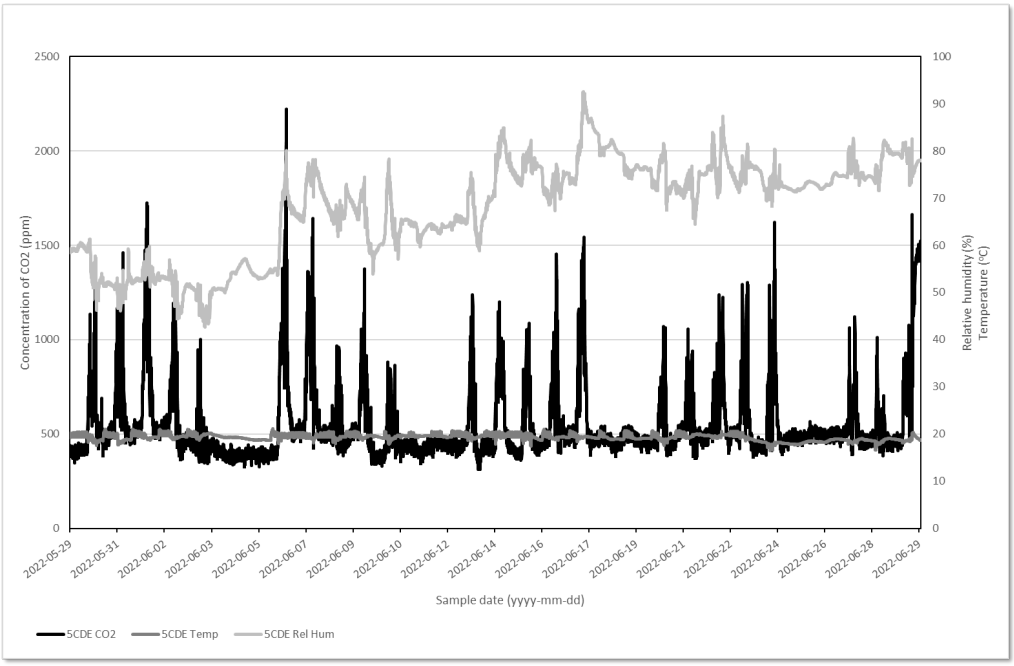
EDUCATIONAL RESEARCH MONOGRAPH

SUZUKI PUBLIC CHARTER SCHOOL
MARCH 2023
And
University of Alberta



Readings from a multi-function air quality sensor placed in the main hallway at Suzuki

Getting schooled: Application of engineering principles in assessing air quality in an elementary school

Project funded by the Natural Sciences and Engineering Research Council of Canada (NSERC) and generously supported by a loan of sensors by Deviceworx, Inc

Lead Researcher: Dr. Lianne Lefsrud, P. Eng
Associate Professor and Director Outreach, Chemical and Materials Engineering

Researcher: Michelle Naef, P. Eng
Graduate Research Assistant, Chemical and Materials Engineering

CONTENTS

PART ONE: SYNOPSIS OF RESEARCH PROJECT IN SIMPLE TERMS

1. What was the original intent or motivation for the research?

When the COVID-19 pandemic struck suddenly in March 2020, public schools in Alberta were closed and permitted to re-open with the requirement to develop pandemic risk management plans. The research team offered their support to schools in Alberta in developing risk management plans, and three public charter schools engaged researchers. This study was a follow-up to that work, questioning the real impact of teaching/classroom activities on CO_2 levels, with particular interest on the risks of choral and ensemble music at Suzuki school.

2. What were the outcomes of the research?

Choral music instruction and simulated wind instrument ensemble instruction had no measurable impact on CO_2 levels in the classroom, as compared to "traditional" classroom instruction.

3. How could the research potentially be applied at Suzuki Charter School?

The research was applied in risk management decisions surrounding classroom teaching activities as public health guidelines became less restrictive. The study also supported communication to school staff, parents and other stakeholders where uncertainty remained about the safety of some classroom activities.

4. Is there a potential message to the broader educational community on the outcomes of the research?

This study demonstrated the effectiveness of "the engineering approach" to risk management and building/facility operation. The study was mobilized quickly, with minimal financial commitment by the school, and the data collected directly supported high-stakes decisions surrounding facility use and planning.

5. Are there suggestions to improve the research partnership and support provided by the school to the research community?

The research partnership was well-managed and suggestions to improve the dissemination of results to school stakeholders were received enthusiastically by the research team.

PART TWO: RESEARCH PROJECT – DIVING DEEPER INTO DETAILS

AN OVERVIEW BY Michelle Naef, P. Eng
(this overview taken in part from a pending publication prepared by Michelle Naef and Dr. Lianne Lefsrud)

This study demonstrates the relative ease with which motivated non-technical community leaders can be empowered and mobilized to collect data, analyze results, and develop meaningful site level risk controls. Six basic concept areas were identified using standard industrial and process engineering frameworks: 1) asset breakdown, 2) identification of mass and energy flows, 3) selection of measurement nodes, 4) specification of measurements, 5) data collection and analysis, and 6) decision-making. The administration of Suzuki Charter School expressed enthusiasm in participating in this experiment as they evaluated their risk management plan at the end of the second "pandemic school year". The school integrates music into the curriculum, and local public health guidelines had applied a near-moratorium on group music of any kind, in particular singing and playing wind instruments. Deviceworx, a Canadian Internet of Things (IIoT) company offered to assist in data collection with the generous loan of 30 air quality monitoring sensors to the school for a period of three weeks. The sensors measured CO_2 concentrations, relative humidity, and temperature measurements every five minutes over the three-week period, half located in a traditional classroom and half located in a music classroom, where some choral singing was cautiously resumed in June 2022.

The results were relatively easy to interpret; the classroom activity had minimally observable impact on the CO_2 levels measured in the space. Students in the choral room were exposed to similar concentrations of CO_2 as students in the traditional classroom, where desks were arranged in rows and public-health recommended distancing maintained.

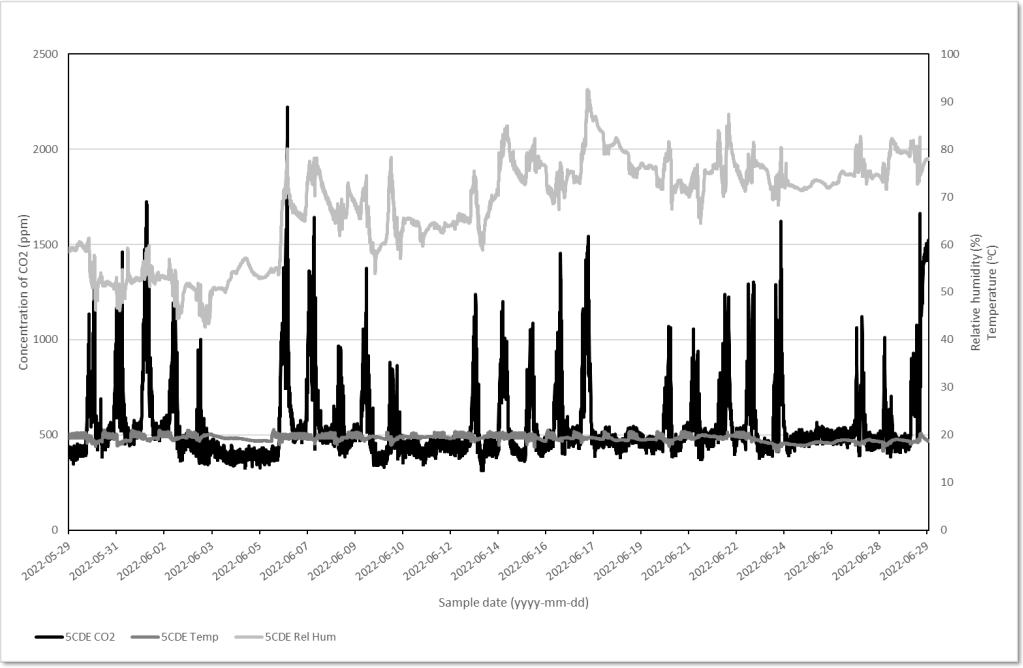


Figure 1 Readings taken by sensor ID 5CDE located in the main hallway, from May 29 through June 29, 2022

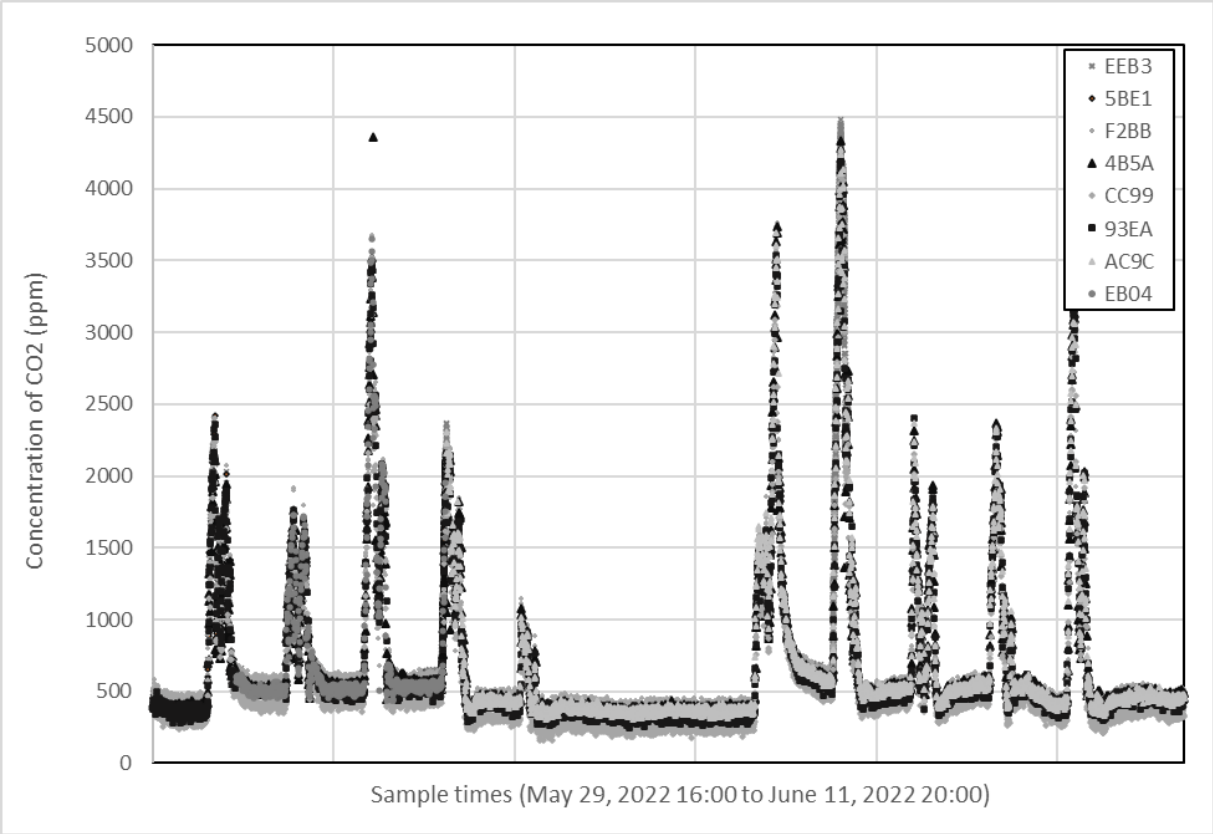


Figure 2 Classroom 27, traditional style grade 5 classroom with readings shown for two weeks

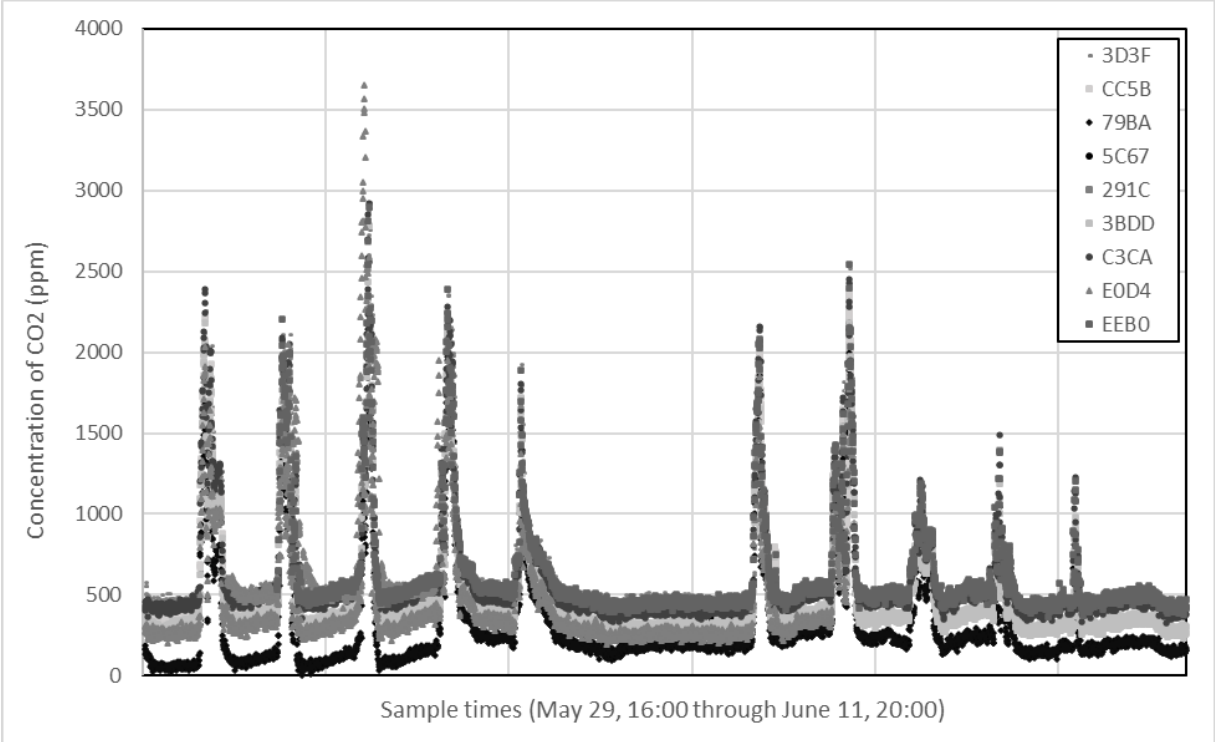


Figure 3 Concentration of CO2 in classroom 36, choral instruction over 2 weeks

The sensor results collected in classrooms 27 and 36 shadow the trends of the reference sensor in the hallway, which demonstrates the cyclic nature of CO_2 concentrations in the entire facility, trending upward during "occupied" periods and predictably decreasing as the facility vacates. Use of ten sensors demonstrated more rapid and complete mixing of the air in the classroom than was expected, particularly in classroom 27, where there was more apparent congestion in the space due to furniture (Figures 2 and 3). More detailed examination of daily results in both classroom spaces showed that CO_2 levels reached levels near "vacant" within 20 minutes of students leaving the classroom for recess and lunch periods, supporting the theory that vacating rooms and allowing "settle" time was a valid control for reducing exposure to exhaled contaminants. The return to average "vacant" levels is highly dependent on local factors, and use of multiple sensors over a relatively short test interval provided confidence in the length of "settle" time that would be effective. There was no significant increase in CO_2 generation in the choral music classroom, as compared to the traditional instruction classroom. Classroom 27 reached higher maximum concentrations of CO_2 than were observed in the choral classroom.

Pai, (2022) interviewed 27 engineers from around the world and summarized their contributions to cost-effective and community centric health solutions, technical expertise and rigorous design and evaluation techniques to measure and validate those solutions where they are used. The method outlined in this paper is a similar contribution, a set of steps to identify to community members where controls can be applied and where they would have measurable impact. This study demonstrates how engineering theory and research can be applied to help communities better understand the facilities in which they live and work, focusing on air quality hazards and the demystification of building safety.

Reference:

Pai, M. (2022). Engineers Are Unsung Heroes Of Global Health. *Forbes*. https://www.forbes.com/sites/madhukarpai/2022/05/22/engineers-are-unsung-heroes-of-global-health/?sh=417599247a28&dgcid=RN_AG_Sourced_…

PART THREE: DIMENSIONS OF THE RESEARCH PROJECT

1. MEET THE RESEARCHER

   Dr. Lianne Lefsrud is an Assistant Professor, Engineering Safety and Risk Management at the University of Alberta. She uses mixed methods to study how institutional and new venture entrepreneurs use persuasive language and imagery to shape our conceptions of technology, the environment, and regulations. Specifically, her research examines methods of hazard identification and risk management, risk evaluation and social license to operate, and drivers of technology adoption in oil and gas, mining, pipelining, construction, agriculture, and railroading, among other industries.

   As most risks are multi-disciplinary in nature, it has also motivated her academic approach: from an MSc in Environmental Engineering and Sociology (the first Engineering-Arts interdisciplinary degree at UAlberta), to a PhD in Strategic Management and Organization, and now a tenure-track position back in Engineering. Given her multi-disciplinary research, Dr. Lefsrud works with scholars in engineering, computer science, cognitive psychology, business, economics, English literature and film studies, and environmental sociology.

   Further, to understand various theoretical model elaboration/validation/ mobilization methods, Dr. Lefsrud moved from academia, to industry and regulation, and back to academia. Professionally, her career spans two decades with senior roles in industry, consulting, and regulation. Prior to returning to academia, she was the Assistant Director Professional Practice with APEGA, an Assistant Director in operations with Canadian National Railway, and worked in construction and oil and gas. Besides doing internationally award winning research, she also provides policy and strategy advice to government and industry. Even while not an academic, she remained instrumental in multi-disciplinary collaborations and publishing, to have the greatest possible impact on organizational and regulatory practices in Canada and worldwide.
   (from https://apps.ualberta.ca/directory/person/lefsrud)

2. SUZUKI CHARTER SCHOOL PARTICIPATION

   The school administration that participated in this study had previously engaged the research team to assist in developing a risk management plan – to synthesize public health guidelines and develop practices for the initial re-opening of public school in September 2020. The initial results of that activity demonstrated the value of basic industrial risk management theory and the layers of protection approach, which was applied to evaluate the value of different non-mandatory controls. The school administration readily adopted the Risk Management process of "Identify-Assess-Plan-Control-Evaluate" and was enthusiastic to be able to "assess" the hazard in a more rigorous and direct manner than had been previously possible. The facility risk management plan had undergone several evaluation cycles and the school administration had made sensible alterations to risk controls when sufficient data was available to determine effectiveness. Practices like increased cleaning of classroom shared materials for example, was dropped as the public communication around COVID showed that the

hazard was primarily aerosol. Some of the practices for sanitation impacted instructional activities significantly, like requiring individually packaged and quarantined craft materials for primary school students as opposed to materials and tools that could be readily shared between groups of students.

The administration's response to the CO_2 study was equally enthusiastic and supported the decision to return choral singing to regular activity in the school. Public health restrictions on instrumental music were lifted before the 2022/2023 school year began, but school administration was prepared to request allowances from public health if restrictions had continued, based on the results of this study. There was no case to be made for instrumental music increasing the exposure risk in the occupied spaces of the facility; if traditional classrooms were safe to operate, then so too were group music lessons.

The school administration reported receiving 10-20 inquiries every week over the course of the COVID-19 pandemic, most attempting to sell devices promising to make schools safer. Products from hand sanitizer to air filtration units were offered, along with the increased communication from parents and staff, questioning different policies, and making suggestions to improve facility safety. Administration reported being generally overwhelmed by the sales inquiries but felt empowered by participating in the study to collect experimental data locally. Many of the risk controls around choral and instrumental music were the result of incident investigations from the early months of the COVID pandemic, which represented risk scenarios that were simply not analogous to the day-to-day operation of an elementary/junior high school. The layers of protection analysis (LOPA) has been a valuable tool in matching controls to risk scenarios, and identifying ways in which existing controls, like the practice of assessing students upon arrival for signs of illness, was offering facility-level protection that did not exist in the early incidents that had shaped the public health guidance.

3. SHARING THE RESEARCH

This study has been written up and will be submitted for publication in a building engineering focused journal. The prior activities surrounding risk management were the subject of a presentation to the Canadian Chemical Engineering Conference (2020).

4. IMPLICATIONS OF THE RESEARCH

The administrators and staff at the school adopted the principles and practice of risk management and provided valuable insight regarding the impact of different controls. They were able to communicate confidence in resuming both choral singing and later wind instrument ensemble classes after participating in this study, which demonstrated no significant change to CO_2 levels from choral singing as compared to traditional classroom activities. Further, the detailed examination of classroom data reinforced the intuition that vacating classrooms between courses, and at recess and lunch times significantly impacted air quality. This increased confidence in school administration decisions around staggering break times and scheduling breaks throughout the day. The study data informed planning decisions for the 2022/2023 school year. This study presents a potential model for future public health strategies that could foster increased public

understanding and empower facility owners to implement realistic and effective risk management plans. The ontological breakdown used to communicate the building mechanical systems and simplify the movement and activity levels of students can be applied to any occupied facility used for any purpose and demonstrates the benefit of direct measurement over the challenges and expense of traditional ventilation models and projections. As part of a broader risk management plan, simple studies can be used to evaluate the effectiveness of controls and reduce uncertainty in both activity planning and spending decisions.

Public communication from community advisory boards and public health officials throughout the COVID-19 pandemic were often directive and paternalistic in tone, focusing on individual controls and emphasizing compliance behavior. The recommended controls varied widely between jurisdictions and, as a result, public confidence was predictably poor. This study demonstrates the effectiveness of basic, rigorous, and well-tested engineering practices to support risk management plans at the facility-level. With the widespread availability of both sensors and analytical capability, this type of study is accessible to facility owners and managers. The controls and protocols implemented in individual facilities should reflect the real consequences of the hazard in each facility itself, not the political decisions made at the regional level. The COVID-19 pandemic may waning, but airborne hazards continue to be a global threat. Assessing air quality and pathogen transmission can be feasibly performed at the facility level if research and industrial practices can be made accessible as required.

5. INITIATION AND PREPARATION OF RESEARCH STUDY

August 2019	Initial risk assessment and risk management plan activities
October 2020	Review of outcomes and preparation of Conference presentation to CCEC 2020
August 2021	Initial contact with Deviceworx and expressions of interest
January 2022	Development of study plan and engagement with Suzuki Charter School
May 2022	Installation of sensors and data collection
July 2022	Analysis of data and communication of results
March 2023	Presentation to Suzuki Charter School Board
May 2023	Submission for publication

6. TESTIMONIALS FROM THE TEACHER PARTICIPANTS

None available at this time

7. SUPPORTING DOCUMENTS

Refer to the Appendix for the following:

A. Presentation delivered to the Canadian Chemical Engineering Conference (2020)

B. Deviceworx technical literature, sensors

PART FOUR:

SUPPORTING DOCUMENT/REFERENCES

Teaching PSM

COVID-19 AND ALBERTA PUBLIC SCHOOL RE-ENTRY

Michelle Naef, P. Eng
- PhD Candidate at University of Alberta
- Chemical and Materials Engineering, process safety and risk management
- Supervised by:
  - Dr. Lianne Lefsrud P. Eng,
  - Dr. Dave Shook, P. Eng
- Parent of school-aged children

Introduction

New context for industrial process safety management

- Three Alberta public schools requested technical assistance
- Challenge to operationalize recommendations from public health authorities
- Engaged a Graduate Student in Process Safety and Risk Management to advise leadership teams

What I taught

- Principles and framework of Process Safety Management
- Risk Management theory and communication guidelines

What I learned

- Methods to improve resilience to changing conditions
- Educators assume achievement and understand the learning process

What can industry learn?

- Improve efficacy in industrial process safety programs – assume achievement
- Organizational factors contributing to success – change the change management paradigm

New hazard – for everyone

WHO declares global pandemic — 11 Mar.

Public Health Emergency declared — 12 Mar.

Gatherings <250 — 17 Mar.

Gatherings <15 — 19 Mar.

First COVID death in AB — 28 Mar.

Face masks — 31 Mar.

Bills 9, 10, 11, 12 passed — 6 Apr.

Phased re-entry plan announced — Apr. 23

Events/festivals cancelled — 30 Apr.

Public Health Emergency over — 15 June

Image credit: https://www.globalbiotechinsights.com/articles/20247/the-worldwide-test-for-covid-19
Timeline developed: https://www.alberta.ca/covid-19-orders-and-legislation.aspx#toc-0

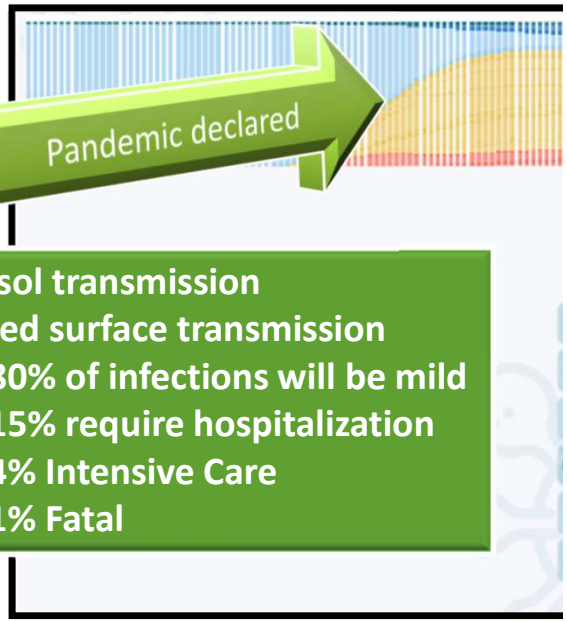
Medical Leadership == Medical paradigm

Controls applied in Alberta

Lockdowns	National lockdown or quarantine orders
Governance	**Economic**, **Emergency Administrative Structures**, Military Deployment, State of Emergency
Movement Restrictions	Border closures, domestic and international travel restrictions, surveillance/monitoring, visa restrictions
Public Health Measures	**Awareness campaigns**, port of entry health screening, **general recommendations, isolation and quarantine policies, mass population testing,** other public health measures enforced, psychological assistance/medical social work, **PPE requirement**, **strength public health system**
Social distancing	**Closure of businesses and public services**, **limit public gatherings**, **closure of schools**
Humanitarian exception	Exceptions to quarantine, lockdown or movement restrictions

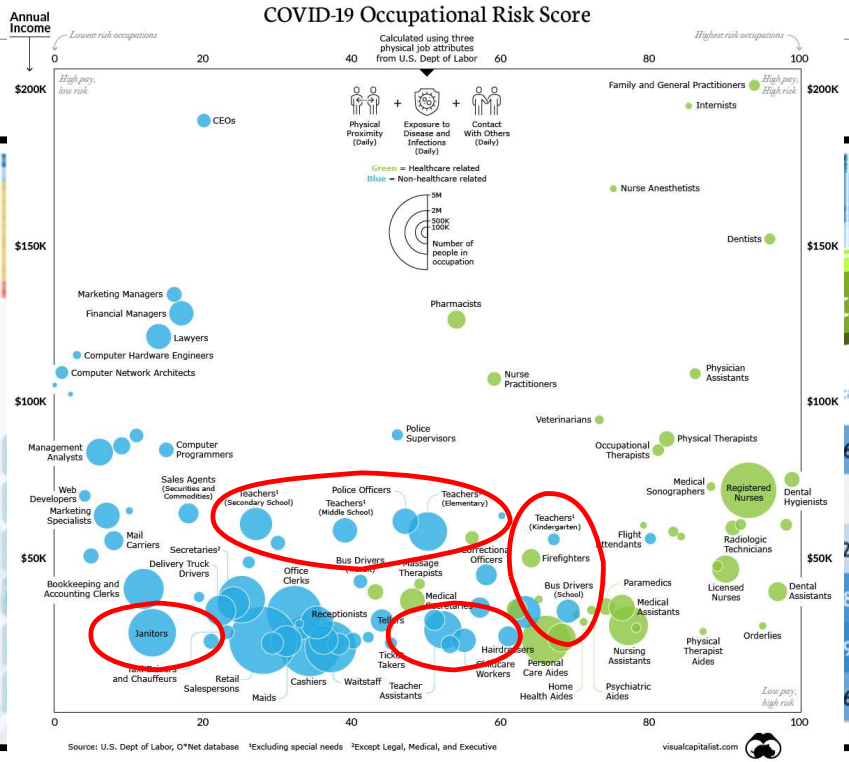
https://public.tableau.com/profile/visualitics#!/vizhome/Covid-19GovermentMeasuresWorldwide/CovidGovernmentMeasuresWorldwide
Accessed October 15, 2020

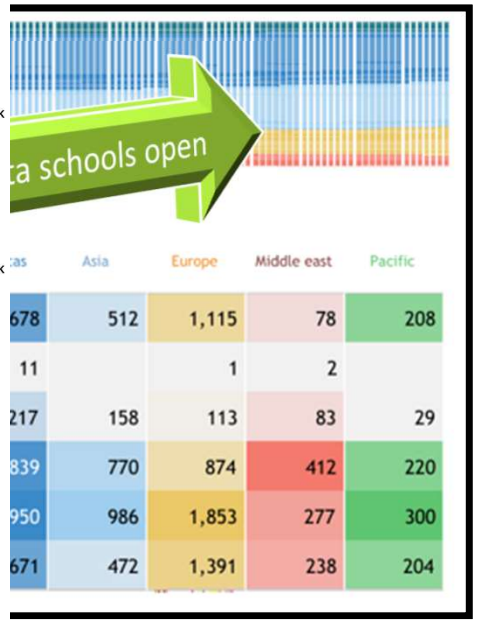
Global controls summary



Aerosol transmission
Limited surface transmission

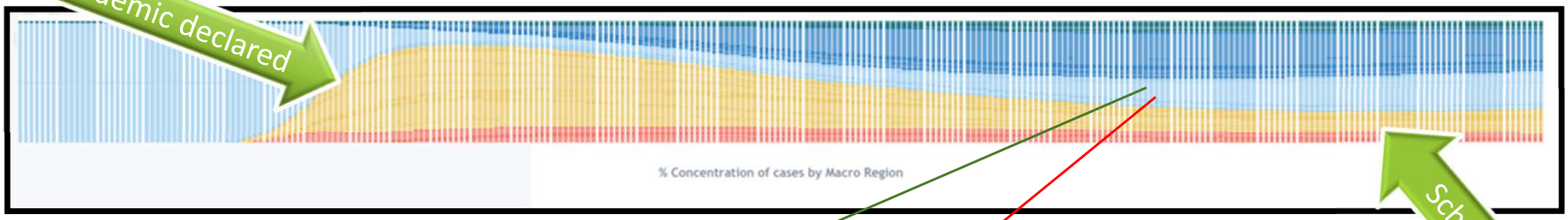
- **~80% of infections will be mild**
- **~15% require hospitalization**
- **~4% Intensive Care**
- **~1% Fatal**





	Asia	Europe	Middle east	Pacific
678	512	1,115	78	208
11	1	2		
217	158	113	83	29
839	770	874	412	220
950	986	1,853	277	300
671	472	1,391	238	204

Transmission summary from synthesis of news articles released from March 2020 through July 2020
Image: https://public.tableau.com/profile/visualitics#!/vizhome/Covid-19GovernmentMeasuresWorldwide/CovidGovernmentMeasures, Accessed October 15, 2020
https://www.visualcapitalist.com/the-front-line-visualizing-the-occupations-with-the-highest-covid-19-risk/



Government announces “Scenario 1”

When I came in

Consulting strategy

- Define organizational objectives
- Apply framework and PSM practices
- PHA and PSI, PSSA and MOC in particular

Refinements

- Schools actively engaged in collaboration
- Strengths from each approach leveraged
- Similar but not identical plans issued

Learning

- Strong engagement and commitment
- Monitoring, evaluating and revising sought
- Compliance framed as data collection

https://www.visualcapitalist.com/the-front-line-visualizing-the-occupations-with-the-highest-covid-19-risk/

Alberta Education – executive leadership

March 22, 2019 – Funding manual released
October 24, 2019 – In-year budget reduction
February 28, 2020 – New funding framework
March 15, 2020 – Schools move to remote delivery
April 30, 2020 – Relaunch strategy released, includes schools
May 5, 2020 – Revision issued to funding framework
June, 18 2020 – Revision issued to funding framework
July 21, 2020 – "Scenario 1" announced for September 2020
July 24, 2020 – Consultation with School A
July 31, 2020 – School A issues re-entry plan to parents
August 5, 2020 – Consultation with School B
August 6, 2020 – Ministerial order set new philosophy for education
August 7, 2020 – Consultation with School C
August 20, 2020 – Resource guide for re-entry issued
August 27, 2020 – Revision issued to re-entry guide
September 1, 2020 – Nominal* re-entry date

*most public school teachers recalled to work beginning August 31 or September 1st, most schools set to begin instruction the week of September 7th

Tools in the toolbox – PSM

"Safety" largely introduced to schools in Alberta via amendment to the School Act[1] (2008)

- Followed nearly a decade of efforts following school shootings in 1999
- Many staff associate "OH&S" with "Columbine Shooting"
- Implicit priorities - behaviour based safety, site security
- Top-down, compliance focus

PSM offered an array of "new" tools

- Theoretical basis to organize and legitimate
- Disciplined documentation - support resilience with external pressures
- Common language supporting collaboration

1. https://open.alberta.ca/publications/4215083
2. Image: https://sphera.com/14-elements-psm/

Schools involved

SCHOOL A

GRADES K-7

~300 STUDENTS

SOLE SITE USER

SCHOOL B

GRADES K-9

~300 STUDENTS

SHARED SITE

SCHOOL C

GRADES K-9

~800 STUDENTS

TWO CAMPUSES

Management of Change

Administrative environment chaotic

- Sought to manage change of the risk management plan
- Accountability for short, mid- and long-term consequences

Recognition that within each community, change was significant

- Empathy for stakeholders apparent
- Evidence based decision making supported
  - High degree of discipline
- Assumptions challenged and usually met

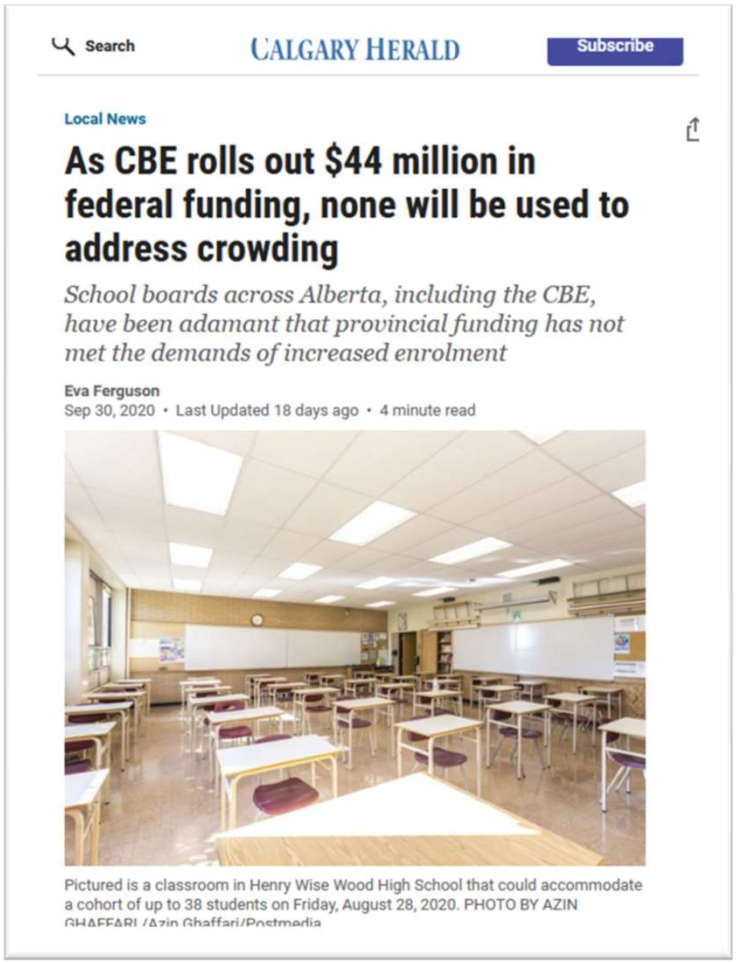
PSI and PHA

Process Safety Information

- Identifying the sources of relevant information
- Categorizing and classifying
- Explicitly identifying uncertainty and unknowns
- Determining information that would drive changes to plan

Process hazard analysis

- Focused on tasks and activities
- Easily adopted a “flow” concept for movement of people
- Readily accepted having multiple “modes” of assessment
- Understanding that there is no single “right” answer
- Site walkthroughs used effectively
- Clear delineation of authority



Search CALGARY HERALD Subscribe

Local News

As CBE rolls out $44 million in federal funding, none will be used to address crowding

School boards across Alberta, including the CBE, have been adamant that provincial funding has not met the demands of increased enrolment

Eva Ferguson
Sep 30, 2020 • Last Updated 18 days ago • 4 minute read

Pictured is a classroom in Henry Wise Wood High School that could accommodate a cohort of up to 38 students on Friday, August 28, 2020. PHOTO BY AZIN GHAFFARI /Azin Ghaffari/Postmedia

Mechanical integrity

Facility initially considered as an afterthought

- Public health focus apparent
- Task and activity focused, systems analysis discouraged
- “Treatment” paradigm

Floor plans and site walkthroughs

- Utility in classifying the recommended controls
- Immediate adoption as a communication tool
- All schools included site layout drawings with changes in plans

Integration of “facility” into the assessment was rapid

- Autonomy within the building clear
- Teachers own the classrooms, Principal owns the common areas
- Custodian owns the mechanical room and cleaning supplies

Pre-start up safety review

Immediate understanding that assessment takes time

- In Education, assessment is the verification of teaching effectiveness
- Assessment is part of learning and can not be an afterthought

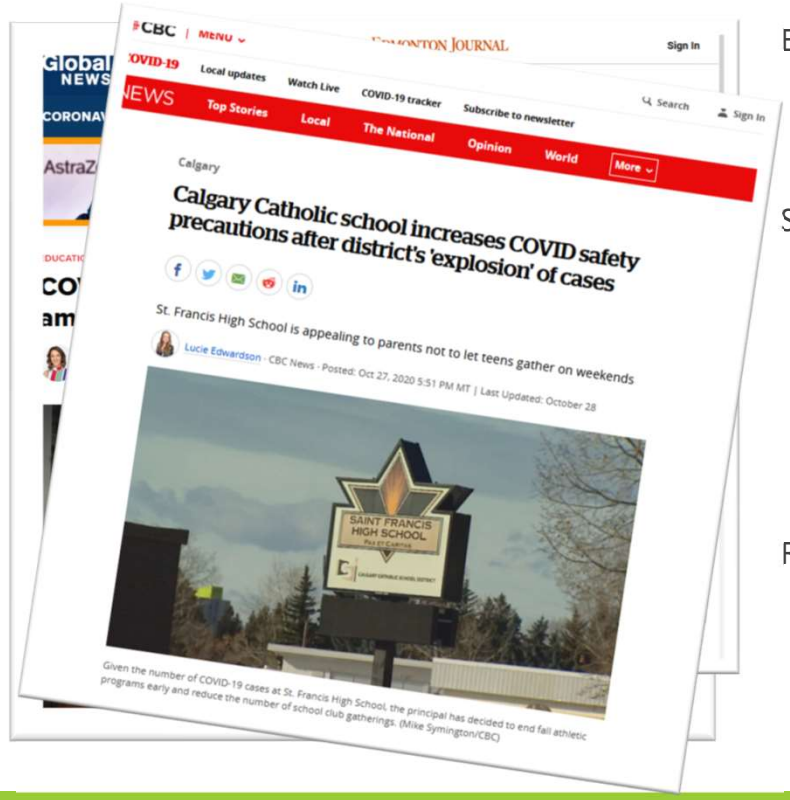
All 3 schools adopted a higher effort approach to re-entry

- Organizing staggered student start increased burden on Administrators
- Increased likelihood of parent complaints
- Risked disapproval by Ministry
- No hesitation that student entry could only occur after detailed PSSR

School officials constantly mindful of time commitment

- Combination of union and non-union teaching staff
- Union considerations were more compliance focused
- Non-union considerations surrounded avoiding burnout
- Active, intentional monitoring and evaluation

Monitoring – Evaluation - Revision



Each school drafted a re-entry plan following consult, supplied to other schools

- Copies submitted to superintendents' association as resources
- Consulting effectiveness significantly increased as a result

Summary document drafted after School C consultation

- Outlined basic principles of risk management
- Summarized key controls
- Synthesized assessment, evaluation and revision practices
- Classified "change" drivers including "don't blink" issues
- Widely circulated to school districts through unofficial channels

Re-entry plans completed early broadly circulated

- Metro boards did not release district plans until late August
- Individual schools disadvantaged by shorter planning windows
- Alberta Teachers' Association recognized risks
  - Called on the Minister to delay school start as of August 20 (refused)

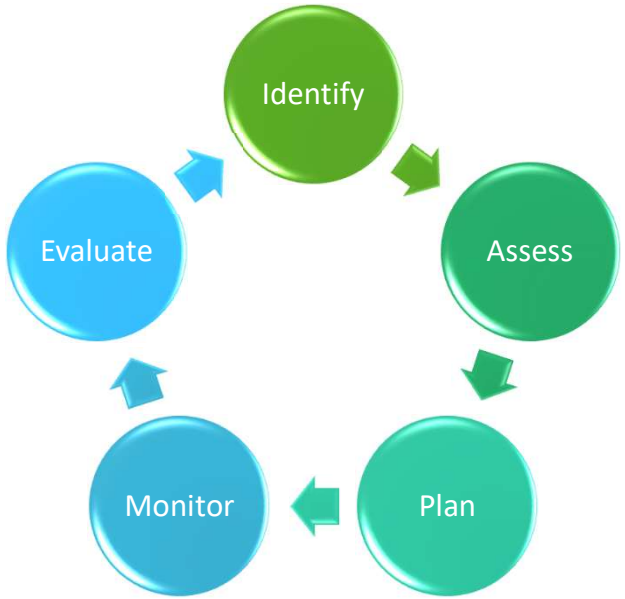
Image: https://rpubs.com/tonynick/sosmap accessed on October 18, 2020

Early results

- Barrage of changes did not disrupt risk management
- Resilience in the face of changing conditions
- Monitoring and evaluation criteria led to confidence
- Schools applying PSM had positive results
- Overall sentiment - “Atmosphere is joyful” (School A)

Report card - risk maturity[1]

- Schools score in the high range of Level 4
  - Deep understanding of risk management as decision support
  - Uncertainty and anxiety centered around conflicting information and instructions
- Direct access to boards allows some elements of Level 5
  - Undermined by the authority/accountability mismatch
  - "Risks" as defined by the Ministry do not align with the risks defined by school officials
  - Organization, inclusive of the Ministry achieves Level 2
- Eager to align decision-making with risk criteria
  - Associated risk management structure with strategic planning



Strategic management == design paradigm

1. *As defined by ISO 31000*

Provincial results

Schools A, B and C have not reported outbreaks

- Alberta transmission trending upward
- Schools reporting outbreaks

Ministry of Labour launched an OH&S audit of schools

- School A selected for audit
- Officials at School A eager – expecting to excel

Staff at schools A, B and C report majority positive outcomes

- No widespread absenteeism among staff
  - No grievances to date
- Boards reporting satisfaction

ATA compiling province-wide data from teacher surveys

- Provincially results are inconsistent
- Teacher stress/burnout is a major concern
- AHS overwhelmed by demands

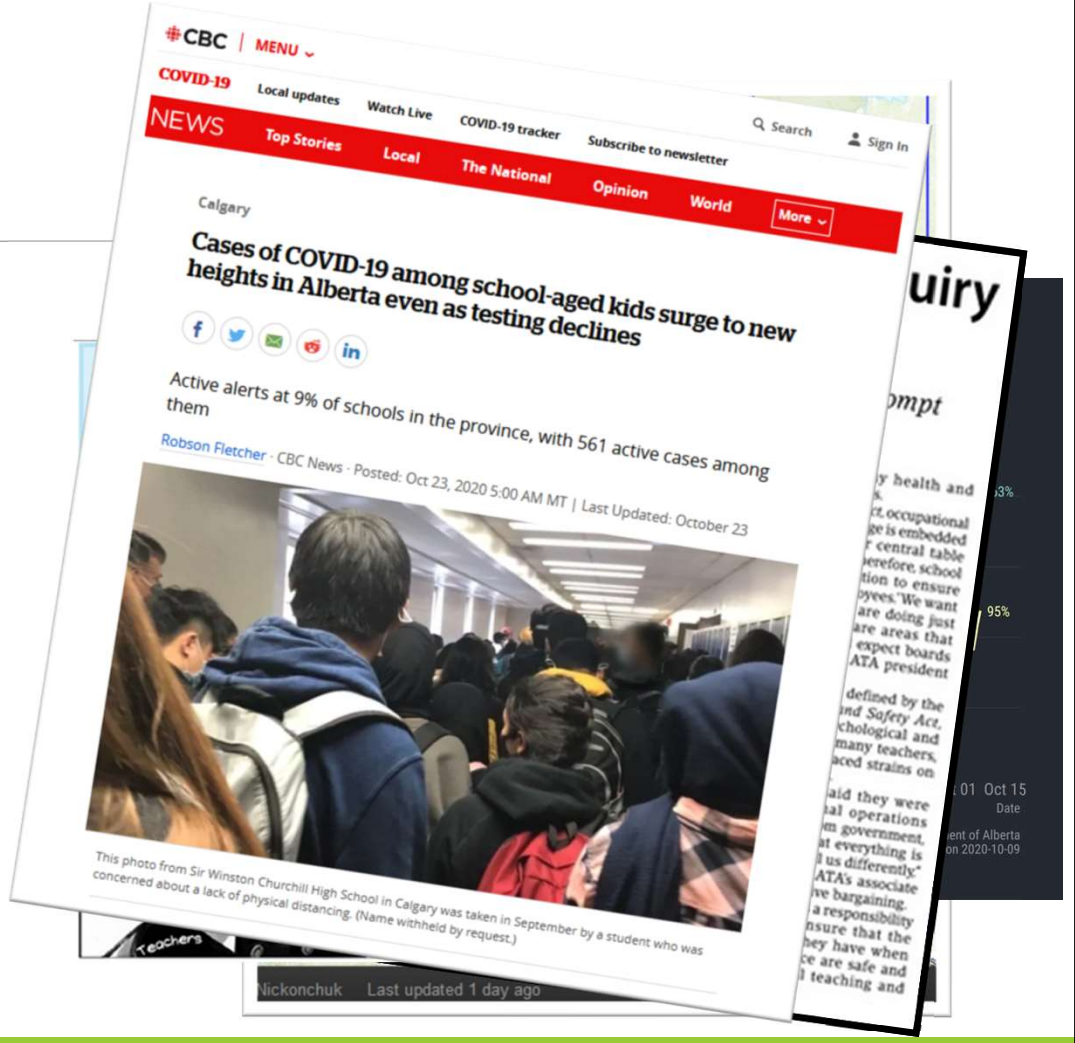


Image from: https://www.supportourstudents.ca/ accessed on October 18, 2020
Infographic from: https://www.teachers.ab.ca/News%20Room/Issues/COVID-19/2020-School-Re-entry/Pages/Teacher-Pandemic-Pulse-Survey-Results--Fall-2020.aspx

What I learned…

Crafting stability for stakeholders despite volatile/demanding authority

- School leadership did not abdicate or delay decision making
- High importance of clearly delineated accountability
- Uncertainties driven by exogenous authority should be identified, named and planned around

Assumptions around compliance and compliance drivers need testing

- Educators were not satisfied with broad assumptions
- Before deciding a control was “too difficult” they demanded a data set or a trial period
- Where low compliance was suspected, time and resources were allocated to training as well as practical training plans

Confidence in the ability to measure understanding reduces fear of non-compliance

- Allows targeted “training”
- Educators did not assume malicious non-compliance in staff, students or parents

Educators have deep knowledge of controls, compliance and assessment

- Rule setting and administration requires time, time that takes away from active classroom engagement
- Do not set a rule you do not intend to enforce
- Assessment techniques must match level of cognition being evaluated

What could industry learn?

Selecting a framework /process should be the least time consuming part
- Excess focus/segregation of risk knowledge undermines objective
  - Seek to align risk management with decision making throughout the organization

Focus on compliance leads to assumptions of incompetence
- Compliance to inappropriate controls is itself a hazard
- Assuming competence/ability integral to risk maturity

Incident investigations/compliance should not be the extent of data collection
- Depth/quantity of data collected → proportional demand on time
- Data collection, evaluation and **assessment** are skilled tasks
  - Should be of concern to leaders
- Reporting/data collection often offloaded to operating departments from support departments

Re-evaluation criteria should be documented and debated extensively
- More important than the selection of a risk management framework
- Often neglected in volatile employment environments

- How can these themes be further explored in Process Safety research?
- How can the practices and culture of schools inform industrial practice?
- How is administrative churn contributing to risk management performance?
- How can the quality of risk management be assessed alongside the compliance?

Learning process safety

LESSONS FROM EDUCATORS

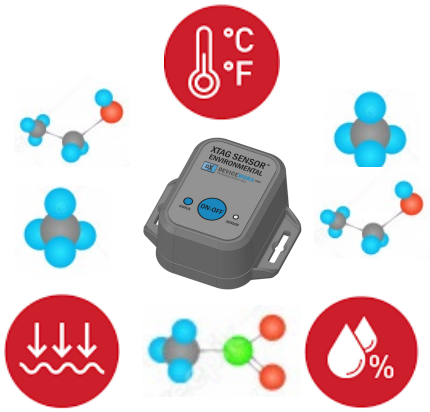
DEVICEWORX.COM
TECHNOLOGIES INC.

Revision 1.0

Protect People, Crops, Animals & Equipment with the xTAG Environmental & xTAG Gas Sensors

Deviceworx xTAG Environmental Sensors accurately measure air temperature, pressure, and humidity. xTAG Gas Sensors measure the concentration of Volatile Organic Compound (VOC) and Volatile Sulphur Compound (VSC) gases in air. There are a vast array of measurable VOC/VSC gases including sewage gas, propane, natural gas (methane), construction off-gases, fire off-gases … The xTAG Gas sensor supports Artificial Intelligence (AI) and can be “trained” to measure any of these gases.

Use these xTAG Sensors to monitor the air within spaces to ensure temperature, humidity and dangerous gases are within safe limits to protect people.



Monitor the exposure of crops to damaging high temperatures and humidity within storage and shipping spaces. Recover crop damages by proving where and when they were exposed to harsh environments.

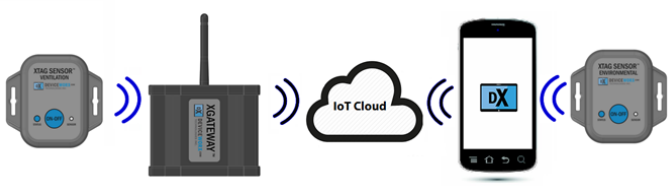
Protect livestock and pets by monitoring their exposure to damaging levels of temperature, humidity and dangerous gases.

Ensure equipment is healthy by collecting operational data such as bearing casing temperatures, filter upstream pressure (increases when clogged), exhaust gas composition etc.

Monitor fire types and burn rates. Specific fire fuels (e.g. grasses vs trees) exhaust specific VOCs. Measuring specific VOCs in smoke using the xTAG Gas Sensor can indicate what is burning as well as how fast.

Operators can review environmental and gas concentration data within Internet of Things (IoT) cloud-based reports. Cloud functions can also trigger alarm messages to Smartphones via email or text alerts whenever data crosses a safety threshold. Alarming can prove crucial in vacating a dangerous space saving the lives of people or animals within that space. Alarming and monitoring of equipment ensures that equipment faults are dealt with in a timely manner to avoid unplanned production stops that cost operations dearly. Sensor-logged crop batch environmental and location data is uploaded to the cloud for later review. Exposure of crops to poor environments can be addressed by process improvements or claims against a storer or shipper. Service providers can deploy xTAG Sensors and charge operators to view reports and receive alerts under a Software as a Service (SaaS) business model to dramatically increase revenue.

All xTAG Sensors can make wireless (long range Bluetooth) cloud connections using Deviceworx xGATEWAY IoT Gateways.



In some cases, simple, opportunistic acquisition of xTAG data to the cloud may be all that is required. In these situations, operators can use the xTAG Explorer app as an IoT Gateway. This app can collect sensor data over Bluetooth for cloud storage, reporting and alarming (using Wi-Fi or cell data).

Contact our sales team (sales@deviceworx.com) to learn more about how we can help address all of your environmental and gas monitoring challenges.