

**NORTON**

SAINT-GOBAIN

**MACHINING TO GRINDING  
FOR GEAR MANUFACTURE**

## ELIMINATES ROUGH CUTTING THE GEARS

- Grinding from solid eliminates the need for a cutting/milling machine and all the complementary tooling and equipment required to start and maintain the rough cutting operation
- Typically a rough-ground gear will be of the same or higher quality than a hobbed, near-net or cut gear – particularly larger bevel gears and gear sets
- Norton MTG wheel specifications create the flexibility to combine grinding in the soft state from solid, to hard finishing – with only one grinder



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## MTG CASE HISTORY

### Large Spiral Bevel Gears

Grinding bevel and pinion gear sets from solid, at a key OEM

#### Customer Assessment

- OEM was approached by a customer interested in producing large gears from a blank
- This customer typically consumes 2,500 gear sets per year
- The cost of purchasing these gear sets escalated dramatically
- Could OEM provide one machine capable of roughing and finishing gears?
- Development work by OEM and Norton application engineers proved that gears could be efficiently ground from solid, and then finish-ground on the same machine

#### TEST DATA

<i>WHEEL SIZE:</i>	19.500" x 3.500" x 1.800" rim
<i>WHEEL TYPE:</i>	O2, plate-mounted cylinder
<i>WHEEL SPECIFICATION:</i>	TG2-80-VPAP
<i>WORKPIECE MATERIAL:</i>	8620, Hardness: 38-42 Rc
<i>BEVEL GEAR:</i>	63 teeth: 21.278" OD, 4.875" face width, 27° helix angle, whole depth .625"
<i>PINION:</i>	40 teeth: 14" OD, .875" face width, 27° spiral angle, whole depth .625"
<i>MACHINE MODEL:</i>	Gleason Phoenix® II 600 Bevel Gear Grinder, 45 hp
<i>WHEEL SPEED:</i>	4,500 SFPM
<i>COOLANT:</i>	Straight oil, high pressure system – chilled and filtered 60 GPM @ 75-80 PSI
<i>MTG RATE OF CUT:</i>	2.35 cubic inches per minute
<i>TYPE DRESSER:</i>	Rotary
<i>TRUING/DRESSING:</i>	Dress every 16 teeth; total dress per 16 teeth: .004"

## TEST RESULTS

MTG Workpiece Finish: **32 RMS**

ROUGH FORM CUT BLANK GEARS FROM SOLID	ROUGH GRIND BLANK GEARS FROM SOLID
Set up cutting head with cutting blades	Eliminated
Set up cutting machine	Eliminated
Cut 5 blank gears; break down cutter head; re-sharpen cutting tools; set up head	Eliminated
Time to cut one gear: 2 hours	Time to grind one gear: 2 hours
Time to cut ten gears: 23 hours	Time to grind ten gears: 20 hours

ECONOMIC ANALYSIS – COSTS	ROUGH FORM CUT BLANK GEARS FROM SOLID	ROUGH GRIND BLANK GEARS FROM SOLID
Cutter vs. wheel costs/annum	\$16,667	\$1,525
Sharpener/dresser costs/annum	\$2,000	\$3,200
Labor and overhead costs/annum	\$209,333	\$81,911
Coolant costs/annum	\$30,000	\$21,780
Scrap disposal costs/annum	\$0.00	\$0
Quality costs/annum	\$3,000	\$1,500
Heat treat costs/annum	\$10,000	\$5,000
<b>Total costs/annum</b>	<b>\$271,000</b>	<b>\$114,916</b>

#### Test Observations and Comments

Objective met with only one capital investment grinder needed.

#### Customer Assessment

The Gleason Phoenix® II 600 bevel gear grinder successfully rough- and finish-ground the large spiral bevel ring and pinion sets providing a process that eliminated the need for a bevel-cutting machine (\$250k – \$400k) and the complementary equipment, i.e. work holding equipment (\$20k) and cutting tools (\$200k). The new grinding process also eliminated the need for resharpening and replacement of cutting tools – and the extensive costs associated with these processes.

#### Opportunities for MTG

- Small to medium job shops where there are two similar machining operations followed by grinding. Ask these questions: Are they machining? Then heat treating? Then finish grinding?
- Where an antiquated cutting machine has caused the need for a rough-machining process followed by a rough grind before the heat treat and finally a finish grind.
- Typical Industries: aerospace, land-based, heavy, off-road truck gears (soft machine, hardened and finish grind)
- Norton MTG specifications create the flexibility to grind in the soft state from solid, to finish in the hardened product – with only one grinder.
- Particularly suitable for prototypes or small-lot production.

## HELICAL SPIRAL BEVEL GEAR SET



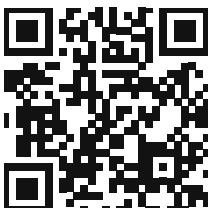
Before MTG – Blank



After MTG – Formed



Targa Wheel Grain After Grinding from Solid



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