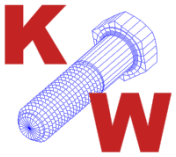
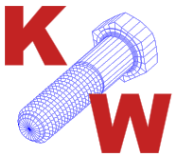
KeyWild 3D Bolt Generator



http://www.keywild.com/cad_library



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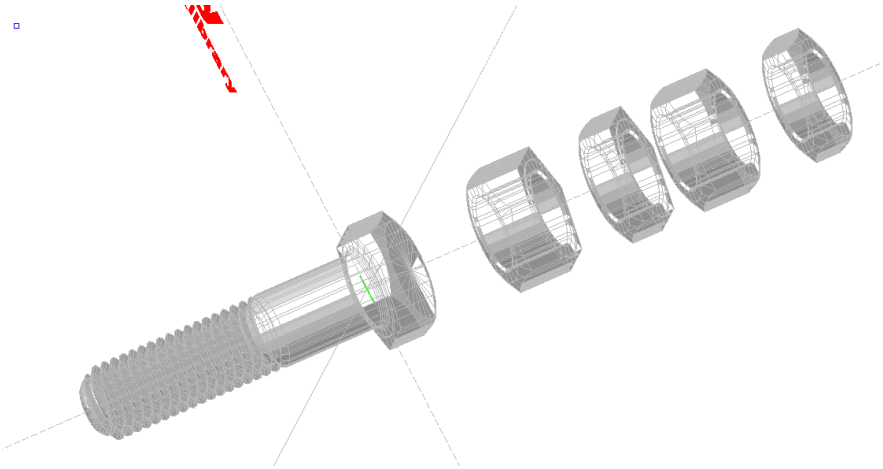
"No good deed goes unpunished." — Oscar Wilde

"Engineering is the art of planning and forethought." — Lewis Balentine

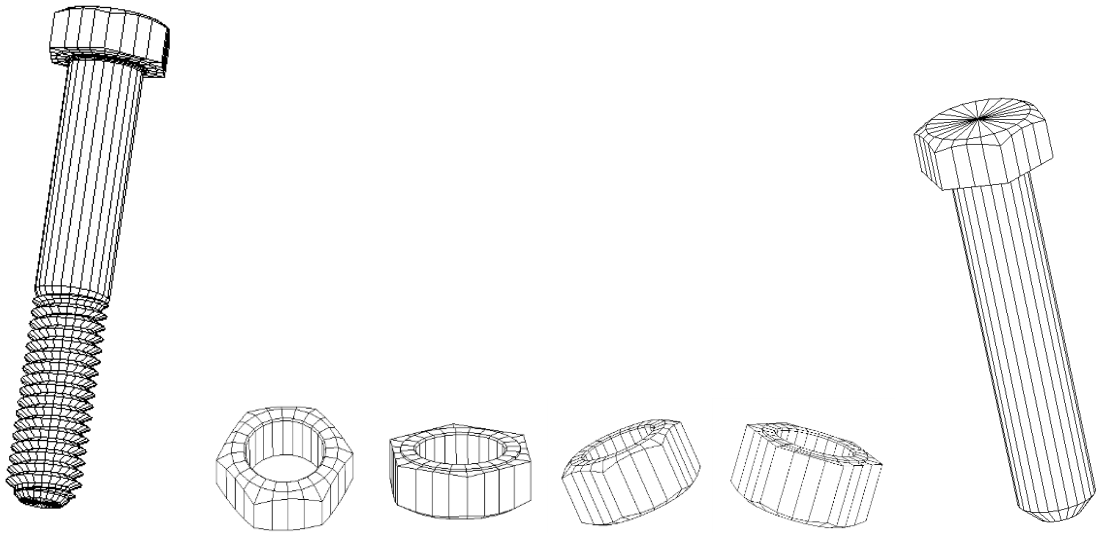
Table of Contents:

Program Description:

The purpose of this program is to generate a script file that can be run in Dessault Systemes “DraftSight.exe” to produce a three dimensional model of a standard hex head cap screw or bolt. Optionally the script may also build models of hex nuts to fit the cap screw. Each object is created as a single closed 3D polymesh.



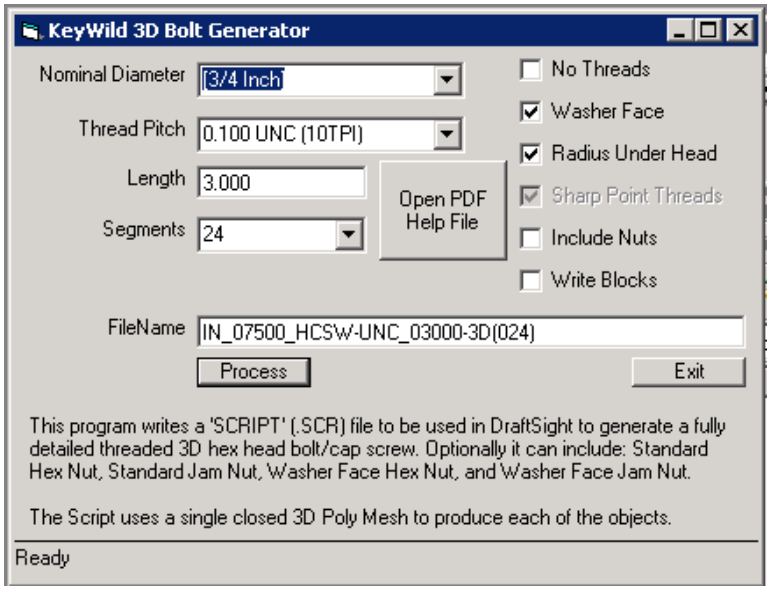
Sample {Master} drawing view with all parts.



Sample views (*in order of appearance*):

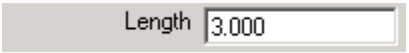
HCSW	(Hex Head Cap Screw with washer face and radius, **UNC**)
HNJP	(Hex Nut, Jam, Plain Face, **###**)
HNJW	(Hex Nut, Jam, Washer Face, **###**)
HNSP	(Hex Nut, Standard, Plain Face, ###)
HNSW	(Hex Nut, Standard, Washer Face, ###)
HBLP	(Hex Bolt, Plain, no threads, ###)

Program Parameters:



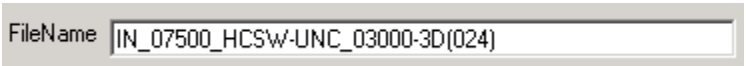
Select the nominal diameter for the fastener. These are read from an INI file that comes with the software. Additional diameters can be added. The program should work with Metric Values but that has not been tested.

Select Thread pitch (*distance between two threads*). These are read from an INI file that comes with the software. Additional pitches can be added but must start with a decimal value. Normally this will be indicated as **UNC** or **UNF** in the file name.



Enter nominal length (*from under the head to the bottom of the bolt shaft*). This must be decimal number. Fractional (i.e. “1-1/2”) numbers are not supported.

The mesh is created as a number of segments around the vertical diameter of the shaft. Options are available for: **24,36,48,72,144,244** segments



This is the file name that will be used for the script file. Note that the extension “**.scr**” will be appended to the end. The program normally tries to generate a file name that matches those in the KeyWild CAD library with the addition of “**-(3D000)”** appended to the end. “**000**” is the number of segments.

If checked no threads will be drawn and the default file name will include “###” in place of the pitch.

If check a “washer face” will be drawn under the head. The Washer face will be 90% of the across flats dimension.

If checked then a Radius will be drawn between the bottom surface of the head and the top of the bolt shaft. This is the default.

If checked then the threads will be drawn with sharp corners. If unchecked (*not implemented at this time*) the threads will be draw with flats for the peaks and valleys. Radius threads are not an option because the number of rows in a mesh is limited to 256. This is adequate in a few cases for radiuses threads but not in most.

This option is only available if you have already chosen the Washer Face option. If checked then the program will include in the script commands to draw four hex nuts. These will be:

Washer Faced Standard hex nut (**HNSW**)
Washer Faced JAM hex nut (**HNJW**)
Plain Faced Standard hex nut (**HNSP**)
Plain Faced JAM hex nut (**HNJP**)

If checked then the program will include in the script commands to write each object out to a file (block) in the current working directory. The names of these files will be similar to:

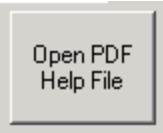
`IN_05000_`**`BLTP`**`-###_03000-3D(024).dwg`	(bolt, plain face)
`IN_05000_`**`HCSW`**`-###_03000-3D(024).dwg`	(hex Cap screw, washer face)
`IN_05000_`**`HNJP`**`-3D(024).dwg`	(hex nut, plain face)
`IN_05000_`**`HNSP`**`-3D(024).dwg`	(standard nut, plain face)
`IN_05000_`**`HNJW`**`-3D(024).dwg`	(hex standard nut, washer face)
`IN_05000_`**`HNSW`**`-3D(024).dwg`	(hex jam nut, washer face)

The file name convention is:

“IN”	Measurement system: IN = Inches, MM = Metric
“_”	Underscore character
“00000”	Five digit nominal diameter (*ten-thousandths of an inch*)
“_”	Underscore character
“XXXX”	Four character designation for part type
“-“	Dash character
“###”	Three character thread pitch: UNC, UNF, ### (no threads)
“00000”	Five digit nominal length (*thousandths of an inch*)
“-“	Dash character
“3D”	Indicates three dimensional model file
“(000)”	Three digits indicating number of segments

Note that pitch and length are not used for nuts or washers.

Process the parameters and write file.



Show this PDF help file (*may also be accessed by pressing the function key "***F1***"*).

Exit the program.

Command Line Arguments:

/?	Invoke help (this message box) and exit.
/D:#	Nominal Diameter: Index into Combobox as read from Ini file. First entry is zero.
/P:#	Nominal Pitch: Index into Combobox as read from Ini file. First entry is zero.
/L:#.##	Nominal Length as decimal number
/S:#	Segments: Index into Combobox; 0=24, 1=36, 2=48, 3=72, 4=144, 5=240
/T:#	Show no threads: 0=False, 1=True (*note the double negative*)
/W:#	Show washer face: 0=False, 1=True
/R:#	Show radius under head: 0=False, 1=True
/A:#	Show sharp points on threads: 0=False, 1=True (*not currently implemented*)
/N:#	Include Nuts: 0=False, 1=True
/F:XXXXX	File Name. No spaces or quote characters.
/B:#	Include commands to write blocks: 0=False, 1=True.
/G:#	Process and exit: 0=False, 1=True

Examples:

```
/D:7 /P:0 /L:3.000 /S:4 /T:0 /W:1 /R:1 /N:0 /F:BOLT.SCR
```

With the INI file that comes with the program this would generate a script named “BOLT.SCR” for a 3/4 inch nominal diameter hex head cap screw (*bolt*) 3 inches in length with 13TPI UNC threads including details for a washer face and a radius under the head. It would NOT include nuts or commands to write blocks to disk. There would be 72 radial segments in the part.

```
/D:4 /P:0 /L:3.00 /S:1 /T:0 /W:1 /R:1 /N:1 /B:1
```

With the INI file that comes with the program this would generate a script named “IN_05000_HCSW-UNC_03000-3D(036).scr” for a 1/2 inch nominal diameter hex head cap screw (*bolt*) 3 inches in length with 13 TPI UNC threads including details for a washer face and a radius under the head. It would also include nuts but not commands to write blocks to disk. There would be 36 radial segments in the part.

```
/D:0 /P:0 /L:3.00 /S:0 /T:1 /W:1 /R:1 /N:1 /B:1 /G:1
```

With the INI file that comes with the program this would generate a script named “IN_02500_HCSW-###_03000-3D(024).scr” for a 1/4 inch nominal diameter hex head cap screw (*bolt*) 3 inches in length without threads including details for a washer face and a radius under the head. It would also include nuts and commands to write blocks to disk. There would be 24 radial segments in the part. The program would write the script and exit.

INI File:

The file “KW Bolt Gen.ini” contains the nominal data needed by the program for each diameter fastener. It (and this help file) should be located in the same directory as the executable program. Blank lines and lines beginning with a semi colon are ignored.

[Section Names]

The section names are used as the entries for the “Nominal Diameter” combo box.

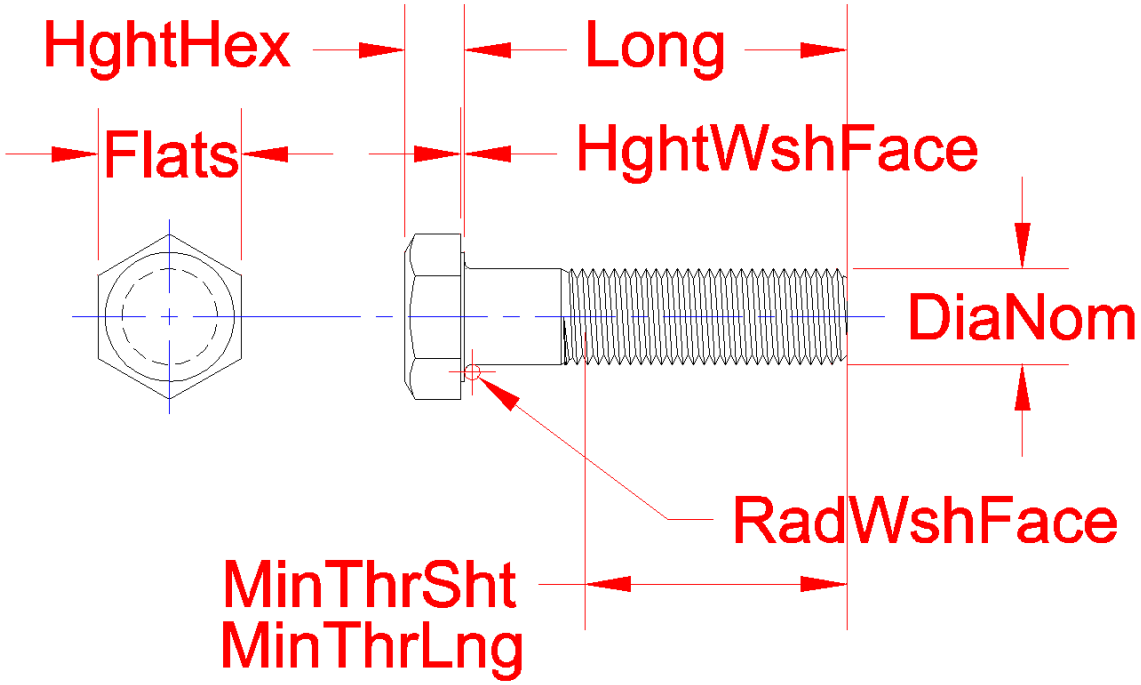
These entries should include the either the word “Inch” or “Metric” to indicate the measurement system used. As supplied the INI file contains data for:

0) 1/4 Inch
1) 5/16 inch
2) 3/8 Inch
3) 7/16 Inch
4) 1/2 Inch
5) 9/16 Inch
6) 5/8 Inch
7) 3/4 Inch
8) 7/8 Inch
9) 1 Inch
10) M24 Metric (*use of Metric dimensions is experimental, proper operation has not been validated*)

Key values:

Key values must be decimal numbers. Fractional notation (*i.e. 1-1/2*) is not supported. The keys may be in any order. No error checking is done for missing keys. The following keys are recognized:

DiaNom	Nominal Diameter
Flats	Across flats (Hex Head)
HghtHex	Height of Hex Head
HghtWshFace	Thickness of washer face below head
MinThrSht	Minimum thread length for short bolts
MinThrLng	Minimum thread length for long bolts
HghtNut	Height of standard Hex Nut
HghtNutJam	Height of jam Hex Nut
RadWshFace	Radius under washer face (*not currently implemented*)
Long	Greater than Length for Minimum thread length for long bolts
Pitch0	Thread Pitch number 0 (*Vertical distance between two threads*)
Pitch1	Thread Pitch number 2 (*Vertical distance between two threads*)
Pitch2	Thread Pitch number 3 (*Vertical distance between two threads*)
Pitch3	Thread Pitch number 4 (*Vertical distance between two threads*)
	The first part of each pitch must be a valid decimal number.
	The rest of the line may be more descriptive text.

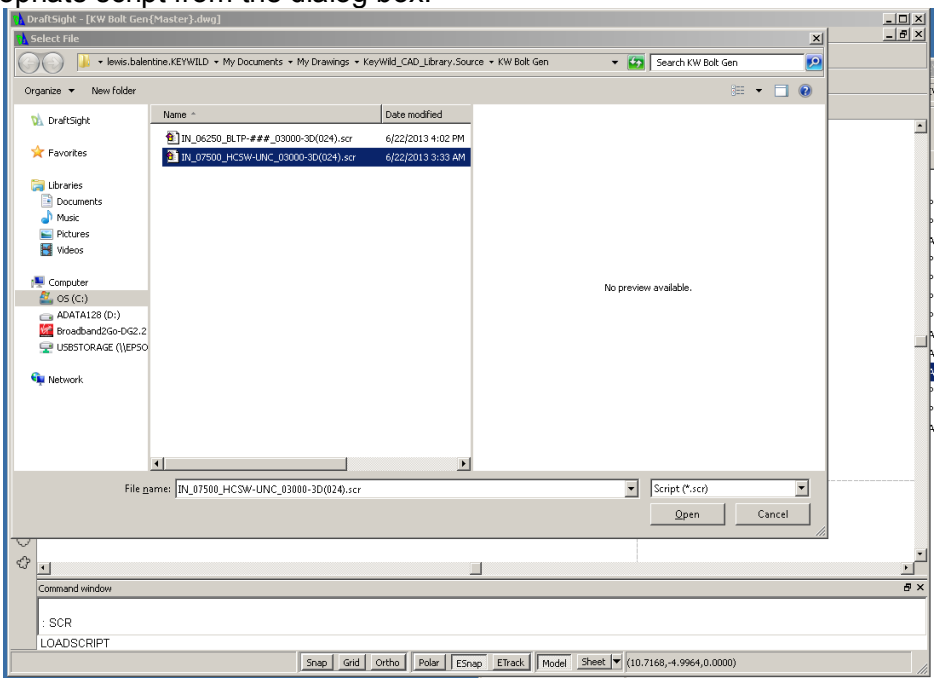


Sample INI file Section:

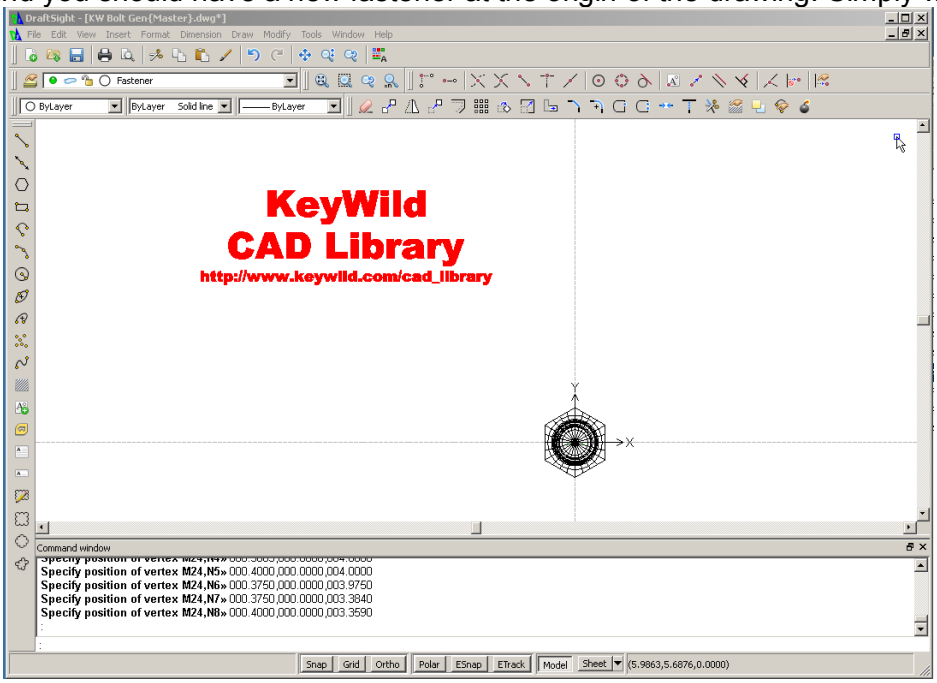
```
[3/4 Inch]
      DiaNom = 0.75
      Flats = 1.125
      HghtHex = 0.4688
      HghtWshFace = 0.016
      MinThrSht = 1.75
      MinThrLng = 2
      HghtNut = 0.641
      HghtNutJam = 0.422
      RadWshFace = 0.06
      Long=6.000
      Pitch0 = 0.100 UNC (10TPI)
      Pitch1 = 0.0625 UNF (16TPI)
      Pitch2 = 0.0833 Odd (12TPI)
```

Script File Usage:

Easy peasy. Open up an existing drawing (KW Bolt Gen{Master}.dwg). Type “SCR” at the command prompt and select the appropriate script from the dialog box.



The script will run and you should have a new fastener at the origin of the drawing. Simply write it out to a file.



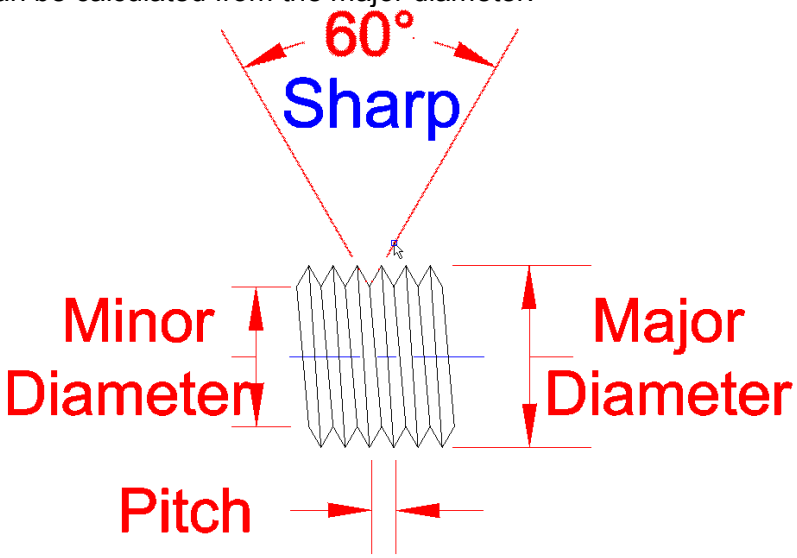
If you have chosen the option to 

then that data should be written to the disk and the program will exit on its own. Note that I have had some problems with starting a “new” drawing and running the scripts. I have gotten a <file error> when the script tries to write to disk. For that reason I suggest opening an existing drawing (*that never seems to fail*). The file “KW Bolt Gen{Master}.dwg” is provided for that purpose (*and the shameless self-promotion value*).

Assumptions, Artistic License and Other Cheats:

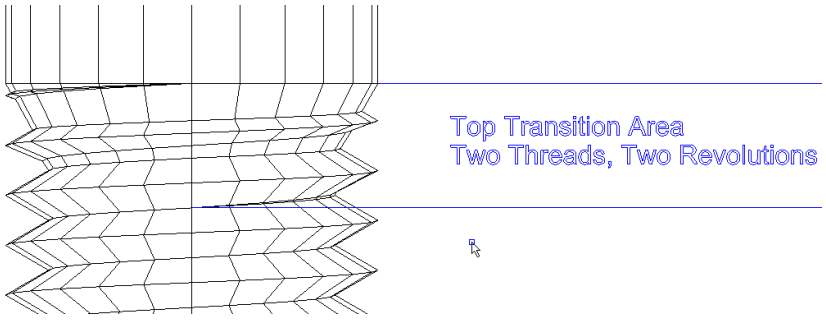
Some of the parameters used by the program are calculated after the nominal information is read from the INI data file. Among these are the across corners, minor diameter, crown height and thread length.

The geometry for the compound helix curve threads is the most complex. The program assumes the thread form is a 60 degree equilateral triangle with the base parallel to the vertical axis of the fastener shaft. Thus each side is equal to the pitch of the threads. There is a limit of 256 columns x 256 rows for a 3D mesh. In some cases that is insufficient for threads with a radius for the ridges and valleys. It might be sufficient for “flat” threads. Thus a sharp corner thread form is assumed. The major diameter is equal to the nominal diameter and the minor diameter can be calculated from the major diameter.



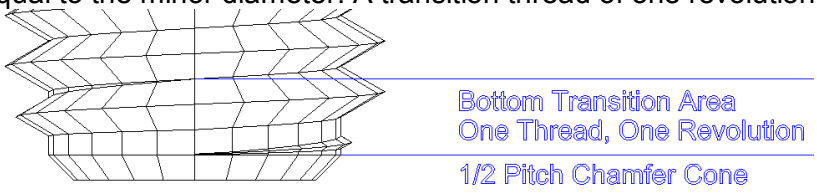
For the poly mesh to close each row definition must begin and end at zero degrees. Thus all threads must be full revolutions. This is the first “cheat”. The “minimum thread length” is rounded up to accommodate this limitation.

At the top of the threaded area there is supposed to be a transition from the threaded portion to the full shaft diameter. I no longer have access to an IFI handbook, but if memory serves (*from four decades ago*) this is supposed to be a 60 degree included angle conical cone with a maximum of 1-1/2 threads transition. Here is our second “cheat”: this transition is two full revolutions and terminates at the bottom of the full diameter shaft body.



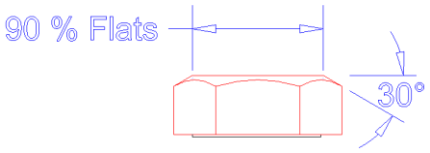
Each thread in this area is defined by three rows: valley row, ridge row, valley row. The ridge rows dimensions are the same as normal threads, however the valleys rows go from the minor diameter to the major diameter with a proportional change for each segment in the two revolutions. A “fudge factor” is applied to the bottom valley row of each thread to “simulate” a conical transition. Every threaded model shows two extra transition threads at the top of the minimum thread length. This was the most difficult portion of the program. I am not yet totally satisfied with the solution but “it is what it is” at the moment.

At the bottom of the threaded area there is supposed to be a chamfer in order to more easily insert the fastener into the female part and line up the threads. Relying on my memory I believe this is supposed to be 45 degrees with a maximum of 1/2 threads transition. There is yet another “cheat”. This program begins with a small 1/2 pitch high 45 degree cone at the bottom (*note: the full thread length must be adjusted up for this 1/2 pitch*). The top of this cone is equal to the minor diameter. A transition thread of one revolution is used.



The thread in this area is defined by three rows: valley row, ridge row, valley row. The ridge row goes from the minor diameter to the major diameter with a proportional change for each segment in the single revolution. The valley rows are defined by the minor diameter and move up proportionally in the revolution to meet the valley rows of the full threaded region. It should be noted that the minimum full thread distance is measured from the bottom of the fastener shaft despite the chamfer and transition thread.

Two assumptions are made in order to model the crown of the hex head. The diameter of the circle is 90 percent of the across flats distance. This dimension is also used for the diameter of the washer face below the head. The external angle of the cone is assumed to be 30 degrees.



One last liberty (*Artistic License*) has been taken. The thickness of the washer face is specified as 0.016 inches. This becomes insignificant on larger diameter fasteners. For clarity this dimension in the supplied INI file has been increased to 0.030 for 1 to 2 inch fasteners, 0.060 for 2 inch fasteners and 0.090 for fasteners over 2 inches.

Lastly none of the nuts have threads. The external threads were a sufficient challenge. The hole through the center is simply the major diameter. If the nuts are used in an assembly then the lack of threads will never be seen.

Program Environment:

This program was written in 32 bit Visual Basic version six on a Windows XP computer. VB6 was used because: I own it (*i.e. it is paid for*), it works and I know how to use it. It does require the use of the VB6 runtime environment but that should be available on most Windows OS machines. It is available for down load at numerous sites including KeyWild.com.

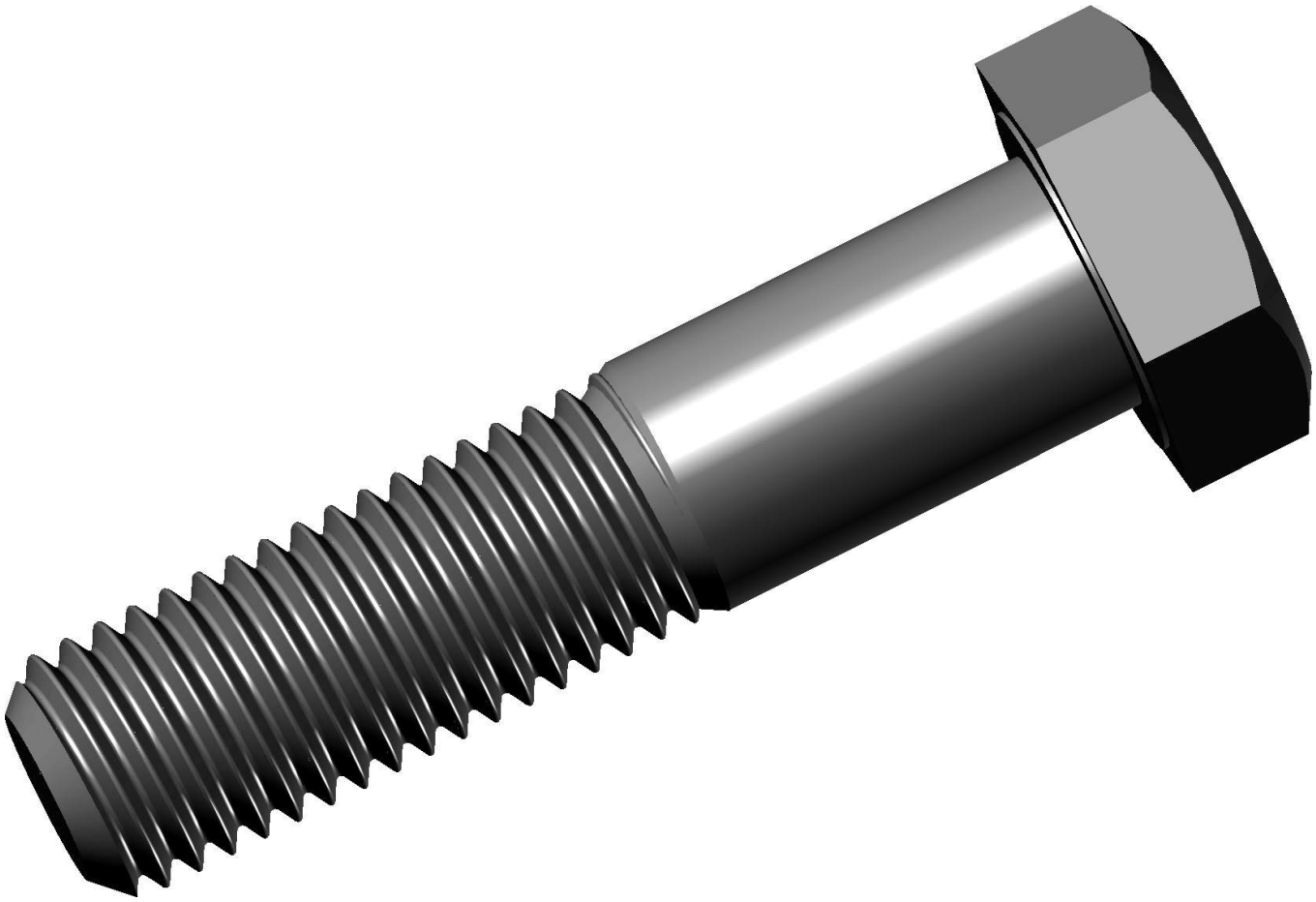
The following files are provided in the distribution and should be in the same directory:

KW Bolt Gen.exe
KW Bolt Gen.ini
KW Bolt Gen.pdf
KW Bolt Gen{Master}.dwg

AICS Solid Model:

Before starting this project I did look at various 3D fastener models others had come with. None that I found were close to being accurate and some approached the level of pure farces. That is not to say there does not exist a system out there that does produce good fastener models … only that I have not been able to locate it with my limited resources.

I also tried to build a solid model in several of the CAD packages. I came closest in Punch! ViaCAD 3D V8. I made use of the “sweep” function and used a “helix” for the path. The resulting model was very nice but nearly three gigabytes in size. That is far cry from the 60KB of the polymesh versions. The illustration below is from that model as rendered in DraftSight. For various reasons I was not able to achieve this level of success in other 3D CAD systems that I tried. I find it interesting that my best results came from the least expensive CAD package.



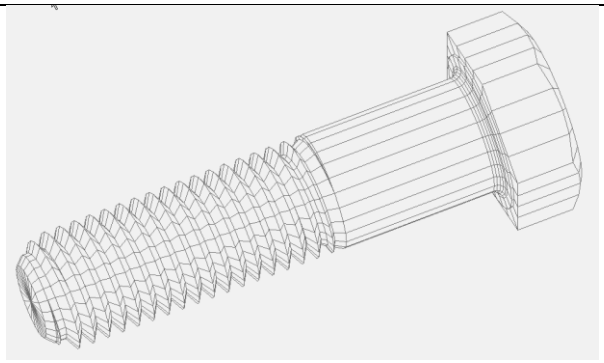
Evaluation and Judgment:

“Success or failure: that is the question.”

As it turns out these models are not recognized by anyone’s CAD software as a “solid” object. Further they do not strictly fulfill the definition of a “closed” polymesh. In order to do that the end point of each row must be the exact same point as the start point of that row. An even greater disappointment is the result of rendering these models in various CAD systems (*please see illustrations on the next page*). To be fair I must note that all the renderings were done in “evaluation” trial versions of the software. I must also mention that my level of experience with 3D CAD systems and rendering systems is somewhat limited to say the least. I have somewhat more experience in the 2D realm of such endeavors.

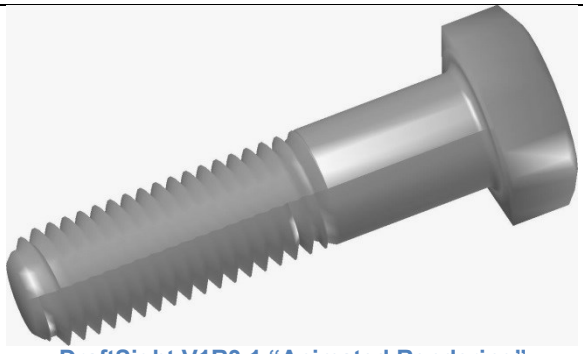
My personal evaluation of my best efforts in this case is: **failure**.

At this point I am going to release these 3D models and the software in its current form to the KeyWIld CAD Library. My success in ViaCAD proves that there is a way to build a thread solid model using AICS primitives. The problem is to figure out how to do it repeatedly with an object size that is somewhat more reasonable. That may require some time and effort.



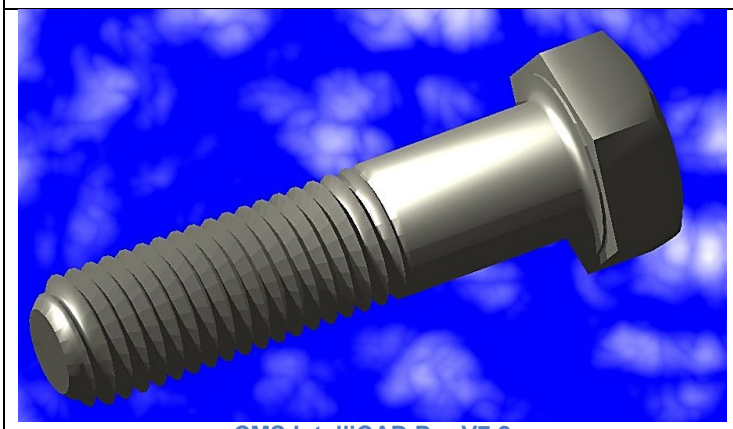
3/4 x 10 UNC x 3 Lg.

This is a DraftSight screen capture of the “hidden line” version of the test subject.



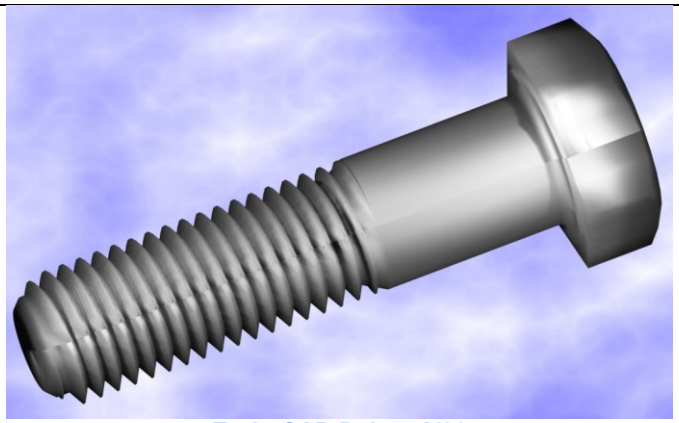
DraftSight V1R3.1 “Animated Rendering”

CorelCAD and Ares Commander share the same code base. Rounded facets and blown highlights. Some adjustment to the lighting might resolve the latter.



CMS IntelliCAD Pro V7.2

This is the best I was able to get, but it is still faceted.

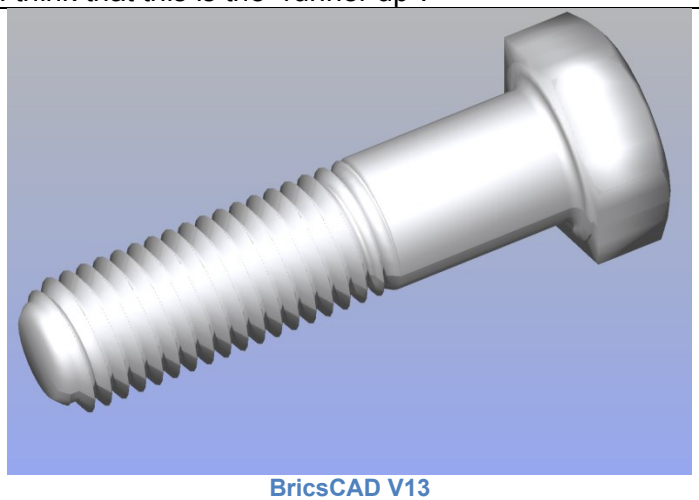


TurboCAD Deluxe V20

I think that this is the “runner up”.

Punch! ViaCAD Pro V8

All I can say is: Strange???



BricsCAD V13

Note the “rounded” corners on the hex.

References:

DraftSight Software:

DraftSight: Professional-grade, free* CAD software
DraftSight lets professional CAD users, students and educators create, edit and view DWG files.
DraftSight runs on Windows®, Mac® and Linux.
Dassault Systèmes, the 3DEXPERIENCE Company
http://www.3ds.com/products/draftsight/free-cad-software/

Other CAD Packages:

ViaCAD 2D/3D, ViaCAD Pro
Encore Software, Punch! Software
http://www.punchcad.com/c-30-compare-viacad.aspx

TurboCAD Delux, TurboCAD Pro, TurboCAD LTE
IMSI/Design, LLC
http://www.turbocad.com/?gclid=CND8ooHJ_LcCFVBp7Aod0ikABg

CMS IntelliCAD
CAD Manufacturing Solutions, Inc.
http://www.intellicadMms.com

BricsCAD
Bricsys nv, Bricsys Inc.
http://www.bricsys.com/en_INTL/bricscad/

ARES Commander
Graebert GmbH
http://www.graebert.com/en/arescommanderedition

CorelCAD
Corel Corporation
http://www.corel.com/corel/allProducts.jsp

Fastener Standards:

It is recommended that values for the keys in the INI file be taken from a well-respected standard. Examples:

"8th Edition, IFI Inch Fastener Standards Book"
Industrial Fasteners Institute
http:// http://www.indfast.org
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"ISO Metric Screw Thread and Fastener Handbook"
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"ASME B18.2.1-2012, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)"
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"SAE J 2295, Fasteners Part Standard Cap Screws, Hex Bolts, and Hex Nuts (inch Dimensioned)"
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Other Web References:

"The ACF Components & Fasteners Handbook"
Eighty pages of dimensional data and reference material in the latest version of our industrial fastener handbook. Products covered include blind rivets, bolts, nuts, washers, screw, anchors, and self-clinching fasteners.
ACF Components & Fasteners, Inc.
http://www.acfcom.com/fastener_handbook/fastener_specifications_handbook.htm
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Web Page: "Dimensions of Hex Cap Screws"
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