MEMORANDUM OF UNDERSTANDING

BETWEEN

THE UNIVERSITY OF EDINBURGH

AND

TONGJI UNIVERSITY

The objective of this memorandum is to establish substantive new collaboration between the University of Edinburgh in the United Kingdom and Tongji University in the People's Republic of China. The following arrangements will operate to evolve a partnership in the spirit of friendship and on the basis of equality and mutual benefit.

1. The main mechanisms of collaboration will include:

(i) The establishment of "Tongji-Edinburgh Research Centre" in the area of fire safety engineering (see Appendix A for details);

(ii) Joint postgraduate student supervision and professional development programmes initially in, but not limited to, engineering areas;

(iii) Shared academic research activities, exchange of students and staff for short-term visits and shared organization of workshops and symposia;

(iv) Joint coordinated proposals to UK/EU and Chinese research funding agencies;

(v) Joint dissemination activities including research publications and best practice guides.

2. Any cooperative programme in the above areas would be set up in accordance with the formal agreement and after the completion of recognition procedures in the two institutions.

3. The Memorandum shall remain in force for a period of five years commencing from the date of signing and may be reviewed by mutual consent by serving six months written notice to the other party. Upon renewal, the terms will have been agreed. New terms may be agreed as part of a renewed understanding.

4. Both the UNIVERSITY OF EDINBURGH and TONGJI UNIVERSITY reserve the right to terminate this memorandum by either party giving six months written notice to the other. Where such termination occurs, the provisions of this memorandum shall continue to apply to ongoing activities until their completion.

5. Participating staff and students involved in any activities under this memorandum must adhere to the law of the host countries and rules and regulations of the host institutions.

6. Nothing in this memorandum shall be construed as creating any legal relationship between the parties. This memorandum is a statement of intent to foster genuine and mutually beneficial collaboration.

The University of Edinburgh and Tongji University welcome the establishment of this memorandum for cooperation and jointly agree to the provisions as set out above. There will be two copies of this memorandum equally valid, one for each party, effective from the date of its signing.

THE UNIVERSITY OF EDINBURGH

Professor Geoffrey Boulton
Vice Principal
The University of Edinburgh

Date:

TONGJI UNIVERSITY

Professor YANG Dongyuan
Vice President
Tongji University

Date:

Appendix A

Proposal for a Tongji-Edinburgh Centre for Fire Safety Engineering Research
Asif Usmani and Li Guo-Qiang

Mission

To foster true collaborative international research in fire safety engineering focused on enabling safer and sustainable built environments through improved understanding of the fundamental arts and sciences and the derived engineering systems and through influencing fire safety engineering practice internationally

Background

Asif Usmani from the University of Edinburgh visited Tongji University in mid-December 2007 to explore collaborative links with Tongji University and met a number of local Faculty and International Office staff. There was a great deal of enthusiasm on both sides to initiate steps that would lead to broad-based collaboration between the two universities. AU has forwarded a report on the details of the meetings and discussions to the decision makers at both Universities.

As part of these discussions AU agreed to write a proposal for establishing a "Tongji-Edinburgh Research Centre" in the area of fire safety engineering to exploit the strength at both institutions in this area.

Tongji is the top ranked Civil Engineering University in China with excellent research pedigree and world class facilities, which continue to improve. Civil Engineering at UoE will benefit a great deal from this link. UoE hosts a world class fire research Centre (BRE Centre for Fire Safety Engineering) which integrates structural and fire safety engineering research in the School of Engineering and Electronics with many cross-disciplinary research projects currently underway. A link-up in this area is highly desirable and should create an international group which could continue to lead research in this area for a long time to come.

Strengths of Tongji University

Tongji University has the State Key Lab for "Hazard Mitigation in Civil engineering". Tongji was also one of the 35 universities in China included in the 985 Program and receives 200 Million Yuan per annum to support research, as part of this. Professor Li Guoqiang who leads the fire safety engineering research at Tongji is also the leading developer of structural fire resistance regulations in China and is in a position to directly influence the practice in China.

Some of the existing and planned facilities related to civil engineering hazard mitigation research at Tongji are:

1. A furnace for testing restrained and unrestrained structural components (acquired two years ago) which can simulate any given time-temperature fire history including standard fires (ISO834 etc). They have recently obtained a grant with Tsinghua University on testing to understand fire behaviour of restrained structural systems (most tests on structures in fire are done on unrestrained systems which do not adequately represent realistic structural boundary conditions, so this work should significantly advance understanding).

2. A three-axis six-DOF shake table used extensively for testing large models of most of the tall buildings that have been constructed in China and ones under construction or in the design stage.
3. They are planning to construct a very large multi-storey structural fire testing facility on a plot of 50mx30m on which a 10m high building will be constructed. This facility will allow the testing of tall building models heated over more than one storey (a very strong interest at UoE) using a system of mobile furnaces for heating columns and beams.
4. A one-of-a-kind 4-shake table system (no other such system exists) where very large structural models can be tested, such as bridges and large space structures. The distance between the tables can be varied and realistic excitation scenarios for these structures can be simulated.

Strengths of the University of Edinburgh

Fundamental research in fire safety engineering has been carried out in Edinburgh for over 40 years and has seen phenomenal growth over the last decade. Currently the Edinburgh fire research group or "BRE Centre for Fire Safety Engineering" (www.see.ed.ac.uk/fire) has over 40 members including 8 members of academic staff. There is a fire lab with a range of state-of-the-art equipment for understanding material behaviour under high temperatures and quantifying heat release rates etc.

One of the key strengths of the group is its expertise and experience in computational modelling of fires and its consequences (material and structural system responses). The structural response modelling capabilities exceed those of any other institution which have led to this group being the first to model the failure of tall buildings in fire including the collapse of WTC buildings. The School of Engineering and Electronics and the University of Edinburgh, in which the BRE centre is located, provide extensive computational facilities that are richly exploited by the group in it activities. One of the ways that this is being done is through the FireGrid project (www.firegrid,org), which is about creating a system that perpetually exists in a distributed computing environment ready to respond to fire emergencies in real-time. FireGrid is an archetypal emergency response system and will in due course be developed for generalised emergency response applications, however it will have another major spin-off that will provide and ideal platform for exactly the kind of collaboration envisaged here, through enabling technologies for exploitation of "distributed" resources, which is of course the key aim of Grid computing research.

Collaboration to be enabled via technologies developed in the FireGrid project

Whilst the computer has been part of the test laboratory for many years, until very recently it has only been used in a passive mode, to setup up a test programme in the servo controller, and then to monitor the results while the test is running. It is only with recent improvements in the servo controller hardware and networking and computation processing speeds that the computer can take an active role in experiments, responding in real time to the behaviour of an experiment, and enabling some interaction between the computation and experiment. Rather than the test equipment and the computer being two separate entities, they can now be coupled into a coupled experimental-computational test environment. This has already been achieved in structural dynamics research (see Reference 1 for example). The computational environment will exploit the rapidly developing e-research and e-science infrastructure in UK and China (see for instance www.grid-support.ac.uk and www.cngrid.org) to enable integrated computation and testing.

After the establishment of the collaborative environment between Edinburgh and Tongji and having initiated real projects, other appropriate international partners will be invited to join the group, such as universities in Hong Kong and Singapore and European and North American universities) to eventually create a NEESgrid (www.NEESgrid.org) type of environment (as it exists in the United States), albeit on an international scale.

Routine collaboration

It should be emphasized that not all research will require the computing environment mentioned above and collaborations will at first be initiated on a people to people contact basis as proposed in the general recommendations included at the end of the notes from the meetings between AU and Tongji faculty members. For completeness those recommendations are reproduced below:

1. Nominated UoE and Tongji University staff should prepare sister proposals for funding of faculty exchanges for EPSRC (with support from UKRC office in Beijing) and appropriate Chinese research funding agency. The main objective of the faculty exchanges will be to organise seminars and workshops in the priority areas mentioned above and to evolve a more detailed research collaboration plan for each priority area.
2. Tongji University faculty (with the help of International Office staff) should explore ways of initiating joint teaching programmes and other teaching collaboration (such as 2+2 UG, 1+1 Masters and 1+3 Masters/PhD programmes). Edinburgh University should consider allocating a number of PhD scholarships (to pay the fees supported by CSC paying the living expenses) to Tongji University students for 1+3 programmes. China sends upto 5000 fully funded students to PhD programmes abroad, the top universities such as Tongji send around 100 each. UoE will endeavour to attract some of the students from Tongji to its programmes, particularly in Engineering and Fire Safety Engineering. The collaborations set up following these discussions should enable this to happen over time

Centre administration and membership

Membership of the centre will be open to all staff and students of both Universities and as mentioned above, it will be expanded over time to include other partners internationally. The administration of the centre will be managed by two nominated coordinators, one at each University. Initially this role will be performed by Asif Usmani at Edinburgh University and Suwen Chen at Tongji University. A webpage of the centre will be created linked to the BRE Centre and Tongji University Civil Engineering pages to provide contact information and post information on collaborative research undertaken and events planned.

Support by the participating institutions

Tongji University will provide the following support to the centre:

- University will encourage students from Tongji University to join 1+3 Masters/PhD programme and jointly-supervised PhD programme supported by CSC Program.
- University will provide strong letters of support for collaborative research proposals developed by members of the Centre to the respective research funding organisations in UK, China and Europe.

The University of Edinburgh will provide the following support to the centre:

- Dedicated fee scholarships for Tongji University students wishing to undertake PhD

research at Edinburgh University (this will be subject to them successfully obtaining their stipends through the CSC Program). Initially two scholarships will be offered each year for the first three years of the partnership beginning from September 2009.

- University will provide strong letters of support for collaborative research proposals developed by members of the Centre to the respective research funding organisations in China, UK and Europe.

Ideas for collaborative projects

The following is a non-exhaustive list of potential projects that could be undertaken collaboratively. It could include other projects on the behaviour of structures in fire, projects on fire science and fire safety engineering and also on emergency response.

Project 1. Performance-Based Safety of Structures in Fire

Content of Research:

(1) ***Failure of restrained RC floor systems in fire***: Testing of model and full scale RC 1-way and 2-way restrained slab systems (in partnership with Tsinghua University?) and computational modelling

(2) ***Behaviour of RC and composite steel frames and connections over the full heating and cooling cycle***: Testing of single and multi-sotrey model and full scale frames and computational modelling

(3) ***Tall building collapse mechanisms in fire***: Testing of multi-strorey model scale frames (heating and cooling) and computational modelling

(4) ***Punching shear failure of RC flat slabs in fire***: Testing of model and full scale RC flat slab and column systems and computational modelling

(5) ***Post earthquake fire resistance of structural components and frames***: Subjecting structural components (beams and columns) and frames to fire exposure after they have been partially damaged under monotonic or cyclic loading

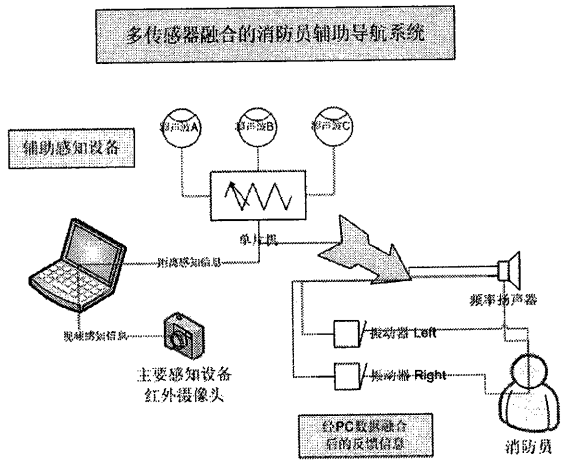
(6) ***Performance based design for structural fire resistance***: Application of risk and reliability concepts to develop a proper performance based design methodology for providing structures with fire resistance involving reasonably accurate quantifications of probable demand (fire loading) and probable capacity (fire resistance).

(7) ***Development of new methods for coupled testing and computation***: Full Exploitation of the aforementioned computing environment will require the development of control algorithms that could allow simultaneous and interactive computation and testing to be performed using the distributed resources. This is being done in earthquake engineering (see for example Reference 1, from which a verbatim quote is reproduced, "to test the structure, a method recently introduced in Japan called Multi-Site Pseudo-Dynamic Substructure (MSPSDS) was applied. In this method, the structure to be tested is divided into several substructures, and each of which is to be physically tested or numerically simulated at the same time at a different location in a coordinated manner. A simulation coordinator controls the overall experiment and communicates with the test sites and simulation computers. This experimental technique allows for testing a wide range of large structures that might otherwise be beyond the experimental capabilities of many laboratories")

Project 2: Built Environment, Industrial and transportation Fire Safety

Content of Research:

1. ***Safety of oil rigs and chemicals processing plants (oil refineries etc.) through application of FireGrid Technologies:*** Just as real time emergency response systems could be helpful in saving lives and property in buildings (as currently being developed in the FireGrid project), they could also be used prevent events such as the Buncefield depot fire.
2. ***Reducing fire related losses in ocean transport:*** Fire is one of the major causes of the loss of ocean-going container and other vessels.
3. ***Navigation Assisted System for Fire Fighter based on Multi-Sensor Fusion:*** In heavy-smoked place where fire occurs, this system could help the fire fighters find the cornered people quickly. It computes the best and quickest rescue route by means of the infrared image processing technology and computer vision algorithm, which is helpful for the fire fighters to undergo the rescuing task.



System Architecture

(1) Analysis of infrared image, which combines the images taken by the infrared camera and the information of the dynamic obstacles taken by the multi-sensors (e.g. sonic sensors).
(2) Localization by means of the network of wireless sensors, our system could distinguish from the fire-happening scenes and undergo the positioning task by means of the network of wireless sensors.
(3) Planning of the rescuing route, to find the best and quickest rescuing route using the localization information of the fire-happening place, which is known in advance. Our system is steady-going in complicated scenes where fire happens (damped ground, dynamic obstacles such as cornered people.)
(4) Construct a solid feedback mechanism by means of the integration of frequency-divided speakers, shaking sensors and embedded display device. It can help the fire fighters get to the cornered people in time.

References

1: NEESGrid: A Distributed Collaboratory for Advanced Earthquake Engineering Experiment and Simulation, Billie SPENCER Jr et. al,.13th World Conference on Earthquake Engineering Vancouver, B.C., Canada, August 1-6, 2004, Paper No. 1674.