Workshop MIST WP3 Local ventilation and air cleaning (March 17th 2026)

TU Eindhoven

Introduction

On March 17th a workshop was organized related to WP3 of the MIST project. The focus of the workshop was on the design of local ventilation and air cleaning to reduce exposure to pathogens.

Originally, 13 participants signed up for the workshop. Due to some last-minute cancellations, 10 people participated in the meeting.

After a short welcome and introduction round, Mohamed provided an introductory presentation in which information was given on the concept of local/personalized ventilation as found in literature. This also set a basis/point-of-departure for the workshop.

During the presentation already some lively discussions developed. An important consideration is on the definitions used. In the meeting we talked about *personalized ventilation/air cleaning* and *localized ventilation/air cleaning (V/AC)*. It is good to distinguish the difference between the two, that we decided on:

- **Personalized V/AC** is defined as really dedicated systems focused on providing or exhausting clean air to/from a single person. In reality/practice we see that such type V/AC systems are not used a lot, despite the fact that they have been investigated, at least the concepts, for a long time.

- **Localized V/AC** can be regarded as an intermediate between ventilation at room level and personalized solutions. The aim is to create zones of clean air around or near one or more persons.

As for the goals of MIST, we are interested in infection risk. However, we could extend this interest also to air quality in general, e.g. PM. There is a health gain if lower exposure is possible.

In the discussions it was also stressed that different type of rooms/use of a room requires different solutions. This notion is included in the workshop, as different contexts were discussed.

After the introductory presentation of Mohamed, he also explained the intentions for the workshop and initiated a discussion on the performance requirements related to personal/localized systems. Apart from the known indicators, the partners stressed also important issues that are known to effect usage in practice. E.g. noise, context (e.g. room) and financial feasibility are issues that we should remain aware of, which are all linked to the general feasibility of a concept.

With these comments in mind we started the actual workshop. The workshop was intended to come up with idea/concepts for personalized/localized (V/AC) concepts in two different contexts. We selected a priori a situation with a desk where two persons are facing each other. Such situations can be found in (open-plan) offices, but also in (doctor) consultation rooms. Typically you have a desk with two persons sitting on either side of the desk. The other context was a high-occupancy density situation, as can be found in for example a train, classroom or waiting room.

With these contexts shortly explained, we started the discussions for the first context, the situation with a desk and two opposite sitting persons. The people present were divided in two groups and discussions were centered around potential ideas. As a last step it was asked to also think about indicators that could be used for the assessment and the method of assessment. It turned out that most time was spent on the ideas/concepts.

Desk situation context

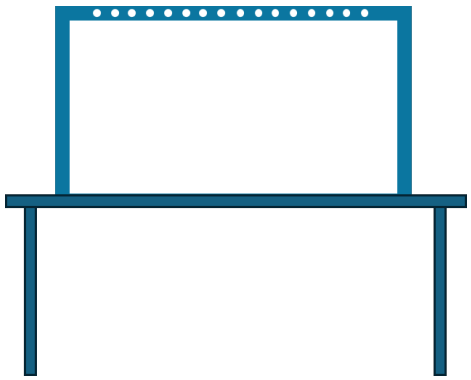
Group Francesco/Marcel/Theo/Rui/Matias

Different options were discussed, starting with solutions that could be applied at ceiling level. It was thought important to mention solutions that also have some practical relevance, i.e. that it is feasible to install them in an actual situation (new/renovation). This means that ducting should be limited if possible. If the interior design changes, it should be easily replaceable.

At the ceiling level, downflow type of solutions were proposed, using AC to clean the air. The room should be ventilated at room level. Issues related to such a concept focused on the amount of air needed, whether an isothermal flow would actually be able to reach the breathing zone of the person. Use of jets were proposed as an alternative. In that case you can expect noise issues, and mixing of air. The latter, additional mixing of air, was regarding potentially positive if there was an awareness that at room level it was difficult to assure that mixing would take place in the room. In that case it was at least possible to dilute the contamination.

To bring the cleaning more close to the table, solutions with barriers and nozzles were proposed. Air for the system could be taken from the room and cleaned before being introduced. This is not ventilation, and the advantage is that there is no need for ducting/connection to the central system. I.e. it is recirculation at room level. A reference was made to the new cooking hoods, that have the exhaust integrated in the stove.

To materialize the idea of a system with nozzles quite close to the person, a tube could be hanging from the ceiling, close to the head of the person. Nozzles are positioned towards the person, providing the person directly with cleaned air.



To make the design more detached from the room/building, an alternative design was sketched that could be placed on the table (see figure). The design looks like a rack, with the opening in the rack open in case of a consultation room (air at least directed at the doctor) or closed, for sound absorption, for an office type of environment.

The system provides personal clean air. It could also add to creating a personalized thermal comfort control. Care should be taken about the direction of the jets, i.e. not towards the eyes.

For the indicator, optimally it is about reducing the number of people getting sick. In the research it can be about assessing the amount (relative) of particles coming from the infector to the receiver. These particles in the end can represent viruses.

Thermal comfort remains an important performance requirements. Noise needs to be solved as well, but not at this stage. As we are recirculating, it is still important to be aware of the ventilation in the entire space (room).

The idea seems interesting to further investigate, and input from partners seems feasible (e.g. VFA Solutions b.v. has an air cleaner designed for elevators that could fit).

Desk situation context

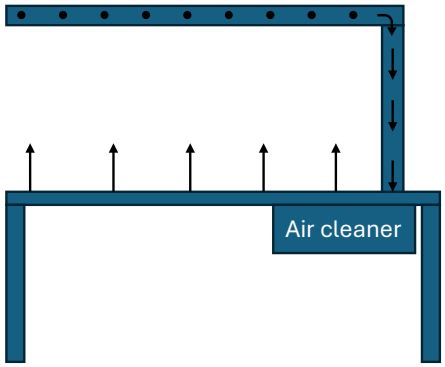
Group Justin/Mohamed/Peng/Twan/Vincent

The group discussed the most used localized ventilation solutions in a desk situation context, and it was agreed that air curtains and personalized ventilation were the most promising and had the highest potential to achieve the defined ventilation objectives.

The group collectively defined the advantages and drawbacks of both solutions; It was agreed that personalized ventilation supplies clean air directly to the occupant's

breathing zone and provides protection by creating a barrier to surrounding contaminants. But that solution was not applied in practice due to its difficult physical implementation, although it was investigated a lot academically. However, a solution using personalized ventilation was suggested in the hope of overcoming the mentioned challenges in the future. It included the supply of clean air directly to the breathing zone in combination with a room mixing ventilation system that helps remove the air behind the occupants, that can be realized by arranging the mixing ventilation inlets and outlets in a favorable manner that creates a velocity field assisting the removal of air behind occupants.

On the other hand, an air curtain was suggested to create two separate zones, where it helps prevent airborne transmission of viruses. A positive addition to the curtain suggested by the group was drawing air from the vicinity of the occupants to an air cleaner then supplying the clean air to a slot in the middle of the desk, creating an upward air curtain between occupants, thus combining both benefits of quickly removing the exhaled air and creating a barrier at the same time. In addition, the full system can be integrated into a single table with an upper cover to contain air intake ducts (see figure). However, a challenge arises from the possibility of virus transmission around the air curtain as it covers only a portion of the room width separating the opposite occupants. A suggested solution was to increase the air mixing so that contaminants are diluted quickly and so by preventing direct exposure by air curtain and minimizing indirect exposure by mixing, infection risk is minimized.



It was concluded that personalized ventilation and air curtains both have large potential to reduce infection but each comes with the previously mentioned challenges. Also, background ventilation was suggested to be added to both concepts, mainly for contaminant removal of the personalized ventilation case and for diluting contaminants of the air curtain case to reduce indirect infection.

High occupancy density

Group Francesco/Marcel/Theo/Rui/Matias

The discussion on this topic started with a focus on trains/buses. But the group concluded that relevance of such solutions would be low, as we don't expect that NS or bus companies at this moment are willing to integrate such solutions in their fleet.

Waiting rooms in hospitals seem more interesting locations to improve ventilation. The same accounts for schools and restaurants. For waiting rooms, the discussion first started on the seating plan, assuming that distancing in case of a pandemic would be needed in any case. A potential indicator came up, identifying the 'minimum distance a ventilation solution can allow for infection control'.

As short range exposure can be expected to happen much more easily in highly occupied rooms, physical barriers were mentioned as a logical solution to minimize such exposure. However, such barriers should be designed in conjunction with the design of the room ventilation system, as there are examples where the situation can worsen when using physical barriers. Extract hoods seem a better solution than localized air supply, as especially in waiting rooms you want potential virus in the air to be removed to lower exposure. And we expect movement which makes it difficult to position the (local) supply in the room. In the end no actual design proposal was made for the context of a waiting room. However, the notion was made that an investigation into use of physical barriers in combination with ventilation could be interesting.

The discussion then turned to class rooms. Here again the occupancy density is quite high. However, a classroom is more difficult as more movement of people (pupils) is expected. There is no fixed layout (in general). The most sensible solution would be to increase the amount of clean air that can be introduced into the room. Part of this is covered by ventilation, the other part can be delivered by an air cleaner. Such a solution does not really address a localized solution, though you could think of providing cleaned air in such a way that a cleaner zone is created near the teacher area for example. The teacher will not stay there continuously, but when referring to the dose, it still would present a better case than perfect mixing. Providing large amounts of air into a classroom requires attention to the supply conditions. An airsock is mentioned as a potential interesting design solution for such a case.

High occupancy density

Group Justin/Mohamed/Peng/Twan/Vincent

The group first examined the interesting case on an airplane which usually employs mixing ventilation with additional personalized gaspers that occupants can control at will. The suggested solution was to replace the side mixing ventilation inlet with an upper one that can direct the air to the exhaust at the floor instead of mixing the air, but that introduced the difficulty of directing the exhaled air downward against the air

movement around the human body due to the thermal plume. Thus, supplying air from a personalized inlet near the floor between the occupant's legs could also reduce infection in occupied spaces such as airplanes, buses, and trains. Another challenge is applying a solution in real life in such environments due to the less interest from companies manufacturing or operating transport systems.

The group found the classroom an alternative potential case where application in real life is possible. Due to classrooms' large width and high ceilings, it is difficult and expensive to install personalized systems. The group focused on implementing a localized solution at first. A solution could be installing air curtains inlet ports on the classroom floor between the desks, thus preventing airborne virus transmission and directing exhalation to the upper part of the classroom and away from the breathing level of students, but the group agreed on the difficulty of installing such a solution. Another suggestion for applying air curtains is to draw air near the ceiling into an air cleaner that filters the air and supply it to a vertical air sock that supplies air in an air curtain manner separating students. Additionally, the group suggested focusing on teacher protection with a localized solution due to the practical difficulty of applying it to every student; an air curtain separating the teacher and the students could be an effective solution, but the challenge arises from the necessary width of the air curtain to cover the full classroom and effectively separating the teacher from the students.

As illustrated, the focus of the group shifted from transportation environments to classrooms where applicability in real life might be possible. The group favored creating a protected teacher zone in addition to classroom background ventilation. Displacement ventilation was suggested but with challenges of controlling the inlet air temperature and the stratification height.

Conclusions

The workshop clarified the difference between personalized ventilation/air-cleaning and localized ventilation/air-cleaning, which creates clean-air zones around one or several people, and used this distinction as a basis for exploring concepts for desk environments and for high-occupancy spaces.

While the goal is infection risk reduction, the discussions also acknowledged air quality in general (e.g., PM) and health gains from lower exposure. Across all sessions, it was emphasized that different environments require different solutions, and that ventilation/air cleaning objectives should include noise, context (e.g., room), economics, feasibility, thermal comfort, and humidity.

For the desk situation, groups considered ceiling-level approaches, near-field recirculating concepts (e.g., barriers/nozzles), and table-integrated solutions, with

attention to airflow reaching the breathing zone, possible noise and mixing. Indicators ranged from reducing the number of people getting sick to relative particle transfer from an infector to a receiver.

In the end, the discussion focused on desk-based solutions that provide personalized clean air through nozzles or air curtains. A promising hybrid solution would draw in air near occupants into an air cleaner and feed clean air to the person, with potential table integration. The risk of transmission around the curtain/rack edges was emphasized and increasing air mixing was proposed to aid dilution and reduce that effect. In all cases, background ventilation was considered necessary (contaminant removal for personalized ventilation and dilution when air curtains are used).

In high-occupancy density contexts, trains/buses/air planes were seen of low relevance at this moment because of limited interest from stakeholders. Waiting rooms in hospitals, classrooms in schools, and restaurants were regarded more interesting high occupancy density contexts. For waiting rooms, the discussion covered seating plans and distancing in a pandemic. If physical barriers would be applied, they should be designed in close connection with the room ventilation system, since outcomes can worsen otherwise; extract hoods were viewed as preferable to localized air supply due to movement and the priority to remove potentially contaminated air. No final design was selected, but barriers in combination with ventilation were considered worth investigating.

For classrooms, a suggested approach was to increase clean air via a combination of ventilation and air cleaning, to arrive at high ACR, with the option to create a cleaner zone near the teacher's area. Other potential ideas were discussed: installing floor air curtains between desks ; adding a column unit with ceiling intake, air cleaner, and vertical air sock supplying air in a horizontal air curtain manner to create isolated zones in the room; and using an air curtain across the classroom width to protect the teacher.

Overall, the workshop produced an innovative set of localized concepts in combination with room ventilation, relevant indicators (e.g., relative particle transfer, minimum distance), and practical considerations (noise, context, economics, feasibility, thermal comfort, and humidity). Several ideas were regarded as interesting to further investigate, with applicability in real situations considered throughout.

As next steps the proposed ideas will be explored and connected to the information found in literature. We plan to connect to the partners when we intend to materialize one or more of the identified (updated) solutions for testing in our lab.

Acknowledgement

We thank the participants for their presence and active participation in the workshop. We really appreciate that input a lot.

Annex

List of participants

1. Francesco Franchimon (Vientiane)
2. Vincent Vons (VFA Solutions)
3. Theo van Veen (NLR)
4. Justin Brusche (NLR)
5. Rui Carneiro (TU/e)
6. Peng Qin (TU/e)
7. Mohamed Zayed (TU/e)
8. Matias Duran Mutate (TU/e)
9. Marcel Loomans (TU/e)
10. Twan van Hooff (TU/e)

Last minute cancellations due to personal circumstances

11. Frank Dreef (Heins engineering)
12. Marc Boers (Extreme air products)
13. Kieran McBrien (Novaerus)