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Get Your Butt Off the Ground!: Consequences of Cigarette Waste and Litter-Reducing Methods

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CONSEQUENCES OF CIGARETTE WASTE AND LITTER-REDUCING METHODS

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Table of Contents

Introduction -- 2

Chemistry of Cigarettes --- 4
The Filter Problem
Biodegradable?
Enhancing Degradation Rates
Persistence of Chemicals

Consequences of Cigarette Litter --- 9
Toxic Exposure to Marine Life
Toxic Exposure in Children and Landfill Demands

Litter-Reducing Methods -- 11
Alternatives to Cellulose Acetate Filters
Creative Repurposing
Practical Solutions

Policies and Programs --- 15
Tax and Deposit Programs
Policies in Consideration
Collaboration with Tobacco Industry

Cigarette Butts at Pomona College --- 20
Background
Methodology
Results and Discussion

Conclusion --- 38

Appendix --- 41

Acknowledgements -- 43

Works Cited -- 44

Introduction

High death rates from lung cancer and other illnesses associated with cigarette smoke have prompted greater efforts to keep communities informed of the harmful consequences of tobacco use. The Downey Fresh Air Coalition is one of several groups that are committed to this effort. The coalition was formed by residents of Downey, CA who wanted their parks and city-sponsored public events to be smoke-free. In the summer of 2011, I joined the youth coalition as an intern and participated in tobacco education, council meetings, and cigarette butt clean-ups. Our efforts were rewarded on November 22, 2011 when the Downey City Council agreed to pass a law for smoke-free parks and public events.

The final and successful council meeting was a memorable experience, but I also cannot forget the cigarette butt clean-up we did at Furman Park. Scouring the ground for cigarette butts in the early hours of the day was tiring but worthwhile; in just two hours, we filled large jars with used butts. The amount we collected was shocking. We had discussed how cigarette litter can accumulate and take an incredibly long time to degrade, but actually seeing the overflowing jars confirmed that cigarette litter is no small issue.

We picked up hundreds of littered cigarette butts, but I wondered what would have happened to them if they had been left on the ground. Would they have just disappeared under layers of soil and eventually disintegrate? Would the chemicals in the cigarettes persist and be potentially toxic? And why do smokers discard their cigarettes on the ground instead of appropriate ashtrays?

Cigarette butts are rapidly accumulating on our planet and they are not going away fast enough. About 5.535 trillion commercially manufactured cigarettes were consumed in 1995 (Novotny and Feng 1999). 4.5 trillion filter-tipped cigarettes are deposited annually worldwide

(Hager 2010). In the United States, more than 175 million pounds of cigarette butts are discarded every year. The Keep America Beautiful (KAB) campaign reports that cigarette butts make up 36% of all visible litter (Keep America Beautiful 2009).

Street cleanups have found that cigarette butts comprise of 25% to 50% of all collected litter from roads and streets (Novotny et al. 2009). Most of these cigarettes were discarded from moving cars. The cigarette butts travel from cars, to street drains, and finally to streams, rivers, and oceans. In beach cleanups, cigarette butts are the single most recovered item (Novotny et al. 2009).

Because filters can take years to degrade, littered cigarette butts almost never disappear at the rate that they are being thrown away. No matter how small they are, 4.5 trillion filter-tipped cigarettes together equate to a significantly large amount of discarded plastic. Their toxicity affects children and animals while the costs of municipal waste management rise.

My thesis further examines the biodegradability of filters and its scientific basis, including ways to enhance degradation rates by chemically manipulating filters. I also discuss the persistence of cigarette chemicals and their potential toxic effects on children and animals. I consider other social, economic, and environmental consequences of cigarette filters and chemicals. Furthermore, I discuss various solutions smokers and non-smokers alike have created to address the problem of cigarette litter; these methods come from a wide range of artistic, science-based, and policy-based perspectives.

Finally, my thesis examines this issue in the context of a college campus – Pomona College in Claremont, CA. I discuss a map showing the number of cigarette litter around buildings and sidewalks on campus and consider factors that influence the location and high counts of litter. Finally, I make recommendations for the college based on my findings.

Chemistry of Cigarettes

This section explains the problem with cigarette waste with a specific focus on chemical composition and interaction with the environment. I discuss synthetic cellulose acetate, how it is manufactured, why cigarette companies make their filters out of this material, its biodegradability, and ways to enhance its degradation rate. Finally, I discuss the persistence of chemicals in cigarettes.

The Filter Problem

In the mid 1950s, the United States Surgeon General's warning that smoking causes lung cancer alarmed the public as well as cigarette manufacturers. They began to investigate new designs for filter-tipped cigarettes in hopes that a filter would reduce the harmful health effects of smoking. Funded by Philip Morris, researchers at the Textile Research Institute in Princeton, New Jersey began developing different fibers. They found the best one to be synthetic cellulose acetate because it was easily manufactured for mass production and the cheapest pound for pound (Harris 2011).

Cellulose acetate is a plastic made of up to 12,000 fibers (Novotny et al. 2009), each one about 20 μm in diameter (U.S. Department of Health and Human Services 1989). It is synthesized by acetylating cellulose, a natural polymer found in wood, with acetic anhydride in the presence of a catalyst. The reaction produces cellulose acetate flakes, which precipitate out and dissolve in acetone. Spinning the solution causes the acetone to evaporate, leaving behind strands of cellulose acetate (Harris 2011). Adding titanium dioxide (TiO_2) to the strands eliminates their sheen and whitens them (Puls et al. 2011). Triacetin, a binding agent, packs the strands together to create a single filter. Finally, the filters are sometimes wrapped with two layers of paper or rayon, which contain glues or alkali metal salts of organic acids to ensure continuous burning in a smoked cigarette (Davis 1999).

There are numerous problems with the cellulose acetate filter (Figure 1). Although they were developed to create safer cigarettes, some studies have correlated its rise with an increase in cases of aggressive adenocarcinoma cell lung cancer (Novotny et al. 2009; Smith 2011) and suggest that the filter has little to do with safety. The filter's fibers can even enter the lungs of smokers (Novotny et al. 2009). In addition, the consumption waste of filter-tipped cigarettes has grown astonishingly to an annual amount of about 4.5 trillion in the world every year (Hager 2010).

Figure 1. Components of a Cigarette.
Source: http://www.bat.com/group/sites/uk__3mnfen.nsf/vwPagesWebLive/DO6HHJ9F?opendocument&SKN=1

Biodegradable?

Although researchers have confirmed cellulose acetate to be photodegradable, there is much debate as to whether it is biodegradable. Biodegradability can be defined as a "microbial initiated conversion of a substrate in a biologically active environment into carbon dioxide (aerobically), methane (anaerobically), cell wall material, and other biological products" (Puls et al. 2011). However, other definitions simply require a minimum rate of degradation (Puls et al. 2011). Numerous studies state that cellulose acetate is not biodegradable, pointing to its extremely slow rate of degradation (Novotny et al. 2009). However, the scientific community reports that it is technically biodegradable.

Initially, scientists also did not consider cellulose acetate to be biodegradable based on early studies that were done with organisms that solely degrade cellulose. But later studies revealed a crucial step – deacetylation – that instigates degradation. Many microorganisms have deacetylating acetyl esterase enzymes that can deacetylate cellulose acetate and began to break it down (Puls et al. 2011). Edgar et al. confirmed this when he observed biodegrading cellulose acetate in compost (Edgar et al. 2001). Thus, cellulose acetate is technically biodegradable, according to the scientific community.

Regardless of whether we can call filters biodegradable or not, there is no question that they take a very long time to degrade. Depending on the environmental conditions, filters can resist degradation and only completely disappear after 10 to 15 years (Greenbutts LLC).

Enhancing Degradation Rates

According to research on cellulose-acetate based materials, a combination of photo and biodegradation as well as product design enhances degradation. The outdoors environment can also positively influence the rate (Puls et al. 2011).

Cellulose acetate is photodegradable by UV wavelengths less than 280 nm. UV wavelengths in sunlight will only go as low as 300 nm at the earth's surface; cellulose acetate's photodegradability is therefore limited. Fortunately, the titanium dioxide (TiO_2) used to whiten filter fibers also functions as a photo oxidation catalyst (Puls et al. 2011). Scientists observed the diminishing of filters containing TiO_2 that were placed on a roof, exposed to sun, wind, and rain but no soil or standing water; they diminished 10-20% the first year due to photo degradation (Haynes et al. 1991). An ultrafine version of titanium dioxide shortens the degradation time even more; filters with 0.7% ultrafine TiO_2 diminished 65% in 6 months. Treatment of barium phosphate also enhances the photo reactivity (Puls et al. 2011).

Increasing the filter's surface area also quickens degradation. Greater surface area leads to increased exposure to microorganisms. One method of increasing exposure is to manufacture cellulose acetate fibers with water soluble additives, such as hydroxypropyl cellulose or starch, which will dissolve away when exposed to water and increase the fibers' surface area (Puls et al. 2011).

Factors such as moisture level and temperature of the surrounding environment also affect the degradation of cellulose acetate. Adding a decomposition accelerating agent to filter fibers may quicken the degradation, but the method is tricky because the cellulose acetate material must not degrade before it is discarded. A reaction controlling agent that is added with the decomposition agents can prevent untimely degradation. One patent suggests adding a hydrolysis causing additive to cigarette filters that will be repressed by a coating but released when discarded into water (Puls et al. 2011).

Perhaps the best way to enhance degradation would be to change the design of cellulose acetate products. In the case of cigarette filters, the entanglement of fibers and the triacetin "glue" that binds them together are serious barriers to the filter's disintegration. Several patents suggest changing the fibers' construction and using different "glues" to increase the rate of disintegration. One patent uses water soluble polyester polymers as the "glue" that eventually dissolves in water and releases fibers. Scientists have also suggested making the fibers shorter and thicker, as well as constructing the filter out of short cut segments. Manufacturers can also make partial cuts on the filter so that the individual fibers are shorter and less tangled. Designers suggest that these cut filters, compared to conventional filters, are twice as likely to degrade after one year (Puls et al. 2011). Scientists have also developed filters that are not made of cellulose acetate, which is later discussed in "Litter-Reducing Methods" (pg. 11).

Although many patents exist for enhancing filters' degradations, cigarette companies are not necessarily implementing these ideas. They must test these ideas for reproducibility and feasibility in manufacturing. Meanwhile, cigarette butts are being discarded in the environment every day and not degrading at the same rate. Time is running out; cigarette manufacturers or independent companies must test and implement methods of quickening filter degradation.

Persistence of Chemicals

It is not only the filter that makes cigarettes an environmental problem. Cigarette butts are a toxic waste due to the persistence of their chemicals and their cumulative effect. Most of these chemicals come from treatments used in growing tobacco. Heavy metals from soil, pesticides, insecticides, herbicides, and fungicides are present in tobacco products (Micevska et al. 2006; Frank et al. 1987). Unfortunately, the U.S. Environmental Protection Agency (EPA) regulates the pesticides used on tobacco crops, but does not look at pesticide residue on tobacco. Consequently, the USDA has found that some tobacco, both imported and domestic, have residue that exceeds the amount that is safe to humans and the environment (U.S. Government Accountability Office 2003).

Processing ingredients such as brightening chemicals on cigarette paper also lends to the toxicity of cigarettes (Owens 1978; Iskander 1985; Iskander et al. 1986). Smoked cigarettes contain numerous chemicals, such as ammonia, formaldehyde, butane, acrylonitrile, toluene, benzene, alkaloid nicotine (Schneider et al. 2011).

These chemical components do not just disappear. Moerman and Potts' analysis on metals leached from smoked cigarette litter found a positive correlation between the concentration of several metals and the soaking time of cigarette butts. They concluded that cigarette litter is a point source of barium, iron, manganese, and strontium contamination for at least a month (Moerman and Potts 2011). Cigarettes may seem harmless because of their size, but they are toxic and persistent in our environment. One cigarette may not do much damage, but trillions will.

From a chemistry perspective, cigarettes involve a complicated network of interactions between compounds. Enhancing the biodegradability of filters and decreasing overall toxicity of cigarettes require an extensive knowledge of this network of chemical mechanisms. Cigarette butts are small in size but are packed with various chemicals that have consequences that scientists are still trying to understand.

Consequences of Cigarette Litter

The following section describes some of the chemical consequences, specifically for animals and children who are exposed to the toxic effects of cigarettes. I also discuss financial consequences in municipal waste management.

Toxic Exposure in Marine Life

Marine life is often at the receiving end of leached chemicals and toxins. Marine animals may be especially harmed by nicotine, ethylphenol, and other organic compounds in cigarettes (Micevska et al. 2006). Ethylphenol, which is commonly used to flavor tobacco, can accumulate to such high levels in aquatic animals that they exceed the concentration in the surrounding environment (Clark and Bunch 1996).

Researchers at San Diego State University examined the toxic effects of smoked cigarette butts (smoked filter and tobacco), smoked cigarette filters (no tobacco), and unsmoked cigarette filters (no tobacco) on topsmelt and fathead minnows (Slaughter et al. 2011). Surprisingly, all three materials were toxic despite the lack of tobacco in two of them. However, the smoked cigarette butts with leftover tobacco did contribute to toxicity significantly more than the smoked and unsmoked filters without tobacco. Remnant tobacco, burned or not, almost always contributes to the cigarette butt's toxicity. The toxicity of unsmoked cigarette filters containing no tobacco indicates that chemicals used in manufacturing of filters are harmful even before the filters absorb chemicals when smoked. Thus, although smoking and the addition of tobacco increase the toxicity of cigarette filters, they are already toxic to begin with (Slaughter et al. 2011).

Toxic Exposure in Children and Landfill Demands

Children and toddlers who ingest cigarettes can also be poisoned, but to a much lesser degree. Children can easily pick up cigarettes and ingest them in places like parks (Novotny et al. 2009). Cases of cigarette ingestion usually involve children who are only a year old or younger. They are often found chewing the cigarettes (Kubo and Chishiro 2008).

Fortunately, cases of significant toxic poisoning in children are rare (McGee et al. 1996). Most children who ingest cigarettes do not show any symptoms, according to observations at poison control centers in both Japan and the U.S. (Kubo 2008; McGee et al. 1996). Symptoms that do appear are usually vomiting or lethargy, both of which eventually cease (McGee et al. 1996). Children do have to be admitted to a hospital's emergency department but usually are not hospitalized (Kubo and Chishiro 2008). Gastric lavage, or stomach pumping, is unnecessary in most cases (McGee et al. 1996).

Although the consequences of cigarette ingestion for children are not life-threatening, it is still an unnecessary danger and can be prevented by less cigarette litter in parks and other play areas.

Like other forms of waste, smoked cigarette butts also contribute to greater landfill demands. In addition, when they are littered, they lead to increased costs of municipalities' waste disposal (Novotny et al. 2009).

Thus, a greater presence of cigarette litter means a higher likelihood for poisoning in children, more exposure to toxicity in marine life, and higher costs of waste management. These financial, social, and environmental consequences clearly emphasize the need to reduce cigarette litter.

Litter-Reducing Methods

Scientists, entrepreneurs, and artists around the world have discovered innovative ways to address the problem of cigarette litter. Some people have chemically manipulated cigarette waste for creative and applicable purposes. Others have developed citywide programs for recycling cigarette butts. Some suggest changing the chemical composition of cigarette filters and finding alternatives to cellulose acetate. In this section, I discuss some of these proposed solutions as well as the feasibility of their global expansion.

Alternatives to Cellulose Acetate Filters

One approach to combating the negative consequences of cigarette litter is to create filters with materials other than cellulose acetate. In 2005, UK company Stanelco acquired a Germany company called Biotec, which makes starch-based polymer products for the pharmaceutical and food industries (Platt 2006). Their collaboration gave rise to a new food starch-based filter made out of carbohydrate polymers from potato or rice. Stanelco's filter degrades in about 60 days and does not carry the risk of smokers inhaling the filter's tobaccocoated fibers into their lungs (ENN 2005). The starch-based filter is also much cheaper than the cellulose acetate kind. Stanelco later hired Rothschild to develop strategies for distributing their cigarette filter worldwide (Business Wire 2005).

Another company, Greenbutts LLC, has developed a new kind of “all-natural” cigarette that aims to mitigate the harmful consequences of litter. Their cigarette’s filter degrades faster than the conventional kind and its tobacco contains no additives or chemicals. In contrast to the cellulose acetate fibers and triacetin binding agent in conventional cigarettes, Greenbutts’ filters are made from organic cotton and de-gummed hemp and bound together by wheat flour and water. Greenbutts can be placed along with seeds in a planter and used to grow a wide variety of plants. The company promises that the smoking experience will be just as satisfying as smoking a conventional cigarette due to their pure tobacco flavor. According to co-founder Xavier Van Osten, Greenbutts is currently working with different cigarette manufacturers and predicts that their filters will be sold to the public in 2012; the company envisions mass producing their filters (Greenbutts LLC).

Both of these filter renovations have great potential for decreasing cigarette waste build-up. The filters degrade much faster and smokers face less risk for inhaling carcinogenic fibers into their lungs. However, these cigarettes are limited in that they do not solve the problem of toxic persistence or the leaching of chemicals into the environment. While Greenbutts promises pure tobacco, their standards for purity may not mean that the tobacco does not carry trace pesticides. In addition, Stanelco seems to be purely focused on filter composition. An alternative to cellulose acetate filters is undoubtedly a step in the direction towards mitigating environmental consequences of cigarettes, but it is not a perfect solution.

Creative Repurposing

Artists around the world have also addressed the problem of cigarette butts; many have repurposed them into creative artwork. In Brazil, fashion designer Alexandra Guerrero makes clothing out of discarded cigarettes as a sustainable and creative way to address cigarette waste (Figure 2). Guerrero has collected around 5,000 cigarette butts to create 5 items of clothing. She uses autoclaves to sterilize the cigarettes, washes them in a solvent, sterilizes them again, rinses and dries them, and finally shreds the fibers. She dyes the fibers, separates them, and spins them with sheep wool to create a durable garment. The final clothing is made of 10% cigarette fibers and 90% sheep wool. Guerrero and her clothing company *Mantis* envision mass producing her clothing line (Greenmuze 2009).

In a similar fashion, Flore, a 22-year-old student and president of a small environmental group called Vents Solidaires, created a dress titled “Lulu” out of discarded cigarette butts in Paris. She began her project out of frustration with the amount of cigarette butts littered in the streets of Paris (Davies 2011).

Cigarette clothing has received mixed reactions – some people praise this creative approach to litter while others are wary of the clothing’s cleanliness. But clothing is not the only artistic response to cigarette waste. In Switzerland, street artist and smoker Jinks Kunst collected 20,394 cigarette filters to create a portrait of French singer Serge Gainsbourg. His project lasted three years and culminated in a special 20th anniversary tribute to the singer (Spooky 2011). Similarly, British artist Damien Hirst created an art piece titled “The Abyss” with stainless steel, glass, cigarettes, cigars, lipstick, and ash (CBS News Staff 2011; Artfact; Figure 3).

Figure 2. Fashion designer Alexandra Guerrero’s shirt made out of recycled cigarettes.
Source: http://mantis-mantis.blogspot.com/

Figure 3. Damien Hirst's "The Abyss" featuring cigarette butts.
Source: http://www.mirror.co.uk/celebs/news/2008/09/16/celebrity-artist-damien-hirst-makes-record-70m-115875-20738917/

Practical Solutions

Uses for cigarette litter go beyond aesthetics. Cigarette butts can be treated and transformed chemically into other functional materials. In China, Zhao et al. found that soaking cigarette butts in water would produce a solution that prevents N80 steel pipes from corroding (Hager 2010). All cigarettes used in their research were collected from trash or the streets. Cigarette butts were soaked in water, combined with a hydrochloric solution, and applied to N80 oil tube steel discs . Zhao et al. found that the cigarette solution acts as a cathodic and anodic inhibitor that adsorbs onto the metal surface, slowing the rate of corrosion. The solution with 5% cigarette inhibitors in 10% hydrochloric solution gave optimum preventative results – 94.6% inhibition efficiency (Zhao et al. 2010). Zhao et al's discovery not only repurposes cigarette litter but also helps oil industries that use steel pipes.

In the United States, Ohioan inventor Blake Burich has also found a clever way to use discarded cigarette butts. His idea is to convert them into adhesive material. His method involves grinding the cigarettes, saturating them with a solvent, adding a petroleum liquid to the mixture, and molding it into a semi-solid material. The material can then be transformed into useful products, such as adhesives, sealers, or coating (Burich 2009).

Students at RMIT University in Australia have discovered a way to incorporate cigarette waste into fired clay bricks. They first disinfected the cigarette butts in 105ºC heat for 24 hours and then sealed them in plastic bags. They used a Hobart mechanical mixture to mix different weights of cigarette butts with brown silt and clay-like sand for 5 minutes and packed them into brick molds. They then dried the cigarette and sand mixtures at 105ºC for 24 hours, removed the molds, and fired the mixtures in a 1050ºC furnace. The resulting bricks were considerably different from standard bricks; they are more porous and less dense with reduced thermal conductivity, compressive strength, and flexural strength. Only insignificant concentrations of metal leachates remained in the bricks. The authors of this project predict that their bricks made with cigarette butts can potentially replace standard bricks, except in situations where construction requires stronger bricks or a specific architectural design (Kadir et al. 2010).

While all of these approaches to reducing cigarette litter are innovative, it may be difficult to expand them globally. Fashion designer Alexandra Guerrero wants to mass produce *Mantis*, but she may be only one of few designers who are willing to take the risk of making cigarette clothing. RMIT University's bricks made with cigarette litter have less strength and needs to be tested over time for durability in buildings. Greenbutts will have to make successful contracts with cigarette manufacturers to put their filters in the market. Whether these methods can be regularly utilized in our society remains questionable.

Policies and Programs

Some of the creative, practical, and scientific approaches to cigarette litter that were previously mentioned are not commonly used (at the time of this study); however, a policy-based approach has been successfully implemented in a few cities. In this section, I discuss examples of smoking policies and programs that currently exist or are being considered in a few cities across the United States. I also discuss those that have failed to be passed. Furthermore, I examine the possibility of collaborating with the tobacco industry and its motivations for reducing cigarette litter.

Tax and Deposit Programs

Installing a citywide recycling program encompasses the creative and practical approaches to cigarette butts while also generating a widespread awareness of cigarette litter. The idea is simple – residents, smokers and non-smokers alike, would collect used cigarette butts and turn them in for some sort of compensation. The used butts would then be utilized in creative and practical ways, depending on how the city plans to recycle them. Ideally, such a program would become part of a city's routine and overall mindfulness towards littering cigarettes.

The city of San Francisco, CA implemented a cigarette recycling program in 2009, despite Prop 26, which restricts California cities and municipalities from imposing "externality offset" fees. Cigarette litter can be considered a negative externality since the prices for cigarettes do not include disposal costs. To offset externalities, San Francisco passed a policy that charges a $0.20 fee on each pack of cigarettes to cover the costs of tobacco product litter (Schneider et al. 2011). One challenge facing city officials was calculating the exact costs of litter abatement and the quantity of cigarette litter in San Francisco. For cost calculations, the city first obtained from its departments the total direct operating costs in general litter management, collection, and abatement. The total annual abatement cost for all types of litter was $25 million. The city then performed Street Litter Audits (SLAs) from 2007 to 2009, and found tobacco product litter to be 22.5% of all litter in San Francisco. Multiplying the percentage of tobacco litter by the total annual litter abatement cost gave the total abatement cost for just tobacco litter – about $5.6 million. The city added $1.4 million to cover the costs of administration, which gave a final cost of $7 million. The city then used the 2007 California Health Interview Survey results, which estimated the number of cigarettes smoked per day in San Francisco to be 31.8 packs per capita. Considering that tourists and commuters do not buy

50% of their cigarettes in San Francisco, the city incorporated an 11% reduction in abatement cost. The final total tobacco litter cost became about $6.5 million for the city of San Francisco (Schneider et al. 2011).

Initially, the program faced numerous oppositions, notably by Philip Morris USA, a large tobacco manufacturer (Hager 2010). In 2011, the city faced a lawsuit against Philip Morris USA as well as local liquor stores and markets. *Saker Kaleh vs. San Francisco* ended with success for the city and a continuation of their cigarette ordinance (Recycling News 2011).

Unfortunately, not all programs have been as successful. In 2001, Maine state representative Joseph Brooks proposed a Returnable Tobacco Bill, which would require consumers to pay a $1 deposit for each pack of cigarettes and later be refunded if they returned the used butts (Philip Morris 2001). The collected butts would be sent to energy recovery companies for incineration or landfills (Albert 2001). Brooks modeled the bill after the returnable bottle and container bills, which had already been in place for years in Maine. He was inspired to do something about the 2.3 billion cigarettes that Maine smokers consume every year, and the litter that inevitably accumulates (Onion 2012). However, the Maine Bureau of Health feared that children would collect the cigarettes and be repeatedly exposed to nicotine (Albert 2001). The Maine Grocers Association and Maine Chapter of the New England Convenience Store Association also opposed Brooks' bill because they were concerned about storeowners' health consequences from the accumulation of cigarettes in stores. Brooks responded with an addition to the bill that would outlaw anyone under the lawful smoking age from collecting used butts. To avoid skin contact with cigarettes, collectors could use a plastic bag that came with the cigarette pack (Onion 2012). Also, bottle redemption centers instead of stores would collect the butts (Albert 2001). Brooks anticipated that this program would profit bottle redemption centers and envisioned high school sports teams and bands doing “butt drives” to collect cigarettes. Despite Brooks’ attempts to appease the bill’s opponents, he was quickly defeated and the deposit system was never implemented. Maine governor Angus King also disagreed with Brooks and preferred an increase in the cigarette tax over the Returnable Tobacco Bill (Onion 2012).

Policies in Consideration

Since the success of San Francisco’s cigarette tax and the failure of Maine’s deposit program, other cigarette butt recycling programs have developed. In May of 2010, New York Assemblyman Michael G. DenDekker proposed a bill for a cigarette butt recycling program, which would require a 1-cent deposit per cigarette. The program would also create jobs for the departments of environmental conservation and health.

In San Diego, California, stock trader Curtis Baffico has created a recycling system in which he pays a “Butt Redemption Value” of $3 per pound of cigarettes that people collect. Baffico raises the money on his website (Ripplelife.org) and redeems the cigarettes at monthly collection events, the first of which was held at Pacific Beach in January of 2011. His system is unique in that it does not require a tax fee or a deposit, unlike the programs suggested by DenDekker or Brooks. Baffico specifically did not develop a deposit system because he felt that smokers would feel justified in littering if they paid a deposit. The most difficult part of his program is repurposing the cigarette butts. One of his ideas is to grind the cigarettes and add them to concrete so that the butts would replace fibermesh, a material that prevents concrete from cracking. The concrete would cover the butts and prevent their toxins from leaching (Skenazy 2011).

The future of both DenDekker bill and Baffico's program is uncertain since both are in the early stages. DenDekker's bill is still being developed and Baffico's program only started in 2011. However, they are promising and have great potential for reducing cigarette litter in New York and San Diego.

Other policy ideas have been suggested by advocates for litter-free cities. These include labeling cigarette packs with "do not litter", fining litterers, requiring filters that degrade faster, banning disposable filters, and educating consumers about their responsibility to keep the environment litter-free (Novotny et al. 2009).

Collaboration with Tobacco Industry

Not all litter reduction programs are led on such a small scale. Some programs have been led by the tobacco industry. The industry has been aware of the cigarette litter problem since the 1970s and the greater stigma that litter adds to smoking. Cigarette companies fear that non-smokers who are neutral about smoking will become less supportive of smokers because of cigarette litter. In addition, laws that ban smoking have used the issue of litter to successfully pass (Philip Morris 1997).

With the idea of increased taxes and more strict regulation looming over their heads, tobacco industry works have partnered with Keep America Beautiful (KAB), an organization dedicated to preventing litter and reducing waste. The industry's program to reduce cigarette litter aims to lower the stigma of smoking, prevent lawmakers from using cigarette litter as a reason to establish further smoking bans, and remove the industry's financial responsibility towards cleaning up cigarette litter (Smith 2011). Their motivations behind reducing tobacco waste are quite different from those that instigated citywide policies and programs.

Regardless of how different their motivations are, tobacco industries and city officials are making progressive changes towards reduced cigarette litter.

Policies and local programs may be some of the easier ways to reduce cigarette litter. They do not require years of testing the chemistry of cigarettes in laboratories and potentially reduce much more cigarette litter than artistic works can. City policies also grab the attention of local residents and can educate them about the environmental consequences of cigarette litter. Local programs bring together communities in the effort to reduce tobacco waste.

Cigarette litter programs may be more successful if they consider collaborating with the tobacco industry, which also strives to reduce cigarette waste.

Cigarette Butts at Pomona College

I have discussed why cigarette litter is a problem as well as approaches people all over the world have taken to reduce it. This next section places the idea of reducing cigarette litter in the context of a college campus.

College campuses accumulate a lot of cigarette litter, especially when 28.5% of college students smoke in the United States (Rigotta et al. 2000). Cigarette clean-ups at San Diego State University (SDSU) have collected close to 25,000 butts in just one hour (Sawdey et al. 2011). At University of California San Diego (UCSD), 17 volunteers collected 6,525 cigarette butts in one hour (Sawdey et al. 2011).

Factors that affect the patterns of cigarette litter on college campuses are unique to each school. Therefore, we cannot simply implement the same policy or program that might work well in a citywide context.

In fact, all the strategies that have been previously discussed cannot be immediately applied to every community. Before applying general methods for reducing cigarette litter, we must first observe the communities' pattern of cigarette disposal and the unique factors that affect their littering. This contextualizes the idea of litter-reducing methods to a specific environment and informs decision makers' actions to reduce litter specifically in their community.

In this case study, I examine cigarette litter at Pomona College, a small liberal arts college in southern California. Pomona College is part of a consortium of five Claremont Colleges (5Cs) in Claremont, California. Despite its small size, about 34% of their students smoke regularly, which is slightly higher than the national average.

I first examine Pomona College's patterns of cigarette disposal – the locations and counts of butts. Then I discuss factors that influence these trends from a sociological, psychological, and space-based perspective. Finally, using these patterns and factors, I make recommendations for what the college can do to reduce cigarette waste on campus.

In order to examine patterns of cigarette disposal, I spent a few weeks walking around campus and counting every visible cigarette butt I spotted on the ground. I mapped the number of cigarettes I found according to buildings or walkways and sidewalks.

The following section describes my methodology in counting and mapping – "rules" I established in counting, areas examined, and possible limitations.

Methodology

I counted butts around 36 buildings at Pomona College, including nearby walkways (Figure 4). I did not count any cigarettes inside the buildings. I counted cigarettes that were clearly visible from concrete or dirt walkways and other non-grassy pathways. For areas equally shared by two buildings (i.e. the space between Pomona Hall and Sontag Hall), I divided the count of that area between the two buildings.

I did a separate count of cigarettes on 42 sidewalk segments, which I distinguished from walkways as raised pathways next to roads (Figure 5). The only exceptions are Marston Quad and the walkway between Walker and Clark V leading to Bixby Plaza, both of which do not fit the designated characteristics of sidewalks. I did not incorporate their number of cigarettes in the count of nearby buildings because they are exceptionally large and popular walkways. Since the weather or leaf-blowers could have swept cigarettes to the side, I counted butts on the edges of sidewalks as well.

Due to several factors, my final count is a very rough estimate of the actual number of littered cigarettes on campus. However, I took several steps to acquire more accuracy in count.

Weather, such as rain and wind, moves discarded cigarettes around, which means that the location of butts I recorded is not necessarily where they were initially discarded. In addition, smokers might be less likely to go outside to smoke during rainy weather. Thus, I did not count during rainy days and tried to count at least two days after a rainy day. There were no severe winds during the period of counting, so I do not perceive them to have a significant effect.

At the time of this study, large areas of the campus were off-limits due to construction. Inaccessible areas are behind Mudd-Blaisdell and Frank, in front of Harwood, between Harwood and Mudd-Blaisdell, behind Bridges Auditorium, and behind Oldenborg. Students and staff, who would have discarded their cigarettes in these areas, throw them away elsewhere. Thus, the concentrated areas on my map may not appear in the same spots in other years. In addition, construction workers who smoke and litter their cigarettes cause an increase in the overall cigarette count. I found around 100 discarded cigarette butts in the construction trailers behind Mudd-Blaisdell, which suggests that construction workers may contribute a large portion to the overall cigarette litter on campus. I did not include this number in the map counts because it came from an external source and not necessarily from students and staff at Pomona. I avoided all other construction areas when counting.

The campus's grounds department affects the location and visibility of cigarette litter. The department uses a leaf blower to clear pathways of leaves and litter on Mondays (at the time of this study). Cigarettes discarded in the middle of pathways are blown to the side where they are easily covered and hidden by mulch. I mostly counted visible litter towards the end of the week so that I could count the maximum number of cigarettes.

Finally, to minimize double-counting, I counted around entire buildings and sidewalks at a time. While counting, I noted areas around buildings that accumulated a significantly large number of cigarettes. The cigarettes in these concentrated spots contribute at least 40% to the overall building's count.

In the next few sections, I describe the results of my map – patterns of buildings, sidewalks, and concentrated areas – as well as possible factors that explain these trends.

Pomona College: Cigarette Litter Around Buildings

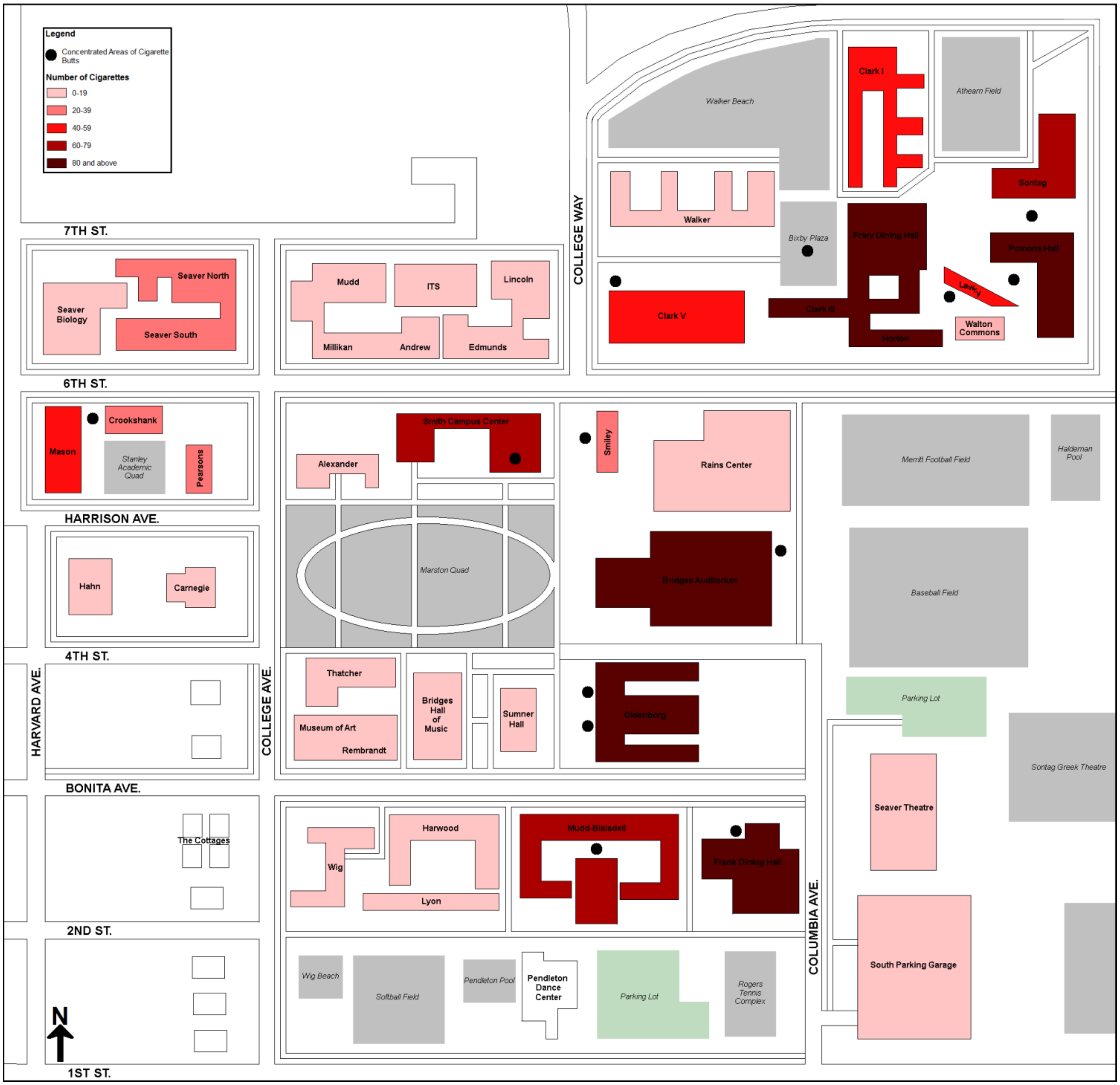

Figure 4. Map of visible cigarette litter surrounding buildings at Pomona College.

Pomona College: Cigarette Litter on Sidewalks

Figure 5. Map of visible cigarette litter on sidewalks at Pomona College.

Results and Discussion

Cigarette Litter Around Buildings. The map of cigarette counts around buildings shows that most of the buildings at Pomona College have lower cigarette counts (Figure 4). Over half of the buildings have 20 or fewer cigarettes discarded around them while only eight buildings have 60 or higher (Table 1); the normal distribution, or bell curve, is positively skewed. Various factors account for the exceptionally high cigarette counts in these five buildings.

High Litter Buildings. Three of these buildings are the college's dining halls – Frary, Oldenborg, and Frank. Each dining hall has over 80 cigarette butts; their average of 95 butts ranks the highest among all types of buildings (Table 2). The high amounts of litter at dining halls may be explained in one way by their function as a space for socializing. Considering that 98% of Pomona students live on campus, most of the student population eat at the dining halls regularly and often socialize as they eat meals together. The dining halls also hold events for students, which leads to more socializing. The degree of socializing may be connected to social smoking; studies show that 51% of current college students who smoke are social smokers, defined as mainly smoking in social situations (Moran et al. 2004). Thus, some students who behave as social smokers may smoke before and after meals as they socialize with their peers near the dining halls.

Frary especially provides a large space for socializing because it is larger and therefore attracts a larger population of students. It is also directly connected to Bixby Plaza, which provides a large space and many benches for smokers to sit and socialize. In fact, Bixby Plaza is one of the concentrated areas of cigarette butts. In addition, the college has special late night snacks during the week; thus, students eat and socialize at Frary after regular meal times. Oldenborg also has a high degree of socializing especially because of their language tables where students sit and socialize in different languages with their peers. This socializing may extend to before and after meals in front of Oldenborg (Figure 8).

While Frank dining hall also has a high degree of socializing, especially from first-year sponsor groups (residence hall groups organized by the college), the locations of cigarette butts at Frank indicate that another factor may influence its high count. I counted 146 butts at Frank (Table 1), but almost all of them were found in isolated nooks in front and behind of the building; students do not normally travel through these areas. It is very likely that these cigarettes came from dining hall staff who spend the most time in this type of building. Thus, the high cigarette count at Frank, along with the other two dining halls, may also be attributed to the type of people who spend the most time there – staff. They too may be socializing or relaxing during work breaks.

It is also important to note that general smoking habits and effects of cigarettes on smokers affects the higher counts around dining halls. The cigarette butts may be discarded by smokers who enjoy relaxing after meals with a cigarette. In fact, the post-meal cigarette is regarded as one of best cigarettes of the day by many smokers (Laurier et al. 2000).

In addition, all three dining halls are one of the few buildings on campus that attract people who are not only from Pomona students. The Claremont Consortium allows students to eat at dining halls at the other campuses, which means that 5C students come to eat, socialize, or relax with a cigarette after a meal at the dining halls. Oldenborg especially attracts a wider pool of students because language classes at the 5Cs require a minimum number of visits to the language tables at Oldenborg's dining hall. A larger pool, or variety, of students may mean higher rates of smoking and consequently more cigarette litter around dining halls.

Another building that has over 80 counts of cigarette litter is Pomona Hall, a residence hall on the north side of campus. Overall, residence halls, both on north and south campus, have the 2nd highest average cigarette count (Table 2).

One factor that may explain the higher count around residence halls is students' ownership of space around them. People smoke in areas where they feel most comfortable, which is helped by close proximity to homes. In the college setting, this may mean that students smoke near their rooms in the residence halls.

Another factor is again, the degree of socializing. Residence halls often throw events and students hold informal parties in their suites or rooms.

It is important to note, however, that the north campus residence halls have a higher count than those on south campus – almost 30% more (Table 2). At Pomona College, students in their first or second year (underclassmen) generally live on south campus while students in their third or fourth year (upperclassmen) live on north campus. This could mean that cigarette counts are affected by the age of students. Studies show that among college-aged smokers, 28% began smoking regularly at age 19 or older, which is typically during the first year of college (Wechsler et al. 1998). In addition, 39.4% of smokers increase their level of smoking in college (Sawdey et al. 2011). Pomona students who smoke may have started smoking during their first year and gradually increased their level of smoking, which explains the greater amount of cigarette litter in north campus dorms.

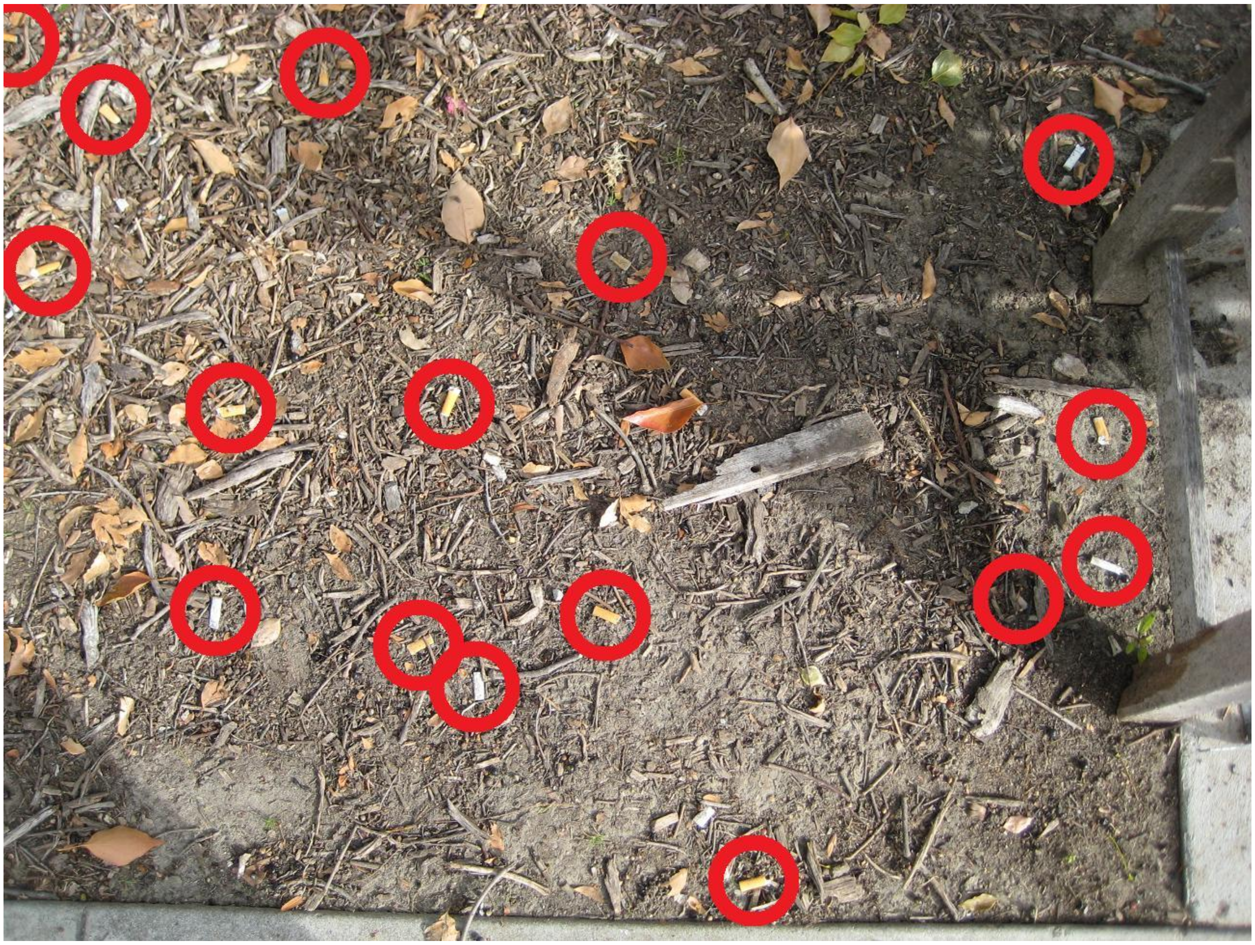

Figure 8. Sixteen discarded cigarette butts on the ground in front of Oldenborg.

Low Litter Buildings. Other factors account for exceptionally low counts of cigarette litter around certain buildings. Academic buildings overall have the lowest average of butts – only about 18 (Table 2). Professors and students seem to be spending the most time at academic buildings but the smoking frequency appears to be low, as reflected in the lower counts of cigarette litter.

Smoking prevalence generally decreases as level of education increases (Centers for Disease Control and Prevention 2010), so fewer professors may be smoking. In addition, although students attend classes in these academic buildings regularly, they may not smoke around them because of a lack of ownership of the space. They may associate academic buildings with work and not a place to call "home" or a space where they can comfortably relax and smoke. Students also tend not to socialize as much near academic buildings, which may also explain the lower counts of cigarette litter around this type of building.

Interestingly, although the overall count is low, science/math buildings have a significantly lower average count than humanities buildings. In fact, the humanities buildings have twice the amount of cigarette litter as science/math buildings.

There are several factors that could have led to this pattern. Many science/math students are on an academic track towards medical school, so they may be more conscious of the medical consequences of smoking. Consequently, fewer science/math students may smoke and fewer cigarettes are being discarded around their buildings. Humanities subjects may attract students who are more likely to engage in socially deviant behaviors, like smoking (Markle and Troyer 1979), leading to greater numbers of cigarette waste around humanities buildings. Humanities students in general smoke more than students who are pursuing a more scientific academic track (Peters 1967).

Concentrated Areas. While building counts overall exhibit interesting trends, it is worth noting the interesting patterns and possible causes among the thirteen concentrated areas of cigarettes. As a reminder, the number of cigarettes in these areas contributes at least 40% to the overall building's count.

Many of these concentrated areas are either isolated or not easily noticeable in public space. More specifically, the areas behind Bridges Auditorium and in front of Frank Dining Hall are isolated from students, indicating that staff workers are most likely contributing the litter count in these areas. Staff workers may be going to these less visible areas due to an obligation to maintain a professional image in the workplace or social stigma (Kaufman et al. 2010).

Social stigma of smoking may explain why so many of the concentrated areas are more isolated. Studies show that a stigma around smoking definitely exists. One study asked participants, who were mostly college students, to share their first impressions of smokers; smokers were viewed as less calm, considerate, disciplined, honest, imaginative, mature, and well-mannered (Dermer and Jacobsen 1986). In addition, over 25% of smokers at the Claremont Colleges have felt disrespected by non-smokers who reacted negatively to their smoking (Rojas 2012). And almost 60% of non-smokers said that their opinion of someone negatively changed if he or she was a smoker (Rojas 2012). Thus, smokers at Pomona College are very likely to experience a social stigma and consequently smoke in places where they can avoid these negative reactions.

Amenities in public space also seem to contribute to the concentrations of cigarettes in certain areas. Many of these areas, such as the area in front of Smiley or in front of Pomona Hall, provide benches or tables for smokers to sit at. These amenities provide more comfortable public space for smokers, which may lead to higher frequency of smoking and larger amounts of litter in these areas.

In addition, some of these concentrated areas exist near places of socializing. Smith Campus Center's cigarette count is largely contributed by the cigarettes found at Dom's Lounge, which serves as a place for parties and other events. At parties, students can more easily partake in socially deviant behaviors. Parties also involve a lot of alcohol use. Social smoking often goes hand in hand with alcohol use and happens more frequently at social events (Rigotta et al. 2000), which may explain the high cigarette concentration at Dom's Lounge. Higher frequencies of socializing, and consequently social smoking, may contribute to the larger amounts of cigarette litter in these concentrated area.

Building Conclusions. Overall, the patterns of cigarette litter around buildings indicates that more cigarette litter is found near places where there is a higher frequency of socializing, a greater variety of people, more staff and older students, greater ownership of space, more amenities like benches, greater acceptability of socially deviant behaviors and less visibility or experience of social stigma with smoking.

Cigarette Litter on Sidewalks. The map of sidewalks shows much less variability than that of buildings. Generally, most of the sidewalk segments have very low counts of cigarette butts; in fact, almost 70% of the segments have less than ten butts.

The sidewalks with exceptionally high counts of cigarettes appear in Marston Quad and around Smith Campus Center. These sidewalks are located at the central core of campus where there is high traffic from students going to class and back to their rooms. Additionally, Smith Campus Center is the main hub of the college; it is a resource for food, career advice, meetings, studying, mail, and more. Thus, people are constantly traveling through these sidewalks.

Other sidewalks with higher counts appear near the border of campus, like the sidewalk behind Mason. This is probably best explained by the fact that these sidewalk segments are likely to be shared by people from other campuses or residents from the city of Claremont.

Sidewalks with benches located nearby also have higher counts of butts. Most of the cigarettes found at Marston Quad were underneath its benches.

The patterns of cigarette litter on sidewalks show that more cigarettes are discarded in high traffic areas used by a greater variety of people and with more benches.

Overall, the factors that affect counts and locations of cigarette litter are the type of people using that space, ownership of space, public furniture, degree of socializing, intensity of traffic, smokers' daily habits, variety of users, and social perception of smoking.

Ineffectiveness of Ashtrays. The implications of these findings are significant in forming strategies to reduce cigarette litter at Pomona College. The college has not completely ignored the problem of cigarette litter; there are ashtrays present all throughout the campus. However, these ashtrays are not as effective as they can be. By transforming their design and placement, the college may decrease its cigarette litter dramatically.

While counting cigarette butts, I often found more butts on the ground around an ashtray rather than in the ashtray. For example, at Crookshanks, I found 51 butts on the ground but only 1 in an ashtray a few feet away. Similarly, I found around 50 butts in the courtyard near Lawry but zero in the ashtray in front of Walton Commons. A few exceptions include the ashtray at the southwest corner of SCC, which had 8 cigarettes compared to 8 in the surrounding area, and at Pearsons, which had 3 in the ashtray and 1 on the ground.

Overall, Pomona's ashtrays are not as effective as they could be, possibly because of their design and location. Ashtrays at Pomona are either small metal urns or larger concrete ones (Figure 6). Cigarette butts are exposed to open air in these uncovered receptacles. The urns are plain and blend in with the surroundings. They are sometimes located near a trash can, but not always.

The placement of ashtrays at Pomona also adds to their ineffectiveness. Pomona's butt receptacles have an open top, which becomes filled with rusty water after rainfall. Thus, they are usually placed under awnings, close to buildings. However, their location is confusing and impractical when it comes to the campus's smoking policy. The college prohibits smoking inside administrative and academic buildings, as well as residence halls. Additionally, they prohibit smoking in an outdoor area if the secondhand smoke can easily drift into a non-smoking area (Pomona College 2011). However, most of Pomona's ashtrays are located within a couple feet of a building's entrance. This means that if a smoker were to carry his or her cigarette butt to the appropriate ashtray, the secondhand smoke would most likely enter the building. It would be more convenient and practical for smokers to discard their cigarettes on the ground far away from buildings than to walk up to the entrance and risk exposing people inside the building to secondhand smoke. Consequently, cigarette butts are constantly discarded on the ground instead of appropriate ashtrays.

On the other hand, Pitzer College uses butt receptacles that have three benefits that our Pomona ashtrays do not have. Pitzer's butt receptacles are uniquely designed so that they enclose cigarette butts. They have a round bottom and restricted openings so that cigarette butts are not exposed to open air and fumes are enclosed (Figure 7). Their receptacles come from the company Global Industrial, which sells several designs of "Butt-tainers" that can hold up to 14,000 butts (Global Industrial). Unlike Pomona's urns, this model of outdoor ashtray reduces fire risk, keeps out rain and wind, and fights odors (Global Industrial). They can be placed on walkways far away from buildings, making it convenient for smokers to properly discard their cigarettes without the risk of violating campus policy. Additionally, they reduce students' exposure to secondhand smoke and cigarette odor because the fumes are enclosed. The concealed cigarette litter may also cause an overall decrease in littering since studies have shown that people are more likely to litter if there is litter around them (Cialdini et al. 1990).

Both Pomona and Pitzer's butt receptacles would be improved, however, by decoration. A study done at East Carolina University confirms that the presence of ashtrays decreases cigarette litter but also suggests that decorated ashtrays causes an even larger decrease (Cope 1993).

Recommendations. I recommend that Pomona switch their urns to these "Butt-tainers" and allow students to decorate them. I also recommend that Pomona conduct future maps of cigarette litter on campus to find where concentrated areas are consistently appearing each year. With this information, they can place butt receptacles in spots where they will be the most effective and utilized. I also recommend that the college research potential recycling programs or other companies to which they can donate collected cigarette butts from the "Butt-tainers".

Figure 6. Metal and Concrete Urns at Pomona College.

Figure 7. Cigarette Butt Receptacles at Pitzer College.

Conclusion

Literature has provided chemistry-based evidence for the slow degradability of cigarette filters and the harmful presence of their chemicals in the environment. Cigarette filters take 10 to 15 years to degrade and meanwhile the cigarettes leach chemicals that have toxic effects on marine life. Alternative filters that degrade much faster have been created and scientists have developed ways to chemically manipulate filters to enhance their degradation rate, but these scientific solutions are still being tested and not commonly utilized by cigarette manufacturers. Artists have incorporated cigarette litter into their artwork, but using cigarettes as a medium does not have a great enough reducing effect. The most realistic approach, at the time of this study, is policy-based; several cities have already implemented tax policies or recycling programs to reduce cigarette litter in their communities.

However, a case study of Pomona College shows that it is important to contextualize litter reduction. At Pomona College, a smoking policy is already being implemented and yet I counted 1,363 butts on its campus over several weeks. Higher amounts of cigarette litter appear in areas with higher traffic, more socializing, visits by a greater variety of people, more staff and older students, more public furniture, greater ownership of space, and less experience with social stigma. These findings show that the college's policy or installment of ashtrays is not doing enough to reduce cigarette litter; instead, they must redesign and relocate their butt receptacles with consideration of the patterns of high cigarette counts listed above.

I recommend that the college curb their cigarette litter by installing cigarette butt receptacles with closed tops, similar to Pitzer College's receptacles. I also suggest that Pomona College donate the discarded cigarette butts to be recycled or repurposed, similar to the donation that fashion designer Guerrero makes to plant pest control companies to be tested as insecticides. The college can also find cigarette recycling programs such as the one started by Baffico in San Diego, California.

At Pomona College and the United States overall, we must take action with cigarette litter. The United States has made significant progress in reducing waste through recycling programs. In many ways, we have recognized that we can relieve the burden of growing waste by taking action. Our society has adopted small but meaningful habits of recycling and reusing glass, plastics, and paper among many other materials.

We can do the same with cigarette litter, which contains plastics and other toxic chemicals. Recycling cigarette butts can become part of our society's daily routine, just as we recycle other products. Many strategies exist to reduce cigarette litter. Although some of them are underdeveloped, they all have great potential for drastically decreasing our tobacco waste.

This is a call to all smokers and non-smokers: let us take responsibility for our trash. We must acknowledge the growing amounts of litter, including cigarettes. Let us be mindful of our planet’s limitations; our giant piles of waste, if they do not degrade quickly enough, will have severe consequences for our world.

Appendix

Table 1. Cigarette Counts for Buildings

Building Name	**Number of Discarded Cigarettes**
ITS	0
Mudd, Millikan, Andrew	2
Seaver Theatre	2
Carnegie	3
Bridges Hall of Music	3
South Parking Garage	3
Alexander	4
Walton Commons	5
Seaver Biology	6
Wig	6
Lincoln Edmunds	8
Rains Center	10
Sumner	12
Thatcher	13
Walker	14
Harwood	14
Museum of Art, Rembrandt	16
Lyon	16
Hahn	17
Pearsons	22
Seaver North & South	25
Frary	26
Crookshank	34
Smiley	38
Clark I	48
Clark V	50
Lawry	50
Mason	51
Sontag	66
Clark III, Norton	66
SCC	73
Mudd-Blaisdell	77
Oldenborg	114
Pomona Hall	136
Frank	146
Bridges Auditorium	187
TOTAL	**1363**

Table 2. Average Cigarette Counts for Types of Buildings

Building Type	**Average Number of Discarded Cigarettes**
Academic Buildings[a]	17.90909091
Social Buildings[b]	33.22222222
South Campus Residence Halls[c]	45.4
North Campus Residence Halls[d]	58.5
Dining Halls[e]	95.33333333

[a]Seaver Biology, Seaver North and South, Mudd, Millikan, Andrew, Lincoln Edmunds, Mason, Crookshank, Pearsons, Hahn, Carnegie, Thatcher, Museum of Art, Rembrandt. [b]Walton Commons, Alexander, Smith Campus Center, Rains Center, Bridges Auditorium, Bridges Hall of Music, Sumner, Seaver Theatre, South Parking Garage. [c]Wig, Harwood, Lyon, Mudd-Blaisdell, Oldenborg. [d]Walker, Clark V, Clark I, Clark III, Norton, Lawry, Sontag, Pomona Hall, Smiley. [e]Frary, Frank, Oldenborg.

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