

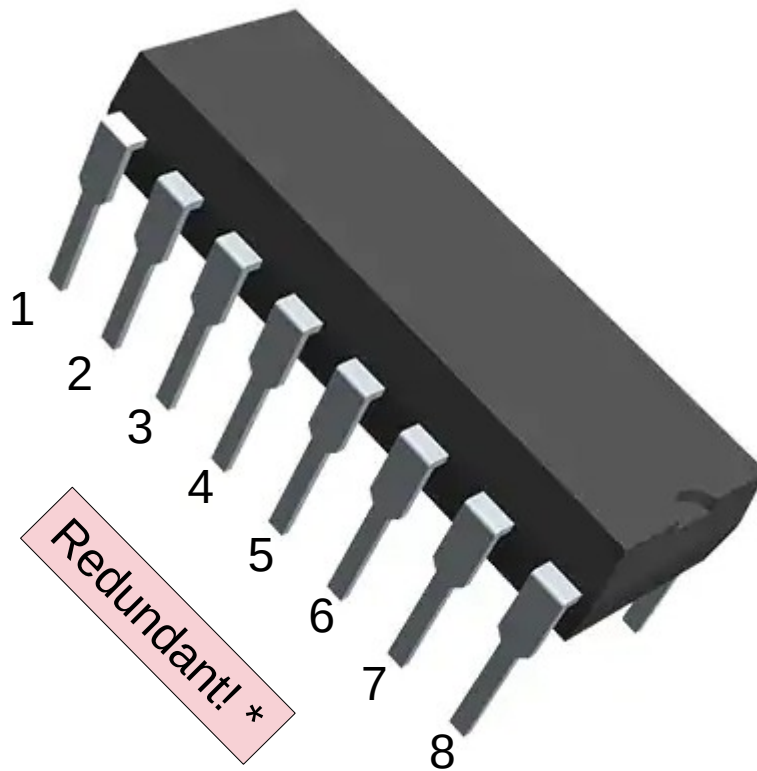


STEP Reduce

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Motivation

- STEP files are the default 3D interchange



Large 3D libraries

- KiCad provides a comprehensive 3d library
 - In exchange for a mere 5.8GB
- DIPTrace (commercial) 3d library
 - 4.7GB
- Manufacturer models
 - High Density → Too large to e-mail

Content Redundancy

```
pqfn-100rv_16x16x0.5.step (~/Downloads/QFN) - GVIM
File Edit Tools Syntax Buffers Window Help

HEADER;
FILE_DESCRIPTION(('for SolidWorks'),'2;1');
FILE_NAME('D:\\Exchange\\QFN\\STS\\pqfn-100rv_16x16x0.5.step',
'2016-07-11T15:47:37',('Serg'),(''),'Open CASCADE STEP processor 6.6',
'DipTrace','Unknown');
FILE_SCHEMA(('AUTOMOTIVE_DESIGN { 1 0 10303 214 1 1 1 1 }'));
ENDSEC;
DATA;
#1 = APPLICATION_PROTOCOL_DEFINITION('international standard',
'automotive_design',2000,#2);
#2 = APPLICATION_CONTEXT(
'core data for automotive mechanical design processes');
#3 = SHAPE_DEFINITION_REPRESENTATION(#4,#10);
#4 = PRODUCT_DEFINITION_SHAPE('', '#5);
#5 = PRODUCT_DEFINITION('design', '#6,#9);
#6 = PRODUCT_DEFINITION_FORMATION('', '#7);
#7 = PRODUCT('ASSEMBLY', 'ASSEMBLY', '#8);
#8 = PRODUCT_CONTEXT('', #2, 'mechanical');
#9 = PRODUCT_DEFINITION_CONTEXT('part definitio
#10 = SHAPE_REPRESENTATION('', (#11,#15), #19);
#11 = AXIS2_PLACEMENT_3D('', #12, #13, #14);
#12 = CARTESIAN_POINT('', (0.E+000, 0.E+000, 0.E+000));
#13 = DIRECTION('', (0.E+000, 0.E+000, 1.));
#14 = DIRECTION('', (1., 0.E+000, -0.E+000));
#15 = AXIS2_PLACEMENT_3D('', #16, #17, #18);
#16 = CARTESIAN_POINT('', (0.E+000, 0.E+000, 0.E+000));
#17 = DIRECTION('', (0.E+000, 0.E+000, 1.));
#18 = DIRECTION('', (1., 0.E+000, 0.E+000));
#19 = ( GEOMETRIC_REPRESENTATION_CONTEXT(3)
GLOBAL_UNCERTAINTY_ASSIGNED_CONTEXT((#23)) GLOB
(#20,#21,#22)) REPRESENTATION_CONTEXT('Context
'3D Context with UNIT and UNCERTAINTY');
#20 = ( LENGTH_UNIT() NAMED_UNIT(*) SI_UNIT(.MILLI., .METRE.) );
#21 = ( NAMED_UNIT(*) PLANE_ANGLE_UNIT() SI_UNIT($, .RADIAN.) );
#22 = ( NAMED_UNIT(*) SI_UNIT($, .STERADIAN.) SOLID_ANGLE_UNIT() );
#23 = UNCERTAINTY_MEASURE_WITH_UNIT(LENGTH_MEASURE(1.E-007), #20,
```

```
#11 = AXIS2_PLACEMENT_3D('', #12, #13, #14);
#12 = CARTESIAN_POINT('', (0.E+000, 0.E+000, 0.E+000));
#13 = DIRECTION('', (0.E+000, 0.E+000, 1.));
#14 = DIRECTION('', (1., 0.E+000, -0.E+000));
#15 = AXIS2_PLACEMENT_3D('', #16, #17, #18);
#16 = CARTESIAN_POINT('', (0.E+000, 0.E+000, 0.E+000));
#17 = DIRECTION('', (0.E+000, 0.E+000, 1.));
#18 = DIRECTION('', (1., 0.E+000, 0.E+000));
#19 = ( GEOMETRIC_REPRESENTATION_CONTEXT(3)
```

After Reduction

- No repeated commands

```
#11=AXIS2_PLACEMENT_3D(' ',#12,#13,#14);  
#12=CARTESIAN_POINT(' ',(0.E+000,0.E+000,0.E+000));  
#13=DIRECTION(' ',(0.E+000,0.E+000,1.));  
#14=DIRECTION(' ',(1.,0.E+000,-0.E+000));  
#15=AXIS2_PLACEMENT_3D(' ',#12,#13,#16);  
#16=DIRECTION(' ',(1.,0.E+000,0.E+000));
```

```
File Edit Tools Syntax Buffers Window Help  
#1=APPLICATION_PROTOCOL_DEFINITION('international standard', 'automotive_design',2000,#2);  
#2=APPLICATION_CONTEXT('core data for automotive mechanical design processes');  
#3=SHAPE_DEFINITION_REPRESENTATION(#4,#10);  
#4=PRODUCT_DEFINITION_SHAPE(' ',',',#5);  
#5=PRODUCT_DEFINITION('design',',',#6,#9);  
#6=PRODUCT_DEFINITION_FORMATION(' ',',',#7);  
#7=PRODUCT('ASSEMBLY','ASSEMBLY',',',(#8));  
#8=PRODUCT_CONTEXT(' ',#2,'mechanical');  
#9=PRODUCT_DEFINITION_CONTEXT('part definition'#2 'design');  
#10=SHAPE_REPRESENTATION(' ',(#11,#13,#14));  
#11=AXIS2_PLACEMENT_3D(' ',#12,#13,#14);  
#12=CARTESIAN_POINT(' ',(0.E+000,0.E+000,0.E+000));  
#13=DIRECTION(' ',(0.E+000,0.E+000,1.));  
#14=DIRECTION(' ',(1.,0.E+000,-0.E+000));  
#15=AXIS2_PLACEMENT_3D(' ',#12,#13,#16);  
#16=DIRECTION(' ',(1.,0.E+000,0.E+000));  
#17=PRODUCT_DEFINITION_CONTEXT('part definition'#2 'design');  
#18=PRODUCT_DEFINITION_CONTEXT('part definition'#2 'design');  
#19=PRODUCT_DEFINITION_CONTEXT('part definition'#2 'design');  
#20=PRODUCT_DEFINITION_CONTEXT('part definition'#2 'design');  
#21=PRODUCT_DEFINITION_CONTEXT('part definition'#2 'design');  
#22=PRODUCT_RELATED_PRODUCT_CATEGORY('part',$,(#7));  
#23=ADVANCED_BREP_SHAPE_REPRESENTATION(' ',(#11,#24),#17);  
#24=MANIFOLD_SOLID_BREP(' ',#25);  
#25=CLOSED_SHELL(' ',(#26,#54,#75,#92,#107,#118,#2860,#2880,#2897, #2913,#2927,#2942,#2959,#2977  
#2988,#3006,#3020,#3034,#3044,#3062, #3076,#3090,#3100,#3118,#3132,#3146,#3156,#3174,#3188,#32  
02,#3212, #3230,#3244,#3258,#3268,#3287,#3300,#3315,#3324,#3343,#3356,#3371, #3380,#3398,#34  
12,#3426,#3436,#3455,#3468,#3483,#3492,#3510,#3524, #3538,#3548,#3566,#3580,#3594,#3604,#3623,#  
3636,#3651,#3660,#3679, #3692,#3707,#3716,#3734,#3748,#3762,#3772,#3790,#3804,#3818,#3828, #  
3846,#3860,#3874,#3884,#3903,#3916,#3931,#3940,#3958,#3972,#3986, #3996,#4014,#4028,#4042,#4052  
#4071,#4084,#4099,#4108,#4127,#4140, #4155,#4164,#4182,#4196,#4210,#4220,#4238,#4252,#4266,#42  
76,#4294, #4308,#4322,#4332,#4350,#4364,#4378,#4388,#4407,#4420,#4435,#4444, #4463,#4476,#44  
@@@  
29,33 0%
```

Example result

- QFN-68 from DIPTrace 3d model library

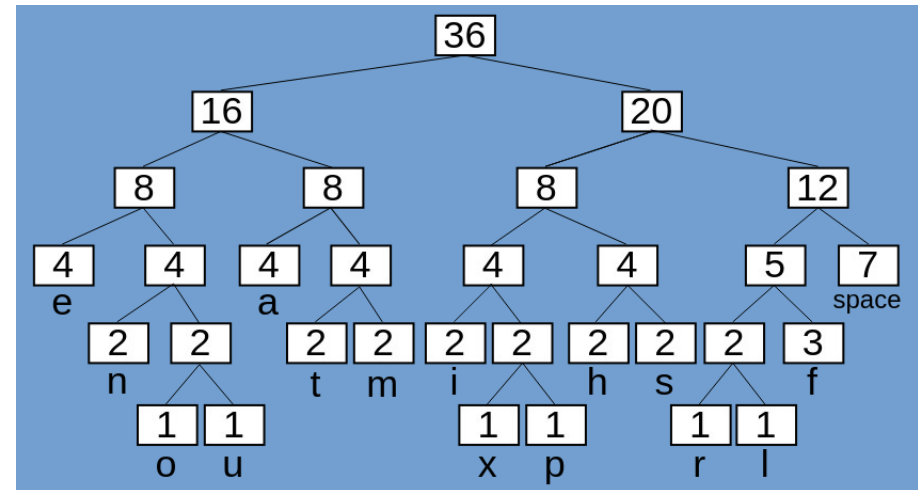
```
seth@shop-laptop % ls -SrgG ~/Downloads/DIPTrace_Models
total 1560
-rw-r--r-- 1 536941 Jan 31 18:50 qfn-68_10x10x0.5-small.step
-rw-r--r-- 1 1055488 Jul 13 2016 qfn-68_10x10x0.5.step
```

- QFN-68 from KiCad 3d model library

```
seth@shop-laptop % ls -SrgG ~/Downloads/KiCad_Models
total 2404
-rw-r--r-- 1 663069 Jan 31 18:55 QFN-68-1EP_8x8mm_P0.4mm_EP5.2x5.2mm-small.step
-rw-r--r-- 1 1795107 Jan 31 18:55 QFN-68-1EP_8x8mm_P0.4mm_EP5.2x5.2mm.step
```

What about STPZ?

- STPZ is great... BUT
 - Layers zlib on STEP files
 - Window context compression
- Huffman windows only deal with first order representation diffs
- DIFFERENT COMPRESSION METHODS



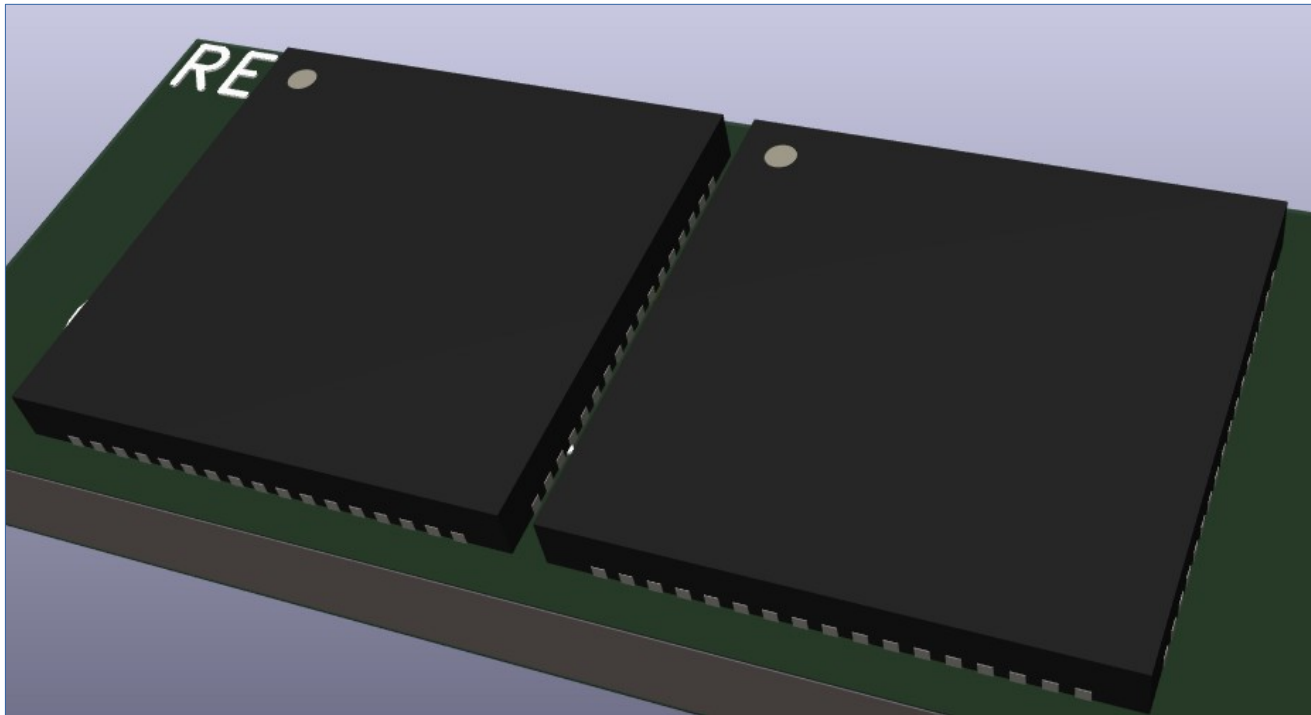
Combine STEPZ/STEPReduce

```
seth@shop-laptop % ls -lGg ~/Downloads/DIPTrace_Models
total 1844
-rw-r--r-- 1 536941 Jan 31 18:50 qfn-68_10x10x0.5-small.step
-rw-r--r-- 1 107343 Jan 31 18:50 qfn-68_10x10x0.5-small.stpz
-rw-r--r-- 1 1055488 Jul 13 2016 qfn-68_10x10x0.5.step
-rw-r--r-- 1 176651 Jul 13 2016 qfn-68_10x10x0.5.stpz
```

```
seth@shop-laptop % ls -lGg ~/Downloads/KiCad_Models
total 2820
-rw-r--r-- 1 663069 Jan 31 18:55 QFN-68-1EP_8x8mm_P0.4mm_EP5.2x5.2mm-small.step
-rw-r--r-- 1 136432 Jan 31 18:55 QFN-68-1EP_8x8mm_P0.4mm_EP5.2x5.2mm-small.stpz
-rw-r--r-- 1 1795107 Jan 31 18:55 QFN-68-1EP_8x8mm_P0.4mm_EP5.2x5.2mm.step
-rw-r--r-- 1 283911 Jan 31 18:55 QFN-68-1EP_8x8mm_P0.4mm_EP5.2x5.2mm.stpz
```


3D comparison

- Compression doesn't matter if the model is not accurate



3D comparison

- Compression doesn't matter if the model is not accurate
- OpenCascade allows for easy, binary verification

◆ BRepAlgoAPI_Cut() [3/4]

```
BRepAlgoAPI_Cut::BRepAlgoAPI_Cut ( const TopoDS_Shape & S1,  
                                   const TopoDS_Shape & S2  
                                   )
```

Constructor with two shapes <S1> -argument <S2> -tool <anOperation> - the type of the operation

3D comparison

- Compression doesn't matter if the model is not accurate
- OpenCascade allows for error verification

Gives NULL result to within face-level FUZZY setting

... with two shapes <S1> -argument <S2> -tool <anOperation> - the type of the operation

Net Reduction

- KiCad STEP library
 - STEP Reduce + STPZ
 - 5.8GB → 1.50GB
- Critically, 60+MB, full board 3d model reduces to 12MB → Fits through most mail servers!



Questions?

- Try it out yourself:

<https://gitlab.com/sethhillbrand/stepreduce>