

Capstone Project: Pastel Dust

Element A: Identification and Justification of the Problem

Breathing in the dust created by the use of pastel sticks has been found to have harmful effects on the respiratory system (contains small enough particles to enter the alveoli, the lung air sacs), and they may contain materials that are suspected carcinogens (complex hydrocarbons such as benzidines and anthraquinones).

This problem applies to those who use pastels and can have second hand effects on those who also exist in the same space (in which the medium is used). This problem has been around since the beginning of this medium's use (though unaware to the public for some time) for about 250 years and should be solved so people can create freely without having to worry about their health or the messiness of their room.

Background & Statistics

Pastels create dust that has heavy metals that can cause serious health problems.

“Blowing excess pastel dust off the drawing is one major source of inhalation of pastel pigments. Pastel artists have often complained of blowing their nose different colors for days after using pastels, a clear indication of inhalation.”
“Both permanent and workable spray fixatives used to fix drawings contain toxic solvents. There is high exposure by inhalation to these solvents because the products are sprayed in the air, often right on a desk or easel. In addition you can be inhaling the plastic particles that comprise the fixative itself.”*

- Baylor University, *Section 10: Painting and Drawing*,
(<https://www.baylor.edu/ehs/index.php?id=94372#dry>)

One article with an opposing position urges the user to take “some sensible precautions” when working with this medium but not as a necessity, citing a study done by Duke University.

“Although pastel dust may contain components that can increase the risk of chronic health effects at high exposure levels, exposures to pastel dust are low. The risk of any adverse effect is correspondingly low as well. No special precautions are necessary to prevent excessive exposure to such dust, either during use or cleanup.”

- *Pastel Painting and Your Health* by Phil Davies

(<https://www.arttutor.com/blog/201810/pastel-painting-and-your-health>
<https://fmch.duke.edu/sites/cfm.duke.edu/files/cfm/occupational-environmental-medicine/documents/pasteldust.pdf>)

Pastels do not necessarily contain enough chromium to cause skin damage but since this chemical is present in many pigments it is still acknowledged to proceed with caution. These are the potential health effects of chromium:

“Adverse health effects associated with Cr(VI) exposure include occupational asthma, eye irritation and damage, perforated eardrums, respiratory irritation, kidney damage, liver damage, pulmonary congestion and edema, upper abdominal pain, nose irritation and damage, respiratory cancer, skin irritation, and erosion and discoloration of the teeth. Some workers can also develop an allergic skin reaction, called allergic contact dermatitis. This occurs from handling liquids or solids containing Cr(VI) such as portland cement.”

- *Occupational Safety and Health Administration*, The United States Department of Labor
(<https://www.osha.gov/SLTC/hexavalentchromium/healtheffects.html>)

Coal-tar and asphalt	Special waterproof coatings (ships, tanks, pipes)	Coal tar Coal-tar pitches Bitumen extracts Bitumen refined	1 1 2B 3
Cobalt compounds	Pigments, driers	Cobalt and cobalt compounds Cobalt, metallic	2B 2B
Copper and copper compounds (e.g. bronze powder, cuprous oxide)	Pigments, antifouling agents	–	–
Dyes and pigments, organic (e.g. aromatic azo dyes, phthalocyanines, rhodamine)	Pigments	CI Basic Red 9 } Magenta production } } 2-naphthylamine } 4-aminobiphenyl } Auramine production } } Benzidine } Benzidine-based } dyes }	2B 1 1 1 1 1 1
Epichlorohydrin	Epoxy resins	Epichlorohydrin	2A
Epoxy resin	Binders	–	–
Esters, aliphatic (e.g. ethyl acetate, isopropyl acetate)	Solvents	–	–
Ethers, aliphatic (e.g. isopropyl ether, tetrahydrofuran) and glycol ethers (e.g. methyl cellosolve)	Solvents	2-Butoxyethanol 1- <i>tert</i> -Butoxypropan- 2-ol	3 3

Figure 1

This table lists the main substances and classes of chemicals present in the pigments, to which workers and consumers may be exposed to when dealing in this trade.

Here is a quote from the research paper that summarizes a part of the history of the use of these pigments:

“Thousands of chemical compounds are used in paint products as pigments, extenders, binders, solvents, and additives. Azo pigments that contain 3,3'-dichlorobenzidine are common, although free aromatic amines are not present in significant quantities. Asbestos was used as a filler until the early 1990s. The main organic solvents used in paints are toluene, xylene, aliphatic compounds, ketones, alcohols, esters, and glycol ethers. Nowadays, solvent-based paints contain much less solvent – and less hazardous solvents – than a decade ago. In some cases the solvent content is reduced to such an extent that the amounts of volatile organic compounds (VOCs) released from the paint are similar to those from water-based paints.”

Here is a quote from the research paper that summarizes why and how pigments are used:

“Pigments can be classified as inorganic and organic ([Bentley & Turner, 1998](#); [Stoye & Freitag, 1998](#); [Brock et al., 2000](#); [Smith, 2002](#)) and they are generally added in considerable proportion (3–60% by weight) to paint formulations to provide colour, opacity, and sheen. Pigments also affect the viscosity, flow, toughness, durability, and other physical or chemical characteristics of the coating (e.g. corrosion-protective properties). The diameter of pigment particles is generally less than 3 µm, but for special performance, the particle size can be up to 15 or 20 µm ([Oyarzún, 2000](#)).

Today the most common pigment employed in paint is the white pigment titanium dioxide, TiO₂ ([IARC, 2010b](#)). It occurs in two different crystal forms – rutile and anatase – with distinct colour properties. The rutile crystal structure has an almost 25% greater opacity than the anatase form. Because of its chemical inertness, extreme whiteness, excellent covering power and lack of toxicity compared with white lead, titanium dioxide is the predominant component in the manufacture of white paint, representing 90% of all pigments on the market worldwide. The most important black pigment in paints is carbon black (micro-crystalline carbon, 10–40 nm, graphite-similar), which belongs to the inorganic pigments ([Buxbaum & Pfaff, 2005](#); [IARC, 2010b](#)).”

- *Occupational Exposure as a Painter*, NCBI, Chemical Agents and Related Occupations (<https://www.ncbi.nlm.nih.gov/books/NBK304433/>)

Experts & Scholarly Articles:

Amy Bouse, Visual Arts Teacher at Santa Monica High School

Jenny Forster, Chemistry Teacher at Santa Monica High School

“Pastel sticks and pencils consist of pigments bound into solid form by a resin. Inhalation of pastel dust is a major hazard. Some pastels are dustier than others. Pastels can contain toxic pigments such as chrome yellow (lead chromate) which can cause lung cancer, and cadmium pigments (which can cause kidney and lung damage and are suspected human carcinogens). Blowing excess pastel dust off the drawing is one major source of inhalation of pastel pigments. Pastel artists have often complained of blowing their nose different colors for days after using pastels, a clear indication of inhalation.”

- Princeton University *Art Safety*,
(<https://ehs.princeton.edu/book/export/html/334>)

*Refer to background information under previous subtitle

Consumers, User - Surveys & Interviews

Have you used pastels before

114 responses

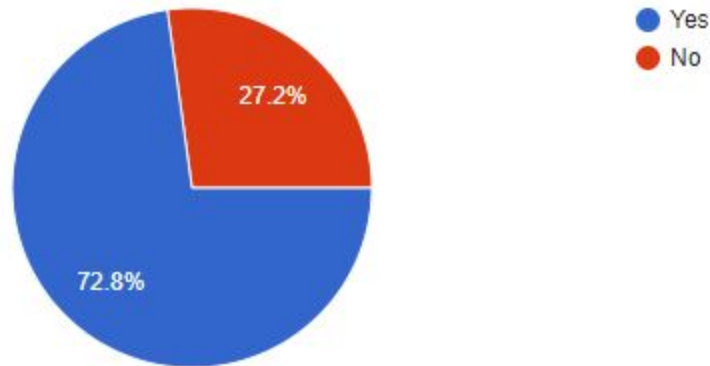


Figure 2

Are you aware that pastels contain pigments with possibly carcinogenic (cancer-causing) elements?

114 responses

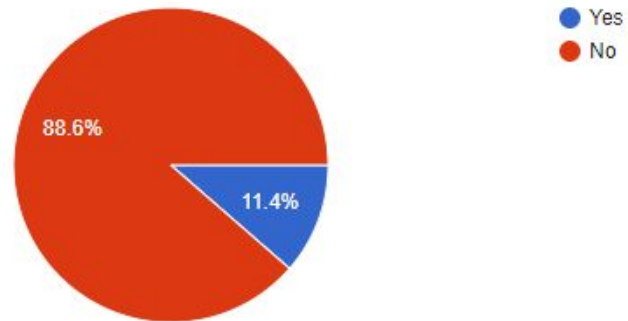


Figure 3

Would you use pastels despite knowing the possible danger?

114 responses

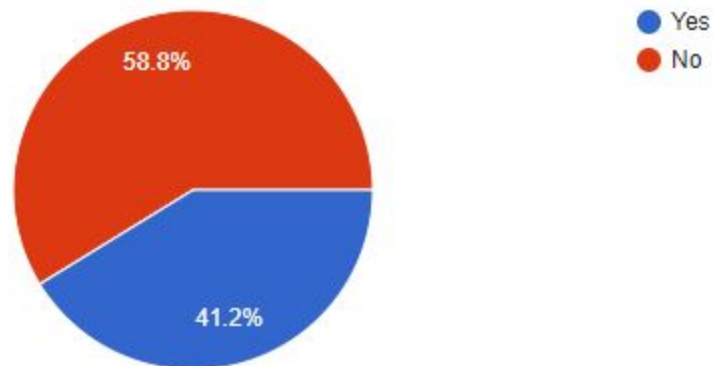


Figure 4

When using pastels, what protective gear would you use?

114 responses

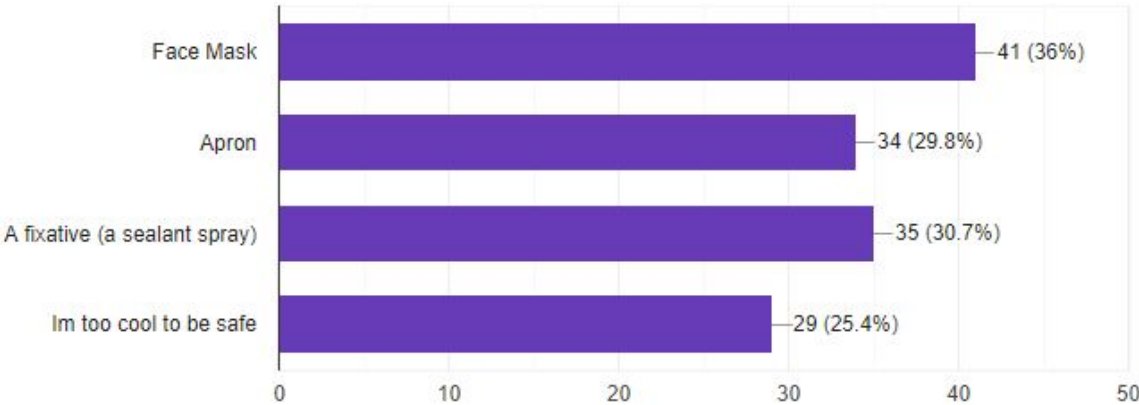


Figure 5

Do you think wearing or applying protective layers to combat the effects of the dust is an effective way of solving this issue?

114 responses

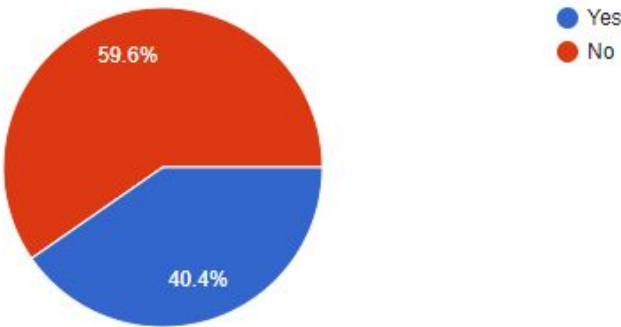


Figure 6

Pastel dust contains fine particles of metal (such as lead and cadmium sulfide) elements that are difficult to contain/capture. Could this be solved with the use of a vacuum?

114 responses

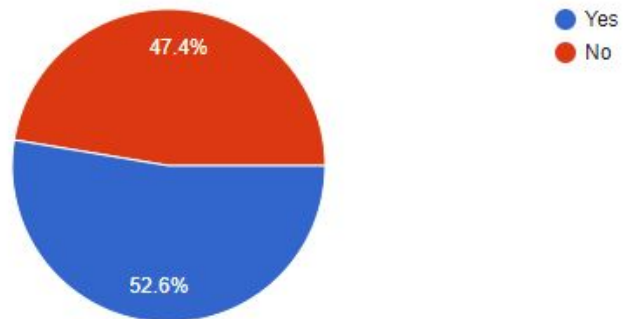


Figure 7

Do you think there is a vacuum that exists that is accessible to the public?

114 responses

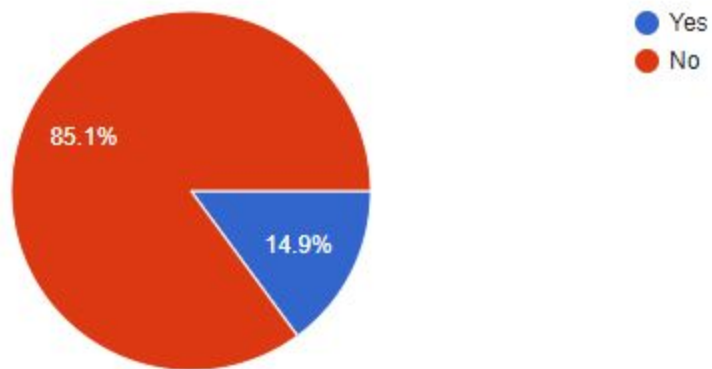


Figure 8

Would a device that captures the dust once the pastel is in contact with a surface be effective?

114 responses

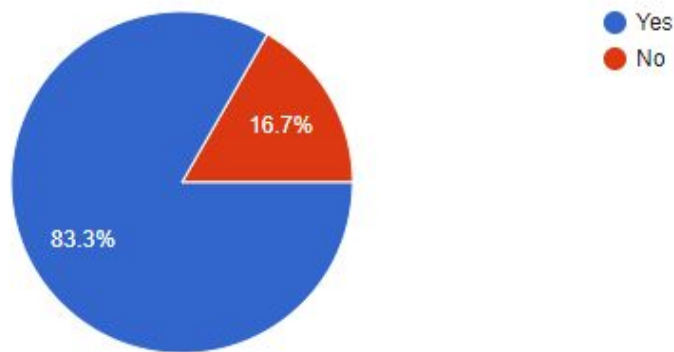


Figure 9

One of the conclusions we were able to formulate from the data collected from our survey is that at one point or another most people have used pastels at least once in their lifetime. This means that many have been exposed to the toxic dust of pastels at least once and most likely were not aware of the dangers. Those who answered to being unaware of the effects, as a result, said they would no longer use pastels if knowing the dangers that could occur (Figure 4). So, in order to encourage consumers to continue to use this product, the product must be deemed safer for use. As shown in Figure 5, people are split on whether they would utilize minimal protection to none versus a fixative or mask (which would likely be safer). In addition, most people indicated that just wearing some sort of protection would not necessarily benefit the user (Figure 6), further demonstrating that the usage of a mask is not completely effective for the safety of the user. In the next figure (Figure 7), the majority of the responses agreed that the use of a vacuum specifically for fine dust particles could be useful but in the following question (Figure 8) most said this kind of vacuum is not accessible to the public, indicating that finding a more affordable and accessible product would be useful. Finally, Figure 9 asked for the opinion of responders on one of our general ideas to which 83.3% answered that they believed our thought of capturing the dust once it comes in contact with a surface would be beneficial.

Existing Products:

- Fixatives

Fixatives provide a protective layer over pastels similar to a finishing glaze. While it helps the dust not rub off, it often ruins the quality of the artwork and can stain the paper. This also does not eliminate the particles already in the air and can only be applied after (to the left are images of different types of fixatives and their application).



Abstract:

“Tissue fixatives, such as diazolidinyl urea, which are free of aldehydes and toxic chemicals are described. When used, either in aqueous or alcoholic solutions, good tissue preservation is attained. In addition, tissue antigens are retained which makes the fixative useful for immunostaining procedures.”



- Masks

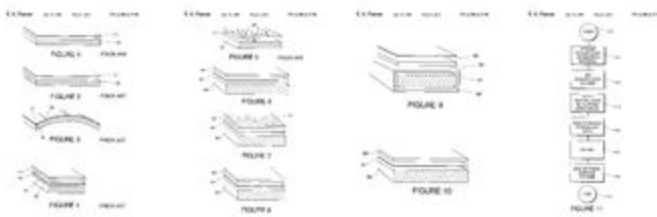
Masks help prevent the inhalation of pastel dust but can provide a false sense of security. For those with certain heart and lung diseases, breathing through a respirator or mask might prove difficult. There is also the issue of sizes and breathing stress.

Element B: Documentation and Analysis of Prior Solution Attempts

From prior solutions, we have learned that while applying or wearing protective layers dust makes slow the particles from getting into the respiratory system, it doesn't stop them from getting in the problem with this is these masks don't make the particles disappear, they are still lingering in the air. Another solution is to work in an outside area, again this doesn't make the particle disappear it just gives them more space to spread out in. This final solution we came upon was to use a sealant spray, while this keeps the particles of pastel dust on the paper, it introduces other toxins that are also bad for the human body, on top of that, the liquid spray ruins the artwork. To determine the problems with these solutions, we had help from Amy Bouse, who helped determine how spray would ruin the artwork. We also had help from Jenny Forster, she helped us determine which toxins were being released in the dust, as well as which ones were the worst.

Patents

Patent #US6258412B1 Method of making an artistic medium 07-10-2001



Abstract: The present invention is directed to a mineral-based coating composition that can be used on a wide range of substrate surfaces. The composition is comprised of a mineral extender, such as a delaminated hydrated aluminum silicate-based clays, having an aspect ratio of about 11 to 1, water, a homopolymer polyvinyl acetate emulsion, a copolymer polyvinyl acetate emulsion, an acrylic emulsion binder containing a metal dioxide and a buffering agent, a surfactant and a deflocculant. Also provided is a method of preparing the mineral-based coating composition. The mineral-based coating composition may be applied to various substrate surfaces to form artistic medium surfaces. The present invention also provides a method of making an artistic medium surface using the composition of the present invention.

<https://patents.google.com/patent/US6258412B1/en>

Patent #US8052890B2 Compositions for dust suppression and methods 11-08-2011

Abstract: The present invention relates to compositions useful for the suppression of fugitive dust emissions and methods of suppressing dust emissions by application of an aqueous solution comprising a surfactant, wetting agent and an acrylic copolymer. The compositions of the invention are effective in wetting, penetrating and improving particle cohesion and reducing water evaporation. They can also be used as a knockdown agent for airborne dust and for minimizing soil and dust erosion, blowing and loss from roads and bulk solids, mineral flotation processes, waste management applications and as a binding agent.

<https://patents.google.com/patent/US8052890B2/en>

Patent # US6673138B2 Multi-color crayon or oil pastel and method of producing the same 1-06-2004

Abstract: The present invention relates to compositions useful for the suppression of fugitive dust emissions and methods of suppressing dust emissions by application of an aqueous solution comprising a surfactant, wetting agent and an acrylic copolymer. The compositions of the invention are effective in wetting, penetrating and improving particle cohesion and reducing water evaporation. They can also be used as a knockdown agent for airborne dust and for minimizing soil and dust erosion, blowing and loss from roads and bulk solids, mineral flotation processes, waste management applications and as a binding agent.

<https://patents.google.com/patent/US6673138B2/en>

Pros	Cons
<ul style="list-style-type: none">- Helps prevents dust from coming off paper- Eliminates the need for use of more than one pastel	<ul style="list-style-type: none">- Adds different toxins into the air when spraying fixative- When the right amount is added, makes artwork runny- Some solutions are only focused on oil pastels instead of soft pastels

Existing/competitive products



GVS SPR457 Elipse P100 Dust Half Mask Respirator

\$27.99

Amazon.com

Strengths/Weaknesses - It circulates air well and is reusable, the weakness is that it doesn't keep out the harmful toxins



3M 8661PC1-A Home Dust Mask, 5-Pack

\$7.52

Amazon.com

Strengths./Weaknesses - It filters air well, not as well as the reusable mask but it isn't reusable and doesn't keep the toxins out



ProTeam® 10 Qt. LineVacer ULPA Backpack Vacuum w/High Filtration Tool Kit - 100280

\$969.00

Globalindustrial.com

Strengths/Weaknesses - it is strong enough to pick up the dust that has the toxins but it is big, bulky and very expensive

Element C: Presentation and Justification of Solution Design Requirements

We conducted a survey that asked if people knew of the dangers of using pastels. It also asked what kind of protective gear they would use and if they had any suggestions or feedback regarding our idea for a solution (refer to the *Consumers, User* section of Element A). From this information, we found that the product should have some sort of vacuum that captures the excess dust and include some sort of element or part that would limit the exposure of toxins to the consumer. Some suggested we could also develop a new formula or take out the harmful chemicals from the pastels themselves, but it is not likely that we will be able to do so. This is mainly an issue for the manufacturers themselves which include, for example: Rembrandt, Unison, Sennelier, Faber Castell, etc. Another possibility (or another side to this issue) would be to also create a safer environment for the works and sellers that handle the raw materials, concerning the ethics of this product in terms of the safety of the providers.

Additionally, we realized that most of the people that took our survey didn't know of the dangers of using pastels, which shows that our problem is significant to not only the art community, but the vast market of consumers who mean to use pastels as a means of education or recreation or neither. We did determine, however, that the majority of those who continue to use pastels tend to be more experienced artists versus those who might have used them once in their childhood (our findings indicated that many recalled using pastels between the ages of 6-14) and thus we provided more surveys to the art classes and environments. By being able to discuss with fellow students the pros and cons of this issue and possible solutions, we were able to gain a wider perspective of the problem in a much smaller context.

Design Specifications/Criteria

Design elements in order of highest priority:

- Captures the excess dust, possibly for extended use of the pastels
- Reduces exposure to toxicity; by altering the fixative or pastel formula, by using some sort of vacuum, or by creating a new type of mask, etc.
- Short learning curve
- Reasonably priced and made accessible to the public

Function

The limiting factors include not having access to raw materials or data indicating the accurate effects of the toxins and dosage on the human body. There would not be enough time to collect this type of data ourselves and there is also the issue of testing the persistence of the toxins within an enclosed environment. There is a possibility of experimenting with synthetic pigments but that would mean taking a deeper dive into the process of pastel manufacturing and would introduce the exposure of other chemicals to us.

We should be able to test what works in terms of decreasing the mess the dust creates but the challenge will be in testing how the product is able to limit the exposure of toxins to the user. If we do decide to experiment with synthetic materials we will need to determine if they are of the same quality as the original product.