Minimum Requirements for Creating a DXF File of a 3D Model

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Introduction

DXF is possibly the most widespread CAD exchange format in use by CAD packages on small computer systems. It was developed primarily by the AutoCAD developers and has thus received it popularity mainly from the high number of AutoCAD stations. Most CAD systems can export and most also import DXF, at least for 2D data.

This document describes the minimum requirements needed to create a DXF description of some 3D object and/or scene. This description is not complete by any means but contains enough information for describing the geometry of 3D models.

A DXF file consists of the following sections: header, tables, blocks, and entities. The file contains a set of groups each of which occupies two lines in the file. The first line is called the group code, it is an integer in the range of 0 to 999. The second line is called the value which depends on the group code.

The group code indicates the type of value that follows according to the table below.

Group code	Value type
0-9	string
10-59	real number
60-79	integer
210-239	real number
999	comment

Header comment and header section

It is common for the first line of a DXF file to contain a comment, the group code for comments is 999. A standard convention is to describe the creator of the DXF file in this comment. It might also be relevant to include the date and time of creation.

The header section contains general information about the drawing, these are only relevant when creating specialised DXF files for AutoCAD. Some examples of what can be included in the header section are: version numbers, unit specification, current layer, grid spacing, tolerances, drawing bounds, fill mode

and pattern, etc. Programs that read DXF files will have sensible defaults for these parameters. Since we are only interested in the transfer of the geometry we don't need a header section. It is good form to include one even though it's empty because some importing software gets confused without it. A header comment and empty header section may look like the following.

```
999
DXF created from <program name>
0
SECTION
2
HEADER
0
ENDSEC
```

Tables Section

These can be used to specify predefined constants, line styles, text styles, view tables, user coordinate systems, etc. We will only use tables to define some layers for use later on. Note: not all programs that support DXF import will support layers and those that do usually insist on the layers being defined before use. The following will initialise layers 1 and 2 for use later on.

```
0
SECTION
2
TABLES
0
TABLE
2
LAYER
0
LAYER
2
1
0
LAYER
2
2
0
ENDTAB
0
ENDSEC
```

Blocks section

Not necessary here but it's good form to include one anyway. The following is an empty block section.

```
0
SECTION
2
BLOCKS
0
ENDSEC
```

Entities section

The entities section is where the geometric elements of the model or scene are described. The following is the standard form of the entities section.

```
0
SECTION
2
ENTITIES
<Geometric entities go here>
0
ENDSEC
```

Colour

Only index colour is supported, it is done with group code 62 within an entity description. The value is the colour index. The way the colours are mapped is dependent on the application and the hardware capabilities. To determine the colour mappings on a particular system create a number of lines segments each with a different colour and import that into the CAD package. Many packages that don't use an index colour model will simply ignore the colour instruction. See appendix 1 for a sample DXF file to determine the first 64 index colours on your system. The following will specify index colour 4

```
62
4
```

Layers

Layer numbers are specified with group code 8 within an entity description. The layers to be used should be defined as described earlier in the tables section. Most DXF importers will insist on predefining the layers in the tables. Note: the number of layers possible will vary on the software used to import the DXF file. The following indicates that the current entity is to be placed on layer 2

```
8
2
```

Geometry

DXF explicitly supports two 3D primitive types, namely, 3DFACE and 3DLINE (usual to just use plain LINE primitive). LINE consists of the two endpoints, 3DFACE specifies either three or four vertex facets (polygonal bounded planes). All four vertices must be specified, in the case of a three point facet the last vertex is specified twice. In general vertex group codes are numbers 10,20,30 for the first (x,y,z) triple, 11,21,31 for the second, 12,22,32 for the third and 13,23,33 for the fourth. Each vertex group code is followed by the appropriate coordinate value. Note: that there is no requirement for the four vertices specifying the facet to be planar but it may be important for the software that imports the DXF file. The vertices can be ordered clockwise or anticlockwise with respect to the outward pointing normal, however some modellers may insist on a particular orientation, especially rendering software.

The following specifies a line on layer 2 of index colour number 4 between the points (8500, -12563.4, 0) and (8500, -12563.4, 4150.99)

```
0
LINE
8
2
62
4
10
8500
20
-12563.4
30
0
11
8500
21
-12563.4
31
4150.99
```

The following specifies a 4 vertex facet on layer 1 with index colour number 3.

```
0
3DFACE
8
1
62
3
10
3000
20
10000
30
5419.35
11
4000
21
10000
31
5605.46
12
4000
22
11000
32
4861.04
13
3000
23
11000
33
4674.94
```

End of file

This simply indicates the end of the DXF file, it is not usually necessary but good form.

```
0
EOF
```

Appendix 1

The following file can be used to determine the colour mapping used on your system. It contains 64 line segments with colours from 0 to 63. Note that many CAD packages only support 8 colours, also the following will indicate whether your package starts its colour numbering at 0 or 1 (the two most common choices)

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999	10	30	21	0	62	20
Colour	0.05	0	0	LINE	14	0
0	20	11	31	8	10	30
SECTION	0	0.2	1	1	0.7	0
2	30	21	0	62	20	11
HEADER	0	0	LINE	11	0	0.85
0	11	31	8	10	30	21
ENDSEC	0.05	1	1	0.55	0	0
0	21	0	62	20	11	31
SECTION	0	LINE	8	0	0.7	1
2	31	8	10	30	21	0
TABLES	1	1	0.4	0	0	LINE
0	0	62	20	11	31	8
TABLE	LINE	5	0	0.55	1	1
2	8	10	30	21	0	62
LAYER	1	0.25	0	0	LINE	18
0	62	20	11	31	8	10
LAYER	2	0	0.4	1	1	0.9
2	10	30	21	0	62	20
1	0.1	0	0	LINE	15	0
0	20	11	31	8	10	30
ENDTAB	0	0.25	1	1	0.75	0
0	30	21	0	62	20	11
ENDSEC	0	0	LINE	12	0	0.9
0	11	31	8	10	30	21
SECTION	0.1	1	1	0.6	0	0
2	21	0	62	20	11	31
BLOCKS	0	LINE	9	0	0.75	1
0	31	8	10	30	21	0
ENDSEC	1	1	0.45	0	0	LINE
0	0	62	20	11	31	8
SECTION	LINE	6	0	0.6	1	1
2	8	10	30	21	0	62
ENTITIES	1	0.3	0	0	LINE	19
0	62	20	11	31	8	10
LINE	3	0	0.45	1	1	0.95
8	10	30	21	0	62	20
1	0.15	0	0	LINE	16	0
62	20	11	31	8	10	30
0	0	0.3	1	1	0.8	0
10	30	21	0	62	20	11
0	0	0	LINE	13	0	0.95
20	11	31	8	10	30	21
0	0.15	1	1	0.65	0	0
30	21	0	62	20	11	31
0	0	LINE	10	0	0.8	1
11	31	8	10	30	21	0
0	1	1	0.5	0	0	LINE
21	0	62	20	11	31	8
0	LINE	7	0	0.65	1	1
31	8	10	30	21	0	62
1	1	0.35	0	0	LINE	
0	62	20	11	31	8	
LINE	4	0	0.5	1	1	
8	10	30	21	0	62	
1	0.2	0	0	LINE	17	
62	20	11	31	8	10	
1	0	0.35	1	1	0.85	

20	62	1	8	LINE	0	1
10	24	62	1	8	LINE	0
1	10	28	62	1	8	LINE
20	1.2	10	32	62	1	8
0	20	1.4	10	36	62	1
30	0	20	1.6	10	40	62
0	30	0	20	1.8	10	44
11	0	30	0	20	2	10
1	11	0	30	0	20	2.2
21	1.2	11	0	30	0	20
0	21	1.4	11	0	30	0
31	0	21	1.6	11	0	30
1	31	0	21	1.8	11	0
0	1	31	0	21	2	11
LINE	0	1	31	0	21	2.2
8	LINE	0	1	31	0	21
1	8	LINE	0	1	31	0
62	1	8	LINE	0	1	31
21	62	1	8	LINE	0	1
10	25	62	1	8	LINE	0
1.05	10	29	62	1	8	LINE
20	1.25	10	33	62	1	8
0	20	1.45	10	37	62	1
30	0	20	1.65	10	41	62
0	30	0	20	1.85	10	45
11	0	30	0	20	2.05	10
1.05	11	0	30	0	20	2.25
21	1.25	11	0	30	0	20
0	21	1.45	11	0	30	0
31	0	21	1.65	11	0	30
1	31	0	21	1.85	11	0
0	1	31	0	21	2.05	11
LINE	0	1	31	0	21	2.25
8	LINE	0	1	31	0	21
1	8	LINE	0	1	31	0
62	1	8	LINE	0	1	31
22	62	1	8	LINE	0	1
10	26	62	1	8	LINE	0
1.1	10	30	62	1	8	LINE
20	1.3	10	34	62	1	8
0	20	1.5	10	38	62	1
30	0	20	1.7	10	42	62
0	30	0	20	1.9	10	46
11	0	30	0	20	2.1	10
1.1	11	0	30	0	20	2.3
21	1.3	11	0	30	0	20
0	21	1.5	11	0	30	0
31	0	21	1.7	11	0	30
1	31	0	21	1.9	11	0
0	1	31	0	21	2.1	11
LINE	0	1	31	0	21	2.3
8	LINE	0	1	31	0	21
1	8	LINE	0	1	31	0
62	1	8	LINE	0	1	31
23	62	1	8	LINE	0	1
10	27	62	1	8	LINE	0
1.15	10	31	62	1	8	LINE
20	1.35	10	35	62	1	8
0	20	1.55	10	39	62	1
30	0	20	1.75	10	43	62
0	30	0	20	1.95	10	47
11	0	30	0	20	2.15	10
1.15	11	0	30	0	20	2.35
21	1.35	11	0	30	0	20
0	21	1.55	11	0	30	
31	0	21	1.75	11	0	
1	31	0	21	1.95	11	
0	1	31	0	21	2.15	
LINE	0	1	31	0	21	
8	LINE	0	1	31	0	
1	8	LINE	0	1	31	

0	31	52	11	LINE	20	0
30	1	10	2.7	8	0	31
0	0	2.6	21	1	30	1
11	LINE	20	0	62	0	0
2.35	8	0	31	57	11	LINE
21	1	30	1	10	2.95	8
0	62	0	0	2.85	21	1
31	50	11	LINE	20	0	62
1	10	2.6	8	0	31	62
0	2.5	21	1	30	1	10
LINE	20	0	62	0	0	3.1
8	0	31	55	11	LINE	20
1	30	1	10	2.85	8	0
62	0	0	2.75	21	1	30
48	11	LINE	20	0	62	0
10	2.5	8	0	31	60	11
2.4	21	1	30	1	10	3.1
20	0	62	0	0	3	21
0	31	53	11	LINE	20	0
30	1	10	2.75	8	0	31
0	0	2.65	21	1	30	1
11	LINE	20	0	62	0	0
2.4	8	0	31	58	11	LINE
21	1	30	1	10	3	8
0	62	0	0	2.9	21	1
31	51	11	LINE	20	0	62
1	10	2.65	8	0	31	63
0	2.55	21	1	30	1	10
LINE	20	0	62	0	0	3.15
8	0	31	56	11	LINE	20
1	30	1	10	2.9	8	0
62	0	0	2.8	21	1	30
49	11	LINE	20	0	62	0
10	2.55	8	0	31	61	11
2.45	21	1	30	1	10	3.15
20	0	62	0	0	3.05	21
0	31	54	11	LINE	20	0
30	1	10	2.8	8	0	31
0	0	2.7	21	1	30	1
11	LINE	20	0	62	0	0
2.45	8	0	31	59	11	ENDSEC
21	1	30	1	10	3.05	0
0	62	0	0	2.95	21	EOF

Appendix 2

The following example is a complete description of a line, a triangular facet, and a four pointed facet. All the objects are on layer 1, and have colour index 1. This can be used to test whether the DXF importer you are using supports all of these 3D primitives. The resulting model should look like the following.
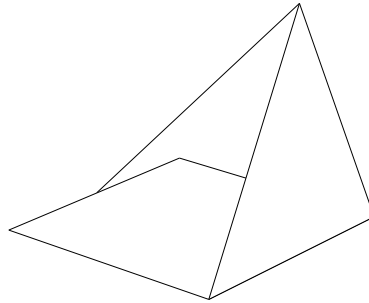
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```
999            ENDSEC       13           0.5
VISION3D DXF   0            0.5          13
0              SECTION      23           0
SECTION        2            -0.5         23
2              ENTITIES     33           -0.5
HEADER         0            -0.5         33
0              3DFACE       0            0.5
ENDSEC         8            3DFACE       0
0              1            8            LINE
SECTION        62           1            8
2              1            62           1
TABLES         10           1            62
0              -0.5         10           1
TABLE          20           -0.5         10
2              -0.5         20           0
LAYER          30           -0.5         20
0              -0.5         30           -0.5
LAYER          11           -0.5         30
2              -0.5         11           0.5
1              21           0.5          11
0              0.5          21           0
ENDTAB         31           -0.5         21
0              -0.5         31           0.5
ENDSEC         12           -0.5         31
0              0.5          12           -0.5
SECTION        22           0            0
2              0.5          22           ENDSEC
BLOCKS         32           -0.5         0
0              -0.5         32           EOF
```