Nesting efficiency in the face of higher prices

For various reasons, many aerospace and automotive manufacturing companies have not improved on their nesting efficiency much over the last few years. Given recent price rises in sheet metal and composite materials, this is starting to bite. Composite materials are already expensive, and recent double-digit price increases by a major composite manufacturer have cut even further into margins. Those companies that employ a more efficient nesting method will gain considerably over their competitors, not only in the amount of material saved but also in the time taken to create the nests. So what can manufacturing companies do to improve their material utilisation?

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Due to the high cost of raw materials, aerospace manufacturers have historically generated static nests manually, or used a computer-aided nesting system and then spent time manually improving the resulting nest. These quite efficient static nests are used over and over to produce specific kits of plies. There are several drawbacks to this method, however. First, the length of time required to nest using a computerised nesting system and then manually intervene to obtain the required nest efficiency is significant, as manual nesting can in some cases add an extra day or two per nest pattern. There is another disadvantage in using static nests: manufacturers will often overproduce when not all plies on the nest are immediately needed, when replacement plies have to be made for spares, or when plies that have been rejected due to quality issues need to be replaced. With the static nest method, there obviously is a lack of flexibility to cut what is needed, when it is needed, in order to avoid wasted material.

The other major issue is that many composite materials have a grain, meaning that they can often be nested only at fixed rotations of 0 and 180 degrees (possibly plus/minus a few degrees). As a result, it has generally been difficult to automate the nesting process to take all of these factors into consideration and still generate efficient layouts.

Fig. 1: Embraer are making significant savings through automated dynamic nests

Composite cutting requirements

Cutting composite components differs greatly, for example, from cutting sheet-metal components on a CNC laser machine. Unlike on laser or plasma cutters, no lead-ins, lead-outs or tabs are required on a knife cutting machine, as plies are cut free and are held in place either by vacuum or gravity. However, because material is supplied on rolls and frequently used on conveyorised machines, the nesting process needs to be managed carefully. Additionally, some materials have to be kept in a freezer and can be held at room temperature for only a relatively short length of time. This needs to be taken into account when processing orders for nesting. Part identification can involve nests that are several metres in length, containing hundreds or even thousands of plies. There is also a need to link material and its life management system the nesting system itself, with a capability to track things like how much material is left on each roll, how many rolls of each material are in stock, the life left per roll (either new or that has already been taken out of the freezer), and which roll individual plies were cut from.

This is obviously very important in the aerospace industry, where the need to maintain traceability is paramount (figure 1).

The solution

The best way to overcome the above issues is to employ an advanced CAM system such as Jetcam International's Expert system, which can provide a very high level of nesting efficiency and automation, while avoiding the pitfalls associated with the use of static nests – a system that can store individual machine/material characteristics and user preferences, and can apply them intelligently during the nesting and cutting process (figure 2). For example, such a system needs to recognise the difference between machines that use a conveyor instead of a fixed flat-bed table, because once the plies currently on the conveyor are cut, the material needs to be pulled forward, the cutting cycle continued across the reposition, and so on, because the need to continue the cut can span across many repositions of the conveyorised table, particularly for large plies. Another example is a common need to add an "oversize condition" to the periphery of a ply. On a modern nesting system, this could be configured as a standard setting and applied automatically, where and when appropriate.

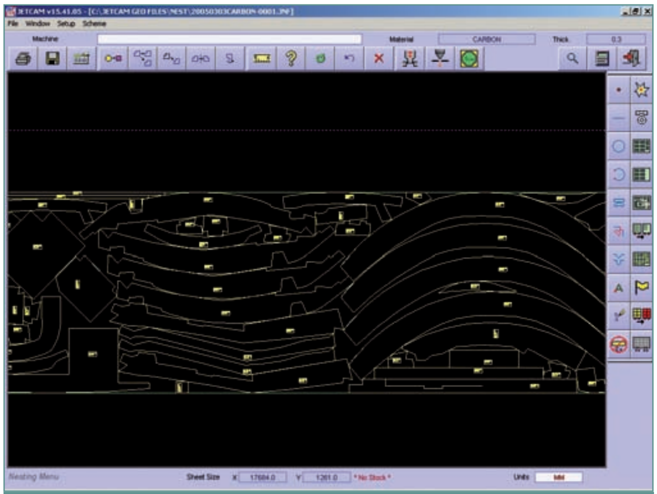

Fig. 2: Material efficiency can be improved by upwards of 15%

Identification of individual plies in a nest is vital with composite cutting. This laborious task has traditionally been done by hand, using a felt-tip pen to mark the plies on the previously cut nest. Later, machines employed pen markers, and now we see marking done by an inkjet marking head or by applying labels. With these automatic marker technologies, all the plies on the nest can have their identification applied rapidly, before the nest is actually cut. This dramatically speeds up the cutting process.

With automatic marking, it is also important to remember that text size and angle can change according to the size and orientation of the ply. Many plies can be long and thin and, depending on their orientation, marking will often end up off the ply if this is not taken into account. The next innovation in ply identification and removal from the nest in correct sequence is to use a laser identification system; i.e. the nesting system sends the nest and ply information to the laser ID system which, when prompted by the operator, will indicate the ID of the next ply to be removed, while the laser beam clearly points out the physical ply on the nest. This simplifies and dramatically speeds up the removal of plies from a nest, and aids in correctly stacking the plies ready for the next operation.

Jetcam offers several options for nesting; the Jetcam free form high performance nester (FFHPN) is the most advanced in the world. The system can be configured to run the nesting algorithm over a pre-specified time period to obtain the highest nesting efficiency. Many users configure the system to queue jobs overnight across one or several Expert systems, so that the computers have the maximum time available for nesting. When Bombardier Aerospace in Northern Ireland evaluated several new CAM systems, Jetcam Expert's FFHPN system demonstrated material efficiency improvements of 10-15%.

Full turn-key automation

A further level of automation can be achieved through integration into legacy production management systems, using products such as Jetcam's Remote Control Processing (RCP) module, which integrates tightly between JETCAM Expert and the production management system. The RCP module will fully automate the process, from processing the orders supplied by the production control system all the way to producing a correct, efficient CNC program for the required machine(s). It will automatically process components using CAD geometry and corresponding pre-programmed input (PPI) files, which can be produced by many CAD systems.
A PPI file contains manufacturing information such as:

• #UNITS=<units>	(this file is in mm or inches)
• #MATERIAL=	(type and thickness)
• #REVISION=	(revision number)
• #CAD_MOVE_PATH=	(where to move processed CAD geometry)
• #PART_NAME=	(component name)
• #SKIP_EXISTING_PART=	(overwrite/do not overwrite a part if it exists)
• #JOB_ID=	(job identification)
• #ROT_ALLOWED=	(component rotations allowed – grain control)
• #FIND_BEST_ANGLE=	(to maximise nesting performance)
• #ROT_ANGLE_TOL=	(allows for slight angular adjustment during nesting)

- #USE_CLUSTER= (parts can be clustered for optimal nesting)
- #MACHINE= (specifies machines(s) for which to program the part)
- …and other (many other optional parameters are available)

Once a part is processed, it is stored in the component database and, since it contains all necessary nesting and manufacturing information, remains ready for nesting at any time in the future. A production control system (or other software for that matter, such as Jetcam's Order Controller) can provide a queue of plies or whole assemblies, which will then be automatically nested according to the machine(s), material type and other parameters. CNC code for the relevant machine(s) is generated and placed in pre-determined locations, ready for the machine operators to use. All of this takes place without any operator programming or intervention.

Jetcam's RCP "Black Box" approach is in operation in many general-manufacturing, aerospace and automotive companies around the world. When coupled with FFHPN, it provides a fully automatic nesting and CNC code generation system that delivers nests even more efficient than the best manually produced nests. Using RCP and FFHPN modules, Bombardier Aerospace (figure 3) in Montreal, Canada is making very significant material savings every day, with Embraer (figure 4) in Brazil citing an overall material saving of 4% and a programming-time saving of six hours per day. Several high-end racing car manufacturers have also standardised on the Expert system, due to the material efficiency and automation it provides. With these levels of savings, it is commonplace for a system such as this to pay for itself in a matter of weeks.

Fig. 3: A Bombardier aircraft in flight

Evaluating a new CAM/nesting system

There are three key areas that one should consider when implementing a new programming/nesting system:
1) it should reduce material waste as much as possible;

Focus ...

Jetcam International develops and distributes the Jetcam Expert CAD/CAM and nesting software. With well over 5,000 licenses in 70 countries, the software supports virtually every profiling and punching machine available today and produces highly optimised nests automatically.

2) it should reduce programming time and, therefore, also possibilities for errors; and
3) it should optimise machine cycle time. The quality of the generated CNC code is also very important, as that is what is ultimately driving your machine! Requesting a benchmark comparison between selected vendors is an ideal way to gauge the efficiency and ease of use of each system. You should select a nest of components and give it to prospective vendors, along with the separate component geometries, to produce a benchmark you can use to compare against. You should also get them to run this benchmark in front of you, so you can see how easy (or difficult) it is to produce an efficient nest. If grain is an issue, ensure that, for example, plus/minus one-degree rotation "freedom" is specified during nesting, so that the best efficiency can be achieved while grain restrictions are still being taken into account. This can make a sizeable difference in the final efficiency percentage. Also, make a note of the time taken to produce the nest, as this can vary greatly between systems.

Fig. 4: A composite cutter used by Embraer

Conclusion

Any company that has sizeable material expenditure can benefit considerably from re-evaluating their nesting processes. Taking the time to assess whether it is possible to save even just 1% on the material used could pay huge dividends, and also have a side benefit by giving you a path to a completely automated nesting process in the future. When evaluating a new system, be sure to focus on the end goal of return on investment, rather than simply comparing like-for-like features. ■
More information: www.jetcam.com