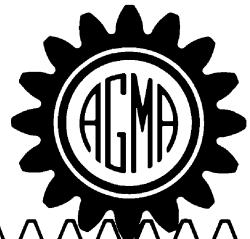


Carbide Hobbing Case Study

by: Y. Kotlyar, Bodine Electric Company

American Gear Manufacturers Association



TECHNICAL PAPER

Carbide Hobbing Case Study

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[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

In today's global economy, there is more and more pressure from the developing countries to produce gears at a greater efficiently and at a lower cost. Carbide hobbing seems as one of the technological innovations that could give both the productivity & the cost improvements.

Nowadays, nobody denies that carbide hobbing is feasible. Many questions remain, however, regarding best applications, carbide material, hob sharpening, coating and re-coating, hob handling, consistency & optimum hob wear, best cutting conditions, concerns for the initial cutting tool investment, and production cost. In short, "the devil is in the details" that sometimes are overwhelming. The industry has few (and sometimes conflicting) recommendations on these details. That is why many people in small to medium lot size manufacturing environment are not rushing to implement the carbide hobbing.

This paper is a case study of a successful implementation of carbide hobbing in one cell with annual output of 250,000 gears, average lot size of about 200-300 gears, producing gears of about 150 different sizes and pitches, with 4 setups per day on average. Most of gears are finish hobbled to AGMA 9 quality level. The pitch ranges from 12 to 64 DP.

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1. Application and historical perspective
2. Considerations for new technology
3. Hobbing test
4. New hobbing technology
5. Support systems
6. Improvements Summary

Introduction.

Bodine Electric had a 90-year history of fine and medium pitch gear manufacturing. Like anywhere else, traditions, old systems, and structures can be beneficial, but they can also become paradigms and obstacles to further improvements. We were producing a high quality product, and our goal was to become more cost effective.

Carbide hobbing is seen as a technological innovation capable of enabling a dramatic, rather than an incremental, enhancement to productivity & cost savings. Nowadays, no one denies that carbide hobbing is feasible. Many questions remain, however, regarding best applications, carbide material, hob sharpening, coating and re-coating, hob handling, consistency & optimum hob wear, best cutting conditions, concerns for the initial cutting tool investment, and production cost.

In short, "the devil was in the details" became, at times, overwhelming. The industry had few, and sometimes conflicting, recommendations on these

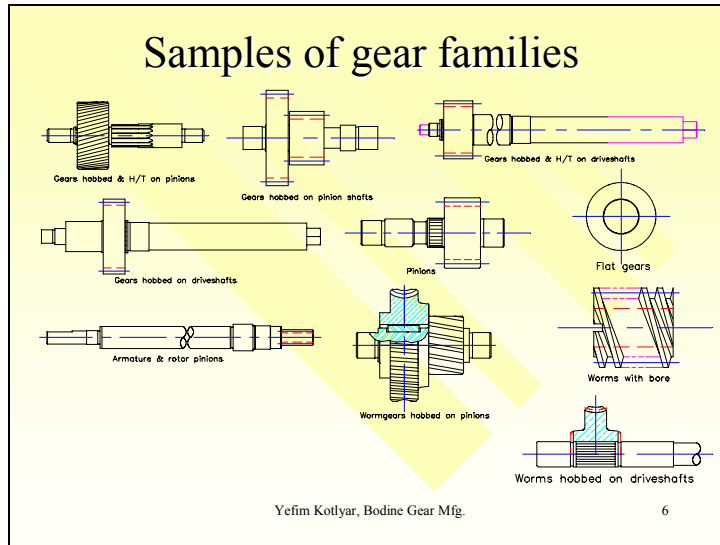
details. This is why many companies, manufacturing in small to medium lot sizes, were not rushing to implement carbide hobbing. Also, some companies tried and then abandoned this technology altogether.

This paper is a case study featuring one manufacturing cell solely implemented with carbide hobbing technology. The annual output is 250,000 – 300,000 gears, with an average JIT lot size of about 200-300 gears. Approximately 150 different sizes and pitches are produced, with an average of four setup changes over two-shift. Most of the gears are finish hobbled to AGMA 9 quality level. The pitch ranges from 12 to 64 DP.

This paper's emphasis is on carbide hobbing. The successful performance of carbide hobbing is predicated on various contributing factors such as machine, fixture, blanks, hob maintenance, and process management systems. These factors will also be discussed.

1. Application and Historical Perspective.

Bodine Electric produces a large variety of parts with gearing elements -- spur and helical gears, shafts, solid and bore type pinions, worms, and worm gear. For the introduction of carbide hobbing, we decided to select the "Flat" gear family because of its large volume.



Machines.

Initially, we had only outdated hobbing machines in the Flat Gear cell. The average machine age was 20 years. The usage of longer and higher performance hobs was limited by the machine's RPM and shifting capability. Only two (out of five) hobbing machines had automatic shifting. There wasn't precise control on hob positioning relative to the workpiece or the hob shifting distance. These machines were in constant need of maintenance.

Fixturing and Automation.

Only two machines in the cell had an automatic loader. Fixturing and automation documentation was not readily available. Some of the fixture items were reverse engineered and not always compatible with each other. Our company relied mostly on the experience of setup people. This led to a wide variance in setups, fixture, and cutting conditions.

Cutting Tools.

A long-standing tradition in fine pitch manufacturing was the usage of so-called

"Square" hobs made out of High Speed Steel. Usage of carbide and longer hobs was limited by machine's RPM capability and shifting length respectively.

Some machines did not have automatic shifting. There wasn't a precise control on hob positioning relative to workpiece.

Cutting Conditions.

Our practice was to use very conservative cutting conditions that were outdated. Different machines had different limitations with respect to rigidity and RPM capability. The performance of each machine was not monitored. The cutting conditions and cycle times could vary depending on the setup person, machine, inspection results, and cutting tool used at the time.

Blanks.

All blanks were outsourced. The suppliers would grind one face of the gear blanks, enabling us to stack (3-5) parts per load during the hobbing process. Despite this effort, the bore's quality and face parallelism were inconsistent.

Outsourcing.

In addition to five machines making flat gears in-house, we were outsourcing hobbing & skiving at an annual cost of \$281,000. Add to that the annual blanking outsourcing of \$563,000, our total flat gear outsourcing cost came to \$844,000. Other concerns with outsourcing were quality and on-time delivery.

Quality.

The flat gear process variation was out of control as shown on the graph. We had extremely knowledgeable people that were able to produce quality parts despite using old technology. Many setups would turn into development projects, thus taking its toll on our productivity and profitability.

The high quality of product was maintained at a cost. Extra, non-value added steps of 100% inspecting and sorting were necessary.

In short, the cost of flat gear manufacturing was high. We wanted to improve the process and replace the “product control” with the “process control”

Productivity. Cycle times were very long. Frequently, to achieve the desired quality, setup personnel would use more conservative cutting conditions; thus further increasing cycle times and reducing productivity. On average, there was less than one setup per machine per day. The inexpensive conventional off-the-shelf “square” hobs had to be re-sharpened quite frequently, thus disrupting production flow.

Lean manufacturing stresses the importance of JIT manufacturing and continuous reduction of WIP. This leads to smaller lot sizes and greater setup frequency per day.

