Standard Practice for
Sewn Products Marker Data Interchange[1]

1. Scope

1.1 This practice describes a format for transferring marker data from a CAD marker software system to another or to a CAM software system.

1.2 This practice does not support curve interpolation or definitions. All curves are represented by discrete vectors and are dependent on the resolution of the CAD software.

1.3 This practice is concerned in limiting differences when processing the same data on different CAD systems.

1.4 This practice is not intended to represent the dimension relationships between pattern pieces or between pattern sizes, or the correspondence between 2D or 3D sewn product pattern piece geometries.

1.5 The file format for the marker data exchange file defined by this standard complies with the XML format.

1.5.1 The XML schema describing marker data exchange standard XML structure is presented in an ASTM adjunct.[2]

1.6 *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:*[3]
D6963 Terminology Relating to Sewn Products Automation
2.2 *ASTM Adjuncts:* ASTM Adjunct:[2]
 XML Schema

3. Terminology

3.1 For all terminology related to Sewn Products Automation, see Terminology D6963.

3.2 The following terms are relevant to this standard: drill hole, grainline, line, notch, style.

3.3 The following terms are new terms related to Sewn Products Automation:

3.3.1 *absolute pattern matching, n*—nesting specification where a nested piece match point shall have a specified position in regard to a repeat line. See Fig. 1.

3.3.2 *bundle, n*—set of nested pieces that are intended to be processed together because they are issued from the same graded style and are parts of the same end user's product.

3.3.2.1 *Discussion*—All bundle pieces are to be cut on the same material.

3.3.3 *bundle group, n*—set of bundles that are used to define constraints.

3.3.3.1 *Discussion*—A bundle may be part of several bundle groups for several different constraints. Example: pockets from the jacket and the trousers of a suit may have a mutual rotation constraint.

3.3.4 *constraint, n*—description of the behavior that one or several nested piece of the marker should follow during marker processing.

3.3.5 *efficiency, n*—area of the produced pieces located on the up side of the fabric, including blocking, versus area of the marker, defined by its length and its width.

3.3.5.1 *Discussion*—Pieces area inside fusing blocks is considered when calculating efficiency. Fusing blocks area is not considered.

3.3.6 *fabric category, n*—identifies the category to which the fabric belongs.

3.3.6.1 *Discussion*—The category allows the definition of fabric groups that will be used for pattern matching constraints definitions.

3.3.7 *fabric type, n*—characteristic of a pattern piece used to identify the material type the piece has to be made of.

3.3.8 *five star pattern, n*—motif on a plaid fabric where the center of the pattern unit cell has the same role as its four corners.

3.3.9 *flip, n*—transformation of a geometry that gives the symmetry of the sized piece geometry either across the X axis or across the Y axis or across both, that is equivalent to a 180 degrees rotation. See Fig. 2.
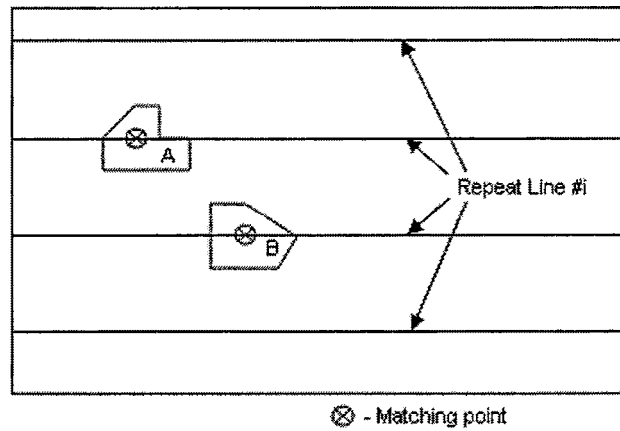
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[1] This practice is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.66 on Sewn Product Automation.
 Current edition approved Jan. 15, 2011. Published March 2011. Originally approved in 2007. Last previous edition approved in 2007 as D7331-07. DOI: 10.1520/D7331-11.
[2] Available from ASTM International Headquarters. Order Adjunct Number ADJD7331A. Original adjunct produced in 2007. Adjunct last revised in 2011.
[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⊗ - Matching point

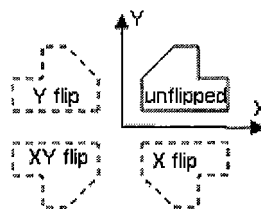**FIG. 1 Absolute Matching**

FIG. 2 Unflipped and Flipped Geometries

3.3.9.1 *Discussion*—The X and Y axis to consider are those from the sized piece referential.

3.3.10 *geometry to nest, n*—geometry of a sized piece or a nested piece used for nesting operation.

3.3.10.1 *Discussion*—Geometry to nest is computed from geometry to produce with spacing added if it exists.

3.3.11 *geometry to produce, n*—geometry of a sized piece or a nested piece used when cutting the marker.

3.3.11.1 *Discussion*—Geometry to produce is computed from reference geometry, enhanced with production processing such as notch insertion and blocking.

3.3.12 *graded piece, n*—explicit description of one or more specific sizes of a pattern piece, and related information used to produce it.

3.3.13 *graded style, n*—explicit description of one or more specific sizes of a style, and related information used for production.

3.3.13.1 *Discussion*—A graded style is composed of graded pieces.

3.3.14 *marker, n*—main object that can be exchanged using this practice and that contains all the theoretical information needed to process nesting and production of a set of nested pieces on a flat material.

3.3.15 *marker order, n*—set of data containing all necessary information to nest a set of bundles.

3.3.16 *match point, n*—specific point on the geometry of a piece used to achieve absolute pattern matching or relative pattern matching.

3.3.17 *material, n*—description of the material structure. It includes material geometric information and optional repeat lines description.

3.3.18 *mutual constraint, n*—constraint that applies to several nested pieces in such way that all these nested pieces must respect this constraint in the same way.

3.3.19 *nested piece, n*—the smallest entity that can be nested. Can be nested or not.

3.3.19.1 *Discussion*—A nested piece is an instance of a sized piece repetition and contains geometrical description and positioning parameters.

3.3.20 *pattern piece, n*—design level description of an elementary part of a sewn product.

3.3.20.1 *Discussion*—The Pattern piece is a design entity, not suited for production. It is not included in the marker.

3.3.21 *plaid fabric, n*—fabric which has repeat lines in both the X and Y directions.

3.3.22 *plot line, n*—internal line intended to be plot.

3.3.23 *primary repeat line, n*—particular repeat line from which can be defined other parallel repeat lines.

3.3.23.1 *Discussion*—There are at most two primary repeat lines on a fabric.

3.3.24 *reference geometry, n*—geometrical description of the graded shape issued from the original CAD system using its own grading engine, without any other computation associated to the production.

3.3.25 *relative pattern matching, n*—nesting specification where nested pieces match point positions are mutually constrained to have the same offset (non-symmetrical matching) or opposite offset (symmetrical matching) in regard to a repeat line. See Fig. 3.

3.3.26 *repeat line, n*—line that is a characteristic of a structured fabric and that is periodically repeated at a known increment throughout the whole material. See Fig. 4.
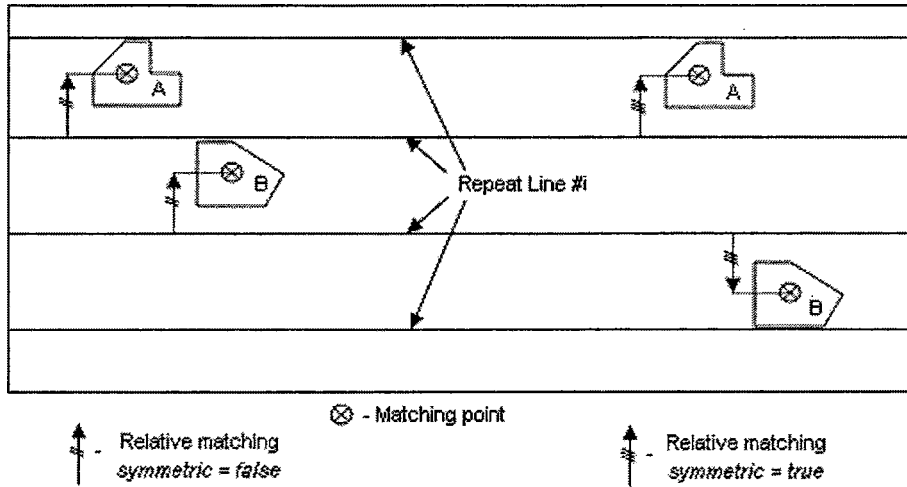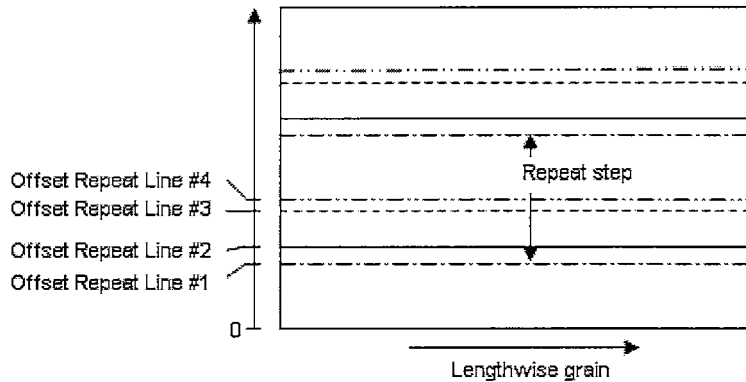
FIG. 3 Relative Matching

FIG. 4 Example of Striped Fabric Described Using X Repeat Lines

3.3.26.1 *Discussion*—An X repeat line is parallel to the X axis and is repeated along the Y direction. Similarly, a Y repeat line is parallel to the Y axis and is repeated along the X direction.

3.3.27 *shrinkage, n*—dimensional reduction that a material will undergo in the part of the processing that will follow the cutting phase.

3.3.27.1 *Discussion*—Two-dimensional anisotropic shrinkage is modeled by two one-dimensional coefficients (X shrinkage and Y shrinkage) that represent respectively the reduction factor that will later apply along each of the X and Y directions.

3.3.28 *sized piece, n*—representation of a graded piece in a specific size.

3.3.29 *sized piece repetition, n*—instance of a sized piece in a graded style.

3.3.29.1 *Discussion*—A sized piece may have several sized piece repetitions if its geometry is repeated several times in the graded style. A sized piece repetition can be:

3.3.29.1 *unflipped*—the repetition geometry is the sized piece geometry.

3.3.29.2 *X flipped*—the repetition geometry is obtained by an X flip of the sized piece geometry.

3.3.29.3 *Y flipped*—the repetition geometry is obtained by a Y flip of the sized piece geometry.

3.3.29.4 *XY flipped*—the repetition geometry is obtained by a Y flip and an X flip of the sized piece geometry.

3.3.30 *splice mark, n*—geometrical information requested to start the spreading process over again at correct position after it has been interrupted due to material physical defect processing.

3.3.31 *split, n*—operation that cuts a piece in two sub parts at marker processing time.

3.3.32 *symmetric pair, n*—set of two sized piece repetitions or nested pieces that differ only by one X or Y flip one from the other and that may ask to be symmetrically processed.

3.3.32.1 *Discussion*—Both sleeves of a shirt are often part of a symmetric pair. Symmetric pairs are often issued from double X or double Y sized piece repetitions.

3.3.33 *tilt, n*—angular tolerance within which a nested piece is allowed to be rotated around its otherwise specified position.

3.3.34 *waste, n*—area of unused material versus total material area.

4. Summary of Practice

4.1 This practice represents a marker containing:

4.1.1 The description of the material used for production,

4.1.2 The quantities of pieces that are to be nested and to be produced,

4.1.3 The description of piece geometries,

4.1.4 The description of nesting constraints, and

4.1.5 The description of piece positions.

5. Significance and Use

5.1 This practice is intended to allow marker data exchange between nesting software or CAM systems.

5.2 The pieces description, exported by a CAD system, is dedicated to CAM systems.

6. General Structure

6.1 This practice defines a tree-based structure composed of elements.

6.2 Full description is available in an XML Schema file appended to this practice, where elements as referenced in 6.1 are mapped to XML elements or XML attributes.

6.3 The root element of this tree structure is the Marker.

6.4 *Units*—This practice allows for information to be exchanged using the international metric system or using the Imperial system. Only one measure system can be used throughout the whole Marker Data Exchange file.

6.4.1 If using metric system:

6.4.1.1 Angles are expressed in degrees, with an optional decimal part introduced by a dot.

6.4.1.2 Lengths, positions and distances are expressed in centimeters, with an optional decimal part introduced by a dot.

6.4.1.3 Surfaces are expressed in square centimeters, with an optional decimal part introduced by a dot.

6.4.2 If using Imperial system:

6.4.2.1 Angles are expressed in degrees, with an optional decimal part introduced by a dot.

6.4.2.2 Lengths, positions and distances are expressed in inches, with an optional decimal part introduced by a dot.

6.4.2.3 Surfaces are expressed in square inches, with an optional decimal part introduced by a dot.

7. Marker (see Fig. 5) [4]

7.1 *schemaVersion*—Version number of the schema used to create the marker.

7.2 *MarkerName*—Name of the marker concerned by this practice.

7.3 *MarkerInformation*—Information about marker generation.

7.3.1 *userName*—(optional) Name of the user who generated the marker file.

7.3.2 *creationDate*—(optional) Creation date of the marker.

7.3.3 *modificationDate*—(optional) Date of the last marker modification.

7.3.4 *platform*—(optional) Vendor name of the application that generated the marker file.

7.3.5 *application*—(optional) Application name that generated the marker file.

7.3.6 *applicationVersion*—(optional) Version of the application that generated the marker file.

7.4 *Marker Attributes:*

7.4.1 *units*—Value is either "Metric" or "Imperial".

7.4.2 *efficiency*—(optional) Value of the current efficiency when at least one piece is nested.

7.4.3 *waste*—(optional) Value of the current waste when at least one piece is nested.

7.4.4 *cutDistance*—(optional) Sum of all cut lines lengths.

7.4.5 *plotDistance*—(optional) Sum of all plot lines lengths.

7.4.6 *pieceArea*—(optional) Area of all cut pieces including blocking.

7.4.7 *notchCount*—(optional) Number of notches.

7.4.8 *drillCount*—(optional) Number of drills.

7.4.9 *styleCount*—(optional) Number of styles.

7.4.10 *bundleCount*—(optional) Number of bundles.

7.4.11 *pieceCount*—(optional) Number of pieces.

7.4.12 *addedPieceCount*—(optional) Number of added pieces.

7.4.13 *unplacedPieceCount*—(optional) Number of unplaced pieces.

7.4.14 *placedPieceCount*—(optional) Number of placed pieces.

7.4.15 *sizeCount*—(optional) Number of different sizes.

7.4.16 *achievedLength*—(optional) Marker length.

7.5 *MarkerOrder* (see Section 8).

7.6 *GradedStyleList* (see Section 9).

7.7 *BundleList* (see Section 11).

7.8 *NestedPieceList* (see Section 12).

7.9 *SpliceMarkList* (see Section 13).

7.10 *NotchDefinition* (see Section 14).

7.11 *DrillDefinition* (see Section 15).

7.12 *ConstraintList* (see Section 16).

8. MarkerOrder (see Fig. 6) [4]

8.1 The MarkerOrder contains the specification of the material, the description of the bundles that are to be produced and their quantities.

8.1.1 *costingMarker*—(optional) Boolean value indicating whether or not the marker is dedicated to cost evaluation.

8.1.2 *automaticMarker*—(optional) Boolean value indicating whether or not the marker has been generated by an automatic nesting engine.

8.1.3 *efficiencyGoal*—(optional) Value of the targeted efficiency.

8.1.4 *lengthGoal*—(optional) Value of the targeted marker length.

8.2 *OrderName*—Name of the marker order.

8.3 *MarkerMaterial*—Description of the material. See Fig. 7.[4]

8.3.1 *name*—(optional) Name of the material.

8.3.2 *description*—(optional) Comment used to describe the material.

8.3.3 *length*—(optional) Maximum marker length.

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[4] XML schema figures are generated with SMLSPY http://www.altova.com/products/smlspy/sml_editor.html
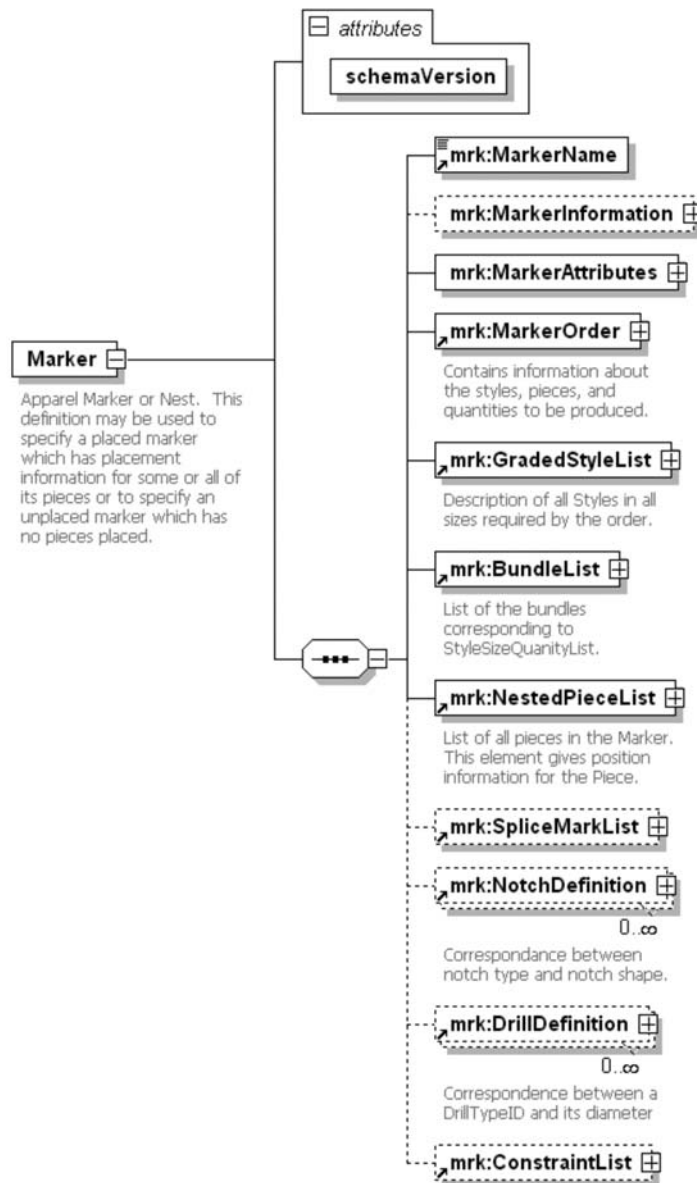
FIG. 5 Marker High Level Schema

8.3.4 *width*—Width of the marker in the crosswise grain direction when the material is spread.

8.3.4.1 *Discussion*—In case of tubular or book fold spreading, marker width represents the half of the fabric width.

8.3.5 *xShrinkage*—(optional) Percentage of shrinkage that the fabric would undergo along the X axis after being cut.

8.3.6 *yShrinkage*—(optional) Percentage of shrinkage that the fabric would undergo along the Y axis after being cut.

8.3.7 *spreadCharacteristic*—(optional) Type of spreading. Only the following values are allowed: "SinglePly," "FaceToFace," "BookFoldTop," "BookFoldBottom" or "Tubular." If no spreadCharacteristic is specified, "Single Ply" is assumed.

8.3.8 *fabricCategory*—Material fabric category.

8.3.9 *PrimaryRepeatLine*—(optional) Description of a primary repeat line.

8.3.9.1 *step*—Repetition length of the primary repeat line, perpendicular to it.

8.3.9.2 *angle*—Angle between x axis and the repeat line.

8.3.9.3 *repeatName*—Unique name of this repeat line.

8.3.9.4 *x,y*—Coordinates of a point that belongs to the primary repeat line.

8.3.9.5 *RepeatLine*—(optional) Repeat line that is parallel to its associated primary repeat line. Several repeat lines can be defined from a primary repeat line.

8.3.9.6 *offset*—Shortest distance between the primary repeat line and the repeat line.

8.3.9.7 *repeatName*—Unique name of this repeat line.

8.3.10 *MaterialBuffering*—(optional) Buffering values added on each edge of the material. These values modify the nesting area dimensions. See Fig. 8.
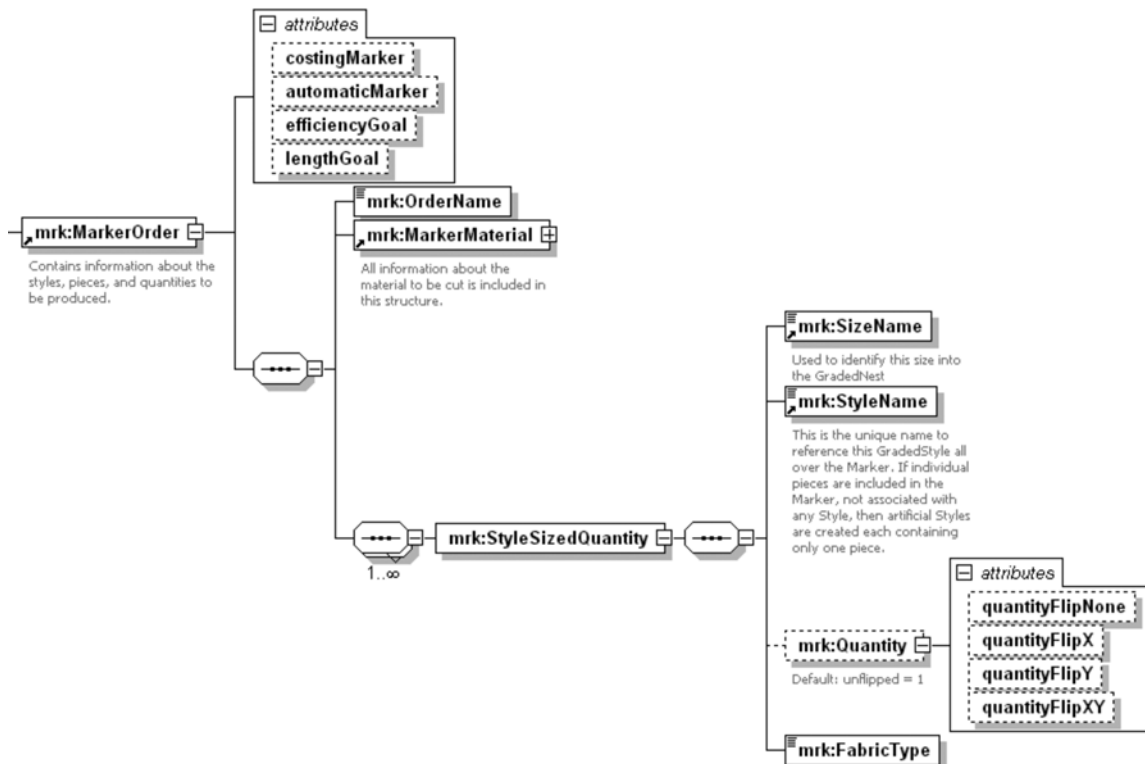
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FIG. 6 MarkerOrder Schema

8.3.10.1 *upBuffer*—(optional) Buffer value on up material edge.

8.3.10.2 *downBuffer*—(optional) Buffer value on down material edge.

8.3.10.3 *leftBuffer*—(optional) Buffer value on left material edge.

8.3.10.4 *rightBuffer*—(optional) Buffer value on right material edge.

8.3.11 *CrossedRepeats*—(optional) Association of two crossed repeat lines in order to define a specific pattern. Repeat lines must be defined in PrimaryRepeatLine data structure. MarkerMaterial element can have several CrossedRepeats elements.

8.3.11.1 *repeatName 1*—Name of one of both repeat lines that compose the pattern.

8.3.11.2 *repeatName 2*—Name of the other repeat line that composes the pattern.

8.3.11.3 *pattern*—Description of the pattern composed by the repeat lines named "RepeatName 1" and RepeatName2". The value of pattern is "fiveStar." This value means that the named repeat lines describe a five star pattern.

8.3.12 *ParallelRepeats*—(optional) Association of two parallel repeat lines in order to define a band represented by a parallel virtual repeat line centered between the two repeat lines.

8.3.12.1 *repeatName1*—Name of the repeat line that delimitates the edge of the band nearest the marker origin. The repeat line must be defined in PrimaryRepeatLine data structure.

8.3.12.2 *repeatName2*—Name of the repeat line that delimitates the edge of the band farthest from marker origin. The repeat line must be defined in PrimaryRepeatLine data structure.

8.3.12.3 *newRepeatName*—Name of the virtual repeat line created.

8.4 *StyleSizedQuantity*—Describes a set of bundles to nest.

8.4.1 *FabricType*—Used to filter the pieces of the style that have to be nested.

8.4.2 *StyleName*—The name of the style from which the bundles to nest are issued.

8.4.3 *SizeName*—The size of the bundles to nest.

8.4.4 *Quantity*—(optional) Defines the quantities of bundles to nest in this set of bundles. If no Quantity is specified, unflipped = 1, quantityFlipX = 0, quantityFlipY = 0, quantityFlipXY = 0 is assumed.

8.4.4.1 *quantityFlipNone*—(optional) Quantity of bundles with no initial flip.

8.4.4.2 *quantityFlipX*—(optional) Quantity of bundles with an initial X flip.

8.4.4.3 *quantityFlipY*—(optional) Quantity of bundles with an initial Y flip.

8.4.4.4 *quantityFlipXY*—(optional) Quantity of bundles with an initial X and Y flip.

9. GradedStyleList (see Fig. 9) [4]
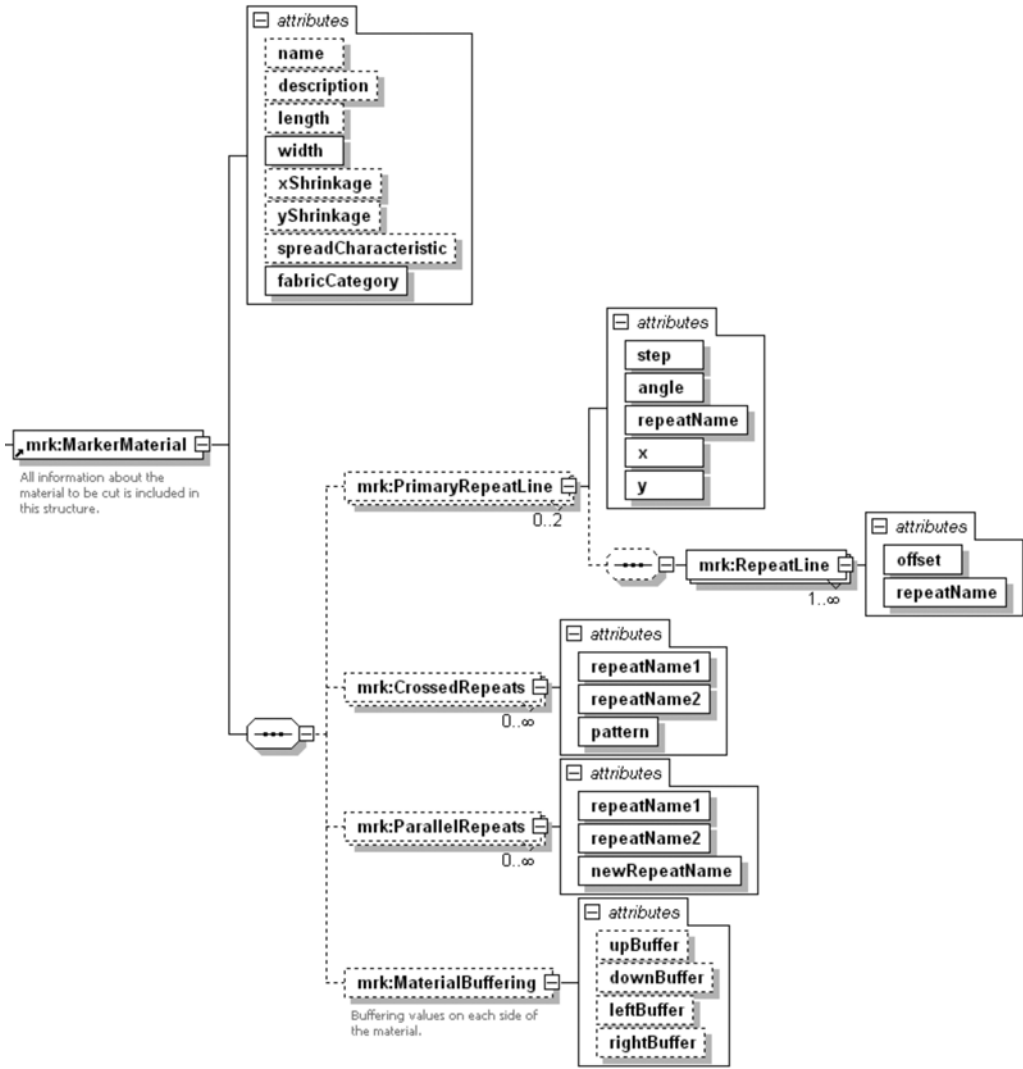
9.1 *GradedStyle*—Description of a graded style.
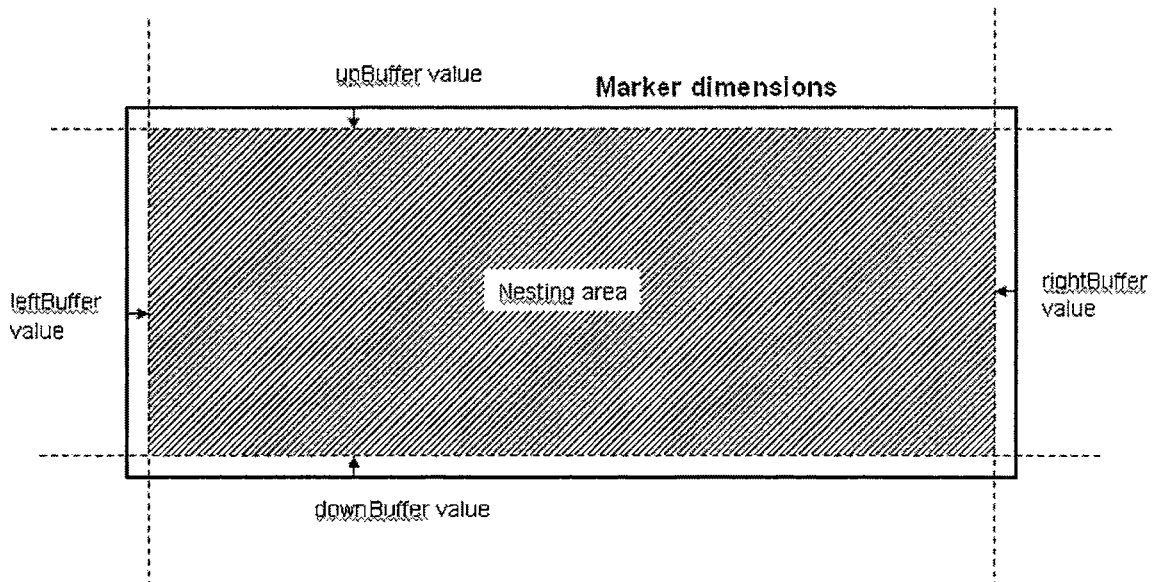
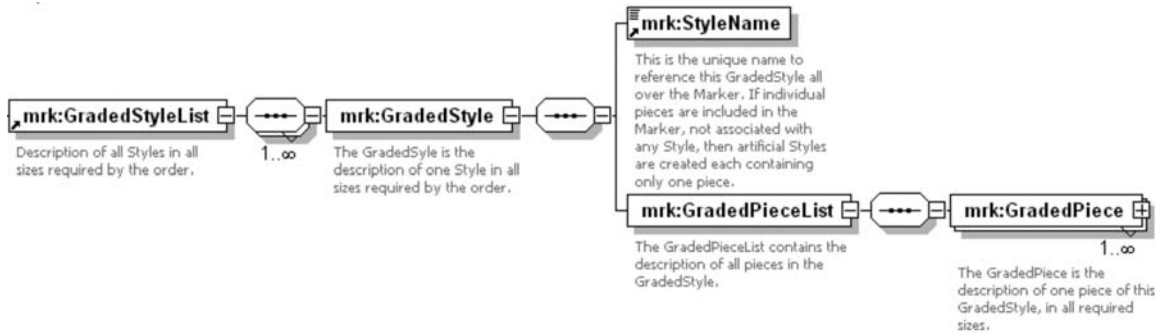FIG. 7 MarkerMaterial Schema

FIG. 8 Material Buffering

FIG. 9 GradedStyleList Schema

9.1.1 *StyleName*—Name of the style from which the graded style results. StyleName is the unique name to reference this graded style all over the marker.

9.2 *GradedPiece*—Description of a graded piece. See Fig. 10.[4]

9.2.1 *quantityFlipNone*—(optional, default = 0) The number of unflipped repetitions of a graded piece in the graded style.

9.2.2 *quantityFlipX*—(optional, default = 0) The number of X flipped repetitions of the graded piece in the graded style.

9.2.3 *quantityFlipY*—(optional, default = 0) The number of Y flipped repetitions of the graded piece in the graded style.

9.2.4 *quantityFlipXY*—(optional, default = 0) The number of XY flipped repetitions of the graded piece in the graded style.

9.2.5 *PieceName*—Name of the pattern piece from which the graded piece results. PieceName is the unique name to reference this graded piece in the graded style.

9.2.6 *FabricType*—Identifies the fabric type of the piece.

9.2.7 *PieceCategory*—(optional) Used to define groups of pieces that may have common constraints. All pieces in a group share the same PieceCategory value.

9.3 *SizedPiece*—Representation of a sized piece.

9.3.1 *quantityFlipNone*—(optional) The number of unflipped repetitions of the sized piece in the graded style.

9.3.2 *quantityXFlip*—(optional) The number of X flipped repetitions of the graded piece in the graded style.

9.3.3 *quantityYFlip*—(optional) The number of Y flipped repetitions of sized piece in the graded style. Inside each pair, one repetition is not flipped, the other is Y flipped.

9.3.4 *quantityXYFlip*—(optional) The number of XY flipped repetitions of the sized piece in the graded style.

9.3.5 *SizeName*—Used to identify the size of the sized piece. SizeName is the unique name to reference this sized piece in the graded piece.
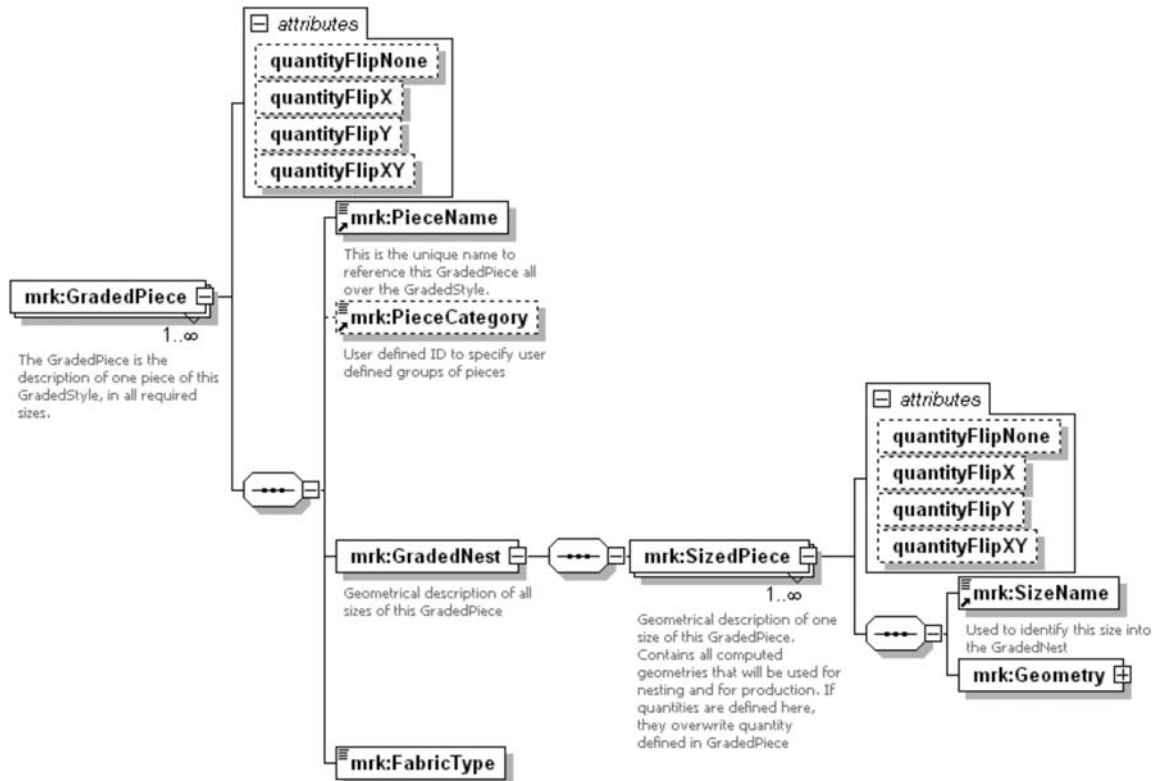

FIG. 10 GradedPiece Schema

10. Geometry (see Fig. 11) [4]

10.1 Geometry includes three representations, which are the geometry description at different levels of computation.

10.1.1 *ReferenceGeometry*—Reference geometry description.

10.1.2 *GeometryToProduce*—(optional) Geometry to produce description. This geometry is optional and is needed only if different from reference geometry.

10.1.3 *GeometryToNest*—(optional) Geometry to nest description. This geometry is optional and is needed only if different from geometry to produce.

10.1.4 *CutInformation*—(optional) See Section 11.

10.2 *AxisList*—List of characteristic axis. Axis list is defined in the reference geometry and is common to the three geometric representations; reference geometry, geometry to nest and geometry to produce.

10.2.1 *GrainLine*—Grainline position, defined by the associated coordinates (startX, startY)-(endX,endY).

10.2.2 *FoldLine*—(optional) Fold line, defined by the associated coordinates (startX, startY)-(endX,endY).

10.3 *PointList*—(optional) List of characteristic points. PointList is defined in the reference geometry and common to the three geometric representations; reference geometry, geometry to nest and geometry to produce.

10.3.1 *MatchPoint*—Representation of a match point.

10.3.1.1 *x,y*—Coordinates of the match point.

10.3.1.2 *MatchPointID*—Unique identifier for this match point in the sized piece.

10.4 *TextBox*—Used to describe a text and its location. The text is included in a rectangle whose low side is parallel to text direction. The text must be close to the low side of the rectangle. See Fig. 12. [4]

10.4.1 *xOrigin and yOrigin*—Coordinates of the lower left point of the rectangle. See Fig. 13.

10.4.2 *xMaxLength and yMaxLength*—Coordinates of the lower right point of the rectangle.

10.4.3 *height*—Rectangle height.

10.4.4 *TextValue*—Contains the text value.

10.5 *GeometryType*—Part of the geometric data that is specific to each of the three representations; reference geometry, geometry to nest and geometry to produce.

10.5.1 *PieceBoundary*—Describes the boundary of the sized piece. See Fig. 14. [4]

10.5.1.1 *ExternalBoundary*—Path element describing the external boundary as a closed geometry.

10.5.1.2 *Hole*—(optional) Path element defining a hole in the piece.

10.5.2 *PieceLine*—(optional) Geometry that is not involved in nesting computation neither altered by blocking or spacing. PieceLine is a Path. See Fig. 15. [4]

10.5.2.1 *lineType*—Identifies the category of the PieceLine. See Fig. 16. lineType value can be:
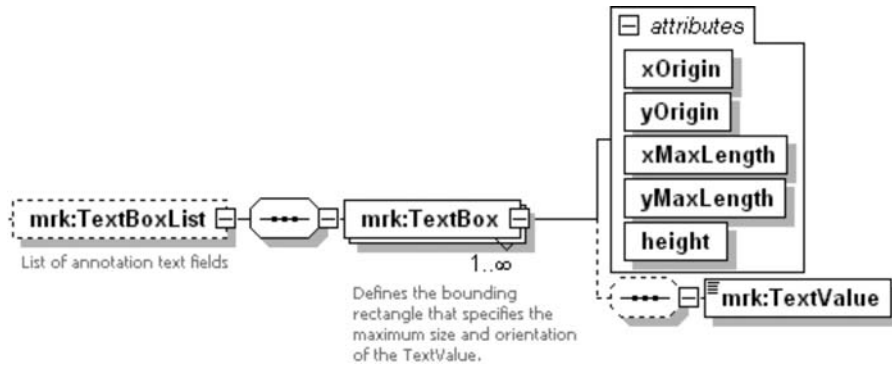

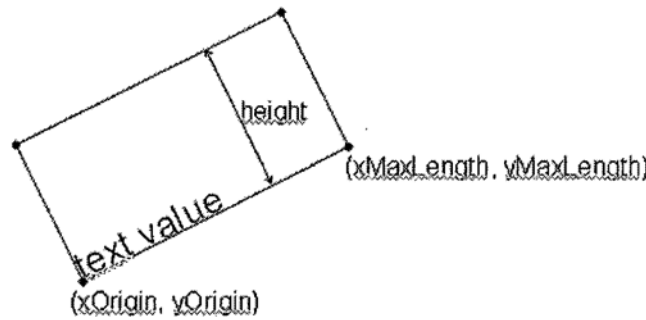**FIG. 11 Geometry Schema**

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FIG. 12 TextBoxList Schema

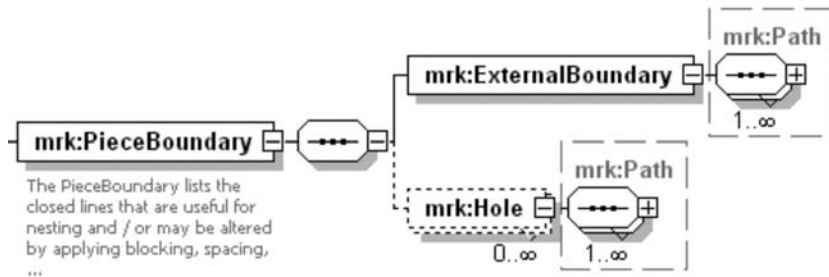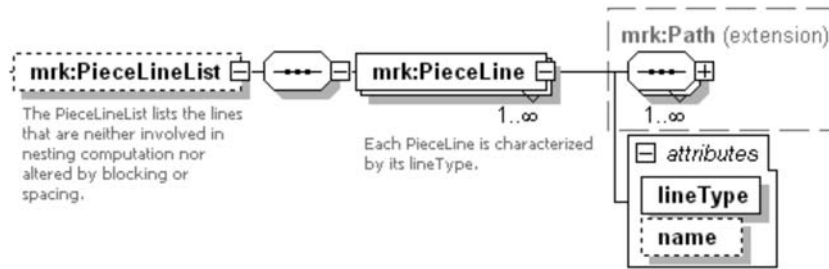**FIG. 13 TextBox Description**

FIG. 14 PieceBoundary Schema

FIG. 15 PieceLineList Schema

(1) CutLine—Line that must be cut.

(2) PlotLine—Line that must be plot.

(3) SewLine—Line indicating the seam line location.

(4) QualityLine—Closed line surrounding a part of a piece that requires to be made of a material that respects a specific quality level.

(5) SuspHole—Closed line representing the boundary of the hole used to hang a cardboard pattern piece.

(6) ChannelLine—Line allowing the construction of a stencil that can be carved into the cardboard pattern piece. The shape of the stencil is obtained by associating a thickness to the channel line.

10.5.2.2 *name*—(optional) Name of the line. If lineType is QualityLine, name indicates the quality level by a string representing an integer. "0" value represents the higher quality level.
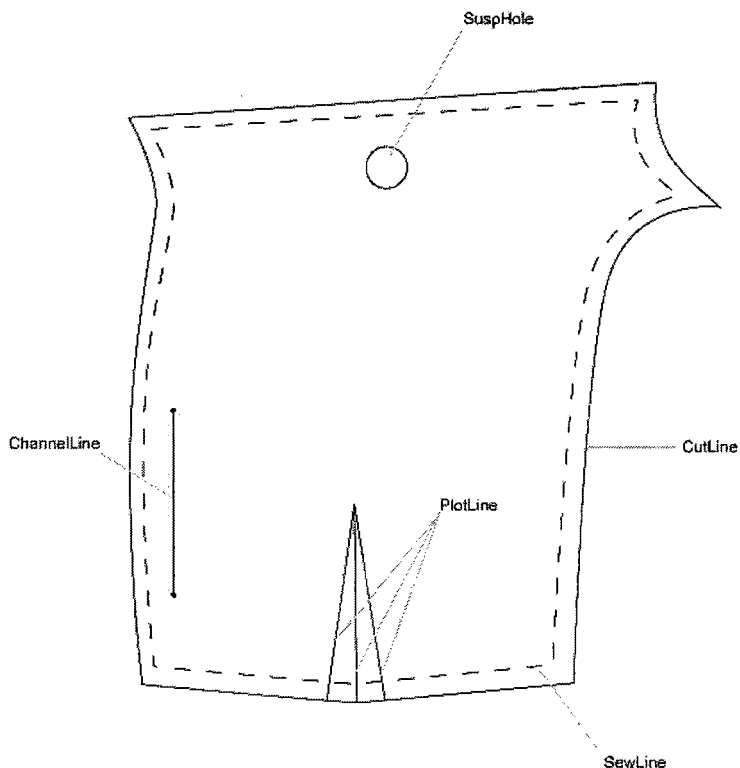
FIG. 16 lineType Values

10.5.3 *DrillHole*—(optional) Drill hole representation.

10.5.3.1 *pointID*—Unique identifier for the drill.

10.5.3.2 *drillTypeID*—Drill type.

10.5.3.3 *x,y*—Coordinates of the center of the drill hole.

10.6 *Path*—Sequence composed of contiguous PolyLine and Notch elements. Notch elements are inserted between two polylines. A Path can describe a closed geometry or not. Two polylines are contiguous if the last point of one polyline has the same coordinates than the first point of the other one. A path describes a closed geometry if the first point and the last point of the path have the same coordinates.

10.7 *PolyLine*—Sequence of at least two Point elements.

10.7.1 *PolylineID*—Uniqe identifier of the point in the SizedPiece element.

10.7.2 *Point*—Definition of a point.

10.7.2.1 *x,y*—Coordinates of the point.

10.7.2.2 *PointID*—(optional) Unique identifier of the point in the SizedPiece element.

10.8 *Notch*—Representation of a notch. The geometry of the notch is optional.

10.8.1 *angle*—Angle of the notch according to x axis in the sized piece referential.

10.8.2 *typeID*—Type of the notch. The type of the notch is linked to the geometry of the notch through NotchDefinition element.

10.8.3 *x,y*—Coordinates of the notch.

10.8.4 *notchID*—(optional) Unique identifier of the notch in the SizedPiece element.

10.8.5 The geometry of a notch is composed of points.

11. BundleList (see Fig. 17) [4]

11.1 *Bundle*—Description of a bundle. A Bundle contains information that specifies initial transformation of this Bundle according to the graded style.

11.1.1 *initialFlip*—(optional) Can be X, Y or XY. Indicates the initial transformation applied to the bundle when creating the marker order.

11.1.2 *SizeName*—Defines the size of the style from which the bundle is issued.

11.1.3 *StyleName*—Defines the name of the style from which the bundle is issued.

11.1.4 *BundleName*—Used to identify the bundle in the marker.

11.1.5 *BundleGroupID*—(optional) Used to identify the group the bundle belongs to.

12. NestedPieceList (see Fig. 18) [4]

12.1 *NestedPiece*—Contains all absolute positioning information about a nested piece.

12.1.1 *nestedPieceID*—Unique identifier of the nested piece all over the marker.

12.1.2 *pairedPieceID*—(optional) Indicates the identifier of the associated nested piece if it exists.

12.1.3 *initialFlip*—(optional) Can be X, Y or XY. Necessary if and only if the nested piece is associated with a flipped sized piece repetition and if the material is single ply. InitialFlip value is "X" in case of a X flipped repetition. InitialFlip value is "Y" in case of a Y flipped repetition. InitialFlip value is "XY" in case of a XY flipped repetition.
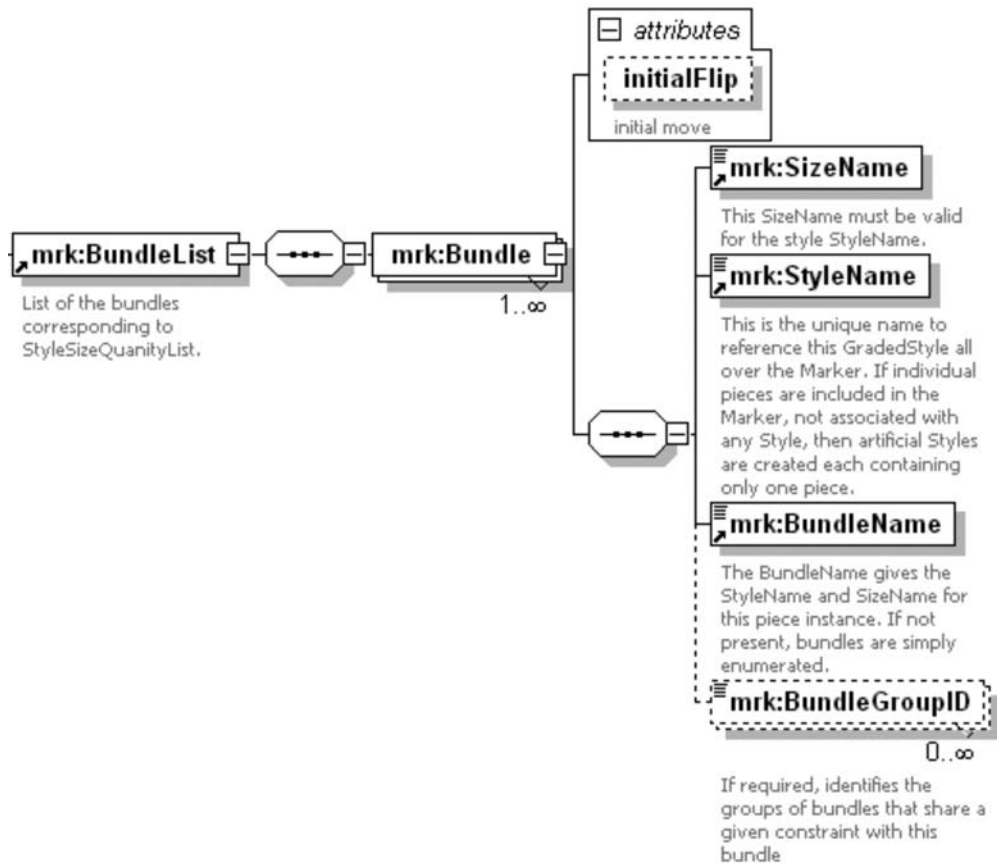
FIG. 17 BundleList Schema

12.1.4 *plot*—(optional) If true, on a plotting machine, the nested piece must be processed. If false, on a plotting machine, the nested piece must be ignored. Default value is true.

12.1.5 *cut*—(optional) If true, on a cutting machine, the nested piece must be processed. If false, on a cutting machine, the nested piece must be ignored. Default value is true.

12.1.6 *PieceName*—Identifies the graded piece associated with the nested piece.

12.1.7 *BundleName*—Identifies the bundle associated with the nested piece.

12.1.8 *GeometryToProduce*—(optional alternate Geometry) Exists if the associated sized piece's geometry to produce is altered for this particular nested piece. Nested piece's geometry to produce is expressed in the same referential than sized piece's geometry to produce. If not present, then the associated sized piece's geometry to produce is used (example: a specific value of blocking).

12.1.9 *GeometryToNest*—(optional alternate Geometry) Exists if the associated sized piece's geometry to nest is altered for this particular nested piece. Nested piece's geometry to nest is expressed in the same referential than sized piece's geometry to nest. If not present, then the associated sized piece's geometry to nest is used (example: a specific value of spacing).

12.1.10 *RepectedMatching*—(optional) Gives information about the respected matching constraint. This element is mandatory in case of a matching constraint. Two Respected-Matching elements at most can be associated to a nested piece,

as a nested piece can be constrained at most by two matching constraints, each one related to a repeat line.

12.1.10.1 *ConstraintID*—Identifier of the matching constraint respected by the nested piece.

12.1.10.2 *nestedPieceID*—(optional) Identifier of the associated nested piece. nestedPieceID must be present only in case of a relative constraint.

12.1.11 *Position*—Describes the actual geometry corresponding to this nested piece in the marker geometry. Pattern matching information is not needed and can be computed from position and material description. The nested piece position is defined by applying transformations in this order: rotation, symmetry, translation.

12.1.11.1 *xOffset*—(optional) x coordinate of the sized piece referential origin into the marker referential. Mandatory if placed=true.

12.1.11.2 *yOffset*—(optional) y coordinate of the sized piece referential origin into the marker referential. Mandatory if placed=true.

12.1.11.3 *flipX*—(optional, default = false) True if the sized piece geometry has been X-flipped for this nested piece. X Flip applies according to piece referential X axis. If not present, then false is assumed.
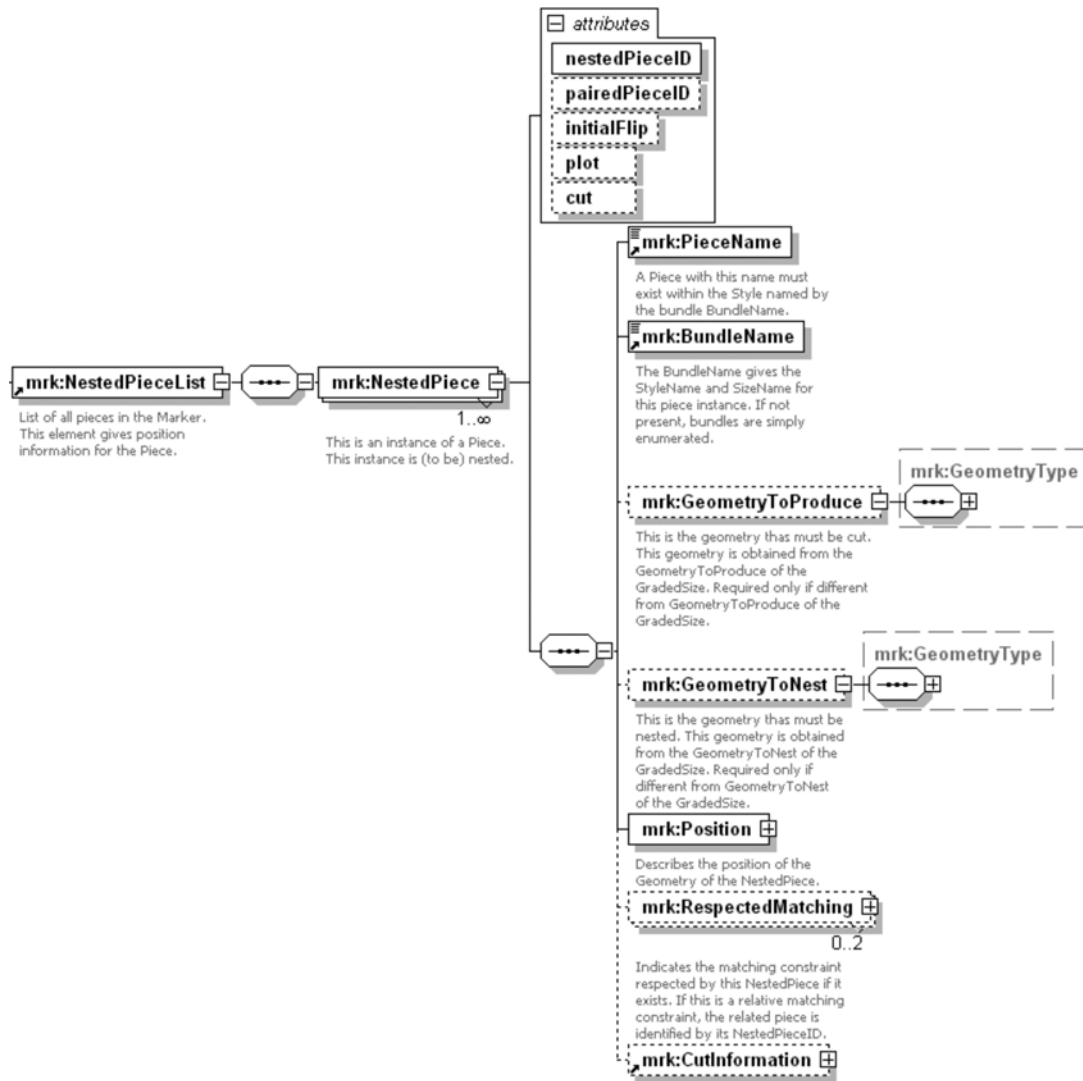
12.1.11.4 *flipY*—(optional, default = false) True if the sized piece geometry has been Y-flipped for this nested piece. Y Flip applies according to piece referential Y axis If not present, then false is assumed.

FIG. 18 NestedPieceList Schema

12.1.11.5 *rotate*—(optional, default = 0) Nested piece's rotation angle around the sized piece referential origin. Rotation applies around the piece origin, independently of the piece center. Angle value is given in degrees, measured counterclockwise from the X-axis. Angle value must be in the interval [0, +360]. If not present, then no rotation is assumed.

12.1.11.6 *placed*—If true, then the nested piece is placed. If false, then the nested piece is not placed and other Position attributes are not significant. A piece that is not placed will not be cut.

12.1.11.7 *side*—Indicates on which side of the fabric the piece is. Possible values are:

(1) up—The nested piece is on the top of the fabric. This is the only possible value if MarkerMaterial SpreadCharacteristic is "Single Ply." If SpreadCharacteristic is "Face To Face," "Book Fold" or "Tubular," this nested piece may be superimposed with another nested piece located on the bottom side of the fabric.

(2) down—The nested piece is on the bottom of the fabric. It may be paired with a superimposed nested piece on the top

side of the fabric. This value is not allowed if SpreadCharacteristic is " Single Ply."

(3) double—The nested piece represents a symmetric pair. This value is not allowed if SpreadCharacteristic is "Single Ply."

(4) folded—The nested piece is folded. This value is not allowed if SpreadCharacteristic is "Single Ply."

12.1.12 *CutInformation*—See Section 17.

13. SpliceMarkList (optional) (see Fig. 19) [4]

13.1 *SpliceMark*—Each splice mark defines an interval along the x axis, delimited by a left limit and a right limit. If a ply of material has to be laid in two passes because of a defect in the material, this interval specifies the minimum overlay between the two laying passes to achieve the targeted piece count. If a defect is present on the material at the coordinate x when laying a ply from left to right and should be eliminated, then the spreading should resume at the left limit of the interval whose right limit is closest to the left of x. Symmetrically, if a defect is present at coordinate x when laying from right to left,
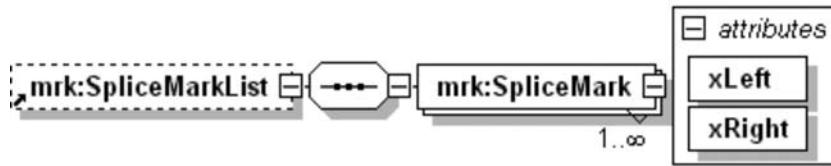
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FIG. 19 SpliceMarkList Schema

then spreading should resume at the right limit of the interval whose left limit is closest to the right of x. See Fig. 20.

13.1.1 *xLeft,xRight*—Defines the splice mark interval. xLeft is the left limit. xRight is the right limit.

14. NotchDefinition (optional)

14.1 *NotchDefinition*—Realizes the correspondence between notch type and notch shape. NotchTypeID is unique for this notch type and is referenced by individual notches in geometry.

14.2 *notchTypeID*—Identifies a notch type. Each notchTypeID is associated to a specific notch shape.

14.3 *perimeterWidth*—(optional) Opening width of the notch on the line.

14.4 *inside Width*—(optional) Width of the end of the notch. Depends on shape.

14.5 *depth*—Notch depth.

14.6 *shape*—Shape of the notch. Values can be:
14.6.1 *V*—V notch.
14.6.2 *T*—T notch.
14.6.3 *U*—U notch.
14.6.4 *Castle*—Castle notch.
14.6.5 *Check*—Check notch.
14.6.6 *Slit*—Slit notch.

15. DrillDefinition (optional)

15.1 *DrillDefinition*—Makes the correspondence between a DrillTypeID and a diameter.

15.2 *drillTypeID*—Identifier for a Drill type.

15.3 *diameter*—Diameter associated with this Drill type.

16. ConstraintList (optional) (see Fig. 21) [4]

16.1 *Constraint*—A Constraint is made of one Rule, a set of PieceProperties and a set of DependencyGroup.

16.1.1 *constraintID*—Unique identifier of the constraint for the whole marker.

16.1.2 *overwriting*—(optional, default = false) Indicates if the constraint is part of original constraints. In this case, overwriting = false. If this constraint has been created during nesting time, overwriting = true.

16.2 *Rule*—Rule constraint description. The Rules that are defined by this Practice are listed below. See Fig. 22.[4]

16.2.1 *Rotation*—Specifies the allowed rotation angles for nested pieces. If no Rotation Constraint is present for a given nested piece, then no rotation is allowed for this nested piece.

16.2.1.1 *angleList*—This parameter can be either a list of comma-separated allowed rotation angles, or the keyword "any" to indicate that rotation is free.

16.2.2 *SymmetricBehavior*—Specifies that all nested pieces obtained from repetitions of a same sized piece must have a symmetric behavior: flips must occur simultaneously, rotation must be opposite for X or Y symmetric repetitions. If not present, then symmetric behavior is not required.

16.2.3 *Flip*—Specifies the allowed flips for nested pieces. If no Flip Constraint is present for a given nested piece, then flipping of this nested piece is not allowed.

16.2.3.1 *flipAllowed*—Contains one of the following values: "X" (X flip is allowed, Y flip is not allowed), "Y" (Y flip is allowed, X flip is not allowed), "XY" (X flip, Y flip or both can apply) or "none" (no flip is allowed).

16.2.4 *Matching*—Specifies how nested piece must behave on structured fabric. If no Matching Constraint is present for a
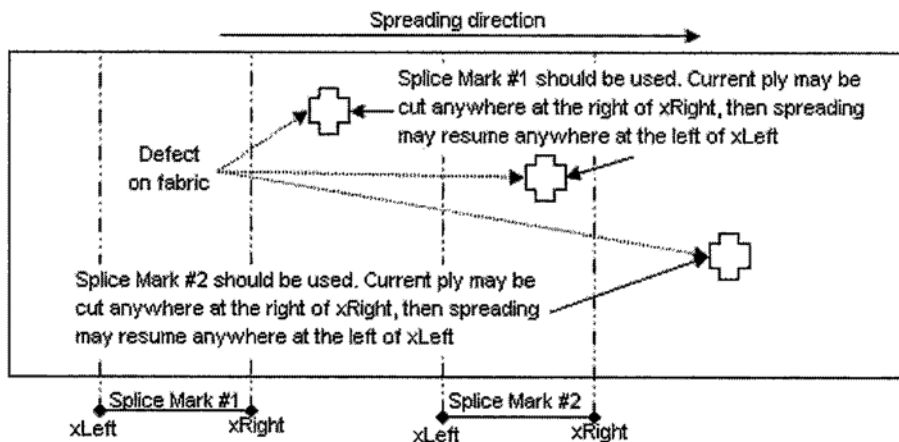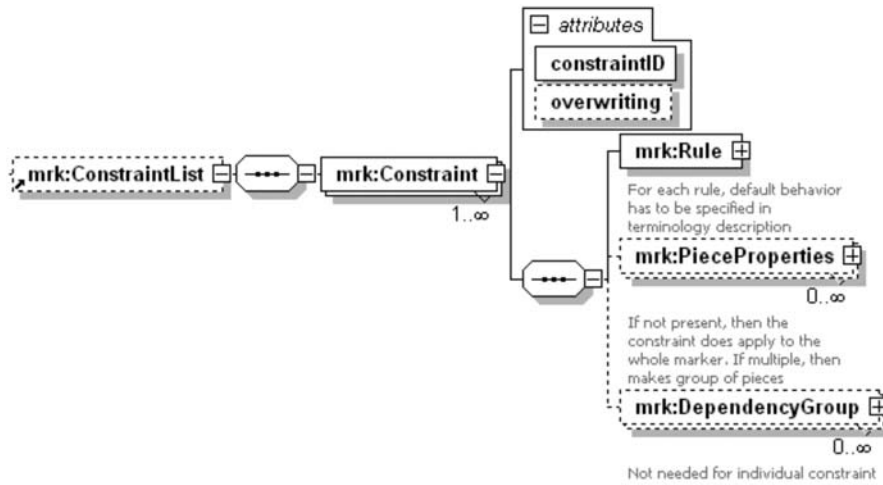

FIG. 20 Splice Marks
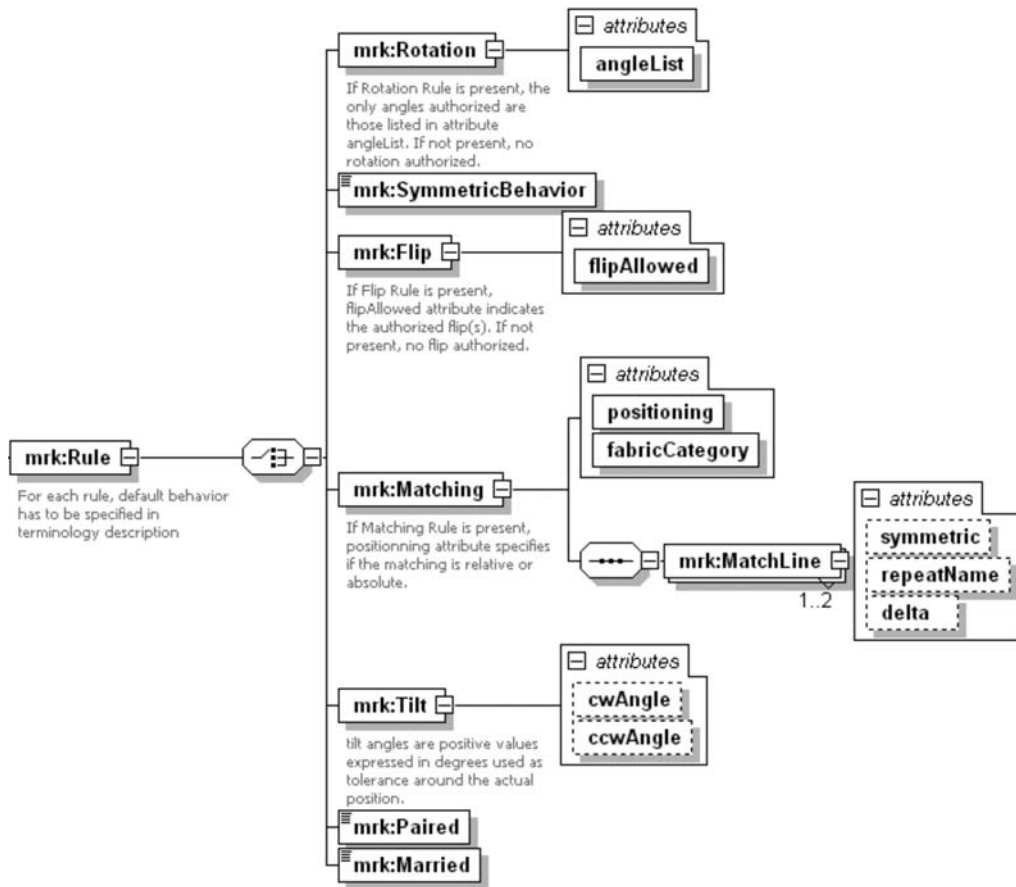
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FIG. 21 ConstraintList Schema

FIG. 22 Rule Schema

given nested piece, then its behavior is not constrained by the structure of the fabric.

16.2.4.1 *positioning*—Specifies whether the matching is relative (associated nested pieces must match together) or absolute (they must match the fabric).

16.2.4.2 *fabricCategory*—Must be the same as the fabricCategory of MaterialAttributes for this constraint to apply; otherwise it does not apply.

16.2.4.3 *MatchLine*—Describes the constraint relative to a RepeatLine.

16.2.4.4 *symmetric*—(optional, default is false) Specifies if relative matching must be symmetric (value set to true) or not (value set to false).

16.2.4.5 *repeatName*—(optional) Reference to the matching repeat line which has the same repeatName. RepeatName is mandatory in case of a symmetric MatchLine constraint.

16.2.4.6 *delta*—Distance of the match point from the repeat line. The delta value is negative if the match point is on the same side than marker origin according to the repeat line. Otherwise the delta value is positive. Default value is 0.

16.2.5 *Tilt*—Specifies a tilt constraint. If no Tilt Constraint is present for a given nested piece, then tilt is not allowed.

16.2.5.1 *cwAngle*—(optional, default is zero) Positive value. Maximum tilt angle value in clockwise direction.

16.2.5.2 *ccwAngle*—(optional, default is zero) Positive value. Maximum tilt angle value in counter-clockwise direction.

16.2.6 *Paired*—Specifies how nested pieces can be paired and nested one upon the other (for Book Fold Top, Book Fold Bottom, Face To Face or Tubular fabric). Upper nested pieces match the master PieceProperties and lower nested pieces match the slave PieceProperties. If no Paired constraint is present, pair pieces is not allowed. Paired nested pieces relative position can be described in PieceProperties xOffset and yOffset attributes.

16.2.7 *Married*—Specifies a set of nested pieces that must be nested with specific relative positions. Each married nested piece is associated to a PieceProperties element and its relative position is described in PieceProperties xOffset and yOffset attributes.

16.3 *PieceProperties*—(optional) Contains all the properties that a given nested piece must simultaneously match in order to be concerned by this constraint. If no PieceProperties is present, then all nested piece in the marker are concerned. See Fig. 23.[4]
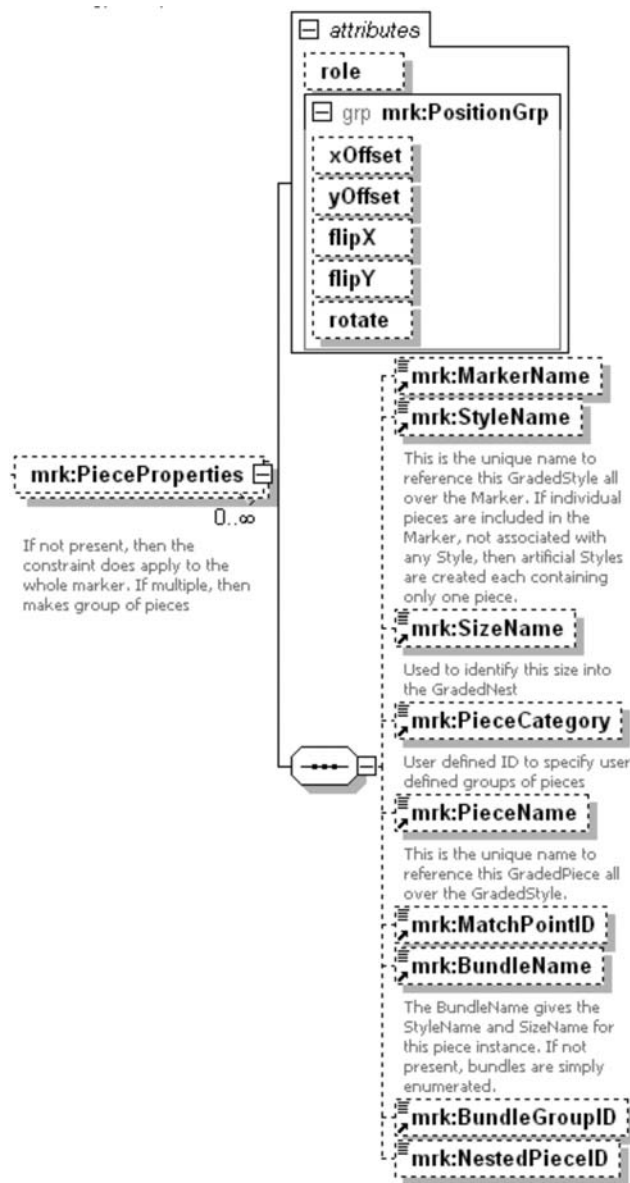

FIG. 23 PieceProperties Schema

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16.3.1 *role*—(optional) Several PieceProperties can be used to associate nested pieces with different characteristics in the same Constraint. If nested pieces defined by each PieceProperties have different behaviors relative to the constraint, Role must be used to specify this behavior. In this case, the Role of some PieceProperties must be master and the Role of the others PieceProperties must be slave.

16.3.2 *xOffset*—(optional) Relative abscissa of the PieceProperties group relatively to another PieceProperties group for the same constraint.

16.3.3 *yOffset*—(optional) Relative ordinate of the PieceProperties group relatively to another PieceProperties group for the same constraint.

16.3.4 *flipX*—(optional, default = false) Relative X flip of the PieceProperties group relatively to another PieceProperties group for the same constraint.

16.3.5 *flipY*—(optional, default = false) Relative Y flip of the PieceProperties group relatively to another PieceProperties group for the same constraint.

16.3.6 *rotate*—(optional, default = 0) Relative rotation of the PieceProperties group relatively to another PieceProperties group for the same constraint.

16.3.7 *MarkerName*—(optional) Name of the marker the nested piece belongs to.

16.3.8 *StyleName*—(optional) StyleName of the graded style the nested piece is associated with.

16.3.9 *SizeName*—(optional) SizeName of the sized piece the nested piece is associated with.

16.3.10 *PieceCategory*—(optional) Name of the PieceCategory of the graded piece the nested piece is associated with.

16.3.11 *PieceName*—(optional) PieceName of the graded piece the nested piece is associated with.

16.3.12 *MatchPointID*—(optional) Refers to the match point in the sized piece the nested piece is associated with.

16.3.13 *BundleName*—(optional) BundleName of the Bundle the nested piece belongs to.

16.3.14 *BundleGroupID*—(optional) BundleGroupID of the group of bundles the nested piece belongs to.

16.3.15 *NestedPieceId*—(optional) Identification of the nested piece concerned with the constraint.

16.4 *DependencyGroup*—(optional) Limits the scope of a mutual constraint. If no DependencyGroup is specified, then the constraint is not a mutual constraint.

16.4.1 *common*—If Common is set to "Bundle," then this constraint applies to nested pieces that belong to the same Bundle. If Common is set to "BundleGroup," then this Constraint applies to nested pieces that belong to the same BundleGroup.

17. CutInformation

17.1 CutInformation defines constraints about the way geometry to produce must be cut. If geometry to produce doesn't exist, CutInformation applies to reference geometry. CutInformation can be associated to a sized piece geometry to produce or to a nested piece geometry to produce. CutInformation contains a list of StartPoint elements, a list of Traject elements and a list of Sequence elements.

17.2 *StartPoint*—Defines a start point.

17.2.1 *pointID*—Identifier of a Point element.

17.3 *Traject*—Defines the cutting direction of the geometry of a Polyline.

17.3.1 *polylineID*—Identifier of the PolyLine element whose direction is defined.

17.3.2 *cutDirection*—Indicates the direction of the cutting tool according to the description direction. cutDirection possible values are:

17.3.2.1 *normal*—This value means that the geometry of the PolyLine should be cut in the description sense.

17.3.2.2 *reverse*—This value means that the geometry of the PolyLine should be cut in an opposite direction according to the description sense.

17.3.2.3 *free*—This value means that there is no direction constraint for cutting the geometry of this PolyLine. free is the default value.

17.4 *Sequence*—Defines an ordered list of geometric entities such as Polylines, Drills, and Notches. This order must be observed by the cutting tool when cutting geometries. Geometric entities that are not ordered in Sequence element can be cut at any time.

17.4.1 *DrillID*—Identifies a drill.

17.4.1.1 *id*—Identifier of the drill.

17.4.2 *PolylineID*—Identifies a Polyline.

17.4.2.1 *id*—Identifier of the Polyline

17.4.3 *NotchID*—Identifies a Notch

17.4.3.1 *id*—Identifier of the Notch

18. Marker Data Exchange XML File Format

18.1 The data structure of marker data exchange file is described in the adjunct[2] as an XML schema.

18.2 XML schema file target namespace is: http://www.astm.org/D1366/marker/2009

18.3 XML schema file version number is "1.0".

18.4 The use of characters encoding UTF-8 or UTF-16 is recommended for marker files generation.

19. Keywords

19.1 CAD system; cutting; geometry; nest; piece; sewn product