Introduction: Concurrent Engineering of Advanced Materials

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Biographical notes: Vistasp M. Karbhari is an Associate Scientist at the Center for Composite Materials and a Research Assistant Professor of Civil Engineering at the University of Delaware. In 1992, Dr Karbhari was invited to serve as a member of the Japanese Technology Evaluation Center (JTEC) Panel on Advanced Manufacturing Technology for Polymer Composite Structures. Dr Karbhari currently serves as a member of the CERF Working Committee on Composites in the Infrastucture. Dr Karbhari's areas of research interest include composites mechanics and manufacturing, RTM, recycling, applications of composites in civil engineering and construction, concurrent engineering, and processing science. He has more than 40 publications in journals including the *Journal of Thermoplastic Composite Materials*, *Processing of Advanced Materials*, *International Journal of Materials and Process Technology*, and *Composites Manufacturing*. Dr Karbhari is also North American Editor of the *International Journal of Materials and Product Technology*, and an editorial board member of *Processing of Advanced Materials*, and the *Journal of Thermoplastic Composite Materials*.

Advances in materials science, processing technology, and sensing and control systems have enabled man to create new materials designed to perform in ways unimaginable with traditional materials. These advances have in turn resulted in developments in areas of existing processes and materials leading to the production of higher quality steels, aluminum and commodity plastics. The materials envelope is constantly being expanded with advances in one area fueling developments in others. With the increasing use (or potential thereof) of these materials, there arises a need for higher quality control, tighter manufacturing tolerances and faster production rates. Increasingly, materials are being designed to be resistant to attack – chemical, environmental and otherwise – but simultaneously the increasing awareness of environmental concerns demands that the very same materials be recyclable. The apparent paradox however, has to be solved through changes in current paradigms and thinking about materials. With the growing acceptance of new materials in a competitive economy there is a need for the integration of processing models that explain how these materials and structures can best be made, with mechanics and durability models that explain their in-service performance – enabling an efficient overall design not merely from a viewpoint of use, but also one of maintenance, disposal and/or reuse.

Winner, Pennell, Bertrand, and Slusarczuk define concurrent engineering as 'a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. The approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule, and user requirements.' It would seem that this philosophy would be immediately adopted by the advanced materials and processes communities. Yet today it has virtually degenerated into a mere philosophy of management rather than an inherent practice of engineering. Notwithstanding this, concurrent engineering is the way of the future – the integration of

the facets of processing, materials science, mechanics, design and economics to create optimized and efficient systems. The theme of the papers in this special issue is the use of the methodology to achieve a synthesis of the different technical facets to create better materials and structures.

The papers in the issue address a number of issues relevant to concurrent engineering of materials and processes including:

- the use of new methodologies in product development (Stubbs and Diaz; Cohen *et al.*)
- development of expert and knowledge-based systems (Prucz; Merhar *et al.*; Messimer and Henshaw)
- application to materials design and development (Brookstein)
- intelligent development of composites through integration (Karbhari and Kukich; Bogetti *et al.*; Nejhad *et al.*, Jog *et al.*, Altan)
- recycling (Henshaw)
- testing and characterization (Tohgo *et al.*)

It is hoped that this collection of papers will provide a useful insight into new developments in a fast growing area of critical importance, that of intelligent processing and design through concurrent engineering.

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Guest Editor