The Fall of Operable School Windows

Kirklynn Patterson

Spring 2024

URB370

Introduction:

Why can't we just open the windows?

In theory, when battling illness based absences in schools, opening the windows and turning on the ceiling fans can help ventilate classrooms and keep students from getting sick. It worked during the Spanish Flu, when we opened all the windows and turned all the ceiling fans on to ventilate the air quicker to keep from getting sick, so why wouldn't it work now? COVID-19 put students into isolation and kept them from going back to their classrooms. One solution to get students back in classrooms, specifically in schools with failing HVAC systems, was to open the windows.

But what happens when the windows don't open? Do kids get left behind? This is one reason why the history of operable windows in schools is relevant right now. At what point did architects, engineers, and contractors begin sealing up the non-operable windows? And why did they make those decisions? There are so many pieces of the puzzle to take into consideration when we are looking at the architecture and construction of schools, and the effects those decisions have on the students and faculty that utilize the schools each day. Windows are a very specific piece of the puzzle that have so many consequences that follow the design choice of such a small and simple thing.

When we think about safety, through history, school buildings burning down used to be a very prevalent worry; and when they added metal screens on the windows there were more deaths than there were before. People were not able to flee quickly and safely, even with the help of the fire department. Now we worry about someone coming in to harm our students, and if there is a shooting, a fire, a bombing, and the main exits are blocked, where are we supposed to

go if the windows are inoperable? Are our architects and engineers questioning this when designing the schools? Safety is a concern of the current times, especially in schools in America, and windows are a player that is often being ignored. There are also new technological advancements that mean maybe we don't have to count on windows for safety. This leads to the concept that there is a hierarchy of safety measures in present day schools and windows may sit at the lower priority end of that hierarchical ladder.

Our climate is changing. We are using more energy than ever. Through history we have gone through waves of using an unlimited amount of energy to being forced to cut back and go into crisis mode. When the energy crisis hit in the seventies, why did we choose to rely on the newer technology instead of building more schools with operable windows to promote temperature control through the opening and closing of windows, rather than the use of energy to dictate the temperature of the school? Is this when the big switch to seal all the windows closed and make them inoperable happened? Were we that sure about windows opening being a problem? Is this a regional question? In North America, the continent is largely very humid and that changes how comfortable we are sitting in different temperatures, and with a greater indoor humidity level comes a greater need to lower the temperature. Was this the primary reason to seal the windows?

The use and design of windows on school buildings is important, and has been important through history, whether it was documented or not. It is an issue of public health, safety, ideal learning environments, energy consumption, and the greater idea of architectural integrity.

As this paper progresses, I want to invite you to visualize yourself in a classroom. You might be sitting a few seats away from a wall that has a window. You might be under a vent and

the air conditioning or heater is blowing on you. You might be distracted by the noises from the HVAC system or the birds chirping outside. As you sit in this room, I want you to notice how you feel as the type of window changes. If you feel trapped, sit in the feeling of wanting to escape. If you feel safe, sit in the comfort of being safe from the outside elements. If you feel a longing for a natural breeze, sit in that annoyance you have for the cold superficiality of the HVAC system roaring in the background. The classroom is changing quickly. The seasons and temperatures of the year are passing you by. Sickness gets more and more prevalent. Whirling around you are the different types of windows that have been used in your mental classroom through history, and it gives you context to the information explored through this paper.

The works that have come before me:

Comfort and Perception in Architecture by J. Alstan Jakubiec

The author describes different studies in which users of buildings could not agree on what would signify a "comfortable" temperature and calls architects and engineers to keep temperature and sunlight in mind when designing spaces, especially for students and workers. The author begins by talking about a study done on a group of students in studios at Harvard. When conducting a quick survey about comfort during the winter, the results were as follows: "During the winter 27.4% of students were either 'Cold' or 'Cool', and during the spring 15.3% were 'Warm' or 'Hot.' Visually, 26.7% of student participants reported dissatisfaction with the quality of the lighting environment." The author later gives us a quick overview of the history of heaters and coolers beginning in 1691, and describing that the earliest modern cooling systems were developed and coined as "air conditioners" by Carriers in 1911. During this description, the author points out that the heating and cooling systems also considered mixing in drier air, and were most productive in controlling temperature when the air was less than or equal to 50% humidity. The author continues to talk about research and the equations that go into determining perceived comfort and the physiological need for thermal neutrality after his brief history of temperature control.

This is relevant to us because window operability as a tool of thermal comfort is not a perfect tool, as it does not automatically create warmer or colder air to ventilate for our comfort. Because windows opening for air ventilation is fully dependent on the natural environment and does not allow us humans access to control the temperature or ventilation manually, a guide for HVAC systems and cooling procedures without operating windows was set.

Toward Better School Design by William Wayne Caudill

In this book, the author describes what should be considered when designing and building a school, also offering a guide of how to go about the process. In this in depth piece of literature, the author goes into details about case studies that were affected by ventilation systems, how deep the classrooms were, how tall the walls were, the types of lighting used, and how the comfort of the room is perceived. It continues to share diagrams and images that show how light and air disseminate in different sizes of classrooms, proposing different ways to create light and ventilation in different types of classrooms via different windows.

One case study in particular that is relevant to this paper is that of the "Texas State Engineering Experimentation Station Project," where architects, physicists, a landscape architect, and an aeronautical engineer looked for solutions regarding natural illumination and natural ventilation. This was a unique project because of the fact that there were two natural elements being considered at the same time, where in previous research regarding windows only one natural element was considered. When submitting their research in this publication, they "hoped that school planners will see the value of a simultaneous approach to the design of the classroom arid laboratory envelope, with consideration given not only to natural lighting and natural ventilation but to sound conditioning, heating, color, and artificial lighting as well." This is valuable for us to look at as we approach the topic of windows, understanding that it wasn't until this study in 1949 that in the design process windows became seen as multifaceted tools of classrooms, responsible for responding to multiple natural elements.

Immediately after describing this study, the author enlightens their audience about the effective and ineffective ways to ventilate a room using the placement of openings as well as shape and size of openings. These openings would turn into operable windows. The author points out that the walls are necessary to keep air that is too hot or too cold from the classroom, also keeping rain and other debris away. But windows or openings in the wall are necessary to let air in and out of the classroom properly, and like water, if air is not properly funneled in and out in the appropriate amount of space, the air can dam up and cause more ventilation problems. The common practice is to situate windows in a way perpendicular to the common breeze and have windows on either side of the classroom to cross ventilate. The author gives us the visual of a lake, where the water is very still with little movement as a whole, yet there is lots of movement at the breakaway point. He uses this analogy to tell us of the way air acts around the windows, and why the window placement could be an ineffective way to ventilate the totality of the classroom (the lake). In the same section, the author praises having as many windows as possible for both ventilation and lighting variety, as bilaterally lit and ventilated classrooms hold much higher perceived comfort and efficiency than that of unilaterally lit and ventilated classrooms.

The primary note to make about this source is that this book was published in 1954, before the highly popularized version of HVAC systems that are used today. So in all the discussion about windows, we must be critical to the time that these claims were deemed true.

Ventilation system type, classroom environmental quality, and pupils' perceptions and symptoms

by Jei Gao, Pawel Wargocki, and Yi Wang

Jei Gao, Pawel Wargocki, and Yi Wang conducted a study on four classrooms in one school in suburban Denmark. They tested window opening behavior of students, and the perceptions and symptoms in the classroom with different types of ventilation systems. In the four classrooms the variables included the manually operable windows, automatically operable windows without an exhaust fan, automatically operable windows with an exhaust fan, and a balanced mechanical ventilation system. The results found the students opened the windows regardless of the type of ventilation, even though the classroom with the mechanical ventilation had the highest outdoor air supply rates. They also found that the perception of the indoor environment was most positive in the room with automatically operable windows and an exhaust fan. Regardless of the ventilation system in each classroom, the students opened the windows frequently during the non-heating season, and less frequently during the heating season.

While this is not a specific history of when, who, or why windows on schools have become inoperable, it gives us an idea about student habits, and what it is like to sit in the classroom. Our instinct is to open the window and the perceived quality of our indoor learning environment is somewhat dependent on if we are able to do so. The results of this study that are most interesting are when the researchers identified that the students opened their windows regardless of if it was a part of the ventilation system or not, they simply wanted the windows open. The researchers go on to recommend that hybrid ventilation systems in classrooms is a possible ventilation solution for schools.

Biophilic Design Patterns for Primary Schools by Rokshid Ghaziana, Mark Lemon, and Paramita Atmodiwirjo

Rokshid Ghaziana, Mark Lemon, and Paramita Atmodiwirjo look at existing frameworks and design patterns for Biophilic design and apply those practices to schools, diagnosing how the school is affected. They are specifically looking at the possibilities of biophilic design principles in primary schools in the United Kingdom. They identify that biophilic design has a profound impact on school aged children's mental and physical wellbeing, and how this is more important now than it could have possibly been before the pandemic. The connection to nature has always been important, but the effort to connect children to nature needs to be continued and strengthened in present times. The paper chooses ten case studies and analyzes the application and manifestation of biophilic design, coming to the conclusion that it has a profoundly positive impact on students. They suggest that the designs would benefit from working with the students to create a beneficial environment for the schools.

Although they don't specifically praise windows that are operable, or suggest it is wrong to make inoperable windows, they paint a bigger picture. A picture that says that a connection between students and nature is far more important than we realize. Students thrive in a learning environment that is connected to the earth. The best learning environment is one where there is enough oxygen, enough light, and less toxins in the air. Students are able to learn best when they have access to nature.

When putting this in the context of windows on school buildings, we must remind ourselves of the purpose of the school. What is the reason this structure is here? That should be a guiding force in choosing elements that exemplify the purpose of the building. If the purpose of the building is to be the best place for students to go learn and grow, then we need to be making design choices that reflect that. One of the most simple ways to connect students that are enclosed in classrooms for eight hours a day is to open the windows. For this to happen, the

windows need to be able to open. It is hard to feel connected to nature when the brick and glass wall separating you from the outside world is completely closed off, with no option to break that barrier.

Thesis:

The use of operable windows on schools was common practice until the rapid decline due to many factors, leaving windows on schools to be fixed in place in the present day. Further exploring this topic through the lens of the implementation of HVAC systems, energy use, public health, and students' ideal learning environment, we will discover why this decision was made, and determine if this decision should be reevaluated as architects continue to design schools.

I'd like to call your attention back to what I asked of you in the beginning. Sit in the classroom, paying attention to the windows. Sit with the feelings these windows give you as you are watching the times change around you. Some window features may not be as apparent as others, but all of the changes lead to new feelings. You will either feel the air conditioner blowing on the back of your neck, or the warm breeze from outside lift the edges of whatever papers are on the desk in front of you. Notice if you feel safe, claustrophobic, distracted. And let those feelings sit with you as you go through this journey of watching the windows in your classroom change.

Evidence:

PEASE SCHOOL IMPROVEMENTS: New Fire Escaped Installed and Windows Cut in Wall
The Austin Statesman (1902-1915); Dec 30, 1910;
ProQuest Historical Newspapers: The Austin American Statesman
pg. 8

PEASE SCHOOL IMPROVEMENTS.

New Fire Escapes Installed and Windows Cut in Wall.

When the boiler house was built last summer at the West Austin school two windows from one of the rooms were cut off, and as a consequence the school board is at the present time having Fischer & Lamble, contractors, to cut two new windows in the wall. On fair days the room has been fairly well lighted without the windows, but in cloudy weather the students have been handicapped in this respect.

The two fire escapes purchased for this school are now just about installed, at a cost of $250. The men have been at work putting in the escapes for about two weeks.

The Austin Statesman (1910) PEASE SCHOOL IMPROVEMENTS: NEW FIRE ESCAPED INSTALLED AND WINDOWS CUT IN WALL. Figure 1

WhisperToMe (2009) Pease Elementary in 2009. Figure 2

In 1910 they were adding windows to a school that was already built. They also added a fire escape for student's safety. In the newspaper clipping, you see they also took note of the weather and the sun affecting the students in the classrooms that needed additional windows. The

school was very new when these construction improvements took place. The school is now a district office building and childcare center. It seems that the windows are still operable.

Jordan Company (1916) Austin Free School Kindergarten Class Picture. Figure 3

This image is likely from 1916 showing Austin Free School and a class portrait of the students and teachers in front of the facility. The windows and doors here are both operable and have screens that might keep bugs and animals that are unwelcome in the classrooms out of the school. This would be in a time when schools and most other buildings are using the windows for ventilation, light, and temperature control.

PICA 08937, Austin History Center, Austin Public Library

Austin History Center (1974) Old Austin High School. Figure 4

This is a picture of the old Austin High School, that clearly shows open windows, proving the windows were operable. Although we can't be certain, the windows being open could potentially reflect the weather of the day for temperature control, the need for feeling a breeze inside the classroom, or a number of other reasons.

PICA 07512, Austin History Center, Austin Public Library

Austin History Center (n.d.) Fire escape at Old Austin High School. Figure 5

This picture is showing students climbing onto a fire escape at old Austin High School. When we are looking at images like this and thinking about fire safety, we have to acknowledge that for these fire exits to be valuable, the windows have to open. We can also picture ourselves at school buildings now, and when we do this, can picture where the fire escapes are? Or if they are there at all? Is this a safety hazard or is this a sign that technology has advanced so far that we are no longer concerned about needing operable windows and getting to fire exits?

Austin History Center (1958) Colorado School. Figure 6

This image shows the old Colorado School near Bergstrom Air Field. In the image, you can see the windows are shuttered, and that is confirmed by the image description from the Austin History Center. The picture is from the 1950s and is a good example of a rural Texas school that needed operable windows to help control temperature, and protect students from wind and dust blowing up.

Freedom Permitted Windows

The Austin American (1914-1973); Jul 19, 1964;

ProQuest Historical Newspapers: The Austin American-Statesman

pg. C7

Freedom Permitted Windows

Windows have come a long way since the days when they were just peepholes to fire arrows through. That was back in the dark old days, literally, when only narrow shafts of light penetrated castle or stone hut, and admitted little fresh air.

Great advances in artificial lighting and ventilation have largely freed the window for other uses if the home owner desires. Now, the view it offers, or simple ornamentation, may well be a window's reason for existence.

Of course plenty of natural light is still desirable to most home owners, and this must be taken into consideration in design. With the advent of air conditioning, ventilation is less of a role of the window today.

The modern home is likely to have considerable more window area than its predecessors, although women fall into two schools of firm opinion on particularly generous areas of glass. Some derive more pleasure from this indoor-outdoor effect, while others favor smaller windows strategically placed.

Appealing to both factions, and gaining favor lately, is the mullioned window. This can be small, or quite large, crisscrossed by many frames. Sometimes the window is one sheet of glass, and the frames one removable plastic piece, for easy cleaning.

Nearly everyone agrees that a large expanse of glass should look out on a nice view, whether natural or created through good landscaping.

The Austin American (1964) Freedom Permitted WIndows. Figure 7

Windows have come a long way since the days when they were just peepholes to fire arrows through. That was back in the dark old days, literally, when only narrow shafts of light penetrated castle or stone hut, and admitted little fresh air.

This brief news article from 1964 simply shares a love for all types of windows and expresses how the technology of the window has advanced. They are now used for ventilation and temperature control (at this point in time). Some people preferred strategically placed windows while others wanted lots of large windows that they could open and create that indoor-outdoor feeling that lots of us crave.

School fire forces tots out windows

School fire forces tots out windows

MANILA, Philippines (AP) — Scores of children leaped today from the second floor of a burning parochial school that had no fire exit and at least 110 youngsters suffered burns or broken limbs, the official Philippines News Agency reported. One pupil said his teacher abandoned the class and fled for her life.

Cpl. Carlos Tiquia, police investigator in the suburb of Valenzuela, said 38 children, ranging in age from 5 to 10 years, were hospitalized, and that two teachers were burned.

"Nobody was killed, and all the students have been accounted for," from among the nearly 300 pupils in the brick-and-wood building, Tiquia said.

He said the only way out of the school's upper floors was on a single staircase. The news agency reported the blaze broke out shortly before noon in a storeroom under the stairs, where paint and paint thinner were stored, trapping pupils from kindergarten through third grade upstairs.

"Many of them piled out through the windows," the agency quoted one witness as telling investigators. "They landed on the pavement, some limping but others had to be carried."

One of the injured teachers, Perla Ferrer, told the news agency, "I had to lead many pupils through the windows as suffocating smoke filled the class rooms."

The Austin American - Statesman (1979) Figure 8

"Many of them piling out of windows" is another early example of schools needing operable windows for the safety of students, as school fires are devastatingly common. When the staircases were blocked by the fire, the children and teachers were trapped upstairs and the windows were the only way out.

Patterson, K. (2024) Anderson High School photos. Figure 9

These four images are taken at Anderson High School. “In 1971 the school was ordered closed by a federal judge as part of desegregation and a new, integrated L. C. Anderson High School was opened in 1973 at the current site.” Some windows on the school seem like they were originally designed to be functioning but unfortunately the placement of the windows doesn’t seem to be conducive to productive airflow nor sunlight. There is an argument to be made that these windows don’t serve any true purpose if they are not accepting any sunlight nor ventilating properly.

Patterson, K. (2024) Barbara Jordan Early College Prep photos. Figure 10

These three photos are of Austin ISD's Barbara Jordan Early College Prep campus.The campus was built in 1993 (*History | Barbara Jordan Elementary School*, n.d.) and has windows that are operable, or were at one time operable. The windows depicted in the images are not fully sealed, and seem to allow air, dust, and bugs into the building inadvertently. While the intention of having open windows is very positive, the reality of having operable windows is that over time they show degradation and are not completely effective in allowing the occupants to fully control their access to the outdoors (and the access of the indoors to outdoor things such as dirt and bugs). You can also see the air conditioning unit in one of the windows that is open, but sealed with a non transparent board around the unit. One has to question how this came to be and why someone would take out the operability aspect of the window to install a window air conditioning unit, especially when the school has a HVAC system already installed.

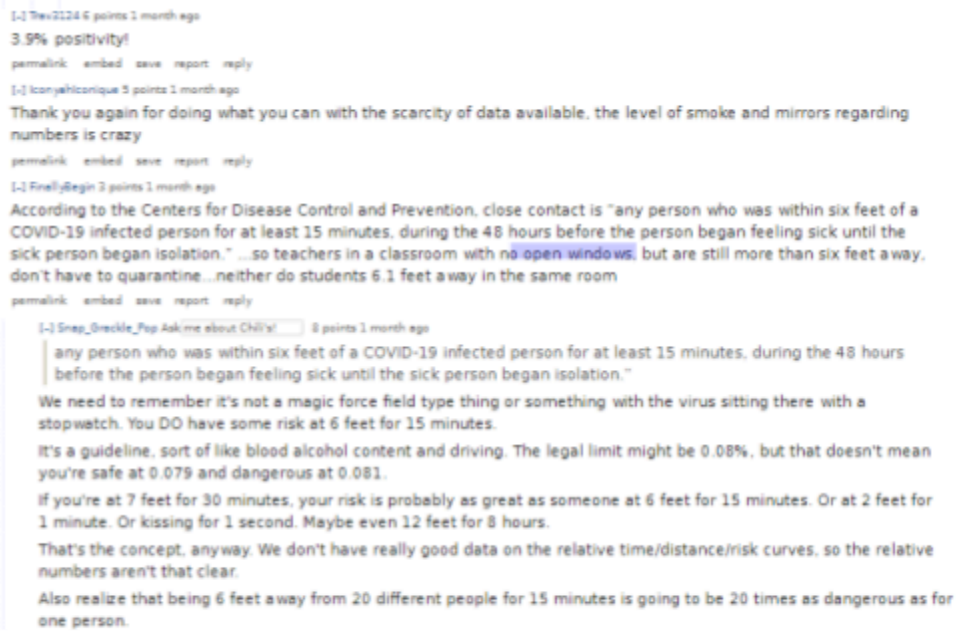
'atterson, K. (2024) McBee Elementary photos. Figure 11

These 8 pictures are from McBee Elementary School. The building was built in 1999 and opened in 2000. (*History | McBee Elementary School*, n.d.) There are many types of windows on this facility, some windows operable and some inoperable. For the windows in the last picture, depicting the windows closest to the main office, those windows are not operable. Because they are non operable, the glass panes had to be taken out of the windows instead of having the windows simply open because they were not built to be flexible, they were built to be fixed in place and offer natural light without being used for temperature control.

Patterson, K. (2024) Padron Elementary School photos. Figure 12

Padron Elementary School is a newer elementary school in Austin, “Jaime D. Padrón Elementary opened in 2014 with 57 classrooms on a bright, inviting, state-of-the-art campus in North Austin.” (*Padrón Elementary School | Austin ISD*, n.d.)

When looking at the design of this school in general, it does not necessarily feel cohesive. When we look at images about the different parts of the schools, it is almost difficult to tell if it is even the same school. When it comes to windows however, all of the windows do look very similar. They were never installed with the intention of being able to open, the size and shape of them allows us to imagine them as strictly being used as a source of light, and to not compete against the existing ventilation system.



Nomai Afsheen (2020) 2020-09-23-Reddit-COVID-User-Comments. Figure 13

In these COVID-19 Reddit statistics compiled by Nomai Afsheen, we can see people discussing if it is safe for students to go back to school while the pandemic was still at its height. One user brings up the fact that the Centers for Disease Control and Prevention identified that if you are within six feet of someone who was infected, then you are now also subjected to the infection. In relation to schools and worries about windows not being able to open, they question the validity of how being 6.1 feet away from a sick student is completely different from 6 feet away. I believe this was a shared sentiment when talking about sending kids back to schools with windows that don’t open during the pandemic.

Analysis:

In the evidence, we see a wide variety of types of windows on a wide variety of school buildings. The windows are of different shapes, sizes, tints, and operability. There is an observed decline in the operability of windows, as seen in the evidence timeline in the prior section. When we imagine sitting in those classrooms, coming from a classroom that has changed from offering a nice breeze and natural air to not allowing any air to go in or out of the building, does this seem like it would be comfortable? We must ask ourselves why the windows slowly stopped opening.

The timeline offers us a brief history of the types of windows found on school buildings and a small history of school safety, sickness, and technology. Taking all of these overlapping histories into account, we can notice the advancement in technology shifting the necessity for functional windows. The advancement of HVAC systems, fire walls, sprinkler systems, and insulation materials makes opening windows a less mandatory act, and at some point is unwelcoming to the opening of windows.

Before we jump into the reasons that the windows don't typically open on school buildings as we see them now, I would love to acknowledge all of the reasons why it would be ideal to open the windows on school buildings. We can think about biophilic design and nature impacting mental health and learning environments for the better; we can think about indoor air quality being dangerous due to chemicals in the materials and cleaning supplies and how the outdoor air might be better for our brains; and we can think about how it is very human to want to be connected to the outdoors even while we are required to be inside, and sometimes more comfortable indoors.

We can recall from the literature review that it is human nature to want to open the window, no matter the temperature indoors or the energy being spent on ventilating the air. Jei Gao, Pawel Wargocki, and Yi Wang's study showed that a hybrid environment of windows that open in addition to a ventilation system was perceived as the most ideal indoor learning environment for the schools in suburban Denmark that they were looking at. (Gao et al., 2014) I can imagine that being able to access the outdoors while sitting in a classroom and learning long division feels less like prison and more like an opportunity than having to sit in a classroom and learn long division without the breeze from outside and the sound of the leaves rustling, sitting there in a room that feels more like a cell with no permeable walls. This idea is further advocated by the idea that Rokshid Ghaziana, Mark Lemon, and Paramita Atmodiwirjo look at in the field of biophilic design in schools. A student's connection to nature is so important. The best learning environment is one where there is enough oxygen, enough light, and less toxins in the air. (Ghaziani et al., 2021) And wouldn't this ideal learning environment be best created in a classroom that has operable windows? It is important to remember however that these studies were done in Denmark and the United Kingdom for the most part. If we are to look at how this is applicable to schools in Austin, TX, what is different here? The answer to that is complicated, but in short, there are drastically different humidity and weather related concerns, safety concerns, and funding concerns. This will have to be kept in mind when further thinking about the context and history of operable windows on schools in Austin.

Although opening windows has a lot of benefits and is preferred by teachers and students and the act of opening windows is our initial instinct when we are in a space that allows for it, as documented in the literature review, the benefits of having the windows sealed makes more sense for the schools in terms of finance and comfort of each classroom.

In terms of finance, public schools are on strict budgets. This, coupled with the fact that energy is expensive, means that there is a limited amount of energy that a school is able to use on a daily basis. When the windows can open and the air conditioned or heated air is able to leave, and the humid air introduces moisture into the classroom, this can cause lots of very expensive problems. Thinking about all of the different things that cost money in this scenario can be overwhelming, but I suggest we break it down anyway.

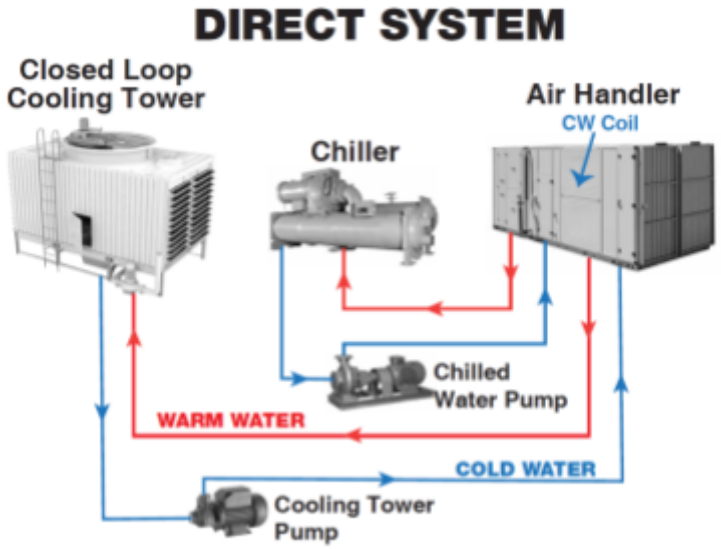
Let's imagine ourselves in a classroom, let's then imagine ourselves opening a window and having a seat. Now look around and just observe your surroundings. The breeze brings in a nice, cool, humid wave of air. We can look at the ceiling and notice the porous acoustical tiles that absorb sound (and moisture) to keep the classroom noise levels from permeating too far outside of the classroom. Following that specific rabbit hole, an acoustical tile ceiling costs about 85 cents per square foot, or 60 dollars for a pack of 20 tiles. (*USG Ceilings 2 Ft. x 2 Ft. Radar Basic White Square Edge Lay-In Ceiling Tile, Pallet of 320 (1280 Sq. Ft.) R2110*, n.d.) There are about 66 of those acoustical tiles in each classroom, hypothetically. If there are 24 classrooms in these hypothetical schools, then it costs roughly $4,442.40 to replace the moldy ceiling tiles because we opened the windows and exposed these acoustical tiles to humidity. This is only thinking about classrooms, disregarding the ceiling tiles in any offices and hallways or cafeterias. When those porous tiles are introduced to the humidity, they mold. When the mold grows, and it does grow rather rapidly, it can make the people in the classroom sick. And that in turn causes students to miss class. This may cause less funding for the school because many schools get funding based on kids attendance per day. (Agency, 2023) Now that we have thought about the acoustical tiles and what would happen to them if we decide to open a window in the classroom,

and we have thought about how much money we might lose to repairs and replacements, as well as loss of funding, let's shift our attention.

We are once again sitting in the classroom after opening the window. The air becomes slightly uncomfortable in temperature despite having the fresh air and breeze coming through the window. The A/C turns on. The whirring noise begins. The cool air starts blowing and the temperature starts decreasing, only now it is working harder and staying on longer in order to make the temperature even lower, as now it has to be a cooler temperature as the humidity is higher for the temperature to be perceived as comfortable. For the temperature to be comfortable at a reasonable temperature on a warm day, such as an indoor air temperature of 70 degrees fahrenheit, the air must be dry. When the air is humid, the same indoor temperature will feel hotter or more suffocating. We then want to lower the temperature, inevitably using more energy. This gets exponentially more complicated and expensive when you are running a facility with over thirty rooms, such as a school, where if someone opens a window in one room then the surrounding rooms will suffer changes in temperature as well, even if they are not yet exposed to the humidity. This can get very pricey very quickly. You didn't know HVAC systems were so complicated, did you?

While we're on the topic of HVAC systems and humidity, and the changes in the air humidity percentage, let's discuss more about why HVAC systems operate better when we keep the windows closed.

HVAC systems ventilate the air as they go through the air ducts, and they typically pull all the moisture out of the air to be collected at the internal system's cooling tower.



Waterline Controls (n.d.) Direct System. Figure 14

This extracted water can be used to water plants or grass and is really a pretty good system for displacing the water from somewhere we don't want it to somewhere it is more useful. When a window opens during this process that the HVAC system is working so hard on, the moisture in the humid air coming through the window does not get to go through the initial steps of ventilating outdoor air inside. And when the indoor air is ventilated indoors, now it is humid as well, again because the air did not go through the initial step of running through the cooling tower due to the fact that we wanted to smell the fresh air or feel a natural breeze. While these technological advancements are helpful and innovative, as well as successful for keeping temperatures from fluctuating out of our indoor comfort range, it is still a little heartbreaking that we created a system that keeps us away from embracing nature while we are stuck indoors. I do not have a solution for this though, so I will choose to believe the engineers.

In regards to fire safety, and thinking about how many people were saved from fires in schools through windows, we have to wonder why it is not a safety priority to have operable windows on these school buildings. The newspaper clippings from the timeline we saw show people escaping from windows when there was a fire, but this was very long ago. Fire marshals now prefer other advancements over operable windows, such as firewalls and sprinkler systems. (Doherty, 2020) While I am longing for an excuse to have operable windows in schools, at every turn there are many more reasons why the windows are sealed up and non operable at the moment.

This brings us to question what it means for a window to be operable, and if the window being operable is the problem, or if the inanimate object of a window only causes problems in the hands of us, the ones operating them. If there is an argument to have or not have operable windows, we must think about if a window can hold the option to be operable without being operated. In the study from Jei Gao, Pawel Wargocki, and Yi Wang, we notice that whether the window needs to be opened or not for ventilation purposes is irrelevant to the users. This means that for a window to become its true full potential, there must be an understanding of when it should and should not be open so that we are not causing problems in our schools that were previously mentioned. So how do we decide who decides when windows should be open? That said, are there any downsides to installing windows that are operable if we are able to use them appropriately? What is the downside to having them there for that "just in case" scenario, such as for a fire escape or another hazard?

Financially, picture windows, or fixed windows, are slightly more expensive on average than single hung or double hung operable windows. They are marketed as higher quality and more energy efficient windows, for the fact that they don't let any air in or out. (*How Much Does*

Window Replacement Cost? (2024 Pricing), n.d.) This means that the financial cost of the physical operable window is often going to be the less expensive choice, but energy use on buildings as big as schools is something that we have been trying to cut down on for a long time.

It seems to come down to what are people willing to prioritize? We understand that the factors to consider when choosing if a window should be operable or not are potentially unlimited. The people with the power to make the simple decision of operable windows versus non operable windows on school buildings are confronted with the decision to choose frugalness in financial and environmental considerations, or to prioritize children's mental health and create an ideal learning environment that is connected to nature and has that extra safety precaution. As it stands now, there seems to be no decision in which all considerations are met with a positive conclusion. No matter the decision that this authority figure makes, something is inevitably looked over.

In order to prioritize children's education and the architectural integrity of our schools, we should be called to continue developing technology so that one day we will be able to have windows that don't have to sacrifice budget, ideal working environments, safety, or the environment. Although we may not understand what that should look like now, I trust that there are architects, engineers, teachers, and students of many disciplines that have the capability to come together and find a solution that is considerate to all factors that are present in schools.

References:

2020-09-23-Reddit-COVID-User-Comments | Austin History Center Digital Collections. (n.d.). Retrieved April 15, 2024, from https://ahc.access.preservica.com/uncategorized/IO_8ed83d96-cb19-4921-b811-284425223b3c/

Agency, T. E. (2023, July 12). *Per Capita Rates*. Texas Education Agency. https://tea.texas.gov/finance-and-grants/state-funding/additional-finance-resources/per-capita-rates

Bingamon, B., 7:30AM, Sep. 4, M., & 2023. (n.d.). *Historic Pease Elementary Becoming Child Care Center for AISD Teachers*. Retrieved April 29, 2024, from https://www.austinchronicle.com/daily/news/2023-09-04/historic-pease-elementary-becoming-child-care-center-for-aisd-teachers/

Caudill, W. W. ([c1954]). *Toward better school design*. N[ew] Y[ork]: F.W. Dodge Corp. http://archive.org/details/towardbetterscho00caud

Direct Cooling Systems. (n.d.). *Waterline Controls™*. Retrieved April 29, 2024, from https://www.waterlinecontrols.com/technical-articles/cooling-towers-use-theory/cooling-tower-types/direct-cooling-systems/

Doherty, W. (2020, October 23). *7 Important Fire Prevention & Safety Measures for Buildings | AIE*. AIE Fire Protection. https://aiefire.com/important-fire-prevention-safety-measures-in-buildings/

Freedom Permitted Windows—ProQuest Historical Newspapers: The Austin American Statesman—ProQuest. (n.d.). Retrieved April 15, 2024, from https://www.proquest.com/hnpaustinamericanstatesman/docview/1559164244/98A210801DB24262PQ/26?accountid=7118&sourcetype=Historical%20Newspapers

Gao, J., Wargocki, P., & Wang, Y. (2014). Ventilation system type, classroom environmental quality and pupils' perceptions and symptoms. *Building and Environment*, *75*, 46–57. https://doi.org/10.1016/j.buildenv.2014.01.015

Ghaziani, R., Lemon, M., & Atmodiwirjo, P. (2021). Biophilic Design Patterns for Primary Schools. *Sustainability*, *13*(21), 12207. https://doi.org/10.3390/su132112207

History | Barbara Jordan Elementary School. (n.d.). Retrieved April 29, 2024, from https://barbarajordan.austinschools.org/about-us/history

History | McBee Elementary School. (n.d.). Retrieved April 29, 2024, from https://mcbee.austinschools.org/about-us/history

How Much Does Window Replacement Cost? (2024 Pricing). (n.d.). Retrieved April 29, 2024, from https://www.thisoldhouse.com/windows/reviews/window-replacement-cost

J. Alstan Jakubiec—Comfort and Perception in Architecture | PDF | Heat Transfer | Humidity. (n.d.). Retrieved April 29, 2024, from https://www.scribd.com/document/692142611/J-Alstan-Jakubiec-Comfort-and-Perception-in-Architecture

Jakubiec, J. A. (2022). *Comfort and Perception in Architecture / J. Alstan Jakubiec.* (1st ed. 2022.). Springer. https://doi.org/10.1007/978-981-10-1775-9

McBee Elementary School | Austin ISD. (n.d.). Retrieved April 29, 2024, from https://www.austinisd.org/schools/mcbee

Padrón Elementary School | Austin ISD. (n.d.). Retrieved April 29, 2024, from https://www.austinisd.org/schools/padron

PEASE SCHOOL IMPROVEMENTS: New Fire Escaped Installed and Windows Cut in Wall—ProQuest Historical Newspapers: The Austin American Statesman—ProQuest. (n.d.). Retrieved April 15, 2024, from https://www.proquest.com/hnpaustinamericanstatesman/docview/1611794068/98A210801DB24262PQ/1?accountid=7118&sourcetype=Historical%20Newspapers

PICA-05156 | Austin History Center Digital Collections. (n.d.). Retrieved April 15, 2024, from https://ahc.access.preservica.com/uncategorized/IO_0a3c36e8-751a-46cc-a2c2-aaf61da81dbb/

PICA-07512 | Austin History Center Digital Collections. (n.d.). Retrieved April 15, 2024, from https://ahc.access.preservica.com/uncategorized/IO_35dc55ea-54ba-4eaf-b57f-5673bb8c8cc3/

PICA-08937 | Austin History Center Digital Collections. (n.d.). Retrieved April 15, 2024, from https://ahc.access.preservica.com/uncategorized/IO_54429063-abbe-4ef7-bd56-1e444fdd2daf/

PICA-11212 | Austin History Center Digital Collections. (n.d.). Retrieved April 15, 2024, from https://ahc.access.preservica.com/uncategorized/IO_a3167a92-fcb5-4464-a755-c8dcbc45df5b/

School fire forces tots out windows—ProQuest Historical Newspapers: The Austin American Statesman—ProQuest. (n.d.). Retrieved April 15, 2024, from https://www.proquest.com/hnpaustinamericanstatesman/docview/2027658012/98A210801DB24262PQ/2?accountid=7118&sourcetype=Historical%20Newspapers

The Original L.C. Anderson High School | Anderson High School. (n.d.). Retrieved April 29, 2024, from https://anderson.austinschools.org/aboutus/lcanderson

USG Ceilings 2 ft. X 2 ft. Radar Basic White Square Edge Lay-In Ceiling Tile, pallet of 320 (1280 sq. Ft.) R2110. (n.d.). The Home Depot. Retrieved April 29, 2024, from https://www.homedepot.com/p/USG-Ceilings-2-ft-x-2-ft-Radar-Basic-White-Square-Edge-Lay-In-Ceiling-Tile-pallet-of-320-1280-sq-ft-R2110/203628487