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Maximizing throughput with Lookahead

How a PMAC motion controller feature helps maintain quality while running the motion profile at the most efficient speeds

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Introduction

Manufacturers are always looking to keep efficiencies as high as possible. This normally includes maintaining the maximum production capabilities of the machine while still producing a high-quality product. In addition, it is helpful to shorten the time from engineering to production while enabling faster machine throughput.

One of the ways to achieve the highest throughput is to use a PMAC motion controller and a feature called Lookahead. This white paper explores this feature in detail and offers some examples of solutions that use it. Relevant industries include subtractive manufacturing (laser, plasma, and waterjet tables, CNC, lathes) and additive manufacturing (3D printing, welding).

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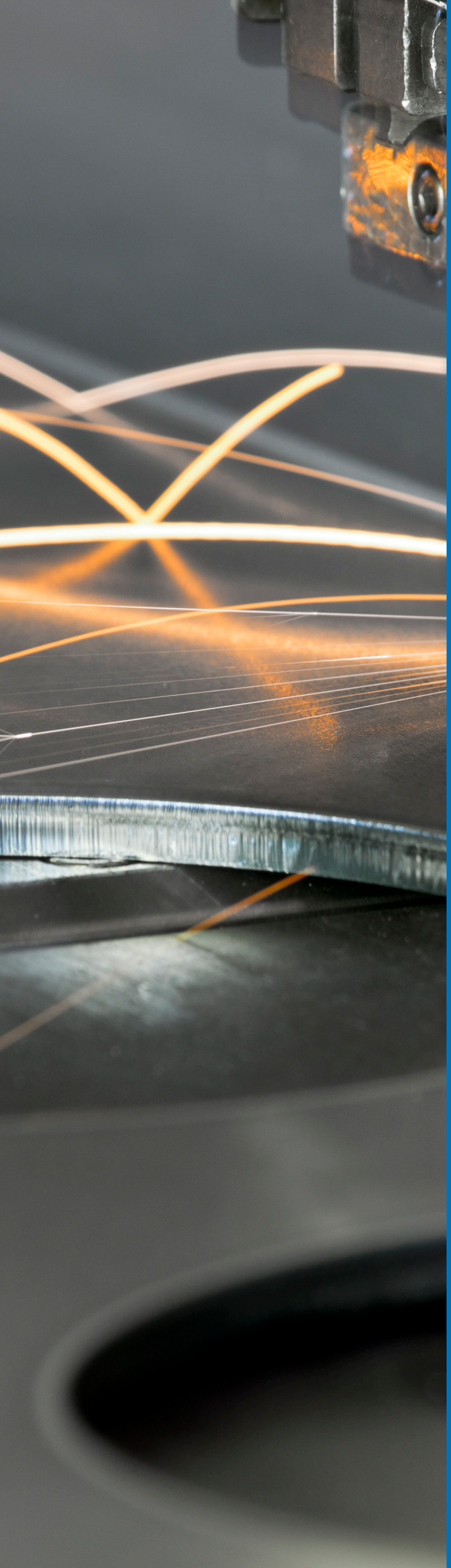

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What is Feed Forward?

Lookahead allows the PMAC to investigate the coming motion profile and analyze the accelerations, decelerations, and velocities that the machine can run to optimize machine cycle while continuing to create products of the highest possible quality.

The PMAC uses this feature to change acceleration, deceleration, and velocity based on the capabilities of the machine. This could be cutting speed and even mechanical flexing if the acceleration or deceleration create overly high G Forces. Lookahead allows the PMAC to run the motion profile at its most efficient speeds while maintaining quality.

What technologies support Lookahead?

When the lookahead function is enabled, Power PMAC will scan ahead in the programmed trajectories, looking for potential violations of its position, velocity, and acceleration limits. If it sees a violation, it will slow the trajectory at that point just enough so that no limit is violated. It will then work backward through the pre-computed buffered trajectories, slowing down the parts of these trajectories going into this point so that the deceleration to this point does not violate any motor limits. These calculations are completed before these sections of the trajectory are executed.

This technique permits Power PMAC to create deceleration slopes in the middle of programmed moves, at the boundaries of programmed moves, or over multiple programmed moves — whichever is required to create the fastest possible move that does not violate constraints. All of this is done automatically and invisibly inside the Power PMAC. The part programmer and operator do not need to understand the workings of the algorithm.

Examples of solutions using Lookahead

One of the best ways to explain Lookahead is with an analogy of a car driving through a winding track at night versus during daylight. If driving happens at night, there is little warning of upcoming curves and obstacles. Caution must be taken, and optimal speeds cannot be achieved. On the other hand, while driving through the same course during the day, a driver can "Look Ahead" and see what is coming up in their path. The driver could then plan when to accelerate or decelerate based on the path that they will follow. This is similar to how the PMAC with Lookahead will check the upcoming part and plan its trajectory to achieve the fastest possible move that does not violate velocity and acceleration constraints.

A common approach is for a person, or CAM software, to look over the path and assign values to the acceleration, deceleration, and feed rates to get a good quality cut on the part as fast as possible. In practice this is like following an overly cautious driver — it is simply too slow. Some can use Feed Rate Override on a machine to boost this by perhaps 20% or more, but this usually only considers feed rates and does not account for acceleration and deceleration. As a result, bad parts are made that are insufficiently smooth and have bad corners. Usually one axis (i.e., a rotary A axis) cannot keep up with others running in the linear (XY) plane, so the tool can be broken or the part quality may suffer.

However, a PMAC with Lookahead is aware of the limits of all axes in the system and knows the path better than anyone, so it can do a much better job of pushing the feed rates and accelerations to achieve maximum production without violating the rules of the road. This helps it make perfect parts each time. Typically, the PMAC Lookahead — once setup with a few parameters — can increase a typical path cutting system by 20% at least over a human-planned path or even CAM software (since this software does not know the machine like the PMAC does).

Summary

While CAM software is setup for a general machine type, it is not optimized for a particular machine, so it does not know the motor and axis capabilities. Nor does it know the full extent of the coordination between axes that may be using special kinematics to coordinate. By using the PAMC with Lookahead, you can achieve the maximum throughput while maintaining the most accurate path possible.

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