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Lean Nesting

Quality Insider Article

One of the most demanding problems lean manufacturing faces in discrete manufacturing is control of first operations, where raw material may be cut into multiple parts. First operations such as laser or CNC Punch Press processes dictate what parts are available to subsequent operations, thereby controlling much of the downstream process flow.

Building an optimal nest of parts is a complex problem. Nesting [1] isn't axiomatic. The ability to read an active-order file for the current demand of parts, extract the appropriate ready-to-nest parts, drawing upon parameters established to create the optimal nesting pattern, is far from axiomatic. A host of factors must be considered, from material efficiency, part priorities (today's orders, hot parts, filler parts), setup costs, order completion, labor, and machine throughput to name a few.

Ironically, Michael D. Lundy, process engineer and CEO of Optimation [2], named the company's nesting software Axiom. "Ultimately, lean nesting solutions must enable manufacturers to get the parts needed, when they are needed, in their exact quantities needed, at the lowest cost. To achieve true lean efficiency, lean nesting software solutions must automatically complete a number of other tasks before it is ready to create a nest, orders have been checked, cleared and prioritized, and placed in the active order file. Part designs must have been translated from CAD to network computer programming and stored, along with key attributes, in the part library; the opportunity to establish critical manufacturing parameters is stored in the software's knowledge base," Lundy notes. Automation ensures that cycle times aren't lengthened.

Some nesting solutions rely on fixed heuristics, which often prove unreliable and allow waste of time, labor, and resources. In the best nests, single-part shapes and predefined kits (or subassemblies), are nested to exacting—often rapidly changing—demand while maintaining optimal results. These solutions can draw upon several powerful tools to produce that optimal nest with little or no human interaction.

Cost-driven nesting proves most lean
Few nesting systems automatically respond to manufacturing priorities (due date, order status, urgent need) that change rapidly. The effect of continuous process improvement can be quantified if the nest solution has the capacity to weigh a number of factors in determining the best nest, including labor, setup, schedule adherence, order cohesion, machine utilization, inventory, and tooling requirements. Each part within each order must be nested based on schedule, ensuring that the most critical parts arrive at downstream operations on time. Rapid, real time response ensures that a hot part will be in the very next nest.

Combinatorial nesting—the first nest may not the best
The first nest isn't always the most material-efficient and yet must be the most optimal. To find the optimal fit, a nesting solution must automatically attempt multiple combinations of parts as well as optimal angle orientations for each part. If at any point during its evaluation of a nesting combination the software realizes that it will not beat the best result of the previous nests, it aborts that layout and moves on to the next. This ability to learn from previous solutions is a form of mathematical fathoming. Fathoming greatly reduces the number of alternative nests while insuring the optimal solution is found.

Devising highly sophisticated automatic nesting methods is central to quality improvements and lean efficiency. The nesting system must have an expert system that will respond to the individual needs of the manufacturing cost structure. This expert system will allow each manufacturer to fully describe their cost structures and manufacturing policies, which the nesting system will use to create a customized optimal solution.

Full-shape nesting
Unlike true-shape nesting, which only looks at half of the part at any time, full-shape nesting visually considers the entire part. Any part not restricted (such as by grain direction), can be optimally placed at any orientation in a nest. In lean manufacturing, it’s essential to see all possibilities to find the optimal solution, which meets all of the special conditions demanded by advanced manufacturers.

Full-shape nesting optimizes part nests by visually and mathematically selecting the optimal mix of parts that meet the complex constraints and manufacturing polices. It will search out opportunities to nest parts inside of parts, increasing material utilization while ensuring the production plan is executed without unprofitable work-in-process inventory or high scrap. Increased material utilization translates into the core lean concept—elimination of waste.

Just-in-time (JIT) nesting delivers the most important parts
Intelligent expert systems embedded in a powerful vision-centered nesting engine allows a special mode of operation that responds automatically to rapidly changing manufacturing demand. When operating in JIT mode, each nest is created one at a time, just prior to being sent to the machine to be cut. The machine operator triggers the automatic build of the next nest by calling for a nest to be downloaded. Any change in the status of the active order file since the last nest is responded automatically and delivered internally to the last few minutes of the normal cycle time of the previous nest.

“This mode enables the user to respond to changes in demand within each cycle time of each machine tool . . . virtually on the fly,” Lundy asserts. “A byproduct of JIT nesting is that multiple machines are loaded with the next most important parts, enabling them to be dynamically balanced. Every machine is always working on the next most important parts, regardless of changes in demand.” JIT nesting greatly shortens the cycle time, which is another central metric of lean.

Nesting—an axiomatic lean starting point
One definition of “axiom [3]” is any mathematical statement that serves as a starting point from which other statements are logically derived. Axioms cannot be derived by principles of deduction, nor are they demonstrable by mathematical proofs—they’re starting points. Perhaps intelligent nesting solutions ought to be the starting point for lean initiatives.

Links:
[1] http://en.wikipedia.org/wiki/Nesting

[2] http://www.optimation.com/
[3] http://www.merriam-webster.com/dictionary/axiom