The Origins of Fire Safety Engineering in the UK

by

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The Origins of Fire Safety Engineering in the UK

What is Fire Safety Engineering?
How did it evolve?
Who is to blame?

Start by comparing Fire Safety Engineering with other Engineering Disciplines
Applying new insights into Physics and Chemistry led to rapid development of Civil Engineering as a discipline

Application of the science

Practical Civil Eng⁹ based on empiricism

Pure research into Chemistry & Physics + Engineering Science

leads to innovation in Civil Engineering practice and Design

This phase existed for many centuries/millennia

This phase has existed for c. 200 years – and continues
The Pyramids of Egypt (c. 2500BC)
The Pantheon, Rome (118 – 126 AD)
But these were the successes!

*We don’t know much about the failures*

Progress relied on lessons learned from failures
But these were the successes! We don't know much about the failures. Progress relied on lessons learned from failures.

Tacoma Narrows Bridge (Galloping Gertie) on November 7th 1940. It was unstable in high winds and collapsed catastrophically as a result of violent oscillation.
Is Fire Safety Engineering any different?

*It shouldn’t be, but consider this:*

Practical FSE
based on
empiricism

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Is Fire Safety Engineering any different?

*It shouldn’t be, but consider this:*

Application of the science

- **Pure research into Chemistry & Physics + Engineering Science**
  - Leads to innovation in FSE Practice and Design

**Practical FSE based on empiricism**

This phase existed for many centuries/millennia

This phase has existed for only 30 years

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The Great Fire of London (1666)

Fire Safety by “Reactive Regulation”

Led to the first proper Building Regulations, which prescribed wide streets acting as firebreaks, non-combustible cladding etc.
The Great Theatre Royal Fire, Exeter 5th September 1887

A naked gas flame ignited some curtains – there were 186 fatalities, many from the upper gallery

Parliament legislated to bring in stringent safety precautions in all British theatres, including the fire proof safety curtain
The Empire Palace Theatre Fire, Edinburgh, 9th May 1911

The illusionist 'The Great Lafayette' accidentally set light to the stage with a lighted torch. The theatre burnt down.

Lafayette was one of ten performers and stage hands who died in the incident. No member of the audience was seriously affected, thanks to the safety curtain.

The audience cleared the theatre in 2½ minutes – this was then adopted as the standard “evacuation time”, particularly for places of public assembly.
Piper Alpha explosion and fire (1988)

This disaster led to the loss of 167 lives. The Public Inquiry (led by Lord Cullen) led to the biggest shake up of the regulation of Health and Safety in the offshore industry.

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Some buildings could not be made to comply with existing regulations

Structural Engineering was sufficiently advanced to allow the designer to prove that these structures were “safe” – at normal temperatures

Not so for Fire Safety Engineering – many of the fire regulations had to be “relaxed” to allow the WTC Towers to be built
Why were these things allowed to happen?

The underpinning “science” was absent until relatively recently

The underpinning “science” (Fire Dynamics) is only now becoming properly established
Qualitative understanding has been around for a long time …..

Firefighters developed their own qualitative understanding through observation

James Braidwood (1st Firemaster of Edinburgh) published a book in 1830 in which he describes compartment fire development from the point of view of the firefighter
The beginnings of the science

Establishment of government-funded Fire Research Labs in several countries after the second world war

UK – Fire Research Station (Borehamwood)
Japan – Fire Research Institute (Tokyo)
USA – Center for Fire Research at NBS (now NIST)
Finland – at VTT (Espoo)
The beginnings of the science

At the same time, key individuals took to the stage:

Philip Thomas, Margaret Law, David Rasbash (FRS)
Yokoi and Kawagoe (FRI/BRI, Japan)
Jim Quintiere, Howard Baum, etc. at NBS/NIST
Howard Emmons at Harvard University, USA
Ove Pettersson at Lund University, Sweden
Brady Williamson at UC Berkley

and many others
The beginnings of the science

Howard Emmons (Harvard University).

Ove Pettersson (Lund University).
The beginnings of the science

Philip Thomas (Fire Research Station)

Bud Nelson (NI ST)

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The beginnings of the science

Kunio Kawagoe (Science University of Tokyo/ Fire Research Institute).

\[ R = 5.5A_w \sqrt{H} \]

David Rasbash (Fire Research Station and Edinburgh University).

Responsible for the development of FSE Curriculum.
The beginnings of the science

Margaret Law (Fire Research Station and Ove Arup and Partners).

Ed Zukoski (California Institute of Technology).
The beginnings of the science

John Bryan (University of Maryland).

Brady Williamson (University of California, Berkley).
The beginnings of the science

John Rockett (NBS/ NIST)

Ray Friedman (Factory Mutual Research Corporation)
The beginnings of the science

Where was this work published?

Mainly in Government Research Reports

- Fire Research Notes
- NBS/NIST Reports
- FMRC Reports

Occasionally in the open literature

- Combustion and Flame
- Combustion Science and Technology
- Symposia of the Combustion Institute

Note – the first Fire Symposium was held in Edinburgh in 1975
The beginnings of the science

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The beginnings of the science

Investigations into the flow of hot gases in roof venting

Design of roof-venting systems for single-storey buildings

London: Her Majesty's Stationery Office
1963 1964

1963 1964

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The beginnings of the science
The beginnings of the science
The beginnings of the science
The beginnings of the science

A Characterization and Analysis of NBS Corridor Fire Experiments in Order to Evaluate the Behavior and Performance of Floor Covering Materials

NBSIR 75-691

J. G. Quastner

Center for Fire Research
Institute for Applied Technology
National Bureau of Standards
Washington, D.C., 20334

June 1975
Final Report

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

1975

Fire Propagation in Concurrent Flows

NBS-GCR-86-505

A. C. Fernandez-Pello

February 1986

Sponsored by
U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Center for Fire Research
Gaithersburg, MD 20899

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The beginnings of the science

1970 – Frank Rushbrook, Firemaster of Edinburgh, persuaded Edinburgh University to create a Department of Fire Engineering
Background:

**WHY?** Rushbrook appreciated that changes were coming and that there would be the need for graduates in the fire service to work alongside Architects and Civil, Structural and Mechanical Engineers

**ALSO –** recognised that there was a body of research which had to be disseminated and put into practise
The beginnings of the Engineering

Development of industry, commerce and society demanded larger, more complex buildings that could not comply with the existing Building Regulations

“Relaxations” were sought, and permitted on the basis of “experience-based judgement” by Building Control Officers and Fire Prevention Officers

No quantitative methods were available
In 1973 – Margaret Law (Fire Research Station) joined Ove Arup and Partners to establish a Fire Safety Engineering Group within the company.

(Research into ignition, compartment fire dynamics, thermal response of structural elements, external flaming, etc.)
Application of the science to engineering practice:

Pompidou Centre, Paris
Application of the science to engineering practice:

Lloyd’s Building, London
Application of the science to engineering practice:

HSBC Headquarters Building in Hong Kong.
Application of the science to engineering practice:

Hong Kong International Airport

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Application of the science to engineering practice:

Margaret Law and others with a background in fire research (Paula Beever, Bill Malhotra, Peter Jackman, Howard Morgan, et al.) formed the first cohort of Fire Safety Engineers

Where were their successors to come from?
In 1973 – a “Department of Fire Engineering” was established at Edinburgh University

David Rasbash appointed as the first Professor

(Previously Division Head at the Fire Research Station, Borehamwood)
In 1973 – a “Department of Fire Engineering” was established at Edinburgh University

Staff:

David Rasbash (Chemical Engineer, originally)
Eric Marchant (Architect and Civil Engineer)
Dougal Drysdale (Physical Chemist, allegedly)
David Colburn (Technical support)
Jean Mills (Secretary)
Ron Hirst (Process Engineer) (from 1978)
The way forward:

October 1974 – First Postgraduate Degree Programme (MSc) in Fire Engineering started

BIG PROBLEMS!

In 1974 the subject did not exist as an academic discipline

and

There were no textbooks!
David Rasbash outlined the courses that we had to teach and told us to get on with it!

**BIG PANIC!**

The key courses had to be created using information contained mainly in Research Reports.
The following fire “courses” were taught:

- Fire chemistry (DDD)
- Fire behaviour of combustible materials (DDD)
- Explosions and special hazards (DDD)
- Fire statistics (DJR)
- Fire legislation and regulation (DJR + EWM)
- Fire risk assessment (DJR + EWM)
- Firefighting and firemanship (DJR)
- Fire safety and building design (EWM)
- Fire protection systems (DRJ)
- Laboratory work (8 experiments) (DDD)
- Heat and mass transfer
- Fluid dynamics
- Structures (an introductory course)

and more … (breathing apparatus, search and rescue (part of Merchant Navy Fire Course), field visits, visits to fire scenes, etc.)
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  + Heat and mass transfer
  + Fluid dynamics
  + Structures (an introductory course)
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Service teaching by

Barbara Lane

Peter Woodburn

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A summary of the achievements

The MSc Course started in 1974 and ran until 1983 (when we ran out of staff and money)

During that period there were:-

53 MSc Graduates and 15 Diploma Graduates, of 17 nationalities

In addition -

Approximately 18 papers published (most based on MSc projects)

Three PhD projects successfully completed
Meanwhile in Worcester, Mass ....

In the 1970s, Bob Fitzgerald and Rex Wilson (FirePro Inc) were instrumental in persuading Worcester Polytechnic Institute to establish a Masters Programme in Fire Protection Engineering.

Dave Lucht appointed as (initially, part-time) Director of CFS in 1978 and set about fund-raising.

Immediately identified the lack of textbooks as a fundamental problem – particularly one on the “science of fire”, i.e. FIRE DYNAMICS.

Lucht raised $100,000 from CIGNA (CG/Aetna) to kick-start the process of creating a series of texts.
Meanwhile in Worcester, Mass ....

Bob Fitzgerald approached several people (including Philip Thomas and David Rasbash) to help out – teach a course on Fire Dynamics and write a textbook

They both said “no”!

I paid a preliminary visit to WPI in August 1981 - then

Taught “Fire Dynamics” at WPI during the spring semester 1982 (late January – May)
The Fire Dynamics course was built on three of the “Edinburgh” modules -

- Fire chemistry
- Fire behaviour of combustible materials
- Explosions and special hazards
- Heat and mass transfer
- Fluid dynamics

One (3 hour) lecture a week (Thursday evening)

Each set of lecture notes formed the first draft of a chapter (thanks to Carolyn Pike)
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Each lecture was followed by tutorial discussion in the Goats Head Pub
Tutorial in Progress
Final m/s passed to the publisher (John Wiley and Son) in May 1984

“Introduction to Fire Dynamics” published in June 1985

In 1985, began discussions with Wiley about the follow-up - a series of Textbooks for students of Fire Safety/Protection Engineering
There are now six “Wiley” textbooks!
In addition:

The SFPE Handbook of Fire Protection Engineering

“Enclosure Fire Dynamics” (Karlsson & Quintiere)

“Combustion Fundamentals of Fire” (ed. Cox)

Journals: Fire Safety Journal
           Fire and Materials
           Fire Technology
           Journal of Fire Protection Engineering

The International Association of Fire Safety Science

Regular conferences (IAFSS, Interflam, Fire and Materials, etc.)
Fire Safety Engineering is now well established at:

University of Edinburgh

David Rasbash
Jose Torero
Asif Usmani
Steve Welch
Martin Gillie
DDD
Guillermo Rein
Luke Bisby
Ricky Carvel

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Fire Safety Engineering is now well established at:

University of Ulster (UK)

Jim Shields  Karen Boyce  Ali Nadjai  Faris Ali  Mike Delichatsios

and Gordon Silcock

BRE Centre for Fire Safety Engineering
Fire Safety Engineering is now well established at:

**WPI (USA)**

Fire Safety Engineering is now well established at:

University of Maryland (USA)

John Bryan  Jim Quintiere  Jim Milke  Fred Mowrer  Vince Brannigan  Arnaud Trouvé  André Marshall
Fire Safety Engineering is now well established at:

University of Canterbury (New Zealand)

Andy Buchanan  Charley Fleischman  Mike Spearpoint
Fire Safety Engineering is now well established at other Universities in the UK:

University of Central Lancashire
Glasgow Caledonian University
University of Leeds (?)
(South Bank University – until 1998)

- it all started with Frank Rushbrook and Margaret Law
Fire Safety Engineering is now well established worldwide!

Frank Rushbrook

David Rasbash
Fire Safety Engineering is now well established worldwide!

Frank Rushbrook
David Rasbash
It’s an uphill task
But it’s worth the effort
Thank you for your attention

Any questions?