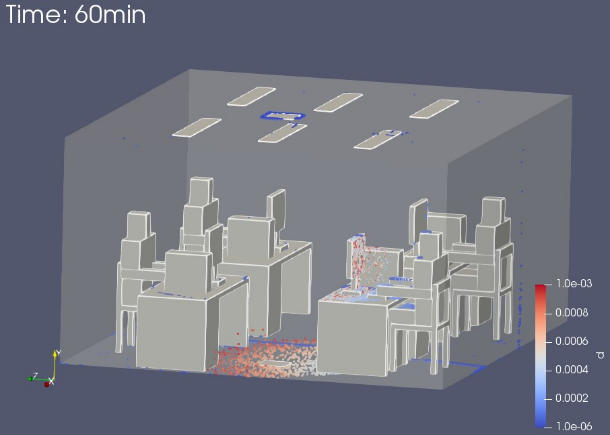
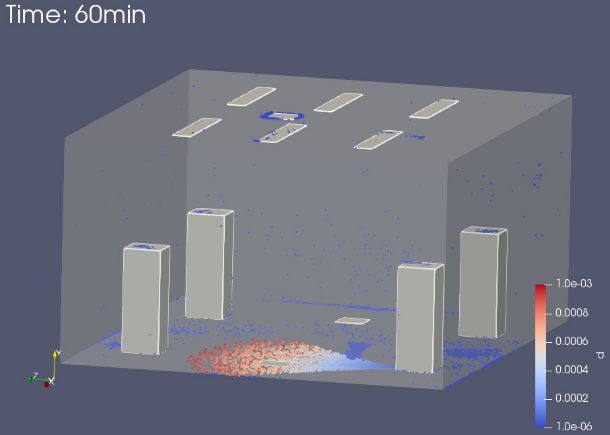
1. Considering what you just observed in the images and videos from the class 4 CFD simulations, and what you learned in classes 1 and 2, answer the following questions.
   1. Complete the scientific report in the differences observed between the simulations of class 3 and the standard case, by filling in the blanks with the correct words. (**Note:** to help you answer, there is one representative image at the end of the simulation, to each case study)..



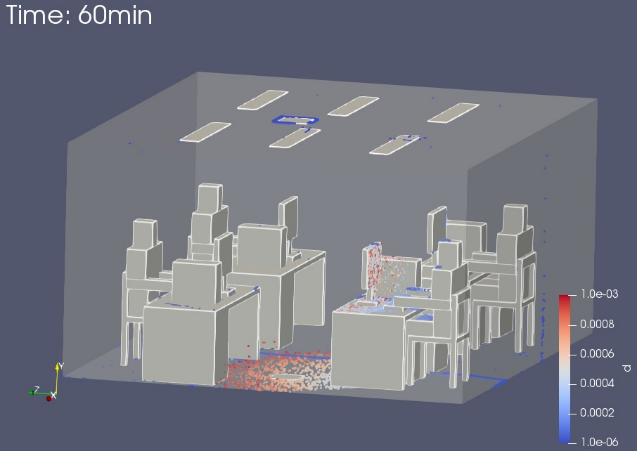
**Speaking standard case**

**Speaking Class 3**

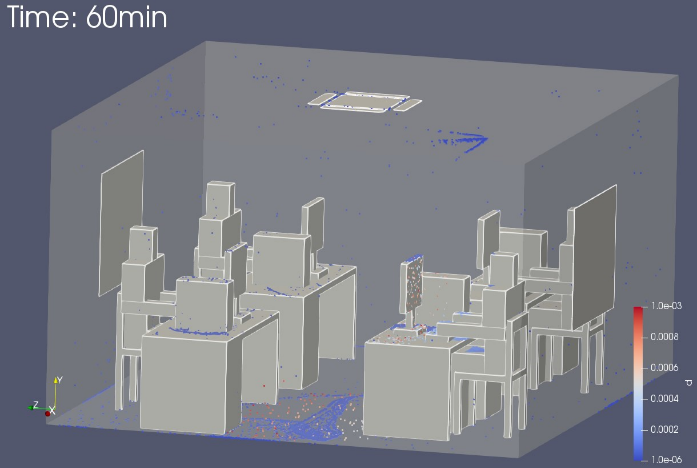


Comparing case studies where occupant 1 speaks on class 3 on the standard room, it was verified, at the beginning, that the room \_\_\_\_from standard case\_\_\_\_ (**class 3/standard case**) presented \_\_\_more\_\_\_ (**more/less**) geographical elements that room \_\_\_from class 3\_\_\_\_\_\_ (**class 3/standard case**). The room occupants \_\_\_from standard case\_\_\_ (**room 3/standard case)** presented \_\_\_bigger\_\_\_ (**bigger/smaller**) geographical complexity than room occupants from \_\_\_class 3\_\_\_ (**class 3/ standard case**). In relation to the trajectory followed by the respiratory droplets, it can be concluded that it was\_\_identical\_\_\_\_(**identical/different**) to both cases. Such as the case in class 3, it was verified, in the standard room, that particles with a \_\_bigger\_\_\_(**bigger/smaller**) dimension were easily deposited in the room, and particles with a \_\_\_smaller\_\_\_ (**bigger/smaller)** dimension were easily removed. In the standard room, since it exists \_\_\_more\_\_\_ (**more/less**) geometrical elements that in case 3 lesson, it was verified, at the end of the simulation, there was \_\_more\_\_(**more/less**) respiratory droplets in the room, and, as such, the infection risk \_\_indirect\_\_ (**direct/indirect**), due to the contact with the geometrical elements in the room, it is \_\_bigger\_ (**bigger/smaller**) in the standard case than in the lesson 3 case. The infection risk \_\_direct\_\_(**direct/indirect**) by \_\_direct\_\_ (**direct/indirect)** contact from the particles with the room occupants was \_\_residual\_\_(**significative/residual)** in both cases.

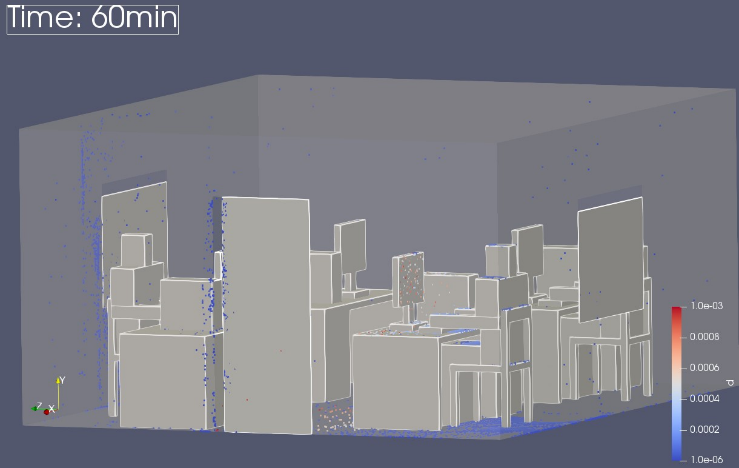
* 1. During lesson 1, it was verified that several parameters can influence the flow of the respiratory droplets. Likewise, the physical space parameters can also influence it. Based on this idea, identify the main difference between the standard case room, the room with a ventilation system on the ceiling, and the room with a natural ventilation system (open door and windows), and explain how this influences the infection risk in each room. (**Note:** to help you answer, the image below represents the end of each simulation for each case study).



**Speaking standard case**



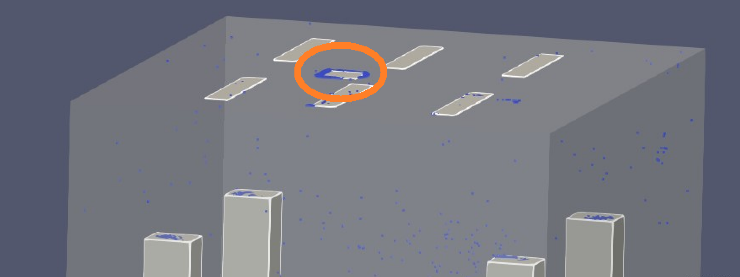
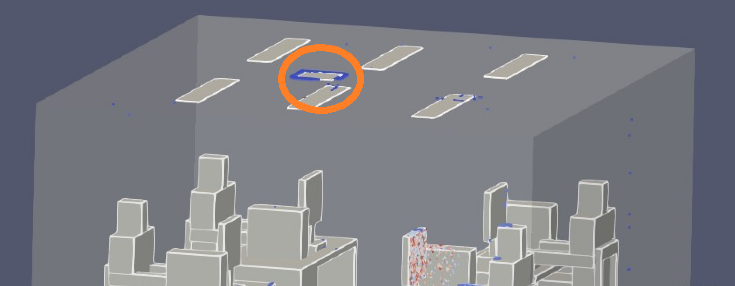
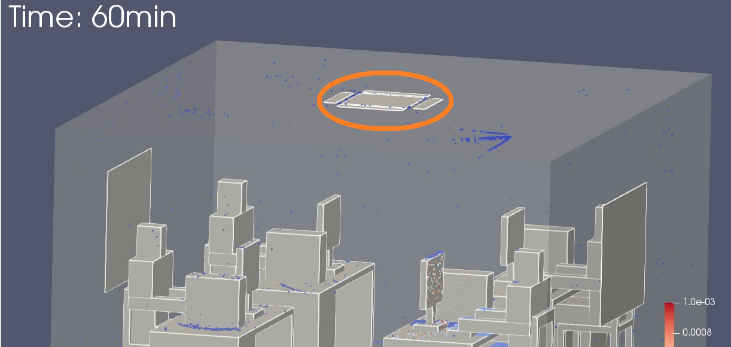
**Speaking with a ceiling ventilation system**



**Speaking with a natural ventilation system**

The major change that occurred between the three rooms was the use of a different ventilation system. In the standard room, the ventilation system of class 3 (diffusers on the floor and extractor on the ceiling) was maintained, in the room with a ventilation system on the ceiling, all the equipment (diffusers + extractor) was installed on the ceiling, and in the room with a natural ventilation system, there was an air current in the direction of the window openings for the door opening. Regarding the differences found for each room, in terms of the trajectory traveled by the particles, it was found that in the standard case, the particles tend to follow the air flow created by the ventilation system, describing an upward trajectory in an "L" shape, in the direction of the extractor, being successively removed from the room over time, as in the case of class 3. In the case where the ventilation system was fully installed on the ceiling, it was found that the particles became more dispersed inside the room. As a consequence, there were more particles in the room, and therefore, the risk of indirect infection in this case is higher than in the standard case. In the case of the room with natural ventilation system, the air current generated was towards the windows to the door. As the door opening is small, there were fewer particles to be removed from the room when compared to previous situations (with mechanical ventilation system). As a consequence, there were more particles in the room, and therefore, the risk of indirect infection in this case is higher than in the two previous cases.

* 1. Identify which phenomena marked in orange in the images of this question was observed at the end of all simulations, what risks it may incur for public health and how we can solve this problem.



In this question, it should be noted that in all situations analyzed in rooms with a mechanical ventilation system, at the end of the simulation, there was an accumulation of particles in the extractor region. This phenomenon may constitute a potential risk of infection for the occupants of the room, since the particles accumulated there may return to the room. As such, it is necessary to carry out periodic maintenance of these equipment, always keeping them sanitized.

1. Considering what was watched during class 4, and the answers of point one, develop a small summary, highlighting the main aspects of what was analyzed: differences between the room, infection risks, among others.

When preparing the report, the main aspects that should be mentioned by the students are the following:

1. The great difference observed between the case of class 3 and the standard case is related to the fact that in the standard case there are more geometric elements in the room, and, as such, there are more "barriers" to the normal flow of particles, with the risk of infection by an upper indirect route.
2. The particles, both in the standard case and in the case with ventilation fully installed in the ceiling, tend to follow the air flow created by the ventilation system, describing an upward trajectory in an "L" shape, in the direction of the extractor, being successively removed from the room over time.
3. In the natural ventilation system, the particles follow the generated air stream in the direction from the window opening to the door opening, where the particles are also removed over time.
4. The infection of the occupants, by direct route, was practically residual for the three room configurations, due to the presence of the ventilation system (both mechanical and natural).
5. In the case with a ventilation system fully installed in the ceiling, it was found that the particles were more dispersed in the room, and, as such, the risk of infection by indirect route was higher in this case, when compared to the standard case.
6. In the case with natural ventilation system, as the door opening is small, and the speed of the air entering the window is lower than the speed of the air imposed by the mechanical ventilation system in the standard cases and total ventilation in the ceiling, there are fewer particles being removed from the room, and, as such, in this case, the risk of infection by indirect route was higher, when compared to the previous two cases.
7. Over time, there has been an accumulation of particles in the extractor region, which may pose a risk to public health. In order to solve the problem, it is always necessary to periodically maintain this equipment, keeping it sanitized.

**To Learn More…**

If you would like to explore further about this class theme, on the Keywords Table there are several links available, with additional information, related to each keyword. To access this information, click on the corresponding link on the section “References”.

**Keywords Table**

|  |  |
| --- | --- |
| **Keywords** | **Reference Number** |
| How to make CFD simulations with respiratory droplets  Results of CFD simulations with respiratory droplets | **[1] [2] [3]** |
| Simulation videos of CFD | **[4] [5] [6]** |

**References**

**[1]**<https://re.public.polimi.it/retrieve/handle/11311/930957/444623/Numerical%20and%20experimental%20analysis%20of%20airborne%20particles%20control%20in%20an%20operating%20theater_11311-930957_Romano.pdf>

**[2]** [Microsoft Word - 2006Atmospheric Environment \_Zhao Zhang1\_.doc (psu.edu)](https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=0fe1dae233f76168f0e0448172a28ca2d21cc952)

**[3]** [Numerical Simulation of Coughed Droplets in the Air-Conditioning Room (sciencedirectassets.com)](https://pdf.sciencedirectassets.com/278653/1-s2.0-S1877705815X00282/1-s2.0-S1877705815027599/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEHYaCXVzLWVhc3QtMSJIMEYCIQCpllZJpZO1irDxfouaVBqqSs4sN5BImK6cqCr8BGM48AIhAOAXLn%2BUnwWRD%2F6K8TbVIXw%2FEO8Ae1zq7RfxP7KmLs6LKrsFCO7%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEQBRoMMDU5MDAzNTQ2ODY1Igy7z%2FJF6hEcm58LqRQqjwU2zMnGUcSF26cO6LK%2F9K3u3PJHqzC1NYDnVl1T7ONGWBDJB%2FZbnGiqbnfeXTMWmsu5GQHGMvOzGeEJijlyoyIl5mPFeYSXeAaGAJTtpaVHXbFXgXDyx0UfTO9nOZSroTHHkpu8bKd7FP%2BPZ8iPN%2FkO%2BMlXcv7fRCVEXzFNzSqr0sK7TBda9%2FIFbjOLTziH9QCaTPF5rX8%2F6GGz43SDavre7MsKxTypv1jCp78zpbxzakBowOayDAPxOA6qypvDYpyIENs8zpg7OUbaR3jOup4B5bLIUAWY38eTyEEe%2BMlsUJUnnQmy27skz0i1zfmQ8qBGtYmyCsXeZ%2BZv0PhMWTIB%2BPtLjTK%2BUoC%2BTySndB%2FI1n7MB6xgn5l7%2BalnnDf%2BNjEQvJgNFnUSgK7zn2ExmXqS%2BMoFIHyMhph11mOOfAr6F6Q51%2F4%2FDLE9oBhZxGa%2BDgkMxstTv%2BzfAulqPcY59LZxogqVxvDGAwGFY3PQM%2BXmlxYK5FhnCcxV4dtjvUSTOCFOBorKpr8%2FhMiqERiliyt%2Fy7fcQ7IvHLjbF2T71QXH97PTp50DOH1PMWMkF8lVSf0bYJ%2BniCTTD%2FByUTLDULnqBqj53BKE73lVEw%2Bnp1dBg8jmA0KAQEqB7j5DqmsdNJFpGhpWvEh2lMZzWcMhfZvHXJL6ZrBynVFIDqwlZNLwn6rgbEv3hMVOdL7dCDpjvXXJoJ9d%2Fr2nXXz1wP3OS3RVj7ybFcm6tuD2Huh0vjKU%2BqLCH6082UqVzlq8bjhZ985EqcbU7lfwlQKUKV5DWI62CkooVoCez9CdhBQULVuz%2BpNy5y8U6k61%2Fb%2Fd%2Bkfg6kzvyzNx4HOSCUE4hKOE8%2B8xdeQSeoIBT13cM4CF%2FJ3eMJv0v6UGOrABpgphmfsqYGRiyr8mwehPX6Y9QT0fG3sBiKiFfD%2FjXoSLOLE7GM7lpmn8vKhkfqpSA0994yhy0E4ZpLSLlWgqjvxuyEao31Y3g6AYdFUrL997zKUmqJyEDCmqfeFiI5ojsp2ddlWXLEv%2FkemvaKoYjvhj%2F0diNpUJjwr8tjDG8H5b%2Fu0yXv1uw1KpQkUEEvEc1Y0%2B%2B8B3LRcJOoCPdC2le4bH0xmYAuclswJeQtyopyA%3D&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20230713T141757Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTYWY4EFEP5%2F20230713%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=e2f951c7815044038be353770ad5ebbfc5153662ae1f126048453cb515121fe6&hash=4d145210c06416e66ffaeacaa035d80304681b14cd8deb8282793dca322531a3&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S1877705815027599&tid=spdf-0709b412-777d-4908-8e42-7c8e14376964&sid=0a46883649c281487e1b30f8d44e1352f241gxrqb&type=client&ts)

**[4]** [CFD simulation - YouTube](https://www.youtube.com/watch?v=GKaOGM8oIJ4)

**[5]** <https://www.youtube.com/watch?v=GKaOGM8oIJ4>

**[6]** [(11) Simulation shows droplets in human breath - YouTube](https://www.youtube.com/watch?v=JtHso9JtgSc)