**Case Study**

## Living PlanIT – *Healthy Buildings*

In our vision for the future, greater understanding of indoor environments will result in buildings that support a more productive, healthier population at lower cost and with reduced impacts on our natural environment. This reality can be achieved by harnessing current and future information about the relationships between built environments, microbial communities around them, and human occupants, and then applying this knowledge to improve building management practices with informed decision-making powered by both our intelligent sensing and artificial intelligence (AI) technology. The joint efforts of Living PlanIT and Santa Casa da Misericordia de Freamunde have resulted in approaches to dealing with the myriad factors involved in the control of microbial exposures in buildings and its influence on patient health, including tools for design and assessment, development of new technologies for building facilities as well as to monitor patients in real-time.

### *People and microbes living together*

The composition and viability of indoor microbial communities are determined largely by characteristics of the building which they inhabit, including the availability of water and nutrients for growth and survival, the building's occupants and the external environment. The building systems, and how these are operated, affect the microbial community.

The characteristics of healthy indoor environments are difficult to define, affected by such things as the building ventilation systems and the chemistry of building materials, which impact the microbial communities. A better understanding is needed to promote human health and prevent disease. The factors and influences are extraordinarily complex and can be explored only as a dynamic, interconnected ecosystem by engaging the fields of microbial biology and ecology, chemistry, building science, human physiology and information technology.
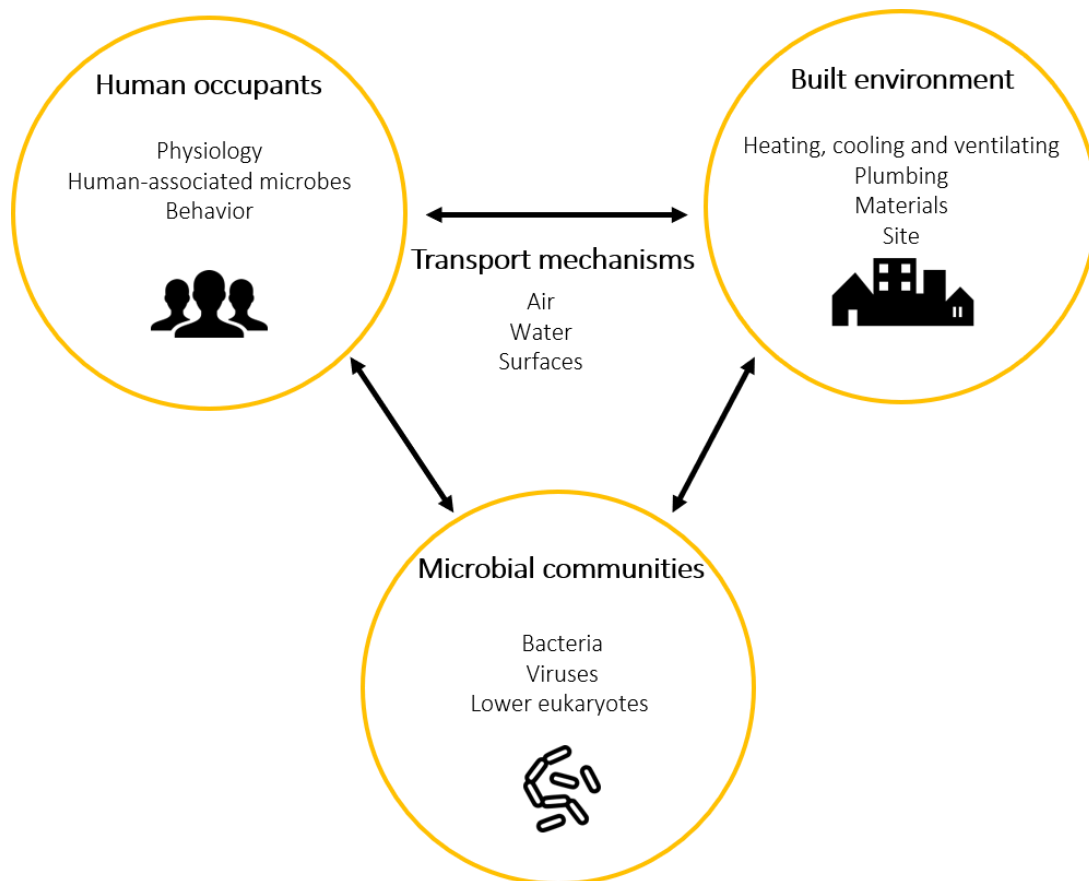
*Figure 1 - The complex interactions among human occupants, built environment and associated microbial communities.*

### Towards healthier buildings

The impact of building operations and maintenance on the health-supporting aspects of the indoor environment are often overlooked. For example, replacing air filters regularly and avoiding water stagnation can have a significant effect on the health of people in a building, but deciding how, when and where to do so is not always clear. The use of intelligent sensing is an effective way of managing these and other important actions. The water quality, air temperature, humidity and performance of natural and artificial ventilation systems all have a strong influence on the survivability of bacteria, fungi and viruses.

There are different sources and reservoirs of microbes in buildings, some of these are concealed and hard to access. For air sources, understanding the implications of a shift towards completely sealed buildings is important, as this can affect indoor air quality, occupant satisfaction, staff productivity and the spread of microbes. For water sources, providing the means for early detection of biofilms, mold and moisture inside building is important, alongside interpreting water activity and moisture measurements to determine the risk of fungal and bacterial growth. Responding to water damage and subsequent mold growth, as well as gaining a more complete understanding of the role of viruses in the evolution of the indoor microbiome over time, is vital. For surfaces, determining relative risk associated with particular surfaces made of specific materials which either suspend dust or support dampness and mold is part of creating a solution for balancing the built environment microbiome and develop targeted disinfection strategies. We must also better understand the outside environment and whether natural or forced mechanical ventilation, or sunlight entering through windows, might reduce or increase harmful microbes indoors.

In general, monitoring and maintenance practices need to be more sophisticated. Unsubstantiated remedies and preventative measures, although well intended, can cause more problems than they address. For example, this is the case with *Legionella* or biofilm cleaning, in which scalding or hyper-chlorination shock will only fragment hotspots, spreading the growth of the organisms to other areas of the building infrastructure.

### Monitoring the microbes

The focus of the joint program between Santa Casa and Living PlanIT has been the indoor environment, using sensing and targeted interventions to reduce the number of harmful pathogens. Our strategy has been to focus

on the microbial world and then use technology to monitor it. Although we cannot see microbes with the naked eye, our technology allow us to take a closer look at these building microbes.

We worked closely throughout 2018 with Santa Casa de Freamunde, a nursing clinic in Portugal, to determine the efficacy of real-time monitoring and interventions for the avoidance of harm. This was the first phase of a longer-term program and comprised early detection and control of harmful pathogens in the built environment. The outcomes were compelling. The number of patients infected over a 12-month period was reduced by more than half and respiratory infections and illnesses associated with multi-resistant bacteria were virtually eliminated. Prescribing powerful antibiotics was no longer needed.

| Period | Patients | Infected | Types of infection | Types of antibiotic |
|---|---|---|---|---|
| Jan 2017 – Jan 2018 | 33 | 9 | Urinary, respiratory & multi-resistant bacterial | Medium to high spectrum |
| Feb 2018 – Mar 2019 | 33 | 4 | Urinary | Low spectrum |

In addition, the Chief Nurse reported fewer instances of staff illness over the 12-month period, together with reduced concern from staff about treating infected patients. Our target is to reduce infections even further by reducing human exposure to harmful microbes, encouraging exposure to beneficial microbes and sustaining healthier buildings.

Future phases will develop this approach further, but also incorporate some of the clinical observations relating to the patient population as a whole. It is expected that this will lead to even better timed and judged interventions.

Living PlanIT is committed to improving the quality of life through technology. We are committed to making all buildings healthier and sustainable, by making better use of space and by reducing the transmission of harmful bacteria, fungi and viruses through the air, water and surfaces.