



A Digital Twin for Airflow and Inhaled Drug Delivery in Human Airways

Organizations

One Simulations is a Dutch SME specialised in generic CFD simulations for more than 15 years.

RBF Morph is an Italian SME that develops advanced tools for mesh morphing, which compute topology-preserving shape variations.

GrepIT is a Dutch SME that provides support and technical realizations in the field of HPC.

Fondazione Toscana Gabriele Monasterio is an Italian research hospital highly specialised in the treatment of cardiovascular and pulmonary pathologies.

TU Delft is the oldest and largest technical university in The Netherlands, the participating department has expertise in drug targeting in human airways.



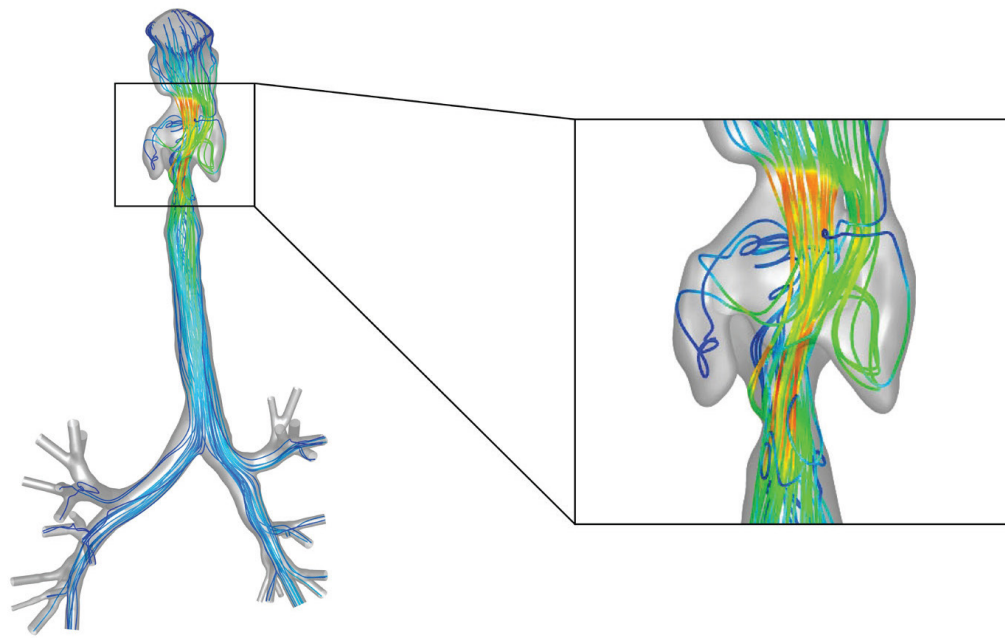
The Challenge

Respiratory diseases such as asthma and Chronic Obstructive Pulmonary Disease (COPD) are caused by narrowing of certain parts of the human airways. The medical treatment for these diseases relies on drug particles being inhaled by the patient. Some patients experience an uneven distribution of drug particles which results in the treatment being ineffective, an increase in side effects, and medicine being wasted.

At present the deposition of inhaled drugs is studied by means of inhaling a radiolabelled drug. This has the negative consequence that the patient is exposed to a certain level of radiation.

One Simulations aims to provide an alternative by performing a detailed CFD simulation of the patient. However, conducting a CFD study for every patient is complex and time consuming due to the manual creation of a 3D model from a CT scan. Even for a skilled CFD expert with access to an HPC system, each study would take several weeks to complete for the entire process, which is a serious disadvantage for urgent medical cases. Associated costs would also be high.





Industry Sector
Healthcare

Technology used:
**HPC,
CFD Simulation**

The Solution

The experiment developed a Digital Twin (DT) able to predict the particle deposition of inhaled drugs for individual human airways. It compresses 1000 high-resolution CFD runs on a 960-core HPC system into a Reduced Order Model giving accurate predictions of particle deposition. Clinical users can now simply feed a medical image into the system and tap the canned power of these simulations with a click to optimise the drug particle size without the need for lengthy and costly CFD runs.

The Impact

The created DT is a valuable asset for One Simulations since it can offer an alternative to hospitals for harmful radiative testing and/or expensive and time consuming CFD simulations, even in emergency situations. Hospitals/clinics can use the solution directly with the consortium operating the DT or by using a licensing structure. Pharmaceutical companies can also benefit from the DT as it can be used to optimize their drug particles or inhalers. DiTAID will also be offered through consultants who are already selling technical solutions to the healthcare industry, thus easily targeting a large group of customers.

This experiment allows One Simulations to expand into the healthcare industry and to gain valuable experience in creating predictive DT's as the principle can be applied in many other industries.

By deploying this unique tool into the market One Simulations expects to have an increase in 5 high level jobs and a yearly turnover increase of €1 million within 5 years.

Benefits

- One Simulations' unique solution offers a practical clinical alternative to harmful radio-labelled drug testing.
- One Simulations expects to create 5 high level jobs within 5 years and expects a yearly turnover increase of €1 million within 5 years.