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DEVELOPMENT OF SOFTWARE FOR THE SELECTION OF PARAMETERS FOR STANDARD GRINDING CYCLES OF THE SIEMENS SINUMERIK 802D SL SYSTEM

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Abstract: An overview of the standard cycles used in the preparation of control programs for cylindrical grinding machines with the Siemens SINUMERIK 802D sl CNC system, as well as the problems associated with the assignment of their parameters, is carried out. The developed software for assigning the parameters of standard cycles used in the preparation of control programs for cylindrical grinding machines with the Siemens SINUMERIK 802D sl CNC system is being carried out.

Keywords: *cylindrical grinding, automatic cycles, parameters of grinding cycles.*

Introduction. Features of the current stage of development of mechanical engineering is characterized by the proliferation of CNC grinding machines. The use of this type of equipment can significantly increase machining productivity and improve the quality of manufactured parts. The main feature of this equipment is that the movement of the tool relative to the workpiece is pre-programmed and recorded in the form of a control program written in G codes according to the ISO standard.

The control program is a sequence of frames. It is recommended to compose the control program in such a way that only the geometric, technological and auxiliary information that changes with respect to the previous frame is recorded in the frame. To increase the performance of CNC cylindrical grinding operations, cycles are used to adapt the machining cycle to specific technological conditions [1–8]. Cycles represent the specified trajectories of movement of the working bodies of the machine. Modern CNC systems have pre-programmed machining cycles. The use of typical cycles (libraries of subprograms) for machining workpiece elements in programming greatly simplifies the compilation of a control program, reduces labor intensity and reduces the possibility of programming errors.

There are several types of single machining cycles: typical, fixed and flexible. Typical cycles reflect available cycle design guidelines for a wide range of possible machining options. Permanent (automatic) cycles are small, hard programs that cannot be changed. Flexible cycles are made as subprograms that can be changed during programming. Permanent cycles and subprograms can be repeated anywhere in the program and thus greatly simplify the programming of machining parts with several identical elements.

According to the Siemens SINUMERIK 802D sl [9] programming and operating manual for cylindrical grinding machines with CNC systems, there is the following list of cycles, for which you must enter the parameters indicated in brackets:

– cone grinding CYCLE 405 (N_SITZ, Z_START, Z_ENDE, X_START, X_ENDE, W_BREITE, UBL, RAD, B_ART, ZU_ART, BVU1, BVU2, X_A_LU, X_A_SR, X_A_SL, X_A_FS, SRZ, SLZ, FSZ, N_SR, N_SL, N_FS, D_SR, D_SL, D_FS, ESL, EFS, FX_SR, FX_SL, FX_FS, FZ_SR, FZ_SL, FZ_FS, MZ, KS, F_KS, UWERK) (see fig. 1, a);

– plunge-cut CYCLE 410 (N_SITZ, X_SOLL, Z_ST, B_ART, A_LU, A_SR, A_SL, A_FSA, F_SR, F_SL, F_FSL, TIME, MZ, KS, F_KS, OSW, F_OSCILL, UWERK) (see fig. 1, b);

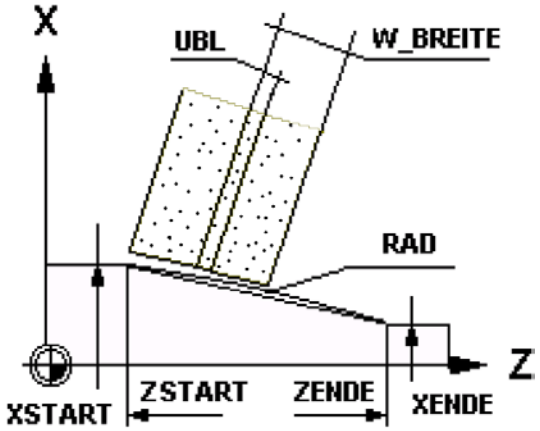
– repeated plunge-cut CYCLE 411 (N_SITZ, X_SOLL, Z_ST, Z_END, UBL, B_ART, A_LU, A_SR, A_SL, A_FSL, SLZ, FSZ, ZU_ART, BVU1, BVU2, F_PE, F_SR, F_SL, F_FSL, N_FR, MZ, KS, F_KS, UWERK) (see fig. 1, c);

–plunge-cut edge grinding CYCLE412 (N_SITZ, Z_SCH, X_ST, B_ART, A_LU, A_SR, A_SL, F_SR, F_SL, TIME, KS, F_KS, OSW, F_OSCILL, UWERK) (see fig. 1, d);

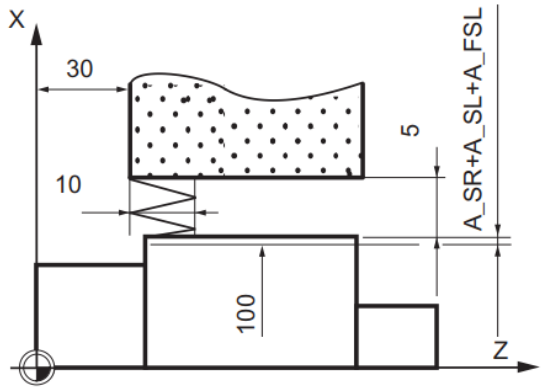
– plunge-cut grinding with angle feed CYCLE413 (N_SITZ, X_SOLL, Z_SCH, WIN, B_ART, A_LU, A_SR, A_SL, A_FSL, F_SR, F_SL, F_FSL, TIME, MZ, KS, F_KS, UWERK) (see fig. 1, e);

– swing CYCLE415(N_SITZ, X_SOLL, Z_ST, Z_END, B_ART, A_LU, A_SR, A_SL, A_FSL, SRZ, SLZ, FSLZ, ZU_ART, BVU1, BVU2, F_PE, FP_SL, FP_FS F_SR, F_SL, F_FSL, N_FR, MZ, KS, F_KS, UWERK) (see fig. 1, f);

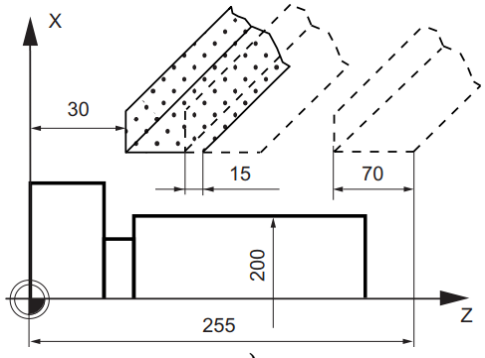
– fillet grinding CYCLE414 (N_SITZ, Z_SCH, X_ST, RAD, LAGE, A_LU, A_SR, F_SR, KS, F_KS, UWERK) (see fig. 1, g).



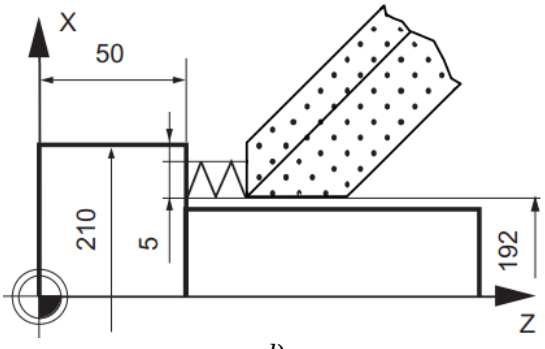
a)



b)



c)



d)

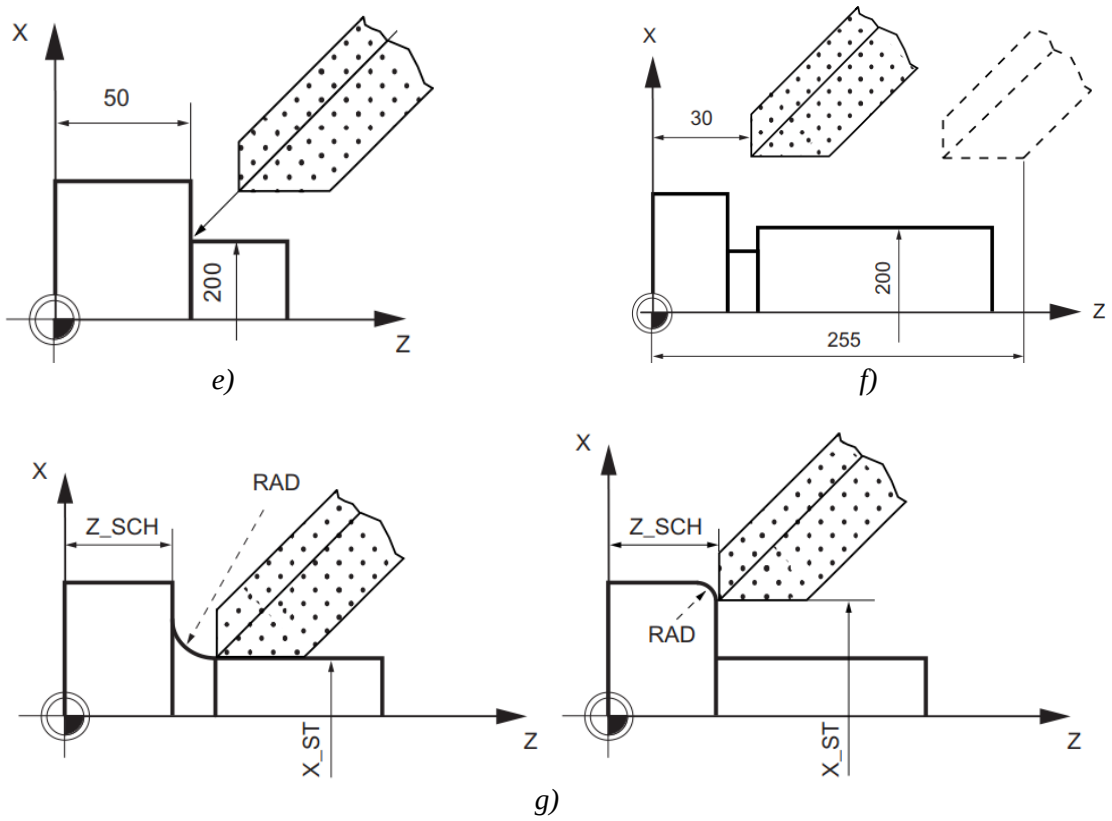


Figure. 1. SINUMERIK 802D sl CNC cylindrical grinding machine cycles [7]:
a) CYCLE 405; b) CYCLE 410; c) CYCLE 411;
d) CYCLE412; e) CYCLE413; f) CYCLE415; g) CYCLE414.

When developing a control program using the above cycles, problems arise related to the assignment of cycle parameters (for example, for the swing cycle CYCLE415, shown in Table 1), namely:

– a large number of strictly regulated parameters;
– lack of recommendations on the assignment of parameters;

Table 1. Description of swing cycle parameters CYCLE415 [7]

Parameter	Data type	Meaning
N_SITZ	INT	Support number
X_SOLL	REAL	Specified diameter (abc.)
Z_ST	REAL	Start position in Z (abc.)
Z_END	REAL	End position in Z (abc.)
B_ART	INT	Machining mode: 1= roughing 2= finishing + tweaking 3=roughing + finishing + tweaking
A_LU	REAL	Air gap (increment)
A_SR	REAL	Cut amount - Roughing (incr.)
A_SF	REAL	Cut amount - Finishing (incr.)
A_FSL	REAL	Cut amount - Tweaking (incr.)
SRZ	REAL	Feed rate value in roughing (incr.)
SLZ	REAL	Feed rate value in finishing (incr.)
FSLZ	REAL	Feed rate value in tweaking (incr.)

ZU_ART	INT	Feed rate -1 = only from left 0 = from both sides 1 = only from right
BVU1	INT	Dwell time at point of return 1
BVU2	INT	Dwell time at point of return 2
F_PE	REAL	Pendulum roughing feed
FP_SL	REAL	Pendulum finishing feed
FP_FS	REAL	Pendulum tweaking feed
F_SR	REAL	Feed in roughing
F_SL	REAL	Feed in tweaking
F_FSL	REAL	The number of moves to exit
N_FR	INT	Active control J=1 / N=0
MZ	INT	Structure-borne noise J=1 / N=0
KS	INT	Feed for grinding wheel idle passes [mm/min]
F_KS	REAL	Peripheral speed of workpiece [m/min]

To solve these problems, it is proposed to develop software that makes it easier for the technologist-programmer to choose the parameters of the cycles, which ultimately will greatly simplify the compilation of the control program. The Microsoft Excel program was considered as a software implementation tool. The functions of the program allow you to carry out almost any manipulation of numbers. The spreadsheet is the main tool that is used to process and analyze digital information using computer technology.

The peculiarity of Microsoft Excel lies in the fact that in the process of calculating, you can simultaneously operate with data that is located in different zones of the spreadsheet and at the same time are connected with a certain dependency. Such calculations are carried out due to the possibility of introducing various formulas into the cells of the table. After performing the calculation, the result will be displayed in the cell with the formula. An important feature of using a spreadsheet is the automatic recalculation of results if cell values change.

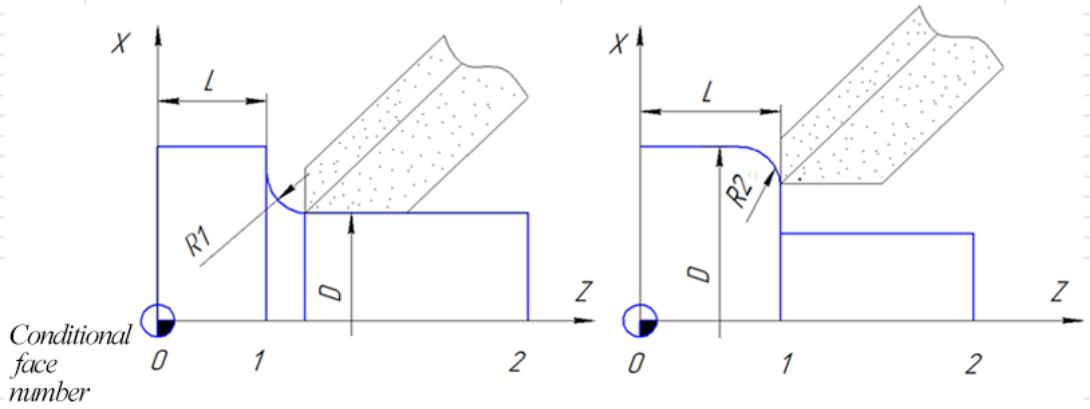
In the Microsoft Excel software environment, eight sheets were created, seven of which correspond to each of the considered cycles and one sheet contains reference information. In fig. 2 shows an example of an Excel sheet with recommendations for assigning parameters for a
canned cycle for radius grinding CYCLE414.

The worksheet (see fig. 2) is divided into 2 zones:

– zone "Initial data", here the user specifies all the necessary data for assigning parameters, such as length, required diameter, etc., depending on the type of cycle;

– parameter assignment zone. Most of the cells are filled in automatically using the original data. However, to fill in some cells it is necessary to perform a number of actions: follow the hyperlink to the sheet with reference information from the reference book of the Chelyabinsk Research Institute of Abrasives and Grinding [9], select the required variable and write in the indicated place. Finally, all data is automatically copied into one record, resulting in a cycle record that can be used on the machine.

INITIAL DATA



Designation in the figure	Value
Conditional face number	1
L	55
D	200
R1	
R2	10
Value of cut amount	0,2
Using a structure-borne noise recorder	yes
Processed material	

Parameter	Meaning	Recommendations	Indicator
1	2	3	4
N_SITZ	The number of the step with the machined surface relative to the 0-part	According to the initial data	1
Z_SCH	Dimension to the end along the Z axis: using this parameter, the value of the width of the technological section of the part is entered, the dimension between the zero of the part to the machined end, mm	According to the initial data	55
X_ST	Start position at X, i.e. coordinate along the 0X axis, corresponding to the initial position of the grinding wheel in the direction of the 0X axis, relative to the 0-part	According to the initial data	200
RAD	Part radius i.e. the required value of the radius of the technological section of the part is entered	According to the initial data	0
LAGE	The processed corner can be both internal and external. Depending on this, this parameter has the value	23 - inner corner, i.e. processing is performed clockwise; 31 - outer corner, i.e. processing is performed counterclockwise;	31
A_LU	Cut amount for idle passes of the grinding wheel: safe position of the tool during idle strokes, i.e. distance between the starting position of the grinding wheel and the roughing allowance	It is recommended to assign this parameter from 5 to 10 mm	5
A_SR	Cut amount for rough machining, increment of coordinates of cut amount during rough machining, mm	According to the initial data	0,2
F_SR	Feed for roughing passes, i.e. increment of grinding wheel feed at reversal points during pendulum grinding	Selected according to reference table 7	50
KS	This parameter specifies the use of the structure-borne noise recorder	1- if used 2- if not used	1
F_KS	The feed value of the grinding wheel at idle, i.e. value of the feed rate with which the grinding wheel travels the distance between the starting point and touching the part with the tool, mm/min	Selected according to reference table 7	700
UWERK	Workpiece rotation speed during machining, m/min	According to reference table 7, the rotation frequency of the workpiece n3 is selected and E is recorded in the corresponding cell	20

n = 32

Fig. 2. Parameter assignment for radius grinding CYCLE414.

Results. A software tool has been developed in the form of a Microsoft Excel book containing tables from the reference book of the Chelyabinsk Research Institute of Abrasives and Grinding. The software tool allows you to determine the parameters of the standard grinding cycles of the Siemens SINUMERIK 802D sl system using reference data.

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