SolidCAM 2011 GPPTool

What's New

Content

1. General

1.1 User-defined Post-processor

For each particular CNC-machine controller, three files are needed as input to GPPtool. These files are:

(1) machine.prp
(2) machine.gpp
(3) machine.vmid

where [machine] is any name chosen by the user for the particular CNC machine controller.

The file [machine.prp] defines the Pre-processor parameters that affect the tool-path generation in **SolidCAM**.

The file [machine.gpp] defines the Post-processor parameters and the GPPL procedures that define how the **SolidCAM** tool-path commands develop into G-Code for the particular CNC controller.

Both these files can be generated and edited using any text-editor at the disposal of the user.

1.2 Trace statement

Format:

trace <procedures>:<trace-level>

Description:

GPP will produce trace information while generating G-Code. The trace information will be generated only for those **SolidCAM** and user procedures which are defined in <procedures> list (see examples below). The <trace-level> determines how much information will be generated. The <trace-level> value must be in the range of 0 to 5, where 0 means no trace information at all, and 5 gives the maximum trace information available.

This information is of great interest in the development phase of a new post-processor; it can significantly shorten the time required to develop such a post-processor.

Examples:

trace “all”: 1	-	All **SolidCAM** and user procedures will be traced with the minimum trace information available.
trace "@proc":level	-	only procedure @proc will be traced, either it is **SolidCAM**'s or user's one**.**

Level definition:

level=0: no trace information
level=1: procedure routine name will be printed
level>1: trace data in produced.

Notes:

- @init_post is the only procedure that will NOT be traced. This is because @init_post initiates many internal variables, include the trace mode. Only after @init_post is executed **GPPTOOL** knows what procedures should be traced, and at what level.
- The trace printout contains the nesting level of the procedure, followed by the procedure name, and followed by a ">" symbol. After that symbol comes the trace data and the generated G-Code. Data.

Examples:

- if @line calls @user1 which calls @user2 (@line ==> @user1 ==> @user2)

  (1)@line > ....
  (2)@user1 > ....
  (3)@user2 > ....

- if @line calls @user1 and then calls @user2 (@line ==> @user1, @user2)

  (1)@line > ....
  (2)@user1 > ....
  (2)@user2 > ....

- If **SolidCAM** called to @proc and this proc was not in the GPP file, the trace would still trace it.

Note:

1. Nesting level for these procs is (0) give you extra information that the proc is missing.
2. If a proc is called from other proc - error message is displayed.

Example:

if @rapid_move does not exist, the trace printout prints it as nesting 0, but if that proc is called from @start_of_file for example, an error message is displayed.

1.3 GPPL Variables

Variable definition

A GPPL variable should adhere to the following rules:

- The first character should be a letter.
- All the other characters should be either a letter, digit or '_'.
- A variable name should not exceed **60** characters.

Note that **GPPL** does not distinguish between lower case and upper case (CAPITAL) letters.

Examples:

xpos , gcode_f , x0

1.4 Display Affix format

This is a new feature of a format string of a numeric variable or expression. GPPL will insert before or append after the number the required prefix of postfix (herein: affix) The <prefix> or <postfix> located at the very beginning or end of the format string, surrounded by '<' and '>' characters.

<prefix><sign><leading-zeroes><integer>.<fraction><trailing-zeroes><options><postfix>

- The affixes are optional.
- Affix might contain no string inside: '<>5.2'. This is the same as not write the <> at all.
- Affix length is limited by 31 characters. If a longer string is found, GPP will use the first 31 chars and will ignore the rest. No error message is produced.
- String variables do not have any format. Only numeric variables.
- The character '>' cannot be used inside the affixes strings..

Examples:

- '<X>5.2(p)' will print "X" just before the number.
- '5.2(p)<abc>' will append "abc" to the number.
- '<X>5.2<abc>' will produce both prefix and suffix.
- Old method: The below example will generate the correct number of spaces.

xpos_f = <X>5.3

ypos_f = <Y>5.3

zpos_f = <Z>5.3

{nb, [xpos' '], [ypos' '], [zpos' ']}

Affix method: The below example will generate the correct number of spaces.

xpos_f = <X>5.3< >

ypos_f = <Y>5.3< >

zpos_f = <Z>5.3< >

{nb, [xpos], [ypos], [zpos]}

1.5 GPPL Internal String functions

1.5.1 replace function

s = replace(str, oldstr, newstr [, k])

Parameters:

Str - string to search in

Oldstr - string to search for

Newstr - string to replace

K - (optional). how many occurrences of oldstr to replace:

= 0: replace all occurrences of oldstr (same if k is omitted)

> 0: replace first k occurrences of oldstr

< 0: replace last k occurrences of oldstr

Description:

This function replace the k appearance of the Oldstr in str with Newstr and returns the str. If oldstr was not found the function returns str as the result string. Note that GPPL does distinguish between lower and upper case letters.

Examples:

Valid:

s = replace("abacad", "a", "x", 0) ==> s = "xbxcxd" (one to one)

s = replace("abacad", "a", "xy", 0) ==> s = "xybxycxyd" (one to many)

s = replace("abacad", "a", "", 0) ==> s = "bcd" (one to null)

s = replace("abacad", "ac", "X", 0) ==> s = "abXad" (many to one/many)

s = replace("abacad", "x", "y", 0) ==> s = "abacad" (nop)

s = replace("abacad", "a", "xa", 0) ==> s = "xabxacxad" (no recursion)

s = replace("", "a", "x", 0) ==> s = "" (nop)

s = replace("abacad", "", "x", 0) ==> s = "abacad" (nop, not error)

s = replace("abacad", "A", "x", 0) ==> s = "abacad" (case sensitive)

s = replace("ab"+"acad", "a", "x", 0) ==> s = "xbxcxd" (expressions allowed)

s = replace("abacad", "a", "x", 2) ==> s = "xbxcad" (only first 2 occurrences)

s = replace("abacad", "a", "x", -2) ==> s = "abXcXd" (only last two occurrences)

s = replace("abacad", "a", "x", 8) ==> s = "xbXcXd" (same as k=0, no error)

Invalid:

s = replace(123, "a", "b", 0) ==> first arg should be string

1.5.2 instr function

instr (str, sub_str, val)

Parameters:

Str - the string expression to be searched.

sub_str- the string expression to be searched for.

Val - the start column to begin the search.
This is optional parameter. default value is 1.

Description:

This function searches for the appearance of the sub_str in str from the Val column and returns its position from the beginning of str. If sub_str was not found the function returns 0. Note that GPPL does distinguish between lower and upper case letters.

Examples:

instr('abcd', 'cd') ==> 3

instr('abcd', 'x') ==> 0

instr('abcd', 'Cd') ==> 0 (lower/upper case sensitivity)

instr('abcdabcd', 'cd') ==> 3 (the first occurance is taken)

instr("supercalifragilisticexpialidocious", "li", 12) ==> 15 (not 8)

1.6 ^ Operator

This operator is defined to perform the same task as the pow(b, p) function.
GPPL pow(b, p) function returns the value of b raised to the power of p.

a = b ^ p It is equivalent to a = pow(b, p);

Parameters:

b - any numeric expression.

p - any numeric expression.

Note:

Tthe ^ operator is right associated.

Example:

x = 4 ^ 3 ^ 2 ==> 4 ^ (3 ^ 2) = 4 ^ 9 = 262,144

1.7 Exit statement

The 'exit' statement stops the execution of the current P-Code (@line, @rapid_move etc), and continues to execute the next P-Code. GPP stop executing the P-Code no matter in which level of subroutines it is, and no matter in which level of if/while block it is.

1.8 Abort statement

The GPP abort statement stop the G-Code generation process no matter the subroutines level or if/while clauses.

1.9 Break statement

- Inside a while clause, 'break' will ignore all statements till the most inner 'endw' statement, and continue execution at the first statement after the 'endw'. Outside a while clause 'break' is valid but does nothing (=nop).
- 'break' is limited to the @proc boundary: GPP searches for 'endw' only in the @proc of the 'break' statement, and does not search in any calling @proc.
- 'break' can (and usualy should) be inside an if/then/else clause, unlimited nested.

1.10 Return statement

- GPPL will stop executing the @proc, and continue executing the calling @proc. The 'return' statement might be in any place of the @proc, including under any nesting level of if/while clauses.
- Note that both 'break' and 'return' statements have local effect: they are limited to the @proc boundary. 'exit' and 'abort' statements are not limited to @proc boundary and have more global effect: either immediatelly stop execution of the most outer @proc and continue executing the next P-Code generation ('exit'), or immediatelly stop generating G-Code at all.

1.11 Stop GCode generation after errors

SolidCAM gives the possibility to break the GPP post processing if any error occurs. If **SolidCAM** detected any error in GPP file during post processing time then **SolidCAM** shows message with description of this error. On this massage dialog there are “OK” and 'CANCEL' buttons. Click on OK button let **SolidCAM** continue with the post processing. Pressing the 'CANCEL' button stop and exist from the post processing.

1.12 Make_dir command

There is a new GPPL command that is helpful in generating the documentation file :

- Create a folder at the beginning of the documentation generation process:
  { '!! make dir = c:\\dir name !!' }

Example:

path_nc_code = 'c:\\nc_code_dir'

{nl,'!!make dir='path_nc_code'!!'}

A folder named path_nc_code will be created under C.

1.13 Include Facility Design

1.13.1 Syntax

synopsis

inc <literal>
Where <literal> is a constant string.

Examples:

Valid:

```
Inc "abc"
```

Invalid:

```
Local string fn
Fn = "abc"
Inc fn          [variables are not allowed. Only literals]
```

1.13.2 Place

Include will only be valid between procedures.

Examples:

Valid:

```
Proc @line
…
Endp
Inc "abc"
Proc @rapid_move
…
Endp
```

Invalid:

```
Proc @line
Inc "abc"               [include is forbidden inside a procedure]
…
Endp

Proc @rapid_move
…
Endp
```

1.13.3 Nesting

Include statements might be nested to a maximum depth of 16 levels. So it is possible to an included code to contain include statements. Direct or indirect recursion of include statements is forbidden.

Examples:

Valid:

```
File: abc.gpp
Proc @line
…
Endp

Inc "xyz"

Proc @rapid_move
…
Endp

File: xyz.gpp
Proc @user_p1
…
Endp

Other optional include statements

Proc @user_p2
…
Endp
```

Invalid:

```
File: abc.gpp
…
Inc "abc"              [Direct recursion is forbidden]

File: abc.gpp
…
Inc "xyz"

File: xyz.gpp
…
Inc "abc"              [Indirect recursion is forbidden]
```

1.13.4 Error messages

GPPL error messages shall display both file name and line number of erroneous line. Only file name will be displayed and not the full path of the file.

1.13.5 GPP file location

Include files will be search according to the standard search logic as for the main GPP file.

1.13.6 GPP file Encryption

An include file might be either encrypted or not. An encrypted file might include a non-encrypted one and vice versa.

1.13.7 Include initialization

An include file may contain a special procedure named '@init_inc'. GPPTool will automatically call this proc after calling to @init_post. That proc serves as an initialization routine for that file. It is a proper place to define global variables that are used in the included file, but the writer should consider that although defined in the included file they are also known at other GPP files. GPPTool does not support variables which are known inside a single file only.

Since a main GPP file might include several GPP files, and some of the included files might also include other GPP files, there are many @init_inc procedures – one for every file. GPPTool will automatically call every @init_inc procedure just after calling to @init_post proc. Note that GPPTool does not guarantee any sequence of calling to @init_inc procedures! It only guarantees that each proc will be called exactly once. More that this: it is possible that the sequence of calling to these routines will be different during different runs of GPPTool. This is a design feature.

2. Postprocessor's writing style

2.1 The old Postprocessor's writing style

One of the most complicated tasks for the postprocessor developer is to set the home in the right place. The difficulties start with the need to set the **PRP** parameters correctly. The following **PRP** parameters have to be defined:

_4th_axes_around	=	Z/Y/X
first_rotation_angle	=	Z/X
_5th_axes_around	=	Z/Y/X
_5x_rotary_axes	=	YZ/ZX/XY/YX/ZYX
tilt_axis_dir	=	CCW
tilt_axis_dir_CW_CCW	=	Y/ N

This set of parameters influent the angles calculation for GPP subroutines: @tmatrix and @home_data. The postprocessor developer has to decide which set of angles that exist in @tmatrix and @home_data he needs to use:

```
..> rotate_angle_x:0.000T rotate_angle_y:0.000T rotate_angle_z:180.000T
..> opposite_rotate_angle_x:180.000T opposite_rotate_angle_y:180.000T
..> opposite_rotate_angle_z:0.000T
 .> rotate_angle_x_dir:cw rotate_angle_y_dir:cw rotate_angle_z_dir:cw
..> x_angle_const_z:0.000T y_angle_const_z:0.000T dev_angle_z:-180.000T
..> opposite_x_angle_const_z:-180.000T opposite_y_angle_const_z:-180.000T
    opposite_dev_angle_z:0.000T
..> x_angle_const_z_dir:cw y_angle_const_z_dir:cw dev_angle_z_dir:cw
..> x_angle_const_y:0.000T z_angle_const_y:0.000T dev_angle_y:-180.000T
..> opposite_x_angle_const_y:0.000T opposite_z_angle_const_y:0.000T
..> opposite_dev_angle_y:-180.000T
..> x_angle_const_y_dir:cw z_angle_const_y_dir:cw dev_angle_y_dir:cw
..> y_angle_const_x:0.000T z_angle_const_x:0.000T dev_angle_x:-180.000T
..> opposite_y_angle_const_x:0.000T opposite_z_angle_const_x:0.000T \
..> opposite_dev_angle_x:180.000T
..> y_angle_const_x_dir:cw z_angle_const_x_dir:cw dev_angle_x_dir:cw
..> angle_4x_around_x:0.000T angle_4x_around_y:0.000T
..> angle_4x_around_x_dir:cw angle_4x_around_y_dir:cw
```

Sometimes some angles have to be taken with opposite signs.
Sometimes no set of angles are correct for the kind of a machine. In this case the postprocessor developer needs to make his own calculation by using transformation matrix.

```
..> tmatrix_l_1:-1.000T tmatrix_l_2:0.000T tmatrix_l_3:0.000T tmatrix_l_4:0.000T
. .> tmatrix_l_5:0.000T tmatrix_l_6:-1.000T tmatrix_l_7:0.000T tmatrix_l_8:0.000T
..> tmatrix_l_9:0.000T tmatrix_l_10:0.000T tmatrix_l_11:1.000T tmatrix_l_12:0.000T
..> tmatrix_l_13:0.000T tmatrix_l_14:0.000T tmatrix_l_15:0.000T tmatrix_l_16:1.000T
```

- Some controllers have build-in new home calculation, as CYCLE 19 exist in the Hermle machine:

```
if save_x_angle_const_y <> opposite_x_angle_const_y
 or save_z_angle_const_y <>   opposite_z_angle_const_y ;
 or change_tool_flag == true
      {nb, ';'}
      {nb, 'CALL LBL 100'}
      {nb, 'L  Z+0 R0 FMAX M92'}
      {nb, 'CYCL DEF 7.0 NULLPUNKT'}
      {nb, 'CYCL DEF 7.1  X', shift_x:xpos_f}
      {nb, 'CYCL DEF 7.2  Y', shift_y:xpos_f}
      {nb, 'CYCL DEF 7.3  Z', shift_z:xpos_f}
      {nb, 'L  A', (-opposite_x_angle_const_y):xpos_f, '  C',
            (-opposite_z_angle_const_y):xpos_f, ' R0 F99999'}
      {nb, 'CYCL DEF 19.0 BEARBEITUNGSEBENE'}
      {nb, 'CYCL DEF 19.1  A', (-opposite_x_angle_const_y):xpos_f, '  C',
            (-opposite_z_angle_const_y):xpos_f}
endif

save_x_angle_const_y = opposite_x_angle_const_y

save_z_angle_const_y = opposite_z_angle_const_y
```

This option make the work of the postprocessor developer easier, but he still needs to decide what to do with the deviation angle depend with the possibilities of the machine. If the machine doesn't support the CYCLE 19 the developer needs a lot of effort to write the post.

Example:

The calculation for Makino controller for **TABLE-TABLE** machine ZX kinematic:

```
(9999)

(HOMES TRANSLATION FOR VERTICAL 5AXES MACHINE)
(5AXE AROUND X)
(PLEASE USE FORMAT  "G65 P9999 I..J..K..C..A..U..D..)
(EXPLAIN: I = X ADRESS IN NEW HOME )
(-------------- J = Y ADRESS IN NEW HOME )
(-------------- K = Z ADRESS IN NEW HOME )
(-------------- C = C ANGLE DISPLACEMENT RELATIVE FROM EXISTING HOME,TABLE)
(-------------- A = A ANGLE DISPLACEMENT RELATIVE FROM EXISTING)
(--------------         HOME,AROUND X +30_-120)
(-------------- U = NUMBER OF OLD HOME: 54,55,.....,59)
(-------------- D = NUMBER OF NEW HOMELIKE U)

(#[5201+#22] = X MAC HOME)
(#[5202+#22] = Y MAC HOME)
(#[5203+#22] = Z MAC HOME)
(#[5204+#22] = A MAC HOME)
(#[5205+#22] = C MAC HOME)


(#1 - SHIFT Angle A POS)
(#3 - SHIFT Angle C POS)
```

```
(#4 - SHIFT X = I POS)
(#5 - SHIFT Y = J POS)
(#6 - SHIFT Z = K POS)

(OLD ROTATION CENTER)
(15.06.06)
(#13=-154.993                          TABLE ROTATION CENTER Y-AXIS)
(#14=-255.056                          TABLE ROTATION CENTER X-AXIS)
(#16=-600.036                          ROTATION CENTER Z-AXIS)
(#17=-154.935                          ROTATION CENTER Y-AXIS)

#13=-155.008                           ( TABLE ROTATION CENTER Y-AXIS)
#14=-255.067                           ( TABLE ROTATION CENTER X-AXIS)
#16=-600.020                           ( ROTATION CENTER Z-AXIS)
#17=-154.956                           ( ROTATION CENTER Y-AXIS)
#22=[#21-53.]*20.                      ( U )
#23=#7-53.                             ( D )
#124=-#1
#125=-#3
#126=#[5204+#22]                       ( A of MAC rotation)
#127=#[5205+#22]                       ( C of MAC rotation)
#130=#126                              ( A of MAC with opposite sign for back rotation)
#131=#[5202+#22]-#17+#5                ( Y distance from POS to A )
#132=#[5203+#22]-#16+#6                ( Z distance from POS to A)
#133=#131*COS[#130]-#132*SIN[#130]     ( Y distance from POS to A after rot -A MAC)
#134=#131*SIN[#130]+#132*COS[#130]     ( Z distance from POS to A after rot -A MAC)
#135=#133+#17                          ( Y distance from POS to abs after rot -A MAC)
#136=#134+#16                          ( Z distance from POS to abs after rot -A MAC)
#100=#[5201+#22]-#14+#4          ( X distance from POS to Rot Axis C before rot -C MAC)
#101=#135-#13                    ( Y distance from POS to Rot Axis C before rot -C MAC)
#103=#100*COS[#127]-#101*SIN[#127]     ( X distance from POS to Rot Axis C after rot -C MAC)
#104=#100*SIN[#127]+#101*COS[#127]     ( Y distance from POS to Rot Axis C after rot -C MAC)
#150=#103                              ( X distance from POS to Rot Axis C)
#151=#104                              ( Y distance from POS to Rot Axis C)
#103=#150*COS[-#127+#125]-#151*SIN[-#127+#125]  ( X distance from POS to Rot Axis C after rot C)
#104=#150*SIN[-#127+#125]+#151*COS[-#127+#125] ( Y distance from POS to Rot Axis C after rot C)
#105=#103+#14                          ( X distance from POS to abs after rot C)
#106=#104+#13                          ( Y distance from POS to abs after rot C)

#107=#136                              ( Z distance from POS to abs after rot C)
#117=#106-#17                          ( Y distance from POS to A after rot C)
#118=#107-#16                          ( Z distance from POS to A after rot C)
#137=-#[5204+#22]+#124                 ( A of POS)
#119=#117*COS[#137]-#118*SIN[#137]     ( Y distance from POS to A after rot C & rot A)
#120=#117*SIN[#137]+#118*COS[#137]     ( Z distance from POS to A after rot C & rot A)
#121=#105                              ( X distance from POS to abs after rot C & rot A)
#122=#119+#17                          ( Y distance from POS to abs after rot C & rot A)
#123=#120+#16                          ( Z distance from POS to abs after rot C & rot A)

#128=#126+#1
#129=#127+#3
G90 G10 L2 P#23 X#121 Y#122 Z#123 C#129 A#128

M99
```

2.2 The New Postprocessor's writing style

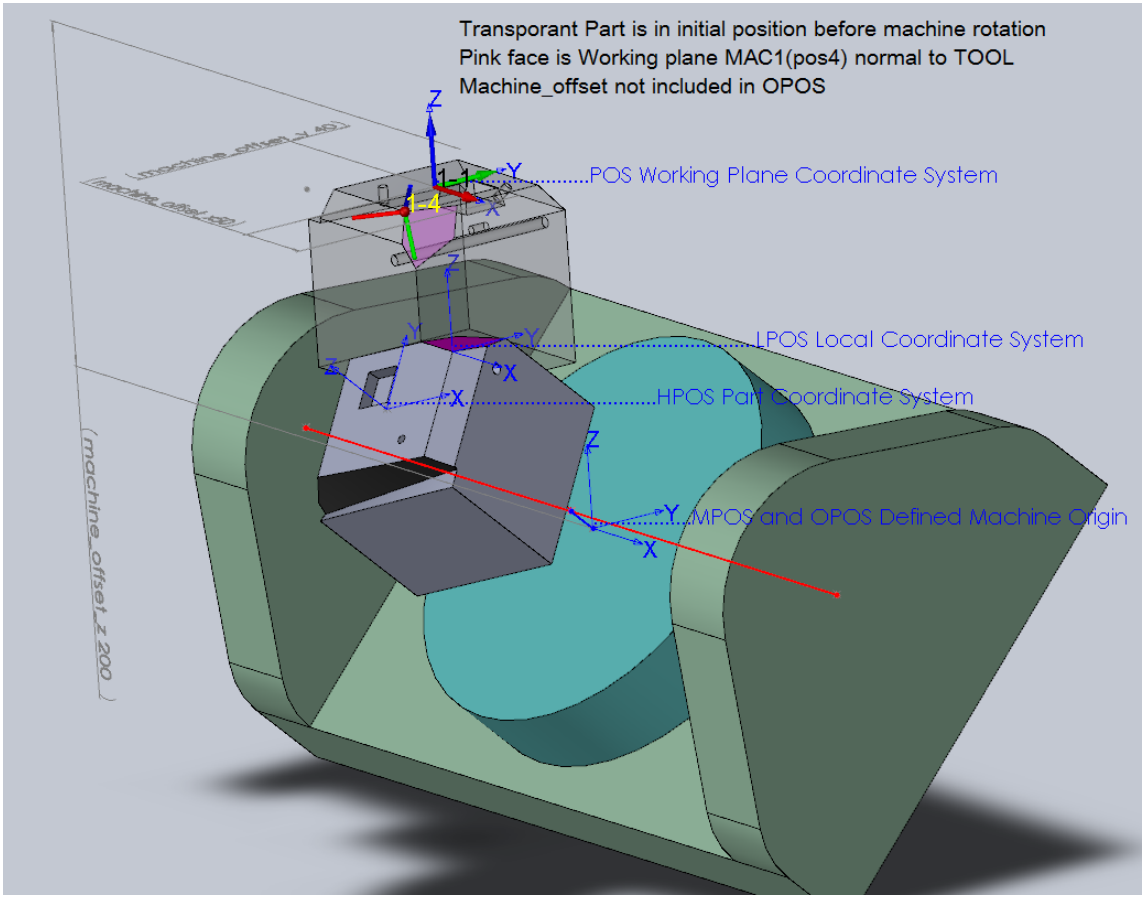
The postprocessor developer does not have to take care about defining of the **PRP** parameters and the GPP @home_data and @tmatrix subroutines.

2.2.1 Type of the supported coordinate systems SolidCAM provide

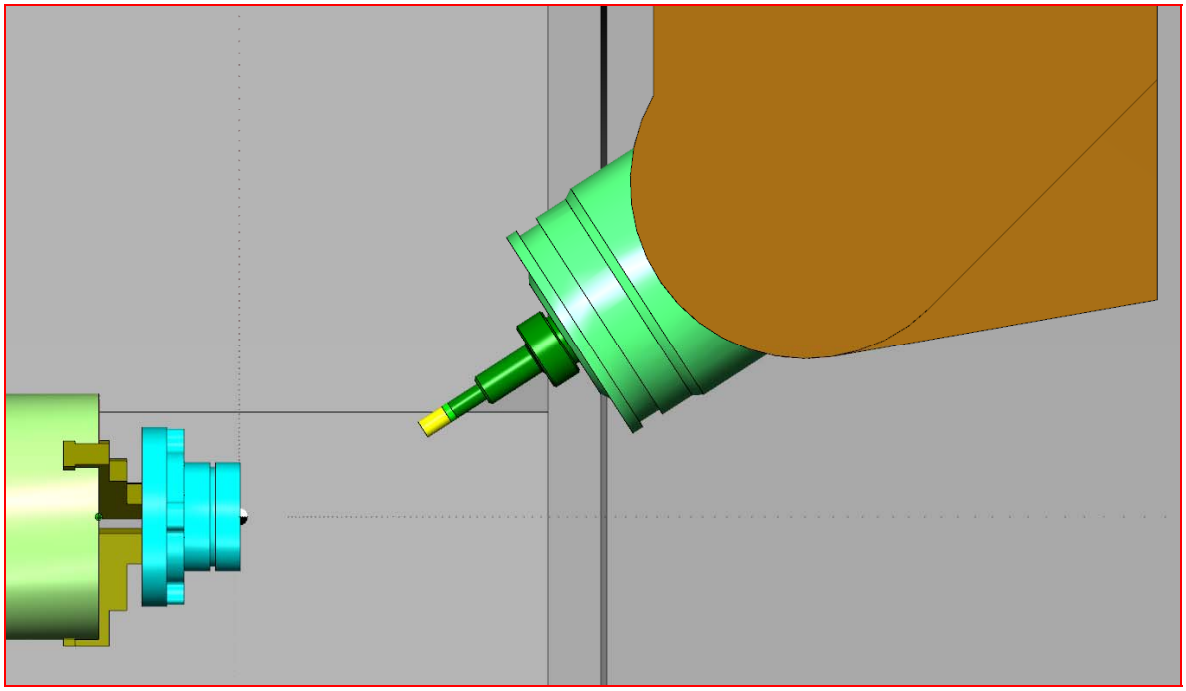
GCode output for a number of coordinate systems:

1. Part coordinate system MAC N Pos 1.
   Located in hpos set.
2. Absolute coordinate system according to absolute defined machine zero.
   Coordinates of tool tip.
   Located in mpos set.
3. Absolute coordinate system according to absolute defined machine zero without machine offset calculation.
   Located in Opos set.
4. Working plane coordinate system with zero point in the Part home position.
   Located in pos set.
5. Local coordinate system with zero point shifted to the position location.
   Located in lpos set.
6. Absolute coordinate system according to absolute defined machine zero.
   Coordinates of pivot point.
   This set coordinates should be used if no tool length compensation option.
   Located in tpos set.
7. Absolute coordinate system according to absolute defined machine zero without machine offset calculation.
   Coordinate of pivot point.
   This set coordinates should be used if no tool length compensation option.
   Located in topos set.

POS,OPOS,MPOS,HPOS,LPOS coordinates sets explanation



TPOS, TOPOS coordinates sets explanation



2.2.2 New PRP parameter

- For working in the new way you have to add the following new parameter to the **PRP** file:

  pos_to_machine = Y

- The machine kinematic is defined in Machine ID in **VMID** file.

The following PRP parameters are used in SolidCAM2011 in addition for 5 axis simultaneous operations and Machine Simulation also for definition of machine .kinematic:

- **tilt_axis_min_limit** type :numeric

  This parameter defines the default min limit for the tilt rotational axis.

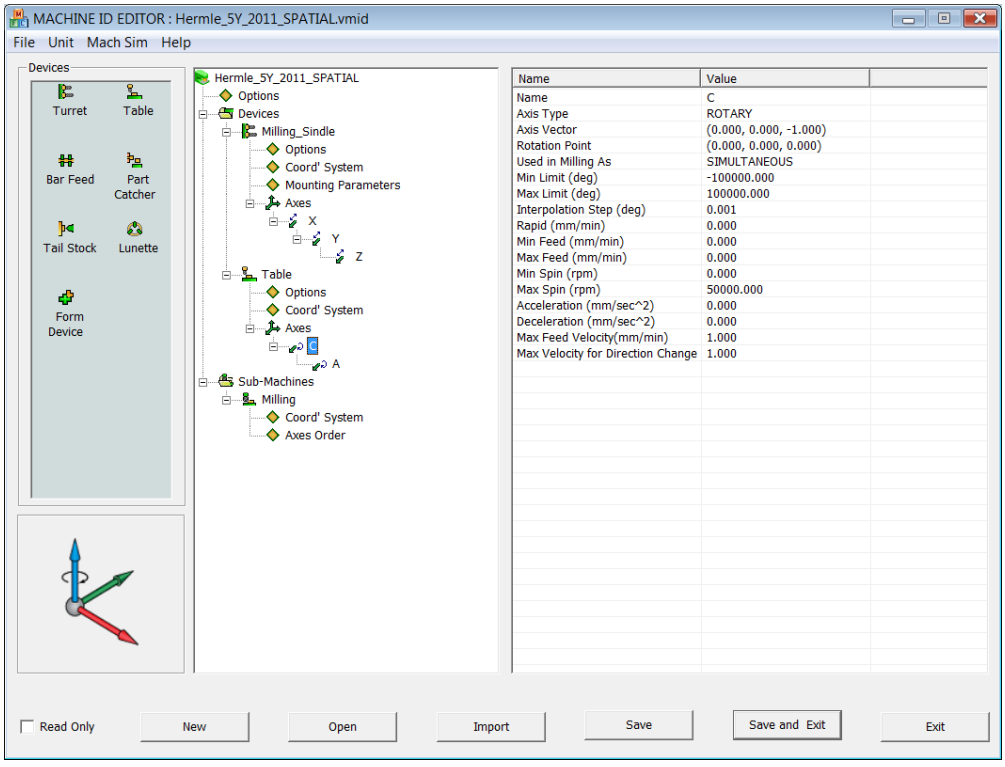
- **tilt_axis_max_limit** type :numeric

  This parameter defines the default max limit for the tilt rotational axis.

Example:
In **TABLE-TABLE** machine these **PRP** parameters are used to control the default angle pair and set as follows:

tilt_axis_min_limit = 0

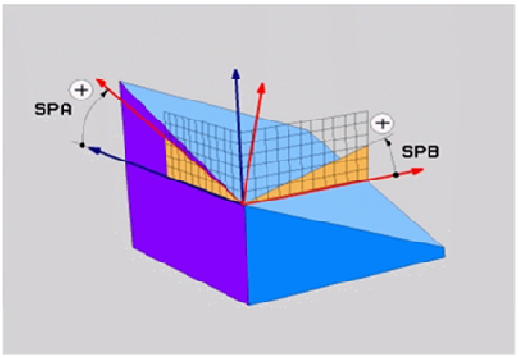
tilt_axis_max_limit = 90

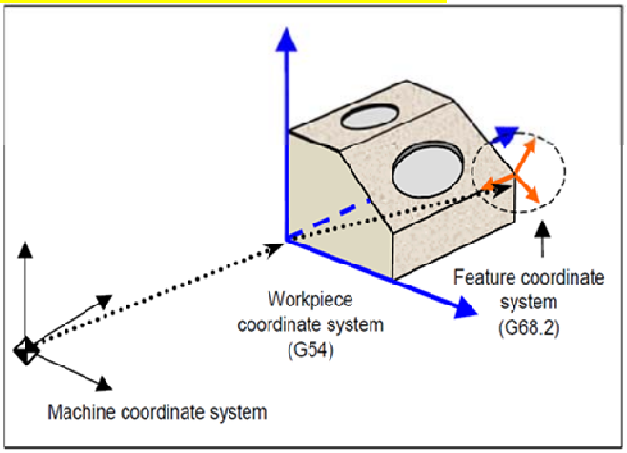


2.2.3 New GPP subroutine

- You have to decide which **ANGLES** for Coordinate System transformation to use, regarding machine settings, options and user's demand.

```
@rotate_to_plane ==>first_axis_angle:66.456 second_axis_angle:47.336
                    ..>rotate_angle_x:-47.336T rotate_angle_y:0.000T rotate_angle_z:-66.456T
                    ..>euler_angle_z:-113.544T euler_angle_x:-47.336T euler_angle_dev_z:180.000T
```





@rotate_to_plane

SolidCAM develops the GPP subroutine @rotate_to_plane each time the machine has to rotate its rotation axes and/or change the working plane:

@rotate_to_plane ==>

first_axis_angle:0.000 second_axis_angle:0.000
opposite_first_axis_angle:0.000 opposite_second_axis_angle:0.000
change_tool_follows:1
rotate_angle_x:0.000T rotate_angle_y:90.000T rotate_angle_z:0.000T
opposite_rotate_angle_x:0.000T opposite_rotate_angle_y:90.000T
opposite_rotate_angle_z:0.000T
euler_angle_z:180.000T euler_angle_x:-90.000T euler_angle_dev_z:-90.000T

opposite_euler_angle_z:0.000T opposite_euler_angle_x:90.000T
opposite_euler_angle_dev_z:90.000T
shift_x:0.000T shift_y:0.000T shift_z:0.000T
shift_x_after_rot:0.000T shift_y_after_rot:0.000T shift_z_after_rot:0.000T
machine_offset_x:0.000 machine_offset_y:0.000 machine_offset_z:0.000
normal_to_plane_x:0.000T normal_to_plane_y:1.000T normal_to_plane_z:0.000T
tool_z_level:10.000 tool_start_plane:2.502
radial_start_tool_level:3.339 rear_start_tool_level:-2.502
xhnext_tool_z_level:0.389T yhnext_tool_z_level:10.000T zhnext_tool_z_level:0.001T
xmnext_tool_z_level:10.000T ymnext_tool_z_level:-0.389T zmnext_tool_z_level:0.001T

xhnext_start_tool_level:0.389T yhnext_start_tool_level:2.502T
zhnext_start_tool_level:0.001T
xmnext_start_tool_level:2.502T ymnext_start_tool_level:-0.389T
zmnext_start_tool_level:0.001T
xonext_start_tool_level:-0.389T yonext_start_tool_level:0.000T
zonext_start_tool_level:0.001T

first_axis_angle and second_axis_angle

first_axis_angle and second_axis_angle are the calculated angles of rotation around machine axes vectors.

- The angles first_axis_angle and second_axis_angle can be used for the rotation movements of rotation axes.
- One of the angles (which one depends of the kinematic) can be used for the working plane definition.

Example:
In the Integrex machine GCode function G68 is used for working plane definition.

rotate_angle_x rotate_angle_y rotate_angle_z

rotate_angle_x, rotate_angle_y and rotate_angle_z are the angles calculated in the ZYX order. Depending on the machine type these angles can be used to rotate its rotation axes and/or define the working plane.

euler_angle_z euler_angle_x euler_angle_dev_z

euler_angle_z, euler_angle_x and euler_angle_dev_z are the euler angles calculated in the ZXZ order. Depending on the machine these angles can be used to rotate its rotation axes and/or change the working plane.

shift_x shift_y shift_z

shift_x, shift_y and shift_z are the shifts in the part coordinate system. They can be used for the working plane defined coordinate system (lpos set) working style.

shift_x _after_rot shift_y _after_rot shift_z _after_rot

shift_x _after_rot, shift_y _after_rot and shift_z_after_rot are the shifts calculated after the machine devices TABLE and HEAD are rotated. They can be used for the working plane defined coordinate system (lpos set) working style.

machine_offset_x machine_offset_y machine_offset_z

machine_offset_x, machine_offset_y and machine_offset_z define the distance of the current home position (G54…) from absolute machine zero in X, Y, Z directions. They have to be set the same as defined in the home offset table on the machine itself.

normal_to_plane_x normal_to_plane_y normal_to_plane_z

normal_to_plane_x, normal_to_plane_y and normal_to_plane_z define a vector to the working plane.

2.2.4 GPP sets of coordinates in the existing GPP subroutines

@line and @rapid_move

The following sets of the coordinates have been developed:

xpos:-35.000T ypos:-29.000T zpos:100.000T
xhpos:-35.000T yhpos:-29.000T zhpos:0.000T
xmpos:-35.000T ympos:-29.000T zmpos:100.000T
xopos:-35.000T yopos:-29.000T zopos:100.000T
xlpos:-35.000T ylpos:-29.000T zlpos:100.000T
xtpos:-35.000T ytpos:-29.000T ztpos:100.000T
xtopos:-35.000T ytopos:-29.000T ztopos:100.000T

- **Part Coordinate System set:**

  xhpos, yhpos, zhpos

This set of coordinates calculation can be used for CL file generation.
It can be useful for a kind of machines that know to convert part coordinates to machine coordinates.

- **Machine Absolute Zero Coordinate System set for tool tip:**

  xmpos, ympos, zmpos

  - For this set coordinates calculation SolidCAM takes in account the kinematic parameters defined in **VMID**.
  - The home machine offset “Center of Rot. Origin based on Machine CoordSys (Sim 5 Axis)” that exist in **SolidCAM** home dialog is taken in account.
  - tool H length is not taken in account.
  - Limits of these coordinates are checked. If one or some limits have override a warning message is shown.

- **Machine Absolute Zero Coordinate System set for pivot point:**

  xtpos, ytpos, ztpos

  - For this set coordinates calculation SolidCAM takes in account the kinematic parameters defined **VMID**.
  - The home machine offset “Center of Rot. Origin based on Machine CoordSys (Sim 5 Axis)” that exist in SolidCAM home dialog is taken in account.
  - the tool H length and pivot length defined in **VMID** are taken in account.
  - Limits of these coordinates are checked. If one or some limits have override a warning message is shown.

- **Machine Coordinate Axes with Current Reference Point set (G54, G55…):**

  xopos, yopos, zopos

  - For this set coordinates calculation SolidCAM takes in account the kinematic parameters defined in **VMID**.

- For calculation this coordinate set the home machine offset parameter “Center of Rot. Origin based on Machine CoordSys (Sim 5 Axis)” that exist in **SolidCAM** CoordSys Data dialog is not taken in account.
- The tool H length value is not taken in account.
- For **HEAD_HEAD** machine this coordinate set has no influence since opos = hpos.

➢ **Working Plane Coordinate System set:**

xpos, ypos, zpos

- For this coordinates set calculation **SolidCAM** takes in account the following:
  - The kinematic parameters defined in **VMID**.
  - The angles that are used to define the working plane.
  - For calculation this coordinate set the home machine offset “Center of Rot. Origin based on Machine CoordSys (Sim 5 Axis)” that exist in **SolidCAM** CoordSys Data dialog is not taken in account.
- The tool H length is not taken in account.
- These are the coordinates in the rotated plane where the tool axis is perpendicular to the plane.

  Example:

  These coordinates can be used after G68 that rotate the plane.
- Zero this coordinate system is in the Reference Point (G54, G55…)
- In case of **TABLE_TABLE** machine pos = opos.

➢ **Shifted Working Plane Coordinate System set:**

xlpos, ylpos, zlpos

This coordinate set is as pos coordinate set but shifted to the local coordinate system point.

➢ **Machine Coordinate Axes with Current Reference Point set (G54, G55…) for pivot point:**

xtopos, ytopos, ztopos

- For this set coordinates calculation **SolidCAM** takes in account the kinematic parameters defined in **VMID**.
- For calculation this coordinate set the home machine offset parameter “Center of Rot. Origin based on Machine CoordSys (Sim 5 Axis)” that exist in **SolidCAM** CoordSys Data dialog is not taken in account.
- The tool H length and pivot length are taken in account.

@arc

Gpp subroutine @arc has the same sets of the coordinates as @line:

xpos:-35.000T ypos:-29.000T zpos:100.000T
xhpos:-35.000T yhpos:-29.000T zhpos:0.000T
xmpos:-35.000T ympos:-29.000T zmpos:100.000T
xopos:-35.000T yopos:-29.000T zopos:100.000T
xlpos:-35.000T ylpos:-29.000T zlpos:100.000T
xtpos:-35.000T ytpos:-29.000T ztpos:100.000T
xtopos:-35.000T yotpos:-29.000T zotpos:100.000T

Gpp subroutine @arc has the following additional data:

xcenter, ycenter, radius, zstart

The coordinates of the center in the Working Plane Coordinate System.

start_angle end_angle

The arc angles in the Working Plane Coordinate System.

arc_direction

The direction CW/CCW in the Working Plane Coordinate System.

xcenter_rel ycenter_rel

The coordinates of the arc center relative to the arc start point in the Working Plane Coordinate System.

xhcenter, yhcenter, zhcenter

The coordinates of the center in the Part Coordinate System.

xhstart, yhstart, zhstart

The coordinates of the start point in the Part Coordinate System.

arc_plane_h, start_angle_h, end_angle_h

The plane start and end angles in the Part Coordinate System.

xmcenter, ymcenter, zmcenter

The coordinates of the center in the Machine Absolute Zero Coordinate System for tool tip.

xmstart, ymstart, zmstart

The coordinates of the start point in the Machine Absolute Zero Coordinate System for tool tip.

start_angle_m, end_angle_m

The start and the end angles in the Machine Absolute Zero Coordinate System.

xmcenter_rel ymcenter_rel

The coordinates of the arc center relative to the arc start point in the Machine Absolute Zero Coordinate System.

arc_plane_m

The plane in the Machine Absolute Zero System.

arc_plane_m:error

If arc plane is not one of main planes XY ZX YZ, the word “error” is shown in arc_plane_m:error.

xocenter, yocenter, zocenter for tool tip

The coordinates of the center in the Machine Coordinate Axes with Current Reference Point.

xostart, yostart, zostart for tool tip

The coordinates of the start point in the Machine Coordinate Axes with Current Reference Point.

arc_odirection

The CW/CCW direction in in the Machine Coordinate Axes System.

xocenter_rel yocenter_rel

The coordinates of the arc center relative to the arc start point in the Machine Coordinate Axes System.

xlcenter, ylcenter, zlcenter

The coordinates of the center in the Shifted Working Plane Coordinate System.

xlstart, ylstart, zlstart

The coordinates of the start point in the Shifted Working Plane Coordinate System.

xocenter_rel yocenter_rel

The coordinates of the arc center relative to the arc start point in the Shifted Working Plane Coordinate System.

xtcenter, ytcenter, ztcenter

The coordinates of the center in the Machine Absolute Zero Coordinate System for pivot point.

xtstart, ytstart, ztstart

The coordinates of the start point in the Machine Absolute Zero Coordinate System for pivot point.

xtocenter, ytocenter, ztocenter for pivot point

The coordinates of the center in the Machine Coordinate Axes with Current Reference Point.

xtostart, ytostart, ztostart pivot point

The coordinates of the start point in the Machine Coordinate Axes with Current Reference Point.

@drill

Gpp subroutine @drill has the following sets of the coordinates:
The same sets of the coordinates as exist in @line:

xpos:-35.000T ypos:-29.000T zpos:100.000T
xhpos:-35.000T yhpos:-29.000T zhpos:0.000T
xmpos:-35.000T ympos:-29.000T zmpos:100.000T
xopos:-35.000T yopos:-29.000T zopos:100.000T
xlpos:-35.000T ylpos:-29.000T zlpos:100.000T
xtpos:-35.000T ytpos:-29.000T ztpos:100.000T
xtopos:-35.000T ytopos:-29.000T ztopos:100.000T

The following additional data sets:

drill_clearance_z:94.000 drill_upper_z:69.334 drill_lower_z:67.334
drill_clearance_zm:94.000 drill_upper_zm:69.334 drill_lower_zm:67.334
drill_clearance_zm:94.000 drill_upper_zm:69.334 drill_lower_zm:67.334
drill_clearance_zl:94.000 drill_upper_zl:69.334 drill_lower_zl:67.334
drill_clearance_zt:94.000 drill_upper_zt:69.334 drill_lower_zt:67.334
drill_clearance_zto:94.000 drill_upper_zto:69.334 drill_lower_zto:67.334

@drill_point

Gpp subroutine @drill_point has the following sets of the coordinates:
The same sets of the coordinates as exist in @line:

xpos:-35.000T ypos:-29.000T zpos:100.000T
xhpos:-35.000T yhpos:-29.000T zhpos:0.000T
xmpos:-35.000T ympos:-29.000T zmpos:100.000T
xopos:-35.000T yopos:-29.000T zopos:100.000T
xtpos:-35.000T ytpos:-29.000T ztpos:100.000T
xtopos:-35.000T ytopos:-29.000T ztopos:100.000T

The following additional data sets:

- **Coordinates of the point on the upper level**

  The Current Machine Home Coordinate System for tool tip:

  xmupos:15.000T ymupos:-10.500T zmupos:67.334F

  The Part Coordinate System:

  xhupos:15.000T yhupos:-10.500T zhupos:-6.666F

  The Machine Coordinate Axes with Current Reference Point:

  xoupos:15.000T youpos:-10.500T zoupos:-6.666F

  The Working Plane Defined and Shifted Coordinate System:

  xlupos:15.000T ylupos:-10.500T zlupos:-6.666F

  The Current Machine Home Coordinate System for pivot point:

  xtupos:15.000T ytupos:-10.500T ztupos:67.334F

- **Coordinates of the point on the safety level**

  The Current Machine Home Coordinate System tool tip:

  xmspos:15.000T ymspos:-10.500T zmspos:67.334F

  The Part Coordinate System:

  xhspos:15.000T yhspos:-10.500T zhspos:-6.666F

  The Machine Coordinate Axes with Current Reference Point for tool tip:

  xospos:15.000T yospos:-10.500T zospos:-6.666F

  The Machine Working Plane Defined and Shifted Coordinate System:

  xlspos:15.000T ylspos:-10.500T zlspos:-6.666F

  The Current Machine Home Coordinate System for pivot point:

  xtspos:15.000T ytspos:-10.500T ztspos:67.334F

  The Machine Coordinate Axes with Current Reference Point for pivot point:

  xtospos:15.000T yospos:-10.500T ztospos:-6.666F

@call_proc

@change_tool

@start_of_job

Gpp subroutines @ call_proc, @change_tool, @start_of_job have the coordinate's sets of the operation first point:

Working Plane Defined Coordinate System set:

xnext:0 ynext:0 znext:100.000

Part Coordinate System set:

xhnext:0 yhnext:0 zhnext:0

Machine Absolute Zero Coordinate System set for tool tip:

xmnext:0 ymnext:0 zmnext:0

Coordinate Axes with Current Reference Point set for tool tip:

xonext:0 yonext:0 zonext:0

Working Plane Defined and Shifted Coordinate System set:

xlnext:0 ylnext:0 zlnext:0

Machine Absolute Zero Coordinate System set for pivot point:

xtnext:0 ytnext:0 ztnext:0

Coordinate Axes with Current Reference Point set for pivot point:

xtonext:0 ytonext:0 ztonext:0

@compensation

Gpp subroutine @compensation has the additional data for opos set:

side_o

2.2.5 New working style for 4 axes FACE and WRAP operations

SolidCAM develop for Face and Wrap operations the following commands:

@line_5x

This command is as @line_5x command that **SolidCAM** develop for 5x ModuleWorks operations. They both take on account the same machine kinematic definition.

```
@line_5x   ==> xpos:47.055T ypos:0.000F zpos:3.000F feed:33.000F
               ..> apos:-90.000F bpos:-90.000F
               ..> xmpos:47.055T ympos:0.000F zmpos:3.000F
               ..> xopos:47.055T yopos:0.000F zopos:3.000F
               ..> xhpos:0.000F yhpos:-47.055T zhpos:3.000F
               ..> xtpos:47.055T ytpos:0.000F ztpos:3.000F
               ..> xtopos:47.055T ytopos:0.000F ztopos:3.000F
```

- **Part Coordinate System set:**

  xhpos, yhpos, zhpos

  For Face operation these coordinates are the Cartesian coordinates as was developed in the old style in the @line4x_cartesian command.

- **Machine Absolute Zero Coordinate System set for tool tip:**

  xmpos, ympos, zmpos

  - For this set coordinates calculation **SolidCAM** take in account the Kinematic parameters defined in **VMID**.
  - The home machine offset “Center of Rot. Origin based on Machine CoordSys (Sim 5 Axis)” that exist in **SolidCAM** CoordSys Data dialog is taken in account.
  - the tool H length is not taken in account.

- **Machine Absolute Zero Coordinate System set for pivot point:**

  xtpos, ytpos, ztpos

  - For this set coordinates calculation **SolidCAM** take in account the Kinematic parameters defined in **VMID**.
  - The home machine offset “Center of Rot. Origin based on Machine CoordSys (Sim 5 Axis)” that exist in **SolidCAM** CoordSys Data dialog is taken in account.
  - the tool H length and pivot lengthare taken in account.

- **Machine Coordinate Axes with Current Reference Point set (G54, G55…):**

  xpos, ypos, zpos

  For Face and Wrap operations these coordinates are the Polar coordinates as was developed in the old style in the commands @line4x_polar /@line_4x/@line_4xdir.

- **Machine Coordinate Axes with Current Reference Point set (G54, G55…) for tool tip:**

  xopos, yopos, zopos

- For this set coordinates calculation **SolidCAM** takes in account the kinematic parameters defined in VMID.
- For calculation this coordinate set the home machine offset parameter “Center of Rot. Origin based on Machine CoordSys (Sim 5 Axis)” that exist in SolidCAM CoordSys Data dialog is not taken in account.
- The tool H length value is not taken in account.

➢ **Machine Coordinate Axes with Current Reference Point set (G54, G55…) for pivot point:**

xtopos, ytopos, ztopos

- For this set coordinates calculation **SolidCAM** takes in account the kinematic parameters defined in **VMID**.
- For calculation this coordinate set the home machine offset parameter “Center of Rot. Origin based on Machine CoordSys (Sim 5 Axis)” that exist in **SolidCAM** CoordSys Data dialog is not taken in account.
- The tool H length value is not taken in account.
- For **HEAD_HEAD** machine this coordinate set has no influence since opos = hpos.

apos bpos

apos and bpos are the calculated angles of rotation around machine axes vectors.

@move_5x

This command is as @move_5x command that **SolidCAM** develop for 5x ModuleWorks operations.

They both take on account the same machine kinematic definition.

```
@move_5x==> xpos:47.055T ypos:0.000F zpos:3.000F feed:33.000F
        ..> apos:-90.000F bpos:-90.000F
        ..> xmpos:47.055T ympos:0.000F zmpos:3.000F
        ..> xopos:47.055T yopos:0.000F zopos:3.000F
        ..> xhpos:0.000F yhpos:-47.055T zhpos:3.000F
        ..> xtpos:47.055T ytpos:0.000F ztpos:3.000F
        ..> xtopos:47.055T ytopos:0.000F ztopos:3.000F
```

@arc_5x

Command @arc_5x is developed for Face operation only.

```
@arc_5x  ==> xpos:21.161F ypos:63.570F zpos:-35.000F feed:100.000T
          ..> feed_type:'finish_feed' feed_teeth:0.050F spin:1000.000F
          ..> arc_direction:ccw xcenter:0.000 ycenter:0.000 radius:67.000
          ..> xcenter_rel:-63.570 ycenter_rel:-21.161
          ..> start_angle:18.412 end_angle:71.588 arc_size:53.177
          ..> xhpos:21.161T yhpos:63.570T zhpos:-35.000F
          ..> xhcenter:0.000 yhcenter:0.000 zhcenter:-35.000
          ..> xmpos:21.161T ympos:63.570T zmpos:65.000F
          ..> xopos:21.161T yopos:63.570T zopos:65.000F
          ..> xtpos:21.161T ytpos:63.570T ztpos:65.000F
          ..> xtopos:21.161T ytopos:63.570T ztopos:65.000F
          ..> start_angle_m:18.412 end_angle_m:71.588
          ..> xmcenter:0.000 ymcenter:0.000 zmcenter:65.000
          ..> xtcenter:0.000 ytcenter:0.000 ztcenter:65.000
          ..> xtocenter:0.000 ytocenter:0.000 ztocenter:65.000
          ..> xocenter:0.000 yocenter:0.000 zocenter:65.000
          ..> xmcenter_rel:-63.570 ymcenter_rel:-21.161 zmcenter_rel:0.000
```

Gpp subroutine @arc_5x has the additional data:

The coordinates of the center in the Working Plane Coordinate System:

xcenter:38.567 ycenter:52.846 radius:23.956 zstart:73.480

The coordinates of the center in the Part Coordinate System:

xhcenter:38.567 yhcenter:52.846 zhcenter:-0.520

The coordinates of the start point in the Part Coordinate System:

xhstart:17.606 yhstart:41.249 zhstart:-0.520

The coordinates of the center in the Machine Absolute Zero Coordinate System for tool tip:

xmcenter:27.902 ymcenter:47.444 zmcenter:73.480

The coordinates of the start point in the Machine Absolute Zero Coordinate System: for tool top:

xmstart:17.196 ymstart:42.022 zmstart:73.480