Computer Models For Evacuation

Model Name: buildingEXODUS

Version: 2.04 (Version 3.0 due Oct/Nov 2000)

Classification: Human behaviour/evacuation model.

Very Short Description: A PC based evacuation model that simulates individual people, behaviour and enclosure details. The model includes aspects of people-people, people-structure and people-environment interaction. It is capable of simulating thousands of people in large geometries and include fire data.

Modeler(s), Organization(s): EXODUS development Team, FSEG, The University of Greenwich, key members consist of Prof Ed Galea, Dr Peter Lawrence, Dr Steve Gwynne, Mr Lazaros Fillipidis, Mr David Cooney and Mr Daren Blackshields.

User's Guide: buildingEXODUS V3.0 User Guide and Technical Manual, Doc Rev 3.0, May 2000.

Technical References: buildingEXODUS User Guide and Technical Manual

Validation References: "A General Approach to Validating Evacuation Models with an Application to EXODUS", E Galea, Journal of Fire Sciencies, Vol. 16 – November/December 1998. pp 414-436. ISSN 0734-9041.

"A Systematic Comparison of Model Predictions Produced by the buildingEXODUS Evacuation Model and the Tsukuba Pavilion Evacuation Data" S Gwynne, E Galea, P Lawrence, M Owen, L Filippidis, Applied Fire Science, Vol. 7, No.3, pp 235-266, 1998. ISSN 1044-4300.

"A comparison of predictions from the buildingEXODUS Evacuation Model with Experimental data", E Galea, S Gwynne, M Owen, P Lawrence, L Filippidis, Proc Human

Behaviour in Fire, ED: Jim Shields, ISBN 85923 103 9, pp 711 – 720, 1998.

“Adapting the buildingEXODUS Evacuation Model for Hospital Specific Evacuation Scenarios”, E Galea, P Lawrence, M Owen, L Filippidis, Proceedings of the 8th International Fire Science and Engineering Conference: Interflam'99, Vol. 2, pp 1247-1252, Edinburgh, Scotland, June 29 – July 1st 1999, published by Interscience Communications Ltd, London, UK, 1999. ISBN 0 9532312 3 2.

“Evacuation of a Theatre:Exercise vs Calculations”, H Weckman, Slehtimaki and S. Mannikko, Fire and Materials, v23, 6, pp357-362,Nov-Dec 1999.

“Validation of the buildingEXODUS Evacuation Model”, S Gwynne, E R Galea, P Lawrence, M Owen, L Filippidis, Report 98/IM/29, CMS Press London, ISBN 1899991298, 1998.

“Adaptive Decision Making in Response to Crowd Formations in buildingEXODUS”, S Gwynne, E R Galea, P Lawrence, M Owen, L Filippidis, Journal of Applied Fire Science, Vol. 8 (4), pp 265-289, 1999.

“An Investigation of the Aspects of Occupant Behaviour Required for Evacuation Modelling” S Gwynne, E Galea, M Owen, P Lawrence, Journal of Applied Fire Science, Vol. 8(1), pp 19-59, 1998-99. ISSN 1044-4300.

Availability: Contact Professor E. Galea, FSEG, The University of Greenwich, 30 Park Row, Greenwich, UK SE10 9LS, e.r.galea@gre.ac.uk, http://fseg.gre.ac.uk/exodus/, phone: +44 (0)20-8331-8730.

Price: Annual commercial licenses: UK£4000 Level 2, UK£2000 Level 1, discounts available for education, fire brigades, local authorities, etc.

Necessary Hardware: Intel architecture running Windows 95, 98 or NT 4.0. Not yet validated under Windows 2000.

Computer Language: C++

Size: Approximately 40MB of disk space and a minimum of 10MB of free memory.

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Detailed Description:

THE buildingEXODUS SOFTWARE

The EXODUS software attempts to take into consideration people-people, people-fire and people-structure interactions. The model tracks the trajectory of each individual as they make their way out of the enclosure, or are overcome by fire hazards such as heat, smoke and toxic gases. More information about EXODUS can be found on our web pages at http://fseg.gre.ac.uk/exodus/. The following is a brief introduction into buildingEXODUS.

EXODUS is a suite of software tools designed to simulate the evacuation of large numbers of people from a variety of enclosures. The buildingEXODUS model comprises five core interacting sub-models, these are the ***Occupant, Movement, Behaviour, Toxicity and Hazard*** sub-models. The software, written in C++ using object orientated techniques, is rule-based, the progressive motion and behaviour of each individual being determined by a set of heuristics or rules.

The spatial and temporal dimensions within buildingEXODUS are spanned by a two-dimensional spatial grid and a simulation clock (SC). The spatial grid maps out the geometry of the building, locating exits, internal compartments, obstacles, etc. Geometries with multiple floors can be made up of multiple grids connected by staircases, with each floor being allocated a separate window. The building layout can be specified using either a DXF file produced by a CAD package, or the interactive tools provided, and may then be stored in a geometry library for later use. The grid is made up of nodes and arcs with each node representing a small region of space and each arc representing the distance between each node. Individuals travel from node to node along the arcs.

On the basis of an individual's personal attributes, the Behaviour Sub-model determines the occupant's response to the current situation, and passes its decision on to the Movement Sub-model. The Behaviour Sub-model functions on two levels. These are known as GLOBAL and LOCAL behaviour. GLOBAL behaviour involves implementing an escape strategy that may lead an occupant to exit via their nearest serviceable exit or most familiar exit. The occupants familiarity with a particular building may be determined by the user prior to commencing the simulation. It is also possible to assign individuals with an itinerary of tasks – such as visit a pre-defined location - that must be completed prior to evacuation.

The desired GLOBAL behaviour is set by the user, but may be modified or overridden through the dictates of LOCAL behaviour. The LOCAL behaviour includes such considerations as determining the occupants initial response to the call to evacuate i.e. will the occupant react immediately or after a short period of time or display behavioural inaction, conflict resolution, overtaking and the selection of possible detouring routes. The manner in which an occupant will react to local situations is determined in part by their attributes. As certain behaviour rules, such as conflict resolution, are probabilistic in nature, the model will not produce identical results if a simulation is repeated.

The Toxicity submodel determines the physiological impact of the environment upon the occupant. To determine the effect of the fire hazards on occupants, EXODUS uses a Fractional Effective Dose (FED) toxicity model, this assumes that the effects of certain fire hazards are related to the *dose* received rather than the exposure *concentration*. The model calculates the ratio of the dose received over time to the effective dose that causes incapacitation or death, and sums these ratios during the exposure. When the total reaches unity, the toxic effect is predicted to occur. Within buildingEXODUS, as the FED approaches unity the occupant's mobility, agility, and travel rates can be reduced making it more difficult for the affected occupant to escape. The core toxicity model implemented within buildingEXODUS is the FED model of Purser. This model considers the toxic and physical hazards associated with elevated temperature, thermal radiation, HCN, CO, CO_2 and low O_2 and estimates the time to incapacitation. In addition to this behaviour, the occupant is allowed to stagger through smoke filled environments and is slowed down according to the data of Jin. Occupants are also given the ability to select another exit path when faced with a smoke barrier based on their familiarity with the structure.

The thermal and toxic environment is determined by the Hazard submodel. This distributes hazards throughout the environment as a function of time and location. buildingEXODUS does not predict these hazards but can accept experimental data or numerical data from other models. A software link has been established between the buildingEXODUS and the CFAST zone model. This allows CFAST (version 4.0) history files to be automatically passed to the buildingEXODUS model, thereby enabling the buildingEXODUS and CFAST models to interact in a relatively straight forward manner.

To aid in the interpretation of the results produced by buildingEXODUS several data analysis tools have been developed. These are intended to be used once a simulation has been completed and enable large data output files to be searched and specific data selectively and efficiently extracted. In addition, a post-processor virtual-reality graphics environment has been developed, providing an animated three-dimensional representation of the evacuation (see Figure 1).

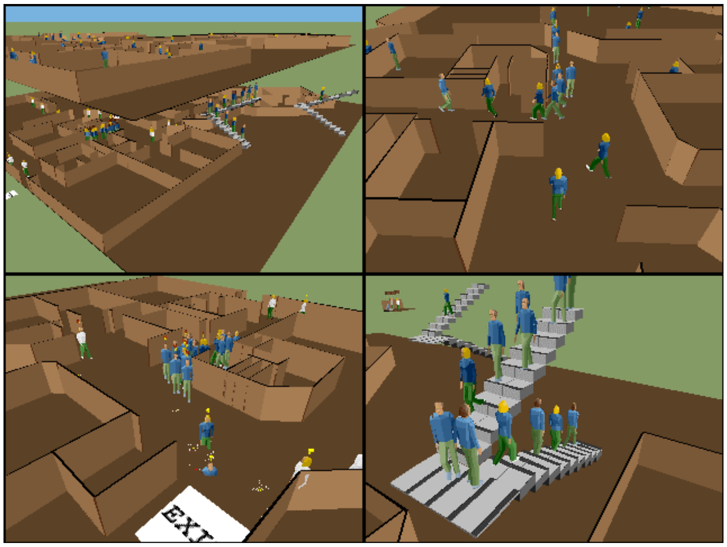

Figure 1 : Post-processor vr representation of buildingEXODUS simulation.