CLIMATE SIMULATION

Limpens-Neilen, Dionne; Schoffelen, Mariëlle and Schellen, Henk Measurements and simulation results of a local bench heating system (presentation at 6th Indoor Air Quality 2004 Meeting (IAQ2004) Padova, Italy, 10-12 November 2004). www.isac.cnr.it/iaq2004/posterabstract/Neilen_poster_abstract.pdf

Problems with the conservation of art works and interior of monumental churches are mostly a result of using a heating system that introduces abrupt variations in the indoor climate. These problems can be prevented by introducing a minimum amount of heat only where it is needed; near the people in the benches. Within the European project "Friendly Heating", such a local bench heating system is being designed on the basis of radiant heating foil. The performance of this local heating system is simulated with help of the CFD package Fluent. (Author's abstract)

Neilen, D; Schoffelen, M. E. A. and Schellen, H. L. Design Study of a local bench heating system for churches, performed by computer simulation. In *Built environments and environmental buildings: 21st International Conference on Passive and Low-Energy Architecture: 19 - 22 September 2004, Eindhoven, The Netherlands.* M.H. de Wit, ed. TU/e, Eindhoven, The Netherlands (2004), pp. 799-803.

Neilen, D; Schoffelen, M. E. A. and Schellen, H. L. Thermal performance of a local bench heating system for churches. In *ROOMVENT 2004: 9th International Conference on Air Distribution in Rooms: 5-8 September 2004, University of Coimbra, Portugal.* Silva, Manuel C. Gameiro da, ed. (2004) http://sts.bwk.tue.nl/friendlyheating/Publicaties/Limpens-Neilen_Netherlands_rv04.pdf

Within the European project "Friendly Heating" a local heating system is designed. The main goal is not to heat the monumental churches themselves, in order to prevent damage to valuable art works and the building itself. The idea is to provide a thermal comfort zone for the people in the pew using radiant heat sources. Measurements in a climate room are used to a) evaluate the local climate created by the bench heating system and b) evaluate the CFD model. The results will be used in ongoing research on the prediction of the indoor climate in a church under real climate conditions. (Author's abstract)

Neuhaus E.; Schellen H. Conservation Heating to Control Relative Humidity and Create Museum Indoor Conditions in a Monumental Building. In *Techologies & sustainable policies for a radical decrease of the energy consumption in buildings: EPIC 2002 AIVC: Proceedings--actes: The 4th European Conference on Energy Performance & Indoor Climate in Buildings: The 27th Conference of the Air Infiltration & Ventilation Centre: Conference of the IEA Programme on Energy Conservation in Buildings and Community Systems.* Guarracino, G., ed. pp. 45-50 .

For the conservation of an important museum collection in a historic building a better controlled indoor climate may be necessary. One of the most important factors is controlling relative humidity. Museum collections often are part of the interior of a historic building. In most cases the installation of an expensive air-conditioning system may cause damage to the building and its historic authenticity. Furthermore humidifying may lead to dramatic indoor air conditions with mould and condensation effects on the cold indoor surfaces or even internal condensation in the construction. One way to overcome this problem is to make use of so-called 'conservation heating'. A humidistat to limit relative humidity controls the heating system. Conservation heating control was tested in an experimental setup in the laboratory and experience was gained in a historic building in the Netherlands. Control strategies and regimes were tested both by experiment and by simulation. The simulation model is validated by measurements. In the historic building the indoor climate was monitored during a long period. The preservation conditions of the indoor climate on the collection and the monumental building were evaluated. The indoor climate for preservation of a monumental building and its monumental interior may be improved by conservation heating. The human comfort however may decline. Furthermore it is a simple and energy efficient system which requires low maintenance.

Schellen, H. L. Tools to evaluate and or design heating systems for (monumental) churches. In *Built environments and environmental buildings: 21st International Conference on Passive and Low-Energy Architecture: 19 - 22 September 2004, Eindhoven, The Netherlands.* M.H. de Wit, ed. TU/e, Eindhoven, The Netherlands (2004), pp. 789-794.

Schellen, H. L.; Aarle, M. A. P. van and Schijndel, A. W. M. van The use of FEMLAB models to protect a monumental church organ in case of hot air church heating. (2005) http://www.comsol.se/academic/papers/1165/

The Walloon Church in Delft is an important monumental church in the Netherlands. The monumental interior parts consist of a monumental pulpit, monumental pews, monumental escutcheons and an important burial monument. The monumental Bätz/Witte organ in the church dates back to 1869 and was last restored in 2000. The heating system in the building was originally a direct hot air system, Mark Fohn type 115RH of Mark Heating Systems. The heat capacity of the heating system was

115/77 kW (high/low). The hot air was brought into the church by a re-circulation system with an airflow rate of 7400/5000 m3/h (high/low). The warm air inlet consisted of a single grille at about 3 m above floor level. The outlet was a single grille in the floor. The air was re-circulated for 100 %. The thermostatic device in the church was located near the pulpit at a height of about 3 meters. (Author's abstract)

Schoffelen, M. E. A.; Neilen, D and Schellen, H. L. Measurement Set-up for the Verification of CFD Modeling Used in a Design Study for a Local Bench Heating System for Churches. In *Built environments and environmental buildings: 21st International Conference on Passive and Low-Energy Architecture: 19 - 22 September 2004, Eindhoven, The Netherlands.* M.H. de Wit , ed. TU/e, Eindhoven, The Netherlands (2004), pp. 821-826.

Taylor, Joel; Blades, Nigel; Cassar, May and Ridley, Ian. Reviewing past environments in a historic house library using building simulation. In *14th triennial meeting, The Hague, 12-16 September 2005: Preprints (ICOM Committee for Conservation): Control of museum climate in Asia and the Pacific area.* Verger, Isabelle; Kamba, Nobuyuki and Miura, Sadatoshi, eds. James & James (Science Publishers) Ltd., London (2005).

Reviews different heating regimes applied to the same space using building simulation. The construction of a computer simulation model to investigate past and present environments in a historic house library is described. The model simulated four hypothetical scenarios based on real data. The simulation outputs were reviewed in terms of the risk of physical and chemical deterioration and their relationship with an existing national standard for archives. The possibility of simulating past environments to investigate natural aging is also discussed. (Author's Abstract. These preprints contain 12 papers given by participants at a meeting on the control of museum climate in Asia and the Pacific area, and an analytical report discussing about 30 answers to inquiries made to about 100 museums in Asia and the Pacific area. The meeting will be held with the aim of discussing problems of climate control in museums. (Author's Abstract)

Schijndel, A. W. M. van; Schellen, H. L. Application of a combined indoor climate and HVAC model for the indoor climate performance of a museum. *Restoration of buildings and monuments: an international journal = Bauinstandsetzen und Baudenkmalpflege: eine internationale Zeitschrift* 12, 3 (2006), pp. 219-228.
http://www.byv.kth.se/avd/byte/reykjavik/pdf/art_168.pdf

A famous museum in the Netherlands has reported possible damage to important preserved wallpaper fragments. The purpose of this article is to evaluate the current indoor climate performance by measurements and to evaluate possible solutions by modeling and simulation. The modeling methodology was as follows. First, an existing model for simulation of the indoor climate was used. Second, basic models for the heating, ventilation, and air conditioning (HVAC) system, the HVAC controller, and the

showcase were developed. Third, the models were validated using measurements. Fourth, a combined model was used to simulate the indoor climate performance for two cases without a showcase, using the current indoor climate control and another control strategy, and the same cases with a showcase. Findings show that the current indoor climate does not satisfy the requirements for the preservation of old paper, and of the four presented cases, only the case with a new controller strategy and a showcase satisfies the required performance. The authors conclude that the presented modeling approach can be useful as an example for similar problems. (Author's Abstract)

Schijndel A.W.M. van; Schellen H.L. and Timmermans W.J. Simulation of the climate system performance of a museum in case of failure. In *Techologies & sustainable policies for a radical decrease of the energy consumption in buildings: EPIC 2002 AIVC: Proceedings--actes: The 4th European Conference on Energy Performance & Indoor Climate in Buildings: The 27th Conference of the Air Infiltration & Ventilation Centre: Conference of the IEA Programme on Energy Conservation in Buildings and Community Systems.* pp. 45-50.

The paper presents the evaluation of the current HVAC components and indoor climate of a high tech Naval Depot in case of failure events. The methodology of the research was: First, implementation of the heat, air & moisture models of the building and HVAC components in SimuLink. Second, validation of the models using measured data from the present building control system. Third, simulation of the current and new HVAC systems designs. Fourth, discussion of the usability of the approach. For this specific case, it is concluded that the current system design performs well if in case of a fault, the air supply to the depots is switched off automatically. The construction of the depots contains sufficient thermal inertia to maintain a stable indoor climate for a longer period in which the system fault can be repaired. A further improvement of the design could be to control the indoor climate surrounding the depots instead of inside the depots itself. In this case, even if the system would not detect a fault and thus supplying uncontrolled air at the surroundings of the depot, the indoor climate in the depot would remain stable. Furthermore it is concluded that the approach presented in this paper appears to be wider applicable than this single case study.