

中英两国大学合作协定

Research Agreement between the University of Science and  
Technology of China and the University of Wales College of Cardiff

1. OBJECTIVE

The agreement is intended to boost the already high research standings of both Universities, simply called Cardiff and Hefei below, in their own national ranking systems and internationally. In effect, the agreement is between the Institute of Applied Mechanics at Hefei and the Cardiff School of Engineering.

The objective is to build upon the partially completed and very successful twelve month visit to Cardiff by Associate Professor Z.Q. Cheng, in order to establish strong and profitable research links between the two Universities. The principal aim is to give a guarantee of stability to collaborative research so as to enable long term objectives to be tackled with confidence. All areas in which Hefei and Cardiff have common or complementary interests are included in this agreement but primary focus areas will include micromechanics of composite materials and on ways this can affect the behaviour of assemblies of laminated plates, e.g. aircraft wings. These areas are ones in which both Universities have well established interests and the visit mentioned above was centred on aspects of them. Visitors from Hefei can make use of the extensive hardware (value with support £250,000) and expertise related to Cardiff being one of the five University Centres chosen in Britain to be lead sites on Parallel Computing.

Section 2 sets the scene by summarising previous collaborative and/or complementary work. Section 3 outlines major areas of co-operative research which it is planned to undertake and to complete within the three years of the agreement. Section 4 indicates other areas in which collaboration is anticipated. Finally, section 5 specifies the degree of commitment guaranteed by each party to this agreement, in terms of both financial and manpower input.

2. BACKGROUND

The existing collaboration has resulted from Associate Professor Z.Q. Cheng's current twelve month visit to Cardiff (21/8/94-20/8/95). This visit was funded by the Cardiff Advanced Chinese Engineering Centre and resulted, within six months, in the submission with Professor F.W. Williams, of a paper to the Journal of Applied Mechanics entitled "*Theory for multilayered anisotropic plates with weakened interfaces*".

Hefei has major research teams in the areas of micromechanics of composite materials, non-destructive testing and numerical methods which interface naturally with the research interests of several academics in Cardiff, including Professor F.W. Williams.



Professor Williams has worked on the buckling and vibration of prismatic laminated composite plate structures by exact methods since the 1960's, with continuous funding by NASA from 1981 and with British Aerospace support.

This work is currently being moved from the initial to post-buckling regions. The possibility of the large deflections associated with post-buckling triggering adverse localised material phenomena needs to be studied. Professor Williams also holds, with Dr D. Kennedy who will be involved in the collaboration, an SERC grant for £76,166 which is currently in its third year and which is exploring various ways of parallelising the exact methods of eigenvalue structural analysis pioneered by Professor Williams and, latterly, by Dr D. Kennedy.

### 3. COOPERATIVE COMPOSITES WORK INVOLVING MICRO AND MACRO BEHAVIOUR

Perhaps the most exciting aspect of this agreement, but the hardest to predict the outcome of because of its innovative nature, is the aim of bringing together the understanding of the behaviour of the structure and that of the composite material from which it is fabricated. The work at the macro level at Cardiff is entirely based on the assumption that the material properties remain constant both as the deflections increase and over the entire volume of the material within a stiffened plate structure. Hefei has a very prestigious expertise in the solid mechanics areas relating to the mechanics of composite materials, micro-mechanics and fracture mechanics. The challenge is to bring together this work, which involves Professors B.C. Yang and J.H. Zhao and Associate Professor Z.Q. Cheng, with the buckling, strength and post-buckling work at Cardiff, to enable localised damage and/or the use of composite materials, other than conventional laminated ones, to be taken into account properly within the complete stiffened panel analysis. This in turn is expected to stimulate enhanced micromechanics and other work at Hefei, and also in collaboration while Hefei academics are in Cardiff.

### 4. OTHER AREAS OF COLLABORATION

This research agreement between Hefei and Cardiff will be supported by the Cardiff Advanced Chinese Engineering (ACE) Centre, which seeks to ensure that such agreements are set up in the optimum way and are then run to the best possible advantage of both collaborating Universities. The Centre already acts in this way for agreements with the Research Institute of Engineering Mechanics at Dalian University of Technology and with Shanghai Jiao Tong University. Experience gained from these agreements, and from the less formal links with Dalian that preceded them, show the undoubted value of allowing research to develop spontaneously and rapidly and to allow collaboration to extend into other fields as soon as opportunities are spotted. Therefore, this agreement between Hefei and Cardiff will deliberately permit workers at Cardiff and at Hefei not anticipated at this time, to join in during the three years, and will permit their areas of work, even if completely different from those given above, to be included under the agreement. It is hoped to link with several staff in the Divisions of Civil and Structural Engineering at Cardiff.



However, work on parallel computing is one possibility which would definitely be allowed to develop freely. It could include work on the exact eigenvalue methods developed in Cardiff and which spring from the SERC grant currently being worked on at Cardiff (see above), and perhaps more importantly, work on the micromechanic behaviour of composite materials or even geotechnics, where Cardiff have a major expertise.

## 5. MANPOWER AND FINANCIAL COMMITMENTS

The arrangements which follow are intended to enable at least one major, long-term project to proceed at any one time, which achieves high standards of excellence with maximum efficiency, while also having a small margin of resources to ensure that promising subsidiary opportunities which arise unexpectedly from the collaboration, can be exploited to the benefit of both Universities. The arrangements are intended to boost the research standings of both Universities in their own national ranking systems and internationally, while also appearing to be very cost effective in both Chinese and UK. terms.

An appropriate mix of key senior staff from both Universities with a small number of high quality academics and research workers from both Universities, is considered essential. Cardiff will commit time of existing staff. Professor Williams will remain heavily involved throughout and Dr. D. Kennedy will be involved in any parallel computing and possibly also other areas of work. Other Cardiff experts will be entrained as appropriate. It is anticipated that the majority of the approximately twenty academic staff in the Divisions of Civil and Structural Engineering at Cardiff will become entrained.

The agreement is for three years, renewable if both parties so decide in the future. The aim is to have in Cardiff twenty four man months of Hefei full professors' time, thirty-six months of Associate Professors' time and one research student from Hefei, throughout a three year period. It is accepted that the three years for which the research student is in Cardiff will only begin part way through the three year agreement. The Hefei professors resident in Cardiff will be allowed to participate in the supervision of the Hefei research student to the extent judged appropriate at the time. Cardiff research students can spend nine man months in Hefei.

To ensure that these manpower objectives are achieved, Cardiff and Hefei undertake to "underwrite" certain commitments. This means that each will definitely pay for the commitments themselves if necessary, but is free to seek help with some or all of the costs from any Research Council, Charity, Government Agency or other source they wish to approach, with the other university supplying information to help whenever necessary and possible. If such financial help were to prove to be quite generous, both parties to this agreement would give serious consideration to re-deploying the released "underwriting" sums of money to underwrite additional collaboration in the areas of this agreement and related areas.



The total commitments underwritten over three years from the date of signature of this agreement by both parties are:

#### CARDIFF

- C1 Subsistence for 24 months of visits by selected Hefei full professors at Royal Society rates, currently interpreted as £750 per month, increasing with inflation, plus 36 months of visits by selected Hefei Associate Professors at 85% of the Full Professor rate given above. Note that this commitment depends upon roughly half of the work being with the top experts in Cardiff and half with other Cardiff Academics. If all the work is with top experts in Cardiff, the commitment would reduce to 18 months for Full Professors plus 31 months for Associate Professors (the above man months exclude the current visit of Dr Cheng, whom Cardiff hope would be able to come again under this agreement).
- C2 Air fares for two visits to Hefei by senior Cardiff academics, of about one or two weeks duration, and for one visit by a Cardiff research student each year. Also one return journey from London to Cardiff per academic visitor from China.
- C3 Waiving of Bench fees for all Hefei academics visiting Cardiff under this agreement. The PhD student will have to pay all the usual overseas student fees.
- C4 Because of the unique situation of Hefei among Chinese Universities in that staff are not paid by their own University while abroad as visiting academics, a goodwill allowance of £50 per month will also be paid to all visiting academics.

#### HEFEI

- S1 Payment of international return air fares for all Hefei academics and of the Chinese research student between China and the UK.
- S2 Meeting of all needs of visiting Cardiff academics from port of arrival, as is done under the British Council ALCS scheme, including return Beijing-Hefei air travel and any necessary overnight stop in Beijing.
- S3 Ensuring that one of the research students that Hefei sends abroad for overseas PhD's is chosen by agreement with Cardiff, is someone who wishes to come to Cardiff to work on a project designed to strengthen one of the projects covered by this Agreement; and will be replaced by an alternate if he or she subsequently decides not to come to Cardiff.
- S4 Nine months of travel and subsistence for Cardiff research students while they are in China, excluding international travel but including internal travel for three students. Cardiff would pay a tuition fee of approximately £200 per month.



RESEARCH AGREEMENT BETWEEN THE UNIVERSITY OF SCIENCE  
AND TECHNOLOGY OF CHINA AND  
THE UNIVERSITY OF WALES COLLEGE OF CARDIFF

Signatories on behalf of University of Wales College of Cardiff

Head of Structures (and Chairman of ACE Centre)

*F.W. Williams*

11/5/95

Professor F.W. Williams

Head of School of Engineering

*D.V. Morgan*

11/5/95

Professor D.V. Morgan

Principal of UWCC

*E.B. Smith*

12/5/95

Dr. E.B. Smith

Signatories on behalf of the University of Science and Technology of China

Head of Institute of Applied Mechanics

*X.P. Wu*

2/6/95

Professor X.P. Wu

Head of Science College

*K.Q. Feng*

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*H.G. Tang*

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Professor H.G. Tang