Objectives and Background for the Joints Modelling Workshop

Objective of the Workshop

To develop a master plan for the research which is necessary to complete the task of developing a truly predictive modelling capability for the joints and interfaces in critical structures for which knowledge and control of the structural dynamics is an imperative.

Starting Point for the October 2006 Workshop

The outcome of three previous workshop sessions (see 'Brief History', below) is summarised in the attached Contact Mechanics RoadMap (Appendix 1). This is the result of a preliminary effort to capture all the different physical phenomena which are relevant to the joints modelling task. The Map starts at the top RHS by indicating the high-level (Macro) models which are currently used for structural dynamics analysis. These models are derived directly by fitting highly simplified models to the data produced by physical tests. The next level down (meso) refers to the current generation of (contact) finite elements which are used to describe the behaviour of contact interface areas, but these also require input data (of friction and stiffness properties) that can only be obtained through extensive and expensive testing). Attempts to develop a predictive model have started at the micro level, but so far have fallen far short of the eventual goal and it is at this stage that a stock taking of the problem suggests a much more comprehensive and detailed understanding of the physical phenomena will be required to achieve the overall goal. Most of the LHS of the Road Map represents suggestions for topics that need to be both individually described in more detail and, importantly, interconnected to provide a holistic description of the underlying problem which is, as has been known for a long time, very complicated.

Plan for the Workshop

The Outline Structure is as follows (ideas and suggestions for specific actions will be welcome up to the days immediately preceding the meeting):

- Review of the engineering imperative for predictive models for joints and interfaces, and of the current state of the art in key industry sectors (see Appendices 1 and 2, below)
- Review of the Current List of topics deemed to be essential ingredients in a solution path for the engineering requirements
- Presentations of some major areas on the RoadMap[1]
- Task 1: To update the Map to ensure that all topics to be addressed/researched/modelled are included on the Map ('towns', 'villages' etc) and that they are properly classified and delineated from each other. Perhaps some items will prove appropriate for deletion.
- Task 2: To add a network of connections (the 'roads') between the various topics which show their interdependencies and links between different areas
- Task 3: To develop a plan of action(s) to prosecute the overall challenge, including appropriate Phases (with intermediate goals, objectives, deliverables) and recommendations for collaborations between researchers, between funding agencies and between end users.

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[1] **Prof Arif Masud**, Univ of Illinois***: "A Multiscale Framework for Bridging Material Length Scales and Consistent Modeling of Strong Discontinuities in Mechanical Joints"***
Prof Mark Robbins, John Hopkins University***: "Contact and Friction: Connecting Atomic Interactions to Macroscopic Behavior"***
Prof Andreas Polycarpou, Univ Illinois***: "Significance of Interfacial Micro-Scale Parameters on the Dynamics of Structures Containing Mechanical Joints"***
Prof David Hills, Oxford University, UK***: " topic - contact elasticity; title - tbc"***

Brief History of the Workshop

In past decade, there have been a number of workshop–type activities that have highlighted the difficulty and importance of the joints modelling problem as regards structural dynamics applications.

- The first was at SD2000 [1], a forum held in Los Alamos in **1999**,
- This was followed by a dedicated workshop on Joints Modelling organised at Sandia in **2000** [2].
- The problems of joint and interface modelling in gas turbines formed the basis of two workshops , one in **2001** and the second one in **2003** (summary reports to be found in [3,4]). Participants from the Sandia 2000 workshop joined the 2003 Gas Turbine meeting.
- The collected results form all these activities were used to compile the 1st draft of the Contact Mechanics RoadMap. Throughout **2005**, this document was discussed and supplemented in a series of informal discussions.

The current 2006 Workshop is tasked with producing a forward-looking Action Plan for how to 'solve' the major challenge that was the subject of the previous discussions and debates.

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