MACHINIST HELPER v1.8

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Machinist Helper is a Machinist program developed for the HP50g graphing calculator. I've been developing this program for the past three years carefully crafting it for machinist to do advance machining calculations. MHv1.8 solves the following topics:

Triangle Solver Solves triangles quickly and easy! No need to memorize cosine laws or recall answers from registers; your answers are always on the stack waiting for you after selecting your case.

Thread Calculations Calculate thread data for Unified, Metric, Acme, British Withworth or NPT threads. MH uses Buckingham Exact Helicoid formulas for calculating Measurements over wire for all threads except NPT

Circular Segment Calculates segment of a circle or any polygon

Taper It converts taper per foot to angle. Calculate depths for drills or countersink and even measures countersink diameter using a ball diameter.

Bolt Circle Can calculate traditional xy coordinates of bolt hole patterns and can also calculate xy coordinates for holes on an arc.

Feeds & Speeds This solver also calculates Chip Thinning for ball or regular endmill. It also uses the effective diameter of a ball endmill to calculate cutting parameters.

Keyways and Hubs calculates keyway data using width and heights of keys

Formulas various handy formulas

True Position It even tells you if the holes are accepted or rejected

Gauge Blocks This program was written by David Hayden. Enter a size on the stack and it calculates the blocks you need. If a block is missing, you can recalculate without that block. You can even create your own sets of blocks

Drill Chart I have a decimal equivalent chart assigned to left and right arrow keys. Put any drill on the stack to search then scroll through chart

Using Machinist Helper

To download programs to your calculator you would need to install HP connectivity kit from http://www.hpcalc.org/hp49/pc/link/conn4x.zip

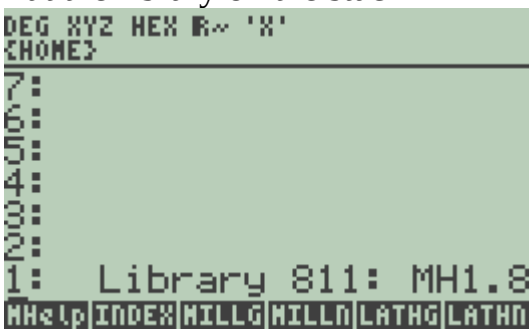
Help for using HP50 calculator is always available from the message board comp.sys.hp48 of which I often frequent.

The zip file should contain

Machinist Helper v1.8	PDF this document
MACHINIST	Machinist Helper v1.8 library
GaugeBlock	David Hayden gauge block program DOCS
gage	David Hayden gauge block program

Using HP connectivity kit download MACHINIST.LIB to your calculator

Put the library on the stack



- Put a port numbert on the stack 0, 1 or 2
- Press STO to attach the library
- Press ON and C simultaneously to warm start
- Press RS arrow key then LIB find MH1.8 on the menu

REMOVING MHv1.8 and key assignments

If for some reason you need to remove MHv1.8 from your calculator press **LS FILES** find library 811 and delete it from a port.

MHv1.8 no longer uses hard key assignments, to get rid of residual key assignments from previous version do the following:

{34.1 36.1 65.1 64.1 75.1 95.1 85.1} DELKEYS
Old key assignments will be removed

GRAPHICAL USER INTERFACE

80% of MH program uses the HP50 Graphical User Input engine. Solvers that use GUI are Threads, Circular Segment, Taper, Bolt Circle, Feed and Speed, Keyway and True Position. Navigating the display with the arrow key will always display help text for the current cursor position. Below are menu and keyboard description of the GUI solvers

GUI Menu Keys
EDIT - edits the contents of current cursor
 # NO – Display machine number screws for UN screws only. Good for finding tap size. For UN thread only
HELP - Reminders on using different solvers
CHOOSE - displays list for choosing
CHK – Used with True Position and Metric threads
CANCL save contents before Exiting

3WIRE – Calculate measurement over threads using Buckingham Exact Involute Helicoid Formula as described in Machinery Handbook 28 edition
SOLVE- Fill variables with solved equation or formulas

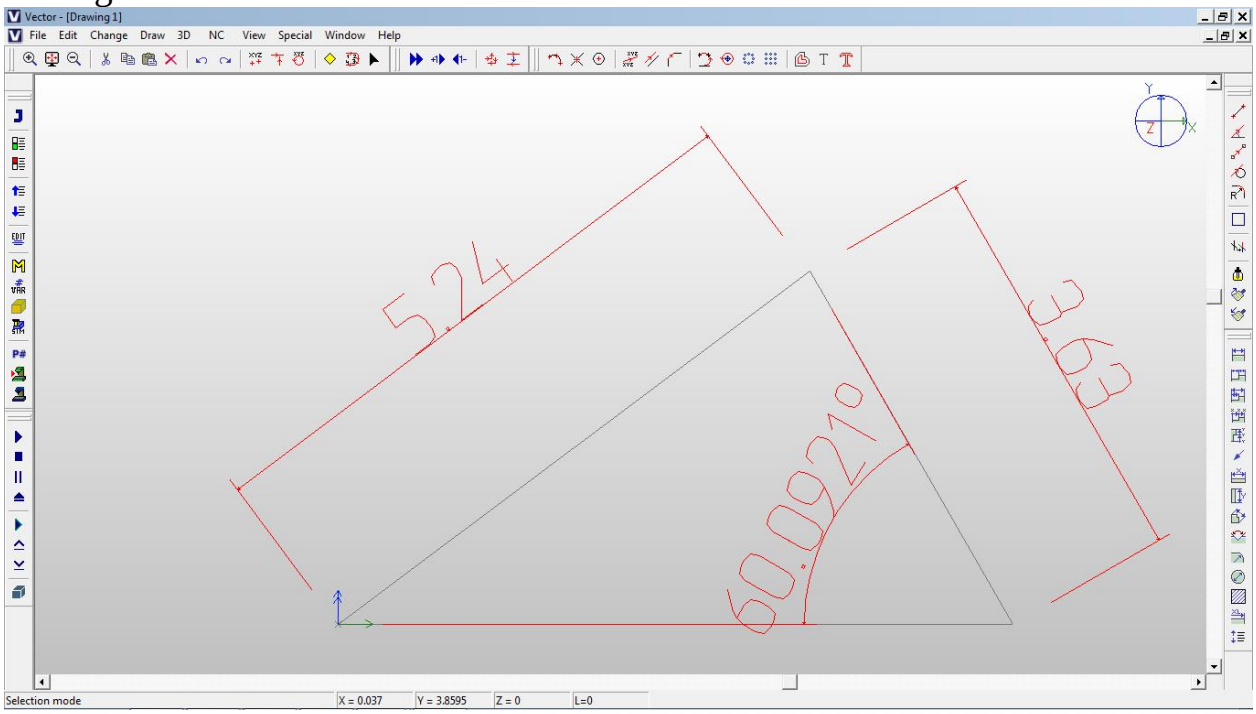
GUI Keyboard keys
ENTER- Calculates then redraw thread data. All other solvers just Error beeps
-/+ scroll list data with this key and check and uncheck check box marks
STO-> Put the number at the current cursor on the stack
ON aborts without saving contents
← Back Arrow key blanks data at current cursor
LS DEL – Built in reset key
RS CLEAR- Clear display
HIST- You can multitask. This is perfect for doing simple calculations on the stack then saving it to display. Never change directory in this environment

Triangle Solver

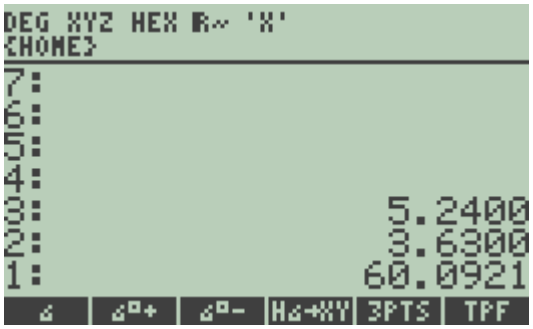
Press menu key [**TRI**] The first five menu keys represent five cases the Triangle Solver will solve. MH Triangle solver will solve oblique or right angle triangle

Side Side Side, Side Side Angle, Side Angle Side, Side Angle Angle, and Angle Side Angle They must be entered on the stack in a consistent clockwise or counter clockwise direction matching the case on the menu.

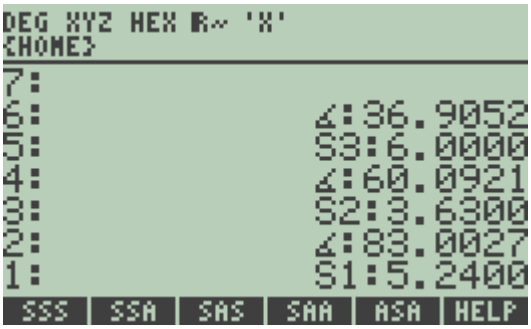
Triangle solved with SSA



INPUT ON STACK



AFTER PRESSING SSA

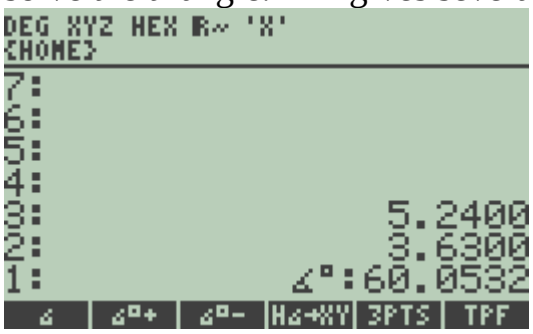


Inputs must always be in one consistent direction; in this case, it is clockwise direction macthing the case **SSA** on the menu. Input angles can also be caluclated with angles tagged.

∡ Tag angle on the stack to Decimal Degrees; convert ∡° to ∡
Angles without a tag will always be Decimal degrees as in the case with the example above

LS ∡ Tag angle on the stack to Degrees Minutes Seconds; converts ∡ to∡°

Converted decimal degrees to °60 05´ 32” by pressing ∡ then LS ∡ then solve the triangle. MH gives several ways of solving triangle



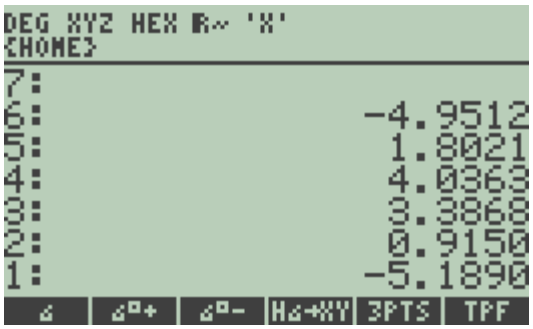
[∡°+] Add like tagged angles ∡° also add ∡ then convert to ∡°

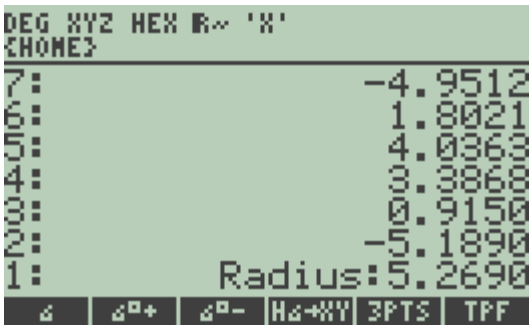
[∡°-] works same as above but Subtract
[H∡→XY] toggle between Polar Coordinates and Rectangular Coordinates. Polar Cordinates angles are always tagged! Convert a 1.5 Hypotenuse with °45 2´ 30” angle to rectangular coordinates.

POLAR	RECTANGULAR
2: 1.5	2: 1.0598
1: ∡°: 45.0230	1: 1.0614

[3PTS] Take three points from the stack and calculate a radius of a circle. Start input with X axis then Y axis until all 3 points are entered.

INPUT ON STACK OUTPUT





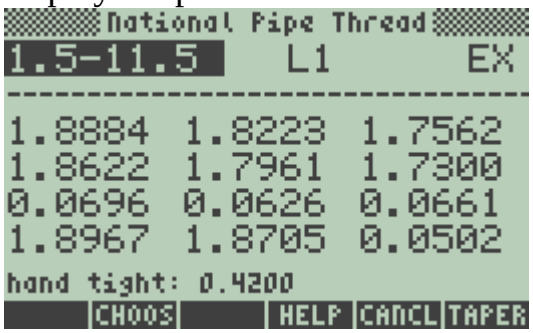
[TPF] Toggle between Taper Per Foot and Angle from the centerline. Angles are always tagged!

Thread Calculations

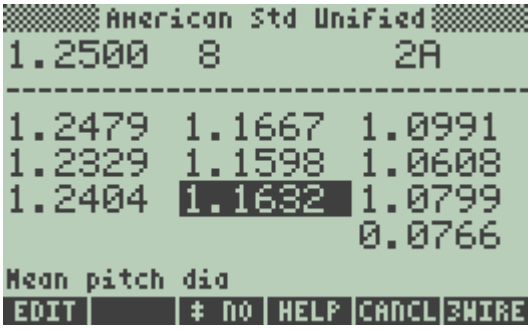
Pressing [**THRD**] will bring up submenus below with seven different thread type
NPT UN METRI GACME CACME SACME BSW

All thread solvers works the same enter thread input above the dash line and press ENTER to populate screen with current thread data input. Entering thread classification will always calculate assuming thread pitch and size are given. The only exception is NPT which dynamically calculates thread data as you input. **3WIRE** will launch **BUCK** for calculating Measurement over three wires. **The cursor will have to be pointed at any pitch diameter spec for storing Pitch Diameter in BUCK pitch diameter field** .

NPT
A help text for machining NPT threads on a CNC lathe. **TAPER** menu displays Taper formula

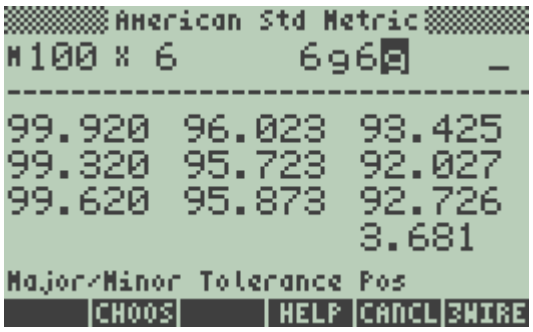


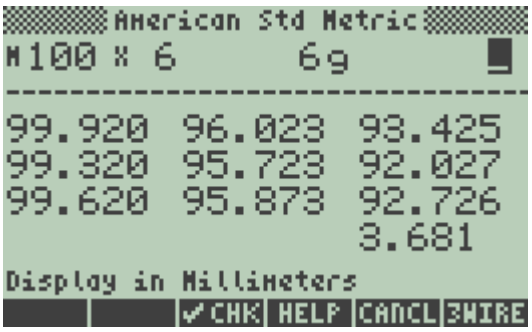
American Unified Threads



The # NO on the menu is just a quick conversion of Number Machine screw size. The user will have to change TPI

METRIC

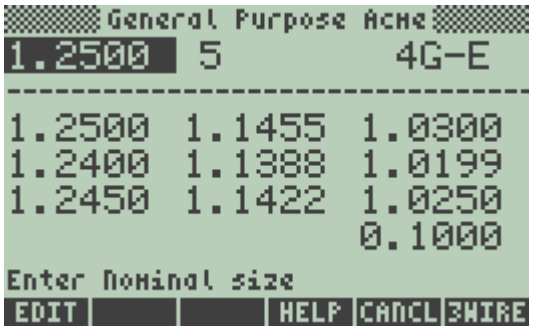


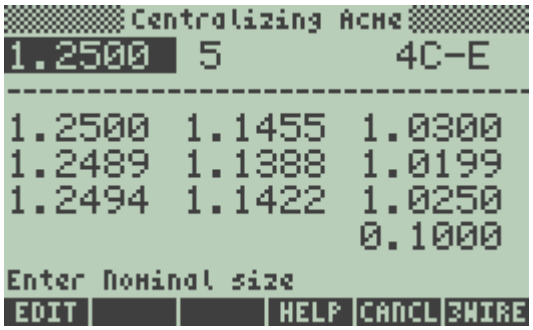


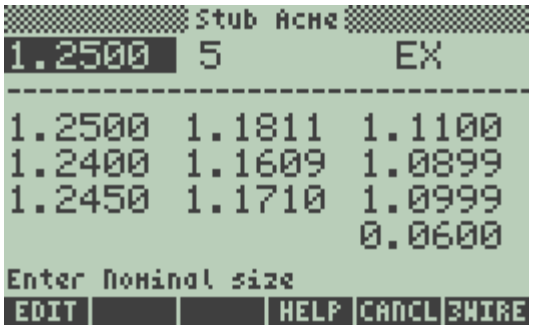
← Keyboard back arrow key erases the last two tolerances

ACME

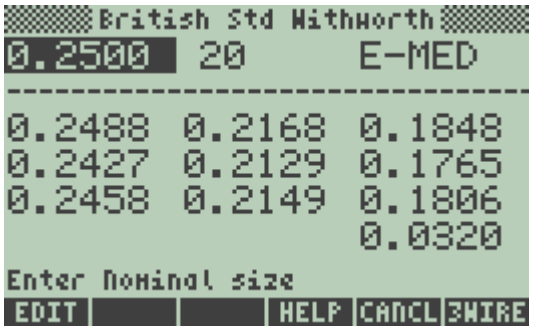
Three different knds of acme threads



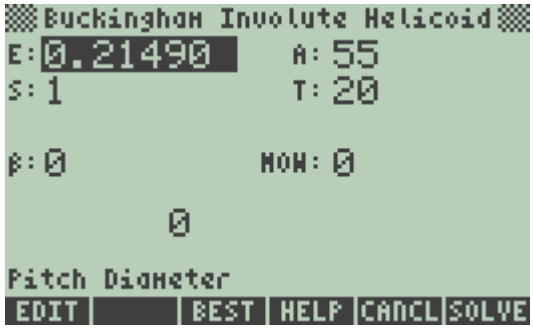




British Standard Withworth

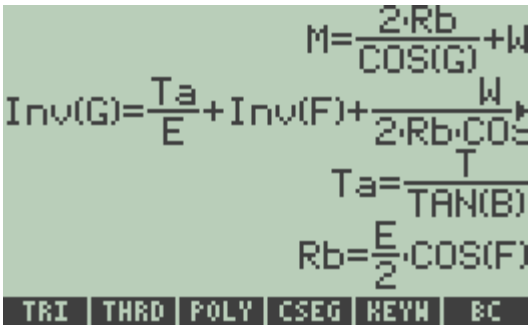


BUCK



MH uses Buckingham Exact Helicoid formula for calculating checking pitch diameters by measuring over three wires. The WIRE menu on thread solvers will launch BUCK or you can launch BUCK by itself on the second page of the THRD menu

After entering variable E, A, S and T, press **BEST** to calculate your best wire size. If you don't have the best wire size, just enter the closest size you have in your three wire set. Press **SOLVE** to calculate MOW. **BUCK** uses 6 equations to calculate the MOW, below is just a view of four. The 28 edition of the Machinery Handbook has an excellent documentation on Buckingham Formula.

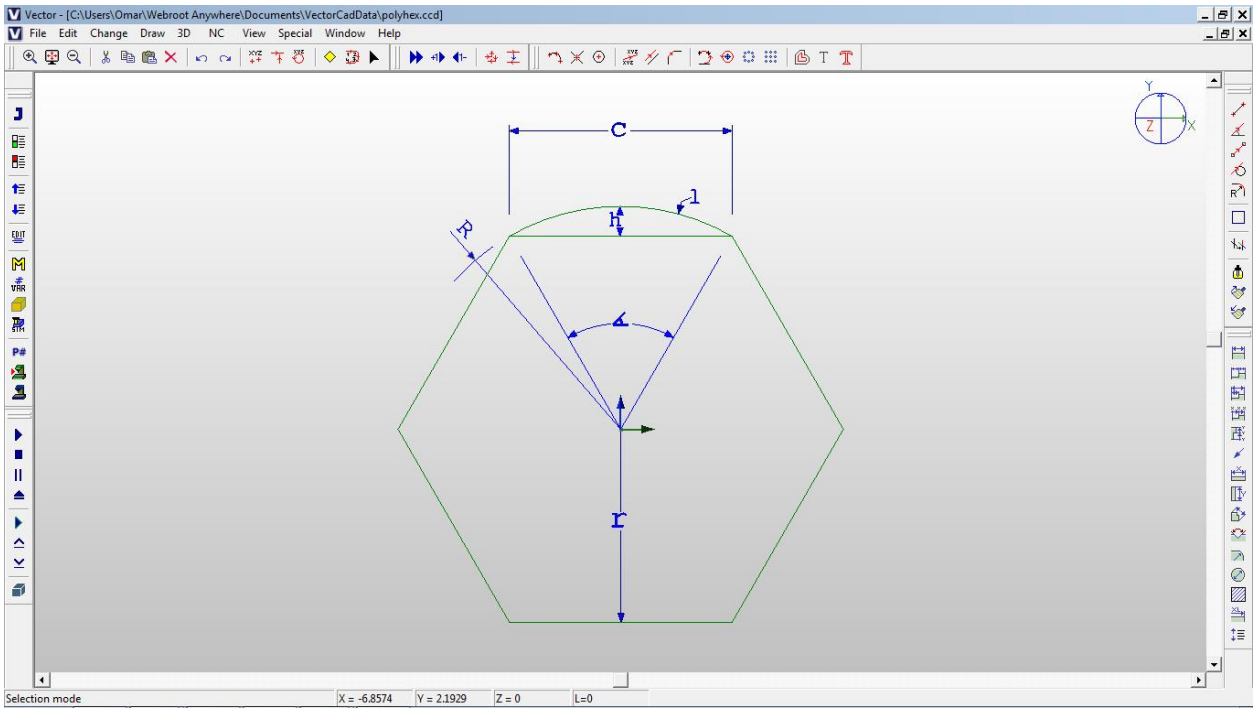


Circular Segment

Circular Segment solver will solve all variable for any two inputs from the drawing below. You can solve circular segment or polygon problems. A typical problem would be calculating depth for making a hex.

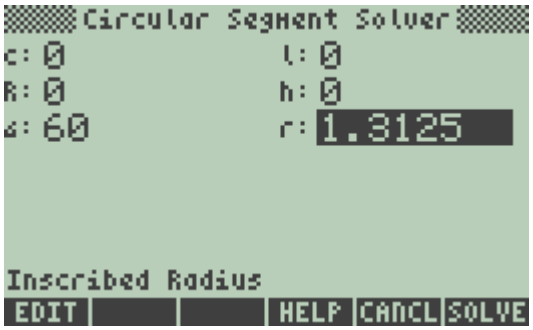
Press **CSEG** then press **RS CLEAR.** Enter any two known variables. Press **SOLVE** to solve for missing variables. Repeat the steps above to solve a new problem.

C Length of the chord
l Length of the arc
R Circumscribed radius which is also equal to r + h
r Inscribed radius. Inscribed diameter is usually given for making polygons
h Height of the segment
∡ Included angle the full length of the chord. This is 360 divided by the number of sides of a polygon

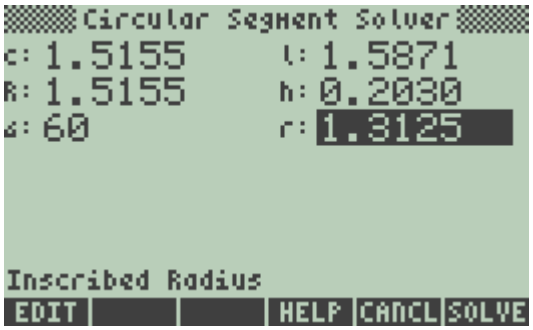


Let's say you need to make a hex with an inscribed diameter of 2.625in.
Press CSEG
Press RS CLEAR

INPUT



PRESS OK RESULTS



Notice at the input variables you are trying to find are 0!

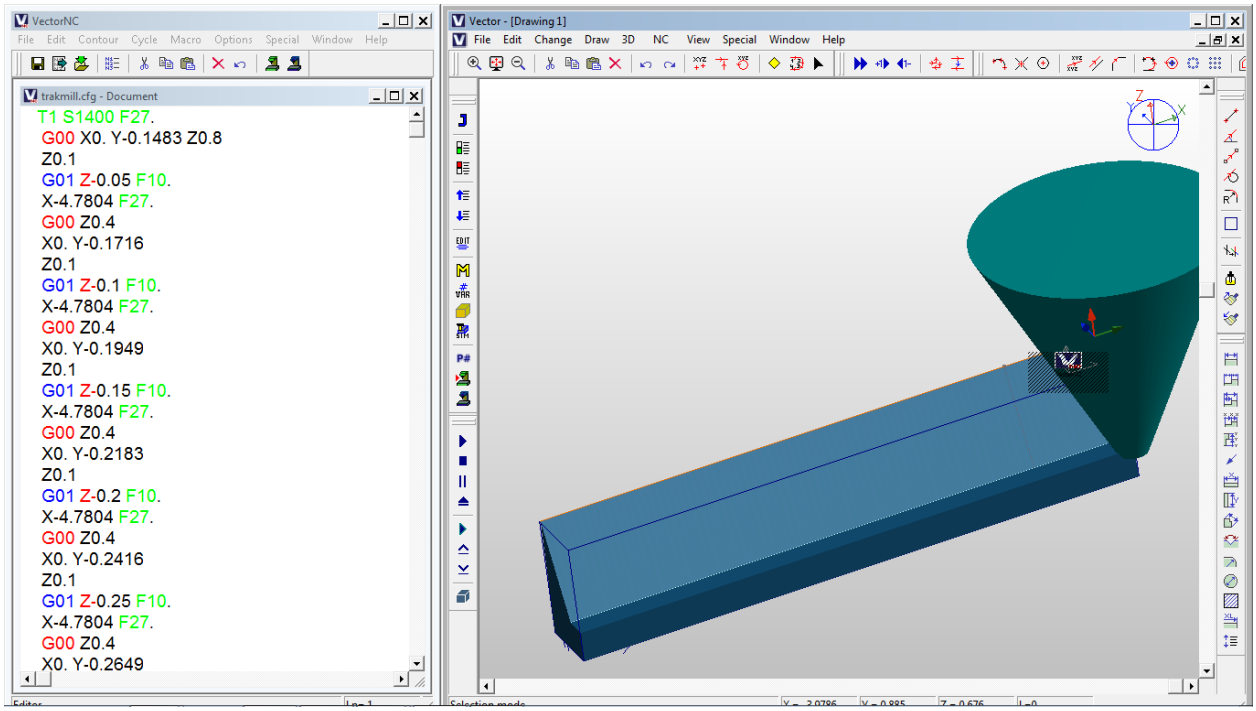
Taper

The **Taper Solver** use the traditional machine shop taper per foot formula. I included the ability to measure large diameter with a ball if you need to

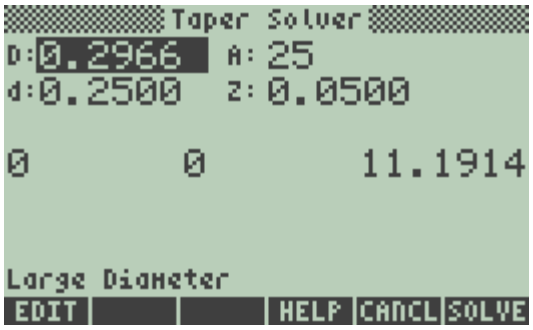
make countersink diameters to a close tolerance. Calculations can be made for external or internal taper problems. Below are a few examples of what the **TAPER SOLVER** can calculate.

EXAMPLE 1
This example is just for demonstration.
The screen shot below is showing a 65 degree weld prep being machine with a taper endmill small diameter of .250 and an included angle of 50 degrees. . TAPER can be used to find the effective diameter at each Z depth.

Notice from the drawing Y0 starts at the length at the baseline. The direction of the cuts will be in Y minus direction



Input the three know variable in the solver
A: 25
d: .250
Z: .05
Move cursor to D and press **SOLVE** to solve for D. press HIST divide by 2 equals Y .1483
Try it for Z at .100



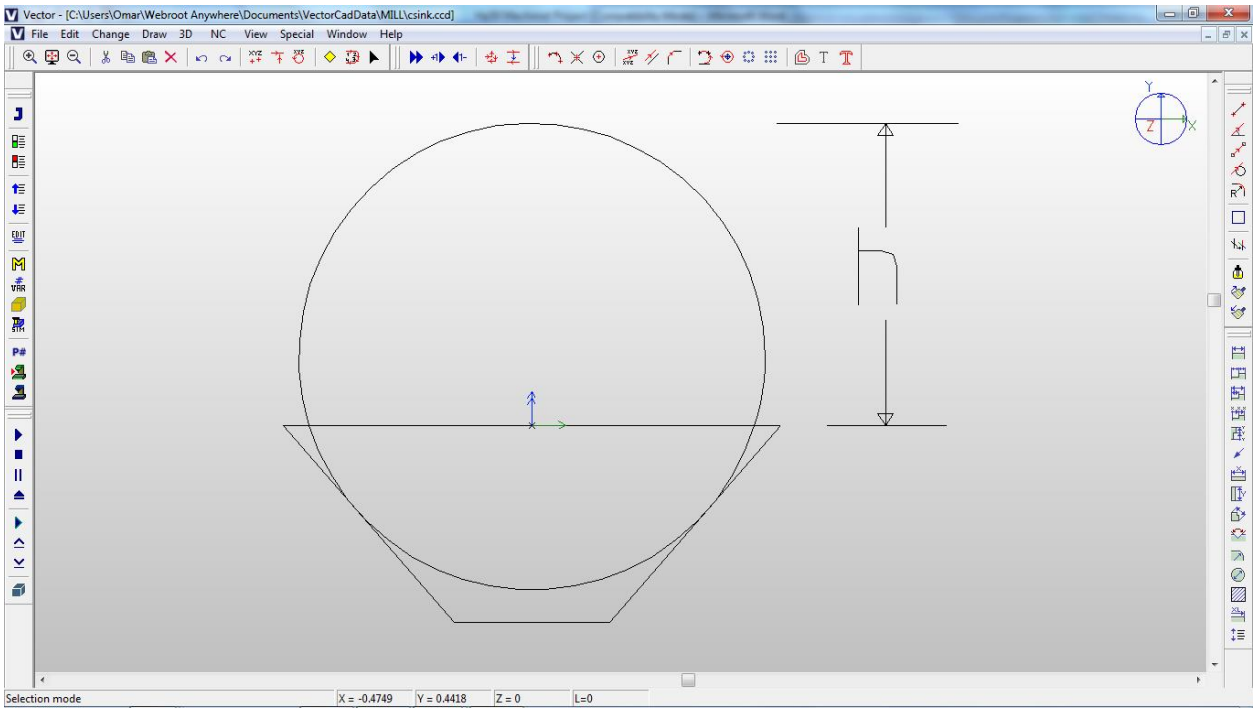
EXAMPLE2
Next example is finding the drill point depth for a .625 drill. Press RS CLEAR and enter the variables below
D: .625
A: 59
D: 0
Solve for Z by moving cursor at Z and pressing **SOLVE**

EXAMLE3
Calculate the small diameter of an external taper for a shaft.
D: 5
Z: 3
TPF: .75
Solve for d: = 4.8125

EXAMPLE4
A countersink hole needs to be .800 diameter with a 82 degree included angle. My countersink tool flat is .250 what will Z need to be to make the large diameter .800

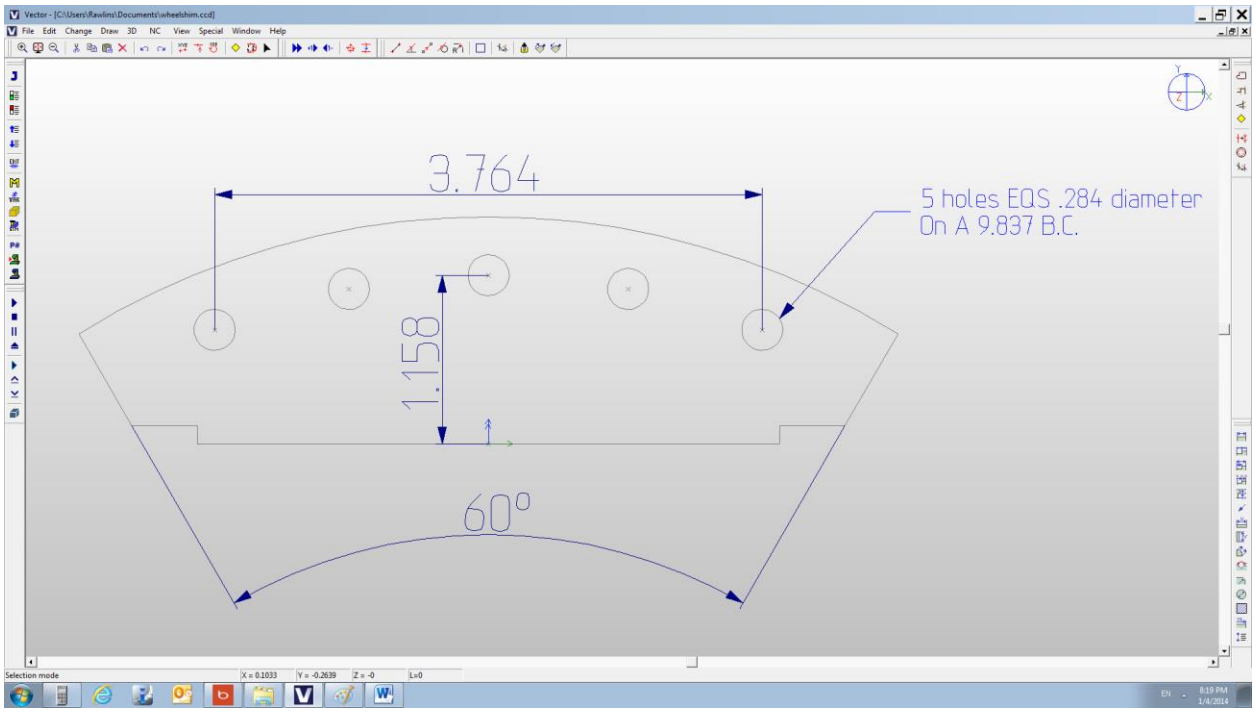
D: .800
A: 41
d: .250
Solve for Z

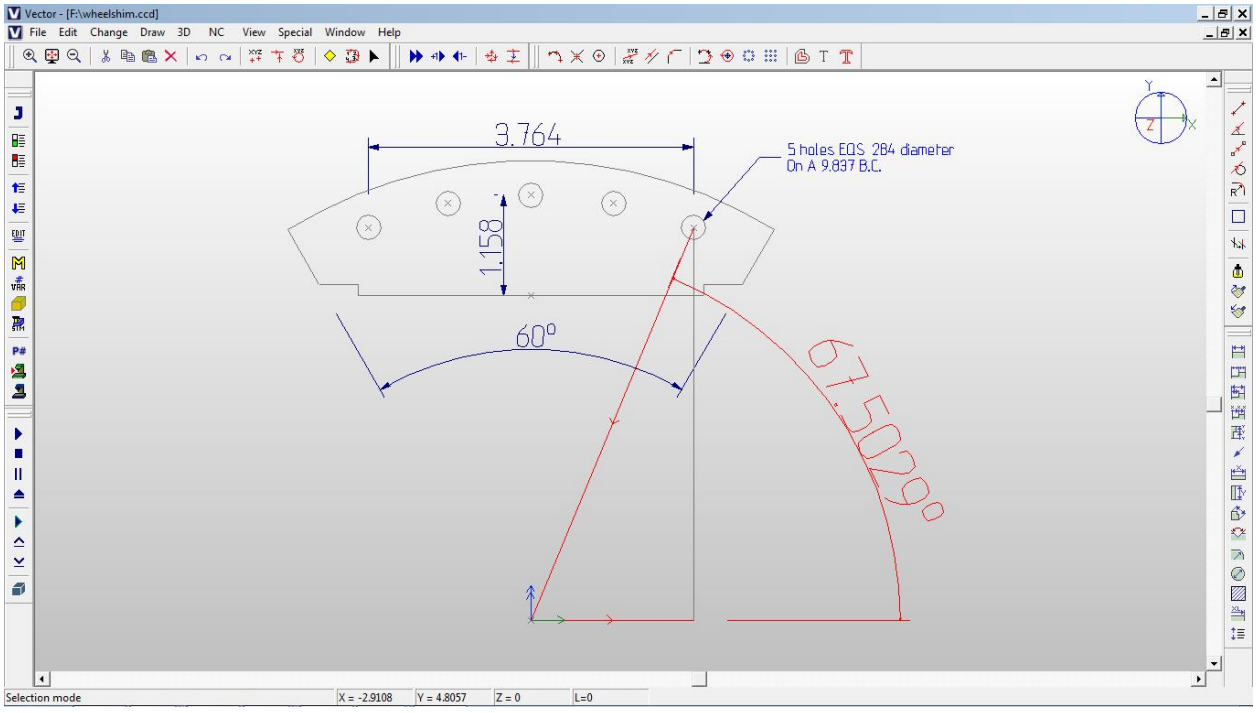
EXAMPLE5 measuring cone large diameter with ball. Use variables from the previous example. Move cursor to ball diameter and enter .75 Move cursor to h press backarrow key or enter 0 then press **SOLVE**, h will be calculated.
If you actually measured h with a height gauge, enter that number in h and press **SOLVE** to calculate the actual large diameter of the counter sink.



Bolt Circle

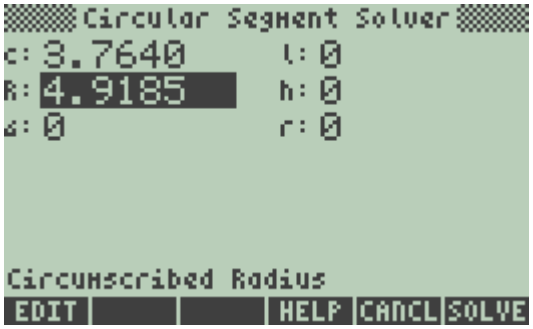
This bolt circle solver can calculate equally space holes xy coordinates for a full circle or an arc. I will use the drawing below to demonstre calculating equally space holes xy coordinates on an arc. The xy Coordinates of 5 equally space holes on an arc will be displayed in a counterclockwise direction.



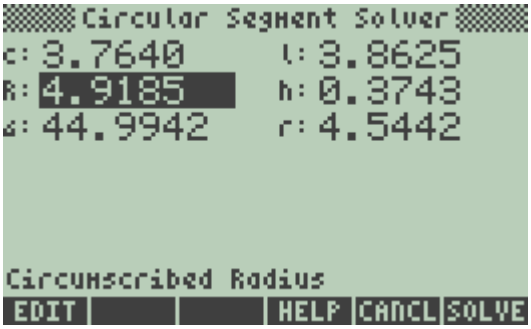


I need the " angle from zero to first hole"
Press **[CSEG]** then RS CLEAR. R will be the radius of the bolt circle

INPUT



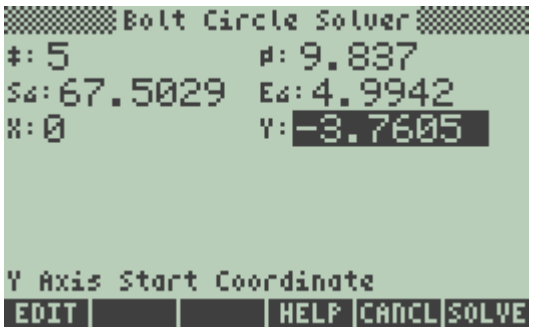
PRESS OK RESULTS



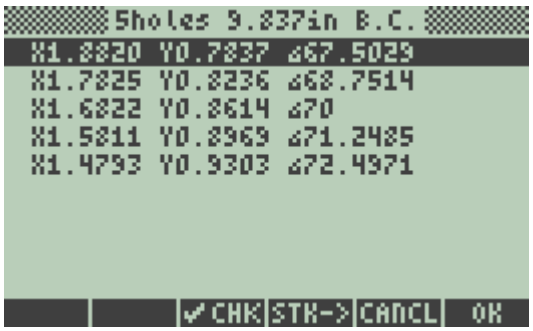
On calculator keyboard move cursor to variable angle then press STO -> to push 44.9942 onto the stack. Press **CANCL** to exit program. Keep in mind that **BC** calculator measures angles starting at 3 o'clock position so, 180 degrees minus 44.9942 divided by 2 is 67.5029

Press **BC**. Remember you can use HIST key to get the number from the stack to the current cursor position. You can now solve your problem!

INPUT



PRESS OK RESULTS



Explanation of input variables

5 holes are needed

Ø 9.837 Bolt Circle Diameter

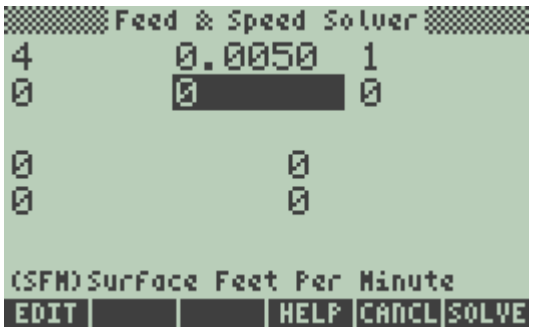
S∠ 67.5029 The angle for the first hole which is from 0 (3 o'clock) to the center point of the first hole.
E∠ 44.9942 this is an incremental angle value from the center point of the first hole to the center point of the last hole. If I needed 5 holes around circle that number would be 360 degrees

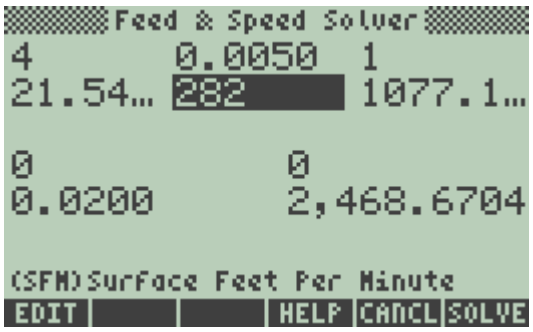
Y -3.7605 my datum on Y is at the edge of the part. The distance from Y0 to the center point of the Bolt Circle. The radius of the Bolt Circle is 4.9185 minus 1.158 that gives me 3.7605. Bolt Circle center point is in the minus direction. Y will be -3.7605

Feeds & Speeds

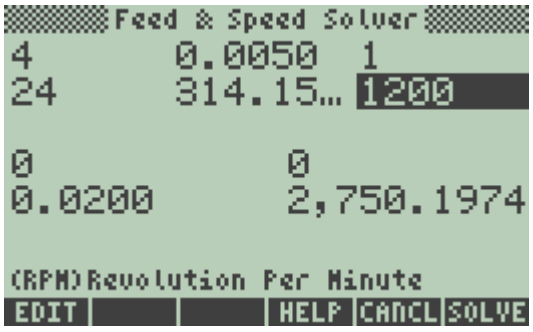
[FE&SP]
They are many factor that affect speeds and feeds in milling turning and drilling. It would an arduous task to include them all in this solver. I think the best approach to using this solver is to use the manufacturer recommended feed and speeds for a specific operation. Then make necessary calculation with MH. Below is an example of using the solver

I have a 4 flutes endmill 1 inch in diameter the manufacturer recommend running .005 chipload Enter SFM 282 and the missing variables will be filled.





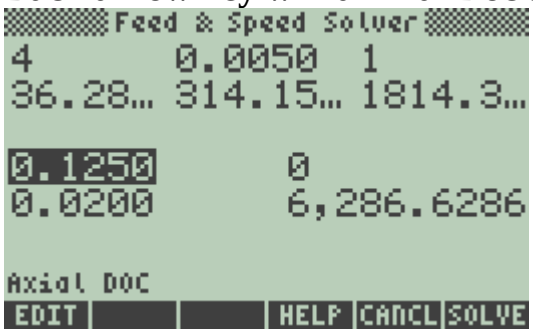
At this point you can make adjustments to any cutting parameters to see the effects on the other parameters. See what happens when you adjust your RPM to 1200



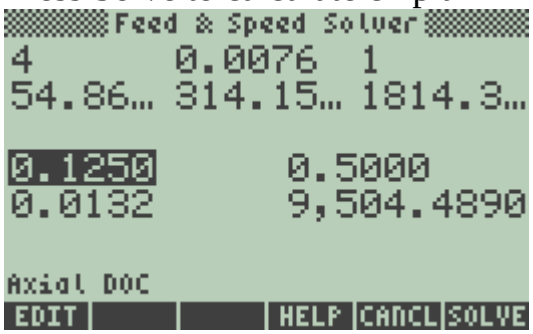
My Chip thinning reference and formulas are from the article below.
http://www.ingersoll-imc.com/products/ingersoll_cat-009_technical.pdf

What are left on the screen are Axial Depth Of Cut and Radial Width Of Cut which calculates chip thinning for speed and feed

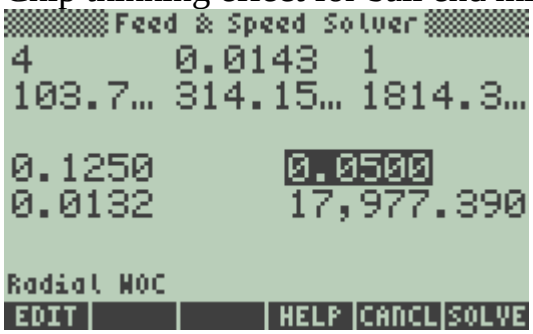
Entering Axial DOC will always assume you are using a ball endmill. The true feed and speed will be calculated based on the effective diameter.
Back arrow key will 0 Axial Doc and return default values



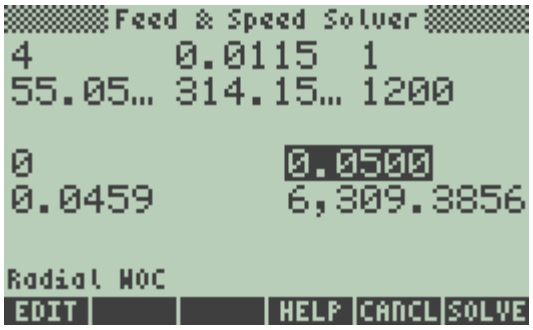
Press Solve to calculate chip thinning effect.



You can populate your own Radial WOC then press SOLVE to calculate Chip thinning effect for ball end mill.

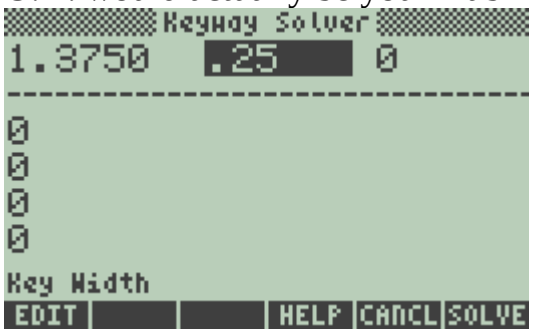


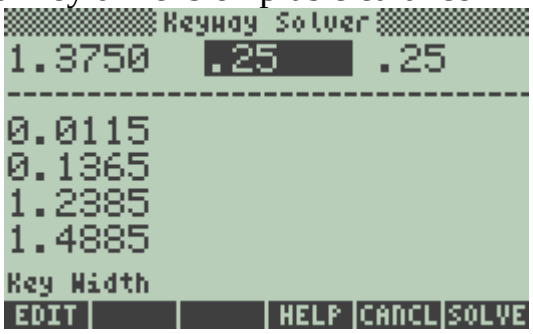
For flat endmill make sure Axial DOC is 0 and move cursor to Radial WOC and press SOLVE to Calcualte

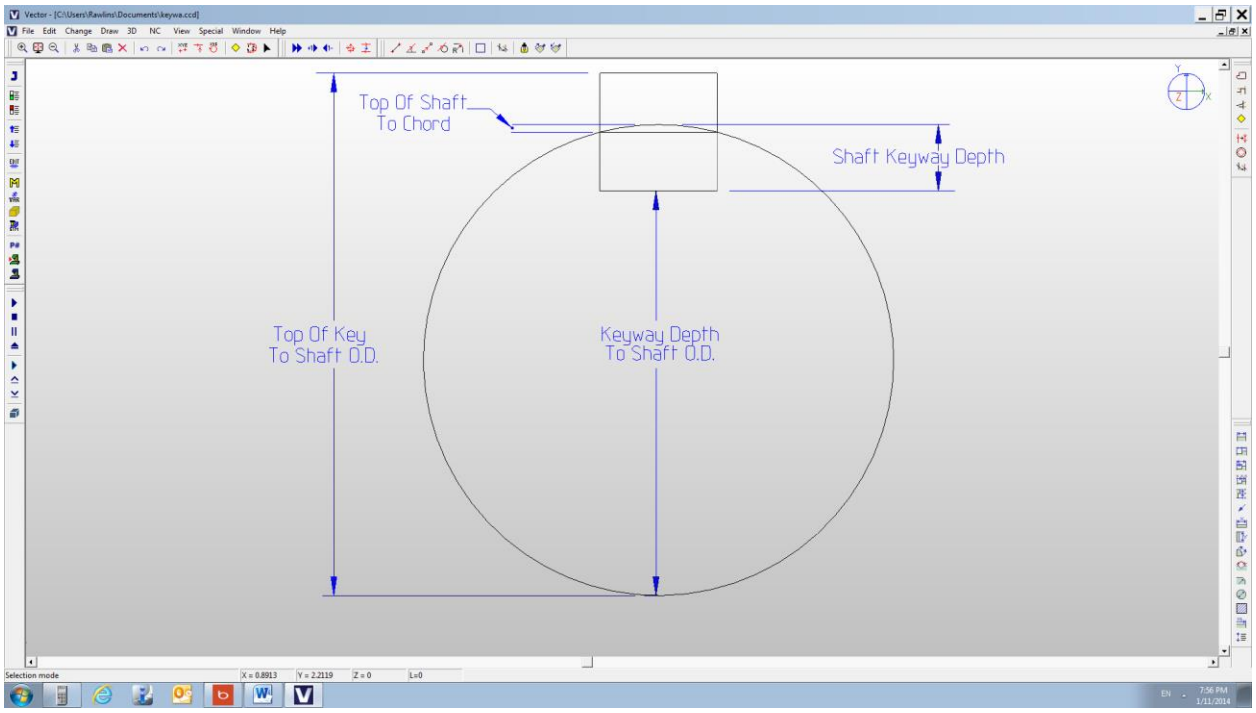


Keyways and Hubs

Input keyway dimensions above the perforated line then press **SOLVE** to find missing variables**.** One thing to make note of is the Top of Key to Shaft O.D. would actually be your Hub internal key dimension plus clearance







Formulas

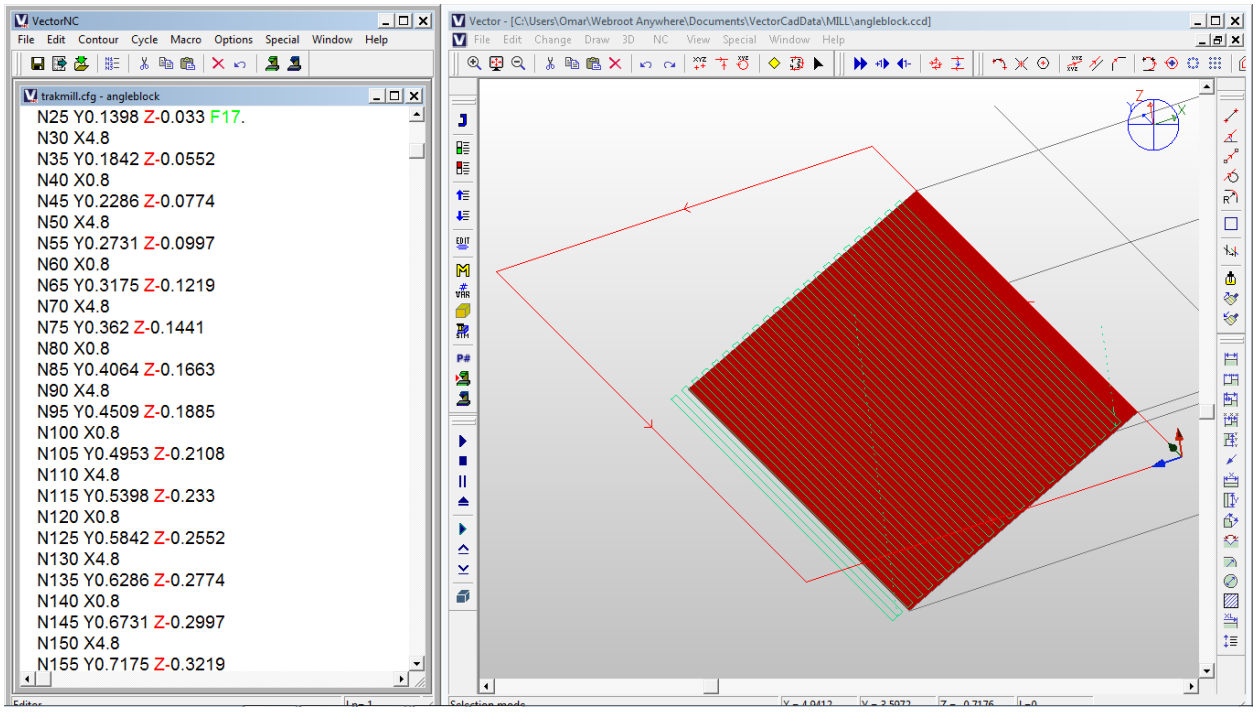
Form is a list of equations that uses HP50 built in equation solver. HP50 equation solver lets you solve for any variable in an equation. Fill in values to variables that you know and place highlight bar on variable you want to solve then press SOLVE on the menu. Below is a list of names of equations

MEASUREMENT OVER TRIANGLE
SCALLOP HEIGHT
EFFECTIVE DIAMETER
METRIC TAPER
RA TO RMS
LATHE FINISH RA
MILL FINISH RA
PIPE MOW
BUTRESS BEST WIRE
BUTRESS MOW
ENGLISH TAP
METRIC TAP

ENGLISH FORM TAP
METRIC FORM TAP

CUSP HEIGHT EXAMPLES

I will use the SCALLOP HEIGHT and EFFECTIVE DIAMETER Formulas to calculate X and Z axis increment to machine an incline from the drawing below. The angle is α 26.5651 degree that will be machine with a .625 ball end mill.



Open scallop height and input variables below
H= .00099
d = .625
α= 26.5651
Solve for s which is the step over in the Y direction
s= .0445
We can use SAA from TRIG menu to calculate the Z depth.

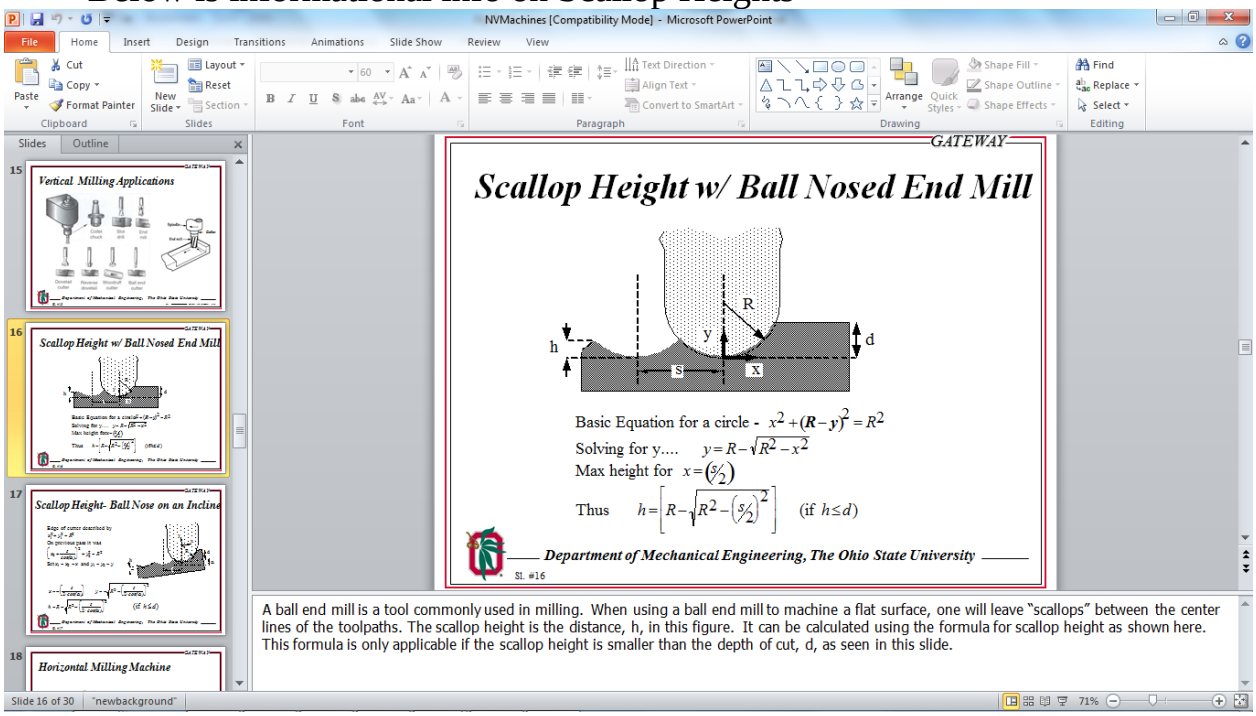
0.0445
90
63.4349

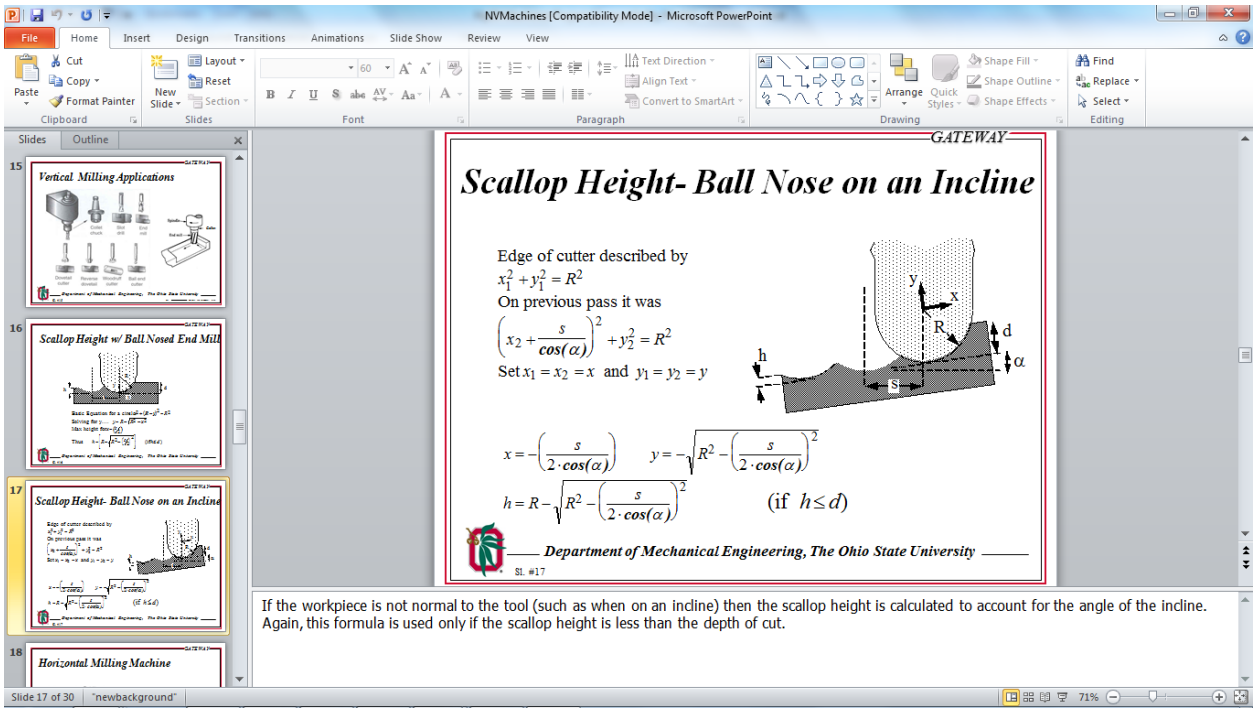
Press SAA
S2=.0222 this is our incremental Z depth.

Look at N25 X-.1398 Z-.033. The cad program by default adds .010 to the first Z move, to get .1398 use the effective diameter program enter the following
D .625
d .033
solve efd then divide by 2 to get .1398

Starting at line N25 we can set up a loop to increment Z .0222 and increment Y .0445 to machine the incline with a scallop height on of about .001. Obviously you can change the incline angle to 0 for non-inclined surfaces

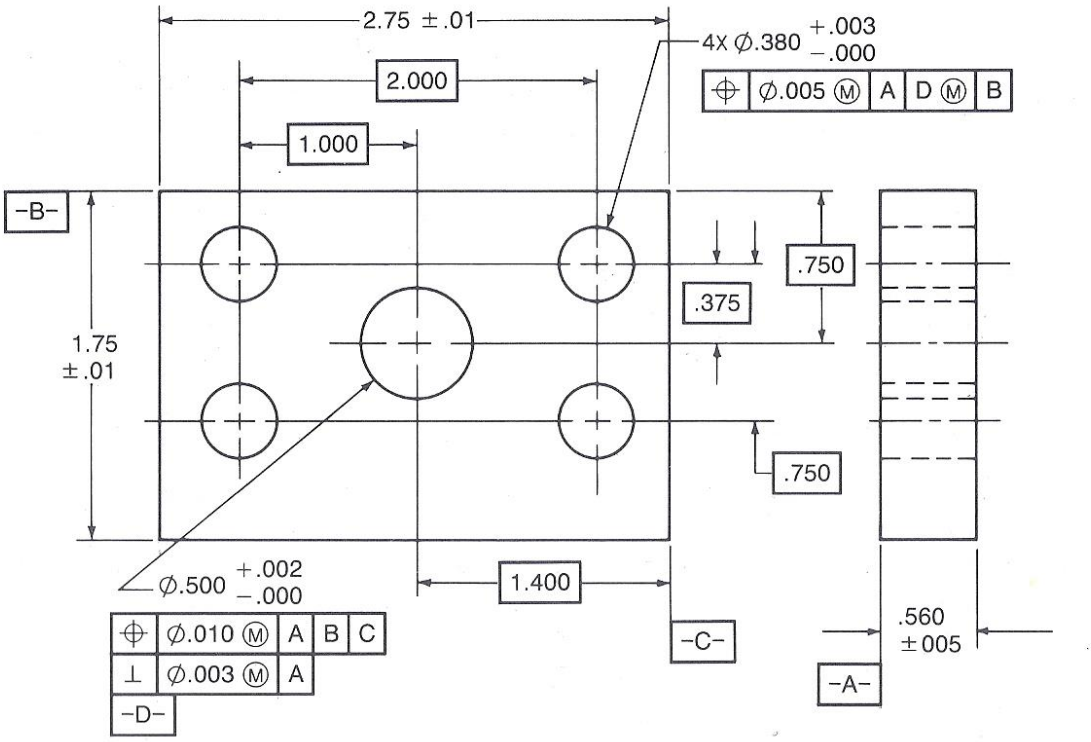
Below is informational info on Scallop Heights



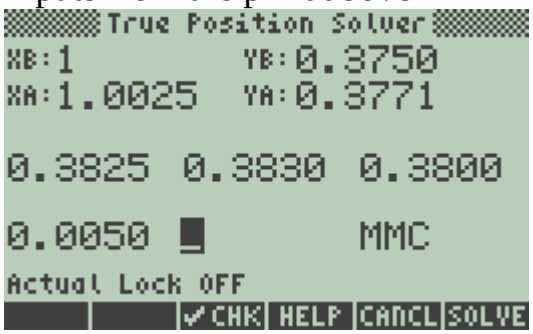

NVMachines [Compatibility Mode] - Microsoft PowerPoint
File
Home
Insert
Design
Transitions
Animations
Slide Show
Review
View
Slides
Outline
15
Vertical Milling Applications
16
Scallop Height w/ Ball Nosed End Mill
17
Scallop Height- Ball Nose on an Incline
18
Horizontal Milling Machine
GATEWAY
Scallop Height- Ball Nose on an Incline
Edge of cutter described by
$x_1^2 + y_1^2 = R^2$
On previous pass it was
$\left(x_2 + \frac{s}{\cos(\alpha)}\right)^2 + y_2^2 = R^2$
Set $x_1 = x_2 = x$ and $y_1 = y_2 = y$
$x = -\left(\frac{s}{2 \cdot \cos(\alpha)}\right)$
$y = -\sqrt{R^2 - \left(\frac{s}{2 \cdot \cos(\alpha)}\right)^2}$
$h = R - \sqrt{R^2 - \left(\frac{s}{2 \cdot \cos(\alpha)}\right)^2}$ (if $h \le d$)
Department of Mechanical Engineering, The Ohio State University
SL #17
If the workpiece is not normal to the tool (such as when on an incline) then the scallop height is calculated to account for the angle of the incline. Again, this formula is used only if the scallop height is less than the depth of cut.
Slide 17 of 30
"newbackground"
71%

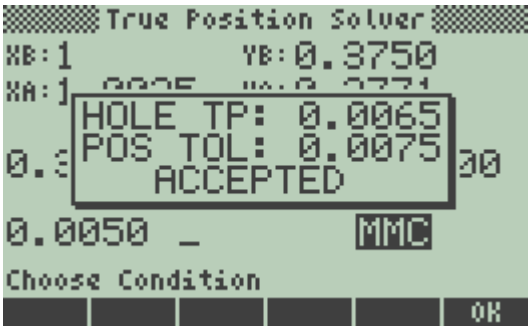
True Position

[TPOS] is a true position solver for holes. It will prompt accepted or rejected for holes positions. I will give example of **TPOS** from the print



Inputs from the print above



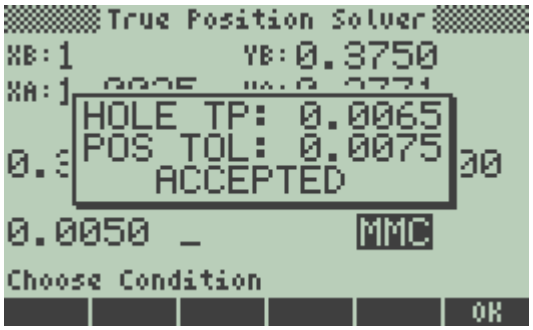


XB X basic dimension on print 1.
YB Y basic dimension on print .375
XA X actual measured dimension 1.0025
YA Y actual measured dimension .3771

.3825 the actual measured hole diameter

.383 max tolerance on print
.380 min tolerance on print
.005 positional tolerance call out on print
Actual Lock ON will always move cursor to all actuals XA YA and actual hole diameter. This is useful if you have many hole to check where the basic dimension and hole tolerance is the same.

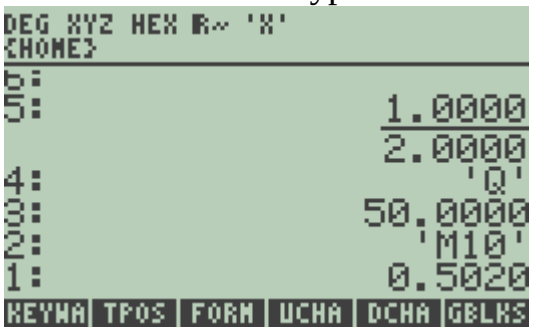
Actual Lock and condition can be navigated with -/+ keys



HOLE TP: Actual true position of the hole .0065
POS TOL: This your positonal tolerance .005 plus bonus of .0025

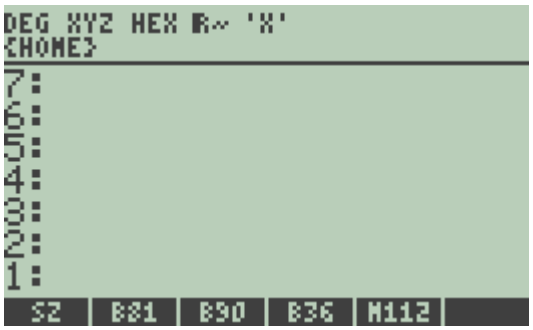
[UCHA] Scroll up decimal equivalent chart search for drill on stack
[DCHA] Scroll down decimal equivalent chart search for drill on stack

UCHA and DCHA will search for the closest drill size for Fractional, Letter, Number or Metric drills. Decimal sizes are also searchable. The screen shot shows the different type of searchable drill



Using Gauge Block Stack program with MH

In this version of MH I included a menu call GBLKS to access Dave Hayden gauge block stack program. The gauge block program is stored in a directory. For me, it was more convenient to extract the files from the directory and store the files in HOME directory like below

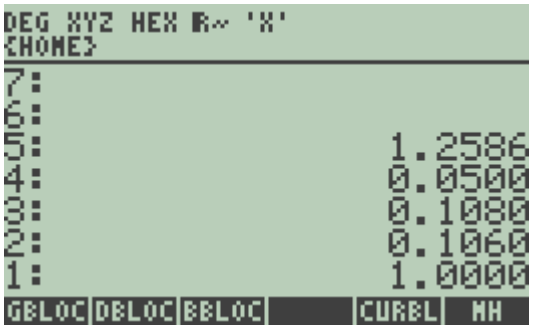


BTEMP should contain the name of the current gauge block data used. The user has three choices 'B81' 'B36' 'M112'

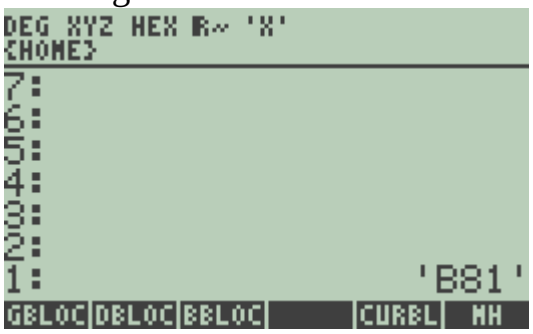
Keep in mind you can build your own set and make sure that the set you use matches the set in your shop. I added BTEMP for the simple reason that all you need is one input to run GBLOC

Press GBLKS

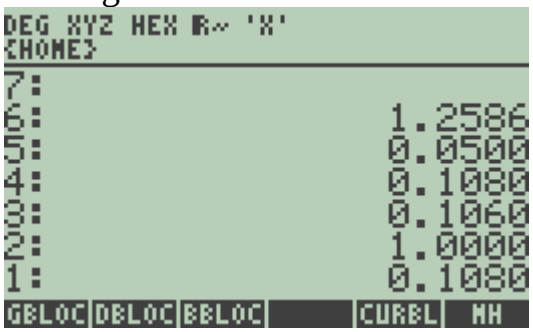
GBLOC calculates blocks from a number on the stack. GBLOC defaults to B81 if BTEMP is not found. In this case 1.2586 blocks was calculated from a B81 block set.



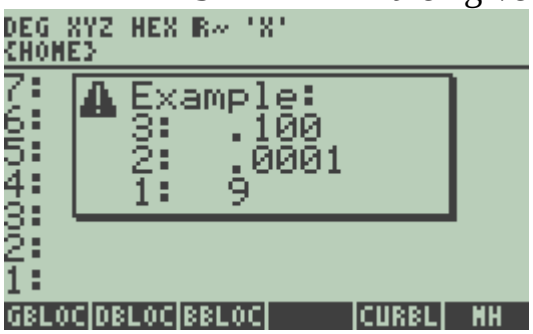
Press LS CURBL to store the name of the current block set in BTEMP
Pressing CURBL recalls the name of the current block set to the stack



DBLOC recalculates with a missing block on stack1. Block .108 was missing from the set .



BBLOC help you build block if you need to build a special set from scratch. Pressing BBLOC with nothing on the stack will give you an input example. Once you have all your blocks on the stack type DEPTH press LS PRG TYPE 1 →LIST →ARRY then give your new block set a name.



My shaft is stuck!

I remember getting a shaft stuck in a hub. I dragged the shaft and hub clear across the shop and set it up on a metal table next to the Oxy acetylene tank. I screwed on the regulator on the tanks and snoop the hoses for any potential leaks. I couldn't remember what number nozzle to use, so I called over the welder who is more skilled at this stuff than I am. He told me I needed a number 2 nozzle of which was not on the cart. He said, "I might have one in my tool box." He came back about fifteen minutes later and screwed on the nozzle. The Welder then said: "Do you have a Hot Work permit?" I said no! He said: "Well -- you will need one" He went to get one. That took another 10 minutes. He came back and put about 300 degrees on that shaft and we were able to pull the hub off.

If I had **ROY,** an induction heater, I could have saved an hour of my time

http://www.fluxeon.com

http://www.johndearmond.com/2014/10/01/using-the-induction-heater-removing-a-stuck-fan/

REVISIONS

Version 1.8 May 1, 2015

- Removed all User key assignments for compatibility with USOLVE
- Moved decimal chart keys to menu named UCHA and DCHA
- MH no longer use MACH directory as a scratch directory. MHelp is now used. User Menus are now preserved after exiting GUI
- Rearrange TRIG menu for easier navigation of menu rename ANG+ and ANG- to ∡°+ and ∡°- .
- Added 4 tap formulas to FORM
- Fixed incorrectly calculated min mean from metric threads
- Did quite a bit of work on all GUI for menu consistency
- Feed & Speed calculates inputs are now dynamic. Entering data will automatically keep in synch data. This helps answer question like if I increase my RPM what will my IPM be?
- Bolt Circle output has been improved. Removed trailing zeroes after angles. Added STK-> B.C. data to stack. Changed the title output
- Added Dave Hayden Gage block stack program to MH menu [GBLKS]

Version 1.7 NOV 2014

- Continue to improve FE&SP. bug fix
- Slight document and help improvements
- Fix conflicts variables with CSEG and ZDEPTH
- Changed menu ZDEPTH to TAPER
- Changed drill chart user key assignments to left and right arrowkeys To prevent user key collision with Usolve Equation Solver
- Included my Home back so users can see my setup
- Merge Polygon Solver with Circular Segment Solver
- Rearrange menu keys

Version 1.6

- Added subtraction and addition of angles to User key
- Fixed user key reduce anomaly
- Added new Feed and Speed Solver
- Added MMC LMC and RFS along with reject or accept to True Position Solver

Version 1.5 June 2014

- Companion to MH v1.5 is Dave Hayden's excellent gauge block stack Program Awesome job Dave!
- Modify FORM menu with description of formulas
- I added versatile Depth Solver
- Added true position solver
- Removed redundant formulas that Depth Solver took place of
- Removed BASIC and assign to user keys
- Added ASA in triangle solver

Version 1.4 January 2014

- Updated help txt, added a needed decimal chart search for drill,
- Changed THRD from scrolling to menu, Re wrote keyway solver just to name a few.

January 1, 2013 version 1.3

- Added function HELP text info
- Update trig menu added radius from three points, add & subtract DMS
- Updated thread menu and output display, added Buckingham Involute Helicoid formula to thread menu as 3wire

September 18, 2012 version 1.2 release