Designation: D6673 – 10

Standard Practice for Sewn Products Pattern Data Interchange—Data Format[1]

This standard is issued under the fixed designation D6673; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This standard is designed to facilitate communication between CAD/CAM systems that represent two-dimensional flat pattern pieces. This standard also provides conventions for representing related information such as grade rule tables. This standard is not intended to represent the relationships between pattern pieces or the correspondence between 2D or 3D sewn product pattern piece geometries.

1.2 The file format for the pattern data exchange file defined by this standard (Practice D6673) complies with the Drawing Interchange File (DXF) format. Autodesk, Inc. developed the DXF format for transferring data between their AutoCAD(r) product and other software applications. This standard documents the manner in which pattern data should be represented within the DXF format. Users of this standard should have Autodesk, Inc.'s documentation on Drawing Interchange Files, found in the AutoCAD Reference Manual, in order to assure compatibility to all DXF format specifications. The AutoCAD Version 13 DXF specification is to be used. The file format for the grade rule table exchange file is an ASCII text file.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*
D6963 Terminology Relating to Sewn Products Automation

2.2 *ANSI/AAMA Standard:*
ANSI/AAMA-292A

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:* For all terminology related t Sewn Porducts Automation see Terminology D6963.

3.1.1 *alternate grade reference line, n*—an optional internal line whose orientation is used for the x axis of a grade rule.

3.1.1.1 *Discussion*—The application of a grade rule will be oriented to the grade reference line unless an alternate grade reference line is specified. (See grade reference line.)

3.1.2 *base size, n*—the digitized or created size of a style.

3.1.2.1 *Discussion*—Base size is a synonym of sample size. (See sample size.)

3.1.3 *block, n*—a DXF keyword that is used to identify a section of the file that has information about one object.

3.1.3.1 *Discussion*—a block keyword should be used to identify the start of information for a pattern piece and the section should be ended with an endblk keyword.

3.1.4 *internal cut outs, n*—lines, part of a pattern piece, not part of the piece boundary, which are cut during the cutting process.

3.1.5 *internal lines, n*—lines, part of a pattern piece, not a part of the piece boundary, which are not cut.

3.1.5.1 *Discussion*—Internal lines are not cut but may be drawn during the cutting process.

3.1.6 *sew lines, n*—internal lines that indicate where stitching of pattern pieces is to be done.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *entities, n*—a DXF keyword that is used to identify the section of the DXF file describing file identification information.

3.2.1.1 *Discussion*—Style system text must be placed in the entities section of the DXF file.

3.2.2 *system text, n*—information related to either the style and/or pattern pieces in the DXF file.

3.2.3 *system text identifier, n*—keywords used in DXF file to construct syntax and associate values with specific system text.

3.2.4 *validation vertex, n*—vertex that is inserted into a polyline in order to guarantee that the resulting polyline represents the original curve in the exporting CAD systems within a given curve tolerance

4. Summary of Practice

4.1 *Pattern Piece Transfer File Format*—The file format defined by this standard complies with the DXF format. A DXF file is a specially formatted ASCII text file. It consists of an optional header as well as tables, blocks and entities sections.

[1] This practice is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.66 on Sewn Product Automation.

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The tables section allows for user-defined functional layering of a CAD drawing. Using this provision, this standard organizes the CAD data representing a pattern piece into a number of layers.

This standard currently can incorporate the following pattern piece information:

annotation (plotted) text;
alternate grade reference line(s);
cut line;
drill holes;
graded nests;
grade reference line;
grade rule identifiers;
grade rule table name;
grainline;
internal cutouts;
internal lines;
mirror line;
notches;
piece boundary, including turn points and curve points;
plaid reference lines;
sew lines;
stripe reference lines;
style information: style name; creation date and time, author, sample size, grade rule table name, units, standard version.
piece information: piece name, quantity, category, rotation, flip, tilt, fold.

4.2 *Header*—An optional header may precede the information in the file defined by this standard. However, because many CAD programs on the market today are unable to generate or accept a header, it is recommended that the use of the optional header be minimized.

4.3 *Layers*—The ASTM D13 proposed standard utilizes a layered file format. Information contained in the file defined by this standard is separated into distinct layers, each layer providing a specific type of information. Layer numbers are used to identify each layer and indicate which information is found in the layer.

Numbers are used, rather that text, since many programs that support the DXF format are unable to generate or accept non-numeric layer designations. Layer 1 is required. Information about each layer is described in 4.3.1 through 4.3.15.

The following four restrictions are placed on layer information:

(*1*) On Layer 1 the piece boundary line will be represented as one or more polylines that form a closed polygon.

(*2*) Layer 2 will contain all the turn points in the piece as found on layers 1, 8, 11, and 14.

(*3*) Layer 3 will contain all the curve points in the piece as found on layers 1, 8, 11, and 14.

(*4*) Layers 5, 6, 7, 9, 10 and 13 cannot contain polylines.

The following list for layer numbers are provided:

Layer 1	piece boundary
Layer 2	turn points
Layer 3	curve points
Layer 4	V-notch and slit notch
Layer 5	grade reference and alternate grade reference line(s)
Layer 6	mirror line
Layer 7	grainline
Layer 8	internal line(s)
Layer 9	stripe reference line(s)
Layer 10	plaid reference line(s)
Layer 11	internal cutout(s)
Layer 12	intentionally left blank
Layer 13	drill holes
Layer 14	sew line(s)
Layer 15	annotation text
Layer 80	T-notch
Layer 81	castle notch
Layer 82	check notch
Layer 83	U-notch
Layer 84	piece boundary quality validation curves
Layer 85	internal lines quality validation curves
Layer 86	internal cutouts quality validation curves
Layer 87	sew lines quality validation curves

4.3.1 *Layer 1–Piece Boundary Layer*—The piece boundary layer contains the boundary lines for each piece in the file. A separate BLOCK is used for each piece. Within each BLOCK are one or more polylines that constitute the piece boundary. Each polyline within the BLOCK corresponds to an individual pattern element.

The Piece Boundary BLOCK includes Turn Points, Curve Points, Notch Base Points, Grade Points and Mirror Line Points. The piece boundary is a continuous, closed line, with points ordered in either the clockwise or counter clockwise direction. This layer is required.

DXF example of a piece boundary polyline containing vectorized curves:

```
0
POLYLINE
8
1                                   layer 1–boundary line
66
1                                   closed-polyline flag
0
VERTEX
8
1                                   layer 1–boundary line
10
450.369                             X coordinate
20
338.697                             Y coordinate
0
VERTEX
8
1                                   layer 1–boundary line
10
459.322                             X coordinate
20
338.316                             Y coordinate
0
VERTEX
8
1                                   layer 1–boundary line
10
457.195                             X coordinate
20
327.486                             Y coordinate
0
SEQEND
```

DXF example of a piece boundary polyline containing circular-interpolated curves:

```
0
POLYLINE
–8
1                                   layer 1–boundary line
66
1
70
1
0
VERTEX
8
1                                   layer 1–boundary line
10
0.0                                 X coordinate
```

```
20
0.0                                   Y coordinate
42
–0.014743                             bulge value
0
VERTEX
8
1                                     layer 1–boundary line
10
–45.900000                            X coordinate
20
–53.800000                            Y coordinate
42
–0.005465                             bulge value
0
VERTEX
8
1
10
–34.200000                            X coordinate
20
–38.600000                            Y coordinate
42
–0.018913                             bulge value
0
VERTEX
8
1                                     layer 1–boundary line
10
–19.100000                            X coordinate
20
–20.200000                            Y coordinate
0
SEQEND
```

4.3.1.1 *Style System Text*—In addition to the piece boundary, this layer contains information referred to as required style system text. It only occurs once on this layer in ENTITIES and is assumed to be valid for all pieces in the DXF file.

Style information is known as system text. This text stands in contrast to annotation text, which is plotted out and is defined as Layer 15 in the DXF file. System text is information about the style and/or pieces in the DXF file.

The correct syntax for system text is the system text identifier followed directly by a colon (:) character followed directly by a string of text representing the actual value of the identifier. Identifiers can be formed from upper or lower case characters but must appear as specified in this standard. The value of the identifier is case sensitive and can include characters from the following ASCII 7-bit character subset, including the space character (' '):

! " # $ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [\ ] ^ _ `a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~

In some cases, the values of identifiers must have a specific format or value.

To avoid a loss of information, all values of identifiers must appear in the DXF file as they appeared in the exporting CAD system. Importing CAD systems should warn the user if the value of an identifier is being truncated on importing, resulting in a loss of information.

Style System Text	Correct Syntax (Identifier:<Value>)
style name	Style Name:<string>
creation date	Creation Date:<string>
creation time	Creation Time:<string>
author	Author:<vendor name>;<application>;<release #>
sample size	Sample Size:<string>
Style System Text	Correct Syntax (Identifier:<Value>)
grade rule table	Grade Rule Table:<string>
units	Units:<METRIC | ENGLISH>
Standard Version	ASTM/D13Proposal 1 Version: XX
curve tolerance	Curve Tolerance:<float>

If the style being transferred has no sample size or grade rule table (as is the case in non-apparel sewn products), then the values of these system text identifiers can be left blank but the system text identifier is still required.

METRIC means that all values are in decimal millimeters to two places (e.g. 12.27) and ENGLISH means that all values are in decimal inches to four places (e.g. 4.8751).

The appropriate format for Creation Date is <dd-mm-yyyy> and for Creation Time it is <hh-mm>.

The curve tolerance system text must exist and only exists when Quality Validation Curves are used in the file. The tolerance value is represented using the units that have been defined. The curve tolerance is defined mathematically as the maximum projected distance of a vertex from a polyline on a Quality Validation Layer to the associated original curve (as calculated by the exporting system). It should be used by a receiving/importing system to determine accuracy of the generated curve (based on the turn points on layer 2 and the curve points on layer 3) to the original curve. Alternatively, the quality validation curve can be used directly to regenerate the original curve in polyline representation.

DXF example of system text:

```
TEXT
8
1
72
3
10
0.000
20
0.000
11
0.004
21
0.000
40
0.394
50
0.000
1
Style Name: SHIRT
0
```

4.3.1.2 *Piece System Text*—This is system text that appears within each piece BLOCK:

Piece System Text	Correct Syntax (Identifier:<Value>)
Piece Name	Piece Name:<string>
Quantity	Quantity:<R,L>
Rotation	Rotation:<0..360>
Flip	Flip:<X|Y>
Tilt	Tilt:<+/-0..90>
Fold	Fold:<Y|N>
Material	Material:<string>

Only Piece Name is required.

Quantity will be given as R, L where R indicates the number of right pieces required and L indicates the number of left pieces required. (Example 3,2)

Rotation is given in step increment degrees. It is assumed that the piece may rotate in this step increment up to 360 degrees.

Flip is defined as X (assuming flipping the piece about the horizontal axis) or Y (assuming flipping the piece about the vertical axis.

Tilt is an integer value that defines the maximum tilt in degrees that a piece may move. It is further assumed that the piece may be tilted positively or negatively up to the maximum defined tilt.

Fold indicates that the piece may be placed on the fold of tubular fabric.

Material is a string giving the name of the material in which the piece is cut.

4.3.1.3 *Piece Arrangement*—When multiple pieces are contained within a single file defined by this standard each piece shall be defined within a separate BLOCK. The BLOCK description must not contain any INSERT operations of other blocks.

Although multiple pieces are allowed within the file only a single style may be represented.

4.3.1.4 *Grade Rule Identifier Text*—Grading information is identified by text within the sample size block on layers containing graded points or notches. Grade information contained in the text entity is associated with a point or vertex entity at the same XY location. The format for this information is as follows:

<string1>, <string2>

where # is required and followed by <string1> which is the grade rule identifier, <string2> is optional and can be used as the alternate grade reference identifier.

Any point or notch that will not be moved through grading must have a grade rule identifier associated with a zero growth grade rule.

The following layers can not include grade rules:

- 2 (turn point)
- 3 (curve point)
- 6 (mirror line)
- 84 (boundary quality validation curves)
- 85 (internal lines quality validation curves)
- 86 (internal cutouts quality validation curves)
- 87 (sew lines quality validation curves)

The grade rules associated with grade rule identifier may optionally be defined in a separate file called a Grade Rule Table File.

4.3.1.5 *Graded Nests*—A graded nest can be used to transfer grading growth information for pieces. Multiple blocks within a DXF file with the same piece name will indicate a graded nest.

Each graded size of a piece must be defined in a separate block with the size name of the piece included in the piece system text. The order of the BLOCKS represents the sequence of the sizes. Each block must contain a grade reference line. The growth information can be determined by stacking the pieces so the grade reference lines are coincident.

Only the sample size must have all of the piece system text for the piece. All points and ATTDEF entities must be repeated in each block (i.e. each size) of the nest. Points and ATTDEF entities for each graded size are given in the same order, quantity and layer as the sample size.

Blocks in the DXF file can be placed on top of each other (i.e. to show stacks of graded patterns) or placed separately in their own coordinate space. The receiving system should be able to interpret the base pattern and appropriate delta grading regardless of which representation is used.

Sample sizes are exported the same as nongraded pieces. Because the points are the same on all sizes, only the sample size needs all the applicable layers. The following layers should not appear within graded sizes:

Layer 2 Turn points
Layer 3 Curve points
Layer 4 Slit/V-notches
Layer 5 Alternate grade reference lines
Layer 80 T-notches
Layer 81 Castle notches
Layer 82 Check notches
Layer 83 U-notch

DXF example of a graded boundary point:

0	
TEXT	
8	
1	layer 1– boundary line
10	
387.900000	X coordinate
20	
–38.100000	Y coordinate
40	
0.100000	text height
1	
# 10	grade rule identifier

4.3.1.5.1 *Graded Nest Piece System Text*—The system text for each graded piece within a graded nest must contain the piece name and size. Quantity may also be included.

Piece System Text	Correct Syntax
Piece Name	Piece Name:<string>
Size Name	Size Name:<string>
Quantity	Quantity:<R,L>

For the sample size, the size name system text specifies the actual Sample Size Name. The piece name for each graded size of a piece must be the same as the piece name for the sample size.

4.3.1.6 *Curve Quality Validation for Graded Piece Boundaries*—Quality validation curves are defined by validation verices of a polyline on a Quality Validation Layer to its associated layer 8. When grade rules are applied to pieces with a given sample size, the curve quality of the resulting graded piece boundaries in the importing system cannot be validated to those of the exporting system. This is because this standard does not define a common curve interpolation algorithm. Under such circumstances, the quality of the graded piece polylines can only be validated using a graded nest. A graded nest will ensure that the piece polylines of all sizes are defined in the corresponding Quality Validation Layers. The following Quality Validation Layers are associated with the corresponding polyline layers:

Layer 84	contains the Quality Validation Curve(s) for layer 1 polyline(s) (boundary)
Layer 85	contains the Quality Validation Curve(s) for layer 8 polyline(s) (internal lines)
Layer 86	contains the Quality Validation Curve(s) for layer 11 polyline(s) (internal counts)
Layer 87	contains the Quality Validation Curve(s) for layer 14 polyline(s) (sew lines)