SUSTAINABLE PRACTICES IN THE SKI RESORT INDUSTRY

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring 2023

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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INTRODUCTION

When choosing a topic for scientific research and analysis, it is commonplace to look in areas where the most impact it felt. The generic route is looking at what major issues currently face society and attempting to provide some sort of solution that will help move humanity in the right direction to foster a better quality of living. In this regard, other areas that may not have as substantial of a direct impact on human life may be looked at as a waste of time or trivial. It seems foolishness to focus on things such as recreation or entertainment when such grave problems plague the world at any given time. While it is true that focus should be drawn to certain issues over others, that is not to say they are meaningless or should be ignored. To quote a popular movie from the 1980's, *Dead Poet Society*; "Medicine, law, business, engineering, these are all noble pursuits, and necessary to sustain life. But poetry, beauty, romance, love, these are what we stay alive for." (Weir, 1989, 0:24:55). Without the enjoyment of things that have nearly nothing to do with functionality or practicality, humans may as well be robots moving about with no purpose other than ruthless efficiency. There is a need for diversion and amusement in life, especially in the modern world where the issue of survival is no longer a grave a threat as it was in centuries and millennia past. This need for entertainment is a driving component in how sports became to exist. One specific sport is the activity of skiing and snowboarding. What originally began as a method of transportation has almost entirely become a recreational activity that people all over the globe enjoy. That is not to say that the only purpose of skiing is that of recreation. While the sport does provide joy and pleasure, it also has health benefits such as physical exercise as well as improving mental wellbeing. Although this is an activity meant mostly for entertainment, because of the interconnected nature of the world, many

of the more serious issues of society end up bleeding in and affecting how it operates. Two such problems are injuries that result in participation in the sport and the effects that climate change is having on the industry as a whole. And, similarly to how things such as health and environmental issues have a large effect on skiing, the industry of skiing has a significant impact outward as well such as in the case of being an economic driver. For a sport that essentially doesn't provide any real functionality to human life, it has a large economic influence, and it was found that "more than 23 million people participated in winter sporting activities … adding an estimated $12.2 billion in economic value to the U.S economy" (Burakowski, 2012, p. 3). Because of this, although at its core skiing is a recreational activity, the collapse and extinction of the industry would have severe detrimental effects. To prevent this, what changes must be made to make the sport more sustainable for both the riders as well as the environment?

IMPLEMENTATION OF SUSTAINABLE PRACTICES IN THE SKI RESORT INDUSTRY

The sport of skiing has a unique interaction with climate change as the entire industry relies heavily on climate conditions. While it is true that essentially all aspects of modern human society are and will continue to be greatly affected by the effects of climate change, this is one area where these effects are much more substantial due to the direct nature of the relationship. Even in immediate times a reduction in winter recreation seasons is being seen, with it being projected that it will continue with seasons seeing declines "exceeding 50% by 2050 and 80% in 2090 for some downhill skiing locations." (Wobus, 2017, p. 1). Skiing exists in specific areas of the world, mainly places with higher average temperatures, high elevation, and consistent snowfall. As the atmosphere warms due to climate change, areas where skiing is a prevalent

sport are seeing decreasing amount of snowfall affecting their capacities to run efficiently. Despite this decline in snow availability, the demand has not decreased where "despite average season length losses, visitation increased as a result of reduced competition" (Scott, 2020, p. 1). With this growing concern amongst the skiing community certain actions have begun to take place. With some companies in the industry committing themselves to zero waste pledges or lessening their carbon emissions output. Ski resorts themselves must begin to change their ways as well in order to help in the battle against climate change as well as their own survival. One major area is that of snow making. Artificially creating snow with machines is a way in which resorts can continue staying open in snowfall droughts. In many cases this is a necessity. However, until more recent times this has not been done with a scientific plan in mind and had no basis for planning. A significant way that resort will be able to minimize their carbon output and waste is to conduct snow making operations more efficiently. It is seen that "from perfect or improved knowledge of upcoming weather and snow conditions in the field of snow management" resorts can save considerably, both in energy and resources (Köberl, 2021, p. 1). By use of "forecasts as well as snow management tools" they are able to calculate more efficiently when, where, and in what quantity to make snow that would be most efficient (Köberl, 2021, p. 1). More research and analysis need to go into this field as this is a way to both maintain ski resorts as well as combat climate change. This is a growing area but crucial in the fight again climate change for ski resorts.

ADVANCED SNOWMAKING

Snow making has been a large part of ski resorts for several decades now. With many resorts seeing less than ideal snowfall, it is a tried method of maintaining slopes so that resorts

can stay open. What started as a more archaic process has slowly become more and more advanced in many different ways. The snow guns themselves have seen massive improvements in efficiency and potency. Obviously increasing this efficiency is beneficial for both the benefit of skiers and resorts to have more coverage while also wasting less water as well as power. This fact is straightforward and therefore manufacturers are constantly at work to increase this efficiency. This is not however the only way to maximize snowmaking. Much of what drives snowmaking is the decision making that must occur. Some of these decisions include whether to wait for colder weather to begin snow making, determining start and stop dates, volume of snow making, and many more. Increased resources are being put into analyzing the snow coverage itself along with weather patterns and forecasts. Real time data on current snow coverage has been a standard practice for many years. Progress is now looking towards analyzing future evolution of snowpacks and creating models to predict how they will react to weather forecasts. On top of this, these new modeling softwares can aid in the prediction of snowfall and assist with decision making regarding snowmaking. Armed with these new tools it is becoming easier to make strategic choices with regards to snowmaking and so optimize water output and ensure a better resort experience.

SNOWPACK MODELS

A new project that aimed to lower the usage of water and energy while simultaneously increasing the efficiency of snow making was the project Prosnow. Meteorological and climatological forecasts are used to analysis and run through snowpack models to make strategic decisions. This provides information on present and future snow conditions and snowfall to maximize snowmaking. Many different simple snow models have been developed in the past decades. These were created to assess the impact that climate change was having on snow

reliability and ski tourism (Hanzer, 2020, p. 1). Three of these models that were used in the Prosnow project were AMUNDSEN, Crocus, and SNOWPACK/Alpine3D model. Although each of these differ in background and purposes as well as design, they have in common their benefits for use in snowmaking. These three were the foundation of the Prosnow project to gather information on the environment. State of the art meteorological and climate forecast are used to feed AMUNDSEN, Crocus, and SNOWPACK/Alpine3D so that they might provide data on future snowpack conditions and therefore advise on potential snowmaking approaches (Hanzer, 2020, p. 1). This was done to assist ski resorts make decisions based on the state of the snow as well as future conditions. Snow production is contingent on many different factors. One of which is demand, whether or not a certain area requires more snow at a certain time. The two models operated on a workflow system regarding snowmaking which was the core of the snowmaking procedure.

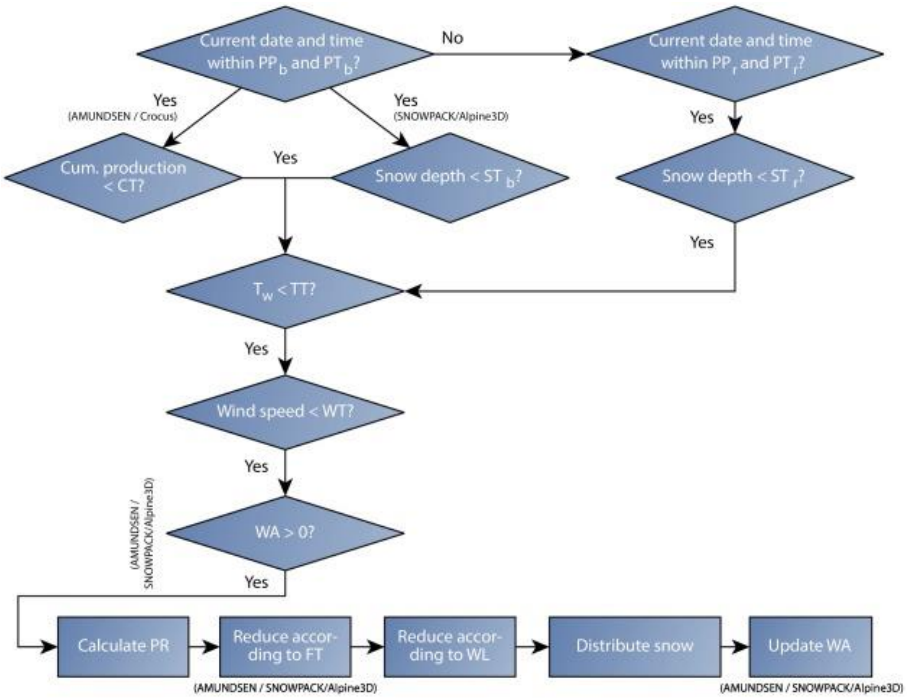

Figure 1: Flowchart of the snow production procedure in the three models (Hanzer, 2020)

AMUNDSEN and Crocus were already equipped with snow management capabilities while SNOWPACK/Alpine3D had a new snow management scheme integrated into it. These three together represent the "state of the art of snow management processes in physical based snowpack models" (Hanzer, 2020, p. 1). They were used to contrast very different seasons 2016/17 which was very dry in terms of snow accumulation and 2017/18 which had an abundance of snow. The models provided results that showed the best functionality of snowmaking based on selected parameters. While these results for snow production were not actually implemented, it showed the optimal approaches the resorts would have had for those seasons. There was a total of 9 resorts that were included in the program. Each ski resort was simulated using only one of the snowpack models. A good next step would be to implement each of the 3 models on one resort to compare the varying results. This approach has its limitations and things are not always very straightforward. But by using hard driven data and analytics resorts will be able to better manage their snowmaking in order to minimize their waste while maintaining the best snow base they can. This technology has demonstrated its usefulness and will hopefully be expanded upon and improved in further iterations. This may be a crucial part in maintaining the sport of skiing while a more permanent solution to the global climate crisis is discovered.

A TECHNOLOGICAL FIX OR BANDAID

The issue of climate change is greatly impacting the skiing industry, but the reverse is also true. Unfortunately, with increased advancements made in technology there is seen detrimental side effects that were not intended. Especially in this area where some of the solutions to the issues caused by climate change are exacerbating it further. As certain areas see

less and less snowfall, skiers in an attempt to find more snow end up traveling more in order to reach destinations where greater snowfall still exists. However, “as a consequence of mass tourism movements in the form of transport to the mountain and on the mountain” is leading to increased emissions of carbon dioxide ultimately worsening global warming (Dragović, 2020, p 108). In an effort to maintain a bigger base and keep the ski surfaces refreshed, snowmaking is common practice on many resorts. But this consumes considerable amount of water as well as electricity and power to make this happen. The things that are being done to attempt to combat the effects of climate change are also worsening them. Societally this also creates a problem where people shift more towards finding a band-aid solution to problems instead of addressing the root. Instead of attempting to find a solution to the climate problem affecting their local resort they end up flying to somewhere it isn’t as much of a problem. Although these methods do exist, instead of escaping elsewhere, focus should be drawn to addressing the technology itself. People end of fixating too much on the “elegance of … technological fixes and become insensitive to the social tensions that … technologies create” (Weinberg, p. 12). This fosters a societal mentally of avoiding the core problem whilst trying to find an easier technological fix, regardless of the side effects. This is a mentality that much be avoided if these issues are to be adequately addressed.

A SHIFT IN TECHNOLOGICAL MENTALITY

Be the last several decades the only focus of creating new technology was the end purpose of the technology itself. People and companies designed cars and trains with only the purpose of how fast they could go, how reliable they would be, and other features of the design. However, with the introduction of climate change there has been a monumental shift in mentality in how companies view newer products. Now, questions like how efficient it is, how much

pollution does it causes, does it contain any toxic material, and the like have become the center point. This represents a large paradigm shift that has occurred in modern society. The Paradigm Shift Theory was developed by Thomas Kuhn's *The Structure of Scientific Revolutions*.

Figure 2: Kuhn Paradigm Shift Theory Cycle (Mcleod, 2023)

This theory shows how science and technology reacts to a major revolutionary discovery that massively changes a certain aspect of how society works (Kuhn, 1962). Such a major change was the introduction of how climate change was affecting the world. Before focus was only given to improvements in technology regardless of the environmental outcome, this was the normal science. After the discovery of climate change a shift occurs and new revolutionary science is born, which then becomes the new normal science. In relation to the specific issue of skiing, the step of model crisis is where the increasing temperatures from climate change is causing the deterioration of the sport. Initially the only focus was on creating the best lifts, making the most snow, and running the resort in the way that best served its riders. But as it was

learned the effects some of these actions are having there need to be a shift that occurs that changes the way things are run. The idea that now it is unrealistic to continue down the path of just creating advancements with unlimited environmental consequences is in itself a paradigm shift. This change in mentality represents what can be described as a paradigm shift within society. However, in terms of solving the issue itself, the industry of skiing and human society are still not quite at that point and are instead currently at the pre-science portion of the Kuhns cycle.

CYCLE STAGE OF ENVIRONMENTALISM

There are many different opinions about which stage of the Kuhns Cycle environmentalism is currently. One interpretation is that climate change prevention and environmental conservation thought is at the pre-science step of the cycle. The thinking here is there is still not enough understanding or advancements in the area of study to place it anywhere further along in the cycle. There is not a valid paradigm that works to solve its central problem. In relation to the skiing industry this is especially apparent as there is clearly chaos in the way this new reality is having an effect. The problem area has just in recent years become apparent and is coming into the limelight. However, at the current stage there have been no clear solutions and major advancements made that address the dilemma. In terms of environmentalism as a whole, certain practices such as recycling, solar power, hydroelectric power, minimized carbon footprints and etc. are becoming more commonplace in order to help slow and aid in the prevention of accelerated climate change. However, these methods are nowhere near a solution to the bigger problem and are only temporary fixes. This is also true for the smaller issue of ski resorts in that certain actions such as intelligent snow making are helping to aid in the issue, but they are not permanent fixes. If the current trend continues there is no amount of these smaller

actions that exist that will prevent the inevitable. Therefore, the world is still waiting on the true paradigm shift to occur in terms of environmental thinking that will revolutionize the way in which society operates and the relationship humankind has with the planet. What this could mean or the path that this will take is unknown at the moment but hopefully in coming years and decades a more complete paradigm shift will occur that will lead society to a brighter future.

CONCLUSION

The future of the planet in the face of a warming atmosphere and climate change is becoming more and more uncertain. The world's brightest and more innovative minds are scrambling for solutions that will advert potential doom. In the face of such a grave potential future, it seems like a waste of resources to focus on something like recreation or fun. Skiing itself is in no way shape or form essential to human life or necessary for society. However, there will always be a need for joy and enjoyment in human life. Since the limited snowfall hurting ski resort and climate change go hand in hand, there is no real easy fix to the current problem plaguing the sport. However, for the time being, in order to extend the survivability of the industry certain actions can be taken. One promising route is better snow making methodologies and predictive software to increase the effectiveness of snowmaking. New modeling capabilities are being developed to aid in a resort's ability to maintain their slopes. By tracking weather patterns and analyzing snowpack, better decisions can be made that will waste less water and electricity. Currently these models are in the earlier stages of development but as they become more accurate and reliable, they are sure to be useful in the snow making process. The new shift in mentality where the environment and planet must be considered in every aspect of industry poses a challenge. This was not previously a concern. In past centuries the only goal of new technology was its purpose and that alone. But now humankind must be conscious to minimize

harming the planet and therefore itself. Skiing brings joy and prosperity to millions of people around the world and is worth protecting. Little by little steps need to be taken so that it may remain a part of people's lives and continue to thrive into the future.

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