

CNC Chassis Design Yielding 24/7/365 Accuracy

Industrial strength and its effect on precision and accuracy

This paper focuses on varying methods of chassis design and fabrication for CNC machines. Further, it defines how the chassis engineering is the most integral aspect of producing machining centers that are deemed **Industrial Strength** by virtue of their ability to maintain accuracy throughout 24/7/365 operation.

Industrial strength and accuracy defined

Machining manufacturers often focus on the size and horsepower of a CNC machine's spindle in order to gauge how it will perform in an industrial setting — or how "industrial strength" it is. The reality is that the size and horsepower of the spindle is in direct relation to the size of the tools that it runs — which is based on the manufacturer's specific application(s).

With a trend towards miniaturization in many industries like electronics and the need for small parts that has always been inherent in industries like engraving, mills and drills with a diameter of 0.250" or less are the norm rather than the exception. To achieve superior surface finishes and avoid tool breakage, these small tools require high-speed and low-force that can only be delivered by spindles specifically designed for them. Conventional CNC machines, with hulking, high-horsepower spindles, designed to muscle through dense substrates with durable large tools, simply cannot run small tools without breaking them and/or sacrificing both the cycle-time and the surface finish of the end product. That's because RPM and feed rates must be slowed down to a snail's pace in order to reduce the force on these fragile, small tools — and this results in burring and slow production times.

So, with micro-tooling, "industrial strength" must be defined differently — and that's where the focus shifts from sheer size or horsepower to accuracy. Industries that employ micro-tooling do so because they require detail and accuracy in their finished part. As a result, these manufacturers evaluate the "industrial strength" of a micro-tooling CNC machine based on its ability to consistently maintain accuracy in the X,Y and Z coordinates over a long period of time with continuous use.

The challenge

Maintaining detailed accuracy over a long period of time requires a chassis designed to minimize vibration and variance of position. CNC manufacturers that have an extensive line of products to serve all types of milling, sometimes make the mistake of utilizing chassis designs, configurations and fabrication methods that were originally developed for machines used in more forgiving applications. While they're big and powerful, that doesn't equate to micro-tooling "industrial strength" as defined above — the ability to perform consistently and

accurately 24/7/365. Fortunately, CNC manufacturers that were born in the micro-tooling niche and have not migrated to other specialty areas are not tempted to retrofit a conventional, large-tooling CNC chassis for use in micro-tooling. To the contrary, they specifically engineer the chassis for the purpose of micro-tooling — including stringent requirements for reduction of vibration and the ability to maintain machining coordinates day in and day out.

First, what doesn't work

The overall size, weight and footprint of conventional CNC machines designed for larger tools is dictated by a necessity to house or accommodate the big motors and parts required to run big tools and machine through steel and other dense materials. The sheer size of the resulting chassis prevents the maker from considering fabrication methods like aged cast steel. Therefore, in many cases, they rely on chassis configurations that are comprised of many parts that are ultimately welded together. But when subjected to significant vibration produced by large motors, over time, each of these welded joints can contribute to variances that compromise long-term accuracy. Additionally, these large machines sometimes weigh-in at a whopping 30,000 lbs. which limits flexibility in terms of changes to manufacturing cells for particular projects — and while this does not necessarily impact accuracy, it does impact efficiency.

Now, what does work

CNC makers with a singular focus on micro-tooling have smaller motors and parts to house and therefore have more flexibility in terms of chassis design. For machines with smaller bed sizes — like Datron's excelsior™ class which is used primarily for engraving — the chassis can be based on one main part comprised of aged cast steel. This yields fewer welded joints, incredible "industrial strength" and long-term accuracy. Any welded joints that remain in the design should be super-heated and aged to insure a rock-solid set. Machines intended for batch-machining with micro-tooling — like Datron's Raptor™ class which features a large 30" x 40" x 12" machining envelope — can utilize the same aged cast steel construction and be reinforced with a concrete polymer poured around the steel for additional vibration dampening qualities and unsurpassed long-term accuracy. When all's said and done, these machines rarely weigh more than 1500 lbs. which provides manufacturers with increased flexibility to adjust manufacturing cells for to fit their changing needs.

Wrapping it up

Simply put, in the world of micro-tooling, the ways that we evaluate "industrial strength" in conventional CNC machines just don't apply. Instead, of looking wide-eyed at raw muscle, we need to be more concerned with long-term accuracy — after all isn't that why we need micro-tooling in the first place? So, in evaluating any micro-tooling CNC machine, we'd best take a good long look at chassis design because that is indeed the foundation for accuracy. The best bet is a machine with a chassis that is largely comprised of aged cast steel and possibly reinforced with concrete polymer. These are the ingredients for sure-fired accuracy and long-term success in micro-manufacturing.