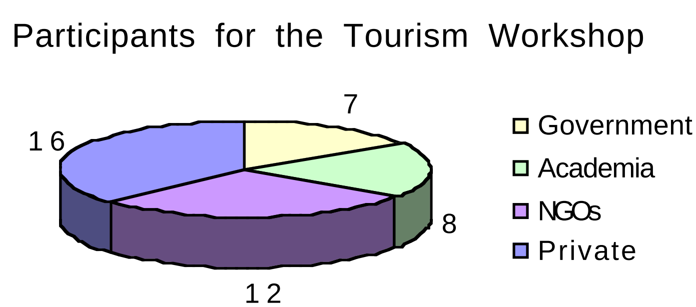
Climate Change and Winter Tourism of the Great Lakes Region: The Potential Impacts and What We Can Do

Climate change in the form of rapidly rising temperatures over the next century could have significant impact o n winter recreation and tourism in the Great Lakes region. Warmer temperatures and less lake-effect snow, for example, may significantly decrease annual snowfall in some areas, a trend that has already been observed in the past few years. While some communities and businesses may benefit from reduced snowfall, it will likely mean significant economic losses for the region's ski areas, winter recreation industries and the businesses they support. This workshop brought together people from the tourism community to discuss the latest science of how projected climate change in the region is likely to affect winter recreation and tourism and explore ways to address the issue.

Crystal Mountain Resort area, near Traverse City, is located close to many local businesses and stakeholders who rely on winter recreation and tourism. Hotel and restaurant owners, ski resort owners and operators, members from snowmobile clubs and other winter enthusiasts groups attended this workshop. There was a noticeable representation by local government, folks from various chamber of commerce, Convention and Visitor's Bureaus and other tourism organizations, such as *Travel Michigan*. Ongoing question and answer sessions throughout the meeting provided a forum for active feedback from the stakeholders. Unfortunately, there was a audio tapping error and there are no transcripts from this workshop. The following is a brief summation of the talks presented at this workshop.



How might climate change affect the Great Lakes region?
Peter Sousounis, Great Lakes Regional Climate Change Assessment, Michigan State University

Dr. Sousounis gave a similar presentation to the previous workshop audiences, explaining the work of the *Great Lakes Regional Assessment*, and explaining findings from the GCM output. Although temperature and precipitation were presented differently, which captured this audience's attention. Dr. Sousounis calculated snow days and snow depth for the Hadley and Canadian Models. Historically, snow depth was reported to be 80 inches per year, compared with 46 inches for the Hadley Model, and only 10 inches for the Canadian Model. As for number of snow days (when 8 inches or more of snowfall occurs over a 24-hour period), past records indicate the average is 32 snow days per year, whereas the Hadley Model indicates there will be 18 days and the Canadian Model suggests only 5 snow day for the year.

Dr. Sousounis concluded by summarizing that climate change in the Great Lakes region may be manifested by some of the following changes:

- Winds and storm tracks as well as by changes in temperature and precipitation
- Extreme hot days will occur at least twice as frequently
- Extreme precipitation events will increase in frequency and intensity
- Number of cyclones may decrease~15%; and windspeeds will decrease by 10%
- Interannual variability will also likely increase
- Magnitudes of the climate changes will likely have significant impacts on ecosystems in the region

What impact might climate change affect lake-effect snowstorms?
Ken Kunkel, Atmospheric Environment Section, Illinois State Water Survey

The Great Lakes not only are affected by climatic forcing on a large scale, they have effects on localized climate conditions, particularly downwind of the lakes. Locations in these areas experience enhanced snowfall in winter, warmer winters, and cooler summers compared to locations distant from the shoreline. This is illustrated by the climate conditions at two nearby locations, Green Bay, Wisconsin and Frankfort, Michigan. With prevailing northwesterly flow during the wintertime, Frankfort is located downwind of Lake Michigan, while Green Bay is upwind. Frankfort receives much more snowfall, particularly in the winter months of December, January, February, due to the lake-effect snowfall phenomenon. For example, in January snowfall at Frankfort is more than double that of Green Bay.

The lakes have these effects on local climates because the water temperatures of the lakes respond more slowly to changes in seasonal solar forcing than do the surrounding land areas. Dr. Kunkel showed a graph of air temperature at Milwaukee compared to the Lake Michigan surface water temperature near Muskegon. During the spring and summer, the air temperature over the land warms more quickly than the lake temperature. However, in the fall and winter the lake temperature drops more slowly than the air temperature and thus remains warmer than the surrounding land.

The lake-effect snowfall phenomenon results directly from these differences in temperature between the land and the lake surface waters. In the late fall and early winter, cold frontal passages from the north and northwest bring in air that is much colder than the lakes. As this cold air passes over the lakes, it is warmed and moistened by the warm lake surface waters. Snow forms in this warmer and moister air, which is still cold enough for snow, and is then deposited on the lee shores of the lakes

Ken Kunkel briefly describes the results of the study that he did as part of the *Great Lakes Regional Assessment.* The study was on lake-effect snow, but in particular focused on heavy lake-effect snowstorms where 8 inches or more of snowfall occurs over a 24-hour period. The initial focus of the study was on Lake Erie, but we extended the results to Lakes Superior and Michigan.

The first part of the study identified the weather conditions that were associated with historical heavy lake-effect snowstorms. Four weather conditions were nearly always present with these storms. The first condition was that the surface air temperature was in the range of 14 to 32ºF. It is obvious that temperatures at or below freezing are needed to have snow. However, it is also important that temperatures are not too cold. When temperatures are very cold, the atmosphere cannot hold as much water and is not as favorable for heavy snowstorms. As noted before, lake-effect snows occur because the water temperatures are warmer than the air temperatures. The difference between lake surface temperature and air temperature was greater than 13ºF during these heavy snowstorms. The third condition was high wind speeds, specifically greater than 14 miles per hour. Finally, the wind direction needed to be such that a long passage of air over the lake occurred, allowing for a long period of time in which the air could be moistened and heated.

As described in the previous talk, two future climate simulations, one from the Hadley Centre climate model and the other from the Canadian Climate Center model were used. The differences in the frequency of those four weather conditions that were associated with heavy lake-effect snowstorms were studied. Dr. Kunkel examined the differences in frequency between the present period and the end of the 21st Century.

Some of the differences in the way these two models are constructed described. Climate models break the atmosphere into boxes and determine values of weather conditions for each box. The boxes in the Hadley Centre model for the atmosphere are smaller than those in the Canadian model. Thus, for the Hadley Centre model there are more boxes representing the Great Lakes and thus somewhat more detail is available.

However, the models also need to simulate circulation patterns in the ocean because of the importance of coupling between the ocean and the atmosphere in the climate system. The boxes in the Canadian model for the ocean are smaller than those of the Hadley Center model. The models also need to treat the land surface, and this treatment is more sophisticated in the Hadley Center model than in the Canadian model. These model differences lead to different projections for the future.

Dr. Kunkel found that the Hadley Centre Model projects a more than 50% reduction in the frequency of heavy lake-effect snowstorms by 2100 while the Canadian Model projects more than a 90% reduction. This reduction is almost entirely due to warmer winter temperatures. The Hadley Center Model projects a 5ºF warming for winter by 2100 while the Canadian Model projects a 10ºF warming. The frequency of the other conditions that are associated with heavy lake-effect snow did not change very much in the future. Because these other conditions did not change but temperature did change, we expect that there could be an increase in lake-effect rain that would occur instead of lake-effect snow.

These were the results for Lake Erie. When we extrapolated the results to the other lakes, we found that the decrease in heavy lake-effect storms was about the same for southern Lake Michigan as for Lake Erie. However, we found a much smaller decrease for the Lake Superior snow belt, only about 10% for the Hadley Centre model projection.

What confidence do we have in these results? Although there are differences in the model projections, these two models (and all other climate model simulations that have been done to date) indicate significant warming over the Great Lakes. Since temperature was found to be the key factor in this study, it seems that the eventual decline in the frequency of heavy lake-effect snowstorms is highly likely.

There are potential compensating effects, particularly related to ice cover. Lake-effect snow is greatly diminished once ice cover develops. With a future warmer climate, it is highly likely that the duration of ice cover will decrease. Thus, there may be a longer season for lake-effect snow, which could wholly or partially compensate for the warmer temperatures. Our results for the end of the 21st Century did take this into account. However this could be an important compensation in the early portion of the 21st Century, which we did not examine.

Since this study indicated that air temperature is the key element, we performed a simple analysis of what could happen in the future based on historical climate data for the Great Lakes region.

This provides some insight into possible future outcomes. This analysis assumes that, as temperatures rise, the day-to-day variations remain the same. This assumption may not be valid but the analysis of the two climate model projections did not indicate significant changes in variations.

In this analysis we used a north-south transect of sites from Benton Harbor near southern Lake Michigan to Traverse City near northern Lake Michigan to Iron Mountain in the Upper Peninsula to Houghton near the shores of Lake Superior.

This graph shows the day-to-day variations in daily air temperature at Benton Harbor for a typical winter season for November through February. The horizontal green lines show the temperature range in which heavy lake-effect snow typically occurs. During December through February there are many days that are within this range. There are very few days that are too cold for heavy lake-effect snow while there are many days that are below freezing by only a few degrees. One very simple scenario for future warming is that the day-to-day variations in temperature remain the same but every day simply becomes warmer by some increment. The example I will show is for a future warming of 7EF. In this scenario each day in this record simply becomes 7ºF warmer.

The next graph shows what happens when we add 7ºF to each day. In this case, many of the days that were within the heavy lake-effect snow band are now warmer than 32ºF. The few days that were too cold for heavy snow now become favorable for heavy snow but they are much fewer in number than the days which now are too warm for heavy snow. Thus the number of days favorable for heavy snow has decreased substantially.

The next graph shows a typical year at Houghton. Winters are colder at Houghton. There are many days during the winter when temperatures fall within the range associated with heavy snow. But there are quite a few days that are colder than this range.

When we add 7ºF of warming, some days that were in the heavy snow range are now too warm for heavy snow. However, this is largely compensated for by the days that were too cold that are now within the heavy snow range. Overall the number of days in the heavy snow range does not change very much.

This is illustrated in the next graph that also shows the results for Iron Mountain and Traverse City. This shows the number of days in the heavy snow range for current climate conditions (0 on the horizontal scale), and then for various degrees of warmth, up to 10ºF. At Benton Harbor, each degree of warming decreases the number of favorable days; by the time we reach 10ºF of warming the number of days has decreased by more than half. By contrast, at Houghton, the number of days decreases very slowly for every degree of warming; by the time we have reached 10ºF of warming, there has been a decrease, but only about 20 percent. The results for Traverse City and Iron Mountain are intermediate between the Benton Harbor and Houghton decreases.

Since this study was performed, new climate model results have become available, one from a newer version of the Hadley Center model and another from a U.S. model. These projections are consistent in indicating significant warming in the Great Lakes region.

This slide shows two of the temperature projections from these models for the winter. Both project substantial warming by 2100. One way of thinking about climate change is that a warming is equivalent to a movement towards the south to warmer climates. Taking one of the warmer projection from the newer model results, how far south would we need to move in today's climate to find similar temperatures?

This next graph shows the answer. For this projection of the future, this is equivalent to Michigan moving south to Arkansas, a radical change in Michigan's climate.

In our assessment study, we did not examine the effects of climate change on total snowfall. However, an examination of past historical data can provide some guidance. This examination shows in general that warmer winters are generally less snowy.

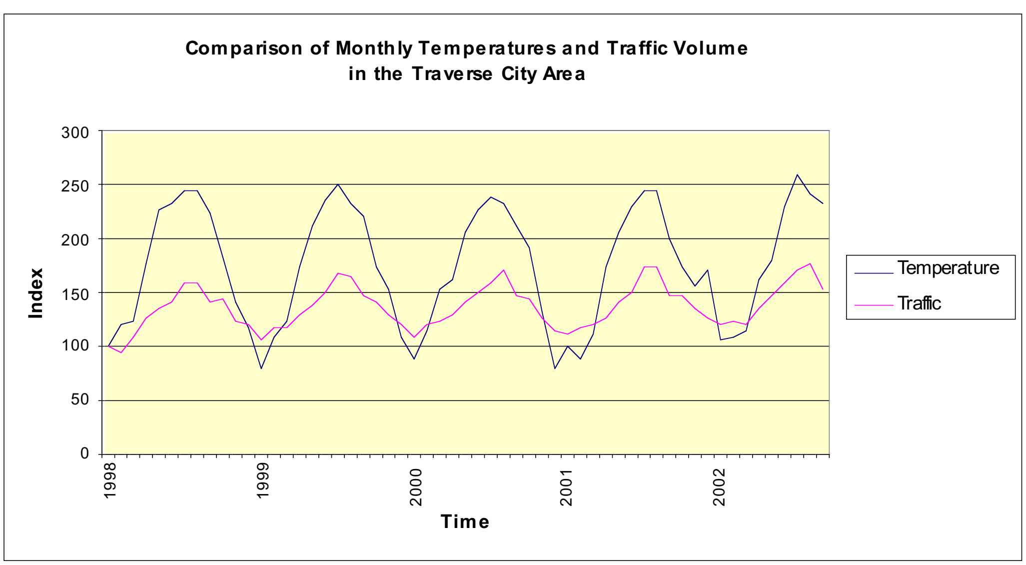
This is illustrated by historical climate data for Traverse City. There are about 100 years of data for Traverse City and in this graph each dot shows the data for one year. November through March snowfall is plotted against November through March air temperature. Although there is a great deal of scatter in the historical data, in general the low snowfall years tend to occur with warmer temperatures while the higher snowfall years tend to occur with colder temperatures. The straight line is the best fit to these data and it shows that there is about a 25% decrease in average snowfall for every 5ºF warming.

To conclude, the models suggest that during the 21st Century heavy lake-effect snowstorms will dramatically decrease in frequency in the southern portions of the Great Lakes basin. However, changes in the northern portions of the basin may be much less. Warmer temperatures cause these changes almost entirely; other conditions favorable for heavy snow do not change much in the climate models. We were not able to examine the speed which these changes will take place. So there remains an important question. Will decreased frequencies begin to occur early in the 21st Century or later? Even if the decreased frequencies do not occur until later, the models do show warming in the early part of the 21st Century, so mid-winter melting events may become more frequent, even if total snowfall does not change.

What might be the impacts of climate change on tourism in the Great Lakes region?
Don Holecek, Department of Park, Recreation and Tourism Resources, MSU

Dr. Holecek began his presentation by briefing the audience on some of the statistics in tourism and travel in Michigan:

- Primary Mode of Transportation on Michigan Pleasure Trips: 96% by private vehicle, 2% air, 2% bus
- Origin of travel to Michigan with scope of study: Indiana 9%, Illinois 8%, Ontario 6%, Wisconsin 9%, Ohio 10%, Michigan 58%
- Purpose for trips in Michigan: recreation 48%, 37% visiting relatives, business 9%, other 6%
- The season pleasure trips occur: 41% summer, 26% fall, 16% winter, 17% spring
- The graph below shows the relationship between temperature and travel in Traverse City area



In 1995, Michigan resident travelers to other U.S. destinations spent over $1.5 billion more than U.S. visitors from other states spent in Michigan. Had this $1.5 billion been captured by Michigan's tourism industry, it would have created about 30,000 jobs for Michigan residents. Impacts of a warmer climate on tourism might have benefits, such as improved road conditions, longer warm season (more golf, angling, trail use, beach visits, boating), and extended second home season. Other impacts of a shorter snow season in northern Michigan would possibly mean a shift in winter sports to western Upper Peninsula and out-of-state. Also, a longer "brown/mud" season is less appealing for pleasure travel.

Climate Change Coping Strategies in the Tourism Industry

- Counter inconsistent weather patterns with more accurate and timely conditions reports
- Adjust timing of promotional message to fit markets' reduced trip planning horizons and existing weather conditions
- Expand non-weather dependent offerings – spa, exercise equipment
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How might a Changing Climate affect Snowmobiling? (No snow, No dough$)
Bill Manson, Michigan Snowmobile Association

Bill Manson presented state and national facts about snowmobiling that appear on the Michigan Snowmobile Association web site:

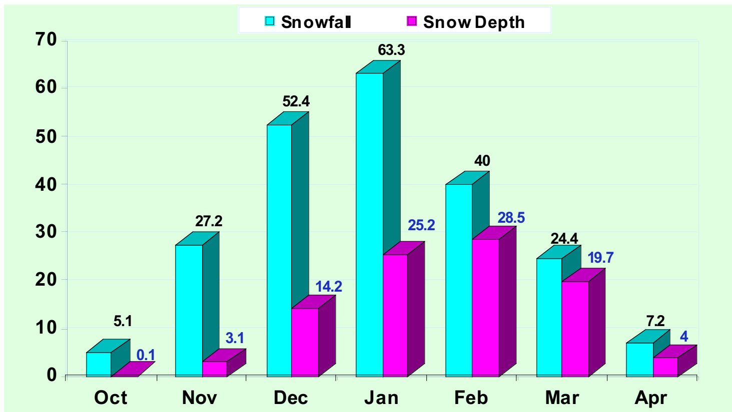
- Total economic impact of snowmobiling in Michigan alone is over $1 billion
- Michigan has over 6500 miles of marked groomed trails
- Over 15,000 new snowmobiles were sold last year at an average price of $6,800 – and of that, over $100 million in new machine retail sales
- The average Michigan snowmobiler spends $4,218 annually on snowmobile activity, equipment and vacations in the state
- 65 Michigan clubs and business groups groom over 6000 miles of trail

Mr. Manson also described the impacts of climate and snow on 2001-2002 season:

First, snow did not happen until December 23, 2001. All the lake-effect snow areas received a large amount of snow, but there was insufficient base for snowmobile riding as it was pounded into "snert" (a combination of snow and dirt). By January 5, 2002, the cold air quit and the lake-effect machine lay dormant until mid February. Clubs were wondering how they were going to make the groomer payment, motel owners and restaurants were wondering how to pay the bills. After the second week of February – it started snowing! Northern Michigan snowmobile trails were opened and groomed until mid-March. All the Upper Peninsula snowmobile trails were open until the second wee of April.

Winter Technology in Upper Peninsula
Jay Meldrum, Keweenaw Research Center, Michigan Technological Institution

Dr. Meldrum gave an idea of how much snow they see in the Upper Peninsula with the graph below:



His talk introduced the technologies used t o handle large amounts of snow and groom trails such as anti-icing coatings, elastomeric overlays, but focused on the "Keweenaw Snow Paver" which may be mass-produced in the future and could possibly help with snowmobile grooming. He also promoted an annual event at Michigan Technological Institute, called the SAE Clean Snow Challenge. This student competition focuses on the re-designing of snowmobiles for better emissions and noise levels while maintaining current performance characteristics. He also showed pictures of a museum and coffee bar made out of snow at an event by Michigan Winter Citites in Houghton, Michigan.

How does Crystal Mountain Adapt to a Changing Climate? (or Why Christmas should be on January 25th?)

Michael Call, Winter Operations, Crystal Mountain

Mike Call, Manager of Operations at beautiful Crystal Mountain is responsible about everything, but one of the things he has to deal with in his job is climate variability. His talk focused on the implications of climate change in terms of managing some of the ski resort operations it impacts.

I'm not going to try to deal with regional or national climate change but just what we've seen here and what we may be expecting in the future. And I'd like to try to show how, obviously being a ski resort and a golf resort, the weather is very critical for us without which we don't exist actually. Crystal is now a four season resort which differs to how it began as a community ski club back in 1950-52. And this area was chosen, not only for the hills, but for its snowbelt location.

And this is what it all stems from. Our great water off to the west is Lake Michigan. It is part of our local consciousness almost; that the lake is always there. It is why we stay warmer this time of year, it's why we stay colder in the spring, and it's why we're humid all year long. It's a temp riser as some of the temperature graphs we're showing. It makes everything wag the air temperatures that the rest of this region sees. The closer you are to the lake, the more predominant that is.

This picture, shows lake effect snow but it is lake-effect snow banding coming right off of Lake Michigan. Crystal Mountain, is at the southeast corner of Benzie County, and the band of snow is coming directly toward them. Lake-effect snow, that it can be very localized. For example Beulah, Benzonia, which is closer over to the coast and only 7 or 8 miles away, typically will get about half as much lake-effect snow as Crystal Mountain does throughout the season.

Mr. Call showed a slide on snow making particulars which if temperature is 28 degrees F or less and humidity is less than 85% then snow is made and as temperature and humidity go down there is an exponential increase in the amount of snow that can be made. Their snow is made with high pressure pumps that pump water at the base of the mountain up to 400 psi so that we can get up to at least 100 lbs at what is called snow guns at various places on the hills. At the snow gun we mix small amounts of compressed air with finely atomized water which form ice nuclei which is the same thing that happens up in the clouds. Distilled water doesn't freeze until you hit something like -40 degrees Fahrenheit. So we are forming our own ice nuclei so that we can then inject larger amounts of water to form to this ice nuclei to make not really snowflakes but more like snow pellets. We then use large amounts of fan cfm of air to blow this mixture of water and air up into the air and give it what we call "tank time." If you have enough tank time with a low enough temperature you'll get snow. And for us that means 28 degrees or less at 85% humidity or less. We translate that into a dew point of about 25 and that's where we say that we can start. And as the temperature and humidity go down there's exponential increase of the snow that we can make.

Crystal has 87 snow guns and we pump 44,000 gallons a minute. That translates into an acre foot of snow in 2 hours at 27 degrees or we can actually do it in 34 minutes when it gets down to 20 degrees. So you can see that there's an exponential increase. And theoretically, although we never use it this way, we could cover the whole area in 4 days with a foot of snow. In general, manmade snow is dense and heavy compared to natural snow. Typically our manmade snow is around 30 pounds per cubic foot; where it's not unusual for natural snow to be 2 or 3 pounds. A nice thing about manmade snow which goes along with some of the grooming techniques on snowmobile trails is you get manmade snow that already starts out quite dense so we still have about 70% of it wet and you'll get only about 10% with natural snow. You take 10 inches of natural snow and pack it and you're only going to have about an inch base. So, manmade snow works very well, as far as, giving us a good base.

What are the impacts of a changing climate on business for a winter city in Northern Michigan? (What's with the weather?)
Carol Potter, Cadillac Area Visitors Bureau

Ms. Potter began her talk by explaining that she is a "winter person" from a "winter family"… her father was a speed skater, her brothers were all state skiers, her daughter was on the US Snowboard Team and one brother was technical director for the ski and snowboard events at the SLC Olympics. She grew up in Cadillac, Michigan and notices a marked change in the amount of snow over recent years. She remarks that "When it snows the hotels are full, the restaurants are busy, there are lines at the gas stations are party stores …everyone is happy!" She described the economic impacts of 2001: early snow in October, 2001 season with a late snow blizzard in March, but very little in between. Her talk concluded with ways that organizations, like the Cadillac Convention Visitor's Bureau could cope with that type of season: First Night Cadillac, encourage the festivals and alternative events, such as the Oldsmobile Outdoor Club, 900 GM-UAW, ice fishing and the winter carnival. Also motorcycle ice racing has become more popular and connecting the trails are important.

What are some actions that Ski Resorts can take to Climate Change?
Auden Schendler, Environmental Affairs, Aspen Skiing Company

(Please find Mr. Schenlder's complete talk in Appendix b - Handouts)

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Trouble in Paradise: The Rough Road to Sustainability in Aspen

How Failure can be the Next Great Tool in Sustainable Business

Auden Schendler

The literature of corporate sustainability is almost exclusively a catalog of successes. But failure is often more instructive to practitioners, and case studies of missteps would help others avoid pitfalls and simplify often complex projects. What businesses need is a catalog of mistakes. Drawing on first-hand experience with projects gone awry at Aspen Skiing Company and elsewhere in Colorado and in the ski industry, this article explores the obstacles to implementing sustainable practices and ways those obstacles can be overcome. *© 2001 Elsevier Science Inc. All rights reserved.*

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Imagine this: you are the environmental director at a world-famous resort. After much political wrangling, you manage to incorporate energy-efficient lighting into a high-end hotel restaurant. The restaurant opens, and the manager is put off by the sight of compact fluorescent bulbs, even though light quality is excellent. He removes the bulbs, throws them out, and replaces them with halogens. Here's what your sustainability efforts have brought you: a wasted design and installation fee; inefficient lighting; a loss of faith in green technology by the manager; hundreds of expensive compact fluorescent bulbs that, instead of being reused (at the very least,) are now leeching mercury into the local unlined landfill; and unanticipated costs for new bulbs and installation. Welcome to the sustainability revolution.

If you're familiar with the field of sustainable development, the above story, which happened here at Aspen Skiing Company (ASC), is probably a shock, because the literature has long been a collection of Panglossian success stories. The discourse has been formulaic: *innovative leader overcomes polluting obstacle at a profit — CEO was thinking*

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outside the box! The best books in the field — *The Ecology of Commerce, Natural Capitalism, Lean and Clean Management*, have become bibles for green business folk (for good reason), but rarely address failure, or even the difficulties associated with implementing sustainable practices.

The problem is the psychology of the sustainability movement — which has always been the kid brother fighting for credibility. To admit failure or mis-steps — let alone document them — would present unacceptable cracks in the evolving doctrine. But now that the movement has some genuine credibility and a host of true successes, it's time for a new era in corporate sustainability, one that documents mistakes as a guide for others. To complement our roadmap to sustainability, we need a book of wrong turns. Failure, after all, is how we learn.

Trench Warfare

Sustainability guru Amory Lovins has called some efficiency projects not just a free lunch, but "a lunch you are paid to eat''.[1] He's right — if corporate politics isn't an issue. But those of us on the front lines know that victories, while increasingly well documented, are never as easy as they sound. They're almost always messy, hard-fought battles fraught with complications and often on the edge of failure. Scratch a "success story'', and you frequently find something that more resembles trench warfare than a finely tuned operation. As Randy Udall of Aspen's Community Office for Resource Efficiency says "If sustainability were easy, we'd be doing it by now. It's not easy; it's damn hard. Often, you are trying to substitute intelligence for energy, and right now the former is more precious than the latter''.[2] Partly because of these difficulties, as Oystein Dahle, a former executive Vice-President for Exxon points out,[3] far from gliding towards utopia, we are further from sustainability today than when the term was coined fifteen years ago.

To turn this around, we need to be honest. Sometimes, "success stories'' could be better described as failures, but are creatively spun as triumphs. The Interface carpet Evergreen Service Agreement[4] — perhaps the flagship of the "next industrial revolution''[5] — is the most prominent global example. It's a brilliant idea — sell the service of carpeting, not the carpet itself, in the form of leasable tiles, which can be replaced individually as needed, then recycled when the service is no longer required. In practice, however, it hasn't been particularly successful, for a variety of reasons. (Initially, when I tried to use the product at Aspen Skiing Company, it was cheaper to buy the tiles than lease them, and the product was prohibitively expensive. Salespeople, meanwhile, didn't have clear incentives to pitch the lease over other options.) But the Evergreen lease is only a failure if we fail to learn from it.

> *Sometimes, ''success stories'' could be better described as failures, but are creatively spun as triumphs.*

Fortunately, Peter Senge, a professor at MIT's Sloan School of Management, has been examining the lease program as part of the Society for Organizational Learning's "Sustainability Consortium'' — a group of researchers, corporate leaders and consultants — to determine why it didn't take off as hoped, what the obstacles were, and how they might be overcome.

As a result of this study, Interface's carpet tile may indeed be the first triumph in the next industrial revolution, but for reasons other than initially intended. This would be par for the course as industrial revolutions go: good ideas often fail for logistical, not technological, reasons. Consider Barthelemy Thimonnie, a player in the same industry during the first revolution. In 1830, the Frenchman who invented one of the first sewing machines was almost killed by enraged tailors who, fearing unemployment,

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burned down his sewing machine factory.[6] Thimonnie's technology was sound, but his political skills were soft.

Hotel Lights and Political Fights

Back in Aspen, the problem with the lighting retrofit was not the quality of light (it was designed by one of the best lighting firms in the country) but the *perception* of fluorescent bulbs as appropriate for prisons and supermarkets, not high-end restaurants. Never mind that substantial cost savings from reduced labor and energy could go straight to Persian rugs, new tablecloths, or the bottom line.

How can we get beyond this? In some cases, you can't. It may be difficult to impossible to install efficient lighting in extremely high-end buildings. At ASC's five star Little Nell hotel, for example, I suggested that the manager install efficient bulbs in guest rooms, offering up the standard menu of benefits — financial savings and reduced labor costs. The suggestion was rejected because the obstacles are numerous, and real: slow startup, colder light, high up-front cost, guest perception of "cheapness'' (though nothing could be further from the case), and one wild card: concern that Mobil and AAA ratings will be hurt by perceived low-quality. (This concern, real or imagined, has also stymied efforts to allow guests to reuse towels and sheets in high-end hotel rooms.)

Sustainability gurus say that all these obstacles can be overcome — new bulbs start fast and don't flicker; they provide warmer light than they used to; they can be hidden; the five-star rating systems don't overtly deduct for bulbs. But the gurus haven't had lunch with a hotel manager whose job and reputation depends on a product of absolutely uncompromised ''quality'' as defined by guests. You don't put Cool-Whip on an éclair. You don't mess around with five-star ratings. (Some discount hotel chains that *have* retrofitted room fixtures found that guests are *stealing* the bulbs. The hotels were forced to buy locking fixtures, which hurt the return on investment. Who says the average American is oblivious to efficiency?)

At the Little Nell, we did something you'll rarely hear about in the sustainability movement: we admitted defeat, at least in the rooms. But we continued the war. Since the rooms were too high a target, we set our sights lower: 110 inefficient metal halide lamps lighted the hotel's two-story underground garage. The fixtures were recessed behind beams, so light quality was terrible. Worse, the lights were on all the time, creating a huge electricity bill. This seemed to be an opportunity no one could resist. We retrofitted the lamps with a simple fluorescent fixture. Light quality improved radically, increasing visibility for valets (we haven't measured if there are fewer dings to Land Rovers and Porches…) and energy savings were outrageous. The retrofit cost $19k and pays back at $11,500 annually, from a combination of energy savings and labor reduction,[7] (since the new bulbs last longer) yielding a sixty percent return on investment. Best of all, the Nell will keep 300,000 lbs. of CO_2 out of the atmosphere annually, forever. The skeptical hotel manager, when asked what he thought of the new retrofit, said the new lights were "Grand!'' Now that we have a successful internal case study, other projects that might have been rejected out of hand now seem more appealing. We might yet get at those bedside lamps…

The barrier was mindset: executives are used to making money by doing, not by saving.

All the Pretty Obstacles

Still, even the road to the garage retrofit was a study in barriers. The project was first proposed in 1996, and only executed in 2000. It was killed probably a dozen times, even with its incredible payback. How could

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this be? Aren't business people supposed to jump at a 60% return on investment?

When I presented the retrofit idea to senior management, the first obstacle wasn't payback, but the "opportunity cost of capital'': if a hotel has $20k to spend, is it better to spend it on efficiency, or on new Italian furniture, beds, or curtains, which might bring in more revenue? The barrier was mindset: executives are used to making money by doing, not by saving. The next obstacle was disbelief. "Prove it to me'', management said. So I brought them a wattmeter, hooked it to two bulbs, and showed them how slowly the fluorescent option used energy. I put the Company Operating Officer on a bike and senior management watched him sweat in high gear to power four incandescents, but pedal effortless to light the fluorescents. I brought case studies of Fortune 500 companies that proved retrofits aren't a fringe activity. The response was the same: "I want to see the bills go down''. That, unfortunately, is very difficult at the Nell where multiple electricity bills are bundled.

The lesson: to assume an efficiency project with a better than 60% return on investment is a "no-brainer'' (as I did) is a mistake. Managers should be prepared for all arguments. Even projects like the Nell garage retrofit — "cream-skimming'' by any standard — can be difficult for businesses not used to making money through savings. Given these substantial obstacles, it's a miracle the retrofit actually occurred. Our key to success? Pure doggedness, not the inherent value of the idea, and a $5,000 grant from a local nonprofit interested in encouraging efficiency projects. Sustainability is cool and avant garde, but it won't happen without two stodgy and staid partners: cash incentives (if available) and grit.

Dirty Green Buildings

We now turn to difficulties businesses may encounter with that darling of sustainable development, green construction. A Colorado builder (who will remain anonymous) was asked by her client, a small homeowner, to eliminate the use of ozone depleting chlorofluorocarbon-based insulation as part of a prescriptive program for green building. The request came late in the design process. The architect substituted a less efficient CFC-free foam, but didn't increase its thickness, because that would require redoing the entire set of plans. As a result, the roof was less efficient that it should have been, and escaping heat caused snowmelt. When the snowmelt hit the eave, it froze, creating a terrible ice-damming problem. The "solution'' was electric heat tape, an inelegant technique akin to using a blowdryer to melt your driveway.

…to assume an efficiency project with a better than 60% return on investment is a ''no-brainer''.. is a mistake.

In this case, the fear of environmental bogeymen — like CFCs — and a checklist approach rather than whole-systems design caused owner and architect to miss the forest for the trees. The checklist — often called the "twenty dumb things'' approach — is the antithesis of holistic design and can be a flaw in the US Green Building Council's Leadership in Energy and Environmental Design (LEED) program, an otherwise admirable cookbook for green development.[8] (Which we used with great success on our Sundeck Restaurant, one of the first LEED-certified buildings.) Sometimes an environmentally "bad'' material needs to be used to make buildings truly green. A strawbale house that collapses in ten years doesn't contribute to a greener planet. But a concrete building that lasts for 200 years is "green'' despite the energy-intensivity of cement manufacturing.

Aspen Skiing Company is now in the process of designing new time-share condominiums at the Snowmass Club. It turns out that in

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the current market, luxury condos must be air-conditioned in order to sell. Any green architect worth his salt would balk: "A/C at 8,000 feet in the Rockies? That's absurd''. True, properly designed units should be comfortable without A/C, even in July. But we are victims of market constraints. Faced with what would be a less environmentally responsible building than what existed previously, we decided to get creative. The condos will sit on a golf course, next to a large "trout pond''. (Or so the guests think. It's actually a tertiary sewage treatment pool for the town of Snowmass.) Why not tap the pond to heat and cool the condos, using it as a heat sink in the summer and source in the winter? It turned out the proposal to use ground (or in this case lake) -source heat pumps would cost no more than a conventional gas-fired heating and cooling system, and would offer significant annual savings. In addition, the system would eliminate the need for an ugly cooling tower, and allow for simultaneous heating and cooling. We decided to do it.

On a whim, I ran the numbers to see what kind of reduction in greenhouse gas emissions we'd garner from this "super green'' project, one of the most innovative in the state. The result: the new system, elegant in its use of the landscape and radically more "efficient'' from an engineering standpoint, would produce *slightly more greenhouse emissions than a gas fired boiler*! How could a cutting-edge system that is several times more efficient than a conventional one emit more greenhouse gases?[9]

It turns out that natural gas, the conventional alternative, is particularly low in greenhouse emissions, and heat pumps use electric compressors, which run on dirty, coal-fired electricity. We decided to go forward with the project anyway. While CO_2 emissions are one important metric, they are not the end-all of green design. We are victims of a 19th century electricity grid, powered by centralized coal plants. Ultimately, the heat pumps at the Snowmass Club are quintessential green design. The system is adapting and conforming to the environment, taking advantage of on-site resources without damaging them. (Pond temperatures will fluctuate only one degree Fahrenheit.) It is simple, elegant construction that saves money. And there still exists the possibility to power the system with wind electricity, making the condos virtually carbon-free!

The condos, by the way, are being built on the site of a previously existing structure. Aspen Skiing Company deconstructed the old building to salvage useable materials (later sold at a gigantic yard sale) and then composted the remaining wood and sheetrock. As a result, 84% of the structure stayed out of the landfill. However, the project cost ASC more than pure demolition would have, while the contractor *saved money* since composting reduces truck trips and dump fees. Because we couldn't guarantee savings to the contractor from the outset (this was a pioneering project) we could not negotiate lower cost. But on the next project…

Snowcat Culture

Green buildings, lighting retrofits — these are the bread and butter of corporate sustainability efforts. But Aspen is, after all, a ski resort — it would be a shame not to hit the slopes in this discussion.

Green buildings, lighting retrofits — these are the bread and butter of corporate sustainability efforts.

At a ski area known for its environmental responsibility (not ASC, in this case), vehicle shop managers became concerned about a particularly ugly environmental problem. Diesel fuel pumps had been fitted with automatic shutoff mechanisms (like you find at gas stations) so that snowcat operators could

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stay warm inside the cab while refueling on cold, snowy nights. But it was just in these kinds of conditions that the shut-off mechanism tended to stick, often flooding the ground with gallons of fuel. The solution was easier on the environment, but hard on the driver: management removed the shut-off mechanism, so the cat operators had to hold the handle. This, in theory, would entirely eliminate spills.

But reality intervened. When it's minus-forty out, few employees are willing to stand outside for ten minutes gripping a metal handle. So they would stick a block of wood or a tennis ball under the trigger, wedging it into the "on'' position. The result: without even the chance of an automatic shutoff, spills got even worse. The solution: reinstall the automatic shutoff, and try to get employees to improve their vigilance. Or, more simply, go back to square one.

In this case, there is no technological fix — it's all training, and employee buy-in. But how do you create buy-in? This is where publicity plays a role. Some environmentally responsible organizations are reluctant to tout their achievements because they fear being labeled "greenwashers.'' But at Aspen Skiing Company, we toot our horn after every victory with press releases, magazine articles, and public presentations. This serves two purposes, beyond the obvious PR benefits of community goodwill and an increasingly green reputation. First, we want to help change the industry, so we need to get the word out. Second, we want to create a corporate culture of environmental responsibility, which will help solve problems by tapping employee brainpower and action. Recently, a colleague at a party for ASC summer staff witnesses this scene:

One employee tossed a beer can into the trash. Immediately, someone said: "You can't do that! Recycle it! You work for Aspen Skiing Company!'' Cultural change happens.

Snowcats also offered us a parable of solving problems at their source, rather than offering Band-Aid (or "end of pipe'') solutions. All snowcats are powered by hydrostatic drives, a kind of propulsion system that uses hydraulic oil to move the wheels. Occasionally, a hose will break, emptying the oil reservoir onto the slope. Not only are blown lines an environmental problem, but they hurt business. Between the repairs, cleanup, wasted time, and ungroomed slopes which lead to customer complaints, ASC was not just hemorrhaging oil, but cash.

On three ASC mountains — Aspen, Buttermilk and Highlands — there were five blown lines in the winter of 1998. Such spills are so common that most ski areas consider them a fact of life. While spills below 25 gallons aren't regulated, and even though hydraulic oil tends to be very clean, they're clearly damaging to the watershed, local vegetation, and wildlife. Most of us had dealt with the problem by shoveling contaminated snow into trash bags, then melting out the oil onto selectively absorbent rags — an ugly and labor-intensive "solution'' that was in fact just another problem. Concerned about what seemed to be an industry-wide "Exxon Valdez'', I asked around for answers from other ski resorts. One claimed to have the solution. "We load up three fifty five gallon drums on the back of a snowcat, and shovel the snow into the drums, then drain them at the shop….'' Another end-of-piper.

We turned to our shop mechanic, Don Mushet, a burly Californian partial to tank tops and Levis, who grew up fixing anything with a motor and has an uncommon practicality to his thinking. A committed environmentalist, he too was unhappy about the spills, (as well as February early-morning phone calls to repair cats). He decided to inspect all hydraulic lines during the summer, replacing worn parts, hoses and gaskets. The following winter, there was only one blown line.

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The Thrill of Defeat

In sustainability circles, pollution, or waste, is often called "a resource out of place". Today, pioneers are mining the waste stream, "closing the loop", finding new uses for what was once trash — plastic bottles become fleece jackets, spent brewery grains are converted to agricultural feed, junked cars become rebar. And yet we, the practitioners of sustainability, discard our intellectual waste — the mistakes we make, by keeping our failures secret. Let's take a lesson from ourselves, and recycle this most valuable asset. Like compost made from the old Snowmass Club that now brings up flowers in Aspen gardens, widespread sharing of this information will help speed the growth of sustainable business.

Endnotes

1. Arnold Fickett, Clark Gellings, and Amory Lovins, "Efficient Use of Electricity," Scientific American, September 1990.
2. Personal communication, 8/6/01.
3. Oystein Dahle, State of the World Conference, July 20, 2001, Aspen Institute, Aspen, CO.
4. Details on this program can be found in the Interface Sustainability Report or through www.interfaceinc.com.
5. Interface, Inc. CEO Ray Anderson's term for the movement toward sustainable business.
6. The Editors of Time Life, *Libraries of Curious and Unusual Facts, Inventive Genius*, Time Life Books, Alexandria, 1991.
7. From analysis done by Chris Myers at Rising Sun Enterprises for Aspen Skiing Company on 10/4/00. Rising Sun Enterprises, 0040 Sunset Drive #1, Basalt, CO 81621, (970) 927-8051.
8. Information on LEED can be found at www.usgbc.org.
9. Heat pumps are much more efficient than conventional systems based on their "coefficient of performance" (COP) an engineering term. COP is the ratio of heat delivered by the heat pump (or other system) to the electricity supplied to the compressor. Thus, the higher the number, the more efficient the system. Heat pumps in this application have a COP of almost five, while a conventional system has a COP of less than 1.

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