ARTIFICIAL INTELLIGENCE AND INDOOR AIR QUALITY: BETTER HEALTH WITH NEW TECHNOLOGIES

Yann Boquillod
Founder of AirVisual

The AirVisual mobile app

Yann Boquillod is a graduate engineer who became interested in air quality issues as a result of living in China. Starting in 2010, his interest in the impact air pollution has on health led him to design a solution for measuring indoor air quality that until then had not existed. The creation of the company AirVisual, in 2015, led to the development of new sensors that are innovative and intuitive, making it possible to measure and interpret air quality (fine particles, CO_2, hygrometry, etc.). The 2017 acquisition of AirVisual by IAQair, a Swiss company specializing in air filters, now makes it possible to offer indoor air quality measurement and purification solutions that use big data and artificial intelligence.

Although many people imagine that enclosed spaces offer protection from outdoor pollution, the indoor air is very often contaminated by harmful substances created by everyday household cleaning and cooking activities as well as from outdoor pollution from sources such as vehicles and industry, particularly in the megacities of Asia.

Founded in 2015 by two French entrepreneurs, *AirVisual* is a company whose primary mission is to raise awareness of air quality. By offering connected sensors for measuring indoor air quality, the company makes it possible for everybody to optimize their indoor air quality, which in turn limits health risks from exposure to fine particles and excessive concentrations of CO_2. In addition, aggregating data from governments, satellite images and outdoor sensors that AirVisual has installed worldwide has enabled the startup to create an interactive world map of air quality on our planet, helping to increase awareness of the importance of air quality and encouraging solutions that are relevant to local contexts.

What drove you to create a startup focused on air quality?

Yann Boquillod: Air quality is a real public health challenge in Beijing because of the levels of exposure to pollution. My awakening to the true seriousness of this issue, dating from when I first moved there, explains the origins of AirVisual. I wanted to use my understanding of big data and artificial intelligence to address the problem of air quality. With my business partner, we decided to set up AirVisual in China because the local logistics and supply chains provide a real advantage compared to alternative locations. Also, the speed of project development in China allowed us to grow our company very quickly.

Another key advantage is that, in heavily polluted cities such as Beijing, enclosed spaces are seen as bulwarks against pollution, so people feel the need to measure their indoor air quality.

But when I first moved to Beijing, there were no possibilities for measuring indoor air pollution apart from the government sensors. Costing $30,000 to $50,000, these were very expensive machines for measuring outdoor air quality and they really didn't seem suitable for monitoring air quality in the home.

Easy access to unambiguous depictions of air quality is important for public health

This was what led to the development of our "Nodes", the sensors now known as *AirVisual Pro*, that measure:

- fine particles, which have long-term health impacts;
- the concentration of CO_2, to assess ventilation in enclosed spaces;
- simpler data such as temperature and humidity.

Air pollution is hard to see with the naked eye, which is why we wanted to make it visible. These sensors make possible an all-encompassing approach to perceived comfort.

What is the principle behind AirVisual?

Y. B.: From the start we were determined to change existing approaches to air quality by incorporating big data and artificial intelligence into our products, especially for data validation purposes, so that we could deliver a measurement system that was accurate.

AirVisual has a twofold objective.

The first is to protect indoor air quality, including with the help of artificial intelligence to provide users with solutions that are both suitable and actionable.

The AirVisual node *(AirVisual Pro)* is a portable personal device for measuring air quality. To calculate the concentration of $PM_{2.5}$, it uses a laser to count the number of particle-related interruptions in a stream of air directed by a tiny fan. The apparatus measures up to six pollutants present in the air, as defined by the AQI.[1] The data is sent to the cloud for analysis by an AI system. The system makes decisions on air quality remediation as a function of the results. Instructions are then sent directly to connected purification systems, providing management of indoor air quality in a way that is almost fully self-contained.

1 Air Quality Index: the six most common air pollutants are PM2.5 and PM10, ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide.

Using an *AirVisual Pro* sensor to measure indoor air quality

It is important to understand that this option is only suitable for countries where aeration and traditional filtration systems are not realistic options. In France, for example, opening windows in enclosed spaces at the right time will sometimes be enough, so there's no need to fit an air purifier. In China, the cost of fitting a complete household system can run to €3-4,000.

The use of outdoor sensors is an adaptation of our project to fit the market. Above all, it's an issue of real social importance. Our goal is to equip the planet with an extensive network of sensors to create a real-time global pollution map with as much granularity as possible. Today, we're able to view fine particle trajectories in real time anywhere in the world using *AirVisual Earth*, our interactive map. We do this using individual sensors to measure indoor and outdoor air quality. The data is then cross-referenced with official data from each country's air quality measurement services, resulting in a global image of fine particle pollution. Where data are hard to access, for example in vast uninhabited regions, we use satellite images and meteorological forecasts to model fine particle concentrations in parts of the world where sensors and public data do not exist.

The success of AirVisual Pro sensors is to a large extent due to their ease of use and the way that information is presented visually. In addition to quantifying certain metrics, we try to make sense of the data

Complementarity between indoor and outdoor sensors means we can adopt a systematic approach, offering solutions tailored to various pollution threats. Today, there are over 100,000 AirVisual sensors running worldwide. We have indoor sensors in 120 countries and 80 countries have our outdoor sensors. These sensors mean we can deliver real-time indications about air quality via a website and an app that currently numbers 10 million users.

What are the challenges to collecting and accessing this type of data?

Y. B.: Governments report their pollution data in a range of formats. Our role is to standardize the data so they can be compared to each other. This is a long-term process but it's a necessary part of forming an overall vision of pollution.

We decided to use the USA AQI index to present our data. This has a range of 1 to 500 and lets us differentiate between six different thresholds, each for a different level of precautionary steps to take.

A second challenge is that outdoor air quality data are sensitive, particularly in China, where publication of outdoor data is extremely reliable but restricted for legal reasons; sources of information are controlled and very few other sources of measurements are permitted. This is one of the reasons that led us to focus on indoor air quality, the other being that we want to improve access to data on indoor air quality to help prevent health risks for everybody.

The sensors are connected objects, but the data remains personal and are not published automatically. Users are able to consult their indoor air quality data without having to send this data to the cloud. The General Data Protection Regulation (GDPR)[2] is not a problem because we ask for users' permission before publishing their data.

Regarding data reliability, extremely strict rules have been drawn up governing the installation of outdoor sensors. We have to make certain of the quality of the installation because the data will be seen by around 10 million users. Similarly, if we issue a pollution alert, we have to be certain that the data are reliable, which is why we have such strict installation procedures. For instance, we ask users to send photographs showing where they have placed the sensor. We use an AI system to check that all the conditions for a perfect installation have been met. If the data seem to be wrong, the system sends notifications to the user and asks them to check the installation.

What do you think makes this type of technology so attractive to consumers?

Y. B.: The success of *AirVisual Pro* sensors is to a large extent due to their ease of use and the way that information is visually presented. In addition to quantifying certain metrics, we try to make sense of the data because not everybody understands the raw numbers for fine particles or CO_2 levels in the air. The data can be accessed via sensor screens or the app in a technique that has become very popular for monitoring outdoor air quality.

The sensors use icons and color codes that make it easy for everybody to have a clear understanding of the situation in real time. This visual system has been adopted by other organizations, including for example the government of Iran in its guidance note on air quality, as well as inspiring other applications in the same field.

What is the user profile for your indoor air quality sensors?

Y. B.: Today, more and more researchers are looking at relationships between a building's air quality and the productivity of its occupants. Although this research is still in its infancy, several studies highlight the impact of CO_2 concentrations on the performance of staff or pupils. More and more businesses are keen to provide their staff with

2 General Data Protection Regulation is the European framework regulation for the protection of personal data. For further information: https://ec.europa.eu/commission/priorities/justice-and-fundamental-rights/data-protection/2018-reform-eu-data-protection-rules/eu-data-protection-rules_en

a healthy working environment. Mercedes, for example, has invested considerably in equipment to improve air quality, especially in China. Sensors are also being increasingly installed at schools. We know that many children use the app to identify the times of day when better air quality encourages outdoor activities.

AirVisual Pro sensors have also been installed in clinics, to provide data on a topic that is central to the challenges facing health care facilities worldwide.

How can these new technologies influence policymaking?

Y. B.: Sensors help to underline the need for a collective approach to the problem. In Thailand,[3] for example, the deployment of over a thousand outdoor sensors has helped to raise nationwide awareness about air quality and has had a real impact on economic and political decision-making. Factoring in outdoor air quality needs to be thought of as a first step, and as something that can help to make governments aware of the urgent need for ambitious policies to promote healthier indoor air.

Sensors help to underline the need for a collective approach to the problem

Similarly, studies using data from the sensors have shown that lower attainment levels at certain schools in comparison to others may be explained by levels of indoor air pollution and the impact this has on pupils' ability to concentrate.

Once governments truly start to take note of the increasing number of similar studies, this should help them to make decisions designed to improve indoor air quality, in public spaces at the very least.

3 https://www.airvisual.com/thailand