Knowledge-based Expert Systems for Composites Manufacturing

The use of knowledge-based systems represents a positive step toward efficient, quality manufacturing.

By: Rangarajan Pitchumani, Visiting Researcher, Peter A. Schwenk, Graduate Student, and Vistasp M. Karbhari, Scientist, University of Delaware, Newark

Knowledge-based expert systems are intelligent computer programs that capture the specific knowledge of a particular domain and mimic the problem-solving process of human experts to accomplish the tasks that normally require competent specialists for their solutions.

Following their earlier successes in such areas as medical diagnosis and mass spectrum analysis, knowledge-based expert systems have rapidly found application in the area of manufacturing. Many rule-based intelligent systems have been developed for various production tasks ranging from design and diagnosis to monitoring and control. A notable example is the successful application of expert systems for plastics injection molding.

A typical sequence of events in a production process, starting with the design of a product for an application, is shown in Fig. 1. The product design stage results in a list of requirements on the product geometry and properties, based on which the next step is the selection of an appropriate material for the part.

![Fig. 1: Components of a knowledge-based expert system for manufacturing applications.](image)

In the context of composites manufacturing, the material selection stage involves decisions on the reinforcement and matrix materials, and the reinforcement morphologies. The material selection stage is followed by the selection and design of the processes for fabricating the part. The detailed processing guidelines which emerge from the process design stage may be used for carrying out the manufacturing process in real-time, as well as for an off-line computer simulation of the process, or virtual manufacturing.

Virtual manufacturing is often used in conjunction with a process control/monitoring module to derive on-the-fly control strategies for the real-time manufacturing process. Improvements to the decisions in the various stages may be driven by a feedback on the quality of the manufactured product.

The shaded blocks in Fig. 1 each involve, in general, numerous, highly interdependent decisions pertaining to the manufacture of a product. The approach in Fig. 1 as implemented on a computer will