Microscrub Proposal
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MicroScrub:
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Problem

How might we reduce germ proliferation amongst individuals in highly-populated university settings, addressing both human-sourced contact and user-object interfaces, in order to lessen frequency and severity of preventable bacterial-generative illnesses?

Implementation of more sanitary practices on a college campus would greatly improve the general health of students and provide a preventative measure for the spread of illnesses. Most students are ambivalent to their standard of sanitary living, due to sparse attentiveness and diversion from health-centered practices. However, future implementation of a simplistic, albeit effective solution device would serve to encourage and proactively thwart the spread of germs and disease-causing microbes. Residential college campuses are amassed with an influx of microbes, stemming from the student-dense populus. A study by the Journal of American College Health declared that with an increased awareness of rectified sanitary techniques, students tended to wash their hands more. Thus, fewer students reported onsets of illness; fewer students missed classes (White 2005). This evidence proves that a concentrated movement toward improved handwashing techniques yields positive results. The aim of our project is to reduce microbe transmission amongst individuals, sourced from both other individuals and abiotic objects. A true understanding of these microbes and their transmission “might provide new strategies for restoring and maintaining human health” (Kolbe 2005). When harmful bacteria are spread, illness propagates; microbes “co-evolve with their human hosts” (White 2005). Because of this, as microbes increasingly permeate their surroundings, they become more complex and difficult to manage and rid. Because of this unfortunate evolutionary phenomenon, it is imperative that bacteria are hindered before first-reproductive multiplication. Areas of high-population density would largely benefit from the success of increased sanitary practices. The overwhelming majority of geographic locations in the modern world, have pockets in which masses of individuals congregate. Control and promotion of better sanitary practices, with a direct focus on these high-population density areas, will be highly advantageous in limiting germ expansion. A 1914 study of over 200 schools in Northern Georgia and Tennessee showed the majority had insanitary conditions, and though the locations were educational institutions, there was still poor supervision of sanitary habits, increasing the number of illnesses in the school. There are innumerable reasons why illnesses harm individuals, as these microbes cause absenteeism, lack of productivity, spread of larger diseases, etc. The increasing frequency of illness hurts the total population. Research also demonstrates the danger of presenteeism and how it can harm those watching.

Significance

High-population density areas desperately need new methods of disease prevention; crowded areas that experience overwhelming amounts of human traffic also experience increased levels of exposure to germs (Hilbur 2003). The heart of the problem lies in the fact that a majority of the population is indifferent to quality sanitation control; students, especially, fall victim to the “soap-less” method of hand-washing. Due to this negligence and inattention to proper sanitary practices, areas such as schools and daycares become optimal grounds for germ spread and overall microbe distribution.

Individuals with compromised immune systems, or autoimmune diseases, also live and work in these heavily populated areas (Stein 2011). In order to make the environment safe and sanitary for these individuals and yet others, an increase in preventative measures is an absolute must. Due to the influx of different individuals with various backgrounds, masses of people nearly always equate to masses of diseases. This variety and diversity of both individuals and microbe type is dangerous and remains a prime cause for germ transmission.

Recent studies have shown that better hygiene habits will decrease the spread of infections in highly populated settings, such as college campuses, schools, daycares, and other public places in society. It has been tested that at least one third of all hospital infections are preventable. Hand hygiene would help prevent and decrease the spread of pathogens in any hospital or medical center (Sandora 2008).

By creating a module that will improve and form hand-washing habits, infections in highly populated environments will be reduced. This would benefit society in multiple ways, one of the ways being in hospitals. People may develop more infections while being in the hospital. This longer hospital stay would consume a large amount of resources that may be better invested somewhere else. If hospitals and institutions have to spread their resources due to scarcity they may be put in a tough position. A seminal intervention study conducted 150 years ago showed that once doctors started washing their hands before delivering babies, the mortality rate because of streptococcal puerperal sepsis decreased from 22% to 3%

Our community is run by societal pressures. People have reported that they're more likely to wash their hands when there are others around than when they are completely alone in a public bathroom. This can cause problems because this lack of hygiene will spread germs in highly populated places. When people use our device they will become accustomed to washing their hands for the optimal time and they will carry on these habits even when they go to bathrooms that may not contain the module. By improving cleanliness in college campuses, we are also improving the student's' academic success. Studies have shown that cleanliness can affect a student's health. Our invention will use the power of people to create better hygiene habits.

Stakeholders

The vast expanse of this problem space allows to an incredible variety of stakeholders, a plethora of different affected individuals. In our tours of both Georgia Tech's Clough Commons and Emory's DUC buildings, we noticed- first and foremost, the potential impact that proper sanitation and an increase in available resources could potentially have on the student populus. Students are directly impacted due to their overwhelming presence on highly-populated university campuses; furthermore, campus initiatives are generally centered around student-advantageous alterations. Any technological advancements on a college campus, especially one that encourages consistent, proper sanitation, would be beneficial to student health. Due to traditional flus and cold viruses, the influx of traffic in urgent care and emergency rooms is both inordinate and entirely preventable. Health care professionals must spend a comparable amount of time treating patients, diagnosing virus presence, and prescribing needless antibiotics that only weaken the virus's susceptibility to known treatments. Because of this quantitative influx of patients in hospital environments, the problem of sanitation is vast and a notably desired preventative measure.

Through high-control control of microorganism spread and pervasiveness, a decrease in emergency room visits would result- an outcome highly suited to give health care professionals a well-deserved rest.

We aim for stability and sustainability of our proposed prototype. Because of this foresight, we must consider the potential private uses of this implemented solution. In the long-run, households may adopt the LED-strip, photon-powered device in order to educate children about the necessity of adequate hand-hygiene. When parents are notified of the impactfulness of the solution device in high-profile, high-population areas, they may so choose to implement a version of the device in their own homes. Though the problem space does not currently encompass private homes, expansion is certainly a probability we must address.

In lieu of increased student healthiness, the faculty of universities may expect more participation and better attendance from their students. Students often miss courses due to legitimate illnesses, especially bacteria-borne diseases that are contracted through both human-sourced contact and user-object interfaces. Because of these absences and inability to participate adequately, students often fall behind in their course studies.

With the successful implementation of an effective yet efficient solution to the sanitary issues of high-populated areas, the mitigation of microbe spread will also be solved. Though a clear solution has not yet been formulated, the desired outcomes are evident and straightforward. Because of this quantitative influx of patients in hospital environments, the problem of sanitation is vast and a notably desired preventative measure. Through high-control control of microorganism spread and pervasiveness, a decrease in emergency room visits would result- an outcome highly suited to give health care professionals a well-deserved rest.

Context and Existing Solutions

There is plenty of research involving sanitation in highly populated areas such as college campuses and there are plenty of solutions that attempt to address the issue. The issue of sanitation is an urgent problem to continue to develop a solution for because although there are many existing solutions to this problem, there will be room for improvement. In the experts interview, our expert concurred with the idea that it would be difficult to find a solution that has not already been applied, since this is such a pressing issue and is for the most part addressed in first world countries. The effects of a lack of sanitation and a lack of good hygiene practices ranges from manageable inconveniences to sickness that can extensively limit the day to day functions of a person. One problem caused by people being sick that has a great impact is absenteeism. The inability of a person to go to work, or to attend class has greater ramifications later on. Simple solutions to the problem, those involving the least effort and infrastructure appear to have the most success to curb microbe transmission.

Contemporary examples of solutions that have been effective include disinfectant wipes and hand sanitizer. In a study carried out over 8 weeks in a primary school – with the sample size of 285 students –results show that the use of disinfectant wipes and hand sanitizer significantly reduces the rates of absenteeism for students. Not only this, but Norovirus, the primary virus detected on surfaces in the classrooms, was found less frequently – 9 percent – in the intervention classrooms than at 29 percent rate in the control classrooms. Another study assessed the incidence of MRSA colonization in gymnasiums. This study chose to focus on gymnasiums because staphylococcal infections are more common in places in which people come in close contact with each other and because surface contamination contributes to MRSA transmission. This study found that in gyms where there were stricter cleaning procedures – in particular where disinfectant wipes were provided for patron use – no MRSA or MRRA colonies were found.

Hand-sanitizer, another effective solution to reduce microbe transmission and thus slow the rate of infection, quickly kills viruses that contribute to respiratory and gastrointestinal (GI) illnesses. In a trial testing the effectiveness of the use of hand-sanitizer in combination with hand-hygiene education versus a control, the results showed that the use of hand-sanitizer dramatically reduces the rate of respiratory and gastrointestinal infections. This experiment's sample size was 292 families, all with children in child care for a minimum of ten hours per week. The rate at which families receiving hand sanitizer and hand-hygiene education materials was significantly lower than the control group, proving the significant impact that hand-sanitizer has as a solution to this sanitation problem. In a study that took place within a hospital – specifically orthopedics – the success of alcohol based hand-sanitizers was tested in a facility with a capacity of 498 beds and 1700 employees. The decision to use hand-sanitizer was because of it's quick kill rate of 15-30 seconds according to a couple different laboratory tests. During the ten-month period during which the alcohol based hand-sanitizer was being used, the infection rate among patients for nosocomial infections was decreased by 36.1 percent.

These two existing solutions to the problem have had a major impact in deterring microbe transmission leading to more serious health implications. Part of their success can be rooted in the ease of use for these products. Hand sanitizer and disinfectant wipes are a simple solution that requires little to no effort on behalf of the user, making it illogical not to make use of the helpful resource. As several studies suggest, the leading issue with compliance to handwashing is the time necessary, lack of knowledge and skin irritation. Hand sanitizer addresses the problems that people see with the alternative of washing their hands and has therefore been effective in it's purpose. Disinfectant wipes have a marginal effect on skin and achieve their purpose simply. Overcoming barriers to compliance with one of the most effective forms of reducing microbe transmission has proved to be the greatest success of these two contemporary solutions. However, with these solutions there are issues. For both of these, the method of delivery to the user has had issues. A patent granted for a newer form of disinfectant wipe dispenser has made the case that previous dispensers have not had an excellent way in which the next wipe would be dispensed, thus leaving some residual on the container from the hand of the previous user. The potential for transmission of microbes coming from one of these dispensers, poses a potential risk for users and limits the success of this solution. Hand sanitizers also have some issues although the benefits outweigh the problems for the most part. Triclosan, a component of alcohol based sanitizers is limited in its antibacterial activity and can promote the colonization of antibiotic resistant variants of *Escherichia coli, Salmonella typhimurium and Myobacterium tuberculosis.* Not only this, but although hand sanitizers work as a short term solution, in the long term, it can cause skin irritation. Frequent use of hand sanitizers can also weaken the effectiveness, thus defeating the purpose of the hand sanitizers.

The issue of sanitation will be an ever-changing problem, and for this reason, it is important there be groups of people attempting to address different problems within this topic. Although there are plenty of solutions currently available, there is always demand for a solution to address another problem. With health issues constantly changing in the world today, arriving at a solution to attempt to positively impact sanitation in areas of high population density can have a major impact moving forward, and would establish an expectation to continue to create innovative solutions to address an important aspect of people's lives.

Why is it still a problem?

Efforts to improve sanitation have been taken continuously throughout society, such as implementing accessible hand sanitizer dispensers in the bathrooms and increasing funding for hygiene education. Other approaches, pertaining to restroom technologies, include automatic-sensor faucets that do not require physical contact with the handle. Although these successive protocols have been implemented, the failure of public adoption limits the predicted impact. We cannot force everybody to use the implemented technologies and practices; even when a majority of the population does, it only takes a small number of people to spread the bacteria and diseases around. If one person doesn't wash his or her hands and touches the doorknob, every person that touches that doorknob from there onwards will be contaminated with bacteria even if they washed their hands. It is difficult to control people's behaviors in sanitation or in their lack of awareness and it only takes a small portion of people to break the system. In order to truly solve the problem of sanitation, the solutions should involve a lot easier and user-friendly devices in order to get a larger portion of the population to adopt the practices.

Also another challenge with sanitation is to keep up with the constantly growing population. The rate at which sanitation programs are being introduced to communities is far lower than the rate of overall population growth (Unite for Sight). People are constantly moving in and out of communities, especially in high density population areas that it is extremely difficult to spread awareness and coordinate new sanitation practices/devices with all of them. It is difficult in high density areas to completely eradicate sanitation problems because humans are always constantly in contact with one another. Therefore, in order to overcome this obstacle, the solution implemented must be able to adapt to the growing population and the different individuals coming into and going out of the system.

Goal

The main focus of our solution is to increase the amount of time students spend washing their hands. If successful, this solution would decrease the rates of student absenteeism, and create a healthier campus. Most valuably, over repeated uses, the solution will cause students to form correct hand-washing habits that can be carried through the rest of their lives.

Objectives

- Reduce microbe transmission among individuals
- Improve sanitation practices among students

- Increase the time students spend washing hands

While the project is introduced and implemented, a series of objectives must be met in order to call the device a success. We must reduce microbe transmission among individuals in densely populated universities as well as increasing the amount of time an individual spends washing his or her hands. Illness is a common problem in residential campuses, as evidenced by the majority of our research, and a lack of sanitary practices only facilitate the spread of diseases among the entire student and faculty body. Particularly in densely populated areas, individuals come in increasing contact with each other, thus increasing the spread of these microbes as well. With a compromised immune system, a student or faculty member on campus will experience decreased productivity and efficiency at the very least. Greater effects may include sickness leading to absenteeism, hospital visits or more serious medical concerns. In any case, resources, whether it be Thus, setting an objective to reduce microbe transmission among individuals promotes an overall safer and healthier community. The need to reduce microbe transmission is essential, Though the actual process of measuring a decrease in overall illness is quite difficult, there are a series of procedures that can be done in order to truly evaluate progress.

Research proves that the optimum time for one to wash hands in 22 seconds, but students in reality wash their hands for a lot less time. We will create a small device that will be placed on top of sinks that will project beams of light into the sink bowl. The lights will be placed in a way that the lights project over the entirety of the bowl, making the colors very visible to the person washing hands and the others near that person. Essentially a timer, this device will use a traffic light-esque system of three lights: red, yellow, and green to determine how long the person has washed his or her hands. Increments on the device will be set in that for the first fifteen seconds, the light will be red, then later turns yellow, and then when the 22 seconds are finally completed, the projected light turns green, indicating that the student is good to go. The device will be triggered once the faucet is turned on and will turn off once the faucet is closed. It works under the system of social consciousness, where in that individuals would not want to leave while the light is red or yellow, and others watching will notice that the individual had not completed washing his/her hands. Because of this social influence, students will not want to face the societal pressures from their peers and will wish to show that they do indeed wash their hands to completion. In turn, the students will in a way be forced to finish the hand washing process because they do not wish to leave a bad impression on those nearby. The goal is that over time, students will develop a proper hand-washing technique and will wash their hands for the complete time even by themselves or in areas where the device is not present. Moreover, as students develop these proper habits, they will take their habits with them everywhere they go, ultimately reducing the likelihood of them contracting illnesses elsewhere as well.

A light will also be placed on the soap dispensers every time the device is triggered to encourage individuals to also use soap to wash their hands. Soap is also crucial to removing the harmful microbes off one’s hands.

While the final idea of the project exists in additional to starting prototypes, we still need to work on the dimensions of the device. Our end product will be compact and will be able to be bought as a single unit and will be easy to install and use.

With the device being created, there are several potential problems with how it will exactly work under different types of sinks. Because sinks come in all shapes and sizes and the bowls vary, the device must work to fit all bowls and make sure the lights are not projected outside of the sink.

The device has to be placed in such a way to work with different facets of different shapes and sizes as well. If the device is placed on the faucet and projects down, then it has to accustom for circular faucets, square faucets, etc.

A problem would arise with faucets that contain sensors to automatically dispense water, as many of them occasionally turn off if the hand is not right under the faucet, and by the way the device works, it would turn off and restart once the water stream starts again.

Outcome

In order to measure if the device actually has an effect on hand-washing time, sensors will be placed with the devices that monitor how long students wash their hands. For testing purposes, we will install sensors in a bathroom that does not contain the device to use as our control to monitor how much time on average students spend washing their hands. Then, we will install a prototype of the device in the sinks in addition to the sensors to examine any change in hand washing time. If there is an increase in average time spent washing hands, the results would yield positive results and would indicate that our device would indeed work. From that point onward, we could work on making the device more efficient and aesthetically pleasing.

In order to measure if the microbe transmission on campus is actually reduced, a series of potential methods can be done. Though it is difficult to measure exactly how many people are sick at all times, we can monitor visits of preventable illnesses to STAMPS on Georgia Tech's campus and similar on-campus clinics at other universities before and after the device has been implemented throughout the campus. We can also take swabs of how much bacteria are on door handles after students leave the bathrooms to notice a change of how much bacteria are on students' hands after they leave the sink.

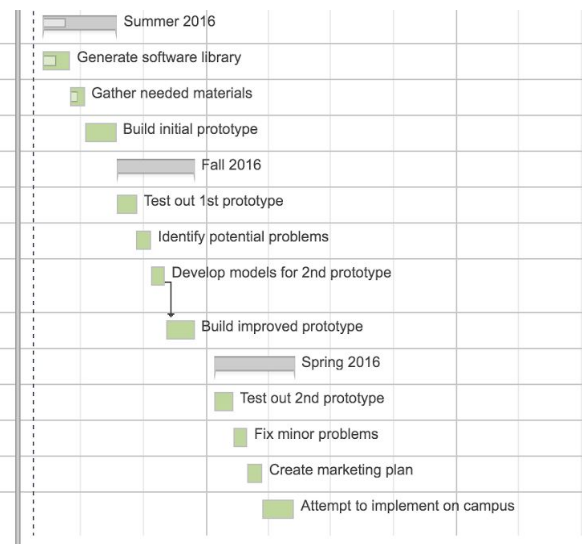
Anticipated Problems. The largest problem that will arise during this process is the whether this sanitation device will actually be used properly by individuals. The failure of public adoption limits the predicted impact. Many sanitation technologies and awareness practices have already been implemented such hand sanitizer stations, but its impact is very limited because not everybody uses them. In order to overcome this obstacle, we have to create something that doesn't take a lot of effort and time for the user so that a larger portion of the population is able to use it. A problem could arise in that though if the device works for a while, the student population as a whole may become apathetic to the device and turn it off even if it is red.

Project Team. Our team consists of six individuals, each of us first year students at Georgia Tech. Three are biomedical engineers, two are industrial engineers, and one is a computer scientist. This mix of majors works extremely well, as we are designing a device that works toward sanitation and overall health. With half the team as biomedical engineers, we can work to develop a more efficient device. Moreover, because the device needs code to function and run, a computer scientist can create such needed code. The industrial engineers have the knowledge of a vast variety of topics and have concentrations that will help in the project. Because we are only first years, we all have a much higher ceiling in learning new and relevant material. Though we all have different specific skills, we do not create distinct roles, as we all have a common interest in developing our project to its fullest potential. All members of our teams have a powerful passion in creating, working on, and implementing our idea, so it is expected that everyone comes forward to work on necessary documents, essays, etc. Every member shows up to all meetings, participates in presentations, writes paperwork, and puts in his or her most effort. Not only are we teammates, but also we are friends; we account for other work we may have with consideration. Through this common understanding and the same end goal in mind, our team runs effectively.

With our group, we receive guidance from the Grand Challenges program and the professors affiliated with the program. We also have a facilitator, Hailey Bureau, who comes to all classes, meets with us to discuss our project, and overall helps us tremendously in our project. She has provided new insight and ideas in how we can improve the device. For our sophomore year, there are many individuals that could provide us with useful advice. We would like to reach out to an individual in the CDC, professors at Georgia Tech such as Dr. Aral who work with sanitation, and the custodial staff to work with implementing our project throughout campus. Though our group has the skillset to create the project, the help of other individuals will bring the project to life.

Timeline

Summer 2016	**05/07/16**	**08/22/16**	**77d**	
Generate software library	05/07/16	06/15/16	29d	
Gather needed materials	06/15/16	07/07/16	17d	
Build initial prototype	07/07/16	08/22/16	33d	
Fall 2016	**08/22/16**	**12/13/16**	**82d**	
Test out 1st prototype	08/22/16	09/20/16	22d	
Identify potential problems	09/20/16	10/12/16	17d	
Develop models for 2nd prototype	10/12/16	11/01/16	15d	
Build improved prototype	11/02/16	12/13/16	30d	8
Spring 2016	**01/11/17**	**05/08/17**	**84d**	
Test out 2nd prototype	01/11/17	02/08/17	21d	
Fix minor problems	02/09/17	02/28/17	14d	
Create marketing plan	03/01/17	03/22/17	16d	
Attempt to implement on campus	03/23/17	05/08/17	33d	



Budget. The project will require a number of components to create a functional module. To make one module, we will require a microprocessor, a solar array, a capacitor, an IR proximity sensor, 2-5 RGB LEDs, possibly a buzzer module, and possibly an NFC shield. As the research has not been conducted fully, we can only provide an estimation of the expected cost. We expect that the cost per module (for the first prototype) will be around $40. This number is expected to drop to around $10 by the production model. Outside of that, if we pursue an NFC-based analytics system, then we would need a minimum of 1 Android phone with NFC compatibility and a dedicated server for data storage.

Expected Outcomes and Future Direction. Make a profitable product and have a major impact on the overall health within college campuses and other highly populated areas. We aim to develop and create a cost effective and successful tool used to exploit the social pressures in order to incentivize people to wash their hands and prevent the spread of disease. After year 2 we expect to see our solution being implemented in college campuses. We hope to start off there and then see our solution in other populated areas, such as bathrooms in restaurants and hospitals. We could work along with Stamps. This is Georgia Tech's Health Services Center. By working with Stamps we can help impact Georgia Tech campus. In order to have a sustainable project, there are various relationships that would need to be developed.

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