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Modelling : Philosophies and Methodologies

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ABSTRACT

Nature is in many ways deeply mathematical. Such a belief is the corner stone of mathematical modelling. It has been the endeavour of scientists and technologists to reduce many physical phenomena to mathematical formulae and gain greater insights through manipulation of these. The most striking examples of successful applications of this approach are to be found in the theories of particle physics and evolution of the universe. Both these domains of scientific activity encompass scales which are far removed from human perception. In the last few years, the phenomenal growth of computer science and technology has resulted in a significant change in the way mathematicians discover, prove and communicate with each other and with the rest of the scientific community. New branches of mathematics such as nonlinear dynamics or chaos, fractals, computer profs etc have also evolved rapidly. These and other changes are beginning to affect the modelling of material behaviour and processes. Selected examples of this theme will be presented. Modelling in metallurgy has been of relatively recent origin and has essentially blossomed over the last two decades. It has now developed methodologies of its own and is beginning to pay dividends in the form of a more detailed and comprehensive understanding of the physical phenomena underlying metallurgical processes. The ever increasing demand for materials with properties tailored for specific applications, the emergence of nanodevices and machines etc, are placing a great emphasis on the predictive capability of modelling. In this presentation, we shall review the various techniques available to us and illustrate these with examples from thermodynamics, kinetics, solidification and reactor behaviour. ❑