buildingEXODUS

Fire Safety Engineering Group
The University of Greenwich
London SE10 9LS

buildingEXODUS The Evacuation Model for the Built Environment

buildingEXODUS is more than simply an evacuation model, it is a computer based laboratory for evaluating the emergency and non-emergency movement and behaviour of people.

Developed within the Fire Safety Engineering Group (FSEG) through pioneering research and development at the University of Greenwich, buildingEXODUS simulates ***people-people, people-fire and people-structure*** interactions. The model tracks the path 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.

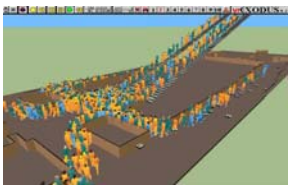
High profile projects buildingEXODUS has been used on include:

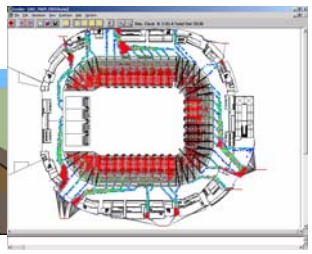
- ***Düsseldorf Airport Redevelopment***
- ***Golden Pyramids Plaza Egypt***
- ***2nd Avenue Subway extension, New York***
- ***San Francisco Subway***
- ***London Millennium Dome***
- ***Sydney Olympic Stadium***
- ***World Trade Center 9/11 evacuation analysis***

buildingEXODUS applications

THE EXODUS MODEL

The software is written in C++ using Object Orientated techniques and utilises rule-based software technology to control the simulation. For additional flexibility these rules have been categorised into five interacting submodels known as the Occupant, Movement, Behaviour, Toxicity and Hazard models. These operate on a region of space defined by the geometry of the enclosure. Internally, the geometry is covered in a mesh of nodes. The nodes are linked by a system of arcs. Each node represents a region of space typically occupied by a single person.

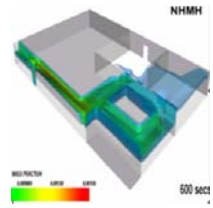


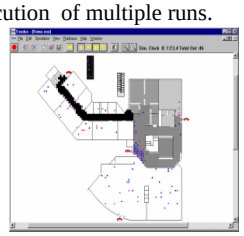


EXODUS examples: pedestrian dynamics for city centre concert, underground station evacuation, station pedestrian circulation, stadium evacuation

buildingEXODUS FEATURES

- buildingEXODUS is available for Windows including: XP and Vista
- Minimum PC spec required: Pent II 300MHz, 128MB RAM.
- Typical software performance:
  - 1,000 people, 2500m^2 enclosure, 15 sec using 1.9GHz, 1Gb PC
  - 8,200 people in 110 storey building, 25 min using 3.6GHz, 3Gb PC.
- Simulates evacuation and normal pedestrian dynamics.
- Ability to distinguish emergency exits from normal exits and assign exit usage according to occupant familiarity.
- Simulates occupant interaction with signage.
- Itinerary function enabling allocation of tasks
- Link to SMARTFIRE CFD fire simulation
- Reads CFAST history files
- Toxicity calculations determined using FED models.
- Occupant reaction to fire irritant gases
- Determines time spent in congestion for each occupant.
- Census nodes/lines allows flow statistics of any arbitrary point within the structure to be recorded.
- vrEXODUS post-proc Virtual Reality animation tool
- askEXODUS is a tool designed to assist in the analysis of large data output files produced from multiple runs
- Interactive run-time 2D graphics allows occupant interrogation.
- Run-time 2D graphics can display:
  - individual occupants,
  - population densities,
  - smoke and temperature distribution.
- Batch Mode allows rapid execution of multiple runs.

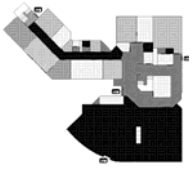


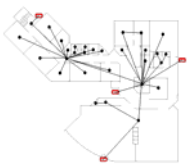


SMARTFIRE fire prediction, smoke spread representation within buildingEXODUS, VR views showing smoke spread and occupants crawling

NEW FEATURES SOON TO BE RELEASED/UNDER DEVELOPMENT

- **Escalators, Travelators and Lifts**
- **Parallel simulation capability**
- **Emotion modelling**
- **Use of gene concept to create related groups**
- **Development of hybrid version linking, course, fine and continuous representation within single model**
- **Use of graph representation of structure for spatial syntax analysis and improved navigational capabilities**





EXODUS graph capabilities: automatic detection of rooms and circulation spaces and generation of spatial graph

EXODUS hybrid model

Contact: Prof Ed Galea
e.r.galea@gre.ac.uk
http://fseg.gre.ac.uk
Phone: + 44 (0)208 331 8730

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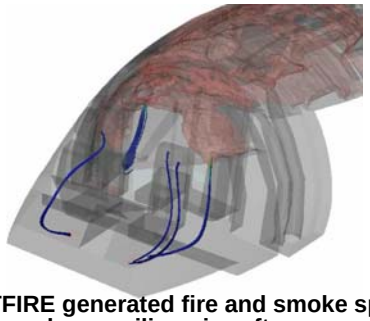
A WORLD LEADER IN COMPUTATIONAL FIRE ENGINEERING

The Fire Safety Engineering Group (FSEG) of the University of Greenwich was founded by Prof Galea in 1986. The research and consultancy interests of the 30 strong team are focused on the development and application of Computational Fire Engineering (CFE) tools for the simulation of evacuation, non-emergency circulation of people, combustion, fire/smoke spread, structural response to fire and fire suppression. High profile applications of FSEG skills and technology in the built environment, aerospace, marine and rail sectors include:

- ***9/11 WTC*** – evacuation analysis
- ***Airbus A380 super jumbo*** - evacuation analysis
- ***SwissAir MD11 disaster inquiry*** – fire analysis
- ***New Royal Navy aircraft carrier (CVF)*** – evacuation analysis
- ***Ladbroke Grove rail disaster inquiry*** – fire/evacuation analysis
- ***Sydney Olympic Stadium*** – evacuation analysis

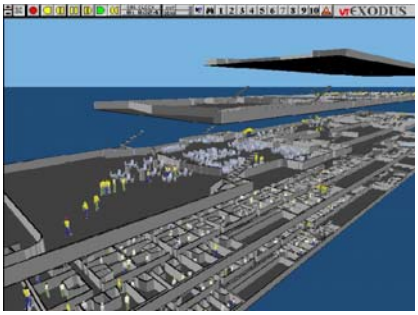


SMARTFIRE generated fire and smoke spread in above ceiling aircraft space

INTERNATIONAL RESEARCH AND CONSULTANCY

FSEG is one of Europe's leading centres of excellence in CFE. It is also one of the largest university-based groups dedicated to the modelling of fire and related phenomena in the world. FSEG has published over 200 academic and professional publications on fire and related topics. Since 1991 FSEG has generated over £6 million worth of research and consultancy funding and its research and consultancy activities have been supported by a client base including:

EADS, BAe Systems, BA, Buro Happold, BMT, Canary Wharf Management Ltd., EPSRC, EU, European Space Agency, Mitsubishi, LPC, MCA, NHS, Arup, RINA, Borealis, Rockwool, Thales, The Engineering Link, MOD, Lloyds Register, CAA, FAA, FRA, Boeing, NTSB, Bombardier, Canadian Dept of Trans, US Dept of Trans, Canadian Transportation Safety Board.



maritimeEXODUS: Simulation of mustering on a large passenger ship

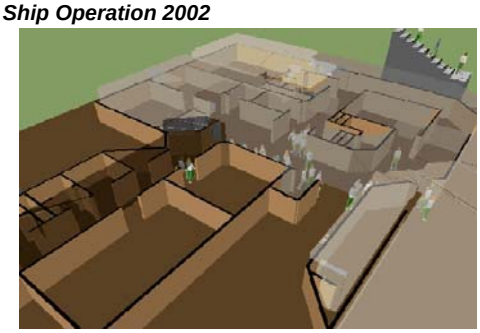
Examples of FSEG research and consultancy projects include:

- Analysis of naval/passenger ship design for evacuation
- Fire/smoke analysis for underground stations
- Evacuation analysis of high-rise buildings
- Fire/evacuation design and certification analyses for aircraft
- Circulation/evacuation analysis for airports and subways
- Analysis of evacuation provision for hospitals
- Prediction of toxic gas generation resulting from cable fires
- Full-scale and experimental scale evacuation trials in aircraft, buildings, ship and rail environments.

AWARD-WINNING SOFTWARE

Research undertaken by FSEG has lead to the development of the CFE software: SMARTFIRE, buildingEXODUS, airEXODUS and maritimeEXODUS. These products are distributed world-wide by FSEG to customers in 30 countries. FSEG's innovation has been recognised through a number of prestigious awards:

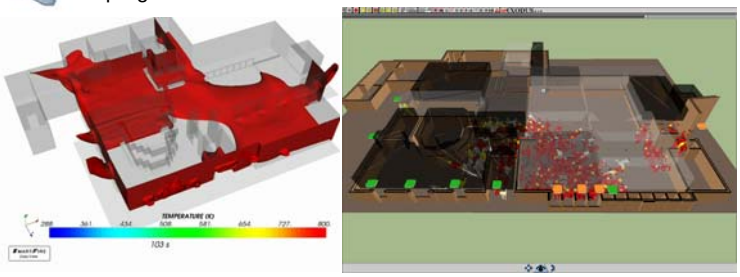
- ***SFPE Bono Award 2008***
- ***Royal Aeronautical Society's Gold Award and George Taylor Prize 2006,***
- ***IST prize 2004 awarded by the EU and the European Council of Applied Sciences, Technology and Engineering***
- ***Queen's Anniversary Prize 2002***
- ***British Computer Society IT Award, 2001***
- ***Royal Institution of Naval Architecture/Lloyds Register Safer Ship Award 2001***
- ***Communications & IT in Shipping Award for Innovation in IT for Ship Operation 2002***



buildingEXODUS: Occupant interaction with fire, smoke and toxic gases

KNOWLEDGE TRANSFER

Members of FSEG are actively involved in the supervision of doctoral and masters level research students concerned with fire safety and the development and delivery of fire safety engineering courses, including, short courses for industry, MSc by Research and Taught MSc programmes.



Linked SMARTFIRE and buildingEXODUS simulation of Rhode Island disco fire incorporating smoke, heat, toxic and irritant gases.

HELPING SET INTERNATIONAL STANDARDS

FSEG expertise is sought by standards bodies such as the BSI, ISO, IMO and SFPE and is used to set standards in life safety, fire safety engineering and the use and validation of CFE tools.

Evacuation Trials: FSEG conduct evacuation trials in a range of environments including hospitals, ships, rail carriages and smoke filled aircraft cabins in order to collect human performance data

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