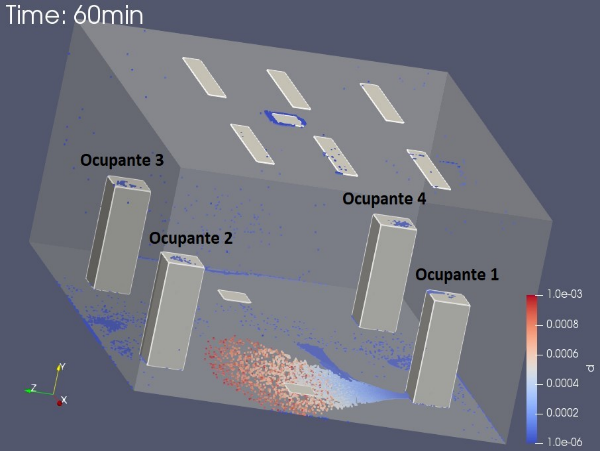
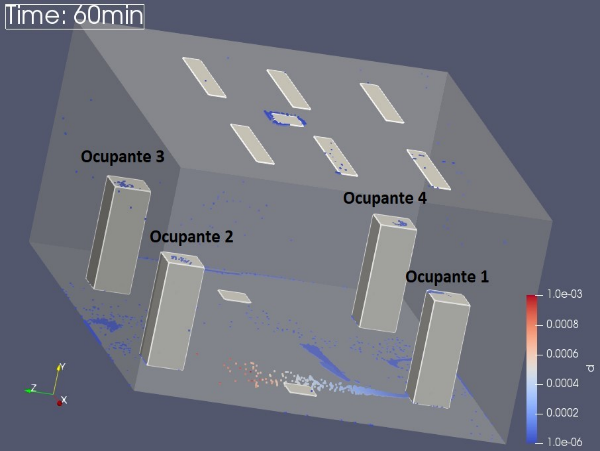
1. Considering what you just watched in the images and videos of the CFD simulations from class 3, and what was learned in classes 1 and 2, answer the following questions.
   1. Considering the images below, which represents the diagonal perspective of speaking and sneezing, state if there were any occupants who were more affected than others, in each simulation.



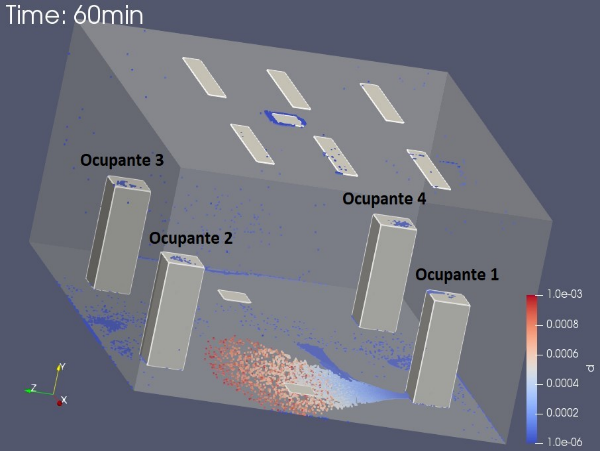
**Speaking**



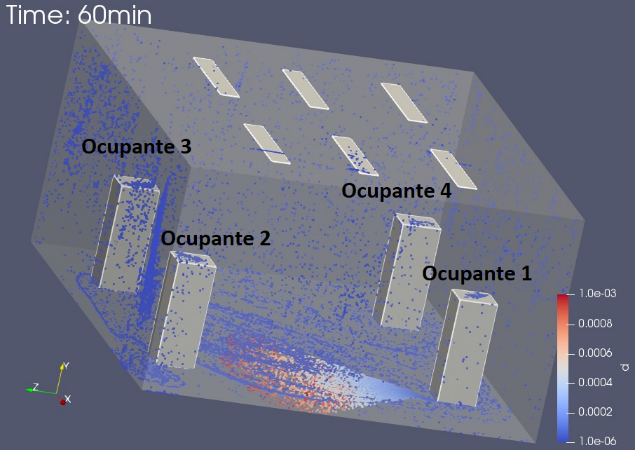
**Sneezing**

To help answer this question, students already have two representative images of the end of the speaking and sneezing simulations. What must be identified is that no human was substantially affected, since few particles directly reached occupants 2, 3 and 4, as shown in the images represented on the sheet. Additionally, in the speaking simulation, speaking without ventilation, sneezing and coughing, by the diagonal perspective images, and detailed of the occupants, we can conclude that occupants 2,3 and 4 were affected equally.

* 1. Explain why the differences observed between the CFD simulations in which occupant 1 spoke with and without ventilation. To help you, the images below represent each one of the situations.



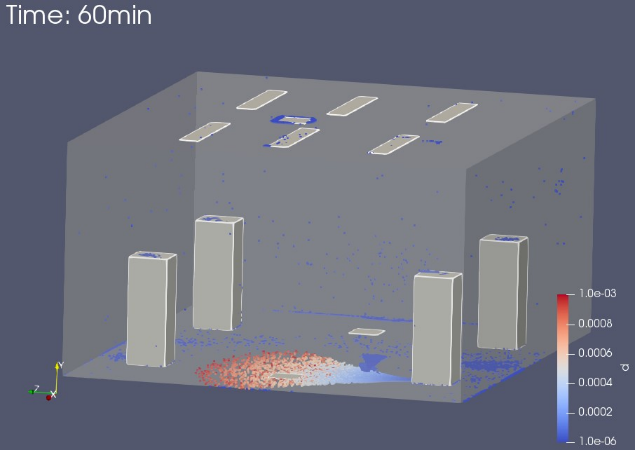
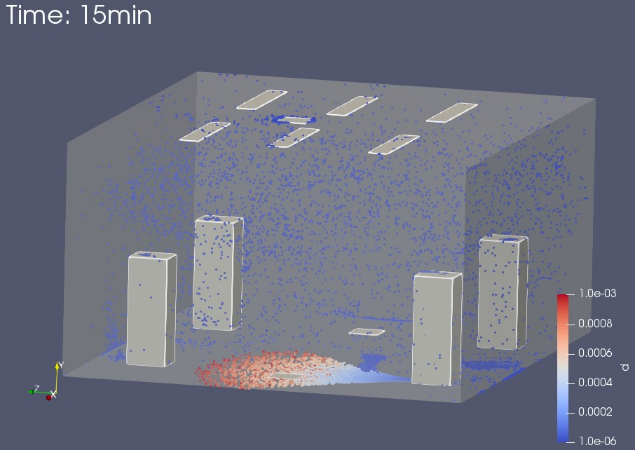
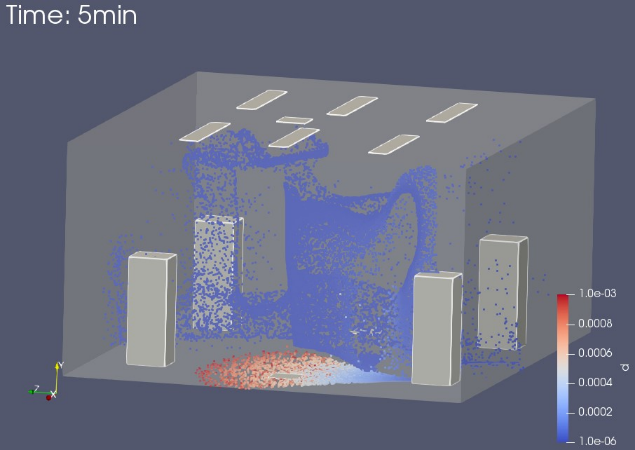
**Speaking**



**Speaking without ventilation**

In this question, students also have two representative images of each situation (end of simulations in which occupant 1 speaks with and without ventilation). Comparing the simulations with and without a ventilation system, it can be noted that there is a greater number of particles suspended in the air (and that remain in the room) without ventilation, due to the lack of a mechanism to remove the particles from the room. Thus, the case without ventilation constitutes a greater risk of infection for the occupants than the case without ventilation.

* 1. As seen in class 1, the air drag force influences the flow of respiratory droplets. Considering the elements that are part of room 3 (occupants and ventilation system), how did each of these elements influence the flow of the particles? To help you, there are three images below representing the class during the speaking simulation on different times (5, 15 and 60 minutes, respectively).



To help answer this question, students have represented the evolution of the simulation of speaking over time with three images of the room (at 5, 15 and 60 minutes). Additionally, there is also a small clue at the beginning of the question that mentions class 1, when it says that air resistance force influences the flow of respiratory particles. What is intended for students to conclude is that in all simulated breathing regimes, the respiratory particles follow the direction of air flow, which forms an "L" shape. The particles follow this direction due to their small size. On the other hand, what is also observed is that larger particles tend to deposit easier, whether in the occupants or on the walls. The geometries present in the room (in these cases, the occupants are the only ones) act as "barriers" to the normal trajectory of the particles, and, as such, influence their flow.

* 1. During lesson 1, it was verified that several parameters influenced the flow of the respiratory droplets, such as temperature, pressure or density. Explain the reason why larger particles (oranges) were deposited in a greater number in the room, and the smaller particles (blue) were removed in greater numbers.

There is also a small clue in the question, when it states that in lesson 1 they verified that existed several parameters which influenced the flow of respiratory particles. What is intended for students to answer is that the larger particles (oranges) were deposited in greater numbers in the room when compared to the smaller ones (blues) due to the fact that they are denser (heavy).

* 1. Was the risk of infection for the occupants always the same for the three breathing regimes? Explain why.

Regarding the risk of infection, it was found that in all breathing regimens, the risk of infection was greatly reduced since direct contact between the particles and the occupants was almost non-existent. Even so, the risk of indirect infection always exists (by contact of the occupants with the walls, for example), and the greater the number of particles inside the room, the greater the risk of infection. Therefore, of all the situations analyzed, the case of speaking will be the one that presents the greatest risk of infection for the occupants, since in this case a greater number of particles were emitted.

1. According to the videos watched during class 3, and the answers given to the prior questions, develop a small scientific summary, highlighting the main aspects of what was analyzed: differences between breathing regimes, differences between having or not having a ventilation system, risks of infection, among others.

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

1. 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.
2. The infection of the occupants was practically residual for the three breathing regimes, due to the presence of the ventilation system.
3. The lower the number of particles emitted, the lower the risk of infection of the occupants.
4. In the situation without ventilation system, the particles were not removed, and the risk of infection of the occupants increased.

**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)