NextVIS
Visibility Prediction Framework – a next-generation model for visibility in smoke in the built environment

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Smoke is the greatest threat in building fires. The smoke and its constituents – the toxic products of combustion, may lead to poisoning, incapacitation or even death. The first effect that smoke has on humans is the reduction of visibility – the smoke conceals evacuation signs and exits, and makes the orientation in space a very difficult task. The loss of visibility happens at a very low concentration of smoke. In fact, this concentration is so low, that if the visibility through smoke is not significantly reduced, it also means the smoke is not a direct threat to life in a short exposure. This concept is profound to the design of safety systems in buildings, and it is the part of determining the Available and Required Safe Evacuation Time.

Assessment of visibility is fundamental to building safety. Yet, we do not have adequate tools to do this. The existing model of T. Jin was created in Japan in the 1970s and has not been significantly modified since then. The tools at our disposal have certainly evolved for the last 50 years, but in the field of visibility in smoke, we can still only 'appraise' it, rather than 'model'. The NextVIS project is our response to this dire need. In place of the existing relationship between the concentration of smoke and visibility (at a smoke concentration of … the visibility is …), we intend to implement a physical model of photon and smoke particle interaction. This will enable us to precisely model the appearance of a target (evacuation sign, exit, obstacle) through a layer of smoke, as in the eye of the observer. If we use this tool to assess the visibility in multiple locations in a building, we will be able to map the areas with good and poor visibility. In contrast to the existing simple model, our tool will allow evaluating the impact of the characteristics of an evacuation sign (size, colour, light intensity) or the architectural context of the building. This will enable safety solutions tailor-fit for the building, e.g. use of larger evacuation signage or change in the emergency lighting strategies. The existing model of Jin does not allow for that.

Our next-generation model for visibility in smoke will have a considerable impact on fire science. The scientists do base their conclusions related to safety on parameters that can be measured. Visibility in smoke is one of such parameters; arguably, the most popular one. Many recent research projects on innovative measures to provide safety in fires is, in fact, the research on how to improve visibility in smoke in the most efficient way. Our model will be built into a software package – the Visibility Prediction Framework. This package will be open-source and available to everyone. This model will be directly useful to the researchers in the most innovative research fields in fire science, such as the use of Virtual Reality to investigate human behaviour in fires.

The project is designed for three years, in which two research teams will conduct their tasks in cooperation. In Poland, the Building Research Institute (ITB) team will perform novel experiments on the visibility in smoke conditions, which should reveal the smoke obscuration effects with the highest precision, so far. Observers will participate in these experiments, to help us determine at what distortion conditions the evacuation sign stops being visible. This data will be used by the German team of the University of Wuppertal (BUW). The German team will be building the heart of the project – the VPF framework. This will be the tool, that will allow modelling the visibility in smoke. After two years in development, we will use the VPF in the built environment. We will carry further experiments, this time in real buildings. We will start fires, and try to model them. By comparing the predicted and observed results, we will be able to improve our model and verify its capabilities in assessing the safety of buildings.

The visibility in smoke model is a key tool for Fire Safety Engineering. We hope that our next-generation model will become a part of this toolbox, and will help design new buildings that provide better safety to their occupants. We also hope that VPF will enable the growth of the most innovative branches of fire science.