The B Respirator Respiratory Protection for the Bearded Man

Joseph R. Allgeier
jrapgd@rit.edu

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The B Respirator
Respiratory Protection for the Bearded Man

by

Joseph R. Allgeier

A Thesis submitted in Partial Fulfillment of the Requirements for the Degree of Masters of Fine Arts in Industrial Design

School of Design
College of Art and Design

Rochester Institute of Technology
Rochester, NY
May 5, 2020
Thesis Approval

The B Respirator Respiratory Protection for the Bearded Man

Thesis Title
Joseph Allgeier

Thesis Author

Submitted in partial fulfillment of the requirements for the degree of Master of Fine Arts

The School of Design | Industrial Design
Rochester Institute of Technology | Rochester, New York

Lorraine Justice

Chief Thesis Advisor

Name

Title

Lorraine Justice

Digitally signed by Lorraine Justice
Date: 2020.05.01 23:10:50 -04'00'

Electronic Signature: Use Adobe Acrobat

Stan Rickel

Graduate Director

Name

Title

Stan Rickel

Digitally signed by Stan Rickel
Date: 2020.05.02 09:50:51 -04'00'

Electronic Signature: Use Adobe Acrobat
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Stan Rickel
Lorraine Justice
Alex Lobos
Chris Lyons
Dave Austin
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Jimy Joe Allgeier
Larry Aloisio
Mike Dear
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2. **Abstract**

The news today is filled with stories of respiratory illnesses. The health risks to people are everywhere. Dangerous health situations are created by nature and they are also man made. One thing stands between people and breathing contaminated air and that is a variety of different types of dust masks and respirators. Unfortunately, a huge portion of our population has been left out of this protective solution since most affordable respirators rely on seal created by skin contact. Men with beards or facial hair that interfere with this seal must choose between faulty protection or no protection at all. “Just shave your beard and there isn’t a problem”, you might say. Far too often men choose their beards over respiratory protection. This hair may act as a natural filter but it is far less effective against small particulate and useless against fumes. The beard is a powerful psychological symbol for men that represents much more than most people may recognize. Choosing to cover one's face with a mask is a transformative act and it is more complicated than simply choosing to protect oneself from largely invisible hazards. Having PPE (Personal Protective Equipment) that is comfortable, attractive, compact, and easily accessible are all very important considerations when people choose to protect themselves. The B Respirator relies on a mouth piece and a nose plug without using a skin contact seal. This device is compact enough to be compatible with all other types of safety equipment including safety glasses, ear muffs, face shields, and hard hats.
3. Review of Literature

Background and Statistics:

Hazards are all around us both in the workplace and the home. Often it is hard to stop during a given job to get the proper safety gear or PPE, (Personal Protective Equipment) that is needed to complete the project safely. As a father and husband, I have a limited amount of time to complete a whole list of projects. On one occasion where my wife and son were out for a few hours, there were several hazardous jobs on my list where I should have been wearing my ½ face respirator. Even though my mask was stored 20 feet away I never stopped to get it and put it on. The projects I was doing that day included spray foam and PVC Glue in my basement as well as sweeping my garage floor (huge dust cloud) and using my leaf blower against the corner of my house where I blew dirt and paint chips into my face. I spent the night after all of this work lying in bed awake and coughing.

Lung Cancer is the number 1 cause of cancer deaths of both women and men in the United States. 156,000 deaths are attributed to lung cancer each year in the US. According to Lungevity.org, one in 16 people will be diagnosed with lung cancer in their lifetime. 391 Americans will die of lung cancer today and every 2.3 minutes someone new is diagnosed with lung cancer.

Anyone who works outside of the home can develop work-related lung disease. The most common setting for work-related asthma in the United States is non-industrial workplaces such as hospitals, schools, and office buildings due to exposure to mold, construction dust, and cleaning agents.

In total, more than 1 billion people suffer from chronic respiratory conditions including asthma, COPD (chronic obstructive pulmonary disease), sleep-disordered breathing, pulmonary hypertension, and occupational lung disorders. Over 160,000 people die from chronic lower respiratory disease (including asthma) every year which is the 4th leading cause of death in the United States (after #1 heart disease, #2 Cancer, #3 Accidents).

What About the Hairy Dude?

A few years ago, I was showing the renowned Industrial Hygienist and founder of ACTS (Arts, Crafts, and Theater Safety Inc.), Monona Rossol, around the facilities of RIT’s College of Art and Design. We happened to run into a Ceramics student who was on his way to mix up a batch of clay and he was wearing an N95 Respirator. He also happened to have a full beard which would affect the close-fitting nature of this dust mask and wouldn’t block the 95% of particulate it was designed to filter. Monona, of course, used this as a teaching opportunity to inform the student that he was not able to wear that respirator with a beard. The student smiled and said that some protection is better than nothing and went on his way to mix up his clay.

I have been involved with fit testing of half-face respirators for several years and it has always been a shock to many students that they need to shave to achieve a proper seal while wearing their ½ face respirator. We have gone as far as declining to fit test those students that are sporting a face full of stubble. Several of the other staff members that I work with have declined to get fit tested at all due to their unwillingness to shave their beards. When I mentioned shaving to several new employees as a necessary part of getting fit tested, I was met with multiple responses that were all equally negative. “When I shave, I look way younger” and “F--- this place, they can’t make me shave.” This is not just a University policy it is the policy of Occupational Safety and Health Administration (OSHA).

OSHA Standard for Respirators, Respiratory Protection, 1910.134

(1) Facepiece seal protection [1910.134(g)(1)]

(i) The employer shall not permit respirators with tight-fitting facepieces who have: [1910.134(g)(1)(i)(A)]

(A) Facial Hair that comes in between the sealing surface of the facepiece and the face or that interferes with valve function [1910.134(g)(1)(i)(A)]
The responses of my colleagues and my reluctance to shave leads me to believe that there is something much deeper involved while thinking about shaving off one’s “Lip Sweater”. What is the significance of a man’s “Crumb Catcher” and why are so many men attached to their “Flavor Savor”?

The beard is a powerful social signal that gives off clues about what kind of a man the wearer is. There are many reasons to have a beard that ranges from religion to reproduction and from intimidation to protection from the weather. Whatever the reason it is clear to me that the importance of the beard goes far beyond the common misconception of laziness. Today allowing beards is an important consideration that is facing many organizations including the public sector and the military and should be dealt with proactively. Solutions should accommodate the individual’s facial hair preferences while protecting them from hazards that they face at work and home.
4. International and National Literature Review:

2019 Respiratory Emergencies in the News:

“Wildfire smoke Threatens Health for Miles Around”
Robert Preidt, Health Daily Reporter, Wednesday, October 30, 2019

The smoke from the wildfires blazing in California is causing a potential health risk for those miles away from the flames. “Small particles in the air can travel hundreds of miles. While the immediate danger is within a 25-mile radius—depending on the winds—particles travel and float in the air for up to two weeks after the fire is out, says Dr. Zab Mosenifar”. The smoke caused by wildfires can cause several health problems for those breathing these particles including both short and long-term damage to the lungs and airways. The very young and the elderly are particularly susceptible along with pets and those individuals suffering from lung and heart disease. They suggest using an N95 dust mask or a wet towel while going outside when there is wildfire smoke in the area.

“I feel robbed’: Stonemasons launch class action over silica dust exposure, Authorities are bracing for a health crisis that could be worse than asbestos exposure”, Lisa Martin, The Guardian, Thursday, May 30, 2019,

This article discusses the effects of harmful dust from working with kitchen countertops. Hundreds of Stonemasons in Australia have been diagnosed with Silicosis. One man affected is 29-year-old Joel Goldby, who says that he feels robbed and that if he tries to run, he is out of breath in 30 seconds. His lungs are covered by nodules ranging from 1mm to 5mm and he says he had never even heard about these types of problems and didn’t understand the danger involved.

“Hundreds of People Suffering Respiratory Problems After Acid Rains in Iran”,
Radio Farda, October 28, 2019

Air pollutants mixed with the first seasonal rains in the southwest of Iran caused hundreds of people to visit medical centers. Many of them were treated for pulmonary complications while others were admitted to the hospital. Khuzestan’s air is polluted and particles in acid rain can cause health problems or make existing problems worse.

“Greenpeace questions Hong Kong police claim that blue dye from water cannon is harmless”, Holmes Chan, The Mozar, October 25, 2019

The Hong Kong Police say that the blue dye that was sprayed on protesters is harmless. The preliminary tests on this water show that it not only had blue dye in it but also had adhesives and toxic tear-inducing chemicals. The immediate reaction to this liquid is severe discomfort to the human body including severe skin irritation, damage to the eyes, and inflammation to the respiratory system. Many people other than the protesters have been negatively affected by this dye including, reporters, restaurant owners, and street cleaners. The police say that the dye is useful to identify who was present at a particular event and that after 10-15 minutes of fresh air and clean water the effects of the solution will subside.

“Why is the Government Refusing to Address the Smog Crisis”, Zeeshan Shah, The Express Tribune Blogs, November 11, 2019,

Smog is an epidemic sweeping across South Asia including India, Russia, and China. This air pollution has been caused by a growth in population, and industrial emissions from farms, factories, and automobiles. The crisis reached emergency levels in New Delhi when the smog got so bad that many commuters could not see 3-5 feet in front of them. Schools were closed and construction was banned in the city temporarily. Many people were brought to the hospital with acute respiratory infections and children were particularly at risk. Smog is a massive toxic haze that can stay in the air for days or even weeks.
“Dust to Dust”, Emma Crates, The Construction Index, Nov. 27, 2019

Silica is found in many common Construction Materials and it is a huge risk factor that is under increased scrutiny for workers to be exposed to. It is viewed as the number 2 health risk to workers, eclipsed only by asbestos as a highly hazardous substance. Silica is everywhere in construction including clay, sand, rocks, mortar, tiles, concrete, ceramics and mining. One of the biggest health problems with Silica is that it may take 20 or 30 years for the effects to show up on an X-Ray in an otherwise healthy adult.

There are new limits to the exposure of workers being put in place in the construction industry and respirators are being viewed as a last resort in protection. The combination of wet methods of cutting and grinding and other administrative controls are being required to minimized worker’s exposure to this deadly mineral.

“Mold in Homes can Present health hazards and legal complications”, Celia Suepel, Daily Freeman, Nov 10, 2019

For many years there has been a discrepancy between experts about what types of mold are bad for a person’s health. New findings show that black mold may have the same effect on the respiratory system as other types of mold when found in the home. These effects include asthma, shortness of breath, respiratory illness and allergies. Since there are no state or local building codes that deal with mold it is difficult to find attorneys that will take the cases of low-income renters who deal with these mold issues.

“Doctors Spot a New Lung Disease Tied to Vaping”, Steven Reinberg, Web MD, Health Day Reporter, Nov. 21, 2019

Popcorn lung is a condition that is associated with workers that are exposed to chemical flavoring used to produce microwave popcorn. This chemical causes an inflammation of the small airways in the lungs when it is inhaled. A 17-year-old boy has had similar symptoms caused by vaping. At this time, it is not clear which of the chemicals that the boy inhaled from his E-cigarette has caused the lung injury but no vaping products can be considered safe.

“Commercial 3D Printer Emit Traces of Toxic Fumes, Study Finds”, E&T Editorial Staff, E&T Engineering and Technology, October 8, 2019

Research conducted at Georgia Institute of Technology has found that particles emitted from 3D Printers can cause a toxic effect on respiratory cells. Both PLA and ABS plastics have been proven to emit toxic particles, however, because ABS is heated to a much higher temperature, these types of plastics are of higher concern. The study also indicated that the environment would play a factor in how much people were exposed. For instance, a building such as a school or an office with better ventilation may be less affected by emissions than say a typical residential situation.

“Safety Check, Wood Dust Rules need to be on your Radar”, Jary Windstead, Pallet Enterprise, June 5, 2019

There are 2 major concerns related to wood dust created in pallet making facilities. One is the health and safety concerns of the employees from the dust. Exposure to airborne dust can irritate the skin, eyes, nose, and throat as well as lung diseases including asthma, COPD, infections, and cancer. The other major concern is the risk of explosion and fire from combustible wood dust. This risk exists in many places where fine dust is suspended in the atmosphere including mines and grain elevators. If there is a concentration above the permissible limit, an explosion can occur.
The Respiratory System

What is the Respiratory System and How Does it work?

The human respiratory system is a series of organs that work together to bring oxygen into the body and expel carbon dioxide. The major organ involved with this gas exchange is the lungs. The average resting respiratory rate for adults is between 12 and 16 breaths each minute. Air travels in through the nasal and oral cavities, down through the trachea (windpipe), and then into the bronchial tubes. These tubes carry air into each lung and are lined with cilia which are tiny hairs that move mucus up and out. From the bronchial tubes, the air splits into the lobes of each lung (the right has 3 and the left has 2 to make room for the heart). These lobes are filled with Alveoli, which are small sacs that separate oxygen and carbon dioxide. From here the oxygen is carried by the blood and pumped by the heart throughout the body (Circulatory System). The diaphragm is the muscle that controls breathing in and out and is located below the lungs.

Illustration 1.1 Major Respiratory Structures

The major respiratory structures span the nasal cavity to the diaphragm.

Anatomy and Physiology, Rice University,

Major Respiratory Structures

Oxygen is critical in sustaining the function of the human body. If oxygen is denied for 5 minutes or more, brain cells begin dying which can lead to extensive damage to the brain followed inevitably by death.

Many illnesses afflict the lungs and respiratory system. These include infections such as Influenza and pneumonia, as well as chronic diseases such as asthma and COPD (Chronic Obstructive Pulmonary Disease). The most common sickness that a healthy adult might face is an infection which is most often
accompanied by a cough. A cough might be a symptom of a chronic condition such as asthma, emphysema, or bronchitis.

Julian Barling and Michael R. Frone discuss the difference between Occupational Illness and Occupational Injury in their book “The Psychology of Workplace Safety”. Occupational Illness represents an abnormal condition resulting from exposure to factors associated with employment. A few of the categories include dust disease of the lungs (ex: asbestosis, silicosis) and respiratory conditions (pneumonitis, pharyngitis). These often fall into the category of intentional occupational injuries instead of unintentional caused by neglect for standards already in place in the industry.

**Air Pollution and Respiratory Health:**

The world continues to get hotter and overpopulated. According to the World Health Organization (WHO), 9 out of 10 people in the world breathe polluted air. The health effects on both children and adults are very serious and contribute to the deaths of 7 million people per year. The 2 main types of air pollution are ambient (outdoor) and household (indoor) which contribute to one another as air moves from inside to outside or the opposite.

Doctors have recommended that people in areas with highly polluted air quality take steps to better their breathing situations. One is to wear a face mask that is N95 or higher and is National Institute for Occupational Safety and Health (NIOSH) certified. Another is to avoid early morning and late evening walking and cardio exercises since these are the times when pollution is most concentrated. It is recommended to avoid burning anything inside the home such as candles, incense, and wood. Keeping the household clean and using wet methods of cleaning when possible, helps increase indoor air quality.
My Sicilian Getaway:

Illustration 1.2 Map of Sicily with Major Cities and Places, Magical Earth,

I was fortunate enough to study in Florence, Italy for a year while I was in college. While learning traditional stone carving techniques and traveling throughout cities in Tuscany, I was also able to travel to the Island of Sicily. The City of Catania was covered in dense black volcanic ash. The people there seemed almost indifferent or slightly annoyed although many of them were wearing paper dust masks or covering their faces with pieces of cloth. I was unaware of the dangerous environment that I had entered into.

Volcanic Ash carries with it a multitude of toxic gases and particulate. These can include Carbon Dioxide, Sulfur dioxide, Hydrofluoric Acid, and Hydrochloric acid according to Gretchen Williams, a geologist who works in the mining and metals industry at Midnight Sun Mining Zambia. The short-term effects of this type of exposure are runny nose, sore throat, coughing, shortness of breath and the possibility of bronchitis. Long term exposure to volcanic ash may result in silicosis.

My painting project:

Over the summer I decided that my 110-year-old house needed to be painted. I had painted interiors and exteriors of houses in the past. By the end of the summer, my house was a patchwork quilt of areas of the house that I could most easily paint by hand. During this big project, I did a ton of paint scrapping on the blistering and peeling paint. Since the house has been painted many times before 1960 there are layers of lead-based paint. During the process, I was so focused on the hazard of not falling off my 24-foot ladder that I did not wear a respirator to protect my respiratory system from this hazardous dust. Through this painting project, I developed a nasty cough that lasted through the summer and persisted into the fall months. E, I called in the experts to finish the job.
In both of the above instances, it would have been very beneficial to have a lightweight compact respirator to protect me from hazards. Many people work with environmental hazards daily. Some of these hazards are natural and others are man-made. The following articles describe respiratory problems in the news from the past several years. The people described in each of these instances could benefit from a readily available, lightweight, compact personal respirator.
The Psychology of the Mask

The Finishing Touch:

Something happens when a person covers their face. It can be as simple as placing a piece of cloth over their nose and mouth and suddenly that person is transformed. The identity of the person is suspended and one’s outlook becomes emboldened. This is the power of the mask. A facial covering that has the capability to transform as well as protect from numerous hazards.

The Veiled Face:

The mask would seem to be a very self-contained and simple concept however masks throughout different cultures across the world have been used in ritual and drama throughout history. Many masks have changed their meaning throughout history and have been reallocated for different purposes. An example of this is the large hooked nosed mask of medieval times that started as a way to shield the wearer from the black death and now is a symbol of fun and spectacle throughout Europe.

Some masks are associated with rites of passage, death, and initiation. For instance, some tribes in Africa use the mask as a part of male initiation and it is a symbol of social transformation. In ancient Egypt, masks were used in both rituals and in death. The Egyptians believed that it was important to preserve the body of the deceased so that the soul had a place to reside in the after-life. The use of a death mask allowed the soul to recognize its body so it could return to it. Rituals were performed by priests in Egypt oftentimes wearing masks resembling different animals or gods.

The mask as an important symbol of transformation is found throughout cultures from around the world. Whatever the purpose of the mask they have great power as both object and symbol. Time changes the meaning of these artifacts but they continue to be used in many ways throughout every culture around the world.

Sara McCarty and John Nonley discuss the mask as it is used in Offense and Defense of the individual wearing it in their book "Masks, Faces of Culture". They describe the mask as “a protective covering for the face”. These coverings are worn by many types of people including athletes, terrorists, and rebels and are used for a variety of reasons. There is a very close relationship between our ancestor’s use of masks and our modern-day versions of these objects. It stems back to “the dangers and hostilities of the surrounding world”. The aggressiveness of the human circumstance is constantly on display whether through sports or constant warring of groups fighting for space and the right to exist.

As opposed to many insects and animals in the natural world, humans have not evolved to have defenses such as claws, venom, and camouflage. We have had to develop our own armor as protection out of many different types of materials including metal, leather, cloth, and plastics.

Outside of western cultures, there are few cultures who made masks for the sole purpose of protection during battle. One such culture is the Samurai of Japan whose helmets were worn by this elite military force that depicted different deities or animals that the wearer wanted to identify with. These helmets also acted to distinguish the wearer during a battle, not only transforming the wearer’s appearance but also inspiring their performance as well.

The European knight of the mid-fifteenth century wore full suits of metal armor along with elaborate helmets. As they developed, visors were added that could open and close along with decorative elements that identified the wearer's status and heroic deeds while in battle. The armor not only signaled the rank of the wearer but became an advertisement for the individual craftsmanship of the metalsmith maker. European armorers were the most important craftsman of their time and the armor itself became an art form and a form of sculpture.

The Man Behind the Curtain:
In the book “Face and Mask, A Double History”, Hans Belting explores the deeper meaning of what the face represents and the psychology of wearing a mask. He discusses the face as having deep meaning in expression, communication, and self-representation. Belting discusses the history of the mask as tied to the history of the face and the superiority of the static mask to capture expression rather than an ever-changing and erratic face.

John W. Nunley discusses how masks have been used for over 30,000 years throughout human civilizations in his book “Masks faces of Culture”. They are a part of what makes us distinctly human and allow us to express our identity individually and as a society. Some of the oldest depictions of people wearing masks are in cave paintings on the Caves of Lascaux. There was a spiritual connection between the animals that were hunted for food and the hunters themselves. Many masks are used in ceremonial dances in which the wearer masquerades as the animal to ensure a safe and productive hunt.

A mask allows us to be anonymous and allows the parts of ourselves otherwise hidden to come to the surface. A great example of this is the anonymity of “road rage”. An otherwise calm and rational person may become very angry and agitated while driving. Rosie Leizrowice explores this topic in an article titled “How Masks Change Us: On Anonymity, Road Rage and Ritual”. The safety of one’s own personal world inside their car allows them to set aside social constraints. The car becomes the mask that for many people allows repressed emotions of frustration to come to the surface.

The face is very important in understanding what other people are thinking and feeling in a given situation. There are subtle cues that allow us to understand how we should act in return. The saying “reading the room” is when a performer adjusts their performance based on the reaction of the audience. Imagine if all of the audience members were wearing masks that covered their entire face. What if they were wearing scarves that covered everything below their eyes? The subtlety of the facial features, the color of the face, the slant of the eyes, the arch of the eyebrows, and even the display of teeth in either a smile or a grimace indicates how the people around us are feeling.

Deborah Blum explores the importance of facial expressions in her article “Face It” which was featured in Psychology Today. She explains that humans send and read facial expressions in an instant (fractions of a second) even from very long distances (300 feet away for a smile). The face is capable of twisting and pulling into nearly 5,000 expressions that communicate a wide range of emotions. We are very good at interpreting these social signals within our own culture and then acting according to the situation.

To make matters more complicated the face is not symmetrical and one side can be saying something separate from the other side. Joe Navarro calls this situation “Chirality”, after the Greek term for something that may appear to be the same but in reality, when folded onto themselves, they are very different. This multiplicity of emotion may indicate that something is being covered up or suppressed in a person.

When considering how important the expressions of the face are, the act of putting on a respirator that covers half of a person’s face is a very serious proposition. These facial cues may not be recognizable and may lead to misunderstandings and misdirection. In the case of potentially hazardous situations, it may be even more important to have one's face visible to telegraph from one worker to another what is going on. A mask that covers less of the face may make this possible.
The Psychology of Safety

*I keep it in my tool bag:*

When I was an undergraduate student studying sculpture, I kept my ½ face respirator in my tool bag with the angle grinder that I used for cutting stone. It was always uncovered and caked with dust from the dry work that I would do in my studio space. Only one of my professors ever gently mentioned that I should keep the respirator in a separate clean container. This was advice that I smiled at and then promptly disregarded. Of course, there was no respirator fit testing at the school that I knew of and I bought my respirator at Home Depot not knowing if it fully fit the contours of my face. I don’t think that I ever changed the cartridges in the 2 or 3 years that I used it. I regarded the fine dust created by the limestone and marble that I was subtracting as “nuisance dust” without doing any research to find out the truth about the hazardous potential that these materials possessed. It is easy in some ways for the young to feel invincible like I did but every action and decision may have long term effects and consequences.

*Photo 1.2  Grinder bag with dust mask, photo by author*
It's Going to Hurt Later:

In the course of a given activity at home and at work I often find myself having to make decisions about safety. For example, the questions of what type of Protective equipment to wear and when to wear it, always circulate through my brain. It is not that I have any question about which type of gear is appropriate for a given hazardous activity. I have been trained on all of the proper safety procedures at work and I hold multiple certificates from the OSHA Training Institute including General Industry Safety and Health Specialist and the Public Sector Safety and Health Fundamentals certificates. These questions about safety come down to additional factors including what is easily accessible, what is comfortable, who else is around (why?), and which types of safety equipment will physically fit together.

There have been many occasions in my professional and personal life that I have chosen the less than safe path for one reason or another. (contradictory statement.) Often when I have needed an N95 dust mask I do not put one on because I have a beard (it does not create a proper seal with facial). I am the Respirator Fit Tester for my Institution and since I have facial hair, I am technically disqualified from using one. Another example is that I do not want to alarm those around me that there is a potential hazard that they should also be protected from. When I put on my respirator the overwhelming size of the thing sends a message of alert (photo 1.6). The extended shape of the respirator also prevents me from wearing a face shield so I have to choose between protecting my face or protecting my lungs (photo 1.7).

Conversely, there are some pieces of safety equipment that I wear that are over-sized on purpose. My hearing protection of choice is a set of large green aviator ear muffs (photo 1.5). These earmuffs that I wear in the shop help me to focus and drown out other distractions. When other people around see me wearing them they get the point that they should not talk to me and cause a distraction. I double up on my safety glasses which go over the top of my impact-resistant eyeglasses (no side shields prevent me from just wearing these glasses so I double up). If I don’t have my safety glasses on while I am using equipment, I feel exposed. I become nervous and while unprotected I am constantly thinking about what can go wrong while I am working. Safe habits can take many years to learn and requires consistent practice. Eventually, the only time you think about them is when you are not doing them.

Photo 1.3 Plaster head, face shield & safety glasses, photo by author. Photo 1.4 Plaster head, safety glasses, photo by author.
Safety and Courage:

A few years ago, there was overhead construction being done on the drop ceiling in my building at work. All of the construction workers were wearing the traditional required hard hat while going about their tasks. Even though in several instances there were very sharp pieces of metal hanging down 15 feet above my head, both my boss and the foreman in charge said “don’t worry about wearing a hard hat” and “I’ll pretend I don’t see you here”. When I needed to have several student workers on the floor doing some work the
same was said for them. At first, I listened to what they said even though I knew at any moment a piece of pointy metal could fall and impale my head or the head of one of the students. It was another day of this before I went against my boss and bought several hard hats at the local home center for our protection.

When working with others it takes courage to do the right and safe thing while surrounded by superiors or senior level co-workers who have always done things in a different, less safe way. In many cases, people do what they are told to do by people in authority without question. Even if safety-related materials such as Safety Data Sheets (SDS’s) are available, people are less likely to search out their safety information if their boss tells them that something is OK.

There are compiled psychology studies in “Psychology book, big ideas explained”, that highlight several important concepts that relate to the psychology of safety. It is stated that 24 hours after learning something we forget 2/3 of it. If safety concepts are not constantly reinforced then they are forgotten and not practiced. Another important concept is that there is a strong urge by individuals for social conformity. Solomon Asch (McLeod, Saul) demonstrated in his studies of groups that even if we believe something to be true our tendency to conform with the group is very strong. Simply, if everyone is doing or saying one thing than the urge to do the same thing may be overwhelming.

An article written by Teal Swan (tealswan.com) discusses the effects of being embarrassed when some aspect of us is revealed to others. Awkward discomfort and a feeling of self-consciousness often accompany this feeling when something happens to undermine the projected image that we have in a social group. When considering safety protection, it may be practical to keep the safety apparatus as small and compact as possible so the user does not feel embarrassed to use it in any given situation. Wearing safety equipment may seem to some as an admittance of weakness while not wearing PPE may be an expression of invincibility and machismo. Someone wanting to protect themselves from danger may skip this for fear of hazing within their social workgroup.

Behavior is shaped by positive and negative experiences. If nothing negative happens when a person is without safety equipment then that reinforces the thinking that the person does not need it. Many exposures to hazards do not cause an immediate, acute reaction. Prolonged exposure may not become a health problem until months or years later. This is illustrated in the multitude of cases of exposure to toxic dust such as silica and asbestos but can also be as simple as developing a sensitivity to fumes from wood stains and finishes.

![Illustration 1. 3 Hazardous Fumes from Stain, Illustration by the author](image)
The author E. Scott Geller states, “Safety is usually a continuous fight against human nature” in his book “The Psychology of Safety, How to Improve Behaviors and Attitudes on the Job”. The author states that it is more convenient, comfortable, and expeditious to take risks at work. We are engaged in a constant fight with human nature to motivate ourselves. Reasons for workplace accidents often share a similar list of circumstances including experiencing attitudes, demands, distractions, and responsibilities. Many times, there are instances where people do not know how to act and proceed safely. Sometimes there are physical states that impair performance including fatigue, boredom, or substance abuse.

Geller suggests that many dangerous activities are rarely met with an accident or near-miss and are often rewarded through time savings, comfort, and encouragement. The concept that “all risks are preventable” may contribute to a relaxed approach to dangerous tasks and additional coverups if anyone is injured at work. “It’s important to understand that the perceptions of risk vary among individuals. We can’t dramatically improve safety until people increase their perception of risk in various situations, and reduce the overall tolerance for risk”, says Geller. The perception of choosing a hazardous activity (Driving) vs. being forced to endure a hazard (environmental pollution) changes the way that we subjectively feel about a situation.

**Habits, Superstitions, and Fear:**

Many workers are superstitious about the gear that they wear and associate each article with luck and longevity of success on the job site. For example, the hard hat that a construction worker wears becomes covered in stickers from different jobs that he or she has worked on. Long after the hard hat is no longer providing optimal protection and should be changed out for a new one, this piece of equipment is still worn each day. Sentimentality, individuality, and connection play a large role in wearing certain things on a job. Pride in one’s accomplishments as well as superstition trumps safety and protection in many cases. Routine and comfort are also factors to consider when looking at safety on the job circumstances.

In her article “Fear Factors on the Psychology of Safety and Danger”, Veronique Greenwood discusses safety-related scenarios and how they vary from country to country. When Greenwood moved from New York City to China she had to learn a new set of safety rules. Compared to New York where eye contact is key, the most important thing to remember in Chinese biking culture is to ignore everyone and you are only responsible for the 12” on every side of you. Bike helmets are not worn so Veronique stopped wearing hers as well to fit in. She discusses systematic bias about how we as humans make decisions. We calculate how likely a scenario will be and how catastrophic, then weigh whether or not it is worth worrying about. While Veronique is riding her biking carelessly and choosing to ignore the risks, she is breathing in air that far exceeds the healthy load of particulate matter set by the World Health Organization (WHO). She explains that as humans we have a “personal risk budget” which means that when we make ourselves safe in one way then we can allow ourselves to be less safe in another way.

Ian Newberry-Clark discusses how we are creatures of habit in his post in Technology Today. We as humans have dozens if not hundreds of habits that we are not entirely aware of. Routines govern our lives and may be very hard to change. “They are hard to change because they are so ingrained, because they’re almost automatic.”

“Fear is Big Business” is the title of a recent article in the Los Angeles Times. Jeff Edelstein is the owner of SOS Survival Products and business is good. With the occurrence of natural disasters on the rise particularly in California, people are very motivated and willing to spend money on all sorts of preparedness products. This ranges from emergency kits, first aid supplies, water purification equipment, and a range of classes on survival related topics. “We are learning to think about the unthinkable”, says Naj Meshakht a professor at USC. Complacency is not an option for many consumers and they have easy access to SOS Survival Products since they are carried in hardware stores, army surplus and camping supply retailers. Many of the people buying these products are survivalists preparing for an end of the world scenario. Fear is a powerful motivator in everything that we decide to do.
The practice of safety-related concepts is as much psychological as it is physical. We must consider why we do or do not do something as much as we should think about how and when. Often the most effective solution is the most convenient and the most discrete. Safety practices must become a habit and they must also be viewed as “normal”. In an ever-changing work and environmental atmosphere, it would seem to be very appropriate to be ready to face the hazards that present themselves every day. Simplification of form and function may help to take the human error out of the equation of safety protection.

What is the Circle of Safety?

Safety must be convenient, easily accessible, and socially acceptable for people to protect themselves from known hazards. Repetition, routine and superstition play a factor in the act of putting on PPE (Personal Protective Equipment).

It is not so simple to be safe in a given situation. Safety is like an onion. There are many layers and each part of it left unattended has the potential to hurt you. The more safety-related topics are unpacked and sifted through the easier it is to see that it is based on a complex system. Multiple decisions need to be made to arrive in the center of the circle where an individual is protected from a given hazard.

The first layer involves physical PPE (personal protective equipment). Is it the right size and type for the given hazard? What type of training has the individual received to use the equipment and in the case of a respirator, has the individual been fit tested to use it?

The next layer involves wrestling with certain physical and mental factors. Is the PPE nearby and easy to get to? Does the wearer have to decide between types of safety protection (ex. Respirator is too big and can’t be worn with a face shield or ear muffs)? Will the wearer feel embarrassed if he/ she puts on the PPE and is it socially acceptable?

The third level of the circle deals with what hazards exist. Is the hazard known or unknown and in what quantity is it? Ignorance is not an excuse but too often seeing is believing. The invisible hazard that is not detectable through the senses may be the most detrimental to an individual’s health.

The duration and the location of the hazard are factors considered in the final layer of the Circle of Safety. As seen in the survey that I conducted about respirator usage, people are more willing to expose themselves to a given hazard if it is for a minute or less than if it is for 15 minutes. Location of where the hazards are being used also plays a factor. According to the survey, people are less willing to expose themselves to a hazard if they are indoors rather than outdoors. The phrase “It will only take a second” applies here.
"The Circle of Safety":

Illustration 1.4 The Circle of Safety, Illustration by the author
The History of the Respirator

Introduction:

I have been fit testing ½ face respirators at my place of employment for the past 4 years. The process is fairly simple and it includes having the wearer to perform a series of facial movements and expressions while the tester puffs irritant smoke around the seal of the respirator. In previous years I have often said that “everyone is a medium (standard same) size”. This year my usual formula was simply not the case. Several students did not fit into our North Brand respirators at all due to very slender defined jaws or very low bridges of the nose. No matter how tight we tried to make the straps we simply could not make a good seal for some individuals.

I sat down with a female employee of mine to interview her about her personal respirator use. She explained that she broke her nose several years ago and so her nose is slightly crooked. The added pressure on the bridge of her nose was painful and the slight irregularity continued to allow air to come out.

Every year several men with stubble or full beards come to our shop for fit testing. Unfortunately, we are not able to fit test them because of the OSHA requirement for being clean-shaven around where the respirator contacts the skin to create a seal. This year one such individual said “Wait, I need to shave? I would rather keep my beard”. I feel the same way and I have coworkers who also share this sentiment. I interviewed the same person later to find out more about his thoughts having to do with his safety vs. his facial hair. He echoed his earlier thoughts and explained that he just tightens the straps on his respirator and hopes for the best. He also said, “something is better than nothing, right?”

What is Chemical Warfare?

In the case of chemical warfare (CW), the philosophy “Something is better than nothing” could not be any further from the truth. On the level of destruction with nuclear and biological weapons, chemical warfare is one of the most brutal weapons created by mankind. It only takes a small quantity of some chemicals to kill many people at one time. Chemical weapons are relatively easy to make and they are inexpensive, making them prime targets of weapons used by terrorist groups. Chemical weapons can be dispersed in several states including gas, liquid, aerosol, and powder. There are several toxic chemicals of note that have been used by various countries including Chlorine Gas, Zyklon B gas, Agent Orange, Phosgene, and Mustard Gas.

CW agents are classified into several different categories including the following:

- Nerve Agents
- Blistering agents
- Blood Agents
- Choking Agents
- Riot-control Agents
- Psychomimetic Agents (thought, perception, and mood)
- Toxins

The most important aspects of emergency response to the suspected release of chemicals are detection and identification, physical and medical protection, and decontamination. There are several types of portable, handheld detection instruments available (ex. TCD detection paper, RVD kit, etc.) for detection. Protection from a chemical attack starts with creating a barrier between the toxic agent and the breathable air of an individual. Most often this is some type of respirator with a HEPA (high-efficiency particulate aerosol) filter canister or cartridge. Decontamination is the removal of all contaminated agents from all subjects that were exposed, including human skin and eyes as well as all other materials exposed. This is often a complex process that involves neutralizing the agents or physically removing them.

The Gas Mask:
According to John Nunley and Cara McCarty the modern-day mask of our industrial culture is the “Gas Mask”. As these devices developed, the face became covered entirely by the mask, came to represent the tendency of the people of this era toward abstraction and the beauty of the machine. Nunley and McCarty explain that “These masks are not only beautiful objects but their designs enhance the visual expression of their purpose. Each feature provides a visual clue to the mask's function.” The modern industrial mask has a similar effect as those made by our ancient human ancestors and can transform the wearer and intimidate or terrify an opponent. Modern warfare has become much less hand to hand combat and is now often fought through chemical, biological, or germ means.

Many new strides have been made in the types of materials available for use on these modern masks. Lightweight and durable materials such as polystyrene foam, reinforced plastics, and Kevlar greatly increase the ability for physical protection as well as allowing for more comfortable, lighter weight products. New considerations have been made in the physical drawbacks of original designs including sound muffling, scratch-resistant, aerodynamics, and ventilation. Additional advancements encompassed into an entire head system include

Respirators Throughout History:

Cristopher T. Carey describes the history of the modern-day defense respirator in his book “U.S. Chemical and Biological Defense Respirators”. He discusses the developments made to the respirator during World War One by each different country involved in the war. With the use of chemical weapons such as Chlorine gas, each side began creating ways to protect its troops from this new threat.

The first iterations of the “gas mask” were improvised by French and Canadian troops by using fabric that was sometimes soaked in water. Others attempted to use broken bottles or lengths of hose that were stuffed with straw and cloth. Some also tried to use handkerchiefs with wet earth as a filter over the nose and mouth.

Germany made several advancements in its protective headgear during the first and second world wars. The first versions consisted of a canister attached to an 8-inch corrugated tube that ended in a mouthpiece. This also had a nose clip and was meant to be used with separate goggles to protect the eyes. Air was inhaled and exhaled through the same canister.

The second German version is simply known as “The German Mask” and remained the same for decades. It consisted of rubber and later an oiled leather facepiece along with 2 round eyepieces. Each eye-opening had two lenses, one with a strong transparent Celluloid and the other a thin, anti-dimming gelatin coating. This mask had one canister filled with chemicals that air was breathed in and out of. The whole mask fits into a cylindrical container attached to a sling for transport.

The British had many versions of masks that ranged in their complexity and improved over time. Original models were termed “Mouth muffs”. They were cotton pads wrapped in muslin and they were not very effective. The “Black Veil” mask was produced in England and was cotton waste sewn together in cloth and then dipped in Glycerin and water to keep them moist.

After a further study of the German respirators, the Harrison Tower Box respirator was developed. It was a canister and hose variety made of layers of muslin and then soaked in chemicals. The nose was plugged by a clip and there was a mouthpiece inside. This developed into the “Small Box” respirator which utilized pumice granules to absorb chemicals. The British Small Box Respirator (BSBR) was made of fabric but was lined with rubber with circular eyepieces and used the rubber mouthpiece and nose clipped like the Tower Box.

The BSBR was the first respirator worn by the US Army in the First World War. This design was very functional against Mustard Gas (introduced in 1917 and was 36 times more toxic than Chlorine) however prolonged use contributed to fatigue and discomfort.
When the US entered the war in 1917, they were far behind the Europeans when it came to gas mask technology. General Wm. L. Siebert stated, “The work to supply of the entire army with this equipment had to be developed from a starting point of nothing. There were no plants in existence when the U.S. entered the war, and we were utterly without experience.”

The US began to develop its respirator design program and the “American Small Box Respirator” (ASBR) was the result. The US Army Service Gas Mask 1919, “The 1919 Model”, was composed of sheet rubber, stockinet material on the outside, the lower part of pattern sewn to go under the chin, elliptical eye holes that stuck out made out of tri-flex safety material, and a cast aluminum snout housed inlet and outlet.

The next versions of the Army Service Gas Masks were developed between 1921-1935. The M1A1 included advances in the eye lenses and the head harness and the M1A2 (1935) had fewer sizes and utilized better rubber that could mold to more faces. It came in a size “U” which stood for universal size and was said to fit 95% of faces.

The M2 used a fully molded rubber facepiece and had excellent features and it was used through the 1950s. The face blank eye holes were smaller than the lenses to ensure a tight fit. There was decreased internal air space in the mask and it had an exhalation valve on the right-hand side. Six buckle sets were attached to edges of the face blank. These buckles were secured with canvas straps and riveted with 2 metal rivets (which potentially could have been a place for leaks).

M9 series was made in 1947 and it was lightweight, using older M2 fully molded rubber face blanks. It was designed for the 3 areas of chemical warfare (requirement, design, production, and field use). The M9 was the first true ABC military respirator. ABC stands for 3 different levels of Respiratory protection:

**Level A:** Worn when the highest level of Respiratory protection is needed. Typically, they include:
- SCBA (Self Contained Breathing Apparatus), NIOSH approved
- Positive Pressure (pressure-demand)
- Chemical Protective Suits
- Inner and outer chemical-resistant Gloves
- Steel Toed/ Shank chemical resistant Boots

**Level B:** Worn when the highest level of respiratory protection is needed but a lesser level of skin and body protection is required. This is the minimum level recommended on initial site entry when a hazard has been detected. They include:
- Positive Pressure (pressure-demand), NIOSH approved
- Chemical resistant clothing (disposable coveralls, overalls, long-sleeved jacket, 2-piece chemical splash suit, etc.)
- Inner and outer chemical-resistant Gloves
- Steel Toed/ Shank chemical resistant Boots

**Level C:** Worn when the type and quantity of airborne hazards are identified and measured and eye and skin exposure is unlikely. Periodic air measurements must be performed. They include:
- Full-face or half-face, air-purifying respirator, NIOSH approved
- Chemical resistant clothing (disposable coveralls, overalls, long-sleeved jacket, 2-piece chemical splash suit, etc.)
- Inner and outer chemical-resistant Gloves
- Steel Toed/ Shank chemical resistant Boots
The most recent versions of modern US military protective masks are the M40 and the M50. The M40 was phased into use with the US Marine Corps and Army in the 1990s. The silicone rubber face seal was susceptible to corrosion by blistering agents and needed a second skin of butyl rubber to be placed over it. It was used primarily as protection from riot control. Later iterations such as the M42 improved on the design making it better suited for soldiers.

The M50 joint service general purpose mask (JSGPM) was first produced in 2009 and is the version used by the US military today. It protects against toxic materials and radioactive particles. The M50 is lightweight and has a low profile and covers the full face. The filters have a color-coded shelf-life indicator that changes from white to blue when they are ready to be changed. These filters incorporate a self-sealing mechanism that can be changed out in an environment that is contaminated. These new filters reduce breathing resistance by 50% making it easier to wear for longer periods.
**What is NIOSH?**

NIOSH stands for National Institute for Occupational Safety and Health, and it is the research arm of OSHA here in the United States. Their main mission is to “develop new knowledge in the field of occupational safety and health and to transfer that knowledge into practice”. They research to reduce worker illness and injury. NIOSH promotes the safety and health of workers across the US by providing recommendations for addressing hazards that are traditional and emerging in the future.

**Respirators and dust masks today:**

Today there are a variety of different types of personal respirators used by individuals to protect themselves from hazards in the workplace and at home. Some of these include N95 paper dust masks, ½ face respirators with dust or vapor cartridges, or full-face respirators with eye protection. Major companies that produce respirators and N95 dust masks that are NIOSH approved are Honeywell North, 3M, and GVS. All of these respirators rely on a close-fitting seal where the mask touches the skin around the mouth jaw and the bridge of the nose.

At this time men with beards do not have many options when it comes to respiratory protection. The PAPR (Powered Air Purifying Respirator) is the only OSHA approved method of respiratory protection for men with facial hair. This product combines a full-faced shield and battery-powered air pump to supply air to the user. While the effectiveness of this system has been proven, the enormous cost of this system is a
prohibitive factor for the average person gaining access to one. A PAPR system costs around $1300 on the low end of the price spectrum and can increase to well above $2000 on the high end. This system also needs a clean space for storage which is another cost of around $300. This financial burden makes the PAPR rare in many public and private sector situations.

Another option for the facial hair group is the Resp-O-Raptor which costs around $50. This unit works in a similar way to scuba gear using the mouth to create a seal around the breathing apparatus and pinching the nose closed to direct the flow of air through the mouth. The cartridges are placed behind the head for a more compact design which fits underneath of welding masks and face shields. This unit is designed only for protection from dust so if a man is using it for welding or spray painting the protection from these toxic fumes is insufficient.

The last option is to go without any protection at all and face the hazard. This has been the route that I have sometimes gone when I am conflicted about the partial protection my respirator will create for me when I have a beard. While this option is free from financial cost the health risks are substantial and not recommended.

I propose that this project, the B Respirator, can make the decision between shaving, safety, cost, and convenience very simple. This product provides an affordable and safe alternative to the other products that are offered on the market currently.

Photo 1.8 Options for Respiratory protection for Men with Beards, photo by author.
Bench Marking:

RZ Mask: Safety Multi-Purpose Air Filtration Mask Valved

RZ Mask M2: $40.89
Replacement filters $6.95 for 3
  o “As we all know it is impossible to create a full seal in any mask if the user has facial hair, but the shape and design of our mask allows the user to create as much of a seal as possible.”
  o Not NIOSH approved but tested at Nelson Laboratories in Salt Lake City, UT, effective to 99.9% of particles .1 micron in size.

Miller Electric ML00895 Half Mask Respirator, Single Filter

$38.99 for Dust cartridges and mask
$52.00 for Organic vapor cartridges and mask
Replacement Dust filters: $8.90
Replacement organic filters: $28.50
o No facial hair that comes in contact with or interfere with the sealing surface of the respirator against the face.

Respirator Survey Summary Results: 9/14/2019

I surveyed 24 people between the ages of 18 and 51 about their respiratory usage. Thirteen were male and 11 were female. Nearly all of them used N95 dust masks (21 or 88%) and 16 of them (67%) reused them. There was a variety of amount of times that people used their ½ face respirators (7 or 29% used them once per month) and only 11 stores them in clean containers (45%) when they are not in use.

There was also a wide range of the amount of money that an individual would spend on a respirator (8 at $25, 6 at $50, and 7 at $100). They also varied in the amounts that they would spend on replacement cartridges (7 said $10, 8 said $25, and 6 said $50). Most people are not aware of what they paid for their respirators and what the cost of replacement cartridges is.

The survey also indicated that the time of exposure and where a person is working relates directly to whether a person wears a respirator or not. For example, 19 of those interviewed always wear a respirator in a closed room when spraying for 15 minutes, while only 7 sometimes wear a respirator when spraying in a closed room for 1 minute. Another example is that only 7 people wear respirators sometimes when spraying in a ventilated area for one minute, as opposed to 15 people who wear a respirator always when spraying in a ventilated area for 15 minutes or more.

One of the most important pieces of information that I gained from this survey was that 95% of the respondents (23 people) said that they do not share their respirators with anyone else. This means that respirators can be customized in the way that they are created and there is less concern about saliva and mucous than if they were being shared.

The top 2 areas that were chosen as uncomfortable were: The Seal around the nose (9 people, 38%), Neck strap (7 people, 29%), Head strap and overall weight (6 each, 25%). These are all areas being considered in the most recent iterations of the B respirator. In short, depending on the person each area mentioned could be a source of discomfort. There does not seem to be a perfect respirator that is one size fits all.
“The Human Beard”

What is your Beard Worth?

The beard is an important symbol for numerous reasons. The importance of facial hair goes beyond personal style, laziness, and rebellion. According to the Mintel Press Office, 41% of US men don’t shave daily with one quarter agreeing beards are fashionable. Asking a man to shave so that he can wear a reasonably priced respirator may not be a simple proposition. An alternative should be available that provides safety and functions with this important symbol of masculinity.

Currently the PAPR (Powered Air Purifying Respirator) is the only respiratory protection option for men with facial hair. This apparatus starts at $1200 and does not include a clean storage container for an additional $250. This piece of equipment is required of any person employed in industry in the United States if they have facial hair and work around hazards that require a respirator.

Why then do so many men insist on keeping their facial hair when their respiratory health may be at risk? Those reasons are many and they are described in the following section.

The Beard and the Beautiful, Beards and Attraction:

There have been many studies on the attractiveness of bearded men to women. The determination of the exact type and length of the beard seems to vary although some findings have found consistencies. The importance of the beard as a tool and social cue to the opposite sex would make having facial hair very important in terms of determining the fitness of a potential mate.

In a 2013 study entitled "The role of facial hair in women’s perceptions of men’s attractiveness, health, masculinity, and parenting abilities", conducted by Barnaby J. Dixon and Robert C. Brooks research was conducted to determine what length of beard growth women find most attractive. It was determined that generally speaking the women preferred heavy stubble as the most sexually attractive and clean-shaven as well as heavy beards as the least attractive. The research points to the heavy stubble growth of 10 days as the most attractive to women. Heavy beards were seen as the healthiest and were linked positively to parenting ability. The fully bearded man was seen as a better father who could invest in and protect his offspring. Men, on the other hand, ranked full beards as the most attractive with clean-shaven as the least attractive. In many cases, there seems to be a strong contrast between the way men view themselves with a beard and the way others view them.

The beard certainly seems to be an important factor in attracting a mate and this is a reason to proudly display one. Procreation and the preservation of the human species are determined by many factors and the beard makes a statement about a man’s fitness to be a potential mate.

Beardy and the Beast, The beard as a weapon:

Hair patterns on the male face have developed throughout human evolution. At one time our species used our canines to fight. The signal of a strong jaw was essential as a warning tool and the hair pattern around the mouth highlighted threat displays. As we evolved to swinging arms and throwing objects rather than biting, the social signal of the beard remained as a symbol of masculinity and prowess.

In the chapter “Full Beards and Weak Chins” of the book “Body Hot Spots: The Anatomy of Human Organs and Behavior”, R. Dale Guthrie argues that the hair patches that humans have on their bodies have one thing in common: menace. Guthrie argues that like many mammals and primates, humans used their teeth for threat displays and canine fighting. However, fighting techniques evolved from biting to flailing arms and throwing weapons. Our tooth size reduced several million years ago and yet we still look for clues to our opponent’s social status and fitness. The beard is an important indicator of maturity, aggression, health, strength, etc. and the lack of facial hair seems to portray the opposite.
In an article entitled “Beneath the Beard: Do facial Morphometrics influence the strength of judgments of men’s Beardedness”, the authors discuss which type of male face is most intimidating. This research found that the jaw size of males with beards was determined to be more dominant and intimidating. The researchers showed different images of the same man both with a small jaw and a large jaw that had been digitally enhanced, both with and without beards. The results of this research were that the bearded faces with both large and small jaws were seen as more dominant than the clean-shaven images of the same individual.

**Frosty the Snow Beard, Protection from the Natural World:**

British philosopher, Thomas S. Gowing, argues in his lecture that the beard is an essential part of the male face and has evolved to protect against the harshest aspects of the natural world. Gowing explains that the location of the beard around the most susceptible areas of the body (along the jaw, upper lip, chin, and neck) to protect from cold and disease. When examined under a microscope the hair of the beard is very different from the hair on the head. It is much more durable and deeply inserted than the hair on the head and is more prone to curl.

In the article “Do Beards Keep Men Warm”, published in *Popular Science* by Daniel Engber in March 2016, Gowing’s hypothesis was proven correct. In a 2012 study in China of 100 men found that lips are on average 1 degree warmer than cheeks which suggests that without facial hair the body is more susceptible to the cold. Engber also suggests that there may be a connection between heavy beard growth and baldness, since there may be a danger of the brain overheating and the loss of hair on the head, might be the body's way to adjust to the temperature.

Illustration 1.7 Beard Season, Illustration by the author

Holly Chavez discusses the many beneficial aspects of the beard in her article “It’s not just cooler, but also Healthier: 10 Reasons why men should Grow Beards”. Chavez claims that having a beard is like the fountain of youth. The facial skin that is covered by beard hair acts to shield the skin from the sun resulting in fewer wrinkles and less cancerous blemishes. Not shaving also protects your skin from potentially harmful bacteria gaining access to the open portals of freshly shorn skin. Beard hair blocks these portals preventing infection.

The importance of the beard for occupations that are working outside is almost essential. Gowing sites examples of soldiers and tradesmen (mason's and smiths) wearing beards. Resistance to colds and sore throats would decrease in these men when they shave and he observes that more dust is breathed in when there is no natural filter surrounding the mouth and nose.
Oh, Holy Beard... Religion and the Beard:

How does religion play a part in beard growth throughout history? What is the effect of beards and religion on the modern-day man trying to find a balance between practicing his religion and conforming to the specification of a particular workplace? What is the Sikh religion and what is the significance of not cutting one’s hair?

In the article “Sikh Soldier Allowed to Keep Beard in Rare Army Exception” by Dave Philips describes the challenges that Captain Simratpal Singh has faced as a member of the United States Army and as a practicing Sikh. From his first day at the US Military Academy at West Point, he was faced with the decision “between showing his faith and living it.” He was granted a temporary religious exemption from shaving his beard. The Sikh religion has had a long tradition of military service and a central theme for them is protecting the innocent and resisting tyrants. Bearded Sikhs fought for the US in WWII and Vietnam and they serve today in militaries around the world. According to the article, over 100,000 troops have been allowed to grow beards after a judge ruled the Army’s denial illegal. However, the issue of active-duty troops has been left untouched. The army has argued in the past that beards under gas masks posed a safety hazard and that breaks in uniformity can jeopardize the credibility of the entire officer corps. In 2014, after this article was written, the US army has allowed all officers and enlisted personnel to request permission to wear beards and other articles of religious clothing.

The article “Facial Hair. Religion and Respiratory Protection” discuss the use of respirators in the firefighter’s academy. The author John K. Murphy sights the OSHA regulations and the problem with creating a tight seal while wearing SCBA (Self Contained Breathing Apparatus). The author sites numerous court cases that have mixed results. The cases generally side with the employer’s rights to determine safety policies regardless of religious beliefs. Murphy states that a fire agency should at least allow the individual to attempt to establish a seal for a Fit Test and if it fails to evaluate what to do based on their department standards. The author also discusses skin conditions that irritate the skin when shaving and states that the employer should provide information on more sensitive shaving techniques.

A Beard a Day Keeps the Doctor Away, The healthy beard?

What is the physical implication of having a beard? We have seen in previous sections how men are viewed by others when they sport the stubble but is it beneficial on a personal and physical level?

This topic is explored in an article by the American Lung Association entitled “Beards and Lung Health: A lung expert weighs in”. Dr. Albert Rizzo, a senior lung association advisor, weighs in on several common claims surrounding beards and health. Dr. Rizzo tackles several main topics associated with beards and health including body warmth, throat disease, asthma, and allergies. He says that beards do keep the skin of the face warmer but they do not keep the body overall warmer in the wintertime. A scarf is better at that than even a very large beard. The key to allowing the beard to act as a natural filter is cleaning the beard regularly to remove bacteria and particles that have been trapped there during the day. When it comes to allergies and throat disease the beard enhances the natural air filtration that nose hairs help with and do seem to have a positive impact on these areas of lung health however if the beard is not cleaned daily then these hazards may become worse and enter the lungs anyway. Dr. Rizzo also notes that some facial hairstyles such as the chin strap or the goatee may offer less protection than styles such as the one Burt Reynolds sported or the lumberjack beard.
So how dirty can a man’s beard get if it is not cleaned properly? In a news piece done by ABC 13 affiliate Albuquerque, NM (KOAT) the claim is made that your beard may be as dirty as your toilet. Several New Mexico men’s beards were swabbed and there were some of the same bacteria (enteric) found in feces present and thriving in their beards. Microbiologist John Golobic conducted the tests and said that he was surprised to see the same type of bacteria that could cause a municipal water system to shut down. In an article titled “How dirty is your beard? The Surprising Answer” published in the UPMC Health Beat this very question is explored. The authors discuss how there are no extensive research studies on this topic and that there are numerous types of bacteria that are beneficial to humans that live on and inside of your body. The above news program had a very small sample size and they also did not sample any chins that were cleanly shaven which may have also had the same type of bacteria present. The answer for a clean beard is proper hygiene habits including trimming and washing regularly. Taking care to wash hands after using the bathroom and being careful not to get food in your beard are essential practices.

The Mintel Press discusses a “new approach toward facial hair grooming that has directly impacted the men’s care market”. There seems to be a shift in attitude that is lessening the stigma around facial hair and an increase in men truly feeling proud of their beard. There is a huge industry for male facial hair products that range from holding creams to cleansing gels that saw large gains in 2014. Sales in this market are predicted to reach 4.7 billion in 2020.
Problem Statement:

Breathing Clean air is a basic human right of every man (bearded or not), woman, and child. There is no “One Size Fits All” version of a ½ face respirator that will universally fit every human face. Bearded men have no affordable alternative in respiratory protection that allows them to keep their facial hair and preserve their identity while also protecting themselves from hazards in the workplace and at home.

Design brief:

The B Respirator will be an affordable, comfortable, alternative to conventional ½ face respirators currently on the market today. This piece of safety equipment will allow men who have beards to protect themselves from potential hazards in the workplace and at home. This new design will also be adjustable and conform to the individual’s facial features. The B respirator will be compact enough so that the user does not have to choose between what to protect on their body. As it is important to keep safety gear close for convenience, the B respirator will be compact and portable to travel with the user as they encounter hazards.

Who: Primary users: Men with facial hair that would otherwise be disqualified from using a conventional ½ face respirator due to interference by the beard with the seal.

Secondary users: Anyone who is looking for an alternative to bulky/heavy ½ face respirators that are reasonably priced and compact to the face

Where: I envision my design solution to be readily available and accessible to men and women who want an alternative to expensive, bulky and uncomfortable alternatives such as PAPR (Powered Air Purifying Respirator). This respirator will be easy to use at home and in the workplace.

When: My design should be available for use within 2 years. Whenever there is a potentially hazardous situation that requires user protection. If shaving is not an option for whatever reason (medical, religious, stylistic, etc.)

What: This respirator will take into account several ergonomic factors such as being lighter weight. Not having to choose between adaptable to additional PPE (personal protective equipment) such as safety glasses, hearing protection, and face shields.

How: Special emphasis will be placed on designing a seal that will work over facial hair on its own or with the aid of a lubricating gel. The respirator will seal beneath the lower lip rather than around the jawline where the most beard hair is present. Special consideration will be placed on the comfort of the straps as well as the seal around the nose.

Why: The beard as an important symbol on a man’s face is very important for many reasons. It is not as simple as asking a man to shave in order to protect himself from hazards in the workplace and at home. It is irresponsible to not have an affordable alternative for a man to protect himself from hazards. The average person cannot afford a PAPR (starting at $1300) and many employers do not place a high priority on recognizing the powerful symbolism and individualism that a beard/ facial hair represents. Many occupations such as the military and Fire department require their recruits to shave even if there are important reasons to have a beard.

The reasonable cost will help this respirator to be an affordable alternative to other options including using nothing. Comfort in the straps, as well as a lightweight design, may make this a more appealing respirator to conventional respirators on the market today. The close-fitting design will also easily allow other PPE to be worn at the same time as the respirator so the user does not have to sacrifice one type of safety for another.
Facial Hair Survey Summary: 02/2018
Questions about your facial hair

I surveyed 35 men ages 19-42 primarily associated with RIT’s College of Art and Design and asked them questions about how they felt while they had a beard and had them rate these feelings from 1-10 (one being the lowest and 10 being the highest). I took their top choices from the group and tallied them. Several of the men surveyed had multiple reasons that tied as their top option so I counted each of these.

The results of the survey were surprising in some ways. The 2 highest categories were “I feel older” with 17 votes and “I feel attractive” with 11 votes. In the above study, there were many different social reasons to have a beard that is psychological in nature. Women in many cases cited in the research above do not find a beard to be attractive. I also had men draw their beards over the top of a generic face and these men were very accurate in portraying their face with a beard suggesting that they know exactly what they look like physically. What this beard conveys to others the results of the “I feel…” questions suggest that they are not aware in many cases how they are being portrayed to other people around them.
5. **Iterations, Sketches**

**Iteration #1**

My first considerations for the B respirator were to cover the entire face including the eyes, ears, and jaw. I was going to use rubber ribs to work their way in between the beard hair along the jaw (photo 5.2). I also thought of using a water-soluble gel to increase the seal over the hair.
Iteration #2:

The second version of the B respirator would have been in two parts that would have had a top that was connected to the filters and exhaust valve. The lower section would have an extra strap to hold it in place under the chin. The seal would be created with a series of ribs like the above iteration.

Illustration 5.5
Iteration #3:

This iteration used two sections like the above model but focused on the comfort of the head strap and the inclusion of hearing and eye protection. This model would be modular and safety gear could be added or taken away as needed.
**Iteration #4** (prototype small front cartridge/ nose plug)

This model utilizes a mouth piece to create a seal using the mouth to hold it in place without straps. It utilizes a nose plug so that air is drawn in only through the mouth. The compact nature of this model makes it easily portable and in later versions pocket sized.

*Illustration 5.10*
Illustration 5.11

Photo 5.14  Artifacts of process, Dust cartridge, nose plug, Sleep Apnea Mask, Silicone cast Nose
Photo 5.15

Photo 5.16, First packed pocket-sized respirator
Iteration #5 (prototype small front cartridge with nostril tubes)

This model attaches the nose plugs to the respirator itself. This would require a seal to be created inside of the nose as well however creating a universal size for the interior of noses was very challenging. I tried using an expandable foam material as an option to fill the nose after it is pinched however these materials may allow air to pass through them.
Nose plug iterations, Nose Plug, Nose Harp, Nose Pin,

I created several models of interior and exterior nose plugs. After completing my interviews it was determined that most people would not want a plug in their nose at all.
**Iteration #6, Final Prototype #1, B Respirator**

This is the model of the B respirator that I used to conduct my interviews with. Overall it was positively received and the results of those interviews are included below. Seeing men wear the respirator helped me to better understand how the weight was distributed as well as additional concerns that each person had regarding the respirator.
Iteration #6B, Final Prototype #2, B Respirator

Included in the final design
- Spit valve concerns
- Simplification of form
- How do I look with it on? Check in the mirror
- Cleaning concerns
- Access to the carbon, separate filter, access from the side
- Where does it sit when I am not wearing it?
Photo 5.31

Photo 5.32, Components of the B Respirator Starter Set
Final Description of B Respirator Product:

The “B respirator” was created for men with beards or other facial hair. It utilizes a mouth piece and a nose plug to protect you from a combination of dust and fume hazards. The seal is created using the mouth so facial hair does not interfere with a conventional sealing method. This respirator is also a light weight, compact alternative for both men and women that want respiratory protection that does not interfere with other forms of PPE (personal protective equipment) including face shields, safety glasses, hearing protection, hard hats, etc.
6. Summary

Better Breathing for a Broken Environment:

The overwhelming number of stories in the news currently about respiratory health should alarm all of us. The world is changing and our ability to breath is under siege. Our chemical-based society has made it difficult to thrive both outside and in some cases inside our own homes. Simple things such as walking your dog in the morning or riding your bike to school or work may soon be a thing of the past. Respiratory protection may be needed in the future as an everyday accessory to living a “new normal” lifestyle.

What is a Holistic Approach?

A holistic approach to something is when the parts are considered as closely as the whole and are viewed as integral. When considering safety this holistic approach is necessary. It is clear that there are many reasons why an individual chooses to wear or not to wear safety equipment. Convenience, embarrassment, encouragement, routine, ritual, superstition, training, and expense (among others) all play a role in decision making when it comes to Safety. A holistic approach to designing safety equipment should take into account all of these factors.

Important Points of Emphasis:

- Covering the face is a transformative act. This act can lead to social misunderstandings and miscues that may be very important in work situation.

- The beard is a powerful symbol for men who choose to wear one. It is a very difficult decision to either shave or be exposed to hazards. Many times, the beard wins out. The bearded man will now have an inexpensive option to keep their respiratory system healthy.

- The Respirator is a symbol of the past as well as our future. There is no one size fits all version of respiratory protection since there is not a standard type of human face.

- The more inconspicuous the safety equipment the more likely an individual may be to use it.

- Safety equipment must be on hand and easily accessible to satisfy the immediate needs that arise.

- The “It will only take a Second” culture of today’s society is problematic when trying to promote a safe and protected society.

With the current state of the world dealing with the outbreak of the Coronavirus (COVID-19), it is very important that all people have options for protecting their respiratory health. The CDC (Center for Disease Control and Prevention) recently released a chart illustrating which types of facial hair were safe to wear with filtering respirators. As shown on the chart below there are many styles of facial hair that do not make the cut when it comes to protection from air borne contaminants.
This is the perfect time in human history to have a respirator for men with beards to be developed and available to the average consumer. Barriers such as cost and convenience will be an important factor as well as the overall aesthetics of the respirator. Increasing the comfort of the unit while decreasing the weight will also be important. Men will not shave their facial hair in many cases even if there is a known threat to their health so the B Respirator will mitigate the choice of hair vs. safety. Now they can have both.

Conclusion

Given the unique circumstances that we are living in currently with the global pandemic of Covid 19, the B respirator is a very important project. This product addresses the OSHA standard about facial hair and respirators [1910.134(g)(1)(ii)(A)] (A) This states that employers shall not allow “Facial Hair that comes in between the sealing surface of the facepiece and the face or that interferes with valve function. This proposed B Respirator has the potential to positively impact the health of millions of American men and men around the world.

Future research could involve analysis of the psychology of fear as well as additional iterations of the product itself. Continuation of interviews to gather data and eventual fit testing trials will need to be completed. NIOSH certification is crucial for the wide spread acceptance of this product as a serious protective respirator and an alternative to conventional models available today. This device is protected by a provisional patent, and further patenting will be obtained. I hope to further develop the branding and business plan for this product in the near future.
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Appendix A:  

**Interview Questions for B Respirator:**

**Interview #:** __________________

**Introduction:**
This is the “B respirator” created for men with beards or other facial hair. It utilizes a mouth piece and a nose plug to protect you from a combination of dust and fume hazards. May I ask you a few questions?

1. May I record the audio and video of our interview.  Yes               No
2. Will you sign an **NDA** (Non-disclosure agreement) before the interview? (Attached)
3. What is your name: ___________________________.   Age? __________
4. Can you spend some time (about 30 seconds) interacting with the B respirator and talk out loud about your thoughts regarding it? **Audio and video recording**
5. Describe the B Respirator on a scale of 1 to 10. (10 BEING THE BEST, 1 the worst )
   • Comfort_____ weight_____ look_____ feel_____ Size _________
6. How does this compare to your current respirator?          Better       Same        Worse
   • Explain Above response
   • _____
   • _____
   • _____
7. What is the max amount of time you think you might wear this respirator? __________
8. What is the range you would pay for the B Respirator? $10-$20, $20-$30, $30-$40, 40-50
   • Replacement Cartridges (3 at a time)? $5-$10     $10-$15    $15-$20
9. Is color an important consideration?   Yes                      No
   • If so, what color would you want it? **Bright, Metallic, Gray, Kevlar, other _____**
10. Give examples of a tasks you might use this respirator for?
   • __________
   • __________
   • __________
11. Are there tasks that you would not use this respirator for?
   • __________
   • __________
12. Do you personally work on repairs in your home?   Yes              No
   • What percentage of the time do you work without a respirator? __________
13. To plug your nose would you prefer a plug that goes **inside** or **outside** your nose?
14. What type of respirator do you use currently? ____________________________-
15. Are there any other things you would like to share about the B Respirator?
Survey Results:

- 12 people interviewed,
- Bearded men ranging from ages 21 to 47 (30 years old the Average)

Interview Results:

- Comparison to current Respirator:
  - Better: 58%  Same: 25%  Worse: 17%
- Payment for respirator: $40-50 or more 50%, $30-40 25%, $20-30 25%
- Payment for Replacement Cartridges: $5-10 42%, $10-15 25%, $15-20 33%
- Repairs in the home:
  - 75% said they did repairs in their home
  - Work Without a respirator: Average 69% of the time
- Is color important?
  - No: 66%
  - Most popular color: Gray: 83%. Black: 42%
    - A bright case would be best as incentive to keep the respirator in a dust free environment. Would help the case be easier to find in a studio or on a job site.
- Interior or exterior of Nose for plug: Exterior: 67%  Interior: 16%

Interesting findings:

- Spit valve concerns
- Simplification of form
- How do I look with it on? Check in the mirror
- Cleaning concerns
- Access to the carbon, separate filter, access from the side
- Where does it sit when I am not wearing it?
- Resemblance to Star Wars air breathing under water apparatus