

# CAMBRIDGE VEHICLE DYNAMICS CONSORTIUM

Invitation to Industry

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## EXECUTIVE SUMMARY

*The Cambridge Vehicle Dynamics consortium is a collaboration between Cambridge University and the heavy vehicle industry. It performs fundamental and applied research into heavy vehicle dynamics and suspension design, including the problems of vehicle safety, ride and road damage. Members of the Consortium influence the aims and directions of research in vehicle dynamics, and obtain the benefits, including exploitation of intellectual property, for relatively low cost. The make-up of the consortium ensures that the members have complementary interests and that commercial confidentiality is maintained. Membership is based on an annual subscription. The Consortium is run by a Steering Committee consisting of members of the University research teams and representatives of each of the industrial sponsors. This document is an invitation to the heavy vehicle industry to participate in the consortium.*

## 1 BACKGROUND

Cambridge University Engineering Department has an established research group investigating the dynamics of heavy commercial vehicles, their suspension components, and their effects on roads and bridges. An increasing amount of work is being concentrated on the design of advanced suspension systems to minimise road damage and to maximise the safety of heavy goods vehicles. The research team currently consist of three members of the academic staff Professor D Cebon, Dr DJ Cole, and Dr MP Sutcliffe; five graduate students and two post doctoral research fellows. An important strength of the group is its multi-disciplinary nature: its ability to address simultaneously, the mechanical, tribological, electrical, control and civil (roads and bridges) aspects of the vehicle/infrastructure system. The group has received substantial research council funding for projects on heavy vehicle suspension design, 'road-friendliness' of suspensions, active roll-control, active steering, rolling resistance of truck tyres, weigh-in-motion technology and the mechanisms of pavement failure. The group has also received funding from various US sources and from the European Commission. All of the research projects are linked closely to industry and several have been performed in collaboration with the Transport Research Laboratory (TRL) and the Motor Industry Research Association (MIRA).

The *Research Consortium* described in this document is a collaborative venture between companies involved in the heavy vehicle industry and researchers in Cambridge University. The main activity of the Consortium is to undertake a core programme of research into heavy vehicle dynamics and suspension design. Further opportunities exist for companies to join the consortium. See [www.cvdc.org](http://www.cvdc.org) for more information about the Consortium.

## 2 OBJECTIVES

The main objectives of the Consortium are:

- (i) To expand current research on vehicle dynamics, with the aim of improving productivity, 'road-friendliness', ride performance, fuel consumption, maneuverability and safety of heavy vehicles.
- (ii) To bring together members of the heavy road vehicle industry in a cooperative group, in order to research and develop innovative solutions to current vehicle design problems.
- (iii) To develop/improve working relationships between the member companies, with a view to co-operative exploitation of the research results.
- (iv) To improve the transfer of research and technology between the universities and industry.

## 3 MEMBERSHIP

The Members of the Consortium are companies from each of the main industrial sectors concerned with heavy vehicle dynamics.

The current members (September 2008) are as follows:

• Arvin Meritor (UK)	Trailer axles and suspensions	Member
• Arvin Meritor (USA)	Steering systems	Member
• Firestone Industrial Products (UK)	Air Springs	Member
• Haldex Brake Products	Brakes	Member
• Goodyear Tires	Truck Tires	Member
• QinetiQ (UK)	Off-road vehicles	Member
• Volvo Global Trucks (Sweden)	Tractor units	Member
• Tinsley Bridge Ltd (UK)	Steel suspension components	Associate
• Camcon Technology (UK)	Fluid valves	Associate
• Denby Transport Ltd (UK)	Fleet Operator	Associate.
• FM Engineering Services	Trailer units	Associate
• Fluid Power Design (UK)	Hydraulic systems	Associate
• Mektronika Systems (UK)	Electronics	Associate
• MIRA Ltd (UK)	Research Association	Associate
• Shell UK Oil Products Ltd (UK)	Fleet operation	Associate

Further members are being sought in the following areas:

- Hydraulic shock absorbers
- Elastomer products
- Composite materials
- Vehicle instrumentation

The Consortium includes companies with *complementary* capabilities, and care is taken to protect proprietary interests. In this way it is possible to promote open discussions and to enable co-operative implementation of the research results by the industrial members of the consortium. All work is undertaken in strict commercial confidence.

Membership of the Consortium is initially for a three-year period. The annual subscription costs are discussed in section 8 below.

## 4 MANAGEMENT

### 4.1 Steering Committee

The Consortium has a Steering Committee consisting of members of the university staff and one representative of each of the industrial sponsors. The Research Director is Dr D Cebon, who is a Reader in Mechanical Engineering in Cambridge University. Mr Martin Peaker, Advanced Engineering and Test Manager, ArvinMeritor, is the Chairman of the Steering Committee.

There are two ex-officio members of Steering Committee:

- (i) The Head of the Mechanics Division of Cambridge University Engineering Department;
- (ii) The Director of the Cambridge University's Industrial Liaison Unit.

The Steering Committee meets at least half-yearly at the universities or at the offices of the industrial members. The Research Director publishes an Annual Report covering research achievements and a summary of finances.

The research is performed by the University research staff, postgraduate students, and by industrial secondees (see section 6.2 below). The Consortium employs additional Research Associates, who are experts in heavy vehicle dynamics.

### 4.2 Membership Agreement

A detailed Membership Agreement was drawn-up and signed by the initial members of the consortium in September 1993, and signed by further members subsequently. This agreement includes articles under the following main headings: (i) objectives, (ii) management and progress reviews, (iii) sponsorship arrangements, (iv) funding, (v) the core research programme, (vi) intellectual property (and exploitation by the industrial sponsors or third party licensees), (vii) confidentiality and publications, (viii) termination, (ix) arbitration, and (x) liability.

## 5 RESEARCH PROGRAMME

The core research topics are proposed by the university researchers and the industrial sponsors, and regulated by the Steering Committee. This mechanism ensures that the research is sufficiently fundamental, while still meeting some medium-term R&D needs of the member companies.

The research is generally concerned with the general areas of 'road-friendliness', handling, steering, ride, roll-over and braking of heavy vehicles, vehicle productivity, environmental impact and design of advanced suspensions. Current work is focussing on development of a computer-controlled articulated vehicle, with active steering and novel fast-acting ABS systems on all axles .

Typical outcomes of the work are:

- (i) User-friendly computer simulation programs ('toolkits') for analysis of heavy vehicle dynamics and suspension design,
- (ii) Vehicle and component testing equipment,
- (iii) Advanced suspension concept designs,
- (iv) Experimental suspensions,
- (v) Suspension controller hardware and software
- (vi) Instrumentation systems for monitoring vehicle behaviour,
- (vii) Improved understanding of the fundamentals of vehicle dynamics.

The more ambitious projects undertaken by the Consortium are funded by research grants from various UK Government and European sources. Such grants pay for major items of equipment

as well as additional research workers. For example, a research grant of £500,000 has recently been awarded by EPSRC for work on active steering systems from 1st Jan 2006 for three years.

A major advantage of this funding arrangement is that the Consortium members gain access to research funds that may not otherwise be available to them. It also scales-up the industrial contributions and adds significant value to the research.

The results of the research are published in reports, conferences and technical journals (subject to confidentiality constraints) and patent applications.

## 6 BENEFITS TO MEMBERS

### 6.1 Access to Research Results

- (i) Members of the Consortium receive licenses to exploit any intellectual property that results from the research, on favoured terms. These terms and arrangements for the ownership of intellectual property are broadly in line with European practice and are described in the Membership Agreement (see section 4.2).
- (ii) Computer simulation programs that result from the work of the researchers are available for internal use by the member companies.
- (iii) Testing equipment built by the researchers and located in the universities is available for use by members of the Consortium as per section 6.3 below. The designs of such equipment are available for internal use by the member companies, should they wish to manufacture duplicate facilities.
- (iv) The researchers often perform component and system tests for the consortium companies, free of charge.

### 6.2 Industrial Secondments

It is possible for *company-specific* R&D projects to be performed by employees of the member companies who are *seconded* to the universities for periods of up to one year. These engineers work on their company's problems under the guidance of the university staff. They may attend suitable lectures, have free access to appropriate university facilities, and gain experience in the modern analytical and experimental methods used in research. They return to the member companies with this experience and the ability to implement the results of their work. A small 'bench fee' is charged by the universities to cover costs associated with these secondments.

Other consulting services are available to the member companies, on favourable terms, by separate agreement.

### 6.3 Use of University Facilities

Members of the Consortium can gain access to research facilities and equipment in the University at reduced rates, subject to the availability of equipment.

### 6.4 Student Projects

All fourth year (MEng) students in Cambridge University perform major research projects during their courses. These usually involve a piece of research or innovative design and can often yield useful results in a relatively short period of time. MEng projects can be proposed by members of the consortium and will be supervised by the university research staff in collaboration with the companies. Several such projects typically run in the universities each year.

## 6.5 Additional Benefits

There are several less obvious benefits of the Consortium arrangement. Firstly it is possible for individual members to influence the aims and directions of research in vehicle dynamics, without committing large resources. Secondly, the Consortium provides a mechanism that enables company engineers to stay in touch with international developments in the field of vehicle dynamics. Thirdly, close contact with the universities provides member companies with access to top quality engineering students, for future employment.

## 7 BENEFITS TO RESEARCHERS

There are also significant benefits in the Consortium arrangement for the university researchers. In particular, secure funding helps to maintain the current level of activity and expertise in the research groups and provides some facilities that cannot be obtained from other sources of funds. Equally important, however, are the closer contacts with industry that result from the Consortium and the benefits of obtaining an industrial perspective on research projects. Further research opportunities are continually created through discussions with the industrial partners.

## 8 FINANCES

### 8.1 Budget

The Consortium finances the salaries of Research Associates and provides ‘top-ups’ to Research Students on EPSRC grants. The remaining funds are spent on equipment, consumables, laboratory and office space, travel and subsistence and university indirect costs. The annual expenditure (excluding contributions from research grants) was approximately £80k in 2007. This was supplemented by £170k per year from EPSRC, beginning in January 2006. Major items of equipment are funded by external research grants from the EPSRC or EU, as described in section 5 above.

### 8.2 Membership Fee

There are two levels of company subscriptions to the consortium. ‘Small’ companies, with less than 400 employees working in their automotive operations, pay an annual subscription of approximately £12k in 2008. ‘Large’ companies (more than 400 employees in their automotive operations) pay an annual subscription at a rate to be negotiated. This fee is normally no less than the small company rate. These subscription levels increase slightly each year according to university wage levels and the RPI. Member companies also make contributions ‘in kind’, for example the provision of suspension components for testing, and access to equipment and vehicles.

All member companies have equal rights in the research co-ordination and other activities of the Consortium, irrespective of their size and subscription level.

Associate members pay an annual subscription of £3k (or equivalent contributions 'in kind'). These companies may attend Steering Committee meetings but do not have voting rights and do not share in the automatic rights to exploitation of IPR.

## 9 CONCLUSION

The Cambridge Vehicle Dynamics Consortium provides a unique opportunity for member companies to influence, and be directly involved in state-of-the-art research into heavy vehicle dynamics and design, without committing large resources. They can work together on medium-term research and development projects in a co-operative environment.

### FURTHER INFORMATION

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