

Undergraduate Thesis Prospectus

Vegetable Gardening Kickstarted by an Industrial Sower

(Technical Research Problem in Mechanical Engineering)

Sustainability Issues Facing Skiing

(Sociotechnical Research Project)

By

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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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General research problem: How can corporate strategy in an industry be influenced to promote sustainability, equity, and accessibility?

Private sector actors often prioritize short-term profits over sustainability and equity. Consumers and stakeholders can influence change through activism and purchasing decisions. Corporations also have opportunities to adopt ethical practices accountable to stakeholders, not just shareholders.

This prospectus examines how consumer influence and corporate responsibility can promote equity, accessibility, and sustainability. Automating vegetable gardening tackles accessibility by simplifying planting (and makes healthy organic meals accessible to students of all socioeconomic classes). Analyzing the ski industry explores how consumers and companies have addressed and could address inequity, environmental damage, and community displacement.

Progress requires both removing barriers to access through innovation, and critically examining business models and practices. This prospectus will explore technological and corporate social responsibility approaches to enabling ethical and sustainable participation in activities and industries.

How Can We Making Vegetable Gardening More Accessible for UVA Students?

Automating seed germination using UR10 industrial robot and passive tools

We want to make the gardening in the O-Hill community garden more approachable by automating the first and most difficult part: germination. Tomas de Oliveira and I (supervised by Dr. Gavin Garner as part of MAE4610/4620) will demonstrate a system that can plant a 2x5 tray of basil seeds by December 2023.

We are using the UR10 Industrial Robot, custom-made simple machines, and exclusively passive end effectors to automate this process. The Universal Robot UR10 is a \$50,000 industrial robot arm capable of 10kg of force with a two-meter reach. Our prototype will be limited to less than \$500 so most components will be made from scrap metal or wood.

Currently, Flier Systems and their competitors sell industrialized sowing machines, but these machines cannot handle customized requests for different seeds or conditions within the same tray. Their solutions fit their industrial customers' needs, but not the needs of smaller agricultural teams that can only afford one machine to germinate different kinds of seeds. Currently, PhD and Faculty researchers in academia hand-sow trays of seeds, and it's one of the most laborious parts of their work. Our solution is novel and unique because of its customizability. While an academic-grade solution is out of the scope for our project, our student-focused solution serves as a prototype for more capable customizable sowing machines.

Slippery Slopes

How are ski leaders dealing with the issues of sustainability facing skiing?

Skiing has been trending towards big destination resorts, which act as tourism businesses, and away from local ski hills, which have acted more as communities. There are three ways that the business of skiing in the age of destination resorts has shown itself to be unsustainable: their work force cannot afford to live there, there aren't enough new skiers being generated, and destination ski resorts are damaging to the natural environment.

Ski resorts face challenges filling their seasonal rosters because their employees aren't paid enough to live nearby, forcing them into long and dangerous commutes (approaching-infinity, 2023). Many Jackson Hole Mountain Resort employees commute from Idaho, enduring perilous journeys. Normalizing a two-hour commute through blizzards is not only inconvenient; it is dangerous (Puzzled_Lock_1428, 2023; approaching-infinity, 2023), irresponsible, and negligent. The ski industry's treatment of employees has been so unsustainable that since the late eighties, big resorts relied on seasonal labor from other countries. The ski industry employs roughly 7000 H2B and J1 visa participants (Blevins, 2020). Importing seasonal labor for service jobs is an unsustainable business model.

Resort skiing depends on a preexisting demand for skiing by skiers. People are not born skiers, and it is becoming harder for people to become them. According to the NSAA (2023), the number of skiers 17-and-under is declining. It's important to attract skiers when they're young, because Williams & Fidgeon (2000) found that converting adult non-skiers into skiers has a difficult barrier to overcome: the "expedition mentality" of a ski trip. Skiing's lack of racial diversity (NSAA, 2023) hurt prospects of growing the sport: whites make up 88.7% of skiers, while only 75.8% of the United States is white. The remainder is split between Latinos and

Asians, with Blacks and Natives underrepresented (NSAA, 2023). According to Harrison (2013), skiing has been particularly uninviting to blacks. Considering that Generation Z is the most racially diverse generation (Pichler et al., 2021), it's imperative to avoid maintaining a racially homogenous image in the skiing industry over the next few decades.

U.S. ski areas heavily rely on snowmaking (Scott et al., 2022), a process that involves transferring water from local reservoirs onto slopes in the form of tiny ice crystals before distributing it using snowcats. They enable longer, more consistent ski seasons, but its unnatural melting timeline (Dingle, 2019) affects local marine ecology. Alpine ecology is affected by skiing. Elk rely on the limited alpine regions in the summer and valleys in the winter, but with the growth of skiing and ski towns, they're being forced to compete with neighboring elk herds for land and resources (Peterson & Andree, 2021) – or die trying.

The profitability of vacation real estate development in skiing communities is a common factor contributing to both the employee housing crisis and the ecological issues affecting elk and other wildlife near ski areas. Profit-seeking developers and ski resort companies alike (Vail, 1998) have developed luxury vacation homes on every square inch they can, which led Price (1972) to note that “it is appalling to see how some of our valuable mountain resources have been blighted by haphazard, ill-conceived developments ... and ignorance of even the most basic tenets of conservation” in his article on the feasibility of skiing (p. 2). Because buildable land is inherently scarce in mountain valleys, luxury real estate development leads to gentrification. The next livable community for the workers to move to is often 20+ miles away. In addition to developing private vacation homes in the valleys, ski resorts develop public alpine land for new lifts into the alpine zones that elk habitate.

Climate change has significantly impacted the feasibility of skiing: “From 1982 to 2021, the snowpack season became shorter at about 86 percent of the sites where snowpack was measured. Across all sites, the length of the snowpack season decreased by about 18 days, on average.” (EPA, 2023). While the shortened season has been effectively counteracted by artificial snowmaking, that dependence is harmful to small ski areas and likely put many of them out of operation (Clifford p. 32, 2003). Ski areas and skiers prefer natural snow for a lot of obvious reasons. One of the less obvious reasons is that snow is the best marketing money can’t buy for ski areas within a day’s drive of their customer base. Small areas suffer more because the only way to weather the storm (or lack thereof) is to invest in snow machines. Even operational costs of snowmaking after installation are costly: “...I was looking at [monthly] electric bills of \$300,000, \$400,000” (Clifford & Ackland, 2000). However, snowmaking is not the sole technology contributing to an arms race that disadvantages small ski areas while benefiting consolidated corporations. In 2020, Vail Resorts allocated \$210 million (SnowBrains, 2019) for lift improvements on three of their mountains. Anything that hurts small ski areas also hurts new skier generation.

Small ski areas play a crucial role in generating new skiers. Becoming a dedicated skier is all about fostering a deeper connection with the sport. Dan Grider (General Manager of Sioux Falls, SD’s only remaining ski hill) believes his mountain’s purpose is to generate new skiers (Winchester & Grider, 2023). Unfortunately for skiing, most mountains like his have closed: “Most of those that folded were the small mom-and-pop operations where many Baby Boomers first tried the sport.” (Clifford & Berry, 1997) Competing with corporate consolidation is the main killer of small ski areas, despite Moscovici’s (2022) argument that environmental regulation is the financial burden putting them under.

On the environmental front, NSAA, Ski Resort Management, and rural ranch communities are taking steps to promote environmental sustainability. The NSAA recognizes environmental sustainability efforts through its Sustainable Slopes Badges and offers Sustainable Slopes Grants (NSAA, 2019). Taos Ski Valley has independently sought and achieved B-Corp status, involving a rigorous review of environmental sustainability practices and “changing their corporate governance structure to be accountable to all stakeholders, not just shareholders.” (B Corp, 2023) The rural ranch communities of West Yellowstone, MT and Bozeman, MT are actively crowdsourcing a \$3 million law suit via Cottonwood Law Firm (Meyer, 2023) against the cartoonishly elite Yellowstone Club for Clean Water Act Violation. Lastly, the public sector at the federal, state, and local level (usually) push back on ski companies when their agendas are out of line with environmental policy for the public good.

On the employee front, a group of Jamaican service workers at the Yellowstone Club are banding together to sue their exploiters (Jamaican Observer, 2021). Some ski patrollers have recently leveraged their unions to strike for a livable wage, as seen with Utah’s PCPSPA, even though the negotiations took two years (Jag, 2020). Loveland Pass, Big Sky, and about a dozen more Patrol stations recently voted to unionize in the wake of COVID’s housing crisis. The mountains, to their credit, are seeing the sustainability crisis for what it is. Affordable housing solutions are under consideration or construction in nearly every resort destination in the US. For example, Sugarbush (who sold to Alterra about a decade ago) has taken steps to make its employment more sustainable (Bleh, 2022). It is possible that some combination of unionization and affordable housing initiatives are able to make ski employment sustainable.

To generate more skiers and help independent small ski hills stay viable amidst the multi-mountain passes of Vail and Alterra, state governments, big corporations, Doug Fish, and NBS

have stepped in. In Vermont, New Hampshire, New York, Idaho, Utah, and Colorado all have instituted programs to offer middle schoolers free (or very nearly free) skiing for an entire season to make skiing more accessible during a formative period. The National Brotherhood of Skiers has instituted programs to help black kids and adults to get on the slopes and feel comfortable in an otherwise exclusionary environment where they make up less than 2% of participants (National Brotherhood of Skiers, 2023; NSAA, 2023). Doug Fish, the creator of the Indy Pass (2023), created a way for independent mountains to remain competitive with Vail's and Alterra's multi-mountain passes without changing the culture or leveraging up for new lifts. The mountains who joined his mission, such as Black Mountain, have done so to keep sustain their small ski areas while many have gone under. Vail and Alterra themselves have begun programs to help non-skiers from local metro areas onto the slopes for free, and Vail CEO Rob Katz "announced 11 organizations receiving approximately \$560,000 in grants as part of an ongoing commitment to increase youth access to outdoor recreation." (Vail, 2021) Alterra's new CEO (Winchester & Smith, 2023) recently commented on a podcast that their pricing model needs to be more advantageous and accessible to new skiers for the sake of their business model.

In STS4600, I plan to analyze the current initiatives and trends further to understand whether skiing is becoming more or less sustainable.

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