Automated tooling design: an application of knowledge-based engineering

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Knowledge-Based Engineering (KBE) enables the knowledge and experience of engineering processes to be captured and deployed in a software environment which allows automatic analysis of inputs and the generation of integrated engineering solutions.

KBE applications are developed in a software environment that can generate CAD geometry according to rules encoded by the KBE development engineer.

The geometry a KBE system generates is different from geometry generated by conventional CAD methods as it can be automatically adapted to design changes. This has the effect of freeing the engineer from manual data generation tasks, allowing more time to focus on the product requirements and the engineering process.

KBE has gained acceptance as an invaluable technology within the aerospace and automotive industries and is particularly effective in automating repetitive engineering processes. However, a majority of the applications have focused on automating component design rather than the down-stream manufacturing issues such as tooling design.

The tooling design challenge

GKN Aerospace Services recently designed a large number of mould tools for the manufacture of composite aircraft wing panels. These mould tools are used to lay-up the composite part and consist of a tool body and the backing structure. Compressed time-scales and preliminary input data complicated the task.

KBE solution

The repetitiveness of the panel geometry and the quantity of individual designs suited the application of KBE. GKN Aerospace Services developed a KBE application that could automate the creation of 3D models and drawings for a complete mould tool, which significantly reduced design time and provided the flexibility to respond to design changes.

The KBE application enabled extensive user control over both the tool body and backing structure design (Figures 1 and 2). The tool body included scribe curves, provisions for drilling jigs, reference holes and a recessed test panel for composite coupons. In addition, the provisions for attaching intensifiers (used to clamp the part down during manufacture) could be controlled.

The backing structure design was based on an arrangement of individually modifiable spars

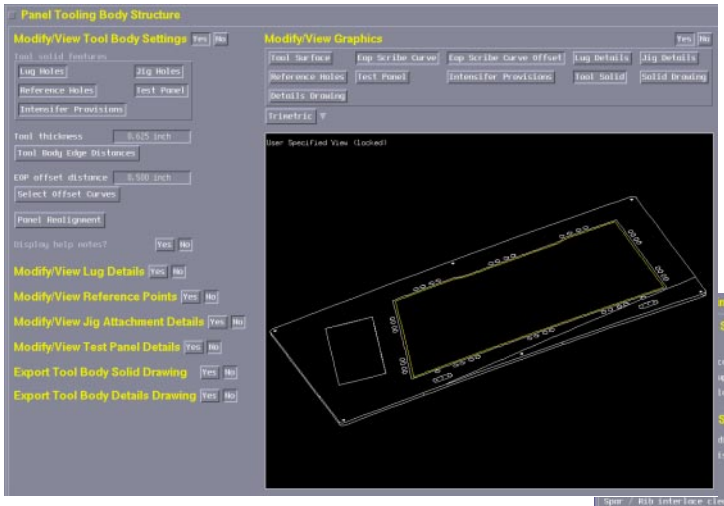

Figure 1 *The KBE application automatically designs the tool body solid based on user inputs. Features include scribe curves, provisions for drilling jigs, reference holes and intensifier provisions*

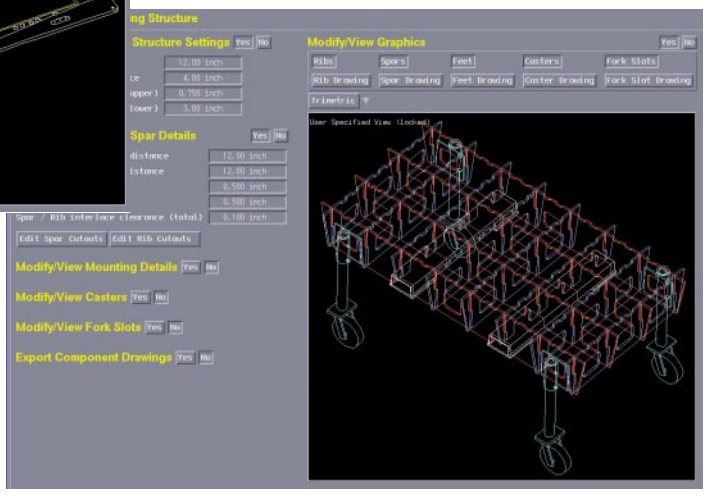

Figure 2 *The backing structure solids are created based on the tool body geometry and user inputs. Features include internal ribs and spars, provisions for fork tines, and supporting casters and legs*

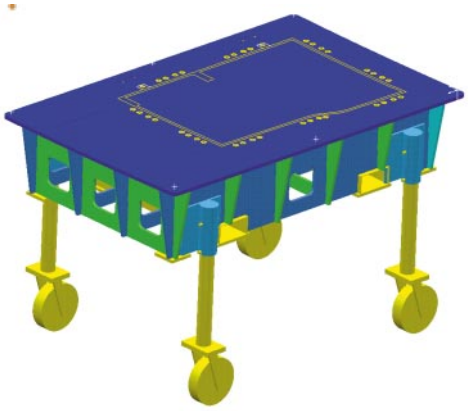

Figure 3 *The final 3D model of the mould tool*

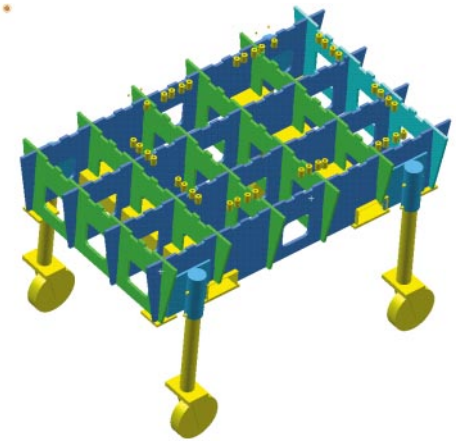

Figure 4 *The final 3D model of the mould tool – tool body removed*

and ribs, which match to the underside of the tool body. The rib and spar designs also allowed for the inclusion of fork-tyne provisions and the attachment of legs and casters.

The KBE application enabled the user to export the final design to a target CAD system. Examples of the final 3D models are shown in Figure 3 and 4. Additionally, the user could automatically generate the NC Code used to trim the panel edges and drill the fastener holes.

Ongoing benefits

Although the initial cost of developing a KBE application can be high, the ongoing benefits are significant:

- Lead-time reduction for new designs;
- flexibility to respond to design changes; and
- elimination of re-work.

A KBE capability can be a real competitive advantage, especially in bidding for new work orders.

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