



## **The Advantages of Utilizing Centerless Ground Bar in CNC Swiss Screw Machines**

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### **Abstract**

The attributes of *centerless ground bar* offer Computer Numerically Controlled (CNC) Swiss screw machine operators a number of distinct advantages over cold drawn material. Centerless ground products exhibit superior dimensional control, straightness, and surface finish. Consequently, facilities which utilize ground bar continue to report improved productivity, lower scrap rates, and enhanced finished part quality. Through the collection and presentation of empirical and anecdotal evidence, the production and strategic benefits of *centerless ground bar* are demonstrated.



## Introduction

As Swiss type turning centers continue to evolve from the cam driven units utilized for over a century to complex CNC machines with up to 11 or more axes under control, <sup>1</sup> manufacturers search for the materials necessary to optimize productivity and product quality.

**Operators of today's CNC Swiss screw machines are able to effectively use centerless ground bar to realize significant productivity benefits, cost savings, and strategic advantages over cold drawn material.**

Operating a CNC machine at maximum spindle speeds is but one method used to increase productivity. The dimensional consistency and precision straightness of a *centerless ground bar* help reduce vibration at maximum speeds, allowing operators to realize the full benefits of machines which can now reach speeds of 20,000 rpm. <sup>1</sup> Additionally, the "near net" nature of ground bar can enable some facilities to eliminate machining on certain parts altogether. Total diameter tolerances after centerless grinding of .0001", or better, can be achieved. Consequently, CNC Swiss machines can be employed to perform only intricate operations instead of "wasting" time turning diameters along the length of parts.

The "near net" shape associated with *centerless ground bar*, also allows the CNC Swiss facility to improve its' yields. The number of parts scrapped is also generally lower when using ground bar due to the improved surface finish and the removal of surface defects during grinding.

The final significant advantage of *centerless ground bar* is, in large part, strategic. To a great degree, "subminiature" parts with more stringent requirements are becoming increasingly common. This is particularly true when considering the medical, aerospace, and automotive industries. Centerless grinding is often considered a critical element of process control. The dimensional and surface consistency of a ground bar provides the CNC Swiss operator with a reliable material with which to begin his process. Final



product quality is often improved and downstream, non-value added inspection can be eliminated through the introduction of consistent raw material, *centerless ground bar*.

## Central Premise

**CNC Swiss screw machine operators can realize a number of significant advantages by using centerless ground bar as opposed to cold drawn material.**

## Evaluation

The advantages measured were categorized as follows: increased productivity, cost savings vis-à-vis yield and tooling purchases, improved process control.

The physical attributes of ground bar and cold drawn bar were established and are summarized in **Table 1**.

**Table 1**

Physical Attribute	Centerless Ground Bar	Cold Drawn Bar
Diameter	.001" total or better	.002" to .006" total
Roundness	.0005" or better	.0012" to .003" typical
Straightness	.006" or better	.030" typical
Surface Finish	32Ra Max, 4Ra possible	Not Guaranteed

\* Data represents products 12' in length and diameters ranging from .032" to 1" across carbon, alloy and stainless grades. <sup>2</sup>

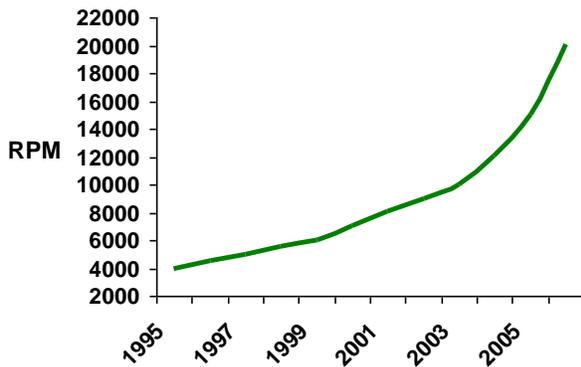
Productivity

Three measures of productivity were gauged: utilization of rated machine speeds, decreased labor hours, and decreased machining.

CNC Swiss screw OEMs and tooling manufacturers have continued to introduce products which allow today's operators to run at ever increasing speeds. **Figure 1** and **Figure 2** provide detail.<sup>3</sup>

**Figure 1**

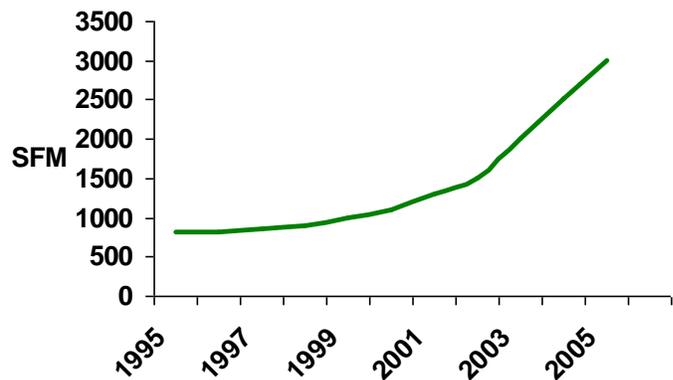
**Spindle Speeds**



Equipment and tooling manufacturers continue to help today's CNC Swiss

**Figure 2**

**Cutting Speeds**





CNC Swiss operators have found that having the equipment to run at higher speeds does not mean it is possible if the raw material precludes them from doing so.

Precision machine shops have reported that the consistency of a *centerless ground bar* can translate into less vibration at top speeds, allowing them to achieve 5% to 30% productivity improvements.<sup>4</sup> This holds true across all materials: stainless, carbon, alloy, aluminum, and exotics.

Of particular interest was a recent trend observed among shops running 2000 series aluminum on CNC Swiss equipment. Many operators have moved toward centerless ground 6000 series product as a substitution. They have found that an extruded bar (as most 6000 series is extruded) ground to +/- .0005" or better on the diameter is a much more cost effective method to satisfy their requirements versus buying cold finished 2000 series aluminum. Total savings is generally from 15% to 20%. The ground aluminum product actually ran up to 10% faster, in many cases.<sup>4</sup>

In addition to the increased productivity measured in terms of time to produce a part, another measure of productivity is important to consider: labor hours. A great number of CNC Swiss operations elect to run their equipment unattended. This is readily accomplished with today's modern machines, bar feed tables, and high resolution cameras. Some operators reported using cold drawn material in unattended operations but a high percentage of those contacted relayed their reluctance to run unattended without the reliability of *centerless ground bar*.

The third component of productivity considered was the elimination of "wasted motion". Stringent specifications in many market segments require final tolerances of .0005" or tighter. In many cases, operators can elect to machine long lengths of a part to these tolerances. However, many shops utilize *centerless ground bar*, with tolerances already to print, instead of "wasting" valuable machine time by turning cold drawn



bar to tight tolerances. Several shops reported 10% to 20% productivity gains after employing this practice. <sup>4</sup>

Of final note, several CNC Swiss OEMs explicitly recommend *centerless ground bar* to their customers in order to maximize productivity. One such company recommends *centerless ground bar* for any application requiring total diameter tolerances under .0005". <sup>1</sup>

#### Cost Savings

Two measures of cost were examined: material yields and tooling/accessory expense.

Precision machining operations using *centerless ground bar* report two distinct reasons for increased material yields when compared to cold drawn product: less "engineered scrap", and less unanticipated part, or even bar, rejections during processing.

The typical amount of material lost during the centerless grinding process ranges from 2% to 11%. The amount lost during grinding is a function of the level of imperfections present in the cold drawn material. Many CNC Swiss operators have elected to exploit the "near net" condition of ground bar and realize increased yields up to 5%, depending on part dimensions. <sup>4</sup>

Paramount to equipment builders is a design which effectively minimizes vibration during processing. Excess vibration reduces productivity, has a deleterious effect on quality, and reduces the life of collets, bushing, and tooling. Using material with optimal straightness and diameter tolerances will also positively impact the life of machine tools and accessories.



### Process Control

As tolerances become more stringent and applications more critical (medical, aerospace), many CNC Swiss operators view the use of *centerless ground bar* as a critical step in controlling their processes.

Unlike cold drawn material, ground bars have already had significant stock removed, and they have been inspected during the grinding process. This results in a surface free from visible surface imperfections, decarburized zones, and sub-surface defects which only reveal themselves during downstream processing. Coupled with tolerances which are often tighter than print, this presents the CNC operator a compelling reason to use ground material.

### **Conclusions**

CNC Swiss operators face increasingly stringent specifications from their customers. Additionally, they are continuously challenged to become more productive and decrease operating costs in order to remain competitive.

By electing to use *centerless ground bar* instead of cold drawn material in their CNC Swiss units, precision machine shops are able to manufacture products of the highest quality while simultaneously increasing productivity and lowering costs.

### **References**

- 1 Destefani, Jim. "Mini-Multitaskers", Manufacturing Engineering, August 2005 Vol.135 No.2
- 2 Banner Service Corporation Proprietary Material Database
- 3 Various CNC Swiss OEM websites including: Citizen, REM Sales (Tsugami)

Banner Service Corporation Proprietary Customer Call Report Database