

# Industrial automation: Clearly seeing part nesting

Thomas R Cutler discusses the importance of industrial automation in manufacturing

Contributors to Wikipedia suggest that, "Automation plays an increasingly important role in the global economy and in daily experience. Engineers strive to combine automated devices with mathematical and organisational tools to create complex systems for a rapidly expanding range of applications and human activities." Many roles for humans in industrial processes presently lie beyond the scope of automation. Human-level pattern recognition, language recognition and language production ability are well beyond the capabilities of modern mechanical and computer systems. Tasks requiring subjective assessment or synthesis of complex sensory data, such as scents and sounds, as well as high-level tasks such as strategic planning, currently require human expertise. The degree to which industrial automation is able to accurately replicate human physical skills, the more cost-effective automation will serve in accomplishing industrial tasks.

## Seeing clearly: A basic human function

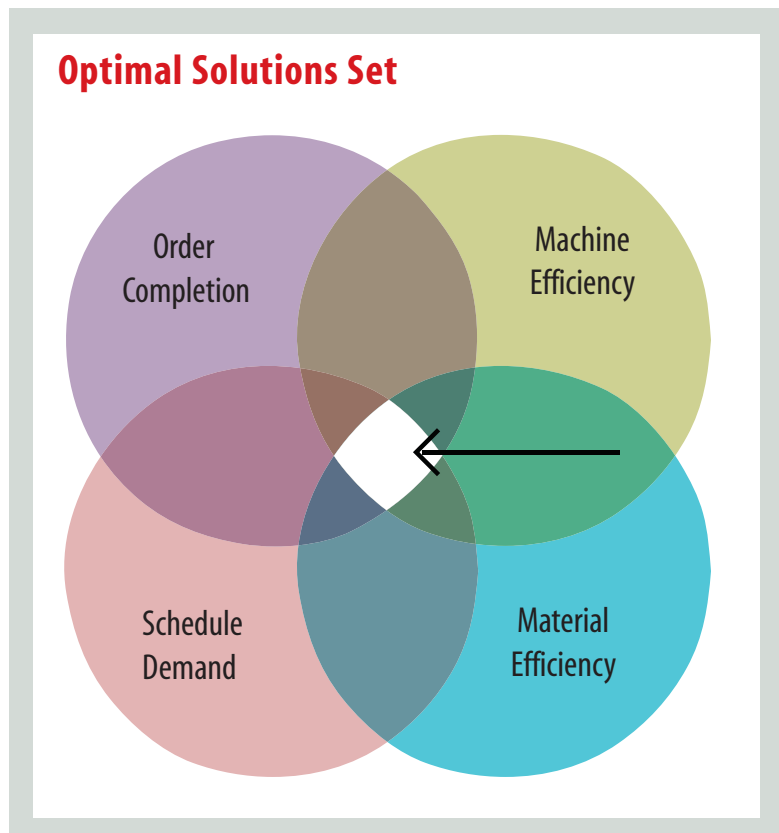
Any human being going on a road trip with multiple pieces of luggage must figure out the sequence of loading suitcases into the trunk of the car. There is a finite amount of trunk space and a certain number of

bags. In a form of trial and error, large bags placed first, then smaller bags, it is quickly learned that the truck will still not close.

The next iteration of loading is attempted based on the visual clue and experience of each attempt. Soon one can clearly see what formula is needed to get all the bags in the car, close the trunk and drive away. This process is called nesting when it pertains to industrial automation.

## Nesting is a big industrial automation challenge

According to Michael D Lundy PE and President of Blue Springs, Missouri-based Optimization ([www.optimization.com](http://www.optimization.com)), "Nesting parts together to make an efficient nest is a very complex problem. For just fifty parts, there are over  $10^{100}$  alternative ways to nest the parts. If a company adds rotation, the number gets much larger.  $10^{100}$  is a number so large that a super





For representational purpose only.

computer could build one million nests per second...it would take over  $10^{84}$  lifetimes to build all possible nests. One cannot brute-force this large challenge."

To solve such large challenges, a mathematical technique called 'fathoming' is required. It is a method used to eliminate most of the alternative nests and focus only on the potential optimal nests. Most nests can be eliminated without ever being considered (placing the luggage in the driver's seat stops the road trip; such a packaging consideration is not needed.)

The optimal solution that satisfies all the real world manufacturing conditions is quite small. Fathoming ensures that only nests that are in the optimal set are evaluated. Lundy explains, "We call this Multi-Dimensional Combinatorial Nesting or MDCN for short. All other companies use heuristics that are often sub-optimal and many not even find feasible solutions." As the graphic indicates, there are a lot of solutions

that will satisfy material efficiency but destroy a manufacturer's schedule and machine efficiency.

Standard heuristics crash badly when presented with real world problems. MDCN looks at many different dimensions affecting cost. Schedule, hot parts, material efficiency, order completion, tool optimisation, common cutting, torch load and other costs make finding the optimal nest Multi-Dimensional.

#### Seeing clearly: Vision Emulation

After the possible nesting solutions have been limited to only optimal results, Vision Emulation technology must be added to 'see' the parts much in the way a person uses their eyes. Lundy explains, "This technology must look at the shape of each part and the shape of the area on the nest to 'see' if the two shapes match. It also sees that the part must be rotated in order to fit in the space available. This ability to see clearly greatly improves the tightness of the nest and saves hundreds of thousands of dollars to

manufacturers. Like fathoming, Vision Emulation naturally selects parts that fit together well.

When Vision Emulation is applied with MDCN, the part selection process is greatly enhanced. By 'looking', which parts will fit into holes or small open areas in the nest, companies can see which orientation would fit best. Vision Emulation works much like a human being; when a person nests parts they look at all of the parts and their individual shapes. It is obvious that some parts will fit together well and other parts will fit inside of holes.

Currently most nesting processes require a large number of rotations in a trial and error approach to orientation; these antiquated nesting systems rotate parts in small increments and try to fit the part after each rotation. This is time-consuming and regularly leads to wrong results. Some heuristic nesting solutions brag about rotating parts at one degree increments; a part may need to be rotated 124.372 degrees to fit optimally. Viewing larger parts helps fabricators and other manufacturers to select the best combinations of parts. Vision Emulation brings a powerful toolset for finding and placing the right parts in combination with other parts to achieve the optimal nest.

#### Benchmarking the nesting solution

Manufacturers currently using any other method of part nesting should benchmark the efficacy of their current solution. Lundy noted that "Recent benchmark comparisons have shown up to 15% improvement in material efficiency alone." Seeing clearly must include profitability and these new nesting industrial automation tools go straight to bottom-line improvements. 📊