Boosting Drilling Productivity

Faster computers optimize drill paths.

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t a time when drilling rooms are busier than ever, faster computers are handling difficult optimizing algorithms that produce shorter drilling paths.

Today, virtually all path optimizers employ either channel-sort or sliding-window-wander algorithms. CAM systems use the former, in which the holes are sorted and output in serpentine channels. While this produces shorter paths than random CAM output, it causes the drilling machines to repeatedly traverse large areas devoid of holes. This waste of valuable drilling time is tolerated because the channel-sort system rum quickly on CAM systems.

Typically used in stand-alone optimizers and on drilling machine controllers, the sliding-window-wander algorithm produces shorter paths but also presents the trade-off of optimization time vs. path length. The term "wander" was derived from the fact that the algorithm directs the drill head to wander around the panel, each time drilling a hole closest to the one most recently drilled. The "sliding-window" term comes from the fact that only a limited number of holes are usually checked to find the closest one in the group. Again, this limitation speeds the optimizer but slows the drilling; it is penny-wise and pound-foolish. Since it always blindly drills the next-closest hole, it leaves single holes behind to be drilled at the end of the program, resulting in huge moves between the "orphan" holes.

An old algorithm called annealing was impossibly slow to use for drill programming until the advent of higher computer speeds. Annealing makes many passes through a drill sequence, swapping holes to change the path. At first it acts like an insane version of the wander algorithm, swapping pairs of holes even when the trade makes the path longer, As the algorithm runs, its tolerance for complicating the path is reduced in a manner analogous to cooling in the metallurgical annealing process until the algorithm is allowed to make only swaps that shorten the drill path. The annealer eventually creates a fairly short path and avoids the wander algorithm's shortsighted orphan finale.

The New Algorithm

The speculation recursion algorithm begins by joining the three older algorithms in producing a hybrid capable of suggesting several reasonable paths. Each path's qual-

ity is evaluated in parallel until gross length disparities appear. Areas of the drill program in which the three algorithms produce very different results are singled out for more detailed attention and recursively evaluated as if they were the entire program. The speculations ultimately result in the evaluation of many paths, and the recursions devote the most processing time to the most sensitive path decisions. Unlike the random cooling of the annealer, the recursion focuses the algorithm on the most sensitive pattern areas, resulting in a tighter path. The new algorithm requires millions of iterations. But when coded in tightly optimized assembly language, speculative recursion produces the shortest drill paths on most programs.

Other Considerations

Other issues to examine when evaluating optimizers are their effects on preproduction engineering. For example, many manufacturers require coupon holes to be drilled first or last on specific tools. Other processes, notably slot drilling, demand that a precise drilling sequence be executed without alteration by the optimizer. It is always best to allow the optimizer to function across step-and-repeat sequences, even though data files grow several times larger. If the drilling machines are networked to a file server, this extra full-panel optimization maybe used without causing data storage problems. To be truly useful, an optimizer must allow its operator to exert sequence control over coupon and slot drilling and to select fullpanel or part-only optimizing.

While the only certain method of comparing optimizers is applying them to test files and recording the

resultant actual drill run times, it is possible to compare them by measuring path lengths. Many drill path-length measuring programs produce nonsensical results because they report the absolute distance between each hole and its neighbor. This is useless information because NC drilling machines travel at full speed in both axes when moving from hole to hole. A correct drill path measurement must therefore record each move's distance as the longer of the two axes moved, not the hypotenuse of the right triangle formed. Whether the move is from XOYO to X 1 OY04 or from XOYO, for the purposes of the drill run time and the path measurement, both movements are exactly 10 units.

Although it's impossible to precisely compute drill run times from drill path lengths, it is possible to reasonably relate the two. Through the course of the development of the speculative recursion algorithm, over 100 actual part programs were optimized in a drill path-length measurement program.' Both the original and re-optimized path lengths and drill times were recorded. While there were some exceptions, it was generally observed that each 10% reduction in drill path length resulted in a 1 to 3'% reduction in the overall drill run time.

Conclusion

Drill path optimization is a valuable tool for increasing drilling productivity. Few manufacturing processes offer such an opportunity to apply faster computers to simple, compute-intensive problems and to directly realize improved profits. **FAB**

References

'The drill path-length measurement program is available at no charge. The MS-DOS utility can he obtained from the author's BBS computer, 612/788-1 732, under the file name PATHLEN.ZIP.

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