The Next Steps in Nesting Systems

By Mike Riley

The Way It Was

Part geometry approximation methods like pixel or vector representation were created to minimize the nest processing time. These approximation methods had a negative impact on efficiency, resulting in higher material costs on the shop floor.

Exact representation of part geometry using arcs, lines and splines was incorporated into the nesting systems to minimize the processing times and increase efficiency. However, this produced another bottleneck that was soon overcome.

The sole purpose of the resultant nest was to generate machine code that would provide a path for the torch on the machine tool to follow in cutting parts out of a nest. The more efficient and complex nests were generating larger machine codes that increased the time it took to load into the machine. Older machines' tools with less sophisticated controllers had smaller capacities that in many instances would prevent the code from being loaded.

Soon, machine tools with higher capacities and more sophisticated controllers were being produced. These controllers supported the use of canned cycles and subroutines that could reduce the length of the actual machine code. This allowed more efficient nests to be run. Nesting software companies responded by incorporating this new technology into their automatic nesting software.

The market for nesting software grew as technology improved and each new CNC process was addressed in niche applications. Intense competition within these specialized niches grew as the number of major software suppliers increased to five or six in the early 90s.

The Way It Is

Today's mature market competition involves sophisticated customers operating on different levels of complexity. From the small job shop that does oxy-fuel plate cutting with one machine, to the giant aerospace enterprise with highly integrated multiple cutting applications, the software supplier must provide a product solution designed to fit their needs. "We look beyond the immediate nesting process to address the integrated business solution," said Greg MacLean, president of Magestic Systems, in Old Tappan, New Jersey. Magestic is a leading software development company specializing in material and process optimization across all CNC cutting applications - laser, plasma, punching, gas, router, ultrasonic knife, and water jet.

Magestic's suite of TruNEST programs works successfully across the aerospace, appliance, construction, automotive, boating and machinery industries, in different levels of complexity. MacLean explained the process of creating solutions to answer diverse customer needs. "There are three levels of software being used in nesting applications today that we support: Level 1 involves the small to mid-sized fabricator with one machine tool involved in basic rectangular nesting. Level 2 is more sophisticated as the user applies optimizers to increase material yield on stair-step remnants and throughput on the machine tool. Level 3 is advanced and includes larger companies with many cutting operations on totally irregular-shaped remnants using a highly integrated solution."

"We offer TruNEST as the standard core product providing the basic framework of the solution. We do not customize it for any specific customer. What is different with each customer is the integration. Open architecture allows us to build the precise solution to the customer's exact needs. Periodic updates are provided which include improvements based on feedback from our user group. The user group meets annually and helps steer the direction of TruNEST for the near future," said MacLean.

TruNEST's suite of PC-based, fully compatible, building-block applications reflects the sophistication of today's nesting systems in improving part quality and material yield, reducing process cycle time, and streamlining production and information flow. Hardware required is a Pentium processor running Windows 95 or NT, with 64 MB RAM, 120MB+ hard disk, and a VGA/SVGA monitor.

TruNEST I

This first-level application increases productivity and profitability in flat pattern cutting by using automatic nesting algorithms and integrated process managers to optimize the cutting cycle. The SmarTran feature translates 2-D part data to and from most CAD/CAM systems, converts a 2-D part from one CAD format to another, and translates most NC data to a CAD format. TruNEST I automatically corrects bad CAD geometry, calculates the minimum rectangle of a part and random nests parts of multiple jobs of like material in a rectangular format.

Parts can be kitted before the minimum rectangle is calculated. It determines the optimum available material size or combination of sizes, generates the optimum NC tool path cutting sequence, and performs unattended batch nesting. It sets grain constraints for individual parts and accommodates filler parts. The Order Scheduling Manager accepts ASCII data from external scheduling systems, establishes and maintains an internal active orders list for nesting based on material type and due dates. It also tracks an order to see if it has been accepted for production or needs to be nested, and updates the active orders list when a part is staged for production.

The Materials Manager tracks the material available for nesting updates inventory quantities as material is consumed, and tracks usable rectangular remnants by placing them in inventory by storage location. The Part Assembly Manager maintains a database specifying assembly details, quantities, material types, and grain orientation on an unlimited number of assemblies. The user orders by complete assembly or individual assembly detail. Production reporting includes number of parts nested, material efficiency, pieces of material used, remnants produced by size, processing time, and parts not nested.

TruNEST II

This second-level application uses true-shape nesting algorithms to nest the actual shape of the most complex parts while simultaneously creating the tool paths and cutting sequences. TruNEST II gives the user the ability to pre-nest a group of parts. It will create nests on stair-stepped and rectangular remnants. Parts can be rotated in one degree increments, and selected parts can be mirrored during nesting. The user can graphically edit a nest and/or part geometry with the TruEDIT/TruPART software utilities.

"The operator has the flexibility to make immediate changes on the machine tool such as cutter compensation and speed, and keep running. Also, design and manufacturing engineering can make necessary changes to the nest further upstream in the information flow process," said MacLean. "There are two methods of making changes in the system. Either MRP sets the shop floor data in a real-time, on-line format, or the shop floor adjusts data and reports it back to MRP. Most users operate in the latter mode since it provides the flexibility they need." The system supports CAD as input for nesting and nests for multiple layers of material and multiple cutting heads.

The Materials Manager allows pre-set cutting and nesting conditions by material code for unattended nesting. It manages stair-stepped and rectangular remnants, and integrates with most ASCII-producing inventory control systems. The Order Scheduling Manager adds estimating of machine tool cut times and costs to its features. The Cost Analysis Manager analyzes minimum, maximum, and average production costs for parts, materials, and machine tools for up to twelve months. It tracks actual material, scrap and labor costs by assembly and/or assembly details, and isolates any cost for a specific time or assembly.

The cost features help the user decide the most profitable material yield by job. "The system compares different material sizes to generate the desired yield for full-plate nesting. If a user has a choice of using sizes 4 x 8, 4 x 10, and two remnants, parameters can be set in TruNEST that will choose the remnants before using full size plates. When the cost per pound of material is considered in the calculation, sometimes a 70% yield is more cost effective than 80%," said Mac Lean.

TruNEST III

This third-level application nests irregular-shaped remnants and drops from internal cutouts. MacLean said one of the major challenges in nesting the higher-level applications is the handling and preparing data coming from other sources. "Data must be accepted from either a digitized process, as NC input, or in a CAD format. A company must decide how it wants to spend the time and money to convert all of its old data into new programs for the project to work most effectively."

TruNEST uses a library of translators to handle this challenge. MacLean shared an example of how these are used. "We have a customer in Mississippi who replaced an older MG flame-cutter with a new ESAB machine tool. Their data was in older CADAM formats and needed to be translated for ProE. We translated 30,000 files in one shift. Some companies opt to translate along the way, instead of all at once. It's their decision to make."

TruNEST III features a variety of options to process shaped materials or remnants.

Commonline Cutting Logic merges tool paths for those parts that are nested within a specified distance, with no limitation by part shape or nested angle. Part Tabbing joins a part(s) to the skeleton of material at user-specified locations. Beveling specifies the edges of a part that require a bevel and produces the corner loops and necessary cut commands.

CNC Material Handling provides the NC code used to dispense the appropriate material for each nest. Part Labeling associates a label to each part and places it by NC command. Minimum Pierce Logic minimizes the number of pierces made during a thermal cutting process. Open Order Tracking controls whether and how a job order gets split by tracking and informing the user of its status. Chain Cutting improves machine tool throughput by continually cutting from one part to another. Material Hold Down determines placement of rivets, nails, screws or breather holes. Multiple Tool Optimization optimizes the cycling of different tools that will be used in a single nest.

Installation varies depending on the size and sophistication of the customer operation. A small job shop with two machine tools running the basic system framework typically takes two weeks. The first week a technician is on-site installing the software and proving out the post processor. Another week of training operators and manufacturing engineering through live nesting trials and system operation follows.

The Way It Will Be

Maturing customer needs will drive the next steps that change nesting technology. "Today TruNEST creates dynamic nesting by incorporating 31 different algorithms to optimize the nesting process. Improvements in the machine controller's sophistication and increases in computer processing speeds will act as a catalyst in the development of "fuzzy logic" nesting algorithms to handle further nesting complexity and support smarter machine tools. If these trends continue the next steps will become commercially attractive that much sooner for the user base," said Mac Lean.

MacLean feels the advances in technology must expand the supplier's focus on optimizing the customer's entire process. "Today we actively nest real-time or batch nest a queue of 30 to 40 jobs overnight in a 2 to 3 hour cycle. Nesting is the not the process bottleneck. As everything gets faster and more complex, we must insure that nesting supports optimization of the entire process and doesn't create a bottleneck downstream."

TruNEST IV

Vision systems are already taking the next step in handling further shape complexity and expanding material management. TruNEST IV integrates a CCD camera, either mounted on the machine tool or hand-held, for automaticly scanning remnants of any size in less than five seconds.

The picture shows the shape of the remnant plus any material defects, and is converted into file parameters for processing. The system calculates gross material area (with defects) and net material area (without defects). One scanner can support multiple cutting stations. The system also uses an SNP3000 laser projector to project a laser image up to 50 feet to assist a layup operator in placing dies or templates. The projector can be remotely controlled from 30 feet, and can be used as a stand-alone system for part identification and/or assembly alignment.

Solid modeling will be the next quantum change in the nesting industry. "CAD/CAM operates in a 3-D world while nesting deals in 2-D. Nesting will adapt to handle 3-D applications and utilize parametric technology in design engineering. Designers must have a 'live' nest that changes when a parameter is changed. This will revolutionize flat pattern nesting. We are beginning to use nesting in tube and bar stock operations, and the future will see more nesting in structural applications," predicted Mr. MacLean.

While the domestic nesting market is approximately $30 million, the worldwide market is $60 million and growing. As other nations become industrialized and institute new cutting technologies, there will be larger opportunities for nesting software suppliers in foreign markets to integrate their products into enterprise-wide solutions.
