

POSSIBILITIES OF INNOVATIVE TECHNOLOGICAL PROCESS INITIATION IN GEAR-GRINDING SECTOR OF "ZMM NOVA ZAGORA" LTD

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Abstract: The manufacturing programme, production conditions and applied technologies for the mechanical treatment of gears in company "ZMM Nova Zagora" Ltd. are analyzed in this article. The basic formulations of an innovative technological process for grinding of gears are presented. The awaited results of the initiation of the worked-out innovative technological process are exposed.

Key words: Innovative technological process, mechanical treatment of gears, gear-grinding

Introduction

The ability for creation and introduction of innovations is of great importance for a higher competitiveness of Bulgarian companies. The combination between scientific researches and modern technologies is a good base for the creation of innovations.

The technological innovations lead to a greater production volume, higher quality of products and lower expenses for production and realization [Kunev et al. 2004]. In this aspect, the initiation of an innovative technological process in the sector of gears grinding in "ZMM Nova Zagora" Ltd. will be conducive to the realization of company strategy called "Innovations – Effectiveness – Competitiveness".

Analysis of Manufacturing

The manufacturing nomenclature of "ZMM Nova Zagora" Ltd covers 560 types of gears, as the predominant part of which is designed for lathes produced by "ZMM Sliven" Ltd. Over 60% of these gears need gear-grinding. The volume of these gears is 50 000, as almost 80% of them are subject to gear-grinding. 340 types of gears have an external diameter up to 500 mm (Table 1) and modulus up to 5 mm (Table 2), respectively, as 99,9% of them have a diameter up to 400 mm, while over 99% have modulus up to 4 mm.

The series of manufacturing includes a large range of gears – from 4 to 1000 pieces. As it is evident in Fig. 1, 82,5% of the gears are in series up to 200 pieces, which is 33% (see Fig. 2) of the manufactured gears.

The parts produced are to the total value of 1 200 000 levs, as the part of the gear grinded is 88% of this value.

In the sector for gear-grinding there are the following (Fig. 3):

- Three machines with abrasive worm OKAMOTO 360-R (position 6) for mechanical treatment of gears with a diameter up to 315 mm;
- Three machines with abrasive worm REISHAUER NZA (position 9) for mechanical treatment of gears with a diameter up to 300 mm;
- One machine NILES ZSTZ 315C (position 7) for profile grinding of gears with a diameter up to 315 mm and one machine NILES ZSTZ 630-C3P for gears with a diameter up to 630 mm.

During the treatment of gears the conventional processing methods and typical technological processes have been applied. A route technological process of a characteristic representative of the manufactured gears is shown in Fig.4.

Table 1: External diameter of manufactured gears

No	External diameter, mm	Manufactured gears in 2012							
		Type		Quantity		Value		Time for grinding	
		pcs	%	pcs	%	BGN	%	min	%
1	Up to $\varnothing 300$, incl.	300	88,24	36650	93,33	864500	68,07	456300	75,33
2	From $\varnothing 300$ to $\varnothing 400$, incl.	36	10,59	2565	6,53	294900	27,82	127250	21,01
3	From $\varnothing 400$ to $\varnothing 500$, incl.	4	1,18	55	0,14	43600	4,11	22150	3,66
	Total	340	100,00	39270	100,00	1203000	100,00	605700	100,00

Table 2: Modulus of manufactured gears

N	Modulus, mm	Manufactured gears in 2012							
		Type		Quantity		Value		Time for grinding	
		pcs	%	pcs	%	BGN	%	min	%
1	Up $m=2$, incl.	108	31,76	18070	46,01	367400	28,68	181400	29,95
2	From $m=2$ to $m=3$, incl.	200	58,82	19535	49,75	613300	50,38	320400	52,90
3	From $m=3$ to $m=4$, incl.	28	8,24	1590	4,05	187200	17,66	87600	14,46
4	From $m=4$ to $m=5$, incl.	4	1,18	75	0,19	34800	3,28	16300	2,69
	Total	340	100,00	39270	100,00	1202700	100,00	605700	100,00

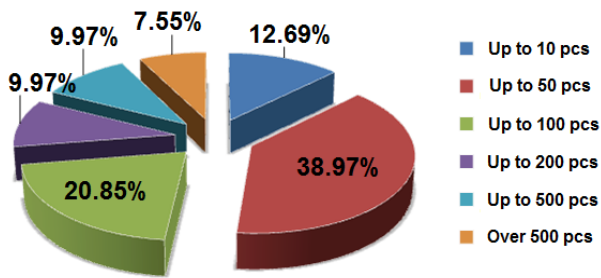


Fig. 1 Distribution of gears types in series

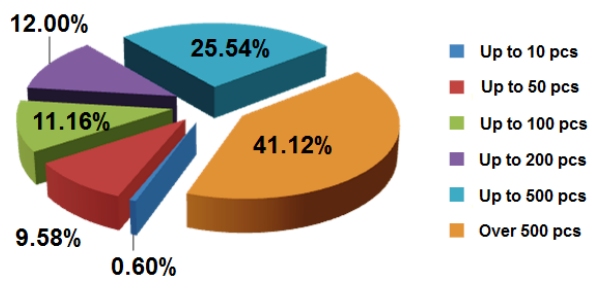


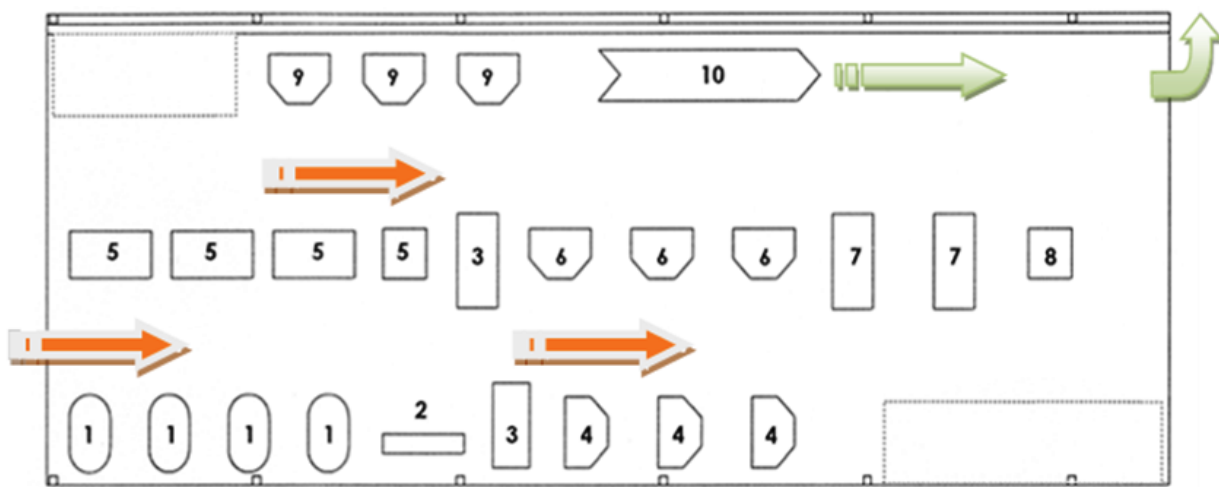
Fig. 2 Distribution of the manufactured gears in series

A predominant part of the blanks for gears are made of rolled metal, as 49% are of steel 20X. In order to be reached the prescribed gears quality the gear-grinding is usually done with feed speed of 1000 mm/min for the rough grinding and 300 mm/min for the fine grinding. Table 3 has an excerpt of

technological data for the gear-grinding of characteristic details belonging to the manufacturing nomenclature.

The operating time standard for gear-grinding is 60000 min, which is 12% of the total time necessary for the gears manufacturing.

The gear-grinding prime cost is between 10% and 12% of the total prime cost of the manufactured gears.



1 - internal grinding machines; 2 - a flat grinding machine; 3 - circular grinding machines; 4 - groove grinding machines; 5 - shaving machines; 6 - gear-grinding machines OKAMOTO; 7 - gear-grinding machines NILES; 8 - a punch-broaching machine; 9 - gear-grinding machines RAISHAUER; 10 - a washing machine;

Fig. 3 Location of the technological equipment in gear-grinding sector

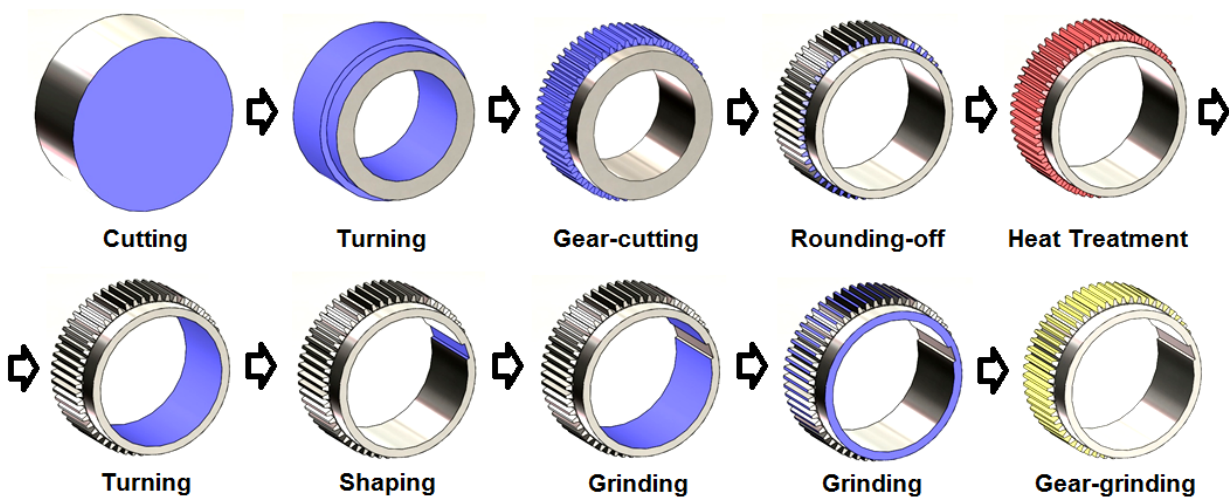


Fig. 4 Route technological process of a characteristic representative

Table: 3 Technological data for the gear-grinding of characteristic parts

No	Design No	Name	Material	Technological parameters of grinding							
				Passes, number		Allowance, mm		Feed speed, mm/min		Time for grinding, min	Prime cost, BGN
				rough	fine	rough	fine	rough	fine		
1	CY03.02.00-318T	Shaft-gear	20X	3	1	0,1	0,05	1000	300	59	7,08
2	CY03.02.00-100T	Gear	20X	3	1	0,1	0,05	1000	300	87	10,44
3	C11T-0100-038	Gear	20X	4	1	0,1	0,05	1000	300	32	3,84

The results of the analysis of the manufacturing programme and production conditions in "ZMM Nova Zagora" Ltd. are generalized in the following way:

- Gears with external diameter up to 400 mm and modulus up to 4 mm predominate.
- The technological equipment is morally antiquated and its exploitation capacity is spend.
- The manufactured gears are up to 7-th degree of accuracy and their quality is not always good.
- During gear-grinding the cutting regimes are processed at low values, which results in high operating time.
- The outside-cycle losses of time for the readjustment of gear-grinding machines, tools resharpening and tools changing are significant.
- The great consumptions for labour and technological equipment maintenance lead to high prime cost of gear-grinding.

Innovative Technological Process

An innovative technological process based on the unification principles and group technology has been developed.

The parts from the manufacturing nomenclature are grouped according technological indications in totalities (technological groups) in such a manner as the technological operations for their processing to be executed in one and the same technological route and situation (machines, equipment, adjustments, etc.)

Unified adjustments are developed for each machine in the production sector. To each adjustment corresponds a certain technological group of parts, which individual technological operations (ITOs) are executed during this adjustment. These ITOs form a unified technological operation (UTO). The details, which UTOS are identical, are members of one and the same group and are processed in one manufacturing series.

A unified group operating technological process is formed for those parts, which technological operations are executed through one and the same technological route and adjustments of the metal-cutting machines.

- The gear manufacturing nomenclature is varied with series in large ranges.

A unified group routing technological process is formed for those parts, which technological operations are executed through one and the same technological route, but at different adjustments of the metal-cutting machines.

Depending on the parts series can be formed unified group operating technological processes (for a small series) or unified group routing technological processes (for a great series).

Using the basic formulations of the innovative approach suggested, an analysis of the technological processes in gear-grinding sector of "ZMM Nova Zagora" Ltd. is made. The parts of the manufacturing nomenclature, which are subject for gear-grinding, are grouped in 11 technological groups.

The unified technological operations for the processing of parts from five technological groups are presented in Fig. 5.

The existed technological equipment in the gear-grinding sector cannot insure the necessary production environment for the initiation of the present working-out. The effective realization of the suggested innovative technological process needs CNC machines with high productivity.

Conclusions

The initiation of the innovative technological process in gear-grinding sector is looking forward to the following more important results:

- An increase of production series on the base of the initiation of unified group technological processes.
- An increase of production capacity by the increase of the effective annual fund-time as a result of the decrease of the basic and subsidiary time, as well the time for readjustments during gear-grinding.
- An improvement of quality including through insurance of conditions for the manufacturing of gears up to the 4-th degree of accuracy.
- An enlargement of the range of the manufactured gears through the start of manufacturing of gears needing internal grinding.

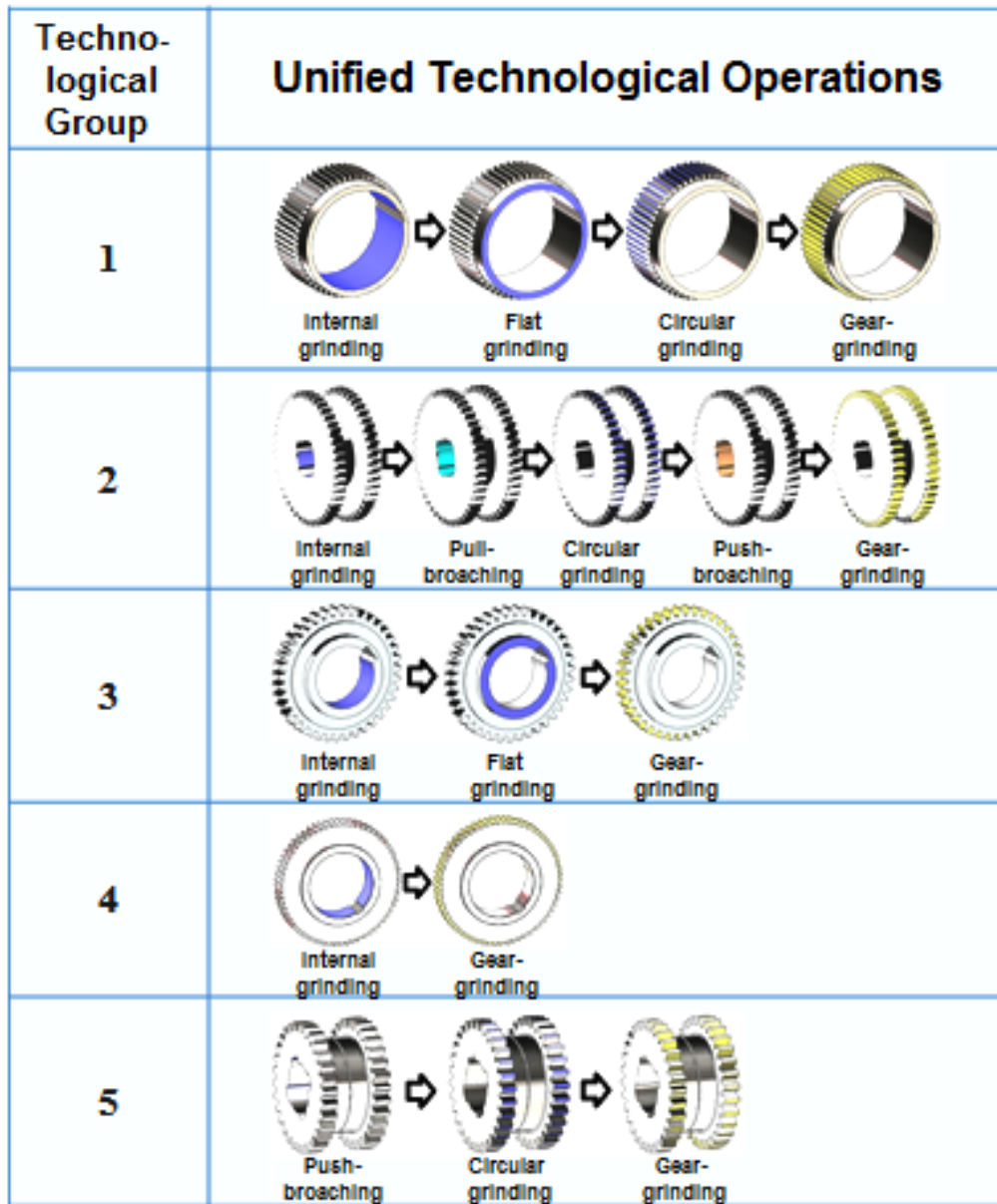


Fig. 5 Unified technological operations of characteristic technological groups

- A reduction of the prime cost of the manufactured gears as a result of the production costs decrease.
- A formation of environment for the initiation of modern CAD/CAM technology by stages in the design and the manufacturing of gears.

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