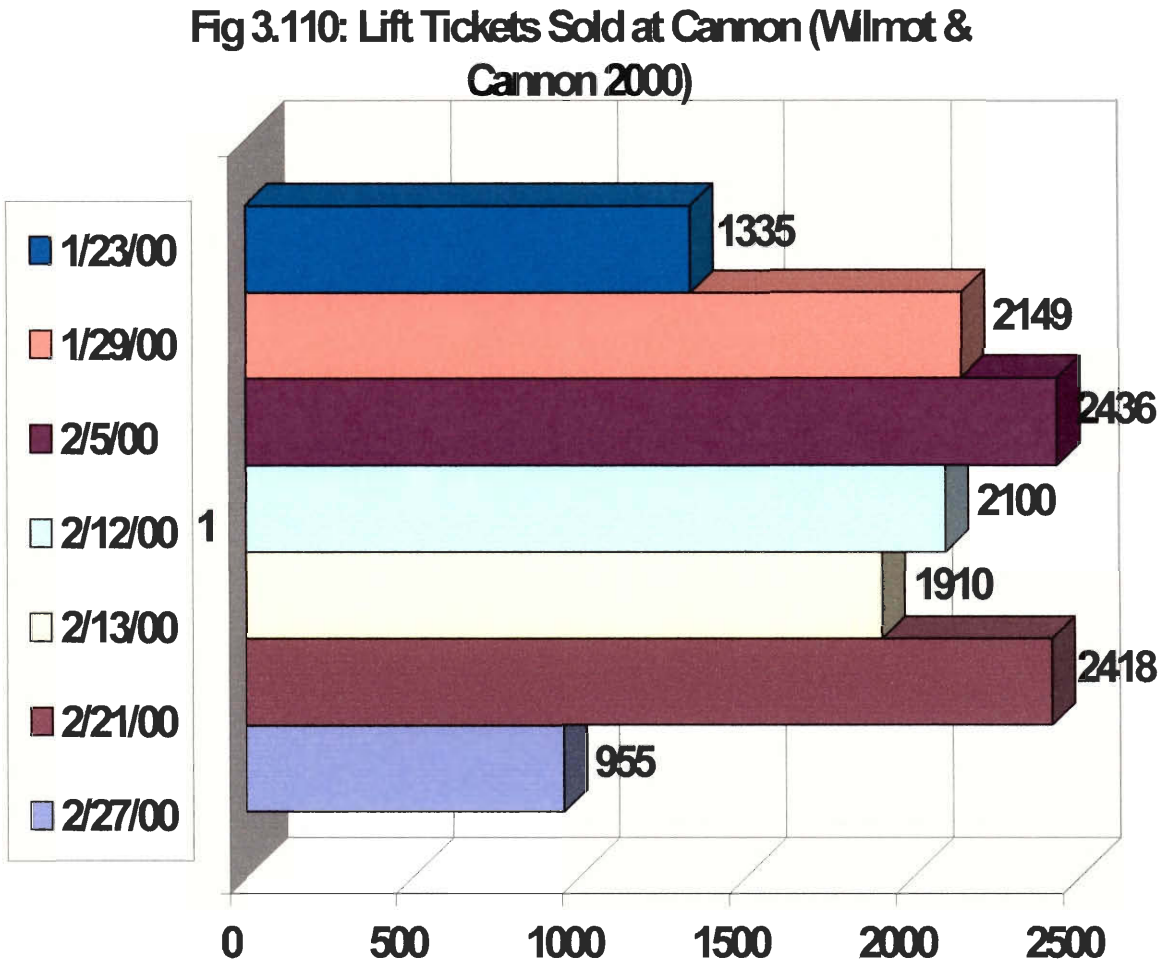


Fig 3.111 shows the data for the Brookside Triple Chairlift that services the beginner area (see Fig 3.109 marked lift G). As you can see the male skiers and snowboarders are close to even when it comes to helmets and non-helmets. With the Females on the other hand a much smaller percentage wear helmets. The large overall number of helmets being worn by people using this lift may be because it services the beginner's area. Young children who tend to wear helmets more than adults mainly use these trails and lift.

Fig 3.111: Helmets on Brookside (Wilmot & Cannon 2000)

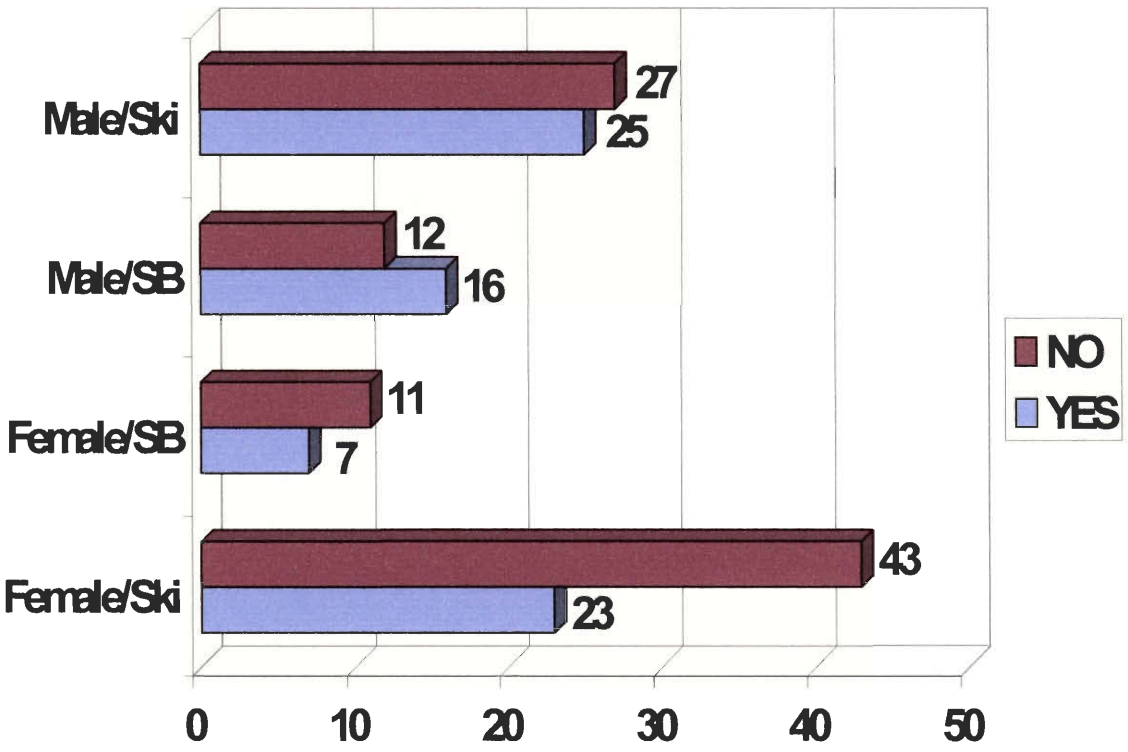


Fig 3.112 shows the data for the Eagle Cliff Triple Chairlift that services beginner trails as well as the Snowboard Park and Half Pipe (see Fig 3.109 marked lift C). As you can see both male and female skiers and snowboarders using this lift have a good percentage wearing helmets. The large overall number of helmets being worn by people using this lift may be because it services the snowboard park and half pipe were there is a much larger amount of dangerous skiing/snowboarding going on.

Fig 3.112: Helmets on Eagle Cliff 2000 (Wilmot & Cannon, 2000)

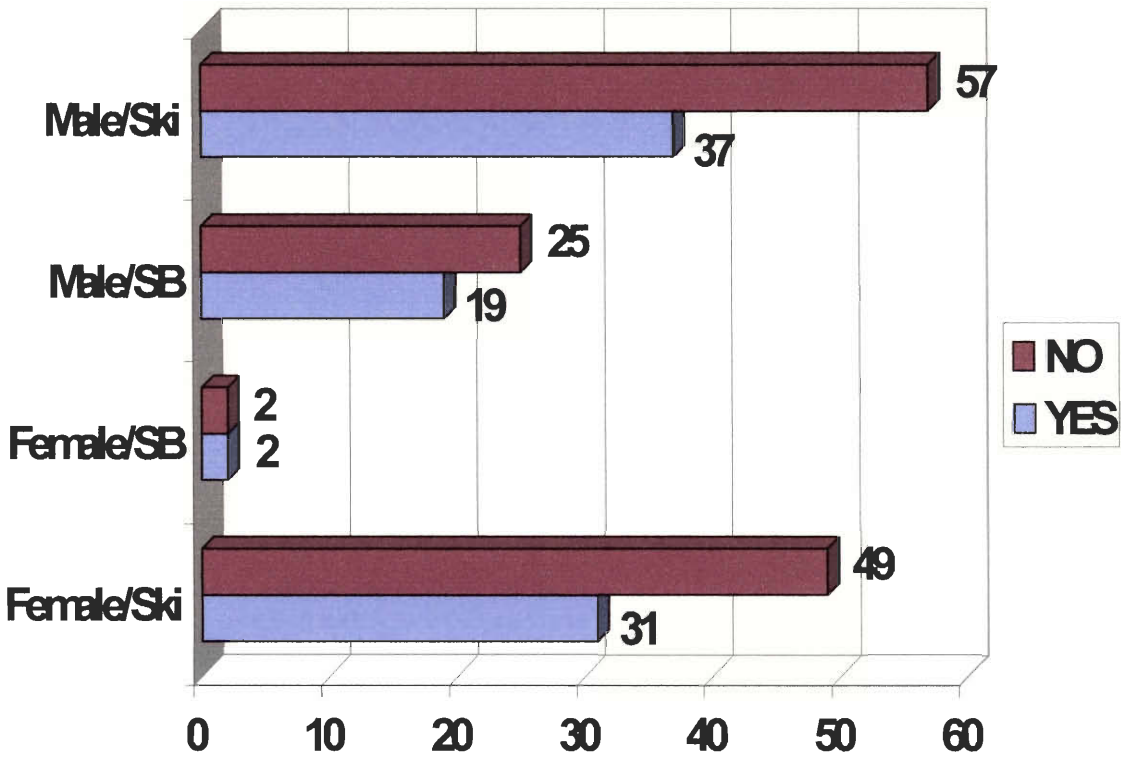


Fig 3.113 shows the data for the Peabody Express Quad Chairlift that services mostly intermediate trails and can also be used to get to the Snowboard Park and Half Pipe (see Fig 3.109 marked lift D). As you can see again both male and female skiers and snowboarders using this lift have a good percentage wearing helmets. The large overall number of helmets being worn by people using this lift may be because it also services the snowboard park/half pipe and because it also services Cannon's racecourse.

Fig 3.113: Helmets on Peadbody (Wilmot & Cannon 2000)

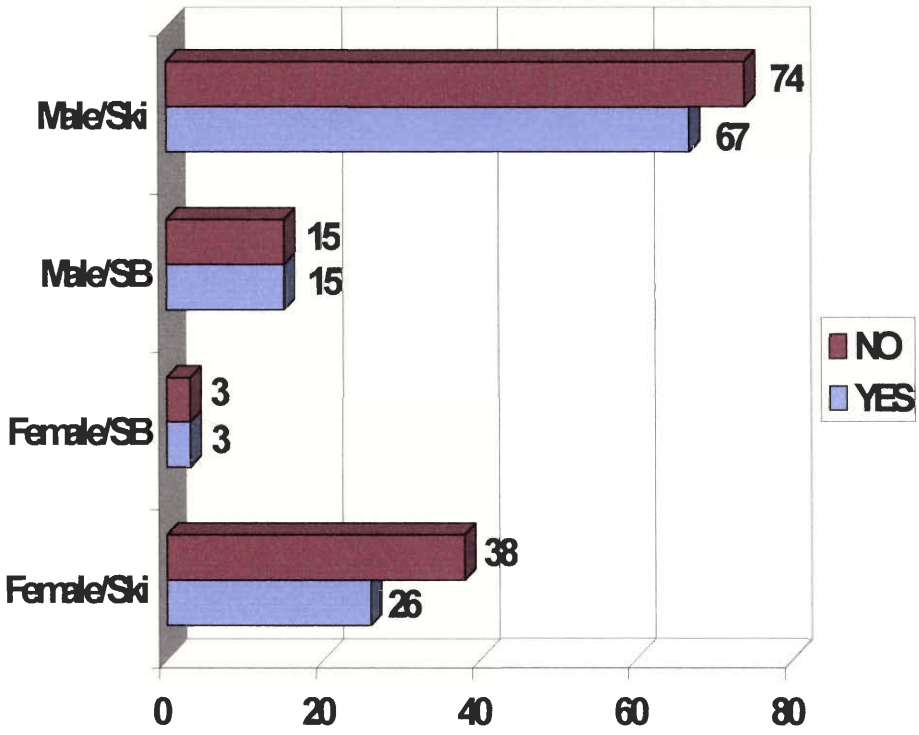
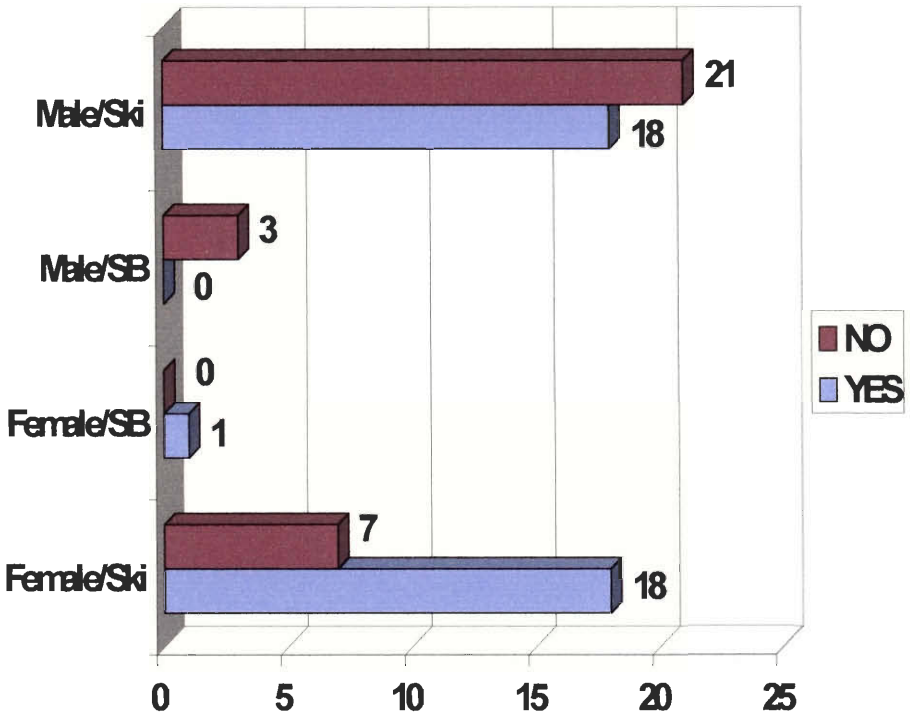


Fig 3.114 shows the data for the Zoomer Triple Chairlift that services both intermediate and expert trails (see Fig 3.109 marked lift B). As you can see except for male skiers the percentage of people wearing helmets is much lower than on the other lifts. The relatively small percentage of people wearing helmets using this lift may be because it services only expert and intermediate trails. The people skiing on these trails are mostly older and are advanced skiers who feel they do not need to wear helmets because they will not fall.

Fig 3.114: Helmets on Zoomer 2/21 and 2/27/00 (Wilmot & Cannon 2000)



In all of the preceding graphs the numbers represent actual numbers of people (Wilmot & Cannon 2000).

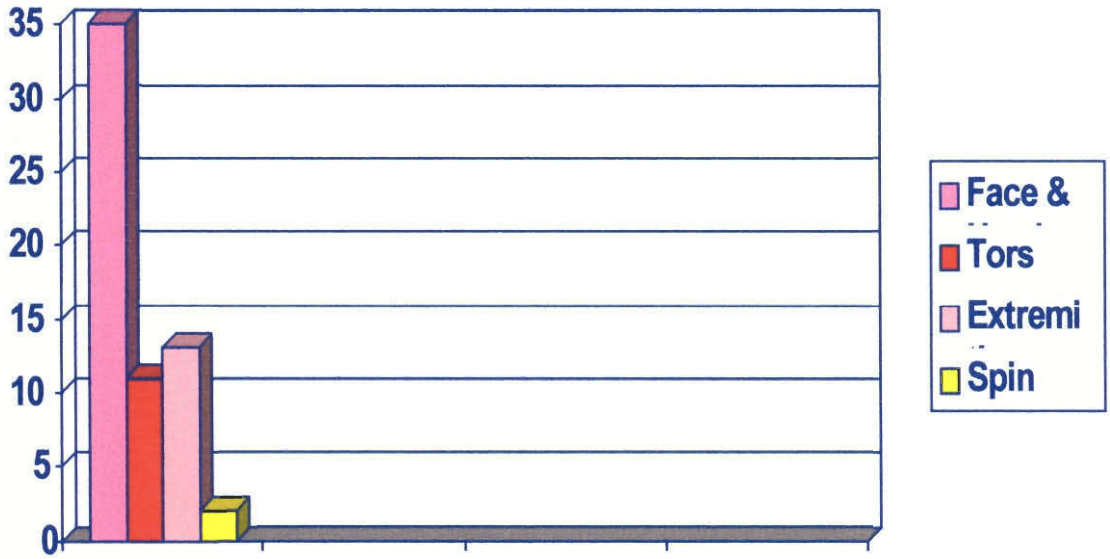
Dr. Wilmot then showed us her PowerPoint presentation on ski and snowboard Head injuries. The presentation is full of information that she has gained from her own research as well as from other studies performed around the world.

Fig 3.115 shows the different types of ski injuries that occurred to children in 1996 in one of the studies mentioned by a Dr. Wilmot in her PowerPoint presentation. There were 38 kids total (34 males), with 58% of the injuries due to collisions. Half of

the 38 were beginner/intermediate and the other half were advanced skier/snowboarders. Of theses 38 children 25% had long-term problems as a result of their injuries. By examining this graph, it is evident that the face and head received the majority of injuries that may possibly be prevented if a helmet had been worn (Wilmot 2000c).

Fig 3.116 portrays the severity of different types of head injuries that occur while skiing within the years of 1996 and 1998. As seen, the severe head injuries stayed about the same due to the fact that at high speeds, hitting your head is detrimental regardless of helmet usage. The sharp drop in moderate injuries would best be accounted for by the big push in helmet use at Cannon Mountain were the data was collected. This increase in helmet use is what probably caused the number of moderate injuries to drop. It could be argued that with the increased use of helmets many of the mild head injuries have been avoided, and since many moderate injuries have become mild, we see the slight increase in mild injuries in 1998compared to those in 1996 (Wilmot 2000c).

Fig 3.115: Percentage of Injuries in Children (Wilmot 2000c)



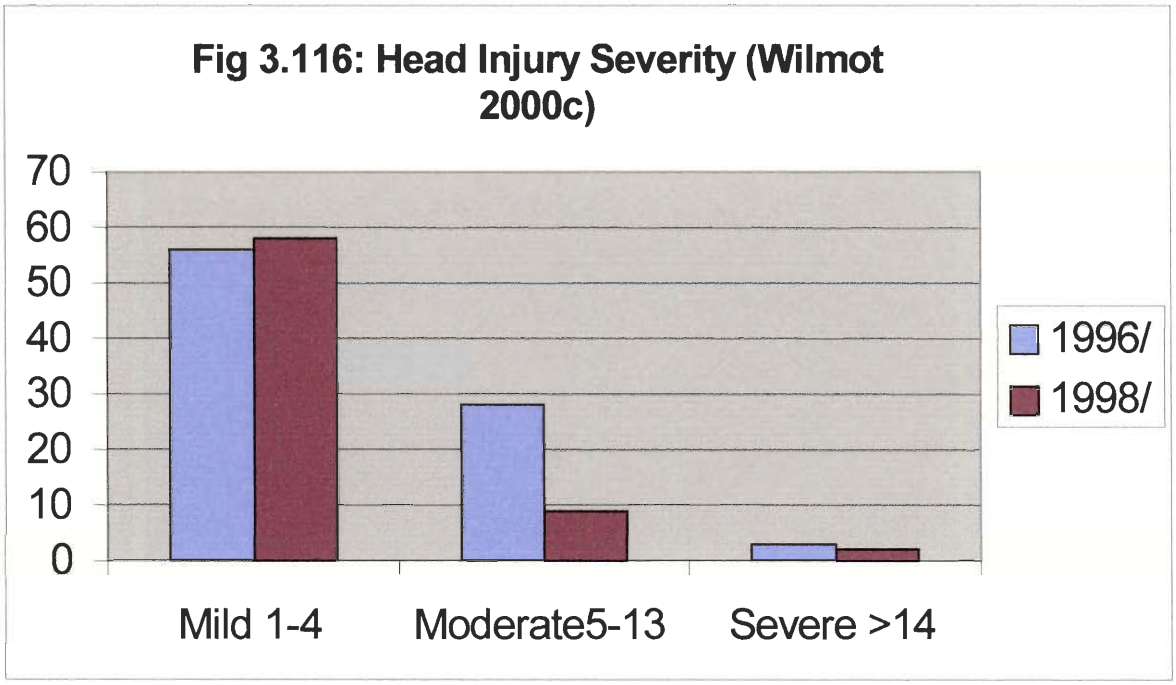
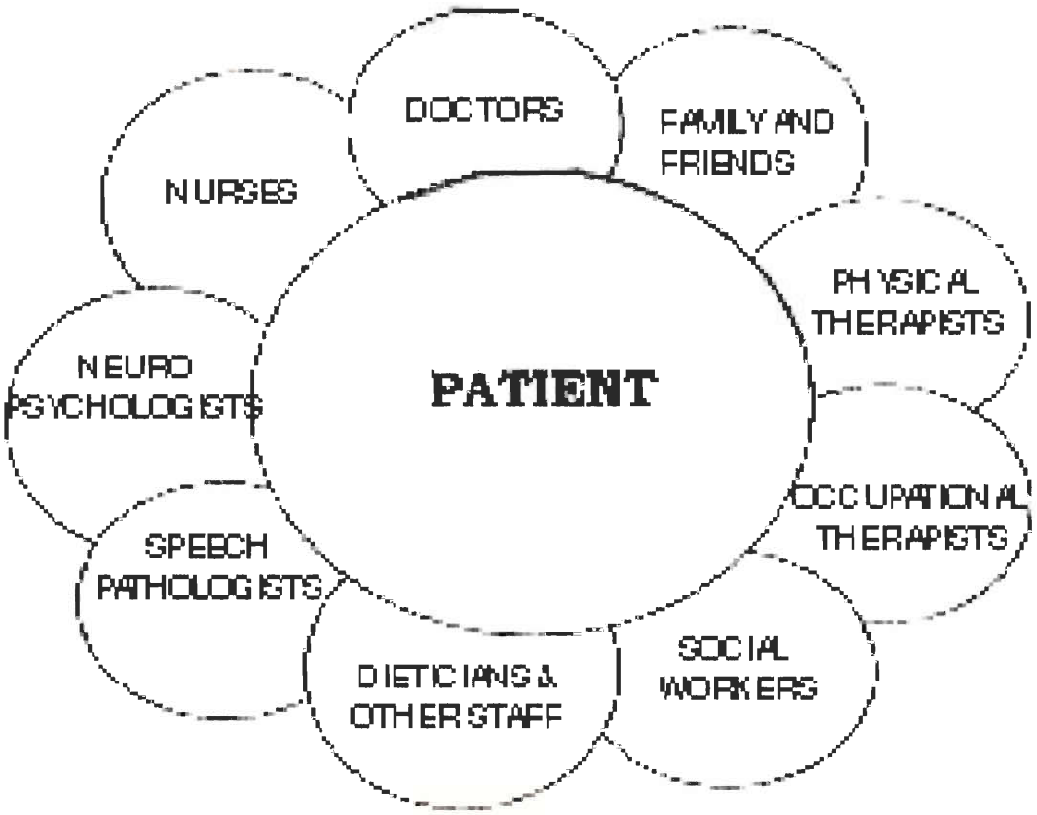


Fig 3.117 shows why brain injuries are expensive in time and Dollars. For moderate and serious head injuries not just the patient but also family and friends suffer the heartache, frustration, and financial drains. As seen from the figure, large numbers of people can become involved in just one injury (Wilmot 2000c).

Fig 3.117: Team Members (Wilmot 2000c)



The majority of the brain injuries caused by ski accidents are usually only mild such as concussions. Many of those people suffer from post concussion syndrome or mild Brain trauma syndrome. Which have symptoms that range from Headaches, Dizziness, Fatigue, Irritability, poor cognition, Anxiety, Insomnia, Black outs, Memory Loss, and Noise sensitivity just to name a few. Most of these symptoms are usually resolved in 3-6 months but some can take years (Wilmot 2000c).

The purpose of Dr. Wilmot's study was outlined in her presentation.

- Looked at potentially helmeted injured from all ED Visits for all recreational sports in 1996 and 1998

- Assumed that Cannon Ski Patrol wearing helmets from Dec 1996 would encourage others to do so. Measured the year before and the year after
    - Tried to see the type and severity of injuries
    - Comparing the 2 years to see if any changes in head injuries
- We are still collecting data, following recommendations from CPSC and NH safe kids offer of helmets < cost (Jan 99)
- Interventions and Events that have taken placed or pertain to her study
    - Cannon Ski Patrol stars wearing Helmets December 1996
    - EMS Conference October 1997/1999 "Head Injuries and Helmets" by Clare Wilmot/Campbell McLaren
- Senator Sonny Bono and Michael Kennedy died with ski injuries early 1998
- CPSC asked to analyze use of ski helmets; study Feb and Mar 1998: 124 head injuries analyzed: 44% would be mitigated by a ski helmet; reported Jan 1999.
- Loon and LRH plan a fundraiser Nov 1998/1999 to promote helmets as part of a ski safety course
- Nov 1998 Injury Prevention Coalition of NH promotes ski helmet wearing by selling "Vigor" Helmets at less than cost
- Jan 1999 program disseminated to all NH schools and ED's
- Fall/Winter program "Safe Kids".... Ski Safety Kit/Helmet orders GO NATIONAL (Wilmot 2000c)

Fig 3.118 shows a comparison of the number of injuries per sport that were treated in the Littleton Emergency Department in 1996 and in 1998. This clearly shows that because it is located in a area of the state with many ski mountains the majority of

the sport related injuries are related to skiing/ snowboarding. This also shows that it is worth looking into preventing these injuries, which includes ones dealing with the head (Wilmot 2000c).

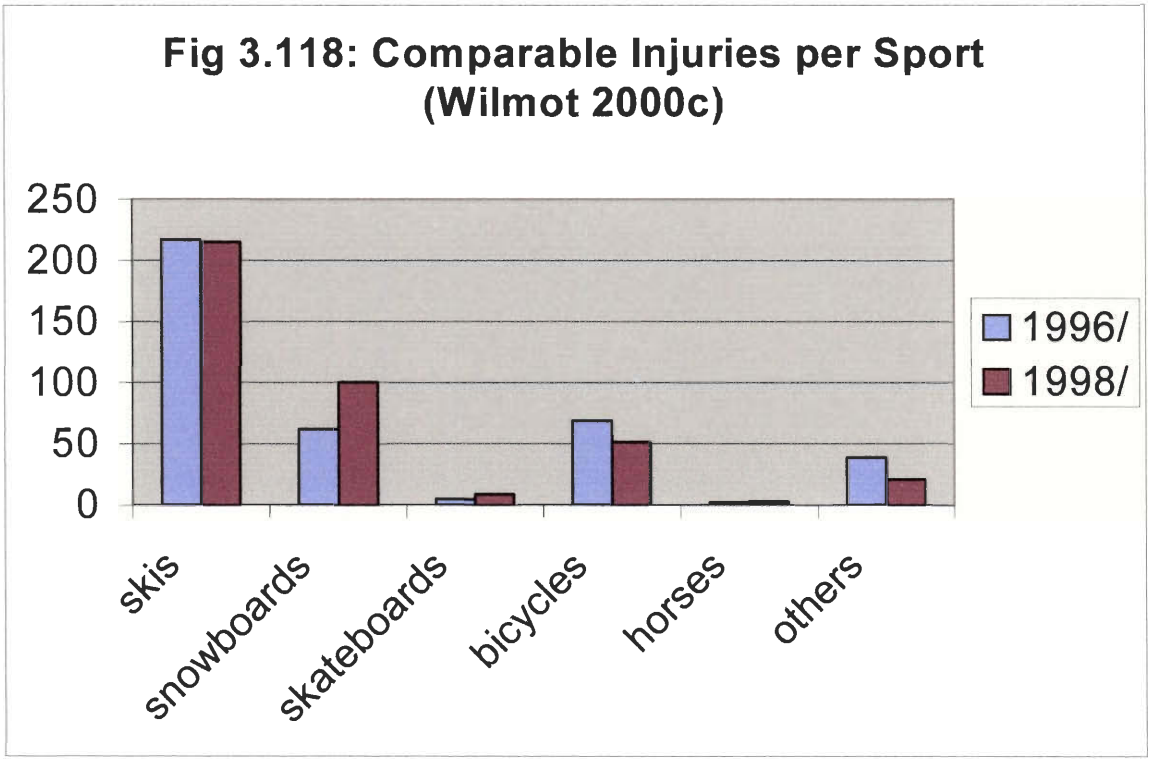
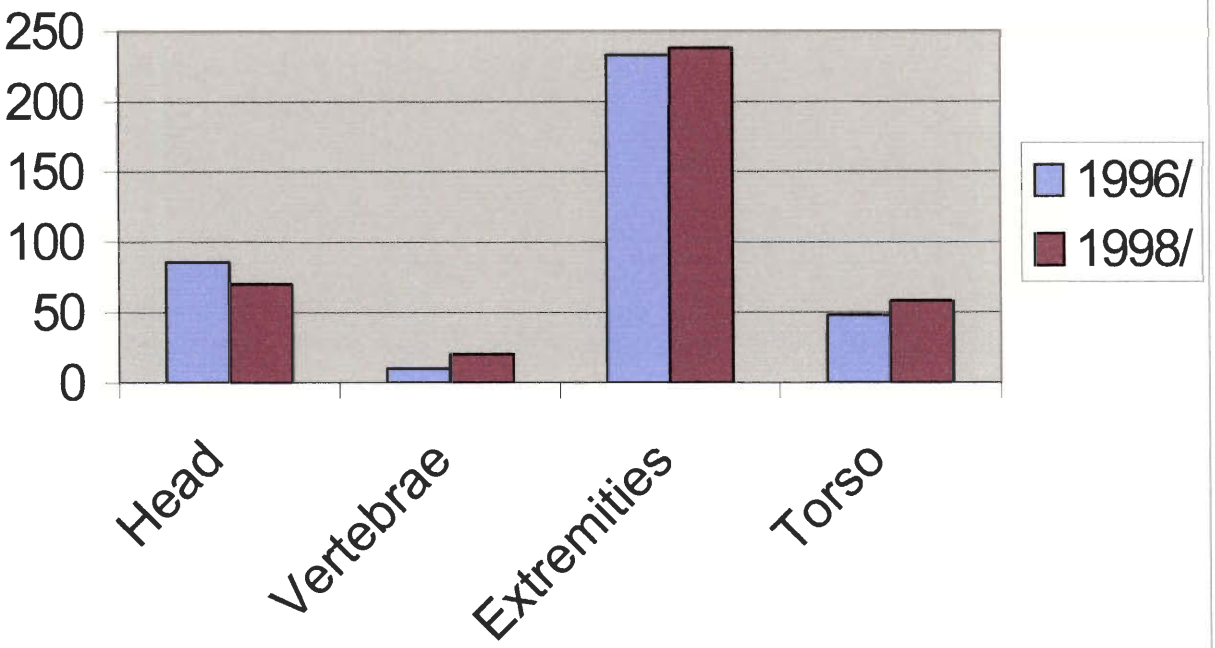


Fig 3.119 then shows the comparison of the type of injuries treated in the Littleton Emergency Department in 1996 and in 1998 for just skiing and snowboarding. From this graph it is seen that the second largest number of injuries suffered are to the head. This again shows that a large amount of injuries suffered from skiing/snowboarding are head related and therefore should be studied furthering in hopes of prevention (Wilmot 2000c).

Fig 3.119: Primary Body Part Injury (Wilmot, 2000c)



The conclusions of Dr. Wilmot's study were outlined in her presentation.

Skiers

- 75% with head injuries have mild ones
- 20% with head injuries have moderate ones
- 1% with head injuries have severe ones

Snowboarders

- 85% with head injuries have mild ones
- 12.5% with head injuries have moderate ones
- <1% with head injuries have severe ones

- Progressively larger proportion of moderate to severe injuries include a head injury compared to mildly severe injuries
- Injuries Plateau'd
- All primary injuries about the same (Extremities most)
- Neck and spine injuries doubled
- Head Injuries are a little fewer
- Especially in the Moderate severity type (7% to 2.3%)
- No real explanation (? Helmets up;? Better snow)
- 75% of helmeted injured do not have Head Injury
- 2% wear helmets and get a HI (mild or mod)
- 15-20% not wearing helmets get HI
- Helmets may modify severity of head Injury
- Males > Females
- Snowboarder injuries greater numbers
- Most injured Age group are 11-15 years old
- WEARING HELMETS 10.6% Rate
- NOT WEARING HELMETS 20.3%Rate

(Wilmot 2000c)

After the 1998 death of actor, singer, and senator Sonny Bono, the Consumer Product Safety Commission started an in depth study of ski and snowboard head injuries. The results looked at dealt with 124 head injury patients from over 50 sites in the months

of February and March of 1998. Of the 124 patients looked at, 94% of had mild head injuries, and only 6% had severe injuries to the head. The study showed that 44% of the adult patients would either not have had a head injury or might have had a lesser injury if they had in fact been wearing a helmet, and the same for 53% of children under the age of 15. In response to the determined data, the CPSC recommends helmet use for all skiers, and additional safety tips were also included in the report ranging from correct equipment selection to physical readiness of the skier (CPSC 1999).

4 Discussion

4.1 Common Factors in Accidents

4.1.1 Trail Features

4.1.1.1 Merges

There are a number of different trail features that lead to injuries or accidents. One of the most dangerous spots that we found on a ski mountain is at a merger or intersection between two trails. We witnessed one merger accident, which can be seen in Section 3.1 and Figs 3.1 to 3.3. There is usually a wooded area between the two trails, which prevents skiers from seeing each other before the merge. Many times the two trails also have a large angle between them, which makes the mergers even more dangerous because merging skiers have less time to react. The picture shown below in Fig 4.1 shows a merger that has been extended with a rope and some poles. The rope and poles have the effect of extending the tree line while enhancing visibility and giving

Fig 4.1 Trail Merger

the skiers more time to react to the merge. Trail merges with a large angle between can cause skiers to merge too quickly, often resulting in skier-on-skier collisions as shown in Fig 4.2.

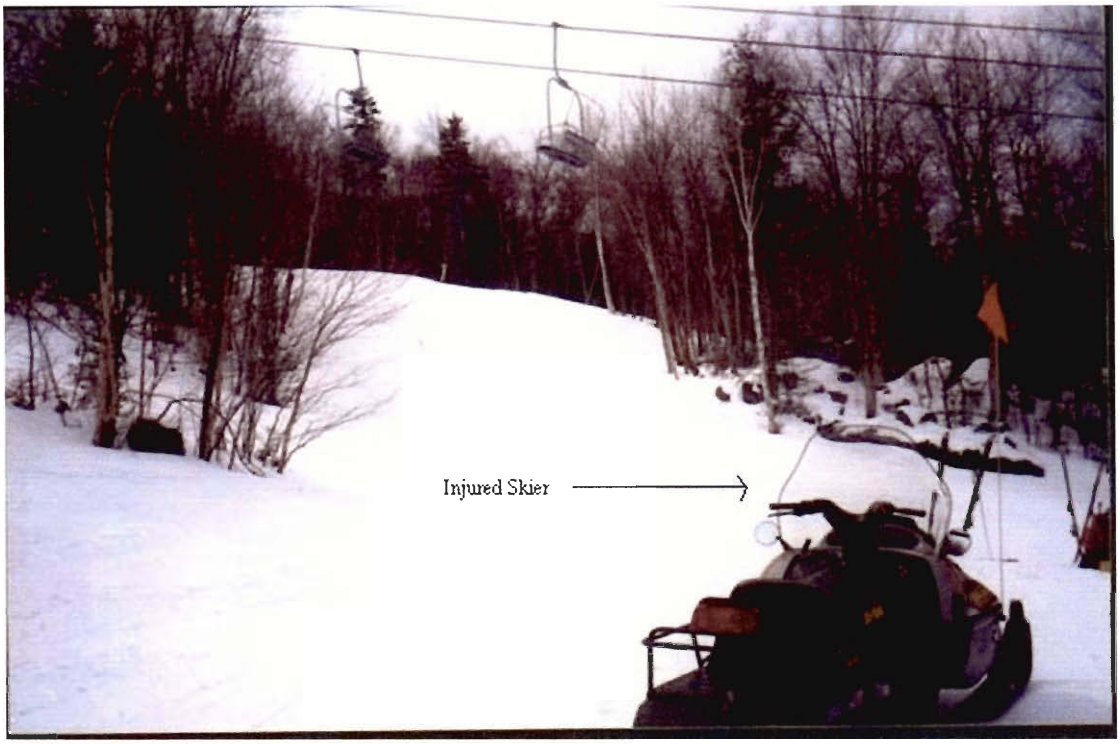


Fig 4.2 Injured Skier after Collision at Merger

4.1.1.2 Fall Line

Another trail feature that has a major impact on injuries is the fall line. The fall line is the direction a skier travels in after he has fallen. When a skier falls, depending on how fast he was traveling and the snow conditions, he slides a certain distance in the direction of the fall line. As shown in Section 3.1, often times the fall line will lead a skier into the woods at the side or bottom of the trail, which can result in injury. This was the case with the WPI student who died a few years ago. He was skiing near a turn in the trail and when he lost his balance his fall line took him directly into the woods.

A fall line that leads into the woods or into closed trails can be very dangerous and when it is combined with an icy trail the results can be deadly. This is exactly what happened on the trail pictured in Fig 4.3 at Loon Mountain.

Fig 4.3 Site of Loon Mountain Death

The trail was very icy and for this reason it was closed. The top of the trail was roped off similar to the trail shown in Fig 4.4. A male skier who was skiing down an upper trail lost his balance and his fall line carried him under the rope and onto the trail. The trail was so icy that it was impossible for him to stop and his fall line continued to carry him into the wooded area where he collided with a tree and died. More details on this accident can be found in Section 3.1 in Figs 3.4 to 3.6.

Fig 4.4 Trail Closed with Rope

4.1.1.3 Obstacles

Another trail feature that we observed at all mountains, and can often lead to injury, is natural or man made obstacles. These results are shown in Section 3.1 in Figs 3.9 to 3.12. Natural obstacles include rocks, dirt patches, and trees. A man made obstacle is any object placed on the trail by the Ski Mountain, such as ski lift towers, shown in Fig 4.5, or snow guns. Injuries usually occur when a skier collides with an obstacle that they were unaware of or when a skier's fall line leads them into an obstacle.

Fig 4.5 Ski Tower

To avoid the first scenario Ski Mountains usually try to at least mark obstacles with crossed poles or signs, however it is much more effective to use some sort of padding or protective gear to cover up the exposed obstacle. Fig 4.6 shows an example of a snow gun marked with crossed poles to help skiers notice it, Fig 4.7 shows the use of padding to help protect skiers when they do collide with obstacles, while Fig 4.8 is a new type of protective device which involves a barrel with a shock absorber. Padding or shielding obstacles is a much more effective method of injury prevention than simply

marking them because in many accidents the skier cannot avoid the obstacle even if it is clearly marked.

Fig 4.6 Marked Snow Gun

Fig 4.7 Padded Obstacles

Fig 4.8 Braced Snow Cannon

4.1.1.4 Trail Difficulty

The final trail feature that needs to be discussed is trail difficulty. It has been shown that injuries occur most often on trails of medium difficulty, 58% of skiing and 38% of snowboarding accidents, and second most on trails of easy difficulty, 28% for skiers and 37% for snowboarders (Boldrino p. 168). Our survey data, as shown in Fig

4.9, did not quite come up with the same results. We found that 49% of the people surveyed were injured on Black Diamond trails and that only 32% were injured on Blue Squares. This could be the result of not interview enough people or possibly because Wachusett Mountain's Black Diamond trails are significantly harder than the Blue Squares are.

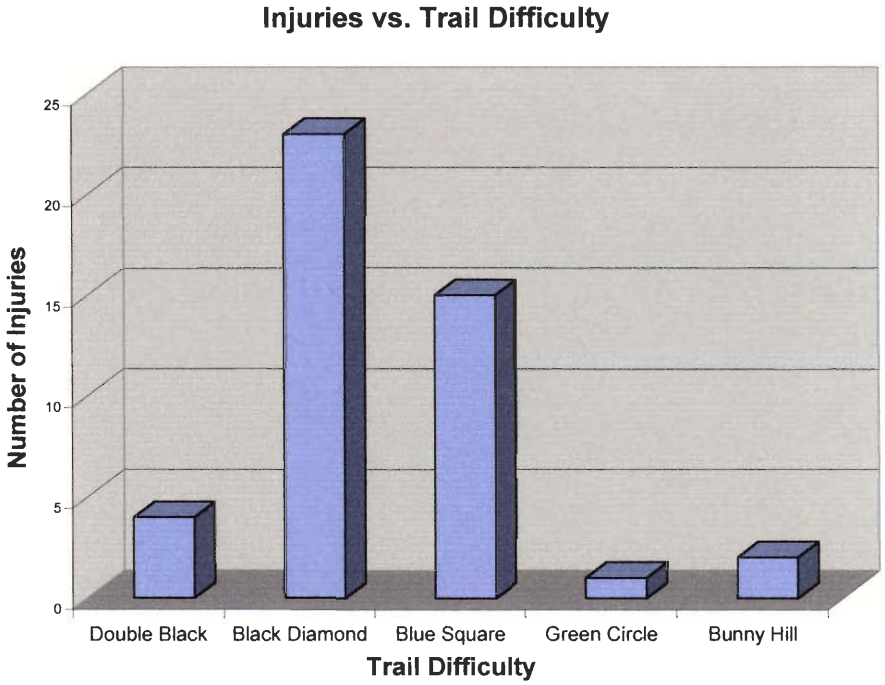


Fig 4.9 Injuries vs. Trail Difficulty

4.1.2 Snow Conditions

There are many different types of snow conditions that can exist on mountains. The type of snow on the trail and the type of equipment in use can have a great effect on the number and type of injuries. For the purposes of this report, snow type will be broken into six different categories: powder (does not stick together when grasped), soft (sticks together when grasped), wet (water oozes out when grasped), packed (compresses

granular snow), hard (cannot be pierced with ski pole but is not as slippery as ice), and icy (cannot be pierced with a ski pole, very slippery). It has been found that 42% of snowboarding injuries occur on icy conditions, but that few ski injuries follow the same rule. The majority of skiing injuries occur in either soft (30%) or hard (35%) snow (Boldrino p. 126). The type of snow can also have an influence on the type of injuries received. A study done in Sapporo, Japan found that lacerations occur most often in soft snow. Fractures on the other hand, occurred on soft snow in children and adults, but on hard snow in adolescence. Sprains occurred mostly on soft snow for all ages, while dislocations only occurred in adults in the study and they happened only on hard. They also found that injuries occur with the least frequency in powder. These results are shown in Table 4.1 below (Sugawara p. 274).

Injury	Snow Type	Child	Alolesence	Adult
Fracture	Soft	33.10%		33.60%
Fracture	Hard		35.80%	
Sprain	Soft	34.80%	36.40%	39.80%
Laceration	Soft	29.20%		30.30%
Laceration	Hard		37%	

Table 4.1 Injuries Based on Snow Type

4.1.3 Weather

Both the weather on an individual day and the general weather pattern for the whole season can have an effect on skiing injuries. Injuries are more likely to occur in conditions of low visibility such as when it is snowing. This is because it is much harder for skiers to avoid trail hazards such as rocks and trees and other skiers when they can only see a few feet in front of themselves.

The day to day weather on a mountain can vary greatly but there are generally only two types of seasons, those with above average temperature and those with below average temperature. During a warm season there are more skiers, more injuries, and two peak injury times. This is because when the weather is warmer, skiers usually start skiing earlier, take a break for lunch, and then continue skiing for the rest of the afternoon. These two periods of skiing lead to two peak injury times, each about an hour after skiing has begun. During a cold season there are fewer people, less injuries, and only one peak injury time. This occurs because when the weather is colder, people usually start skiing later in the day, ski for fewer hours, and usually don't take much of a lunch break. This results in only one peak injury time, which is also usually about an hour after the start of skiing (Serita p. 280).

4.1.4 Crowds

The size of the crowd can have a detrimental effect on the number of injuries that occur. During a warmer season or day there are larger crowds and less room for each individual skier. The more skiers in an area the higher the chances of a collision and the greater the risk of injury. This seems to be the general rule of thumb and is what happened at Waterville Valley when they installed a new high-speed quad. Due to the increased number of skiers on the slopes their injury rates rose by 10-15% depending on what Figs were used. Despite this, the distribution of the time of day that the injuries occurred remained virtually unchanged from previous years (Young p 127).

Our interviews with ski patrol have shown that terrain parks are responsible for a large number of injuries (Bill Mead 2000). It is suspected that the features of these terrain

parks are causing the accidents but over crowding could also be part of the problem. Because many people are interested in performing tricks or jumps terrain parks are often very crowded. If terrain parks are receiving more traffic than regular trails then this over crowding is perhaps the reason that so many accidents occur there.

4.1.5 Fatigue

Time and fatigue have a definite effect on injuries, but their relationship has changed in the past years. In the years 1960 to 1973 it was found that most injuries occurred after 3 or more hours of skiing, when fatigue had set in. More recently though, since 1974 most injuries have been occurring less than one hour after the skiing has started. These findings are shown in Figs 4.10 and 4.11 below (Serita p. 286). It is possible that the improvement in lift technology and ski equipment has allowed people to make runs quicker than previous technology allowed and for this reason they tire faster.

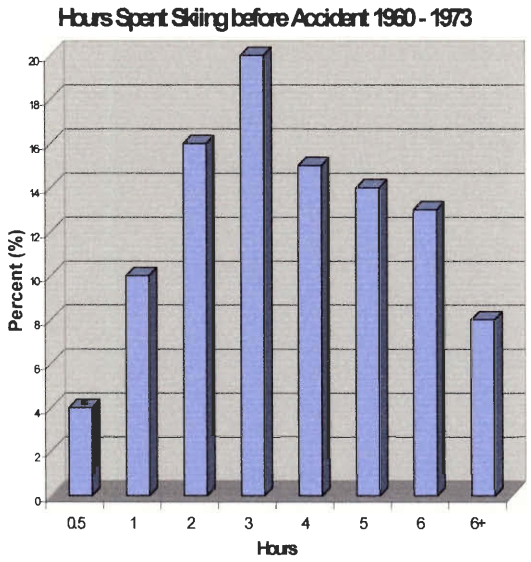


Fig 4.10 Injuries between 1960-1973

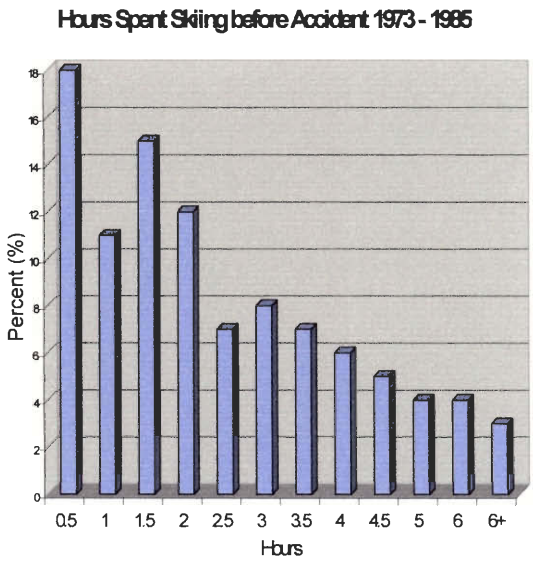


Fig 4.11 Injuries between 1973-1985

4.1.6 Time of Day

There is also a pattern to the time of day that injuries occur. As mentioned earlier there are two different types of seasons, those with two peak injury times and those with one peak injury time. A two-peak injury season occurs when skiers begin skiing at two separate times, early morning and afternoon. This pattern occurs on a warmer day or season. A one-peak injury season on the other hand occurs when skiers begin skiing at only one time, usually late morning. Most of our survey data was collected at Wachusett Mountain where they have night skiing which starts at 4pm so our results are slightly different from those gathered at mountains with no night skiing. Even so our data suggests that this past season was a two-peak. The first peak occurs in the late afternoon, when night skiing begins, and the other peak is near the end of the night, possibly once people have started skiing again after a dinner break. These results are shown in Fig 4.12.

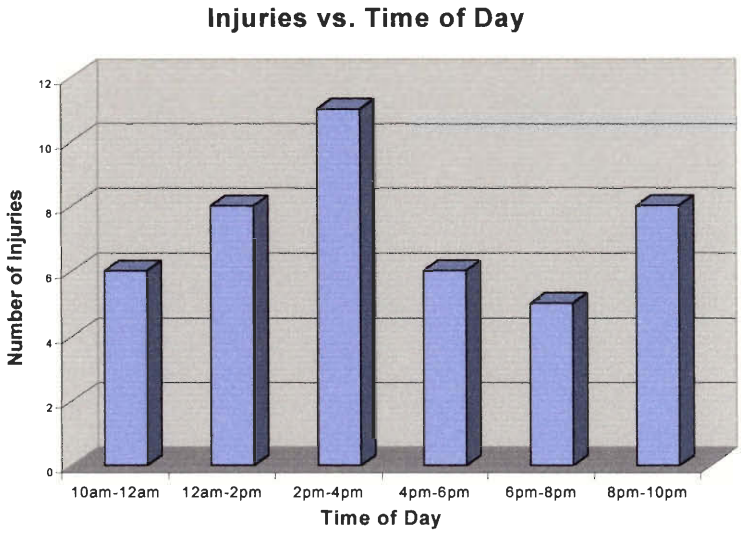


Fig 4.12 Injuries vs. Time of Day

4.1.7 Who's at fault

The question of who is at fault for most skiing accidents is very hard to determine and depends on whom you ask. Even the laws of most states are unclear as to who is responsible for accidents. Some people blame the Ski Mountains, while others blame bad equipment, Mother Nature, or other skiers. Our survey however showed us that most people just blame themselves for the accident. In fact 72% of the injured skiers that we interviewed said that they were responsible for their injuries. As shown is Section 3.3, Table 3.1, most ski patrol members agree. They said that skiers going to fast for their ability cause most accidents. The rest of the people who were surveyed about the reason for their accident were split between Mother Nature at 13% and another skier at 11%. Our results for skier on skier accidents is similar to the results from a study done in Austria where it was found that skier on skier collisions are responsible for 7% of injuries (Boldrino p. 172).

4.2 Accident Prevention Methods

4.2.1 Trail Design

4.2.1.1 Merging

Most merging trail intersections at all mountains are marked with signs to the side of the trail. This measure is not always efficient method of warning people of upcoming merging trails, since most people are likely to go by the sign without even seeing it because of the sign's location. In spots where accidents occur in greater frequency, merging signs and other types of warning signs are placed in the middle of the trail, to make the message being presented by ski patrol more visible and effective. Trail merging signs are a good medium to help deter merging accidents, however signs alone are not always 100% effective.

There are two additional relatively good methods to increase the safety of trail merges in addition to signage. One method is using bamboo poles and ropes to extend the tree line between merging trails. This method completely prevents people from merging perpendicular to the adjacent trail and allows traffic on the trails to flow together gently and easily. Another added benefit is that people on both trails can see traffic on the other side before the two trails actually merge. The other method to reduce the number of merging trail injuries applies to newly designed trails. When designing a trail, careful consideration should be taken on all trail mergings. Trails should not be designed to merge abruptly, but rather designed to flow together more easily by having trails merge at acute angles and by extending the tree line slightly, pointing the flow of traffic in the proper direction.

4.2.1.2 Terrain Parks

Terrain parks are where most of the serious injuries occur on most mountains. The terrain features are mostly responsible for the accidents, but good terrain park design can significantly reduce the number of potential accidents. Wider and spread out terrain parks are the most favorable. Trail features such as jumps are can be set a greater distances apart, which allows people who lose control in the terrain parks more time to regain control of themselves and stop before hitting another terrain feature. In small terrain parks, people have a greater chance of being injured because of the closer terrain features. People are more likely to collide and lose control without having the chance to regain control in smaller terrain parks. The wider and more spread out parks are designed, the safer they are for the people that use them.

4.2.1.3 Trail Difficulty

The interview data collected by the group shows that intermediate trails have the highest frequency of accidents, while expert trails have the lowest. Intermediate trails are often wide and groomed, allowing people of higher ability levels to go very fast on these trails. The intermediate trails are very easy to ski and snowboard on and sometimes beginner skiers and snowboarders overrate their ability and go on these more difficult trails. This makes them more susceptible to losing control and getting injured. The faster a person goes on a trail, the more susceptible they are to having an accident. The only feasible solution to preventing these types of accidents is education. If people are educated to follow the rules of the mountain, fewer people will do things that will get themselves injured.

4.2.1.4 Fall Lines

Trails on older mountains are usually very narrow and curvy. These older design trails have more numerous and dangerous fall lines. The trail designs of most new trails are wide highway type trails, which have straight fall lines down the center of the trails. Wider and straighter trails have much safer fall lines and are less susceptible to severe injury since the person has more straight trail to stop and get up instead of going off the trail into the woods on a curvy narrow trail. New trail designs have generally much safer fall lines.

4.2.1.5 Environment

Most ski areas would like to expand their mountain by building more trails, however there are limitations. All the mountains that were investigated are on state forests, therefore if a mountain desires to clear some forest to build new trails they must get permission from the state to do so. Even if the mountain receives permission from the state, environmentalists get involved and file lawsuits against the trail expansion, and often win. If a ski area wishes to redesign a trail to make it safer, the plans cannot be easily implemented due to environmentalist actions.

4.2.1.6 Economic Analysis of Trail Redesign

Since ski areas are a business, they must make decisions based on cost benefits analysis. We assume this economic analysis extends to how and when the ski areas will implement ski improvement to their trails. While ski areas may not always make safety decisions based on economic costs and benefits because of personal sentiments managers, owners, or employees, economic costs are the focus of this section. A business should implement a change when the $cost<benifts$. Since costs and especially benefits are

uncertain, there is room for interpretation of the exact monetary amounts of costs and benefits. Different ski areas may draw different conclusions about trail redesign based on varied opinions of these costs and benefits. We have broken these cost and benefits down into several categories shown in the table below.

Cost abbreviation	Cost description	Benefit abbreviation	Benefit description
Construction	Immediate cost of construction of safety improvement	Value change	Increase in value of ski area due to safety improvement
Maintenance	Maintenance cost per year times the number of years used to calculate cost	Marketability	The benefits a ski area receives due to improved safety
Hazard	Cost attributed to an admission of a hazard	Insurance Cost	Reduced insurance Cost due to safety improvement
Enjoyment	Cost of decrease in skier enjoyment due to safety improvement	Cancellation	Value of reduced risk of cancellation of insurance
		Limit	Risk of Exceeding insurance coverage limit
		Medical	The money saved on ski patrol and medical attention.

Construction + Maintenance + Hazard + Enjoyment < Value change + Marketability + Insurance Cost + Cancellation + Limit Medical

Table 4.2 Economic Factors

Many of these terms can be determined accurately. Construction costs are usually predictable because contractors wile often give cost estimates. Maintenance costs are usually either predictable or minimal. Construction that redesigns a fall line involves leveling of moving a trail and usually should not require repairs. Other improvement such as, removing the lower branches of trees near a merger to allow skiers to see to the

other trail may need periodic grooming. Insurance cost can be predicted by asking how an improvement will effect rates.

Hazard costs vary depending on if there is a pending claim dealing with the trail feature in question and the legal nature of the trail feature. Most states have laws protecting skiers against the inherent dangers of skiing; however, if a trail feature can be fixed then it might not be considered an inherent danger. So sometimes, there is a significant risk of admitting that a trail feature is dangerous by attempting to make the trail safer. There are also risks in not fixing dangerous trail features because injured skiers could argue that the ski area could have prevented their accident. Usually the costs of lawsuits are absorbed by the insurance company but the ski area may risk canceled insurance or may have a lawsuit that exceeds its insurance limit. Reducing these risks has an economic value to a ski area that may be difficult to predict but they are a function of legal liability and injury risk. If the trail feature being fixed were a dangerous merger, the main injury risks would be skier to skier collisions, which are usually not considered the fault of the ski area. Fixing the trail feature would reduce risks to skiers but would not decrease the risk of a successful suit against the ski area significantly. While other risks such as hydrants in the middle of a trail might be considered a liability against the ski area because the hydrant was placed in the middle of the trail by the ski area. Improving overall safety may also reduce the resources a ski area spends on ski patroller rescue and on site medical expenses. These reductions in cost might be predicted by examining previous accidents at that sight.

Skier enjoyment and safety marketability are two factors that often conflict since improving safety sometimes subtracts from the enjoyment of skiers. A ski area that

caters to families has an interest in convincing parents that their children are safe at that mountain. Skiers areas that attempt to market to families will be more successful if they are viewed as safe. Since a larger ski area has more skiers there is a greater risk of having an accident that draws media coverage. So large ski areas must be more careful to avoid accidents then smaller ski areas. Sometimes making a trial safer can conflict or detract from a skier enjoyment. For example, cutting down trees can decrease the enjoyment of a skier by reducing the some of the challenge of the slope but also give skiers less obstacles to hit. Ski areas should balance safety and skier enjoyment differently depending on the types of skiers they try to attract.

4.2.2 Protective Gear

4.2.2.1 Helmets

Based on data from the surveys we conducted and information provided to us by Dr. Wilmot it is evident that not a large amount of people are wearing helmets on the slopes. The vast majority of people that responded to our surveys claimed that they don't wear helmets while skiing and snowboarding. Only 3% of the responses claim that they use helmets. When the participants of both the handout and web survey were asked why they didn't wear helmets 46% claimed that they don't think helmets are necessary. Fig 3.94 shows the distribution of responses on why people choose not to wear helmets. By looking at that graph it is clear that the majority of the people who participated in the survey do not think they need helmets. The other four main reasons why people don't wear helmets are evenly distributed. These other four reasons consist of, helmets aren't cool, helmets don't look good on my head, helmets are uncomfortable, and other written in reasons. Since most of the responses to our survey were from college students these

results are best interpreted for the age group of 17-24 years old. This may explain why the majority of the responses we received from our study were people believing they did not need helmets. People of that age group often do not think about the risks they take when on the slopes or the ramifications of their actions. They often believe they are expert skiers when in reality they are not nor do they have the amount of experience of other skiers. In one of her interviews Dr. Wilmot comments on how people that believe they will not get a head injury are commonly wrong. She goes on to say, "…. If you get injured badly even if it is two people one of those people, which is fifty percent, will have a head injury. The worse the injury the more likely you are to have a head injury. So you cant say I'm not going to get into an accident cause if you get into a mild one…one in five will have a head injury. If you get into a bad injury one in two will have one." (Wilmot 2000b). This shows that a large percentage of the people who do get injured on slopes often have an associated head injury.

Based on data from the Consumer product Safety Commission and information provided to us by Dr. Wilmot it is clear that children would benefit most from wearing helmets. Fig 3.115 shows the different types of ski injuries that occurred to children in 1996 in one of the studies mentioned by a Dr. Wilmot in her PowerPoint presentation. Of the 38 children in the study 25% had long-term problems as a result of their injuries. By examining this graph, it is evident that the face and head received the majority of injuries that may possibly be prevented if a helmet had been worn (Wilmot, 2000c). Also from the data in Fig 3.116 it is seen that moderate ski related head injuries went down between the years 1996 to 1998 most likely due to the to the increase in the use of helmets at Cannon Mountain. Dr. Wilmot credits the increase in helmet use over the two years to

the increase in education done a t Cannon and other mountains in the area as well as the example the cannon ski patrol has made by all wearing helmets since the beginning of the 1996 season. From her work she found that the most injured age group are 11-15 years old. During her first interview Dr. Wilmot gave us a good example of how important it is for children to wear helmets. She told us, "A girl yesterday fell down so hard she whacked her head, and she was wearing a helmet, whacked her head broke the clip off the helmet went bouncing down the hill, she had to go down and get the helmet, she finished snowboarding, she went snow shoeing afterwards, she felt fine, of coarse her neck hurts today, but if had not been wearing a helmet even though it came off she would have had a severe head injury…" (Wilmot 2000a). This clearly shows how beneficial helmet use can be to children as well as all people. One of the most interesting findings of her study was based on the data she collected from 1996 to 1998 with the help of Cannon Mountain and the Littleton Hospital. She found that people injured when skiing/snowboarding and not wearing a helmet had an associated head injury 20.3% of the time. While people injured when skiing/snowboarding who were wearing a helmet had an associated head injury only 10.6% of the time (Wilmot 2000c). This means that your chance of injuring your head when you get in an accident is almost 50% less when you wear a helmet. Dr. Wilmot's numbers are very close to those found by The Consumer Product Safety Commission in January of 1999. The study found that 44% of the injured adult patients would either not have had a head injury or might have had a lesser injury if they had in fact been wearing a helmet, and the same for 53% of children under the age of 15 (CPSC 1999). Both Dr. Wilmot's and The Consumer Product Safety

Commission findings clearly show that wearing helmets greatly decreases head injuries and even more in children under the age of 15.

It was evident from our research that there is a lot more research that could be done on the use of helmets as well as ways to get the public to use them more. This is a relatively important subject in the ski industry and would be worth the time and money to research the subject further. There seems to be little published data on this subject. The only information we found was the Consumer Product Safety Commission report (Dr. Wilmot's studies being unpublished at this time). Due to the fact that the number of head injuries in snowboarders has increased from 1000 in 1993 to 5200 in 1997 (CPSC, 2000) and our survey data (Fig 3.99) that shows head injuries tied for the second most amount of injuries suffered by males it can be seen that there is defiantly a need to further investigate helmets effects on reducing head injuries. A lot of the Ski Patrol we talked to told us that they did not get many head injuries at all so mandatory helmet use would not prevent many head injuries. During our interview at her office we told Dr. Wilmot what ski patrol had told us. She then explained why the mountains do not see many head injuries and therefore do not feel the need to do anything about it. She said, "We get the head injuries here (meaning at hospital), so the people get injured at the mountain but don't realize it until when they go home so the mountains don't hear about it..." (Wilmot, 2000b). It is possible that not much has been done in research on helmets because the mountains and ski industry have not actually seen the large numbers of head injuries for just this reason. The effects of many concussions are not discovered until much after the injury has taken place. So if the injury is not reported to the ski patrol, as seen in Fig 3.13 with 72% of people surveyed saying they were not helped by ski patrol when they

were injured, the mountains do not know about the injuries suffered on their slopes. It is clear that people who work at medical facilities such as Dr. Wilmot can help the mountains better see what injuries are actually taking place so they can work on prevention methods. This has seemed to work extremely well at Cannon and could be implemented at other mountains with possibly the same effects.

As seen from most of the data we looked at every level skier can benefit from helmet use. We found no evidence that wearing helmets would have any major detriments. The only small detriments we can see are that people don't want to hurt their ego. They take the risk of suffering a head injury because they either don't think they are or they don't want others to think they are not skilled skiers and therefore need a helmet.

4.2.2.2 Bindings

Ski Bindings

Bindings are one of the most important features in terms of safety for skiers (Roberts, 1980). The significance of releasable bindings is amplified by the evolution observed in boots over the past two decades.

The thing that's caused more knee injuries than anything is that boots keep getting higher and higher. You used to have an ankle high, or a little higher boot, you break leg bones. And now you push all the forces up into a knee. It's a lot easier to fix a leg than it is a knee. (Meads, Interview, 2000)

This change in boot design made it extremely important for releasable bindings to become industry standard. Several people have proposed, or even designed and tested bindings that use electrical or electronic components in an attempt to make the bindings

respond to different types of accidents (Roberts, 1980). For right now, regular mechanical bindings do a good job without adding extra cost or weight to the equipment.

Snowboard Bindings

In contrast, snowboards generally do not have release bindings. Prototypes have been built for different types of releasable snowboard bindings, but they have not caught on because of added cost, inappropriate releases and reluctance by manufacturers to implement features that are not in high demand.

4.2.2.3 Wrist Guards

Wrist guards are a relatively recent addition to the ski-safety industry, although they have been used in skateboarding and other sports for a long time. Although we have no concrete data to quantify exactly how many ski/snowboarders use wrist guards, our time spent at ski areas over the course of this project has made it clear that it is very rare to see a snowboarder wearing wrist-guards on the slopes.

4.2.2.4 Goggles

Figure 3.95 shows that 80% of skiers use goggles during harsh weather. Skiing while it is snowing without them is uncomfortable, and dangerous (Senner et. al., 1999). Vision is one of the most important factors in alpine sports; without a clear idea of his surroundings, a skier is much more likely to cause some kind of accident. To complicate matters, foggy goggles can severely impair vision (Senner et. al., 1999). As a safety device, goggles provide good visibility in adverse conditions as long as they are kept from fogging up.

4.2.2.5 High Friction Coefficient Clothing

One safety feature commonly overlooked by skiers and snowboarders is the clothing they wear. Materials with a high friction coefficient (rough rather than slippery to the touch) will stop an out-of-control skier from sliding down the hill much quicker than slick materials designed to reduce wind resistance. This is a minor consideration in the grand scope of trail safety, and we were unable to find any data quantifying the advantage afforded by wearing clothes with a high friction coefficient. However, from the experiences of our group members, the added wind resistance of high friction coefficient materials makes little difference in the overall experience while providing a safer landing in the event of a fall.

4.2.3 Ski Patrollers

The ski patrol is the mountain's primary means of providing assistance to injured skiers. It is also responsible for making sure that all of the regulations set forth by the mountain are actually obeyed on the slopes, and are one of the resort's best resources for gathering information about injuries and locating trouble spots on the mountain.

4.2.3.1 Skier to Patroller Ratio

From our interviews, we found that skier to patroller ratio is not something that is generally monitored at resorts. Out of five ski patrol interviews at five different resorts, we were only able to get an estimate from Wachusett. Mike Hallaren, head of the Wachusett ski patrol estimated a 150:1 ratio (See Appendix I). The rest of the resorts explained that the number of staff working at any given time is based primarily on the amount of terrain and lifts that are open, who is available to work and the time of day (Shaft, interview, 2000).

4.2.3.2 Methods used by the Ski Patrol

The role of the ski patroller on a mountain can be likened to the role of a police officer in society. The patroller has a responsibility to make sure that the mountain remains a safe and fun place for all visitors. Some of the methods the patrollers use, as cited from our patroller interviews include:

- Moving injured skiers off the trail to avoid further injury and collisions
- Helping injured skiers' back to the lodge, and obtaining appropriate medical attention
- Educating skiers about the skiers' code, and warning or ejecting people who are not adhering to the code.

On our visit to Cannon, we learned about a new way that the Ski Patrol is helping to keep the resort safe. The Cannon ski patrol noticed that a lot of families visiting the resort bring pocket-sized 2-way radios with them so that they can keep in contact while skiing independently. The patrol now monitors channel 14, so anyone with a radio can call in pertinent information to the patrol (Meads, Interview, 2000).

4.2.4 Education

Education is by far the most cost-effective way a mountain can improve safety on the overall ski/snowboarder population. Our survey reported that 60% of injured skiers blame themselves for their injuries whereas only 12% blame the mountain (Figure 3.107). Clearly the majority of ski/snowboard accidents are the result of human error, and these human errors can be significantly reduced with appropriate education.

Lessons

Formal ski/snowboard lessons can be an excellent safety tool for new skiers. Not only do the students learn the correct way to get down the mountain, but they are also introduced to the skiers code and taught about responsibility on the slopes. Making these lessons mandatory for new skiers could be beneficial in terms of safety, but such a regulation would be tricky to enforce, and many newcomers would prefer to learn from family or friends.

The AAA Program

The three A's stand for Attitude, Awareness and Accountability.

Attitude: A positive attitude on the slopes can make all the difference. Ski resorts are designed so that visitors will have a good time. If every visitor keeps a positive attitude towards others, and looks out for his fellow skier, safety on the slopes will increase.

Awareness: Keeping aware of the trail and the people close by is a good way to reduce skier on skier accidents and the dreaded skier on tree accidents.

Accountability: The third part of the AAA program is accountability. This emphasizes the importance of being accountable for your actions on the slopes, and thinking about the consequences before acting. (Shaft, interview, 2000)

4.3 Ski Safety Counsels

Some government organizations like the Consumer Products Safety Commission examine and sometimes regulate products relating to skiing safety, such as helmets. While some government agencies have investigated different aspects of skiing safety, there is no national government organization in the United States responsible for coordinating safety research or regulating ski safety. In Sweden, a skiing safety interest group is now backed with government funding and recognition. This support helps the organization to investigate aspects relating to skiing safety and to more easily communicate their finds to the public. Based on the effects of the Swedish safety interest group giving a national government agency the responsibility of investigating and reporting on all aspects of ski safety, this would help further the public's understanding of the issues relating to skiing safety (Eriksson, 1993). If a national government organization was responsible for skiing safety in the United States, their reports would provide a valuable resource for media organizations reporting information relevant to skiers.

While many states regulate ski lifts and tows with tramway boards, they do not always regulate many other areas important to skiing safety. State safety organizations do not always regulate ski areas with respect to trail design and other important issues. While Massachusetts as mentioned in the legal review in section 1.3 and other states have standardized the signs that must label trail difficulty, closing, and hazard signs, we have been unable to find any evidence of the Massachusetts Tramway Board asking ski areas to modify trails. Our study of the Massachusetts Tramway Board in section 3.4 has also found that the board was not set up effectively to answer questions about its own

functions or about other issues important to skiing safety. The boards primary function was the regulation of tramways and setting standards for Alpine and Nordic signs. The only accidents that the board collects information on relates to tramways. Assuming that other states' organizations have similar characteristics, the states leave many issues important to ski safety uninvestigated and many ski area practices unregulated.

Some private organizations contribute to the public's understanding of issues relating to safety, but many of these organizations have agendas that could cause some information not to be reported accurately or completely. The National Ski Area Association (NSAA) is a national trade organization for ski areas. The NSAA shares industry statistics, and organizes conferences. The choice of statistics and information distributed by this organization is probably influenced heavily by the interest of ski areas and thus might not always share all information important to the public interest. Another organization that distributes information on skiing is the National Ski Patrol, but their resources are limited and much of their information focuses on injury treatment and not accident prevention. The Ski Trauma and Safety International Symposium provides a forum were scholars in the field of skiing safety can share research, but this conference is not focused on providing the public with information on skiing safety. These non-government organizations may have biases on reporting information or do not provide the public as a whole with information.

4.4 Sign Standardization

The purpose of signs while skiing is to increase safety and to provide the skier with information to improve their skiing experience. Signs that improve safety belong to

two general categories those that inform skiers of hazards or difficulty and those that are give instructions or recommendations to skiers.

As mentioned in section 3.4 the tramway board has standardized a number of trail signs. The signs give information to skiers about overall difficulty of the trail, indicate a closed trail, or that there is a hazard ahead. Signs that indicate the difficulty of a trail are usually effective in identifying the difficulty rating since they are standardize and they are located at the beginning of a trial where the skier is not traveling quickly. Unfortunately there is no universal difficulty rating of trials so skiers may find a intermediate trail at one ski resort is more difficulty then the advanced trail at another resort. Caution sign are placed up trail of hazards to alert skiers to hazards further down the trail. The signs are used to mark snowmaking, grooming operations, and any other hazards that may need to be marked. The meaning of this sign can be ambiguous since the same sign is used to mark any variety of hazards. The only hazard marking that identifies a specific type of hazards is a hydrant marking (Massachuesetts 1993).

Since hazard signs are ambiguous, many mountains have found that it is necessary to use signs other than those standardized by their state tramway boards. In figure 3.39, a merger is labeled with a Massachusetts standard caution sign, a hazard sign, and a merger sign that is not standardized. If a skier is not familiar with the meaning of the caution sign or the merger sign when arriving at the ski area, he should see an explanation of the meaning of the caution sign but he will not necessarily see an explanation of the merger sign. Since all signs required by the Massachusetts Tramway Board must explained and illustrated in a prominent manor at the ski resort, skiers are more likely to know the meaning of the sign. Although many non-standardized sign such

as the yield sign shown in figure 3.40 giving the right of way to the faster moving trail, may be obvious to English-speaking skiers other skiers may not understand. While non-standardized signs may be necessary to identify unique trail features properly, they may often be misunderstood by some skiers.

Trail hazards may also be marked with poles, netting, and padding. Poles are a common way a marking a relatively small sized hazard such as the spicket shown in figure 3.51 and 3.52 and may sometimes be effective in drawing attention to a hazard. Also brightly colored netting may be used as shown in figure 3.53 for marking small sized hazards. In addition to helping to reduced the stresses exerted on the body at impact, brightly colored padding helps make hazardous lift lines or spikets more visible as shown in figure 3.54 and figure 3.50 respectively. Non-sign markings make obstacles more obvious to skiers, but they may not show the nature of the obstacle. For example, a set of ski poles might be marking jump or they might be marking an obstacle that is not easily visible. While the National Ski Patrol and insurance companies may help set standards for trail marking, enforcing additional signing standards would help ensure uniform implementation of these standards.

5 Conclusions

- Trail merges with smaller angles between them have fewer accidents than those with larger angles.
- Fall lines that lead into trees or other obstacles are one of the major causes of injury.
- Natural and man-made obstacles can cause injury if the skier does not notice them or is unable to avoid them.
- Most snowboarding injuries occur during icy conditions while most ski injuries occur in either soft or hard snow.
- Poor visibility increases the chance of an accident.
- The less room a skier has to maneuver the greater the chances of a collision.
- Increasing the number of skiers on the mountain results in an increase in injury rate.
- Most accidents occur less than 1 hour after the start of skiing.
- The time of day that most injuries occur is related to the type of season.
- In a warm season injuries are most common in the morning and just after lunch.
- In a cold season injuries usually occur in the late morning/early afternoon.
- Most skiers blame themselves for their accidents.
- A small percentage of injuries are the result of skier on skier collisions.
- Speed is the major factor in serious skiing and snowboarding accidents.
- In recent years, straight trails are constructed to allow more trails on a mountain as opposed to older trail design, which were long and curvy trails.
- New mountain trail design and well-groomed trails have contributed to the increase of individual's speed on the mountain.

- The relatively small percentage of people wearing helmets on the ski slopes is due mostly to a lack of public awareness on the benefits and detriments of helmet use.
- Children under a certain age would benefit from wearing helmets while skiing or snowboarding.
- More Research should be done on helmets as well on how to increase the public's awareness on the importance of wearing helmets.
- Environmentalists interfere with trail safety reconstruction and expansion.
- Increased skier and snowboarder education will decrease the number of accidents.
- New trail designs have generally much safer fall lines than older trails
- Most accidents occur on intermediate trails
- Good terrain park design can significantly reduce the number of potential accidents
- The United States could benefit from greater and better-organized government involvement in skiing safety.
- Ski areas may make different safety decisions because their impressions of their cost and benefits of improving safety are different.
- Standardization of signs by the tramway boards increases the probability of a skier understanding the meaning of the sign.

6 Recommendations

- Trail merges with large angles should extend the tree line with rope or fence to give skiers more time to merge fluidly.
- Trees and other obstacles that are in the path of a fall line should be padded or fenced off.
- Obstacles should be clearly marked at a bare minimum, and padded if there is any chance of a skier hitting them.
- Goggles should be worn when visibility is poor to help reduce the chance of an accident.
- Proper stretching can help avoid injuries during the first hour of skiing.
- New trails should be designed wide and straight to make fall lines safer
- New merging trails should be designed safer
- Assign an existing government agency with examining all aspects of skiing safety issues.
- Children under a certain age should be required to wear helmets while skiing/snowboarding
- More research should be done on helmets as well on how to increase the public's awareness on the importance of wearing helmets
- Tramway boards should standardize more signs

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Forward:

We would like to call your attention to the appendices of this paper. Besides the usual compilations of survey response data and copies of correspondences relating to our project, you will find copies of interviews conducted with members of various ski patrols, a medical expert, and other professionals involved with the ski industry. Most importantly however is Appendix N. It was written in order to give the reader a better understanding of what our group went through trying to work with eight people.

We recognize that a typical IQP group is made up of three or four people, a much smaller and more manageable size. We have not heard of, nor found reference to, an IQP group approaching eight people. Appendix N delves into the interactions within our group. It presents some of the advantages and disadvantages we found to working in a group of this size. Working with eight people makes the project harder. While there are more people to do the work, more work needs to be done to warrant the larger number of people. A larger number of people amplify the difficulties that a smaller group might encounter.

Appendix A

Christopher J.Tremblay
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(508) 752-2307 ext. 31

To whom it may concern,

Each year numerous people get seriously injured due to skiing and snowboarding accidents. Even though recent studies have shown that in the past few years there has been a decline in the amount of these injuries, further reductions of these dangers would be desirable. We are a group of students from Worcester Polytechnic Institute (WPI) working on an Interactive Qualifying Project aimed at mitigating these risks. The IQP challenges students to investigate and report on a topic that interests them. This topic should examine how science or technology interacts with societal structures and values. This IQP will attempt to bridge the technical and mechanical aspects of preventing ski injuries with the social and economic needs to prevent injury.

Currently we are involved in looking at past accidents and what has been done to avoid them. We will soon be reaching the next step in our project where we will be going out and determining what causes these accidents. By doing this we can identify the most effective and practical methods to reduce these injuries. In order for us to meet these goals, we need your mountain's assistance. We are interested in any input that you would be willing to give us that could help our project, as well as allowing us to come up to your mountain for a visit. With the help of your mountain, we can accomplish our goal of determining which factors are responsible for injuries and accidents. Because our IQP will be covering many of the ski resorts in New England, we can gather the information needed to develop strategies and conclusions that could be implemented at mountains across the United States.

We look forward to your ski resort joining our efforts in our IQP by helping us achieve our goal. If you can be of any assistance to our efforts, your ski resort will be recognized in our IQP report and published in May of 2000. With experts in ski safety, faculty, and numerous students reading this report this could be a great opportunity for your mountain to show its efforts concerning the safety of the ski community. Thank you for your time and I look forward from hearing from you. You can contact me by phone at (508) 752-2307 ext.31, by email at fiona@wpi.edu, or by writing me at the address above.

Sincerely,

Christopher J. Tremblay

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IQP/MQP SCANNING PROJECT

Appendix C

Mountain's Name_____ Phone Number_____

Hi my name is _____ and I'm a college student working on a group ski safety project, can you please assist me in finding me someone who can answer a few questions?_____=Who I talked to

Hi my name is _____ and I'm a college student working on a group ski safety project. About three weeks ago we sent a letter to your mountain and this is a follow-up call to see if you are interested in assisting us. _____=Their Response

What we need from them

- Visit any new prevention methods you have applied to your mountain
- Visit locations where accidents occurred to see if there are any common factors
- Set up a time to talk to a person on the ski patrol so we can ask a few questions

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Well let me tell you a little bit about it. The group consists of eight students from WPI that is currently working on a ski safety project. Our objectives are to reduce the number of serious injuries while keeping the cost economically viable for ski resorts. We plan on accomplish this by looking at past accidents and where they occurred and see if there are any common factors that are involved. We are currently working with other ski resorts and we are wondering if you are willing join our efforts?_____

Great, with your help we can gather the necessary information needed to find what we can do to reduce the number of injuries that occur from skiing and snowboarding. We would like to visit your mountain and visit these sites to try to find any common factors that occurred with these accidents. We would also like to look at any new prevention methods you have implemented on your mountain to help reduce the number of accidents on your mountain.

How would be the best way to visit these locations?(ex. Snowmobiles,Skies)_____
When would be a good time for a couple of us to come up for a visit?_____

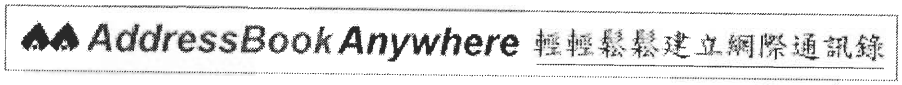
Great, I'll call you back with a date with which we can come up

Well it's been great talking to you. Thanks for you time and I look forward to talking to you soon. Thanks again.

Willingness to help (1-5)_____ Attitude I got from him/her on our project (1-5)_____

Time ended_____

Appendix D



Survey Name : Alpine Trail Safety IQP Survey
Survey Owner : WPI
Start Date : 02/12/2000
End Date : 04/14/2000

PLEASE READ FIRST

We are a group of students from Worcester Polytechnic Institute (WPI) working on a project about ski related injuries. By filling out this survey you will be helping us gather information that we will use to determine what causes these accidents and how to prevent them. We are interested in any input that you would be willing to give us. Any help would be greatly appreciated and we thank you for your time.

Choose the most appropriate answers (you may select more than one if applicable) for each question and fill in the blanks when needed.

-IMPORTANT- If you have never been injured while skiing/snowboarding, please skip the questions pertaining to those injuries, basically skipping to the end of the survey after question #8.

Leave your email address at the end of the survey to enter in the drawing for a FREE lift ticket to Wachusett Mountain. You email address will be kept confidential and will only be used for the purpose of contacting you if you win the lift ticket.

Single/Multiple Answer(s) Question:

1. What is your sex?

- ○ Male
- ○ Female

2. What is your age?

- ○ 17 yrs
- ○ 18 yrs
- ○ 19 yrs
- ○ 20 yrs
- ○ 21 yrs
- ○ 22 yrs
- ○ 23 yrs
- ○ 24 yrs
- ○ 25 yrs
- ○ Other: _____

3. What type of equipment do you use?

- ☐ Skis
- ☐ Snowboard
- ☐ Other: _____

4. Have you ever taken instructional courses (ski lessons)?

- ○ Yes
- ○ No

5. How would you rate your skiing style?

- ○ Cautious
- ○ Moderate
- ○ Extreme
- ○ Reckless and out of control

6. Do you wear a helmet?

- ○ Yes
- ○ No

7. Why or why not?

- ☐ Cost
- ☐ Don't like the way it looks
- ☐ Don't feel you need it
- ☐ Uncomfortable
- ☐ Other: _____

8. Have you ever been injured while skiing/snowboarding?

- ○ Yes, minor
- ○ Yes, major
- ○ No

9. What type of equipment were you using when you got injured?

- ○ Skis
- ○ Snowboard
- ○ Other: _____

10. At the time of your accident, how were you skiing?

- ○ In control
- ○ Out of control

11. At the time of your accident, what was your speed?

- ○ Slow
- ○ Medium
- ○ Fast
- ○ Extremely fast

12. At the time of your accident, what was your level of intensity?

- ○ Low
- ○ Moderate
- ○ Extreme (i.e. jumping, etc)

13. At the time of your accident, how were you skiing?

- ○ Carefully
- ○ Casually
- ○ Fooling around

14. What level trail were you skiing on when you got injured?

- ○ Bunny hill
- ○ Green circle
- ○ Blue square
- ○ Black diamond
- ○ Double black diamond

15. What were the trail conditions when you got injured?

- ○ Powder
- ○ Packed powder
- ○ Granular
- ○ Loose Granular
- ○ Icy
- ○ Slush

16. What time of day did the accident take place?

- ○ 8am - 10 am
- ○ 10am - 12pm
- ○ 12pm - 2pm
- ○ 2pm - 4pm
- ○ 4pm - 6pm
- ○ 6pm - 8pm
- ○ 8pm - 10pm
- ○ 10pm - 12pm
- ○ Other: _____

17. What was the weather like when you got injured?

- ☐ Sunny
- ☐ Cloudy
- ☐ Snowing
- ☐ Raining
- ☐ Sleeting
- ☐ Freezing rain
- ☐ Foggy
- ☐ Windy
- ☐ Other: _____

18. Was the trail too crowded when you got injured?

- ○ Yes
- ○ No

19. Did Ski Patrol come and help you when you got injured?

- ○ Yes
- ○ No

20. Who or what do you believe caused your injury?

- ☐ You
- ☐ Another skier
- ☐ Another snowboarder
- ☐ The mountain
- ☐ Mother nature
- ☐ _____

Comments/Feedback Question:

1. If you responded 'Yes' on whether you were injured (question 8), please describe the injury below

2. If you have any comments/questions about the survey, please write them in the box below

3. Leave your email address here

Submit

We are a group of students from Worcester Polytechnic Institute (WPI) working on a project about ski related injuries. By filling out this survey you will be helping us gather information that we will use to determine what causes these accidents and how to prevent them. We are interested in any input that you would be willing to give us. Any help would be greatly appreciated and we thank you for your time.

Circle the most appropriate answers (you may circle more than one if necessary) for each question and fill in the blanks when needed.

1. **Sex?** Male Female
2. **Age?** _____
3. **Do you use?** Skis Snowboard Other _____
4. **How many times a year do you go skiing/snowboarding?** _____
5. **How would you rate your level of ski/snowboard ability?** Beginner Intermediate Expert
6. **Have you ever taken instructional courses (i.e. ski lessons)?** Yes No
   If you answered yes then how many have you taken? _____
7. **If you own your own equipment, how often do you have it checked and maintenance done?**
   Yearly Every two years More than two years
8. **If you own your own equipment how old is it?** _____ Years old
9. **On average how often do you fall on a given day?** _____
10. **How would you rate your skiing style?**
    Cautious Moderate Extreme Reckless and out of control
11. **Do you normally wear ski goggles during harsh weather?** Yes No
12. **Do you wear a helmet?** Yes No
    If no, why not? Cost Don't like the way it looks Don't feel you need it Uncomfortable Other _____
13. **Have you ever been injured while ski/snowboarding?** Yes, minor Yes, major No

If you circled YES on the last question, please answer the questions on the back.

Briefly describe your injuries and what happened in your accident below.

_____

_____

_____

_____

14. What type of equipment were you using when you got injured?

Skis Snowboard Other _____

15. If you answered skis then what type are they?

Shaped Normal Race Other _____

16. If you answered snowboard then what type?

Downhill Freestyle Other_____

17. If you answered snowboard then what type of bindings?

Step-in Strap (or soft) Other _____

18. If you answered snowboard then what type of boots?

Hard Soft Other _____

19. Please circle the statement that best describes the way you were skiing/snowboarding at the time of your injury for a. thru d.

a. Were you In control Out of control In between

b. Your speed Slow Medium Fast Extremely fast

c. Your intensity Low Moderate Extreme (i.e. jumping, skiing out of bounds)

d. Were you Skiing carefully Casual Fooling around Jumping

Trying something new Other _____

20. What level trail were you skiing on when you got injured? Bunny hill Green circle

Blue square Black diamond Double black diamond

21. What were the trail conditions when you got injured? Powder Packed powder

Granular Loose granular Icy Other _____

22. What time of day did your accident take place? _____

23. What was the weather like at the time of the accident?

_____

24. What was the temperature like at the time of the accident? _____**°F**

25. Who or what do you believe was the cause your injury.

You

Another Skier/Snowboarder

Mother Nature (i.e. fallen tree branches, poor visibility due to snow or fog, icy conditions, etc.)

Other _____

Appendix F

May 4, 2000

Dear ,

On the behalf of my group, I would like to take an opportunity to express my gratitude. I would like to thank you for the time and effort you contributed throughout our visit at your mountain.

Your contributions towards our project were greatly appreciated and aided us towards our goal of determining the common factors involved in skiing and snowboarding accidents. In May, our project will come to a successful close. You are welcome to visit our website located at http://www.wpi.edu/~dustind/ to see the final report.

Without the assistance from all people who contributed to our project including yourself, we could have never accomplished our goals. Thanks again for all your time and effort.

Sincerely,

Christopher J. Tremblay
Worcester Polytechnic Institute
100 Institute Road Box # 890
Worcester, MA 01609

Appendix G

Q1. What is your sex?	
Male	230
Female	60

Q2. What is your age?	
17	1
18	59
19	86
20	62
21	59
22	18
23	4
24	1
25	1

Q3. What type of equipment do you use?	
Skis	243
Snowboard	83

Q4. Have you ever taken instructional courses?	
Yes	218
No	70

Q5. How would you rate your skiing style?	
Cautious	31
Moderate	167
Extreme	89
Reckless	4

Q6. Do you wear a helmet?	
Yes	17
No	273

Q7. Why not?	
Cost	53
Don't like the way it looks	54
Don't feel you need it	181
Uncomfortable	62
Feel safer wearing it	11
Other	49

Q8. Have you ever been injured while skiing/snowboarding?	
Yes, Major	127
Yes, Minor	18
No	140

Q9. What type of equipment were you using when you got injured?	
Skis	118
Snowboard	38
Other	2

Q10. At the time of the accident, how were you skiing?	
In control	106
Out of control	44

Q11. At the time of your accident, what was your rate of speed?	
Slow	18
Medium	68
Fast	51
Extremely fast	12

Q12. At the time of your accident, what was your level of intensity?	
Low	35
Moderate	62
Extreme	52

Q13. At the time of your accident, how were you skiing?	
Carefully	41
Casually	76
Fooling around	29

Q14. What level trail were you skiing on when you got injured?	
Bunny hill	5
Green Circle	16
Blue square	57
Black diamond	55
Double black diamond	17

Q15. What were the trail conditions when you got injured?	
Powder	11
Packed powder	38
Granular	19
Loose granular	19
Icy	57
Slush	5

Q16. What was the weather like when you got injured?	
Sunny	69
Night	14
Cloudy	44
Snowing	17
Raining	2
Sleeting	2
Freezing rain	3
Foggy	4
Windy	9

Q17. What time of day did the accident take place?	
8am - 10am	5
10am - 12pm	21
12pm - 2pm	29
2pm - 4pm	50
4pm - 6pm	14
6pm - 8pm	13
8pm - 10pm	12
10pm - 12pm	0

Q18. Was the trail too crowded when you got injured?	
Yes	24
No	125

Q19. Did Ski Patrol come and help when you got injured?	
Yes	41
No	107

Q20. Who or what do you believe caused your injury?	
You	98
Another skiier	16
Another snowboarder	4
The mountain	27
Mother nature	16
Other	14

Region of body injured	
Head	23
Shoulder	11
Arm	4
Elbow	1
Wrist	13
Hand	9
Back	10
Torso	6
Hip	2
Leg	10
Knee	20
Tailbone	7
Ankle	7

Appendix H

Q1. Sex?	
Male	77
Female	29

Q2. Age?	
1 to 10	1
11 to 15	9
16 to 20	43
21 to 25	2
26 to 30	12
31 to 35	7
36 to 40	12
41 to 45	4
46 to 50	4
51 to 55	7
56 to 60	1
61 to 65	0
66+	1

Q3. What type of equipment do you use?	
Skis	71
Snowboard	31
Other	2

Q4. How many times a year do you go skiing/snowboarding?	
Total	

Q5. How would you rate your level of ski/snowboard ability?	
Beginner	14
Intermediate	41
Expert	48

Q6. Have you ever taken instructional courses?	
Yes	70
No	34

Q6a. If you answered yes, how many have you taken?	
1 - 5	34
6 - 10	11
11 - 15	1
16 - 20	0
21 - 25	2
26 - 30	2
31 - 35	1
36 - 40	0
41+	10

Q7. If you own your own equipment, how often do you have it checked and maintenance done?	
Yearly	70
Every two years	13
More than two years	6

Q8. If you own your own equipment, how old is it?	
New	20
1 year	28
2 years	15
3 years	4
4 years	6
5 years	4
6+ years	13

Q9. On average, how often do you fall on a given day?	
Never	39
Once	11
Twice	20
3 - 5 times	21
6 - 10 times	8
11+ times	3

Q10. How would you rate your skiing style?	
Cautious	5
Moderate	45
Extreme	37
Reckless	3

Q11. Do you normally wear ski goggles during harsh weather?	
Yes	82
No	21

Q12. Do you wear a helmet?	
Yes	13
No	91

Q12a. If no, why not?	
Cost	6
Don't like the way it lo	13
Don't feel you need it	40
Uncomfortable	13
Other	13

Q13. Have you ever been injured while skiing/snowboarding?	
Yes, Major	12
Yes, Minor	35
No	57

Q14. What type of equipment were you using when you got injured?	
Skis	29
Snowboarc	16
Other	0

Q15. If you answered skis, what type were they?	
Shaped	6
Normal	14
Race	9
Other	0

Q16. If you answered snowboard, then what type?	
Downhill	1
Freestyle	14
Other	1

Q17. If you answered snowboard, then what type?	
Step in	1
Strap (or soft)	16
Other	0

Q18. If you answered snowboard, then what type of boots?	
Hard	3
Soft	13
Other	0

Q19a. At the time of the accident, what was you level of control?	
In control	34
Out of control	2
In between	9

Q19b. At the time of your accident, what was your rate of speed?	
Slow	5
Medium	13
Fast	16
Extremely fast	12

Q19c. At the time of your accident, what was your level of intensity?	
Low	11
Moderate	13
Extreme	22

Q19d. At the time of your accident, how were you skiing?	
Carefully	13
Casually	4
Fooling around	7
Jumping	12
Trying something new	5
Other	5

Q20. What level trail were you skiing on when you got injured?	
Bunny hill	2
Green Circle	1
Blue square	15
Black diamond	23
Double black diamond	4

Q21. What were the trail conditions when you got injured?	
Powder	4
Packed powder	15
Granular	4
Loose granular	4
Icy	18
Other	1

Q22. What time of day did the accident take place?	
8am - 10am	4
10am - 12pm	6
12pm - 2pm	8
2pm - 4pm	11
4pm - 6pm	6
6pm - 8pm	5
8pm - 10pm	4

Q23. What was the weather like when you got injured?	
Sunny	32
Night	4
Cloudy	1
Snowing	5
Raining	1
Sleeting	1
Foggy	4

Q24. What was the temperature like at the time of the accident?	
Below -20 F	0
-20 to -10	3
-9 to 0	1
1 - 10	5
11 - 20	10
21 - 30	12
31+	10

Q25. Who or what do you believe caused your injury?	
You	34
Another skier	5
Another snowboarder	4
Mother nature	6
Other	2

Part of body injured	
Head	8
Neck	3
Shoulder	6
Arm	2
Elbow	1
Wrist	8
Hand	4
Torso	2
Hip	3
Leg	8
Knee	13
Tailbone	3
Ankle	3
Back	1

Bill Mead Interview at Cannon Mountain 2/11/00

Given By: Christopher J. Tremblay and Jeff Marchese

What are the most common injuries that you see? (For Skier's/Snowboarders)

Probably knee… with skiers. And probably shoulders for Snowboarders that twist their arms.

What trail features are the most responsible for accidents?

I don't think it's so much a trail feature as it is a skier problem, they get in over their head. We try and do a lot of preventative stuff with marking and closing trails, opening trails, moving trails.

Yeah, we noticed that all the snow making pipes coming up have those plastic things on them.

What trail features are the most responsible for accidents? I'd like to say none, but it's not a perfect world.

How about stuff like, two trails are merging at too big of a degree, you get stuff like that. Or the woods are too thick between the two trails and they can't see as they're coming down.

Where we have intersections like that, that're blind, we will sign them. We don't sign them all, and where we see there's a problem or a potential problem we do what we can to prevent it from happening.

All the ones we've seen, though, they're pretty well marked. But that's basically what that company did… that (?) million dollars is they'll come in and do stuff like that.

That's part of it… also, you see a lot of wooden fences now where trails used to be we did reconstruction last summer. Those would have created intersections at degrees of angle greater than probably appropriate.

Now, those wooden fences, do those cause a hazard, like with people hitting those because they're hard objects.

We haven't had anybody hit a fence yet. Not one of those new ones, nope.

What is the average ski patrol to skier ratio?

Hard to say, it depends on what you get for a crowd on a given day. The staffing is based on the number of acres you have open, and how many lifts you have running, not so much what your anticipated skier flow it. Sometimes we get too many, sometimes we don't have enough. It's hard to staff on a day-to-day basis.

Do you think making helmets mandatory would result in decreased head injuries?

Wouldn't decrease leg and arm and wrist injuries but it's certainly decrease head injuries.

If so do you think it is feasible?

They haven't been able to do it with the motorcycle, so I don't think they're going to do it here. It's still a freedom thing.

Are there any common factors involved in skiing/snowboarding accidents? (I.e. weather, experience of skier, time of day, conditions, features on the trail)

Weather somewhat, visibility, people get in over their head. Cannon has a pretty good amount of experienced skiers, and I think that helps diminish our rates. Time of day certainly is a factor, as it gets on in the day it can get worse, and people get tired. I can't specify one trail over another one, it's all new this year because we've basically redone our whole trail system at least down at the bottom, and we're trying to gather data on that right now.

How could most of these accidents been prevented? And would it be cost effective for the mountain?

I don't think some are preventable. Release bindings certainly help a lot on the light stuff, but there's certain planes of fall where the vectors, the forces and stuff are such that nothing's going to release.

I read some articles about the new shaped skis, and how they cause more knee injuries.

I don't agree with that. The thing that's caused more knee injuries than anything is that boots keep getting higher and higher. You used to have an ankle high, or a little higher boot, you break leg bones. And now you force all the forces up into a knee. It's a lot easier to fix a leg than it is a knee. You engineering guys know that.

... dumb ACL crap...

What actions has your mountain done to prevent accidents? And have you seen direct results from them?

We're always monitoring the locations of accidents, and we try and determine what at any given location is causing those accidents and then if we can figure that out then we see what we can do to rectify it. We do a lot of preventative stuff with marking, grooming, fencing where we have problems. Signs. And we do some actual enforcement. We go out, either we, or we get some of our trail safety people get out and try to keep an eye on things. Especially in problem areas. You get fast skiers in slow areas and such.

Down at the bottom at the New-England club lift, the trail that's serviced by that is the old lower Cannon, which is a fairly wide trail and we've put up a barrier fence running the whole length of it from the top of the lift all the way down, and if you're coming down the mountain, the right side of the fence is for high-speed traffic coming down from above. The rest of it's fenced in because it's a beginner, intermediate area... and that's slow-speed in there.

So the fence is to keep the high-speed away from the...

Yeah, we use it for that and we also use it at some intersections to increase the visibility or to change the angle of intersections.

So you'd say that fences and signs are the best and least expensive ways to prevent accidents?

I can't answer that generally. It depends what the accident is and where it is. We try to group them into areas and figure out what the problem is.

What steps and procedures are taken when there is an accident on the mountain?

Dispatch a patroller initially to check it out, see what it is. He can make the assessment of what the injury is, and what resources are needed to get him off the hill. That could be a sled, one person to a team of six with some heavy-duty trauma equipment.

We've also started something here, that I haven't seen anywhere else. You know these little personal Motorola radios people carry. Well, we got a couple and we put up signs at the bottom of the lifts saying that we monitor channel 14 on that system, so we've got all these people with radios that can give us information. If they find something, they can let us know.

How often does mountain equipment contribute to accidents on the trails?
(I.e. snow making machines, lift posts, trail groomers, snowmobiles)

We don't allow equipment on the trails with the skiers. Once in a while they're still on in the morning, and we delay opening if we can or we close the trail until we can get them off. I've been here 32 years, and I can't recall the last time anybody hit a piece of machinery.

So do you see more skier to skier collisions, or like poles and stuff like that?

Depends on the conditions. Earlier this year when we were on the hard man-made snow. A lot of them would go off into the woods. When there's no snow in the woods it hurts, but when there's snow in the woods it'll slow you down and not hurt as much.

Has the large increase in the number of snowboarders caused a proportionate increase in accidents and problems at your mountain?

I thought it would cause collision problems initially because you're using two different speeds in the same place. The other thing with a snowboard is that both feet are hooked on the same way and their field of vision is limited because they're not on the fall line. They can't see behind them, only to one side. But it really hasn't been a problem

How about the snowboard parks, sometimes kids go in there and do stuff they shouldn't be doing?

We get a couple of them. We build different types of bumps and mounds and stuff for them to play on, and I think that's a factor. But that's what these guys want.

What would determine how high you make a jump or...?

I think there are standards, but I don't know. I'm not a snowboard guy.

Are you aware of alcohol and drugs playing a role in accidents?

Yeah. I think it's an age-group thing. Teens through late college seem to be the ones that are effected the most. Alcohol is obvious, you can smell it, but drugs we don't know. There's certain signs you can tell but we don't test for it or anything… but you can tell. I can tell if somebody's stoned. That's a no-brainer. How often that effects an accident, I don't know.

Does serving alcohol at mountain bars causes problems and if so what are your opinions on it?

I don't think that's created more or less of a problem than before we did it. We didn't do it before five or six years ago and there was some concern with that. But those who want to drink are going to drink anyways, whether it's from a six-pack in their backpack, or if they buy it from us. I don't think skiing and alcohol mix at all. Skiing is not that intolerable that you need a drink.

Ski Patrol Interview at Cannon Mountain 2/11/00

What are the most common injuries that you see? (For Skier's/Snowboarders)

Knees for skiers, wrists and shoulders for snowboarders

What trail features are the most responsible for accidents?

Natural features are trees, but man made are terrain parks. But the half pipe we don't get many calls there.

What is the average ski patrol to skier ratio?

Didn't ask.

Do you think making helmets mandatory would result in decreased head injuries?

We had three head injuries before we got a lot of snow in the woods. That if they didn't have helmets on the injuries would have been worse, wouldn't say death but it would have been worse.

If so do you think it is feasible?

We have liberties, it shouldn't be mandatory. Ya, live free or get the fuck out! I highly recommend it, we all wear them, except for one, I wear it because it is warm, this is a very cold mountain and kids should wear them. I cringe when I see a kid without one . I highly recommend it but lets not infringe on our rights.

Are there any common factors involved in skiing/snowboarding accidents? (I.e. weather, experience of skier, time of day, conditions, features on the trail)

Time of day more than anything else, sometimes you see knees in the afternoon when people get tired. Most of our calls come in after noon. The bewitching hours I would say are between one and two in the afternoon. In the past with older equipment there were different injuries, like with release bindings, which has helped change the injuries.

How could most of these accidents been prevented? And would it be cost effective for the mountain?

Educating the skier. That's probably the best way but we have certain hot spots where we put nets up, even with the renovations we have created some hazards, probably as many as we took out. That is what the pin board used to do for us, if we had 35 accidents in one spot we would go look at the spot and find out how we can make it better.

What actions has your mountain done to prevent accidents? And have you seen direct results from them?

Put fences up where they need to go and signage.

What are the best and least expensive ways to prevent accidents?

Didn't ask.

What steps and procedures are taken when there is an accident on the mountain?

We usually send a patroller down to find the accident, access, and tell us what we need. We have four different types of sleds (two trauma sleds, others with backboards). Here is a survey from the National Registry on our check protocol. (Enclosed)

How often does mountain equipment contribute to accidents on the trails? (I.e. snow making machines, lift posts, trail groomers, snowmobiles)

Not much, more of non-manmade things like trees.

Has the large increase in the number of snowboarders caused a proportionate increase in accidents and problems at your mountain?

No, I think our accidents have decreased here in the last three years. But that is due to more experienced snowboarders.

Are you aware of alcohol and drugs playing a role in accidents?

Didn't ask because we asked next question first.

Does serving alcohol at mountain bars causes problems and if so what are your opinions on it?

If people use their heads, it doesn't cause a problem. They have to realize that skiing is a dangerous sport. Just like driving a car. Maybe College students more than anyone but it is not a big problem. We have a much different cliental than other mountains. Others are destination resorts where they park their car on Friday and leave it their until Sunday. Here we get more skiers.

Have you seen that shaped skies cause more knee problems?

They can put you in a position where the Acl is probably easier to tear. I've seen more Acl's than before, because with less effort the ski goes into a turn. There is probably some credibility to that.

Other questions or notes

We noticed the wooden fences that are up, are those better than the net ones?

No, but most of the wooden ones are in places that are not in fall zones, people couldn't slide into it if they fell. I couldn't say all of them because we had one person fall into a wooden fence and but he got up and walked away from it. It wasn't the fences fault, it was the fact that he had had like eight to ten beers.

How come you don't have a pin map anymore?

Probably just because it has gone by the wayside, but I think its worthy to bring it back. But we have made a lot of changes here.

Is there any common factors in serious accidents?

Well, the biggest involves an immovable object, such as a tree. Speed seems to be the main factor. We have more skier to object rather than skier to skier collisions.

Have you had any serious accidents in the last couple of years?

A couple of serious ones, a death last year. But we had a serious injury last week, a prerelease into the woods.

How often do you see a serious injury?

Probably one or two serious ones. (a year)

Comments

At Attitash, we gave a guy a sobriety test before we gave him his ticket back to him. I work there two days a week.

We are kind of lucky, we are pretty close to a medical facility. We are close enough were when we get something that serious down, there is an ambulance waiting for us. But we could get a helicopter if we need it.

Snowboarders came around five to ten years ago and came right off the streets from the summer and haven't gone through a ski school regiment, where you learn the edict and codes. But I think they're coming around now. They were bad cutting off people and such but now they are better.

Ski Patrol Interview with Mike Hallaren (head of ski patrol) Wachusett Mountain, 2/17/2000

Given By: Christopher J. Tremblay and Jeff Marchese

What are the most common injuries that you see? (For Skier's/Snowboarders)

What trail features are the most responsible for accidents?

I don't think it's trail features, I think it's skiers that are not capable of skiing on the summit. I don't blame the features really.

Do you think trails can be designed that would lower the rate of accidents?

Yes. I think what we've done over the years, and people come to accept it, is that we groom so well that they get going too fast and tend to lose control. It doesn't take much, another person cutting in front of them or whatever. You have less injuries on trails where there's less moguls and turns. I was thinking the other day that the larger and more difficult you make a hit, it seems the less injuries you have. People are more cautious about going off of them, whereas if they look at it and are like, "I can do that" and they take off. Then they go too fast, they take the hit too fast, whereas if it's a large hit they tend to be more cautious and hold back.

If we didn't have such well groomed trails, the speed would be down. Speed is the main factor in major injuries.

What is the average ski patrol to skier ratio?

Yeah, it varies by day. It depends how many people are on the shift, how many people can work. Some days there might be 2 people here, during the day. At night we have a larger contingency of patrollers... part time. The guys during the day are the only full-time here. I have firemen that work...

I would say one patroller per 150 skiers or something like that.

Do you think making helmets mandatory would result in decreased head injuries?

No.

We got the same response in NH.

If I could give advice to anybody it would be snowboarders. They should wear helmets because they take such abrupt falls, it's not like skiing where you tend to slide when you fall. Snowboarders tend to go right over, and they tend to hurt their heads, and their wrists.

If so do you think it is feasible?

Are there any common factors involved in skiing/snowboarding accidents? (I.e. weather, experience of skier, time of day, conditions, features on the trail)

Time of day, probably late afternoon. And it's high-intermediate, or more advanced skier that has the more severe injuries. They tend to ski at a higher rate and if they have a fall… it's all related to speed.

How could most of these accidents been prevented? And would it be cost effective for the mountain, specifically these high speed ones?

We try to educate them, we have a "know the code", we have a "rewrite the code" contest, plenty of signs. We try to educate them… This is a great sport, it's unfortunate that people get injured at it. It's the only sport where you can really be free, and some people take it to the limits, unfortunately, and they pay the price.

What actions has your mountain done to prevent accidents? And have you seen direct results from them?

Like I said, we started the "know the code" contest, to make people more aware of the fact that there is a code. A lot of these snowboarders come into the sport from right off the street. Most of the skiers have come through generations of people skiing, so they are educated from a very early age. Snowboarders on the other hand are coming right off the street… and there's nothing wrong with that except that they really have no ski etiquette, they have no idea and it's really not their fault. Unfortunately they're the ones that don't read the signs or participate in the "know the code" contest, they're that kind of kid, that 13 to 20 year old. When the second generation of snowboarders come along, it's going to be a lot better. They'll try to teach their kids from their mistakes.

Has the large increase in the number of snowboarders caused a proportionate increase in accidents and problems at your mountain?

Well, to say they're caused by snowboarders… it would have happened if we had the same amount of skiers on the trail, but there are a lot of different types of accidents that take place now because of snowboarders. They have a blind side to them, and they don't always see the guy coming so they might turn in front of them. And like I said, they don't' have a lot of etiquette so, for example, when they pass me… an instance that happened to me a couple of weeks ago was I was skiing near the edge of the trail near the woods, and a snowboarder went by on the woods side. So I got to him at the bottom and I said "Hey, if I'd turned to the right, you would have been in the woods, or one of us would have been.", and he said "Oh, I knew where I was going." But he didn't know where I was going really. He assumed I was going to the left, he didn't know if I was going to go to the right. That's another thing… you can usually tell where a skier is going to turn because of his body language, but with a snowboarder, you just don't know. I try to stay away from them as much as possible. It's tough.

They say that it's tough to pass snowboarders because they go back and forth all the way across.

Yeah, and they don't use "on your right", "on your left", I've followed them before and if they're parallel to the trail, it's hard to say what side you're going to pass them on.
So getting back to what happened with that snowboarder who passed me on the left, I said "Why don't you let me know what side you're going to pass me on?" and he said "what do you mean?" He had no idea… so it's a matter of education.

What are the best and least expensive ways to prevent accidents?

What steps and procedures are taken when there is an accident on the mountain?

Usually we call up to the summit to the top of the minuteman lift, and we respond from there with a sled. During the day we usually send a guy down first and see if we need a sled, or whatever equipment. It could be a backbone, it could be oxygen, but we send a person down first.

And if there is a serious accident, do you transport them by ambulance... helicopter?

Ambulance. Helicopters don't... In the early years when lifeflite(?) first started. I think we might have had the first lifeflite... flight... I don't know if it was the first one or not, but they gave it to the kid for nothing, I know that. They landed out here and... it's really difficult to do because you need to clear the trail off. So what we do now is we transport to Princeton, the ambulance takes them there, and they transport them by helicopter. It's a logistic nightmare.

How often does mountain equipment contribute to accidents on the trails? (I.e. snow making machines, lift posts, trail groomers, snowmobiles)

Much more skier-to-skier. We don't have any... all of that stuff is marked pretty well.

The other thing is that the snowmaking equipment is high up, out of the trail so people don't have to get out of the way like you would if it were low.

Well, we have those too, but we mark them with bamboo and they're pretty obvious. Earlier in the year we make snow while people are skiing, but once we have enough base, we don't.

Are you aware of alcohol and drugs playing a role in accidents?

In recent years it's diminished. I know years ago it used to be more of an issue. I read the reports every morning, and there's usually never anything about alcohol involved, which is really great.

What happened years ago is that lifts were so slow that guys would drink beers, smoke a joint or something on the way up. Now they're so fast that they don't have time to finish a beer... so we don't really see a lot of it for the number of skiers we see.

Does serving alcohol at mountain bars causes problems and if so what are your opinions on it?

Not really, people come here to have a good time, and, good or bad, alcohol's a part of it so we really don't have a problem with alcohol. Maybe one time a year we have a problem where a guy is totally blasted, but it's not like going to a Patriots game where everybody's drunk.

About night skiing, what injuries do you tend to see?

Well, there's definitely more at night because we have a lot of schools coming up, and they're minor injuries. I don't know that these kids have ever got hurt before. When I was a kid I was hurt all the time… didn't you ever play football, baseball… you get in the head with a bat, you know. Now, they bump their head they're in here… it's amazing. It's nice to be cautious, but I think some of these kids are a little bit overboard. I think they spend too much time with the computer or something.

Interview Questions for Loon Ski Patrol

Chris: "What are the most common injuries that you see?"
Dan Healey: "Skiers is probably still knees follow by thumbs. Snowboarders, it's always wrists. Knees for skiers, ACL and MCL, then wrist injuries, sprains or breaks, most of the time we don't see the end result of whatever it is that we're packaging. When you fall and put your hand out like that…it's called the Gamekeepers thumb…Skiers fall and tear that ligament. Snowboarders always break their wrists"

Chris: "What trail features are the most responsible for accidents?"
DH: "The terrain park we try to keep a little bit separate, because those have man made elements in it and it has it's own level of difficulty and people in there taking the big air and it kind of changes the accident rate a little bit. I don't think there's any one specific element that's getting people. I've always found that most accidents have nothing to do with the trails, it has to do with skiers. It comes from inexperience, not knowing how to fall. Most accidents happen on our easiest trails, it's not a terrain issue, as much as the ability level. They don't know how to let your body fall. It's probably the groomed intermediate trails where the highest number of people get hurt on. It attracts the most number of people and people tend to ski better than their ability. Believe it or not we have so few incidents on our expert trails. Don't get me wrong, but we do have a just a fraction (of our injuries on them)."

Chris: What is the average ski patrol to skier ratio?
DH: "We typically have a sellout of 6000 tickets…and we would have about 22 patrollers here for 6000 tickets. Monday, Tuesday, Wednesday, and Thursday are out lightest days, actually Monday is a little bit higher because we have people that come Sunday and Monday, and Fridays we boost up, there's a lot of people that ski Friday and Saturday, you know people play hooky from work. Like today we might do 1000 tickets today and we have 10 patrollers including the dispatcher."

Chris: Do you think making helmets mandatory would result in decreased injuries?
DH: "A small amount, but head injuries is such a small amount to begin with. They just get big publicity. And would it save many of the people that get killed? Probably not. It would help a lot of the people that get headaches, people that fall and bang their head. Fantastic for that. So yeah it would reduce a certain number of them. We get about one a week, which is probably a concussion. Then there's all the different levels of concussion, from the one where you bang your head and get a little headache and saw some stars that's still a concussion, but you go on your merry way. And other times there's people who bang their head and black out for 30 seconds to a minute, something like that, but they're fine, they remember everything that happened before it and after it. The people that don't remember what happened, there's maybe one or two a month that we see. It's typically (from hitting) the snow. Especially on the terrain park, they go big air and overshoot the landing and come down. It's that acceleration when you hit the ground and

your head gets snapped down. Most of those people are fine too and some black out and wake up and have a hell of a headache.

Chris: "Are there any common factors involved in skiing/snowboarding accidents? (I.e. weather, experience of skier, time of day, conditions, features on the trail)"
DH: "I think that the biggest thing today is that people aren't as courteous as they used to be when they're out there, the way that they pass each other. People don't tell each other I'm going by on your right or I'm going by on your left, you know they don't talk to snowboarders and say I'm behind you and then there's collisions. That's the basic thing, people aren't as courteous as they used to be, everybody's in a big rush.
Jeff: SO skier collisions is a bigger problem than it used to be?"
DH: "yup. But snowboarders rarely collide with snowboarders, skiers collide with far more snowboarders, than snowboarders hitting skiers. Skiers hit skiers the most frequently. On a day like today, I don't expect to have any collisions but on Saturday and Sunday when we're sold out…the density fills up. Skier to skier collisions are typically on the intermediate trails and maybe even on an expert trail. The times when a snowboarder hits a skier, it's typically a better snowboarder on a beginner trail and it's interesting that snowboarders sometimes tend to gravitate to beginner trails and go a lot faster than you would normally go on the trail and they end up in collisions with the beginners. I don't know why they're drawn more to that terrain but they do. More so than the better skiers."

Chris: "do you think time of day is a factor in accidents?"
DH: "On a Saturday just for an example, we know that around 9am, there's people that come out that are still tired and not awake, we have a flurry of incidents. Then it quiets down until 10:30 to 11 and then just before lunch a whole big slew of crashes. And then again later on in the afternoon like around 3 when people get tired."

Chris: "How could most of these accidents been prevented? And would it be cost effective for the mountain?"
DH: "Certainly a lot of them could have been prevented with the development of the release bindings. Some of the stuff that we have put on our fixed objects, our awareness devices, but they're not designed to protect you but they do have zones of deceleration built into them, there's a hollow cylinder with a cover sheet over it. Kind of like the stuff you see on the highway now on the barriers, so when they hit, they compress you and we hardly ever pick up anybody that hits anything anymore. By doing that, that saves a lot. We get calls that somebody hit a lift tower and when you get there, they're gone. As soon as they hit it, they get up and ski away, they're fine. So by spending the money on that it does make a difference. The mandate that everybody wear a helmet, I don't think that you'd see, you know you'd see a small improvement, but the cost of that would be huge to make those available as rental stuff, cuz you're forcing everybody to wear it. Anything's doable if you have enough money."
Jeff: "What about just children?"

DH: "Well the thing is with them is that you're adding all that weight to their head and their neck muscles haven't developed enough to protect the cervical spine and you might all of a sudden start seeing a lot more injuries in their necks."

Chris: "What actions has your mountain done to prevent accidents? And have you seen direct results from them?"
<He gets those fun guides and hands them out and goes over it. He explains how they made those safety videos and sold them to the NSAA. They show it on their TV station. It's mostly on ACL safety.>

Chris: "What are the best and least expensive ways to prevent accidents?"
DH: "Educating"

Jeff: "Is the Tramway board oversee the signs?"
DH: "No, what happens out on the trail is pretty much between us and our insurance company"

Chris: "What steps and procedures are taken when there is an accident on the mountain?"
DH: "Well that all depends on the level of the accident. The basic, kind of first aid only incident, where a patroller comes down, say if somebody blew their ACL out, we pick em up and stabilize it and give them a good survey and take them down to the first aid room and fill out the NSAA form completely and … that's the documentation for that, it's the standard documentation for everybody who gets hurt. And then depending on the severity of it or what the circumstances were in it then we take it to a different levels of statement and whether we can back out"

Chris: "How often does mountain equipment contribute to accidents on the trails? (I.e. snow making machines, lift posts, trail groomers, snowmobiles)"
DH: "Excluding the elements that we make in the park, I would have to think that you're down in the tenth of a percent.

Chris: "Are you aware of alcohol and drugs playing a role in accidents?"
DH: "Very rare, maybe one a year"
Chris: "Does serving alcohol at mountain bars causes problems and if so what are your opinions on it?"
DH: "It's not a great idea but it hasn't been a problem so, it's a big portion a revenue for the ski area."

Jeff: "Since high speed lift lines have been put in have you seen an increase in accidents?"
DH: "I heard that when I first came here that there were a lot more accidents near the end of the day than there have been in the past. In my opinion I don't think so"

<when asked about trail merging>
DH: "Well we use ropes now with bamboo. When it looks like a smooth merge coming in, but in reality when people come along this tree line, they go 90 degrees across the traffic, so what we've done is that you take a rope that follows the tree line and comes down parallel to divide it to divert traffic more. You're extending the tree line, so that people can't cut across, but you're also allowing them to look over and see"

Interview Questions for Wildcat Ski Patrol

Jim Bilotta: "Pole rope barriers in the industry are not designed to be a barrier to stop anyone. They are designed to be a warning…they're never designed to stop anyone. Fences are usually on fixed objects being a padded 4X4 post or trees which are in question, you know you'd certainly like most fences protecting a real dangerous corner. It's hard to decide if you're doing something for one, to keep it uniform throughout all your mountain, and that's always a tough call that every mountain is having to grapple with and get uniform. I think we here at Wildcat have a reputation and tend to be very aggressive on what we open, the type of terrain, whether it be a lack of snow, natural terrain, bumps, we like to open all of those, we think we have an aggressive skiing mountain here and we get a lot of positive feedback, the way we do that is be really careful and uniform as to how we open these things, there's usually a gated opening with ropes and that gated opening would show, caution, thin cover, something to alert the skier that this isn't your natural terrain that you've been on all day. That's our approach here. I see a variety of things at other places. My experience is that the tougher the terrain and the tougher the conditions, the fewer the accidents. I think that the accidents, the severe accidents are caused by one thing and that's speed and reckless skiing."

Chris: "What is the average ski patrol to skier ratio?"
JB: "Our smallest number of patrollers would be five and that would be a 200 to 300 skier day. Today is a day where we probably have six on and there's 1200 people. This is unusual. On a normal Wednesday there would be five or six people on and there would be 800 people here. On weekends, we'll have 10 to 15 patrollers on with 2000 to 2200 skiers and those are the kind of numbers you get here at Wildcat. It's not a real busy mountain."

Chris: "What are the most common injuries that you see?"
JB: "The most common injuries for skiers would be knees and thumbs and head injuries, the toughest decision that we make is somebody who gets hit in the head and that is hitting the hard surface and this runs by way of the ski conditions, when the skier is firm, hard and fast and people falling and hitting their heads. And we have to evaluate these people in a very short window as to them losing consciousness, trying to piece together the mechanism of injury so that we can try to determine what we got here, and we have to make a decision to protect us, if you got a head injury severe enough to lose consciousness you may have a neck injury. And what does that mean for the EMT? They got to board them and let an emergency room doctor evaluate them and release them. It's very common here, we do a lot a precautionary back boarding here for that reason. Snowboarding, very very common for wrists and clavicles because when you first learn to snowboard you're always hooking up that front edge and fall forward and put your hands out and you're going to break your wrist."

Chris: "What trail features are the most responsible for accidents?"
JB: "I would say fresh snow, ungroomed snow for knees and fast packed and icy conditions for back and neck injuries."

Chris: "Do you think making helmets mandatory would result in a decrease in the amount of head injuries?"
JB: "My honest answer is yes but I'm not a big proponent in helmets because I believe the key is skier awareness and safety and slower speeds."

Chris: "Are there any common factors involved in skiing/snowboarding accidents? (I.e. weather, experience of skier, time of day, conditions, features on the trail)"
JB: "Weather conditions and time of day. Because late in the day when people get tired that's kind of a witching hour, 3:30-4 where you get a little bit more activity and I don't think you can separate them really, snowboarding and skiing accidents at that time of day. And the conditions, if we got fresh snowfall and difficult conditions um, that will increase a little bit but more of a minor category."

Chris: "do you think time of day is a factor in accidents?"
JB: "On a Saturday just for an example, we know that around 9am, there's people that come out that are still tired and not awake, we have a flurry of incidents. Then it quiets down until 10:30 to 11 and then just before lunch a whole big slew of crashes. And then again later on in the afternoon like around 3 when people get tired."

Chris: "How could most of these accidents been prevented? And would it be cost effective for the mountain?"
JB: "I think they can prevented by setting a presence on a busy Saturday, we try to do that where key locations on your mountain have slow banners, you have a presence but the patrol and you set a presence from 9 to 11 in the morning where you're out there and it's a very careful and delicate thing to patrol people's speed and all the mountains do it and you got to do it in a guest service, friendly way and it's for their safety and you'd be surprised what kind of precedence that will set…To me that's the best prevention. Good signage is another key thing, have you novice runs as long as you pay attention to the most and the time when you groom, we try to do that on the big polecat ride out here, if there's any question in the weather, we'll try to groom that at a time when that's your freshest, best groomed product. Because here on a very windy mountain you get out at 5pm the previous evening and they're done their grooming and you got a night of 60mph winds, it will just blow off. Then you get here in the morning and what you've got for the novice skiers is a nice icy trail. So we try to time our grooming so that our novice runs are in the best shape that they can be and have your signs set up accordingly."

Chris: "What actions has your mountain done to prevent accidents? And have you seen direct results from them?"
JB: "Here are two examples, one mountain I visited has remarkable snowmaking and earlier in the season they put such a quantity of snow in the middle of the trail and gets an incredible amount of snow that crowned from the middle out and when you fell you would literally slip into the woods. What we do here at wildcat is that the groomers make the trails from the outside in, and in the course of their grooming, cut into the edge bankments and when you ski around this mountain you actually see a burm on all the

edges of the trail. So when somebody falls and goes out of control into the woods they hit the ridge and it stops them. I've seen just the contrary at other areas. We have very few accidents on our ungroomed surfaces as opposed to our groomed surfaces, all the bad accidents happen on groomed surfaces, so basically less grooming is better. And the thing about helmets is that once they put a helmet on they think they're invincible and they tend to go a lot faster"

Chris: "What steps and procedures are taken when there is an accident on the mountain?"
JB: "Usually the reports will come to us by a person at the scene who goes down and reports an accident and that call will come to us and then we send out a patroller. He goes down and does his assessment of the injury and the equipment and personnel needed. Then that personnel and equipment will arrive at the scene and they'll treat and go to first aid from there. Our response time when the call comes in from the first patroller at the scene is roughly 3 minutes and 5 minutes for the equipment and second patroller if needed. If it's a real confirmed accident, ski school will call in and say I have so and so down here who twisted their knee, again that one patroller will go down will the equipment needed and that will be taken care of."

Chris: "How often does mountain equipment contribute to accidents on the trails? (I.e. snow making machines, lift posts, trail groomers, snowmobiles)"
JB: "Very rarely, we're very careful about machines on the mountain, I think we're very conservative when it comes to having grooming equipment on the mountain, it's almost never. If it's absolutely needed we'll close the trail it's on or escort the machine will a patroller, telling people there's a machine or something like that. Our snowmaking system isn't a system that's in place. Some mountains have all their guns right there and fire them up on the trail, our system gets moved around with projects and if there's anything left, near or around the trail it's often in the wood line. It doesn't come into play with accidents whatsoever."

Chris: "Does serving alcohol at mountain bars causes problems and if so what are your opinions on it?"
JB: "Yes. I can say it's been the result of an accident this year in particular, we've had at least 3 cases of very intoxicated people who could barely ski and had to escort them off the hill and basically baby sit these people. Personally I can recall an incident that was caused by excessive drinking or drugs but it goes on a lot, a little of it is a nuisance, I think it's a mixed message but every mountain has alcohol served at the mountain. But if its found in a controlled atmosphere I guess it's acceptable in our industry and it would be hard to change."

<When asked about the lack of padding on lift poles and gondola>
JB: "Well I think it's a huge concern to everybody. There's always much discussion about that, and my question to our insurance carrier was how do you feel about that and she turned the question right back to me and said 'do you have a system?' So all our groomed runs have padded towers, and all our ungroomed runs are not padded so there's a consistency to it. It was acceptable to her that that was the right way to go. Cost is the

issue; it's $110 for the pads now. It wouldn't be an issue to put them up and raise them and lower them and we'd do it in a heartbeat but the cost reasons is why we haven't padded anything. There's an exception to that here, it's not the best scenario but on one trail that is groomed by these big erector set gondola lift towers. What we try to do is have the groomers create a wall of snow to protect people from falling into them and that's what we have for those. That's the exception to our system."

<when asked about when fences are put up>
JB: "this is a very old design mountain, the new design have very wide highway trails with straight fall lines, the old design wiggles around many many spots where you could have a fence up and there are very good reasons. I think our fences up where we've had one or more very bad accidents."

Stowe Interview:

Given by Amar Clark
Interviewee: William Shaft, head of ski patrol for Stowe

AC: "What trail features are most responsible for accidents?"
BS: "Well, I wouldn't necessarily say that trail features are one of the bigger factors. Some of them that probably are, as far as trail features is the little rise in the trail where you can't see over the other side, or some of the little bumps that get built up. I think it's more some of the… I wouldn't necessarily call them trail features, but the conditions we had last Friday… it was really warm, 60 degrees sunny on Thursday… Friday it was 15 degrees. So everything froze up; it was all groomed, but it was just chopped up ice… so as people ski it, it just gets pushed into big piles of sand that you go into, kind of get hung up on then you're falling, you're stuck on something. So you get a little twisting going on, plus you're falling on something that's hard."

AC: "Can trails be designed that would lower the rate of accidents, and how?"
BS: "Well, to be a totally safe trail would have to be something that was absolutely straight."
AC: "So it would take the fun out of it…"
BS: That's right, you're taking the terrain and the everything else out of it."
AC: So there's an inherent risk.
BS: Yeah, there's always going to be an inherent risk.

AC: What would you say is the average patroller to skier ratio on this mountain?
BS: Well, it varies from day to day, you know, any weekday I have 15 to 17 patrollers on, that's paid patrollers. I might have a couple of volunteers on too. Our midweek would be, as far as people, anywhere from a thousand to 3000. Weekends tend to have a few more people on. There we could go anywhere from two thousand to you know…
AC: Five thousand, Ten thousand?
BS: Yeah. We kinda look at it not so much as a skier to patroller ratio, but more in terms of how much terrain is open.
AC: So more like a patroller to trail ratio.

AC: Do you think that making helmets mandatory would result in decreased injuries?
BS: It would help. Certainly we see a lot of the head injuries where, maybe if they were wearing a helmet… you can only guess but… maybe if they were wearing a helmet they might not have had the type injuries they did.

ACCIDENT FORM: (he was filling this out when a hurt kid came into the office during the interview)

Name, Height, Weight, Rate your ability,
Where were you? (terrain park)
Remember which jump were you going off of? (second one down)
Where were you hurt? (wrist)
Are you here with anybody? (friends)
Was this your first time in the terrain park? (no)
You went down there how many times today? (4)
Was today your first day? (no)
Ever hurt your wrist before? (no)

On any kind of medication?
Any allergies?
Medical insurance?
Do you have a multi-day ticket, or single?

He then told the kid's friends to go try to find the kid's parents, and the kid went to wait tin the lodge.

NOTE: He mentioned a doctor in Stowe that they send pretty much all of their accidents to… might be an idea for further study.

AC: All right… Helmets. So basically, you said that it depends a lot on the skier and the injury?
BS: It would help. There are a number of injuries that would be less serious of the person was wearing a helmet. There are a number of injuries where it wouldn't have helped at all.
AC: If you hit a tree going 35 miles an hour, a helmet's probably not going to help you no matter what.
BS: Exactly.

AC: Okay… Do you think that making helmets mandatory would be feasible?
BS: It would be a very hard thing to enforce. There's a lot of people who would be very persistent. Plus they're expensive.

AC: Do you think that there's any common factors involved in skiing and snowboarding accidents? Is there something that you see all the time?
BS: Well, there's specific injuries related to both. Obviously there's going to be some kind of overlap (between ski and snowboard injuries). As far as snowboards go, by far and large it's either wrist, arm or shoulder injuries, whereas the skier, it's more likely to be some kind of a leg injury.

AC: Is there any way that you think most of these accidents could be prevented, and would it be cost-effective to the mountain to do this?
BS: We have been for a number of years using the term "reduce the risk". That is what we are after. That's why we pad stuff, that's why we mark stuff, it's a big factor in whether we open or close trails. Our triple-A program that we have this year is all aimed at that.
AC: What's the triple-A program?
BS: It's to educate people so that they're more aware of what's going on out there. More aware of the conditions, more aware of the people around them, and while they're out there they have the right attitude so that everybody's friendly, everybody wants to have a good time. That's what we want. We want everybody to have a good time so if they go out there with the right attitude, that they're going to be courteous, that they're going to be respectful of other people, everybody's going to have fun.
AC: Okay, so the three A's are what? Attitude, awareness…
BS: …and accountability. So if you are doing something wrong, you want to be held accountable for it.

AC: What actions has your mountain taken to prevent accidents, and have you seen direct results from these things.
BS: It's hard to say… the amount of people who get hurt by hitting hydrants or towers… stuff like that, we've seen a decrease since we've marked them with bamboo and a disc. A lot of them

we actually put a shield around. We really have very few of those kinds of injuries compared to what we used to have. So marking (these features) one way or another has definitely helped.
AC: So these things have been beneficial, but it's hard to gauge exactly how beneficial?
BS: Yeah, as far as the number of accidents we've had it's been steady throughout the years. But in terms of those types of injuries have dropped.

AC: What are the best and least expensive ways to prevent injuries?
BS: Well, I think that what we have going this year with the patrol, with the hosts being out on the hill, we try to get the ski instructors more involved, trying to spread the word, the whole skier responsibility code. Just trying to get that message out.
AC: So basically, education.
BS: Yeah, education, communications and a couple of signs on the trail.

AC: What steps and procedures are taken when there's an accident on the mountain?
BS: Usually if somebody's hurt somewhere usually they'll have somebody come down to the base of the lift, or the customer service counter down here, and basically make a call. At the top of each lift, we have a room where we keep a certain number of people at all times. So the call goes into there, we try to get a location, description of the person and what their injury might be, and then we respond.

AC: How often does mountain equipment contribute to accidents on the trails? Snow-making machines, lift posts, trail groomers, snowmobiles.
BS: It's very seldom that you find those, I can't think of one in the last couple of years. We've never had a groomer-skier accident.

AC: Has a large increase in the number of snowboarders caused a proportionate increase in problems at your mountain?
BS: No, I wouldn't say so, despite the general feeling that skiers have, especially older skiers have toward snowboarders. We haven't seen a big increase in accidents at all.
AC: So just the type of accidents have changed?
BS: Right. We see a lot more wrists, dislocated shoulders, that sort of thing.

AC: Do you think alcohol and drugs play a big role in accidents?
BS: We've probably had a couple, now and then. But we don't really see much of that.
AC: Do you think that serving alcohol at mountain bars causes problems.
BS: We haven't really seen where it's caused a lot of problems.

Claire Wilmot Interview at Cannon First Aide on 2/11/00

DR.W "The problem is if you have a shiny helmet and you fall on a road with a shiny helmet you get a linear brain injury, if you have a dull one that catches the road with much higher friction you not only get the neck but you get your whole brain goes around in a circle so that you get…but I imagine it doesn't make much difference on snow because you hit and you slide on the snow…"

US "But if you were to hit a tree or something that is not slippery like snow it would make a difference?"

DR.W "No there is nothing …hitting a tree is kind of instantaneous…get a lot of deflection of huge trees I doubt it ever happens"

US "What are the most common injuries you see"?

DR.W "With ski injuries you tend to get the knee, with snowboarding slow people get the wrist fast people get their shoulders and then the head and neck, I had a guy that I just discharged…. put his fist in his belly… I thought he got his spleen but he actually got his ribs…a lot of the snowboarders are taught to fall like this so that they don't hurt their wrists but they land and hurt their ribs and body…thumbs wrists and ski poles….I had a guy with a spleen and a thumb about a month ago he got his thumb snapped back medial collateral ligament on the thumb and then he got his spleen…"

"The head injuries, since 1996 the ski patrol has been wearing helmets and I studied the whole of 1996 with one person with a head injury that was a 73 year old man who I think really had a severe intro cranial injury with the helmet, so I think he would have died if he hadn't had the helmet, the helmet didn't really do anything because it was so severe, that was are only one, so basically I discounted that one, 1997 I didn't do any study because I was so busy looking at 1996, 1998 and 1999 we studied them prospectively, 20 percent of the injuries that come thru the Littleton Hospital that have ski or snowboarding injuries 20 percent of them have an associated head injury, they are not all severe but I didn't brake up which were severe and which weren't, there were very few sever ones, in 1999 the same, with helmets the associated injuries were one in ten head injuries, so the helmets from my little tiny study cut the injury rate in half for head injuries. A girl yesterday fell down so hard she whacked her head, and she was wearing a helmet, whacked her head broke the clip off the helmet went bouncing down the hill, she had to go down and get the helmet, she finished snowboarding, she went snow shoeing afterwards, she felt fine, of coarse her neck hurts today, but if had not

been wearing a helmet even though it came off she would have had a severe head injury…"

US "If helmets were made mandatory would it decrease the number of head injuries"?

DR. W "It would definitely decrease head injuries I think that people have to I mean skiing carefully is the biggest thing. People don't ski carefully when they wear helmets, they tend to think that they are invincible so they ski faster….I think they are wearing more helmets because of sonny bono and Michael Kennedy…after Sonny Bono died the consumer products safety commission were asked by congress to do a study of head injuries. Their conclusion was that 44% of the people if they had worn a helmet would not have had a head injury, if they were under 15 it would have been 53 % would not have had an injury if they hurt themselves in the are that the helmet protects, now you have to wear a chin guard to protect the face."

"Ok we had a snowboarder, experienced snowboarder, 14 feet of air off the side of the trail and hit a tree on the way down"

US "Should there have been a net there"?

DR. W "It's a Black diamond, should there be a net there, probably there should be a net if people are going to do dumb things then you should have nets everywhere…"

"Heavy week because of vacation, there were 27 accident reports for the last week."

US "What do think about alcohol being served at mountains"

DR. W "I think that it is a ridiculous idea…. After lunch when people get sleepy just having a hamburger makes you sleepy…so after lunch people are tired their bodies are worn out…push push push, I think they should have half day ski passes, I think they make more money cause people do get tired and go home, but I think they should have half day ski passes so people really can leave the mountain without feeling they have to use up that whole pass…"

"I think they should have half day tickets. I think they shouldn't serve alcohol and I think they should just really make people pay attention cause they really could get hurt…"

Claire Wilmot Interview at Littleton Hospital NH 3/15/00

US "When most of the people wearing helmets fall and hit their head can't really tell because they just get up and ski away, if they don't have on a helmet and they hit their head then they come down and see a head injury, but they don't see all those people who fall and don't get an injury because they had a helmet on…"

DR.W "Exactly, that is why it is hard to see the positive effects of helmets…"

US "Allot of the mountain told us that they don't get many head injuries at all"

DR.W "We get the head injuries here (meaning at hospital), so the people get injured at the mountain but don't realize it until when they go home so the mountains don't hear about it…"

Went over data that she collected at Cannon Mountain on numbers of people wearing helmets on 7 test days. Based on tickets sold and data taken by lift attendants.

Some interesting facts from that study:

-No women on novice slopes had helmets on one particular day
-Overall women tend not to wear helmets
-Male and female Snowboarders tend to wear helmets more than male and female skiers

US "We have asked allot of the ski patrol at different mountains if mandatory helmets would help…."

DR. W "I think little kids should wear them…."

US "They always say ya it would be good but you can't do it and also not many people get head injuries so it would not do much…maybe you could get little kids to wear them but I don't think you could get everybody to wear them…One guy made a good point they can't make us wear them on motorcycles (New Hampshire) I don't think they are going to be able to make us on mountains."

DR. W "They are not going to be, you are going to have to educate to have many people…In Australia for ridding bikes, because they actually use bikes to get around rather than for recreation, they had five percent of the population wear helmets, it's a publicly funded medical insurance, so everybody got injured it came out of the publics pocket to heal them or just to take care of them for the rest of their lives cause they are vegetables. So then they did an educational push in

Victoria, which is one of the huge terotories, and um they got eleven percent compliance, and then they made it mandatory, they passed a law and they got seventy percent and it really cut down the number of head injuries…"

"…. If you get injured badly even if it is two people one of those people, which is fifty percent, will have a head injury. The worse the injury the more likely you are to have a head injury. So you cant say I'm not going to get into an accident cause if you get into a mild one…one in five will have a head injury. If you get into a bad injury one in two will have one."

US "What Mountains generally use this hospital to send their injured?"

DR. W " I would say ninety percent of our ski injuries come from Cannon, and then the other ten percent is taken up by Bretton Woods and Loon

US "Allot of what we have heard is that in a severe accident like when a death occurs there are multiple injuries like chest head…."

DR. W "right, that's what makes the numbers go up"

US "They were trying to use that to say that its not worth having helmets because they die from a number of things."

DR. W "That's not true because that young snowmaker at cannon, the only injury he had was an internal head injury, he did not break his neck he did not hit his chest he did not hurt his belly he did not break any arms or legs just his head and he died instantly…so they make a difference if you get a head injury…"

Doctor Wilmot went thru her power point presentation with us and explained it and answered our questions on it.

US "So why are they saying the percentages of head injuries is small?"

DR. W "Because they don't see that many on the slopes. They probably don't ask them if they have a head injury, if they have a broken leg they don't ask them if they have a head injury, they call it a broken leg and not a broken leg and a concussion…If you hit your head and your wearing a helmet you are more likely to complain of a sore neck than you are of seeing a concussion…"

"Shealy said helmets are going to cause more neck injuries, but what he is saying is that they are not causing the neck injuries its just you are paying attention to the neck because you not worrying about the head…"

US "The majority of deaths are caused by head injuries correct?"

DR. W "I would say it is included in it…we had six deaths last year I know that one died of an MI…heart attack, I think the other five died of head injuries, that was in New Hampshire…"

"I don't think it's all the mountains fault, I think it is the choice of the trail and then it's the whether you are a competent skier, a lot of people think that they are more competent then they are.

Appendix J
Dick Penniman:

Other Methods

An initial contact letter was sent to Dick Penniman Appendix K, a ski safety consultant. The purpose for the letter was twofold. The main reason was to see if he had published any other articles besides those that we had already read. The second reason was to make contact with someone else in the field. Up until this letter was sent, the majority of the people contacted were through ski resorts. It was thus desirable to contact someone who was outside the influence of the resorts. Mr. Penniman was a good candidate for this, because the two articles that were read of his gave some idea as to what to look for when visiting mountains. He also works as an expert witness in ski accident cases.

The letter itself was short and to the point. It starts with a brief introduction as to who we are and why the letter was sent. The main question, inquiring as to if he has published other articles that we may not have seen, was then asked. This was followed by a succinct closing which also asked for any other information he might be willing to share, thanked him for his time, and offered two methods for replying. Lastly a brief description of the project was attached for his reference.

Mr. Penniman would eventually respond via e-mail to this letter. He had been on the road for a while and thus hadn't seen the letter until he got back. He expressed an interest in the project and invited a phone call back so that it could be discussed and he could learn more about what was being done. Additional e-mails were exchanged in order to coordinate a phone call across several time zones and still fit into each person's schedule. Just when an appropriate time to call during the day was decided upon he had

to leave town again, so a phone call was placed the next day to his office and a message was left detailing the best times to call back. About two days later he would return the call, from Wyoming, and the project was discussed at length.

Judy Over:

Prior to the start of this project a letter was written to Judy & Steve Over Appendix M, who are friends with the mother of one of the group members. The reason for this is that they are involved in the National Ski Patrol and it gave the group an early direction to look for information off campus.

The letter opened with a brief explanation as to why the letter was sent. The rest of the letter was a commentary regarding what the general concept and direction for the project would be. It suggested two possible directions the project could head in. There are a couple inquiries throughout the letter regarding if they would have any interest in helping with the project and what sort of information they might be able to supply. In closing two methods of contact were given.

A brief note was received in their Christmas card regarding this letter Appendix M. This note made mention of the letter having been lost. Because of this a follow up letter was written and sent Appendix M near the start of the second term of the project. This letter acknowledged that the first letter had been lost but did not dwell on it. Instead it briefly reiterated what had been said in the first letter and moved on.

Since one term's worth of work had since been completed there was more that could be included in this letter. Hoping to better explain the idea for the project a brief two-paragraph summary was included; it was quoted from a contact letter that had been

written the term before. Based off of the note that had been received a new line of questioning was also introduced. The goal of this questioning was to better understand what the industry is guarded about and why. It was believed that this sort of information could be use to understand what sort of information might be obtained from within the industry and what subjects might need to be avoided when contacting resorts. The letter was then brought to a close, offering two possible means of contact, and thanking them for their time.

Stuart Thomson:

As it had been suspected, Mr. Penniman could not pass along any information relating to the work he had done relating to the project he was following up on. Mr. Penniman had suggested contacting Stuart Thomson and had passed along the necessary contact information. Mr. Thomson was whom the work had been done for and would thus be able to make a decision regarding what could be released.

A phone call was placed to Mr. Thomson's office. It had been hoped that through talking with Mr. Thomson information could be gathered relating to the recent redesign of his mountain's trails. It was found however, that calling him by phone would be quite difficult, as he is quite a busy person. We were given his fax number in order to send him a project description so he could review it and then give us a call back.

A fax was thus sent to Mr. Thomson's office. It started with a brief introduction as to who we are and what our project was about, followed by an explanation as to how we came to contacting him. A brief project description was included for his review. There were two main reasons presented to him as to why he had been contacted. The first was to inquire as to whether he had any information relating to common factors between accidents. The second was to find out if there was any information relating to the recent trail redesigns that he would be willing to release. Because we had acquired his contact information through another contact, an inquiry was also made as to whether he would

mind if his contact information was passed on to anyone who is to continue this project, or one like it, in the future. Mr. Thomson replied by phone within 48 hrs of receiving the fax.

Other Result

Penniman

The initial contact via e-mail was encouraging though brief. Mr. Penniman expressed an interest in talking about the project and finding out what was being done. He also offered to do what he could to help.

In preparation for his phone call a short list of questions and comments had been devised in order to make sure certain items were mentioned; however, the phone call its self ended up much more free form. It quickly became more of a conversation than any sort of interview. Both sides asked questions and talked freely. What follows is a summary of what he related.

When Mr. Penniman called he was actually working on a follow up to a project he had helped with some time earlier. The project related to a portion of our project. The project involved the redesign of a mountain's trails in the interests of safety. Possible hazardous points had been determined, based at least partially off of Mr. Penniman's articles, and the trails were reshaped accordingly. This was the first season the mountain was open since the redesign. It is therefor not yet know how successful this undertaking was, though initial results have shown to be encouraging.

Over the next several years there will be a study conducted at this mountain to observe the accident trends further. From this information the trails may be further redesigned, as new hazards become know. This study will also help to evaluate the relative value of this sort of trail redesign.

Mr. Penniman is an expert witness in ski accident cases. Upon being questioned about this, he dictated the general method he employs when called upon to investigate a ski accident in Appendix L. Upon completing the dictation he offered to review it for accuracy if a copy were to be sent to him via e-mail. This was done on 3/29/00 however a response has not been received as of this time. Part of this method made reference to his articles published in Ski Trauma and Safety. Our group had only read two of them, so he pointed out the third and offered to send us a copy if one was not already available.

As was mentioned earlier (in the methods section), Mr. Penniman needs to travel a lot because of work. It would be unfair to expect him to go out of his way to help out on a project such as this but he did anyway. When he called he was actually on business in Wyoming but had made it a point to take some time out of his day to call. If he hadn't, talking with him would have been delayed for another week or so, until he returned from his trip. As it turns out he had to travel some more when he finished up in Wyoming.

Perhaps the most useful thing to come out of contacting Mr. Penniman was not any particular piece of information he could share, for the letter was sent to him a bit late in the project and a response was not received until the start of the last term of the project. This was too late for anything ground breaking to come of it. The most useful thing instead might simply be that contact was made with someone in the field who showed enthusiasm towards the project. He expressed an interested in seeing the final result of this project and is also willing to work with other students if they wish to do a continuation of this project in the future.

Judy Over:

Judy Over sent a response via e-mail in appendix M regarding the second letter that had been sent. This response could be broken into two main parts. The first of which expressed further her inability to supply any information. This was not because her hands were tied but rather that "the National Ski Patrol (NSP) does not collect data on injuries or inherent risks on the slopes." She went further to say that the issues we appeared to be dealing with are considered 'operational'. That is to say that they are seen to completely by the ski resorts "and not controlled by any association."

The second part of her response gave a few directions to pursue in order to gather data that might relate to what was being looked for. She suggested contacting or otherwise looking into,

- The National Ski Areas Association
- Ski Area Management (magazine)
- Vermont Safety Research
- International Brain Injury Association
- Going to the actual resorts

She also included the necessary contact information where she could. Most of these suggestions were already being looked into by this time; however, it was good to know that what we had thought to look into was also now being suggested.

Stuart Thomson:

Once the fax had been sent there was little else to do but wait to hear back from Mr. Thomson. Thankfully he was quick to respond. He had made it a point to take some time out and contact us. He wanted to let us know that he was interested in hearing about the project and that our inquiry had not fallen on deaf ears. After getting a chance to further explain the project to him, he expressed that it sounded like a worthwhile task and

that it was great we were attempting such an endeavor. While he would possibly be interested in helping with future projects of this nature, he could not comfortably help with ours at this time. There were a variety of reasons for this. What follows is a brief recollection regarding some of what was said. None of what follows was quoted directly from him but is rather an expression of one group member's impressions.

The nature of the industry makes this a potentially harmful document. While it is just a term paper or school project to us, it involves his livelihood. Because of this he felt we might not be aware of the repercussion it could potentially have nor would we have to live with them once the project ends. Incorrect conclusions drawn from partial information could be worse than not having had the information to begin with. Regardless of how well the information you have supports a conclusion, it may be invalid if the information it was drawn from failed to consider all relevant factors. Such conclusions could actually be detrimental towards what it is this project would like to have accomplished. He would not want to be tied to such a conclusion, in case there is any fall out from it. A paper must demonstrate the following if it is to be considered credible within the industry.

- A well-documented method that is both sound and logical.
- A scientific approach from which all conclusions freely and clearly flow
- The data used must include are possible relevant factors.
- The conclusions must be sound and readily provable from the date.

Appendix K

Penniman's Letter

David Martin
Worcester Polytechnic Institute
Box #752
100 Institute Road
Worcester, MA 01609
2/22/00

Dear Mr. Penniman,

I am a student at Worcester Polytechnic Institute (WPI). A group of us have been working on a project relating to ski trail safety for the past few months. As part of our background research we read up on what we could find relating to the subject of ski trail safety. One such resource that was available at our Library was several volumes of "Skiing Trauma and Safety." Within their pages we have encountered multiple articles that you wrote which pertain to our project. I found, in the 12th volume, your "Customs and Practices at U.S. Ski Areas for Mitigating Common Hazards through Trail Configuration and Maintenance," which has proven to be among the most useful. We were therefore wondering if you might have articles in other publications that may prove useful and if so where we might be able to find them.

We are also open to any insight you may wish to share. I have enclosed a brief description of our project if you are interested. Thank you for your time and I look forward from hearing from you. You can contact me either by email at lost@wpi.edu or by writing me at the above address.

Sincerely,

David M. Martin

Please find attached a brief project description.

Appendix L

Penniman's accident investigation method:

1. Receive call from an attorney or injured party looking for an analysis as to whether to proceed with legal action or not.

2. Aquires a retainer such that he is guaranteed to get paid regardless of his findings.

    - The importance of this is that it helps guarantee impartiality on his part.
    - His getting paid doesn't depend on the case going to court.

3. Uses his three papers published in Ski Trauma and Safety as a standard guide as to things to take note of.

4. Asks for as much 'discovery material' as the prospective client can provide.

    - Video
    - Witnesses
    - Photos
    - Accident investigation reports, including diagrams of accident
    - Depositions
    - Manuals, written sources that establish mountain procedures

5. Goes to the site to get a feel for it.

6. Looks for a 'common thread' in all the material. What do all the witnesses agree upon? That is most likely the truth.

7. Figure out what else is most likely to have happened.

8. Render his opinion. Often has two scenarios:

    - It is often a case of victims vs. employees
    - Gives opinion on both

His job is to 'educate' the jury. This could be regarding:

- What mountain policy is vs. what was done.
- Whether or not mountain policy is adequate enough.

Appendix M
Correspondence with Judy and Steve Over

10/24/99

Dear Judy & Steve,

My name is David Martin and I last saw you approximately eight years ago when on a ski vacation in Colorado. My mother (April Mosher) gave me your address when it was suggested that you might be able to help me with a project at college. I'm currently in my Junior year at WPI (Worcester Polytechnic Institute) and I'm starting my second of the three major projects that are required to graduate. It's called the IQP (Interactive Qualifying Project).

Up until recently I only had one partner but now I believe there are about six of us working together. The topic for our project is broadly defined as "ski-trail safety." The whole group hasn't event met everyone else yet, so what everyone is looking to get out of this project hasn't yet been clearly established. However, I thought that, considering your ski patrol background, I might write to you in order to fin out if this project would be something you would be able to help us with (at least once we get a little more organized). The project will run for three terms, so I'll be working on it through the end of the school year (sometime in May).

Like I said the project hasn't been laid out too clearly just yet. I'd be happy to know what kind of things you might be able to help with. That is of course if this is something you would be interested in doing. No hard feelings if you can't or don't want to. I just thought I would bring it to your attention. Some possible directions the project will probably head in are:

1. Liability: Was the accident was the skier's fault or was there something the resort should have done.
2. Similar Circumstances: Were there any common factors between various accidents? Weather, ski conditions, trail design…

These are just two possibilities that might be explored. If you think this is something you'd be interested in helping with, I can be reached either by mail at:

David Martin
WPI Box 752
100 Institute Rd.
Worcester, MA
01609

or by e-mail at:

lost@wpi.edu

Sincerely,

David Martin

1/26/00

Dear Judy & Steve,

I wrote you a letter a couple of months ago in regards to a project that I would be starting soon. Well I'm now about a third of the way into it. I understand that you misplaced my earlier letter and that's fine. I also understand when you say that you don't know if you'll be able to be of much (if at all). I'm writing again in order to better articulate what it is we are trying to do and what we are looking for. Any help you may be able to supply would be greatly appreciated, whether it be written information, suggestions as to where to possibly find relevant information, or what ever else you might think of. Here's a portion of one of our letters. Hopefully it'll give you at least a brief idea of what our project entails.

"Each year numerous people get seriously injured due to skiing and snowboarding accidents. Even though recent studies have shown that in the past few years there has been a decline in the amount of these injuries, further reductions of these dangers would be desirable. We are a group of students from Worcester Polytechnic Institute (WPI) working on an Interactive Qualifying Project (IQP) aimed at mitigating these risks. The IQP challenges students to investigate and report on a topic that interests them. This topic should examine how science or technology interacts with societal structures and values. This IQP will attempt to bridge the technical and mechanical aspects of preventing ski injuries with the social and economic needs to prevent injury.

We have been looking at past accidents and what has been done to avoid them. Next we plan on visiting common accident sites in order to look for possible common factors between them. We will also be looking at what has been tried, if anything, in response to these accidents in order to make the trail safer. By doing this we hope to identify the most effective and practical methods of reducing these injuries."

You mentioned in your Christmas card (something to the effect) that you "really don't expect to be able to help much…because of the nature of the industry…" I don't recall off hand just what you said. If that is the case, could you write me a brief letter explaining "what & why"? That information could be just as valuable. It could help give us an idea of what kind of information we can expect to get (or not get) from the industry in general. Something else we're trying to look at is indeed "negative feedback." In other words, we're trying to investigate just how hard it is to get responses and why (Is it legal issues? Money? …). At the very least this kind of information could be of use when we actually start writing our report near the end of the year.

It was either Mom or Jim that had originally suggested that I might try contacting you, however, ultimately I don't know what exactly to ask you about. So I guess, with all that I've now said, is there anything that you think you might be able/willing to help with? Do you have any questions or things that you'd like clarified? I can be reached at school either by e-mail at lost@wpi.edu or at the below address. Messages can also be gotten to me through home (I believe you all ready have that contact info).

Thanks for your time.

Sincerely

David M. Martin
Worcester Polytechnic Institute
Box # 752
100 Institute Road
Worcester, MA 01609

Appendix N

Group Dynamics

Foreword

This foreword is given to explain to the reader the process of developing this group dynamics appendix. Originally this was supposed to express how our group, consisting of eight people functioned and interacted. It then became a discussion of the problems that the group encountered. The group felt it necessary to show the additional work that went in to the project, which would not be visible in the report it self. Background information was then deemed necessary and was added to compare with how the group functioned. In order to not dwell on just the problems encountered, it was decided to add in a discussion of the benefits of having 8 people. At the same time it was realized that one person's work regarding this discussion would be inadequate, no matter how impartial it was done. So, the group was surveyed to get each members opinions. The survey answers were then compiled and presented to each member of the group. Each member was asked if they agreed and their responses were recorded (See Group Survey). All that had been done was combined and summarized.

Introduction

Working with a group of eight members can have many benefits and detriments. Eight people is an unusually large group size for an IQP, so therefore it is these detriments and benefits which we are of particular interest. Following, we discuss our own group dynamics, and from that hope to find what worked and what should have been done differently.

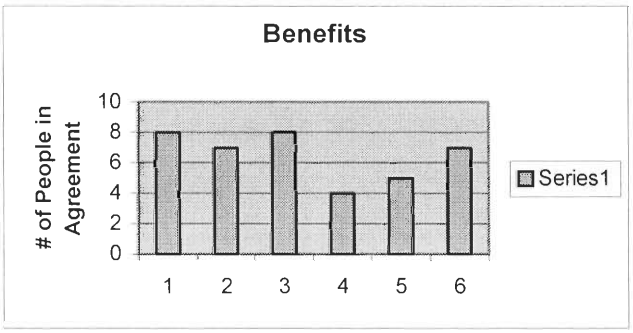
Group Survey Results

1. What benefits where there to the group being 8 people large?

The purpose of this question was to develop a list of what the group thought was advantageous about working with eight people on this project. There were six answers which members of the group came up with.

1) Could cover a broader range of information topics
2) Individuals could focus on specific tasks at a given time rather than working on several different ones.
3) There were many ideas and plenty of input from the group.
4) More fieldwork could be done (more places could be visited).
5) Research could be done faster.

6) There were a variety of strengths; each person brought something to the group that they were good at.



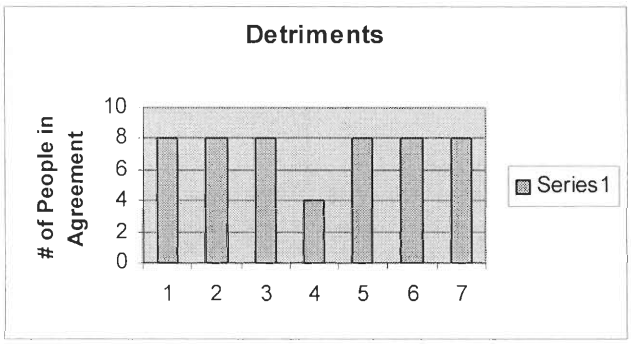
The agreement distribution associated with these statements is shown to the right. It can be seen at a glance that while 50 % or more of the group agreed with each statement; 'Amount of fieldwork' and 'Speed of research' were viewed by a smaller portion of the group to be a benefit.

2. What detriments were there as a result of the group having 8 people?

The purpose of this question was to develop a list of what the group considered to be detrimental regarding working with eight people on this project. There were seven answers, which members of the group came up with.

1) Finding meeting times.
2) Keeping focused and on track at meetings.
3) A difference in the level of work done by each group member (some people put less effort into their work, possibly because they didn't feel their portion was too important).

4) Organization and communication.
5) The amount of work to go around at times was not sufficient to keep everyone adequately busy.
6) It was hard to get everyone to agree on things.
7) Some people did less work then others.



The agreement distribution associated with these statements is shown to the right. It can be seen that except for 'Organization' the group unanimously agreed with all of the detriments. It should be safe to say, save for the noted exception, that these were all detriments encountered with this project.

3. What do you feel was the greatest problem our IQP group encountered?

This was perhaps the most important question. It was hoped that from it a general consensus could be found as to what the biggest problem was. There were seven suggestions.

1) Duplication of work because it was not well known who was working (or had worked) on what.

2) Getting everyone together

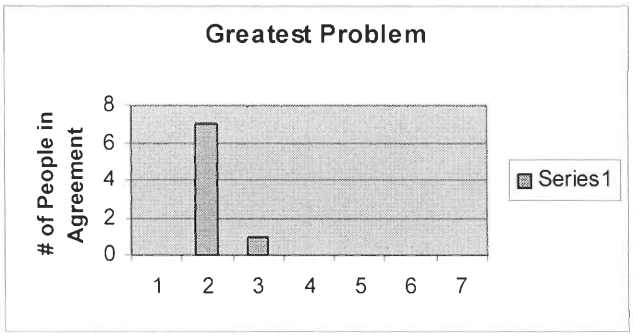
3) Keeping on track at meetings

4) Organization and Communication

5) Scheduling meeting times

6) People not doing enough work

7) Some people were harder to get along with than others



The agreement distribution associated with these statements is shown to the right. As hoped for a general consensus was identified. Seven out of eight group members agreed that 'Getting everyone together' was the greatest problem our group had relating to efficiently functioning with eight people.

4. Do you think the group was strong in any particular aspect? If so, what?

This was nearly as important of a question as the previous one regarding detriments, now that the scope of this portion of the project was interested in expressing some of the benefits of such a large IQP group. There were five suggestions made.

1) It was possible to gather larger amounts of data.

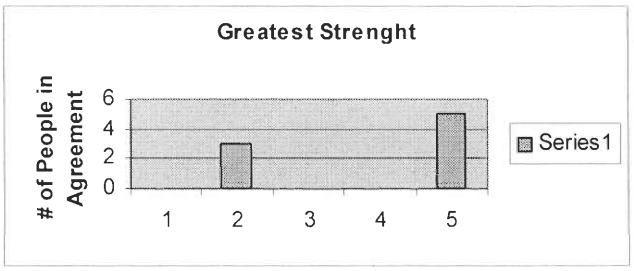
2) Could cover a broader range of information topics.

3) Fieldwork was thorough and well documented

4) Each topic could be investigated in greater depth

5) Work could be distributed based upon the strengths of each group member.

The agreement distribution associated with these statements is shown to the right. It can again be seen that there is a strong agreement. This time however there is a close second choice. It therefore can not clearly be said what the group's greatest strength was.



5. Would you work with 8 people again if you had this project to do all over again? If not, how many would you like?

With regards to this project being done in such a large group again, the group was for the most part in agreement. They were given Yes, No, or Maybe as choices. 75 % chose "No;" given the choice, they would not do this project again with eight people. The other 25 % chose "maybe," both sitting the stipulation that they would want to choose their partners, not just be given them.

When asked what size group they would have preferred to do this project in, the group was more diverse in its answers. Two people answered 3, three said 4, and three

said 6. Some had wanted to answer 3-4 but then chose what they ultimately felt would be better. This was also a somewhat ambiguous question, which may also account for some of the diversity in the answers. The question was open to personal interpretation regarding what constituted 'this project'. Mainly, it could mean one of two things. Either, it could mean "everything this eight-person group had chosen to look at and try to accomplish," or "a Ski Trail Safety project with goals and topics appropriately chosen for a different size group."

State of the Art and Background

A small group can consist of a many members, ranging from two and up. It is not the number of people in a group, which directly determines if it is a small group, but rather how it operates. This operation is directly based on face-to-face contact also known as interaction. A small group is made up of people who can communicate with each other often over a given period of time. The important factor is that each person is able to communicate with all others on a face-to-face level. In addition in order for a small group to succeed, they must share a common goal. This gives them a reason to work together. Every member of the group must clearly understand these objectives. (Verba 1961)

Leadership of a small group can either be directly appointed or not appointed. If a leader is appointed, they assume more of a coordinator's role. It is not necessary for them to argue to get their point because it is generally more accepted. On the other hand if a leader is not appointed it, is considered a non-legitimate leadership. They must fight

to get their ideas across because any directive attempt will be looked at as a challenge to other group members. If other members feel that someone is trying to assume leadership, they may feel threatened. Though they may go along in order to achieve the group's objectives there will be tension. Once they do get accepted as being a leader within the group, they can relax and there will be less tension. In the case where a leader is not assigned, the development of such leadership would have to go through three stages. First, members of the group must differentiate their activities from other members. Second, the other group members need to perceive this difference. Finally, the group members must come to regard the differentiated activity as right and proper. The first two steps usually happen with a small group, but the third rarely occurs because the group never bothers to deal with the leadership issue directly. (Verba, 1961)

Multiple people working together bring a greater variety of insights towards any given problem. If the differences of group members are seen as enriching rather than as conflicting, the end solution will be much better than a solution that any single group member would propose. Members of the group who have these differences need to come together and pool their information. It is these differences that lead to greater range of alternatives when solving a problem. Whenever a rapid decision is needed it is more practical to just ignore one side of an argument in order to move into action. This can easily work if less people are involved. (Tannenbaum et. Al. 1961)

For a group to function properly and obtain its goals, it is necessary for there to be clear objectives laid out. A complete statement of objectives must be translated into a specific set of instructions, which answers the questions of who, when, where, and how it is to be done. Objectives rarely remain constant; they are modified many times through

the course of a project. Initial objectives are usually hazy, and once some work is done to achieve those objectives there is a need to reshape them. This reshaping of objectives usually happens several times before the goals are achieved. (Tannenbaum et. Al. 1961)

Discussion

Finding a common time that eight students could meet together to plan and work on the project was difficult. Besides schoolwork, many group members also held jobs. We not only had to meet as a group on a regular basis, but we also needed to meet with our advisor at least weekly. The survey results clearly show that getting the group to meet together proved to be one of the biggest detriments of working with such a large group. A small group can successfully exist when all members can communicate with each other with face-to-face contact (Verba 1961), however due to the large numbers we were unable to accomplish this regularly. Email was used as a way to find free times and setup group meetings. With eight people we could never seem to agree on a time with this method. It was then decided to use another approach to schedule group meetings. One person would be responsible for collecting that group members were unavailable, and then overlaying them to find the time when the greatest number of group members could meet. There were almost always meetings that not all group members could be present.

Group meetings always ran well whenever they involved the advisor, which was on a weekly basis. However our own group meetings did not run as smoothly. There were multiple conversations going on at once, and the discussion was always going in

multiple directions. The Group Survey reveals that all of the group members were in agreement that keeping focused and on track at meetings was difficult for our group. It was something we all clearly saw as a problem. There was no leader of our group apart from our advisor. Therefore, there was no one to stem the side conversations and keep the meetings on track. In fact, whenever someone tried to assume a leadership role, the other group members did not embrace it. A leader who is not appointed must struggle to get their ideas across, while the rest of the group may feel threatened by this directive attempt (Verba 1961). As it was found necessary, if the group was ever to find meeting times and stay on track, a group member eventually emerged to handle such administrative tasks.

The group agreed that there were plenty of ideas and input to go around. The number of people working together brought a greater variety of insights toward any given problem (Tannenbaum et. Al 1961). On the other hand the group also agreed that it was hard to get everyone to come to a consensus. These conflicts often resulted in opposition in one form or another. Members of a group need to come together and pool these conflicts of opinions. It is these differences that will allow the group to be stronger and more powerful than any single member (Tannenbaum et. Al 1961).

Assigning and completing tasks to achieve our goal was also a problem. Our eight group members all felt that some people did less work than others and that the total amount of work was not always sufficient to keep everyone busy. In the beginning, our objectives were not stated as clearly as they were towards the end. As the project grew and matured, we developed hierarchy and Gantt charts to keep everyone on track and busy. For a group to function properly there needs to be a clearly laid out set of

objectives (Tannenbaum et. Al 1961). In our case, we could all clearly see the effects of not having a set of specific instructions in place. As these objectives changed, we became more successful at operation. It is normal for the reshaping and changing of these objectives before the end goal is achieved (Tannenbaum et. Al 1961).

Conclusions

Our group experienced problems getting everyone together. Not getting everyone together leads to lack of communication and potential problems. If the group had fewer members then there would have not been such a difficult time getting every together. The lack of leadership in our group resulted in chaos at meetings. There was no group member appointed to take charge as a leader, and therefore come meetings we has no one to take charge. An appointed leader to handle administrative tasks, and such would have reduced these problems. A great benefit to having eight members was the fact that there was always plenty of input and ideas. Every member brought different diversity in the task of solving problems we came across. Another positive part of our group dynamics was the use of different tools to help us achieve our objectives, such as a hierarchy and Gantt charts. If these tools were a little more defined in the the beginning of our project it would have helped, but it is typical for these sort of tools to sharpen as you end a project.