INTERNATIONAL STANDARD

ISO 22432

First edition
2011-11-15

Geometrical product specifications (GPS) — Features utilized in specification and verification

Spécification géométrique des produits (GPS) — Éléments utilisés en spécification et vérification

Reference number
ISO 22432:2011(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 22432 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

Introduction

This International Standard is a Geometrical Product Specifications (GPS) standard and is to be regarded as a global GPS standard (see ISO/TR 14638). It influences all chain links in all chains of standards in the general GPS matrix.

The ISO/GPS Masterplan given in ISO/TR 14638 gives an overview of the ISO/GPS system of which this document is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this document and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this document, unless otherwise indicated.

Geometrical features exist in three “worlds”:

— the world of nominal definition, where an ideal representation of the workpiece is defined by the designer;

— the world of specification, where the designer has in mind several representations of the workpiece;

— the world of verification, where one (or more) representation(s) of a given workpiece is (are) identified in the application of measuring procedure(s).

In the world of verification, mathematical operations can be distinguished from physical operations. The physical operations are the operations based on physical procedures; they are generally mechanical, optical or electromagnetic. The mathematical operations are mathematical treatments of the sampling of the workpiece. This treatment is generally achieved by computing or electronic treatment.

It is important to understand the relationship between these three worlds. This International Standard defines standardized terminology for geometrical features principally in the world of specification and the world of verification, to be used in communication between each world.

The features defined in this International Standard are well suited for the specification of rigid parts and assemblies, and may also be applied to non-rigid parts and assemblies by specifying allowable variation according to rigid solids.

Geometrical product specifications (GPS) — Features utilized in specification and verification

1 Scope

This International Standard defines general terms and types of features for geometrical features of specifications for workpieces. These definitions are based on concepts developed in ISO/TS 17450-1.

This International Standard aims to serve as the "road map" mapping out the interrelationship between geometrical features, thus enabling future standardization for industry and software makers in a consistent manner.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14660-1:1999, *Geometrical Product Specifications (GPS) — Geometrical features — Part 1: General terms and definitions*

ISO/TS 17450-1:2005, *Geometrical product specifications (GPS) — General concepts — Part 1: Model for geometrical specification and verification*

ISO/TS 17450-2:2002, *Geometrical product specifications (GPS) — General concepts — Part 2: Basic tenets, specifications, operators and uncertainties*

3 Terms and definitions

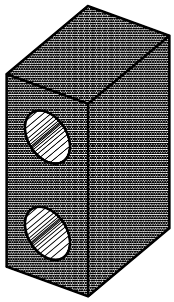
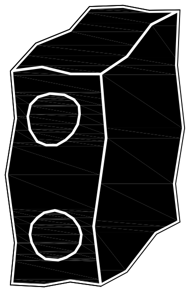
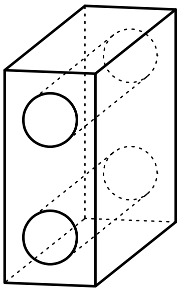
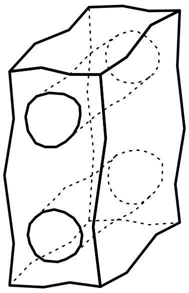
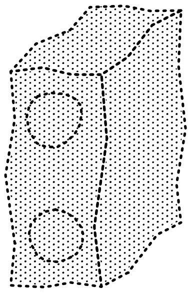
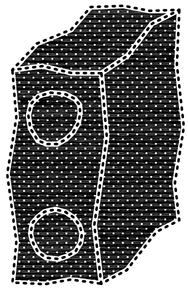
For the purposes of this document, the terms and definitions given in ISO 14660-1, ISO/TS 17450-1 and ISO/TS 17450-2 and the following apply.

3.1
surface model
model representing the set of features limiting the virtual or the real workpiece

NOTE 1 All closed surfaces (see Figures 1 and A.1) are included.

NOTE 2 The surface model allows the definition of single features, sets of features, and/or portions of features. The total product is modelled by a set of surface models corresponding to each workpiece.

EXAMPLE Case of a hollow surface.

<table>
<tr><td colspan="2">Representation of a real surface of the workpiece</td><td colspan="2">Representation of the real workpiece[a]</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Representation of nominal surface model</td><td>Representation of skin model</td><td>Representation of discrete surface model</td><td>Representation of sampled surface model</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">[a] For the purpose of this International Standard.</td></tr>
</table>

NOTE It is impossible to predict the total geometry of the real workpiece due to its geometrical imperfections. In this International Standard, a real surface of the workpiece is illustrated in solid black.

Figure 1 — Example of real surface of the workpiece and its models

3.1.1
nominal surface model
surface model of ideal geometry defined by the technical product documentation

NOTE 1 A nominal surface model is an ideal feature (See Figure 1 and Table 1).

NOTE 2 A nominal surface model is a continuous surface composed of an infinite number of points.

NOTE 3 Any feature on the nominal surface model (skin model) contains a continuous infinite number of points.

3.1.2
skin model
surface model of non-ideal geometry

NOTE 1 The skin model is a virtual model used to express the specification operator and the verification operator considering a continuous surface (see Table 1 and ISO/TS 17450-1).

NOTE 2 A skin model is a non-ideal feature (see Figure 1).

NOTE 3 A skin model is a continuous surface consisting of an infinite number of points.

NOTE 4 Any feature on the skin model contains a continuous infinite number of points.

3.1.3
discrete surface model
surface model obtained from the skin model by an extraction

NOTE 1 In addition to the required points, the extraction implies an interpolation.

NOTE 2 The discrete surface model is used to express the specification operator and the verification operator considering a finite number of points (see Table 1).

NOTE 3 A discrete surface model is a non-ideal feature (see Figure 1).

3.1.4
sampled surface model
surface model obtained from the real workpiece model by a physical extraction

NOTE 1 In addition to the sampled points, the verification may imply an interpolation.

NOTE 2 The sampled surface model is used in verification by coordinate metrology, not, for example, in verification by a gauge because gauging makes no measurement of points. In verification by a gauge, the real surface of the workpiece is directly considered (see Table 1).

NOTE 3 A sampled surface model is a non-ideal feature (see Figure 1).

3.2
geometrical feature
point, line, surface, volume or a set of these previous items

NOTE 1 The non-ideal surface model is a particular geometrical feature, corresponding to the infinite set of points defining the interface between the workpiece and the surrounding.

NOTE 2 A geometrical feature can be an ideal feature or a non-ideal feature, and can be considered as a single feature or a compound feature.

3.2.1
nominal feature
geometrical feature of ideal geometry defined in the technical product documentation by the product designer

NOTE 1 See Figure B.1.

NOTE 2 A nominal feature is defined by the technical product documentation. See Table 1.

NOTE 3 A nominal feature can be finite or infinite; by default it is infinite.

EXAMPLE A perfect cylinder, defined in a drawing, is a nominal feature obeying a specific mathematical formula, which is defined in a coordinate system related to the situation feature, and for which dimensional parameters are associated. The situation feature of a cylinder is a line which is commonly called "its axis". Taking this line as an axis of a Cartesian coordinate system leads to writing $x^2 + y^2 = D/2$, D being a dimensional parameter. A cylinder is a feature of size, of which the size is its diameter D.

3.2.2
real feature
geometrical feature corresponding to a part of the workpiece real surface

3.2.3
discrete feature
geometrical feature corresponding to a part of the discrete surface model

3.2.4
sampled feature
geometrical feature corresponding to a part of the sampled surface model

3.2.5
ideal feature
feature defined by a parameterized equation

[ISO/TS 17450-1:2005, definition 3.13]

NOTE 1 The expression of the parameterized equation depends on the type of ideal feature and on the intrinsic characteristics.

NOTE 2 By default, an ideal feature is infinite. To change its nature, it is appropriate to specify it by the term “restricted”, e.g. restricted ideal feature.

NOTE 3 For a complex surface defined by a cloud of points and an interpolation method, the cloud of points is considered the parameter.

NOTE 4 This definition is also contained in ISO/TS 17450-1:2005. It is envisaged that it will be deleted from ISO 17450-1:2011.

3.2.5.1
attribute of an ideal feature
property intrinsically attached to an ideal feature

NOTE 1 Four levels of attributes can be defined for an ideal feature: shape, dimensional parameters from which a size can be defined in the case of a feature of size, situation feature and skeleton (when the size tends to zero).

NOTE 2 If the ideal feature is a feature of size, then one of the parameters of the shape can be considered as a size.

3.2.5.1.1
feature of size
geometrical feature having one or more intrinsic characteristics, only one of which may be considered as a variable parameter, that additionally is a member of a “one-parameter family”, and obey the monotonic containment property, for that parameter

NOTE 1 A feature of size can be a sphere, a circle, two straight lines, two parallel opposite planes, a cylinder, a torus, etc. In former International Standards a wedge and a cone were considered as features of size, and a torus was not mentioned.

NOTE 2 There are restrictions when there is more than one intrinsic characteristic (e.g. a torus).

NOTE 3 Relative to the function, a feature of size is particularly useful for the expression of material requirements (LMR and MMR, see ISO 2692).

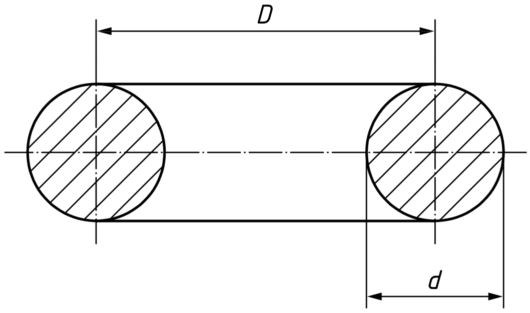
EXAMPLE 1 A single cylinder constituting a hole or a shaft is a feature of size. Its size is its diameter.

EXAMPLE 2 A compound feature of two single parallel plans constituting a groove or a key is a feature of size. Its size is its width.

3.2.5.1.1.1
one-parameter family
set of ideal geometrical features defined by one or more dimensional parameters whose members are generated by varying one parameter

EXAMPLE 1 A set of o-rings (torus-shaped) with the same fixed median-ring diameter and different cross-sectional diameters is a one-parameter family (see Figure 2).

EXAMPLE 2 A set of gauge blocks defined by the gauge blocks' thickness is a one-parameter family.



Key

D median-ring diameter

d cross-sectional diameter

Figure 2 — Example of one-parameter family

3.2.5.1.1.2
monotonic containment property
property of a one-parameter family where a member with a given size contains any member with a smaller size

EXAMPLE 1 A torus belonging to a one-parameter family, corresponding to a set of o-rings (torus-shaped) with the same fixed median-ring diameter and different cross-sectional diameters, respects the monotonic containment property, because from an ideal point of view, the larger family member completely envelopes the smaller family member (see Figure 3).

EXAMPLE 2 A torus belonging to a one-parameter family, corresponding to a set of o-rings (torus-shaped) with different median-ring diameters and the same fixed cross-sectional diameter, does not respect the monotonic containment property and therefore cannot be considered as a feature of size.

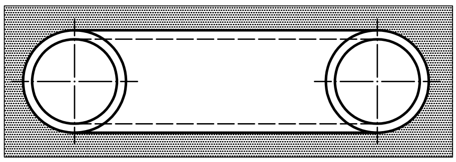
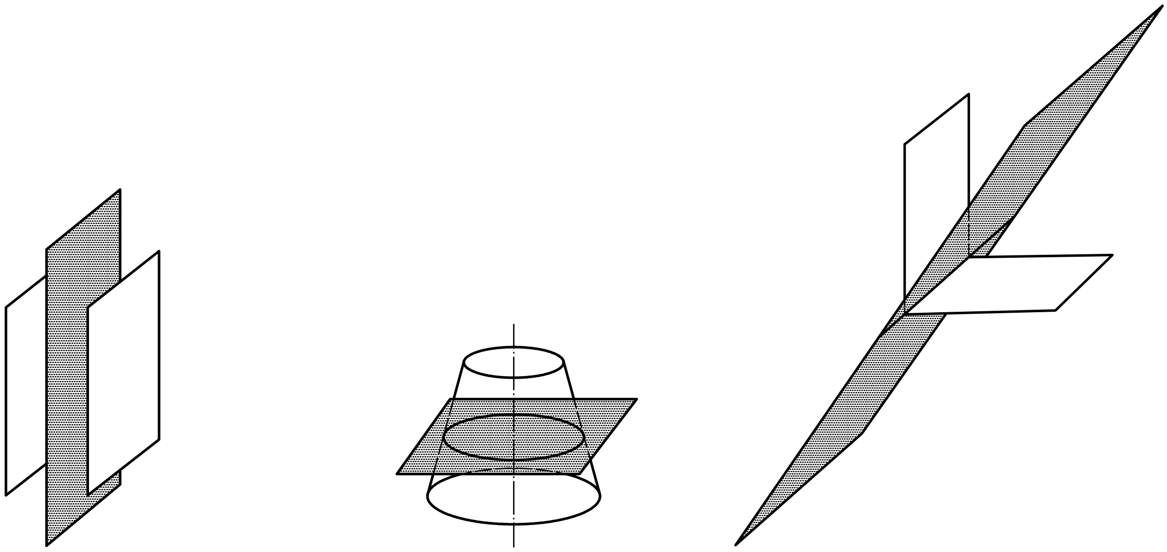


Figure 3 — Monotonic containment property

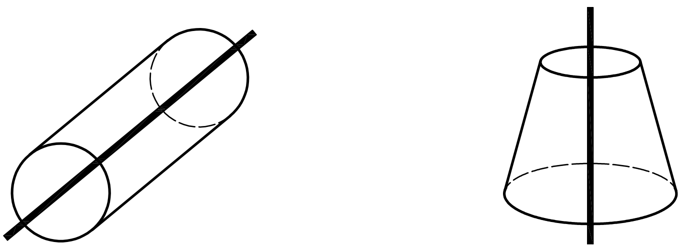
3.2.5.1.2
situation feature
geometrical feature defining the location or orientation of an ideal feature and which is a geometrical attribute of the ideal feature

See Figures 4 to 7.



a) Pair of parallel planes b) Cone c) Two non-parallel planes

Figure 4 — Example of situation planes



a) Axis of a cylinder b) Axis of a cone

Figure 5 — Example of situation lines

a) Situation point of a cone b) Situation point of a sphere

Figure 6 — Example of situation points

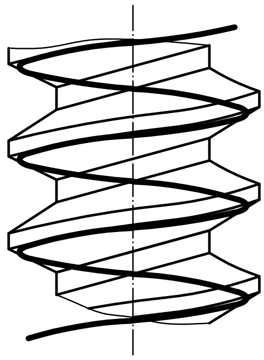


Figure 7 — Example of situation helix

NOTE In many cases, instead of using the situation helix, the axis of the situation helix is used.

3.2.5.2
shape of an ideal feature
mathematical generic description defining the ideal geometry of a feature

NOTE An ideal feature of a preset shape can be qualified or named.

EXAMPLE 1 Planar shape, cylindrical shape, spherical shape, conical shape.

EXAMPLE 2 A surface can be qualified “planar surface” or be directly named “plane”.

3.2.5.3
skeleton feature
reduction of an ideal feature when its size is equal to zero

NOTE In some cases, the skeleton feature is identical to the situation feature. In the case of the cylinder, the skeleton feature is identical to the situation feature, which is not the case for the torus.

EXAMPLE In the case of a torus, there are two dimensional parameters of which one is a size (the cross-sectional diameter of the torus). Its skeleton is a circle and its situation features are its plane and a perpendicular line.

3.2.6
non-ideal feature
imperfect feature fully dependent on the non-ideal surface model (skin model)

[ISO/TS 17450-1:2005, definition 3.19]

NOTE 1 A non-ideal feature is, by default, of finite dimension. To change this nature, it is appropriate to specify it by associating the restricted term.

NOTE 2 This definition is also contained in ISO/TS 17450-1:2005. It is envisaged that it will be deleted from ISO 17450-1:2011.

3.2.7
specification feature
geometrical feature identified from the skin model or from the discrete surface model and defined by the specification operator

See Table 1 and Figure B.2.

NOTE Specification and verification operators are defined in ISO/TS 17450-2.

EXAMPLE 1 In the process of specification, an ideal cylinder identified from the skin model by an association is an ideal specification feature.

EXAMPLE 2 In the process of specification, a non-ideal cylindrical surface identified from the skin model by a partition is a non-ideal specification feature.

3.2.8
verification feature
geometrical feature (identified from the skin model, the discrete surface model or the sampled surface model) or real feature defined by the verification operator

See Table 1 and Figure B.3

NOTE 1 In the world of verification, mathematical operations can be distinguished from physical operations. These physical operations are based on physical procedures; they are generally mechanical, optical or electromagnetic. The complete specification operator includes the type of physical property to which the specification applies.

NOTE 2 The geometrical feature identified from the skin model or from the discrete surface model is used to define the verification operator. The geometrical feature identified from the sampled surface model and the real feature are used to implement the verification operator.

EXAMPLE 1 In the process of verification, a perfect cylinder identified from the workpiece by an association is an ideal verification feature.

EXAMPLE 2 In the process of verification, an imperfect cylindrical surface identified from the workpiece by a partition is a non-ideal verification feature.

Table 1 — Use of surface models

Field of use	Surface model				Real surface
	Nominal surface model	Skin model	Discrete surface model	Sampled surface model	
Technical product documentation	Applicable	Non-applicable	Non-applicable	Non-applicable	Non-applicable
Specification operator	Non-applicable	Applicable	Applicable	Non-applicable	Non-applicable
Verification operator	Non-applicable	Applicable	Applicable	Applicable	Applicable

3.2.9
single feature
geometrical feature which is a single point, a single line, or a single surface

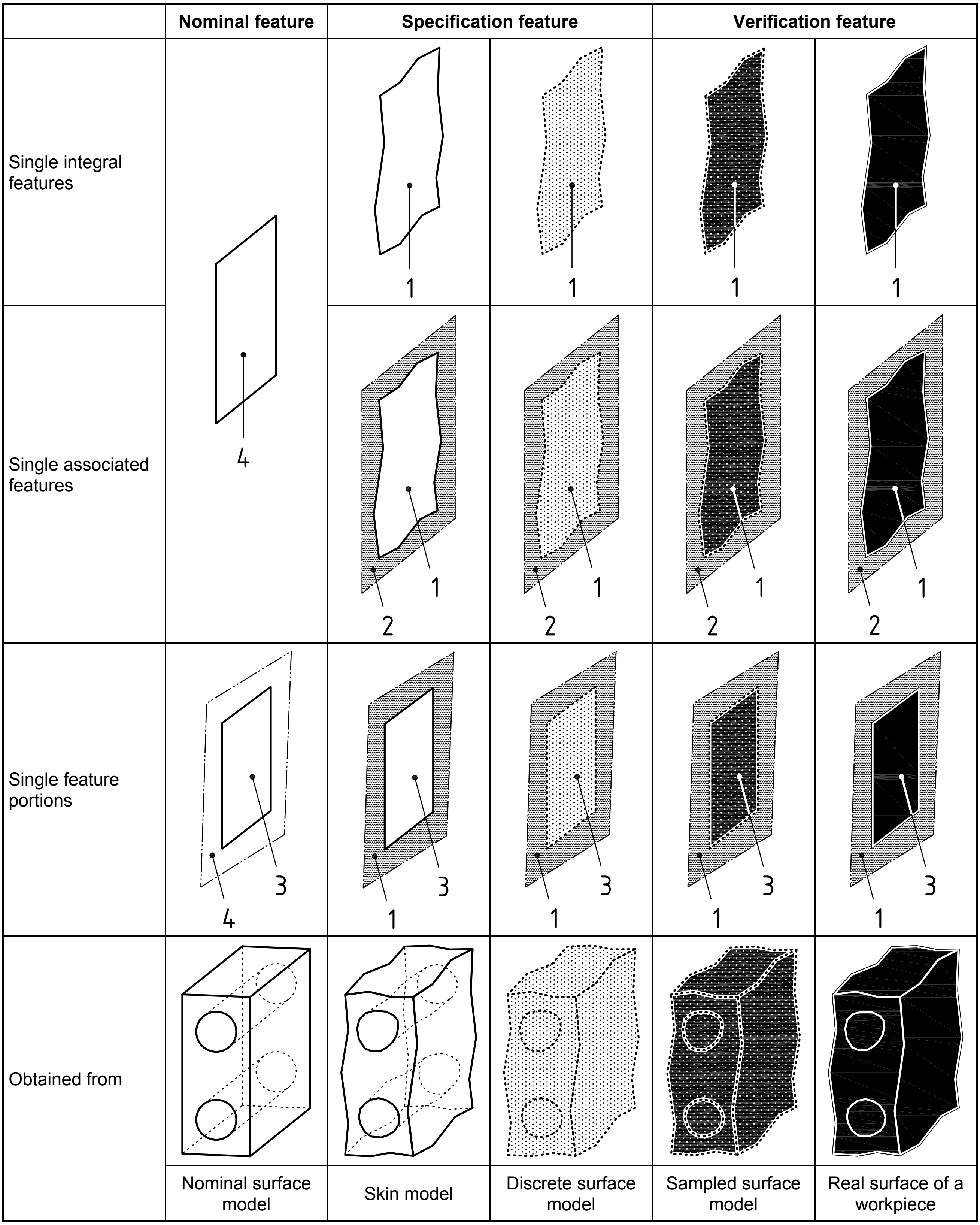
NOTE A single feature can have none, or one or more intrinsic characteristics, e.g.:

— a plane is a single feature but has no intrinsic characteristic;

— a cylinder has only one intrinsic characteristic;

— a torus has two intrinsic characteristics.

EXAMPLE A cylinder is a single feature (see Figures 8 and 9). A set of surfaces made up of two intersecting planes is not a single feature, because one plane has a greater invariance degree than two planes (see 3.2.9.4, Note 3).



Key

1 single integral features

2 single associated features

3 single feature portions

4 single nominal features

Figure 8 — Examples of single features built from the same nominal plane

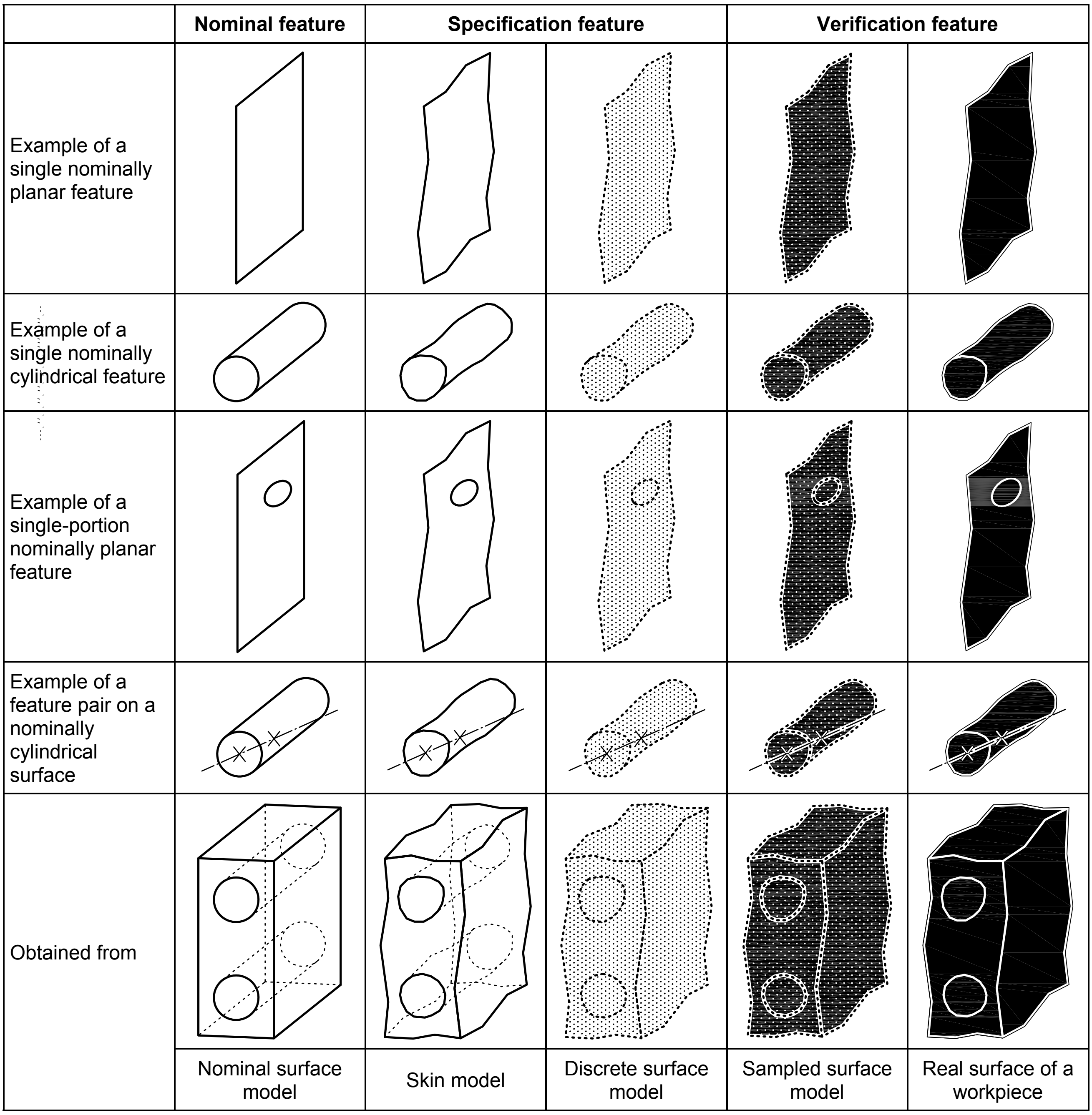


Figure 9 — Examples of single features built from different surface models

3.2.9.1
single point
point taken from a single surface or from a single line

3.2.9.2
single line
continuous line which is nominally a straight line, a circle or a complex line

NOTE 1 An arc is a restricted circle (see Figure 10).

NOTE 2 A single line does not intersect itself.

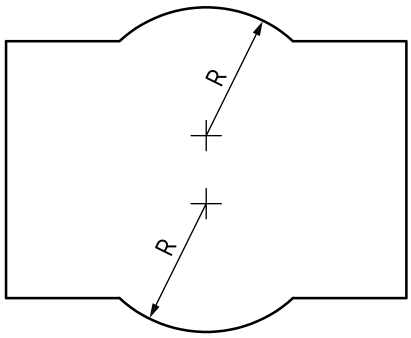


Figure 10 — Example of single lines

3.2.9.3
complex line
continuous line that is not a straight line or a circular line of which the shape and the extension are defined and indicated by the designer in respect of the writing rules

3.2.9.4
single surface
continuous surface which is nominally a plane, a cylinder, a sphere, a cone, a torus, another surface of revolute invariance class, a surface of prismatic invariance class, a helix, a surface of complex invariance class, or a restricted part of one of them

NOTE 1 A revolute surface is a single surface if its generatrix is a single line (see Figure 11).

NOTE 2 Table 1 of ISO/TS 17450-1:2005 illustrates the types of single surfaces with their invariance degree.

NOTE 3 If a surface contains a surface portion of higher invariance degree than itself then it is not a single surface. A partial ordering of single-surface types, based on whether they can contain each other, is given in Figure 12. The ordering is partial because some surface types cannot be contained within each other.

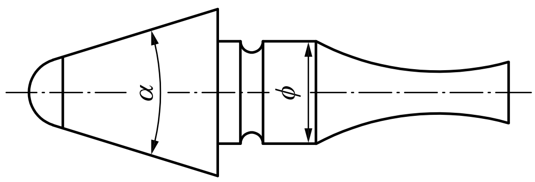


Figure 11 — Example of single surfaces

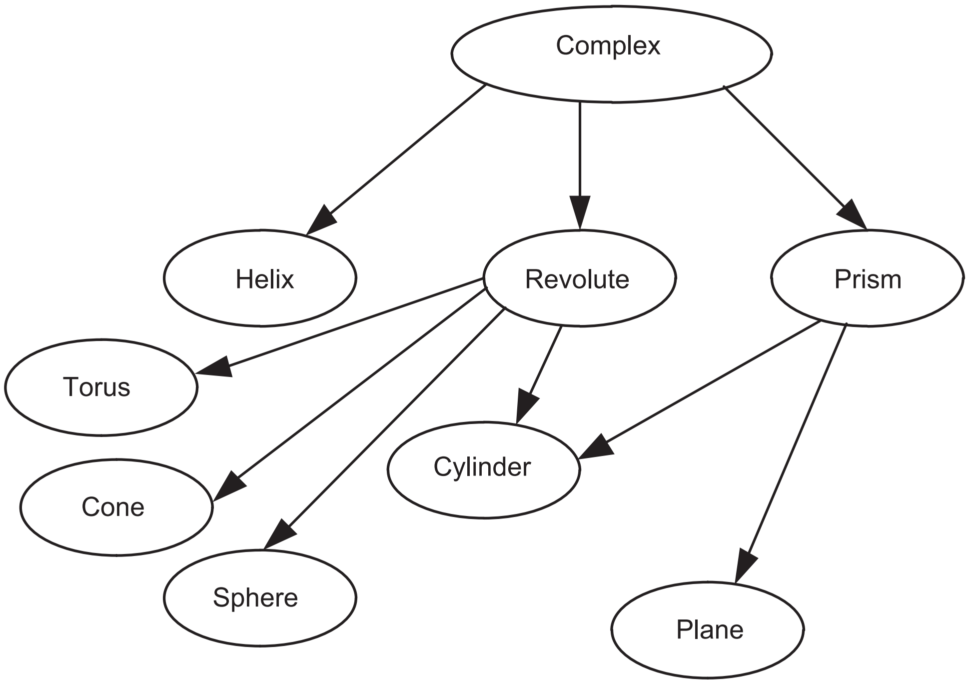


Figure 12 — Partial ordering of single-surface types

3.2.9.5
complex surface
continuous surface of which the shape and the extension are defined and indicated by the designer in respect of the writing rules, and is not considered a plane, cylinder, cone, torus or sphere

3.2.10
compound feature
geometrical feature which is a collection of several single features

NOTE 1 A compound feature can have none, or one or more intrinsic characteristics. For instance, the set of two parallel planes is a compound feature, which has one intrinsic characteristic.

NOTE 2 The number of features constituting a compound feature can be finite (countable) or infinite (continuous) in number (see Figure 13).

EXAMPLE 1 A set of surfaces consisting of two parallel cylinders is a compound feature (see Figure 14).

EXAMPLE 2 A geometrical feature made up from two groups of two parallel planes is a compound feature.

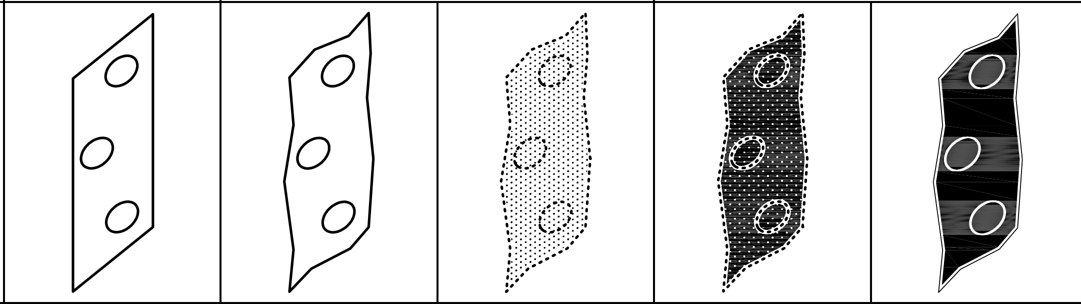
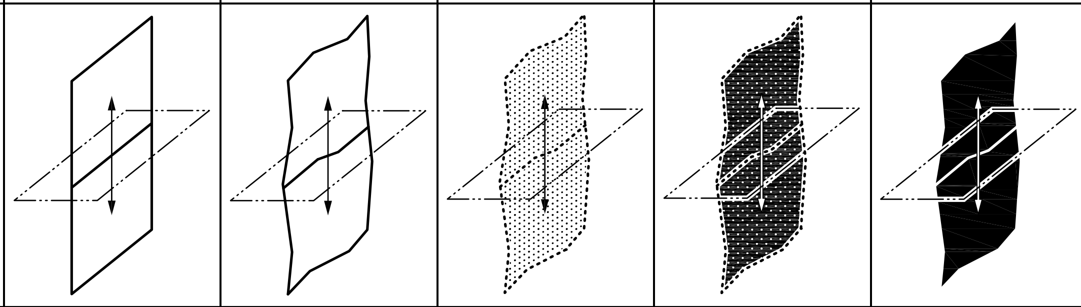
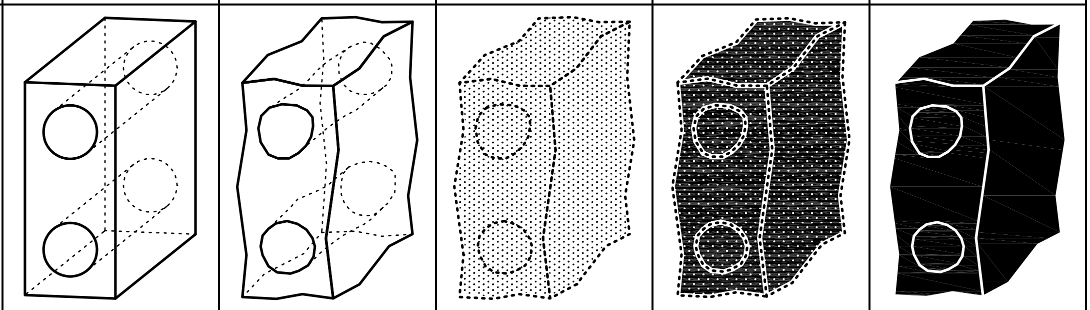
	Nominal feature	Specification feature		Verification feature	
Example of a compound feature consisting of a finite number of single-portion nominally planar features					
Example of a compound feature consisting of an infinite number of single nominally straight lines					
Obtained from					
	Nominal surface model	Skin model	Discrete surface model	Sampled surface model	Real surface of a workpiece

Figure 13 — Example of compound feature built from a finite or infinite number of single features

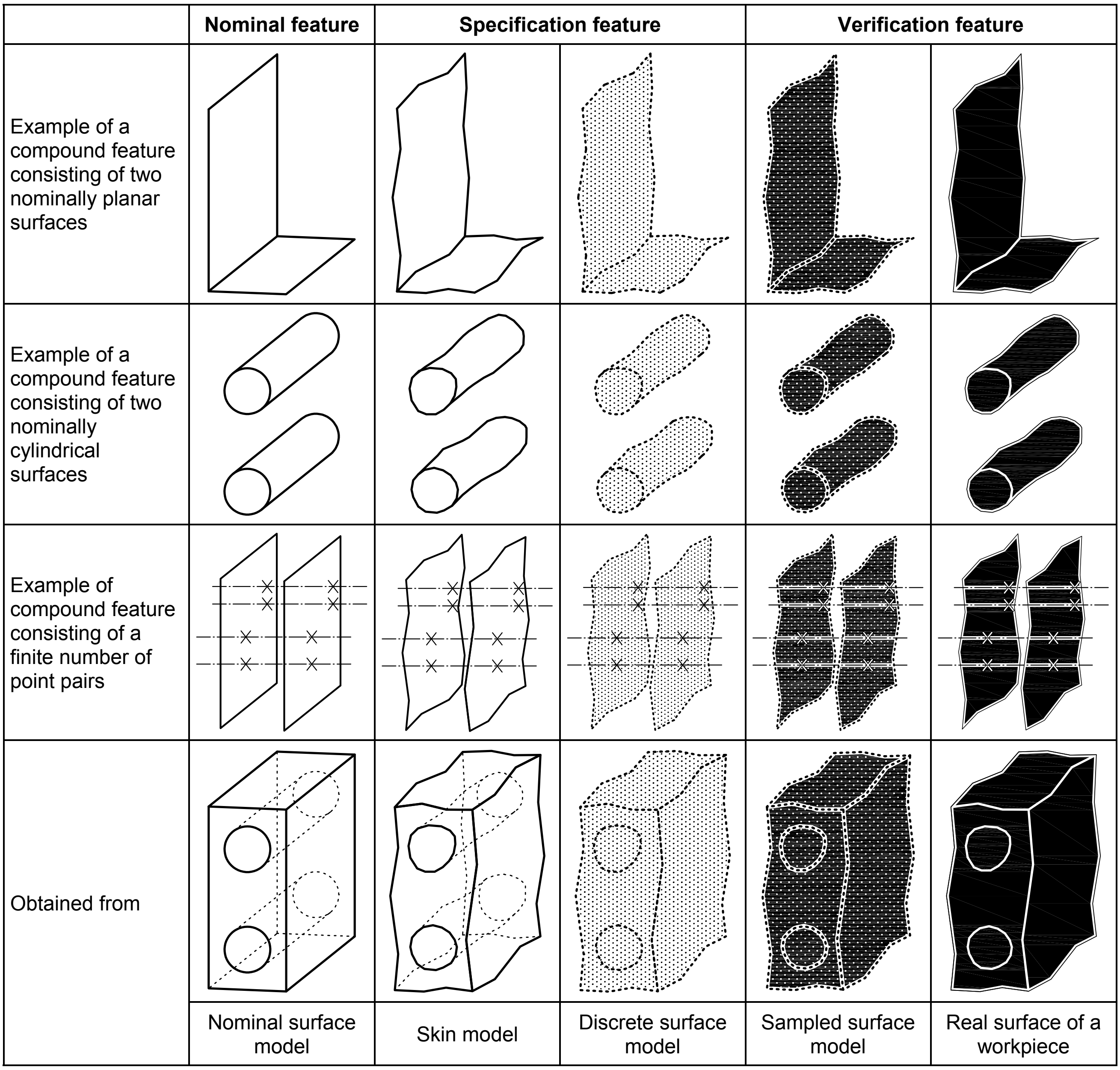


Figure 14 — Examples of compound features

3.2.11
extracted feature
geometrical feature consisting of a finite number of points

NOTE 1 When the representation is defined by an infinite number of points, the word “extracted” is not used with the considered terms.

EXAMPLE An integral feature is, by default, an infinite representation, whereas an integral feature is extracted with a finite representation.

NOTE 2 The concept of “extracted” can apply to an integral feature or a derived feature.

3.2.12
infinite feature
geometrical feature consisting of an infinite number of points

3.2.13
complete feature
total feature
geometrical feature containing the totality of the points corresponding to one or more single geometrical features and pertaining to the surface model

3.2.14
restricted feature
geometrical feature corresponding to a portion of a complete/total non-ideal feature or having a portion of an (ideal) infinite feature

3.3
integral feature
surface or line on a surface

[ISO 14660-1:1999, definition 2.1.1]

NOTE 1 An integral feature is intrinsically defined.

NOTE 2 For the statement of specifications, features obtained from partition of the surface model must be defined. These features are models of the different physical parts of the workpiece that have specific functions, especially contact with the adjacent workpieces. These features are called “integral features”.

NOTE 3 The integral feature is either a single or compound feature (see Figures 14 and A.3).

NOTE 4 An integral feature is identified either

— by a partition of the surface model, or

— by a partition of another integral feature, or

— by a collection of other integral features.

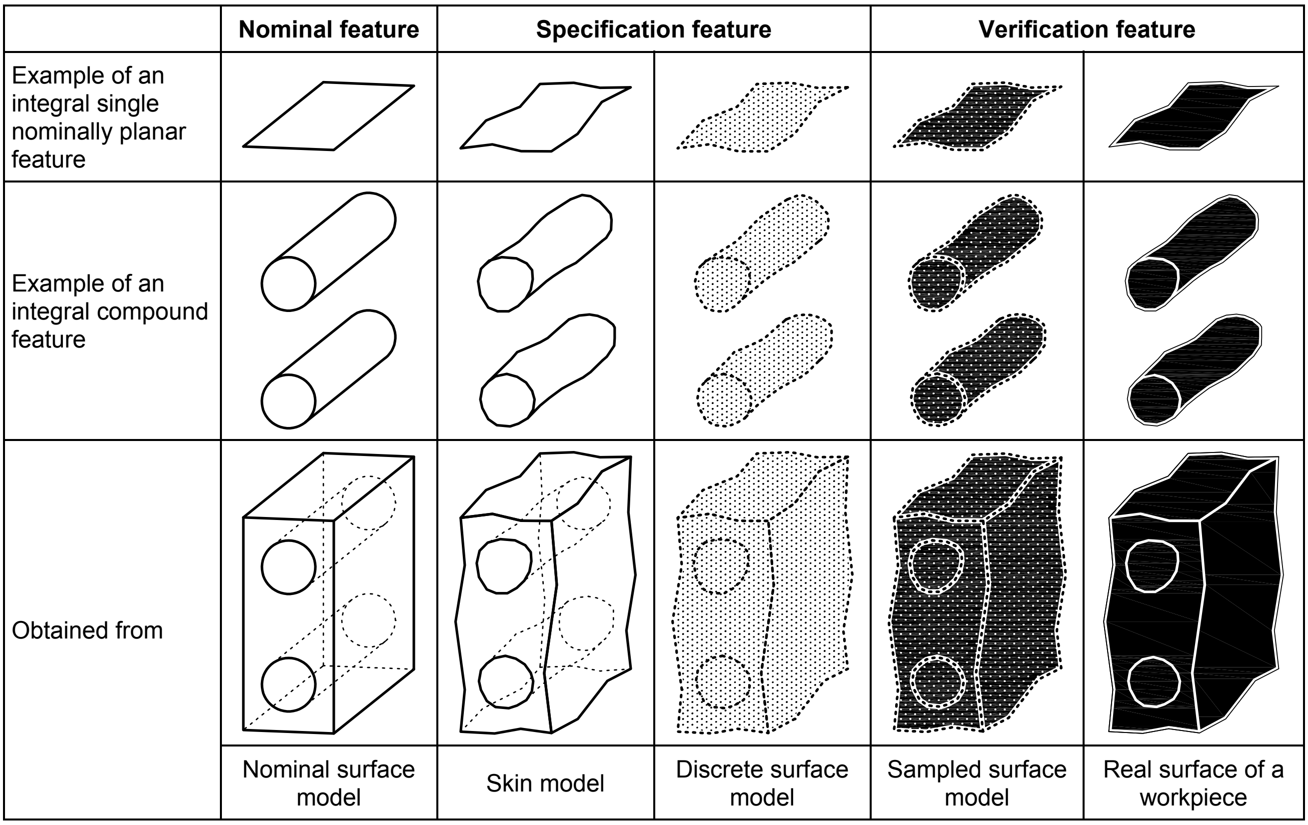


Figure 15 — Example of integral features

3.3.1
integral surface portion
integral surface which is a portion of the complete surface

NOTE An integral surface portion is obtained from any type of section volume (see Figure 16).

3.3.2
integral line portion
integral line which is a portion of the complete line

NOTE An integral line portion is obtained from a defined section volume, e.g. by two parallel planes (see Figure 16).

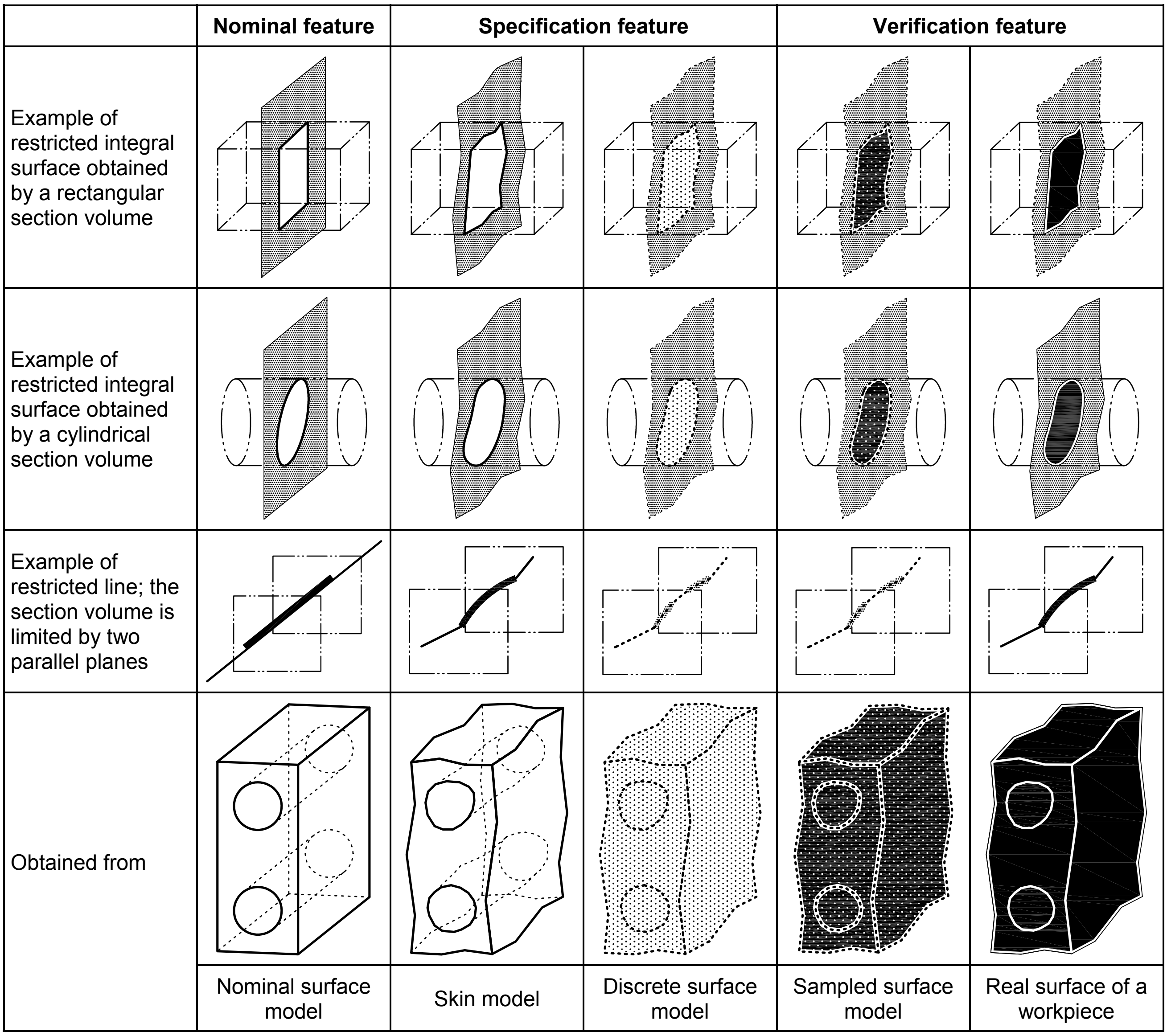


Figure 16 — Example of restricted feature

3.3.3
coupled feature
surface pair, line pair and point pair

NOTE A coupled feature is a special collection of ideal or non-ideal features which are obtained together in a partition (see Figure 17).

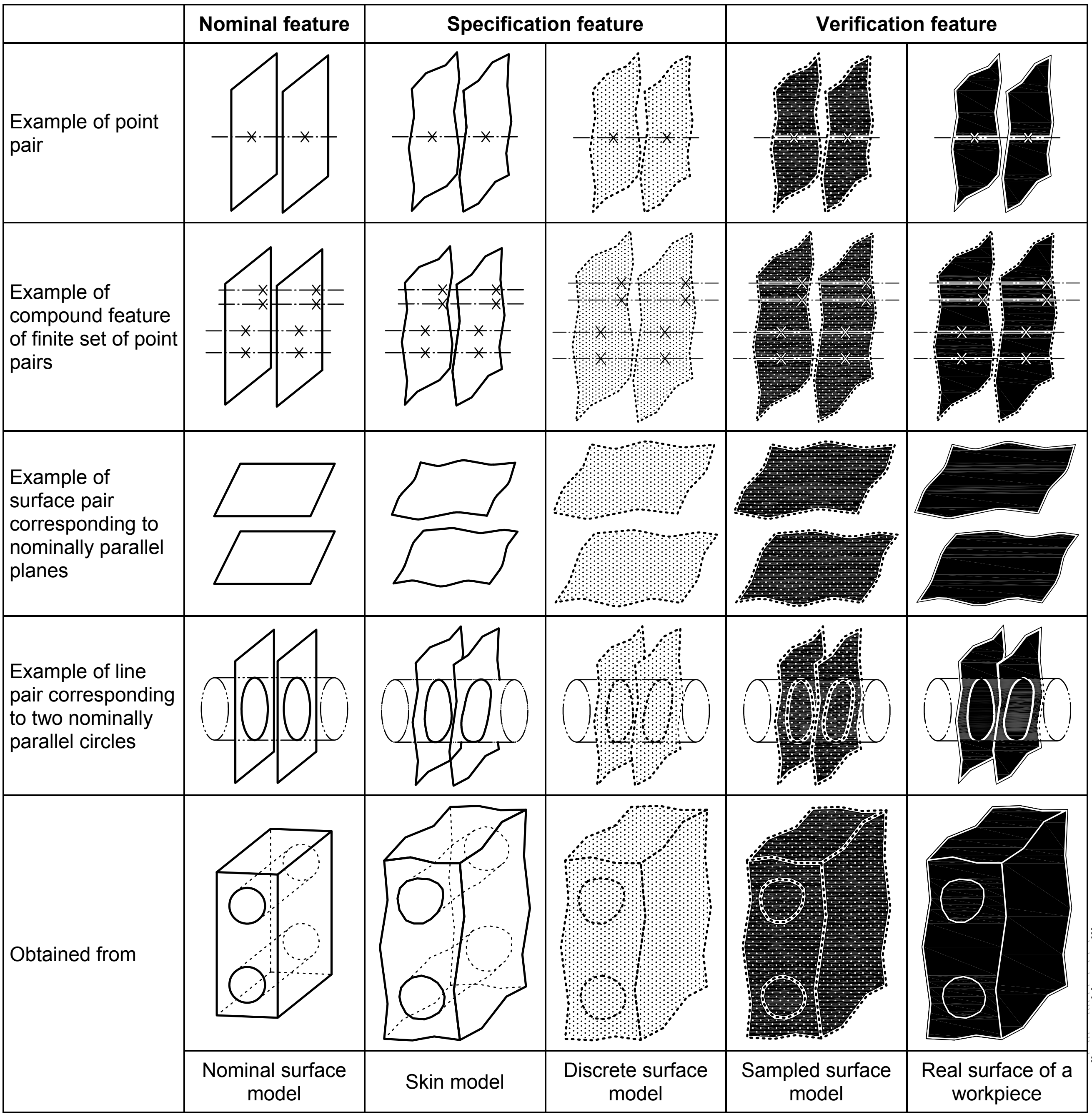


Figure 17 — Examples of coupled features

3.3.3.1
surface pair
set of at least two surfaces obtained from partition of a geometrical feature by a section volume

3.3.3.2
line pair
set of at least two lines obtained from partition of a geometrical feature by a section surface

3.3.3.3
point pair
set of at least two points obtained from partition of a geometrical feature by a section line

NOTE To define a point pair, the section line is often taken perpendicular to an ideal median-considered feature.

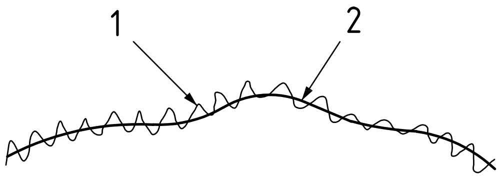
3.4
filtered feature
non-ideal feature which is the result of a filtration of a non-ideal feature

See Figures 18 and A.5.

NOTE 1 The filtered feature is a specification or verification filtered feature, depending on the model from which it is defined. Nominal filtered features do not exist.

NOTE 2 Relating to the function, the features considered are often not directly integral features, but integral features after a filtration.

NOTE 3 To describe a filter, it is sometimes necessary to use other types of features, for example associated features, offset features, enabling features (section features, structuring features).



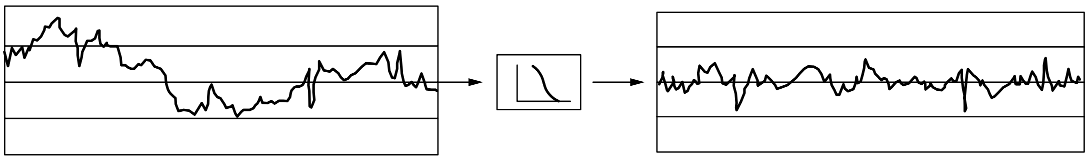
Key

1 non-ideal feature before filtration

2 filtered feature (non-ideal feature after filtration)

Figure 18 — Specification and verification filtered features

EXAMPLE 1 Creation of the roughness profile by applying a longwave cut-off filter to remove long wavelengths and form from the primary profile. The roughness profile is one of the family of filtered features. The primary profile is one of the family of integral features (see Figure 19).



Primary profile	Filter	Roughness profile
Integral feature	Filter	Filtered feature

Figure 19 — Example of creation of roughness profile

EXAMPLE 2 Roundness profile resulting from applying a Gaussian longwave-pass filter to the extracted circumferential line: the roundness profile belongs to the family of filtered features. The extracted circumferential line belongs to the family of integral features (see Figure 18).

3.4.1
filtered surface
surface which is the result of a filtration of a surface

3.4.2
filtered line
line which is the result of a filtration of a line

3.5
derived feature
geometrical feature, which is a median, displaced, congruent or reflected feature resulting from a set of operations on an integral or filtered feature

NOTE 1 The set of operations either preserve the nature of the original feature in such a way that the derived feature has the appearance of the original feature or convert the nature of the original feature in such a way that the derived feature becomes the median feature of the original feature (see Figure 20).

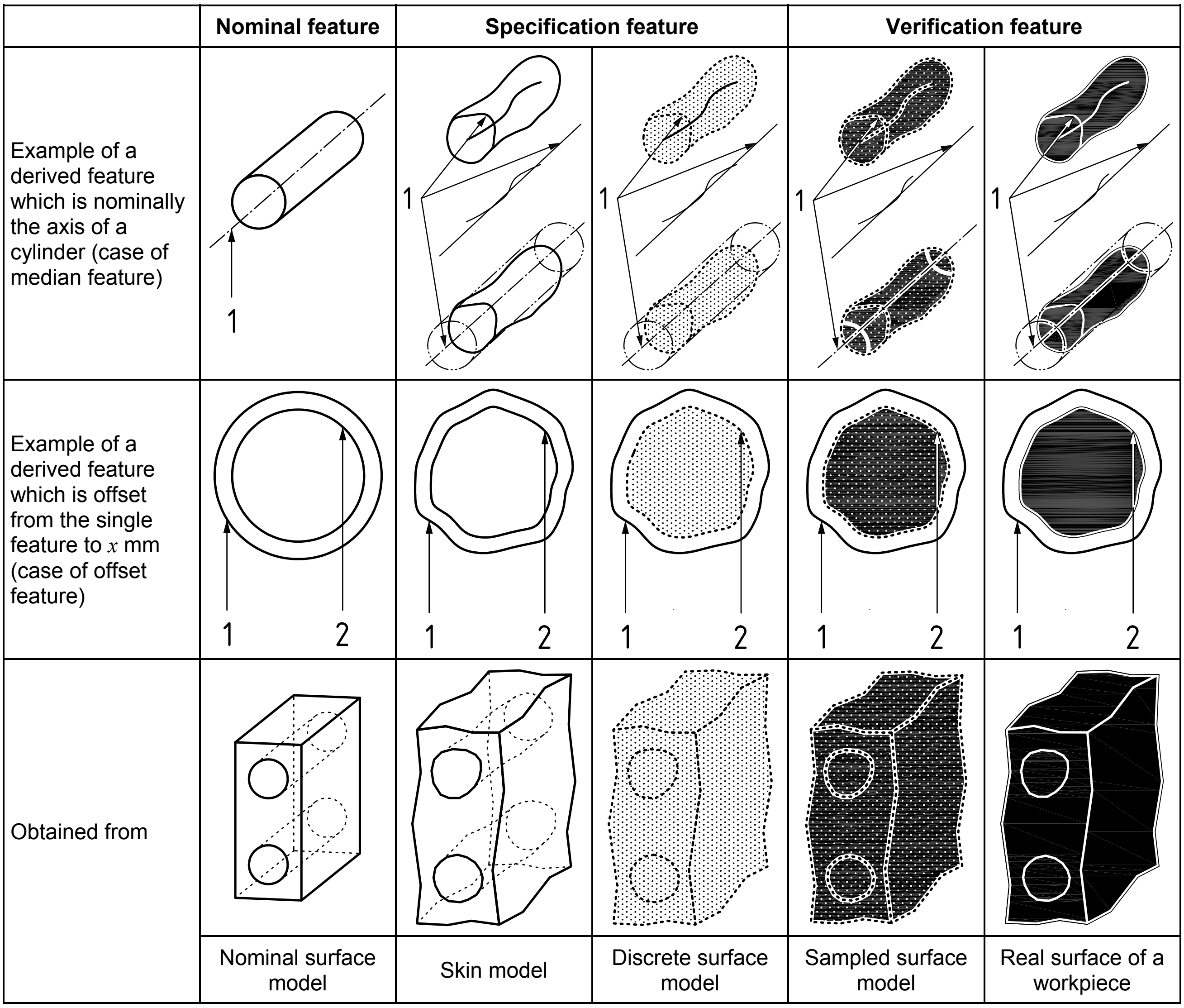
NOTE 2 A derived feature is non-ideal when it is obtained from a non-ideal feature. It is ideal when it is obtained from an ideal feature.

NOTE 3 The derived feature is a nominal, specification or verification derived feature, depending on the model from which it is defined.

NOTE 4 The derived feature can be established from a nominal feature, associated feature, or non-ideal feature.

NOTE 5 Integral features and filtered features are used in specifications, as well as features identified from them, such as displaced features and median features (see Figure 21).

EXAMPLE The axis of a nominal cylinder is a nominal derived feature.

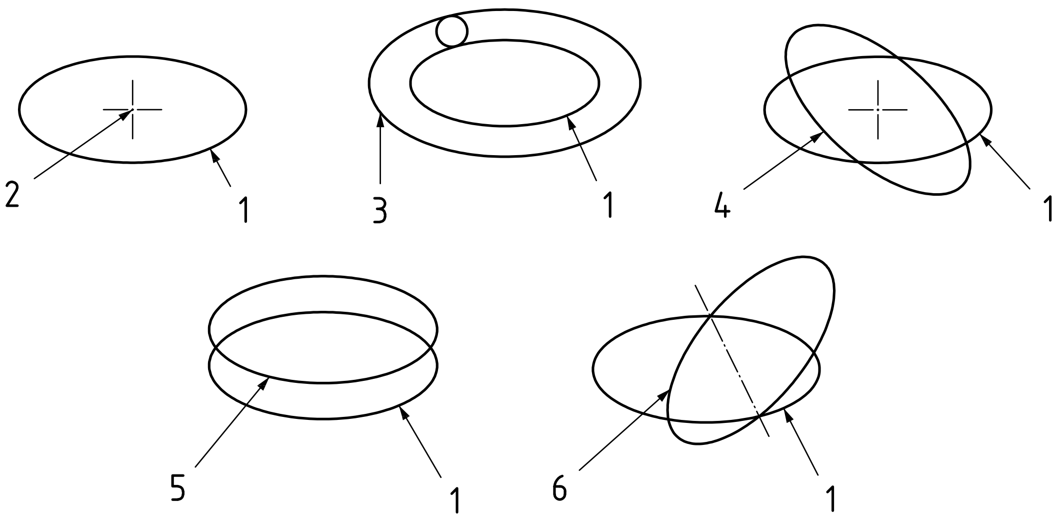


Key

1 derived feature

2 offset of the derived feature

Figure 20 — Example of derived features



Key

1 nominal integral feature
2 nominal median feature
3 nominal offset feature
4 nominal rotated feature
5 nominal translated feature
6 nominal reflected feature

Figure 21 — Illustration of nominal derived feature shown in 2D

3.5.1
median feature
median point, ideal or non-ideal median line or median surface

NOTE 1 A median feature is defined by the construction of a collection of points.

NOTE 2 A median feature is not an integral feature.

NOTE 3 The type of median feature relative to the real workpiece is not necessarily the same as the nominal median feature (see Figure 22). For example:

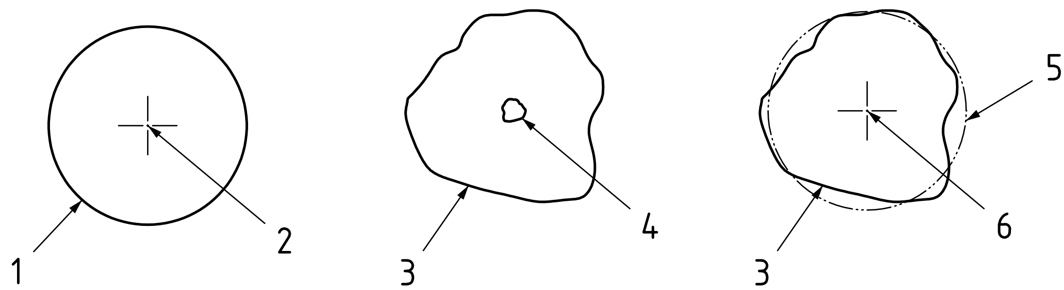
— a median feature, which is nominally a line, may be seen on the workpiece as a line or a surface;

— a median feature, which is nominally a point, may be seen on the workpiece as a point, a line or a surface.

NOTE 4 Median features are defined from "local symmetry centres". They are defined in order to specify permissible deviations on symmetry features.

NOTE 5 A median feature is not always a situation feature (e.g. the median feature of a torus, which is not the "line and point" situation feature).

NOTE 6 A median feature can be ideal or non-ideal.



Key

1 nominal integral line
2 nominal median point
3 non-ideal integral line
4 non-ideal median line (each point of the median line is defined as the centre of the two opposite points)
5 associated line
6 directly associated median point

Figure 22 — Example of type changing related to a median feature

3.5.1.1
median surface
nominal median surface, non-ideal median surface, indirectly associated median surface or directly associated median surface

See Figure 23.

3.5.1.1.1
nominal median surface
surface consisting of a set of an infinite number of centres of the point pairs of the nominal integral surface(s)

See Figure 23.

3.5.1.1.2
non-ideal median surface
surface consisting of a set of an infinite number of centres of the point pairs of the non-ideal integral or filtered surface(s)

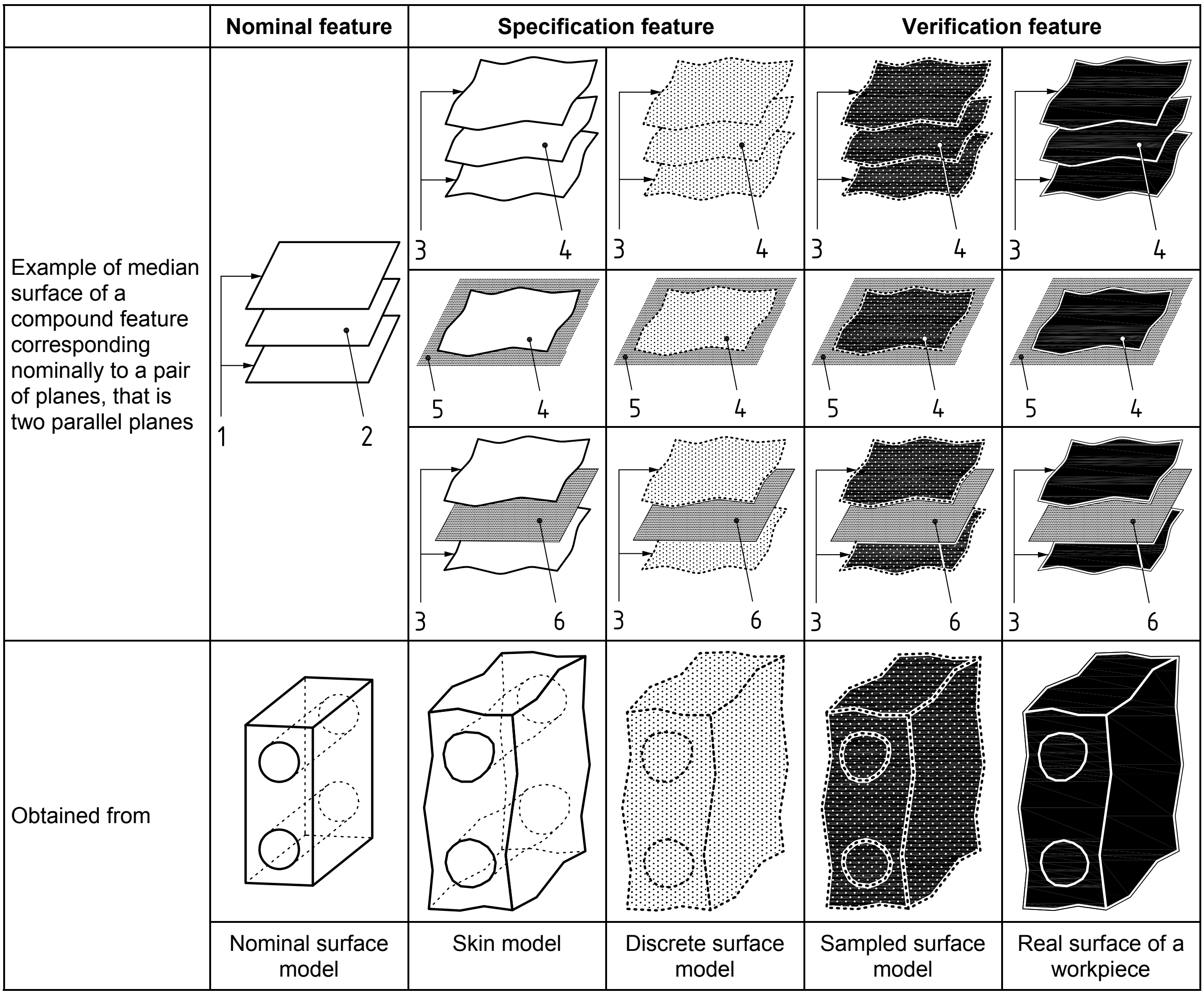
See Figure 23.

3.5.1.1.3
indirectly associated median surface
substitute feature of the non-ideal median surface

See Figure 23.

3.5.1.1.4
directly associated median surface
surface consisting of a set of an infinite number of centres of the point pairs of the substitute surface(s)

See Figure 23.



Key

1 nominal pair of surfaces

2 nominal median surface

3 non-ideal pair of surfaces

4 non-ideal median surface

5 indirectly associated median surface

6 substitute surface

Figure 23 — Example of median surfaces

3.5.1.2
median line
nominal median line, non-ideal median line, indirectly associated median line or directly associated median line

See Figure 24.

3.5.1.2.1
nominal median line
line consisting of a set of an infinite number of section centres or centres of point pairs of the nominal integral surface(s) or line(s)

See Figure 24.

3.5.1.2.2
non-ideal median line
line consisting of a set of an infinite number of section centres or centres of point pairs of the non-ideal integral or filtered surface(s) or line(s)

See Figure 24.

3.5.1.2.3
indirectly associated median line
substitute feature of the non-ideal median line

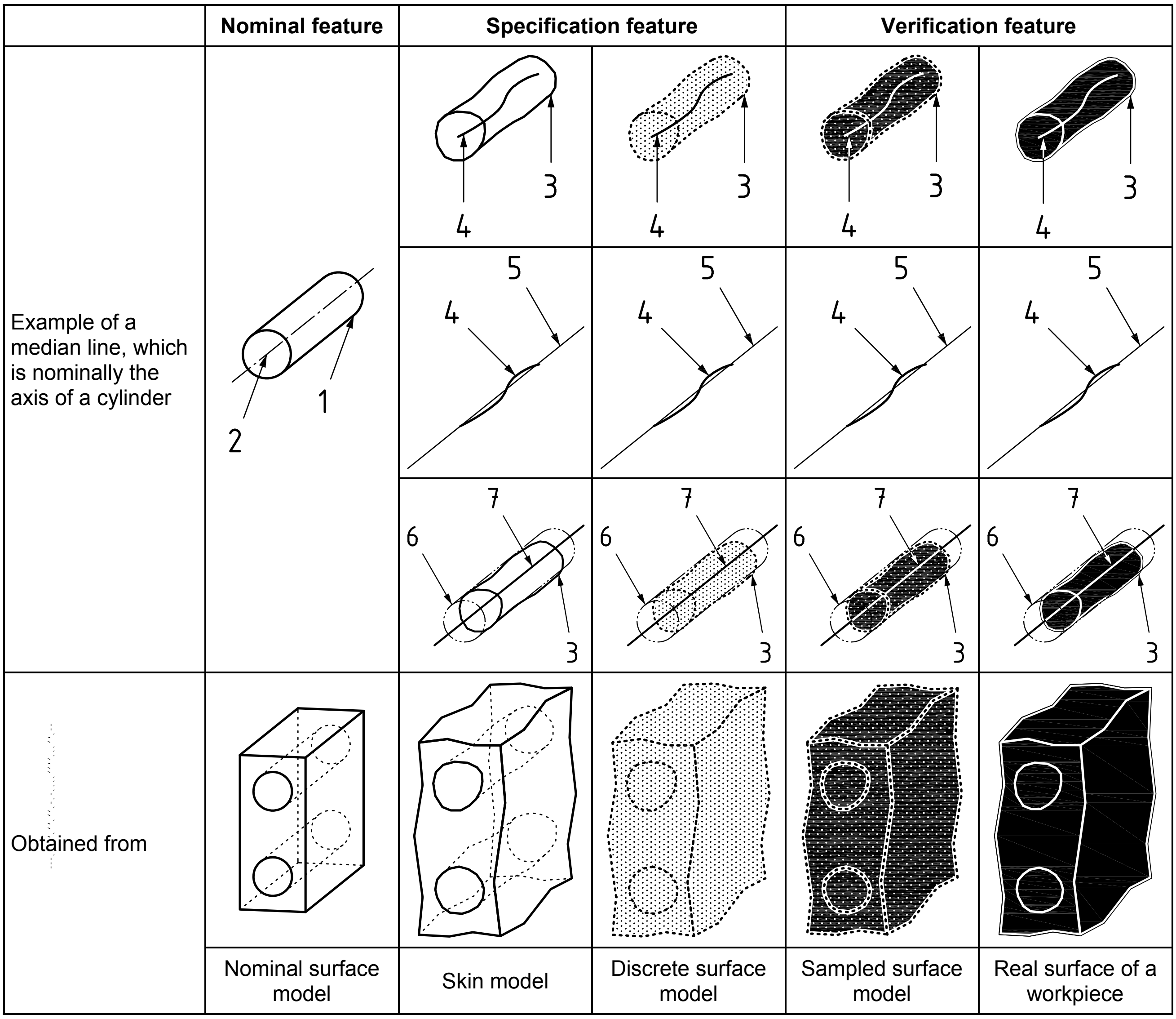
NOTE When an indirectly or directly associated median line is not to be considered as infinite, it is necessary to qualify it as an indirectly or directly associated median-line portion.

See Figure 24.

3.5.1.2.4
directly associated median line
situation feature or feature portion of the substitute feature, of the integral or filtered surface(s) or line(s)

NOTE Line consisting of a set of an infinite number of section centres.

See Figure 24.



Key

1 nominal integral surface
2 nominal median line
3 non-ideal integral surface
4 non-ideal median line
5 indirectly associated median line (substitute line)
6 directly associated integral surface (substitute surface)
7 directly associated median line

Figure 24 — Example of median lines

3.5.1.3
median point
nominal median point, calculated median point or directly associated median point

See Figure 25.

3.5.1.3.1
nominal median point
calculated centre of a point pair or of an infinite number of points of the nominal integral surface(s) or line(s)

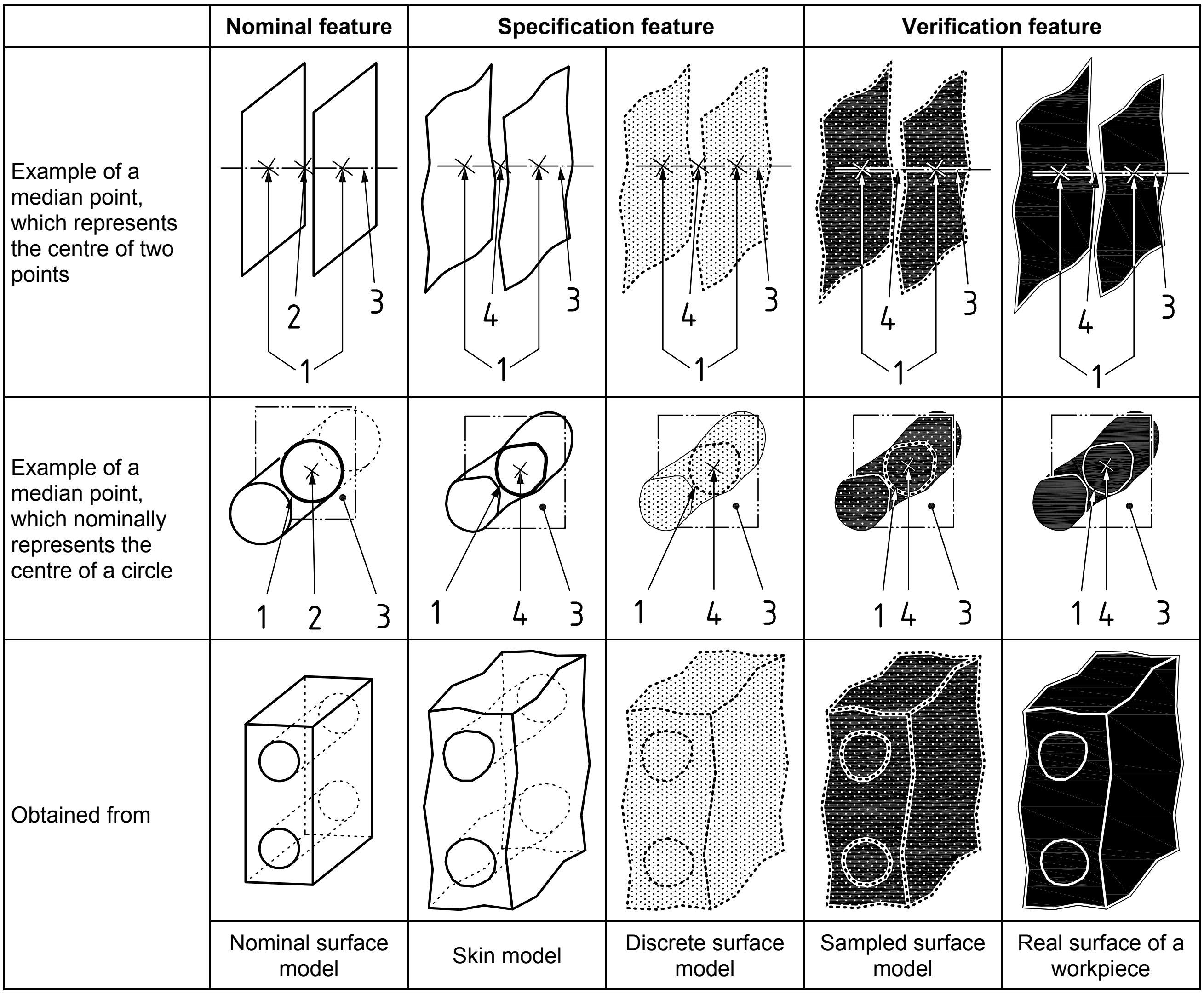
See Figure 25.

3.5.1.3.2
calculated median point
calculated centre of a finite number of points of the non-ideal integral or filtered surface(s) or line(s) or point pair

See Figure 25.

3.5.1.3.3
directly associated median point
calculated centre of a point pair or of an infinite number of points of the substitute surface(s) or line(s)

See Figure 25.



Key

1 integral or filtered feature

2 nominal median point

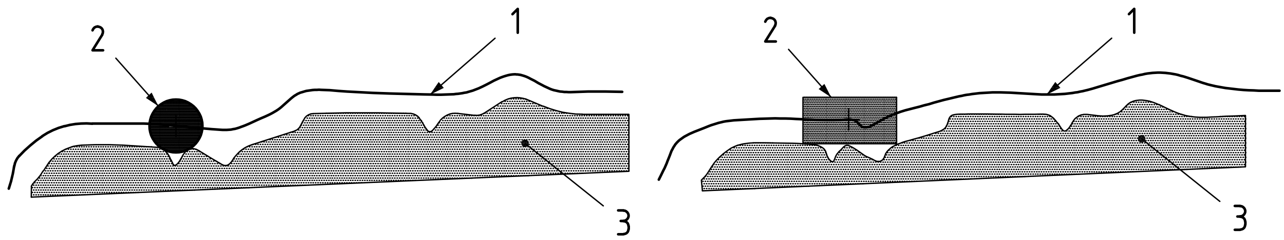
3 section line or section surface

4 calculated median point

Figure 25 — Example of median points

3.5.2
offset feature
displaced line or displaced surface

EXAMPLE See Figure 26.



a) Offset feature obtained using a two-dimensional contact feature which is a disk

b) Offset feature obtained using a two-dimensional contact feature which is a rectangle

Key

1 offset feature

2 contact feature

3 real integral feature

Figure 26 — Example of offset feature

3.5.2.1
offset surface
surface defined by the locus of a predetermined point of a contact feature when traversing in contact with the original surface, in a predefined orientation

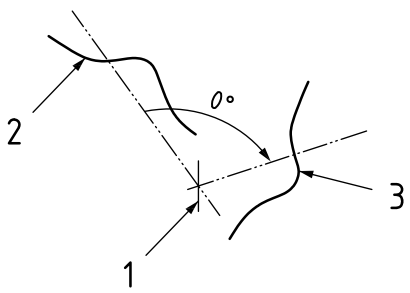
3.5.2.2
offset line
line defined by the locus of a predetermined point of a contact feature when traversing in contact with the original line, in a predefined orientation

3.5.3
congruent feature
rotated feature or translated feature

NOTE A congruent feature can be obtained by an ordered sequence of translated congruent features and rotated congruent features.

3.5.3.1
rotated feature
rotated surface, rotated line or rotated point

See Figure 27.



Key

1 axis of rotation

2 original feature

3 rotated feature

Figure 27 — Illustration of a rotated feature

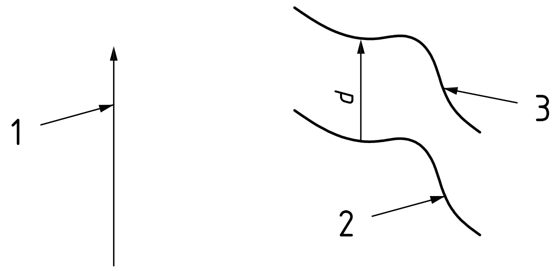
3.5.3.1.1
rotated surface
surface resulting from rotation of a surface by a specified amount about a defined axis

3.5.3.1.2
rotated line
line resulting from rotation of a line by a specified amount about a defined axis

3.5.3.1.3
rotated point
point resulting from rotation of a point by a specified amount about a defined axis

3.5.3.2
translated feature
translated surface, translated line or translated point

See Figure 28.



Key

1 direction of translation

2 original feature

3 translated feature

Figure 28 — Illustration of a translated feature

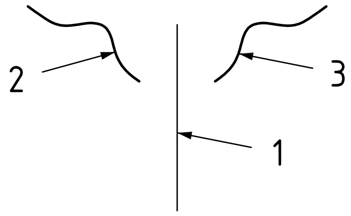
3.5.3.2.1
translated surface
surface resulting from translation of a surface by a specified amount in a defined direction

3.5.3.2.2
translated line
line resulting from translation of a line by a specified amount in a defined direction

3.5.3.2.3
translated point
point resulting from translation of a point by a specified amount in a defined direction

3.5.4
reflected feature
reflected surface, reflected line or reflected point

See Figure 29.



Key

1 reflection plane

2 original feature

3 reflected feature

Figure 29 — Illustration of a reflected feature

3.5.4.1
reflected surface
surface resulting from the reflection of a surface about a defined plane

3.5.4.2
reflected line
line resulting from the reflection of a line about a defined plane

3.5.4.3
reflected point
point resulting from the reflection of a point about a defined plane

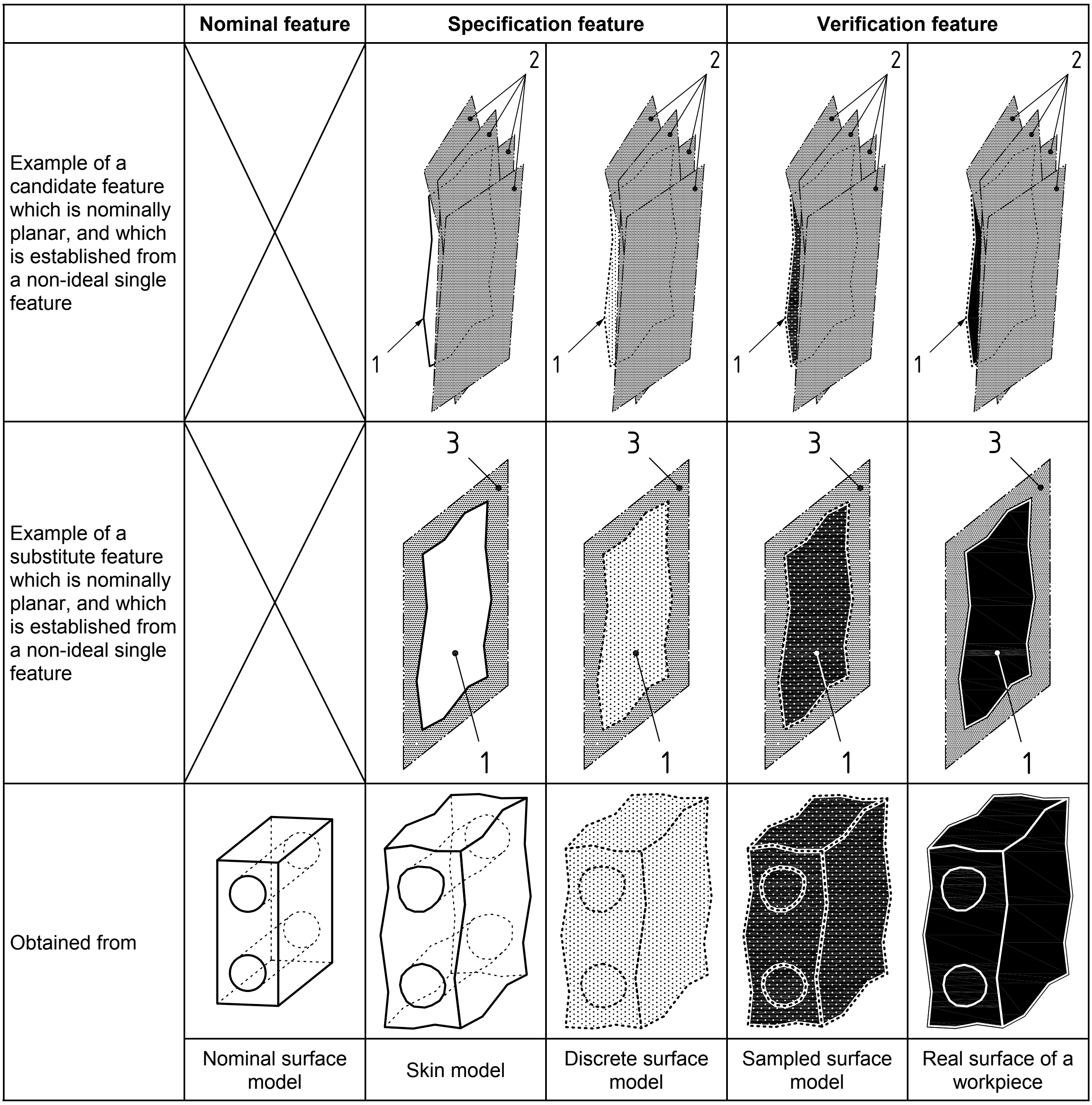
3.6
associated feature
ideal feature or set of ideal features obtained by a series of operations of which association is the final one

NOTE 1 An associated feature may be a substitute feature or a candidate feature.

NOTE 2 An associated feature can be finite or infinite, and by default it is infinite. When finite, it is called an associated feature portion.

NOTE 3 For one geometrical feature, several candidate features can exist, but only one substitute feature.

See Figure 30.



Key

1 non-ideal single feature

2 candidate feature

3 substitute feature

Figure 30 — Example of associated features

3.6.1
candidate feature
any ideal feature, within a set, that satisfies geometrical constraints with respect to a non-ideal feature

NOTE 1 Some examples of geometrical constraints are: outside of the material, inside of the material, tangential.

NOTE 2 Nominal candidate features do not exist.

NOTE 3 The candidate feature is a specification or verification candidate feature, depending on the model from which it is defined (see Figure 30).

NOTE 4 Candidate features are mainly used to model the function of fit between workpieces in an assembly.

NOTE 5 Candidate features represent a set of ideal features satisfying one or more constraints. These constraints concern situation characteristics between the candidate feature and an integral feature. Supplementary constraints with other ideal features may also be defined, to constrain, for instance, the orientation from other associated features.

NOTE 6 The association could be provided from different association criteria, e.g. tangent outside of the material.

NOTE 7 The candidate feature may also be an ideal feature of a type which is different from the type of the corresponding nominal feature (e.g. associate a V-block to a sphere).

3.6.2
substitute feature
unique ideal feature which is associated to a non-ideal feature

NOTE 1 The substitute feature can be a specification substitute feature or a verification substitute feature. Nominal substitute features do not exist (see Figure 30).

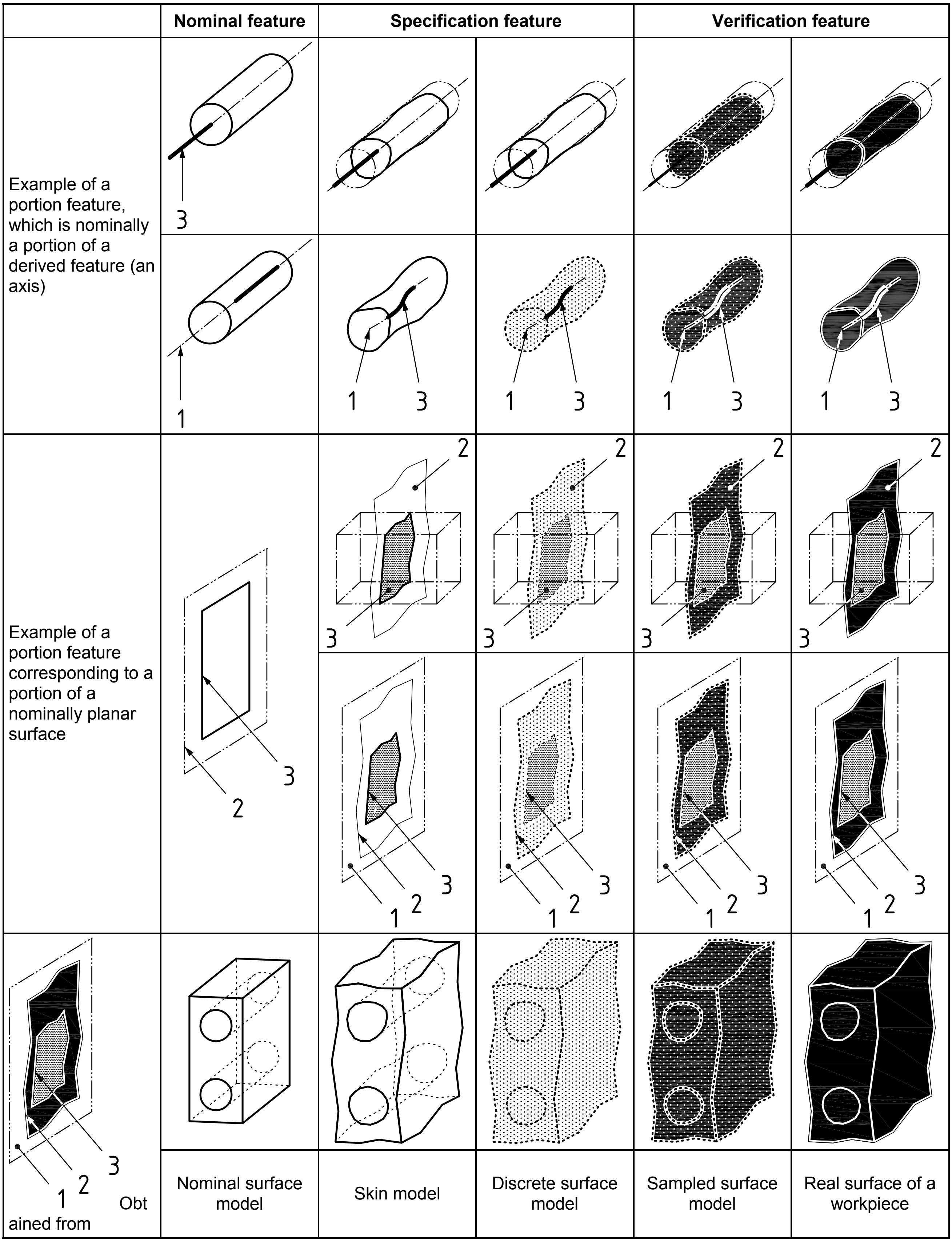
NOTE 2 The association criteria, e.g. least square, Chebyshev, maximum distance minimized, minimum circumscribed and maximum inscribed, used to establish the substitute feature can provide a unique solution.

3.7
feature portion
bounded feature
ideal feature or non-ideal feature contained within a sphere of finite radius

NOTE 1 The ideal feature can be a derived feature, an associated feature or a nominal feature. The non-ideal feature can be a derived feature or an integral feature.

NOTE 2 The feature portion is qualified as a specification or a verification feature portion, depending on the model from which it is defined (see Figure 31).

NOTE 3 Feature portions are defined to enable the specification of a particular part of an ideal feature (e.g. projected features), or of a particular part of a non-ideal feature (e.g. datum target).



Key

1 derived feature

2 nominally planar surface

3 portion feature

Figure 31 — Example of feature portion

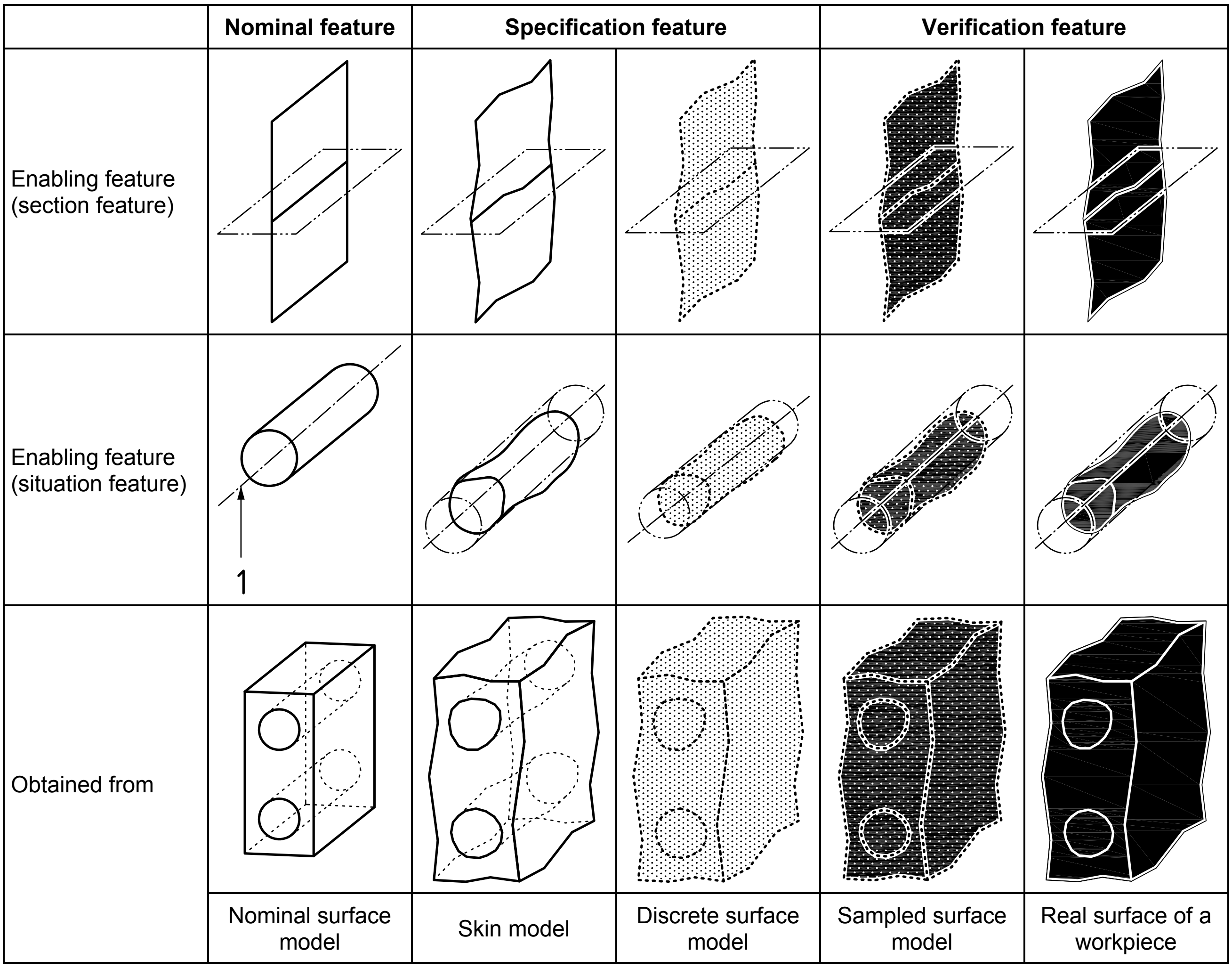
3.8
enabling feature
situation feature or section feature or contact feature

NOTE 1 This is an ideal feature used to enable other features to be built through an operation.

NOTE 2 An enabling feature is used in the operations of filtration, construction or partition.

NOTE 3 An enabling feature can be an axis of a cylinder, a section plane, axis of rotation, direction of translation or reflection plane.

NOTE 4 The enabling feature is a nominal, specification or verification enabling feature, depending on the model from which it is defined (see Figure 32).



Key
1 situation feature

Figure 32 — Example of enabling features

3.8.1
section feature
section volume, section surface or section line

NOTE 1 A section feature can be used for partitioning.

NOTE 2 A section feature is an ideal feature which facilitates the definition of an integral feature or a feature portion.

3.8.1.1
section volume
volume defined by a set of one or more ideal features, used to define a feature portion

See Figure 33.

NOTE A section volume is a portion of space identified by limits. These limits are ideal surfaces created from ideal features.

a) Cylindrical section volume, perpendicular to the axis of a cylinder **b) Section volume limited by a ruled surface**

Key

1 integral feature

2 section volume

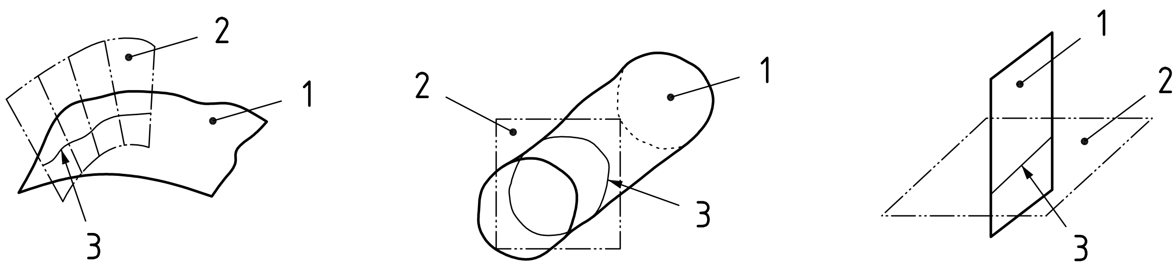
3 surface portion (resulting)

Figure 33 — Example of section volumes

3.8.1.2
section surface
surface defined by a set of one or more ideal features, used to define an integral line or line pair

See Figure 34.

NOTE A section surface is created from ideal feature(s).



a) Section surface of ruled type **b) Section plane of a cylinder** **c) Section plane of a plane**

Key

1 integral feature

2 section surface

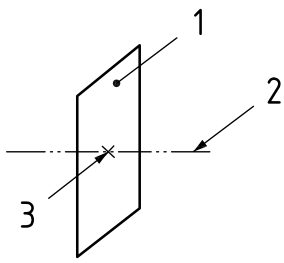
3 line portion (resulting)

Figure 34 — Examples of section surfaces

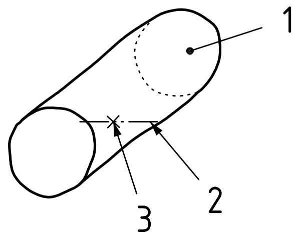
3.8.1.3
section line
straight line used to define an integral point or a point pair

See Figure 35.

NOTE A section line is an ideal line created from ideal feature(s).



a) Section line of straight line type, perpendicular to a plane



b) Section line of straight line type, perpendicular to a cylinder

Key

1 integral feature

2 section line

3 integral point (resulting)

Figure 35 — Examples of section lines

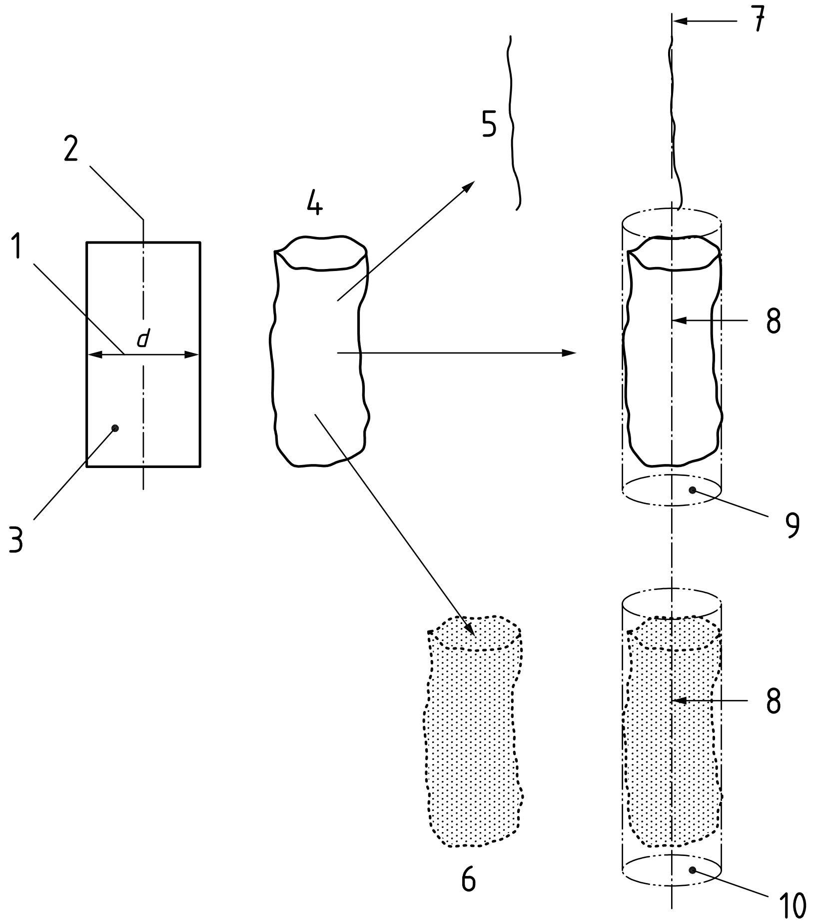
3.8.2
contact feature
ideal feature of finite extent simulating the possible contact interfaces with a workpiece or one surface model of it and for which the set of its attributes and contact constraints are predefined

4 Relations between the geometrical feature terms

To characterize or describe a feature compared to itself or to another feature, different approaches are conceivable. These allow, for example, to consider an ideal geometry or non-ideal geometry, to consider the skin or its skeleton, to consider a number of more or less tightly packed points on the workpiece surface. These slight differences call for particular terms generically defined in this International Standard and illustrated in Figures 36 and 37.

Tables 2 and 3 give the possible relation between terms related to geometrical features.

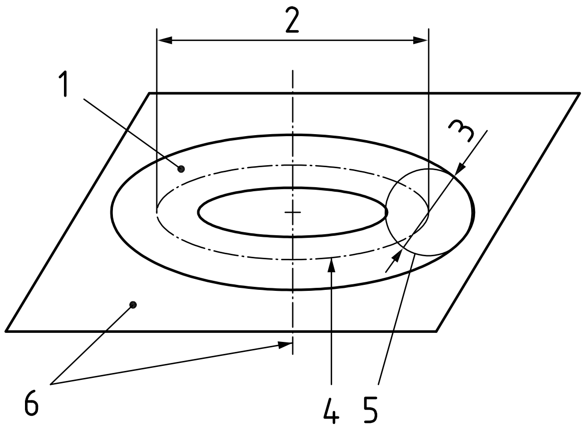
Table 4 shows the attributes of a geometrical feature, which are illustrated in Figure 36.



Key

1 size of the feature of size
2 nominal median feature
3 nominal integral surface
4 non-ideal model of surface representing the real surface of the workpiece
5 non-ideal median feature
6 integral extracted surface (non-ideal)
7 extracted median line
8 directly associated median feature
9 directly associated feature (from the non-ideal integral feature)
10 directly associated feature (from the extracted integral feature)

Figure 36 — Relations between definitions of geometrical features



Key

1 integral nominal surface: a torus
2 other dimensional parameter of the torus
3 size of the torus
4 skeleton
5 generatrix of the torus
6 situation features of the torus (straight line and perpendicular plane, or straight line and particular point of the straight line: this point corresponds to the intersection of a plane and a line)

Figure 37 — Relation between definitions of attributes of an ideal feature

Table 2 — Term relations between integral feature and derived feature

		Integral feature		Derived feature				
		Non-filtered	Filtered	Median	Congruent			Offset
					Translated	Rotated	Reflected	
Real workpiece	Real	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Surface model	Nominal	Applicable	Non-applicable					
	Non-ideal	Applicable	Applicable	Not relevant				
	Discrete	Applicable	Applicable					
	Sampled	Applicable	Applicable					
Extent of the feature	Infinite	Non-applicable	Non-applicable	Applicable	Applicable	Applicable	Applicable	Applicable
	Complete/total	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
	Restricted	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Representation of the feature	Extract	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
	Non-extract	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Composition of the feature	Single	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
	Compound	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
	Pair	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Use of the feature	Specification	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
	Verification	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Nature of the feature	Surface	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
	Line	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
	Point	Applicable	Forbidden	Applicable	Applicable	Forbidden	Applicable	Forbidden

Table 3 — Geometrical feature and other types of features

Geometrical feature		Non-ideal		Ideal				
		Non-filtered	Filtered	Nominal	Associated			Calculated
					Substitute		Candidate	
					Directly associated	Indirectly associated		
Nature of the feature	Integral	Applicable	Applicable	Applicable	Applicable	Non-applicable	Applicable	Non-applicable
	Derived	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Extent of the feature	Infinite	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Non-applicable
	Complete/total	Applicable	Applicable	Applicable	Non-applicable	Non-applicable	Applicable	Applicable
	Restricted	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable

Table 4 — Feature attributes

Geometrical definition of the feature relating to the feature form			Attribute of an ideal feature	
			Dimensional feature	Non-dimensional feature
Dimensional parameters	Yes	Size	Applicable	Non-applicable
		Other?	Applicable	Applicable
	No		Applicable	Applicable
Situation feature	Point		Applicable	Applicable
	Line		Not relevant	Applicable
	Plane			Applicable
	Helix			Applicable
Feature skeleton			Applicable	Applicable
Composition of the feature	Single		Applicable	Applicable
	Compound		Applicable	Applicable
	Pair		Applicable	Applicable

Annex A
(normative)

Overview diagram

This annex shows the link between the real workpiece and its representation (surface models). Geometrical features are built from surface models. Geometrical features cover different types of features and subtypes of features. Relationships between the real surface of the workpiece and its surface models are illustrated in Figures A.1 to A.6.

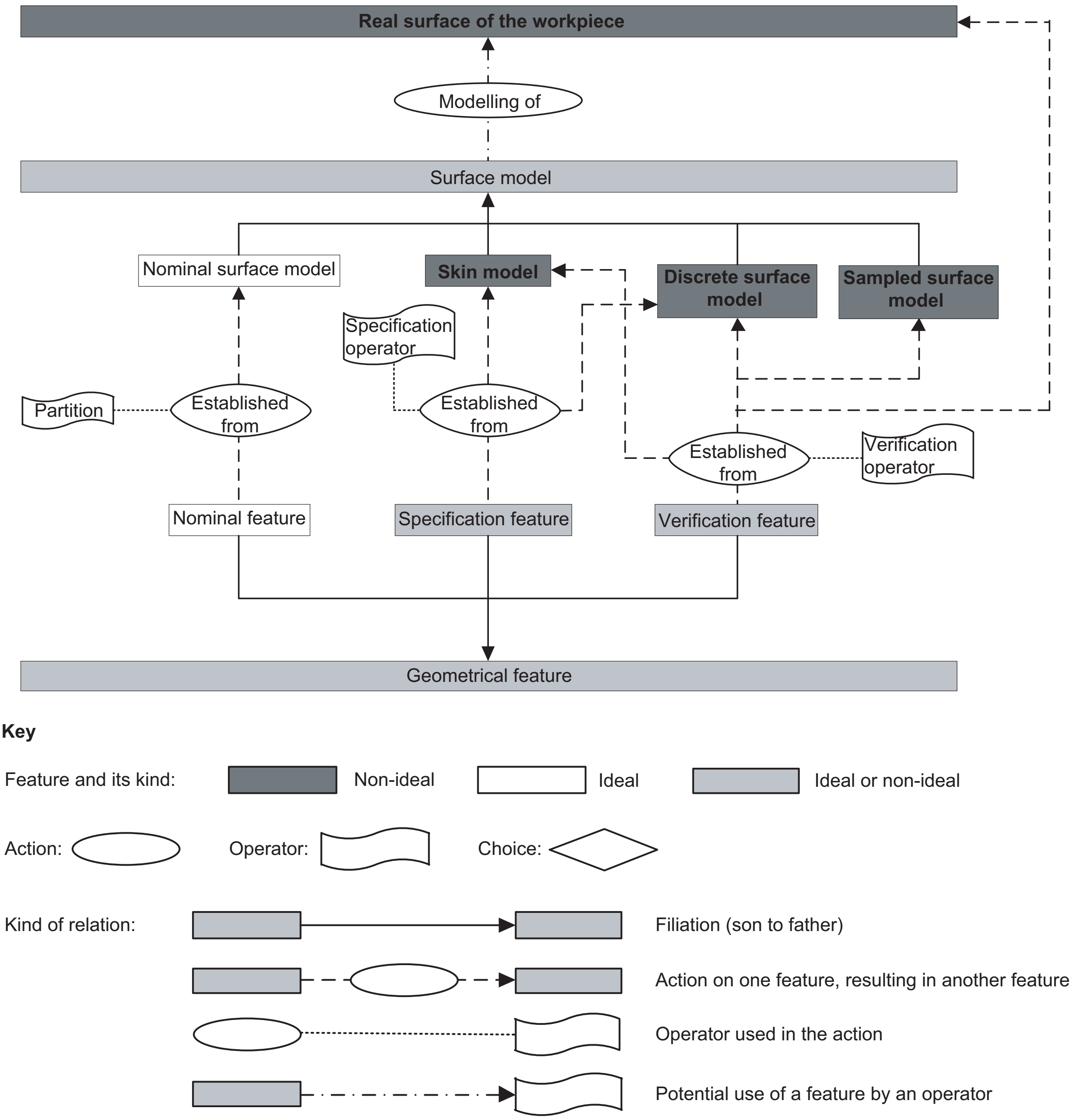


Figure A.1 — Relationship between the surface models and a geometrical feature

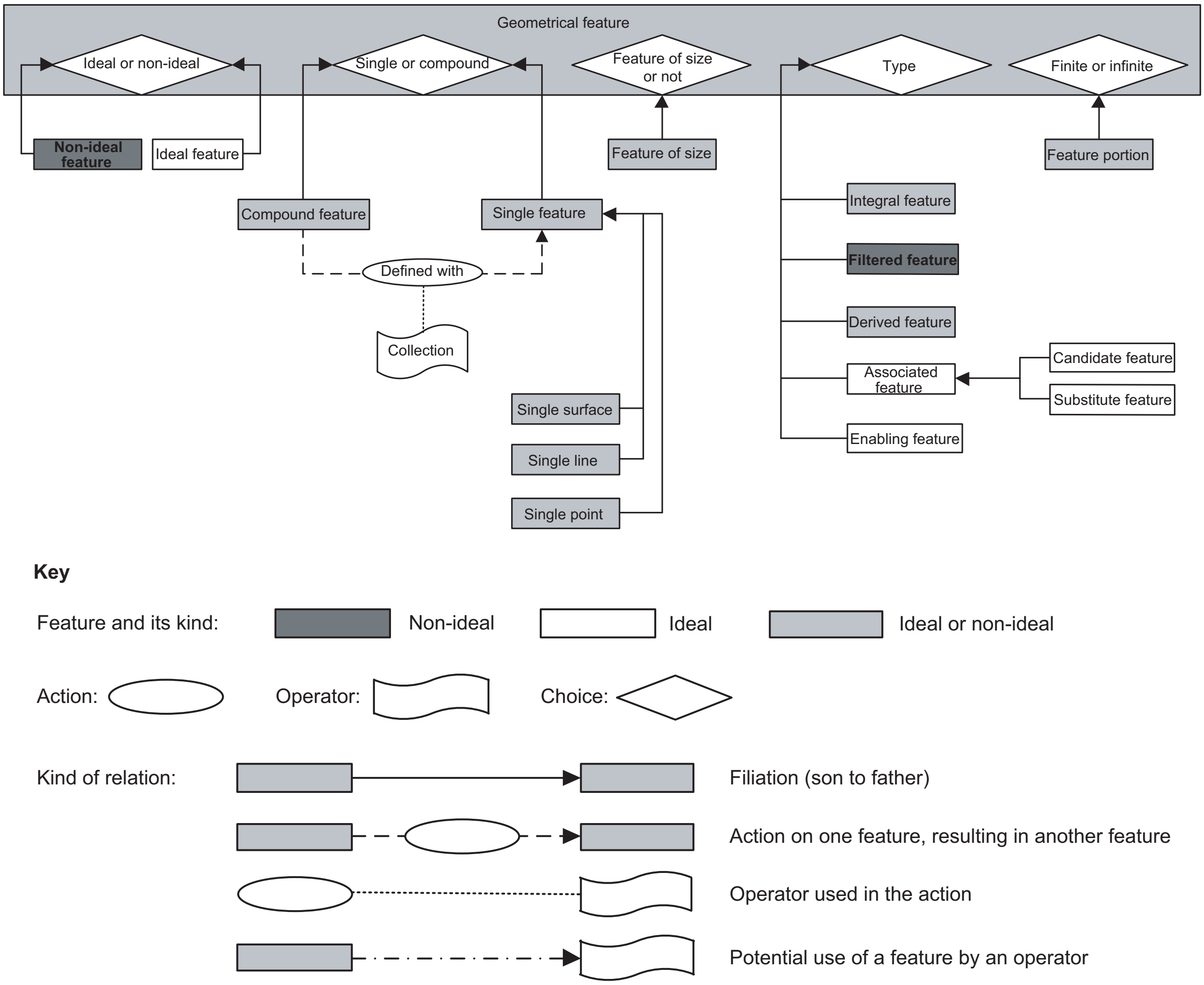


Figure A.2 — Attributes of a geometrical feature and types of feature

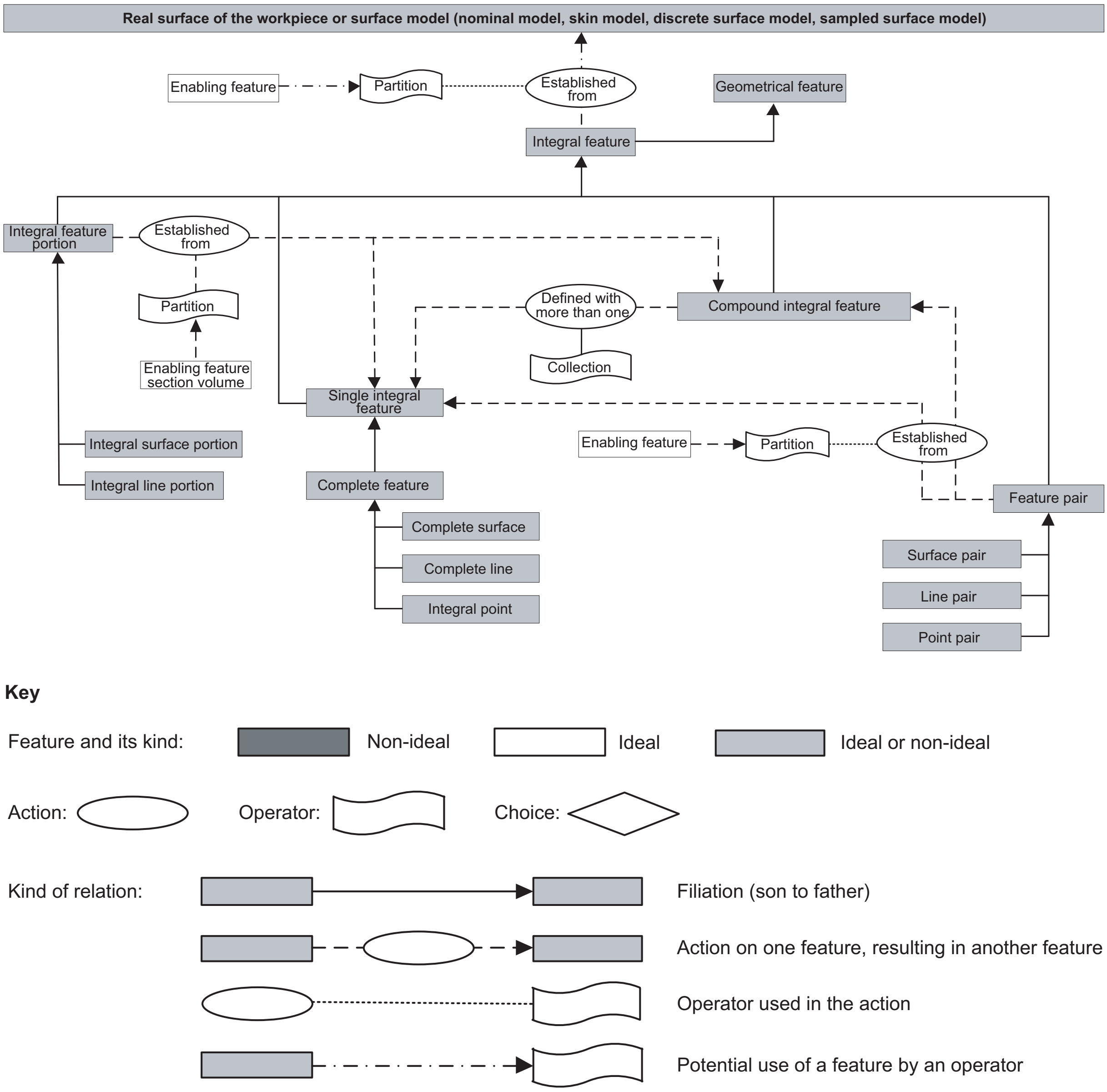


Figure A.3 — Integral features

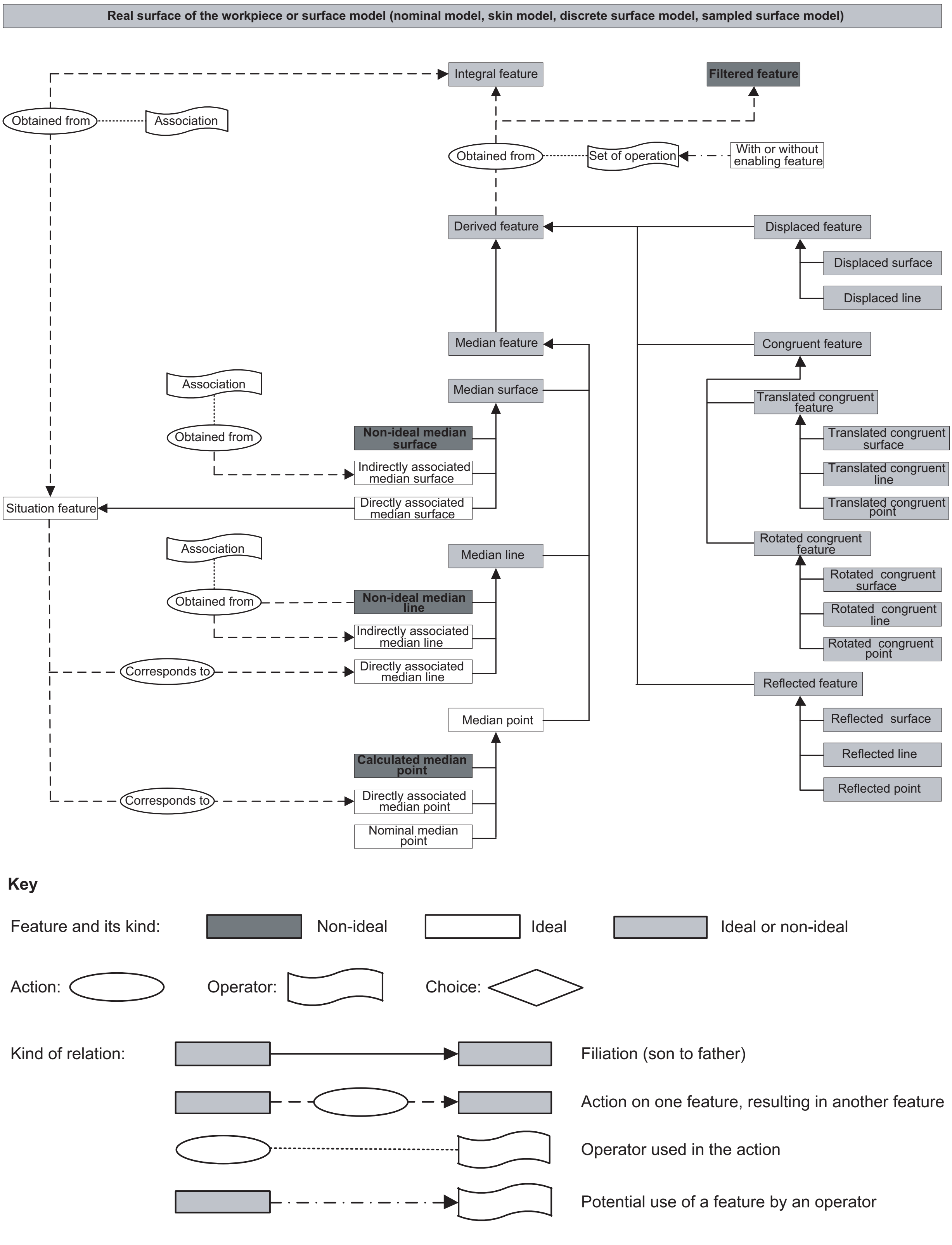


Figure A.4 — Derived features

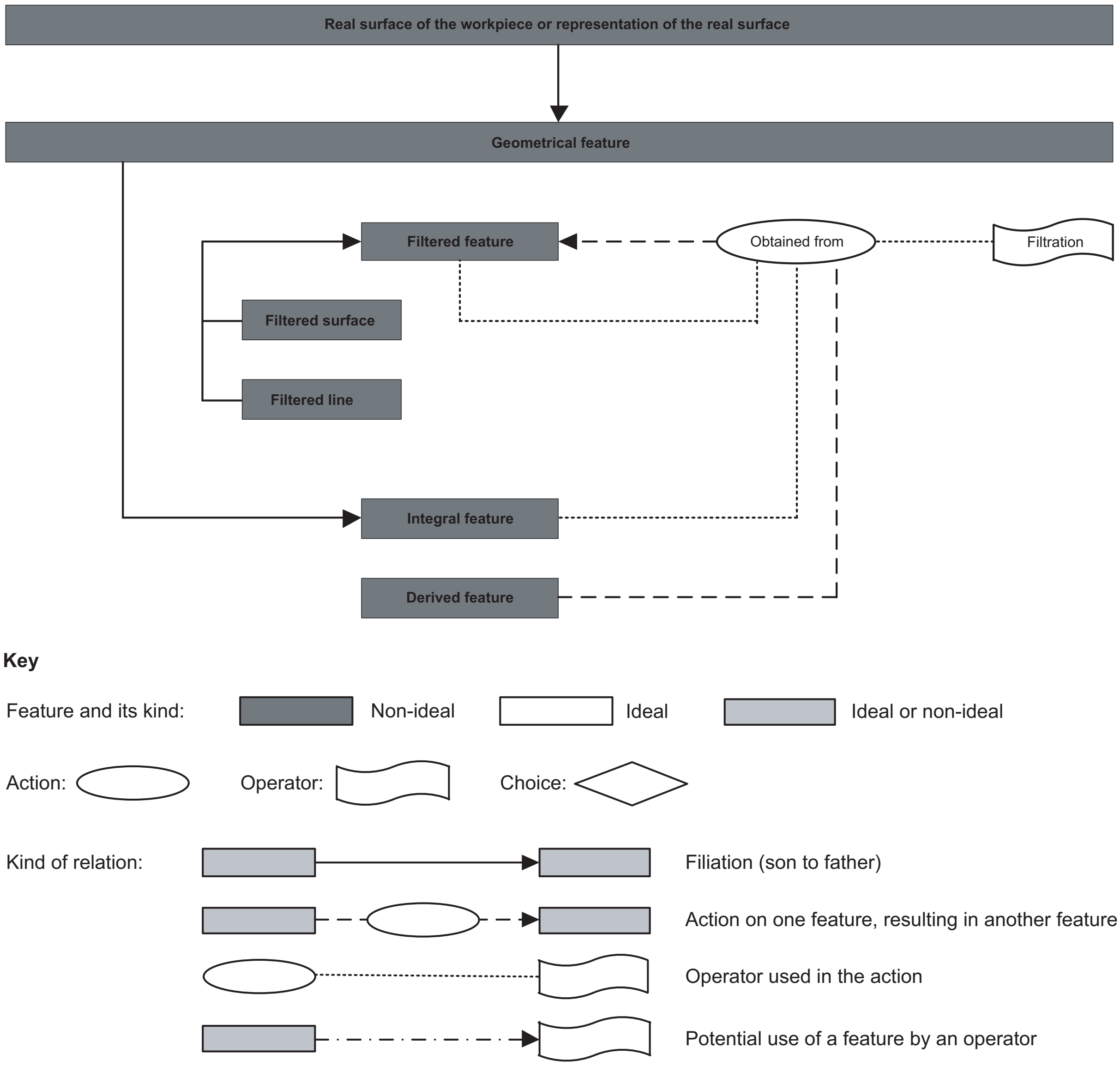


Figure A.5 — Filtered features

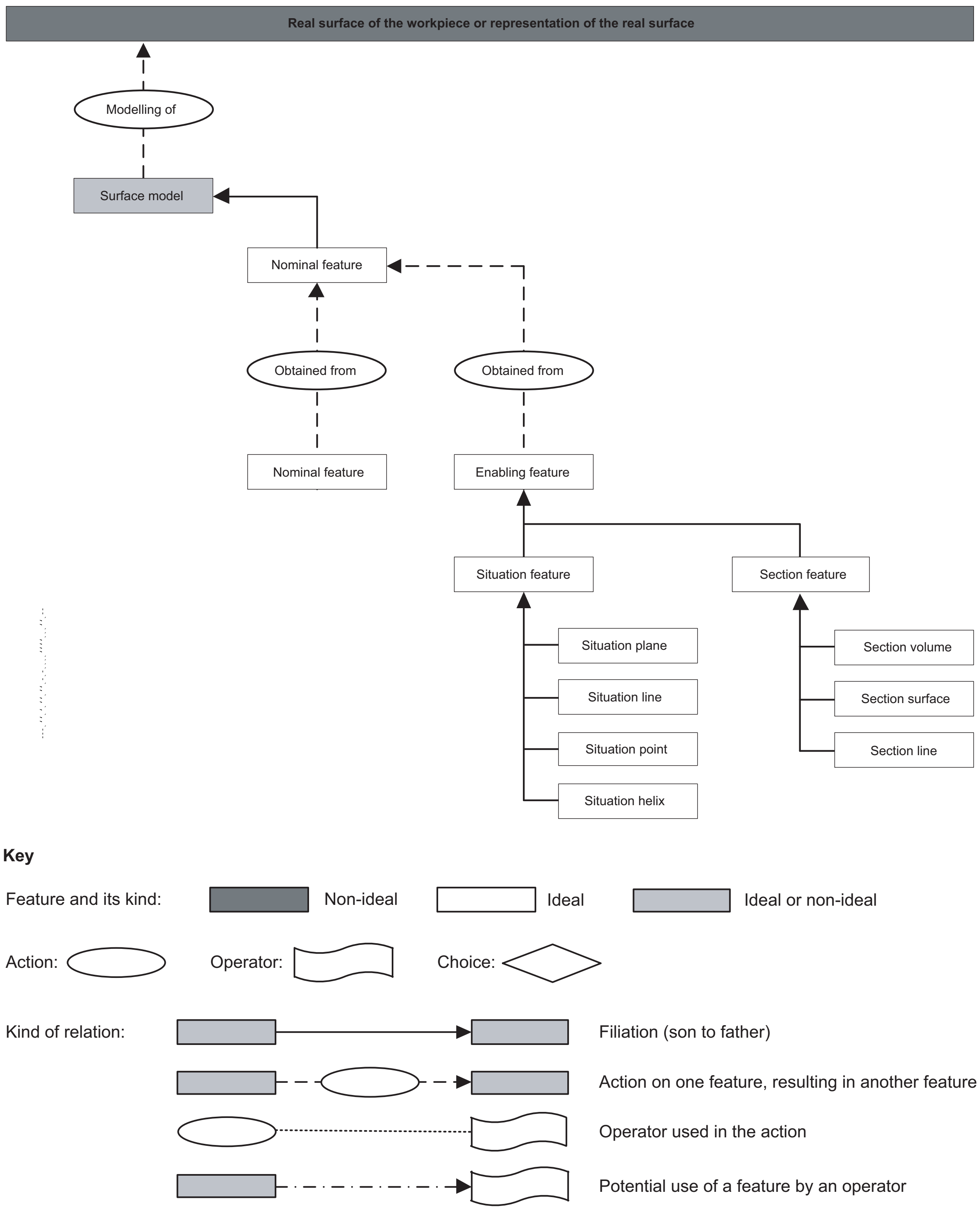
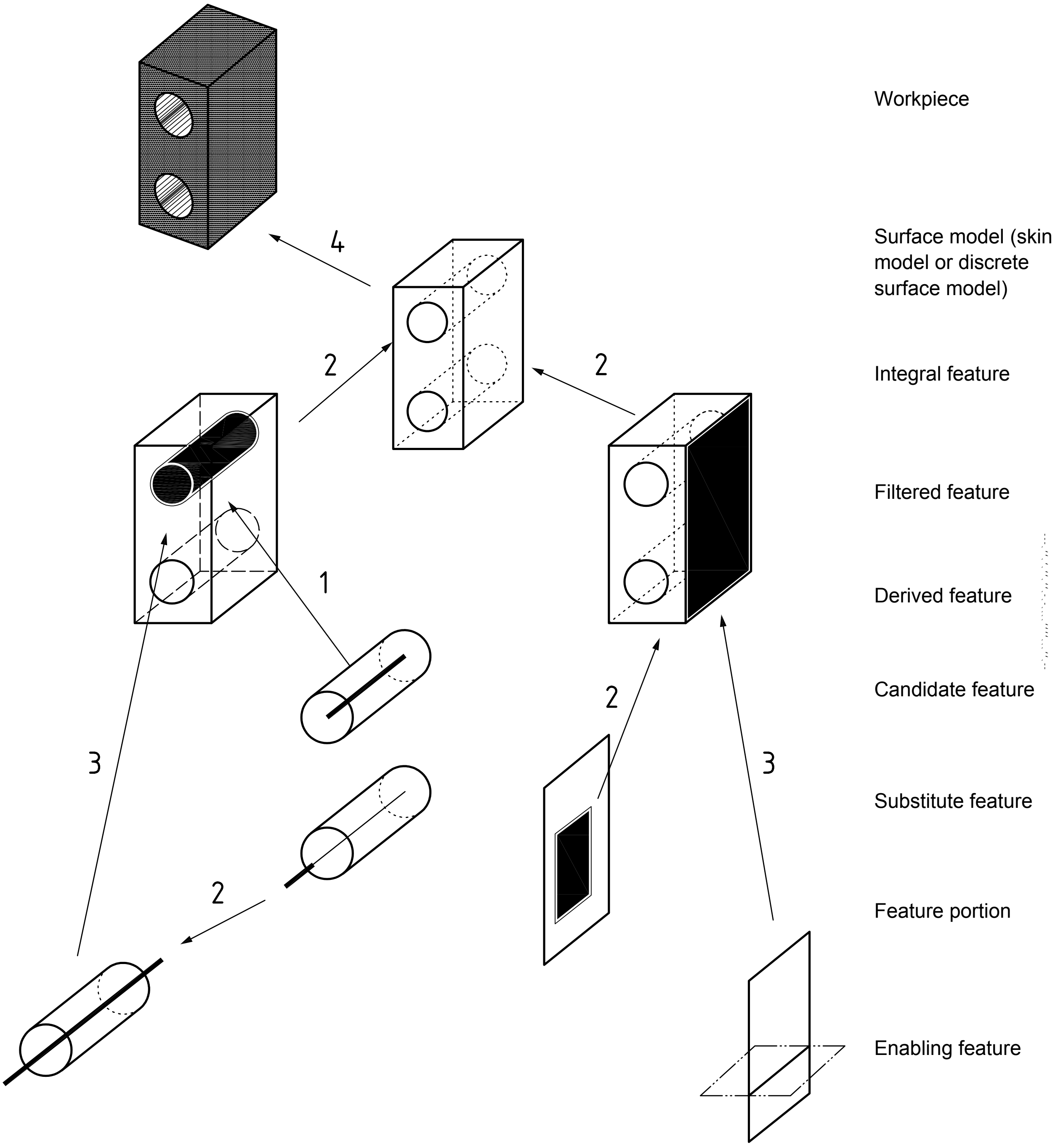


Figure A.6 — Enabling features

Annex B
(informative)

Examples of links between the features

Examples of identification and links of the different types of features are given in Figures B.1 to B.3.



Key

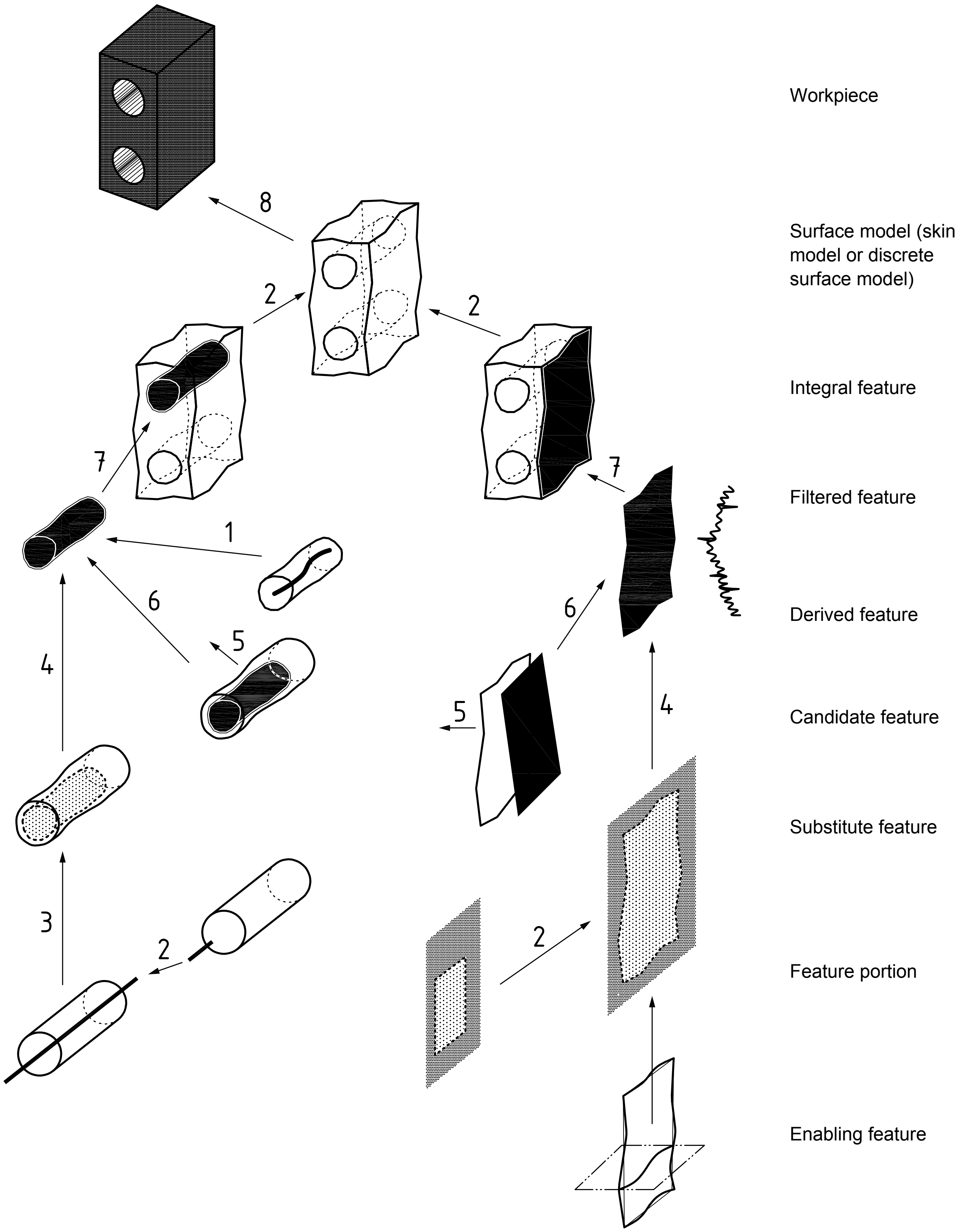
1 set of operations

2 part of

3 locating

4 modelling of

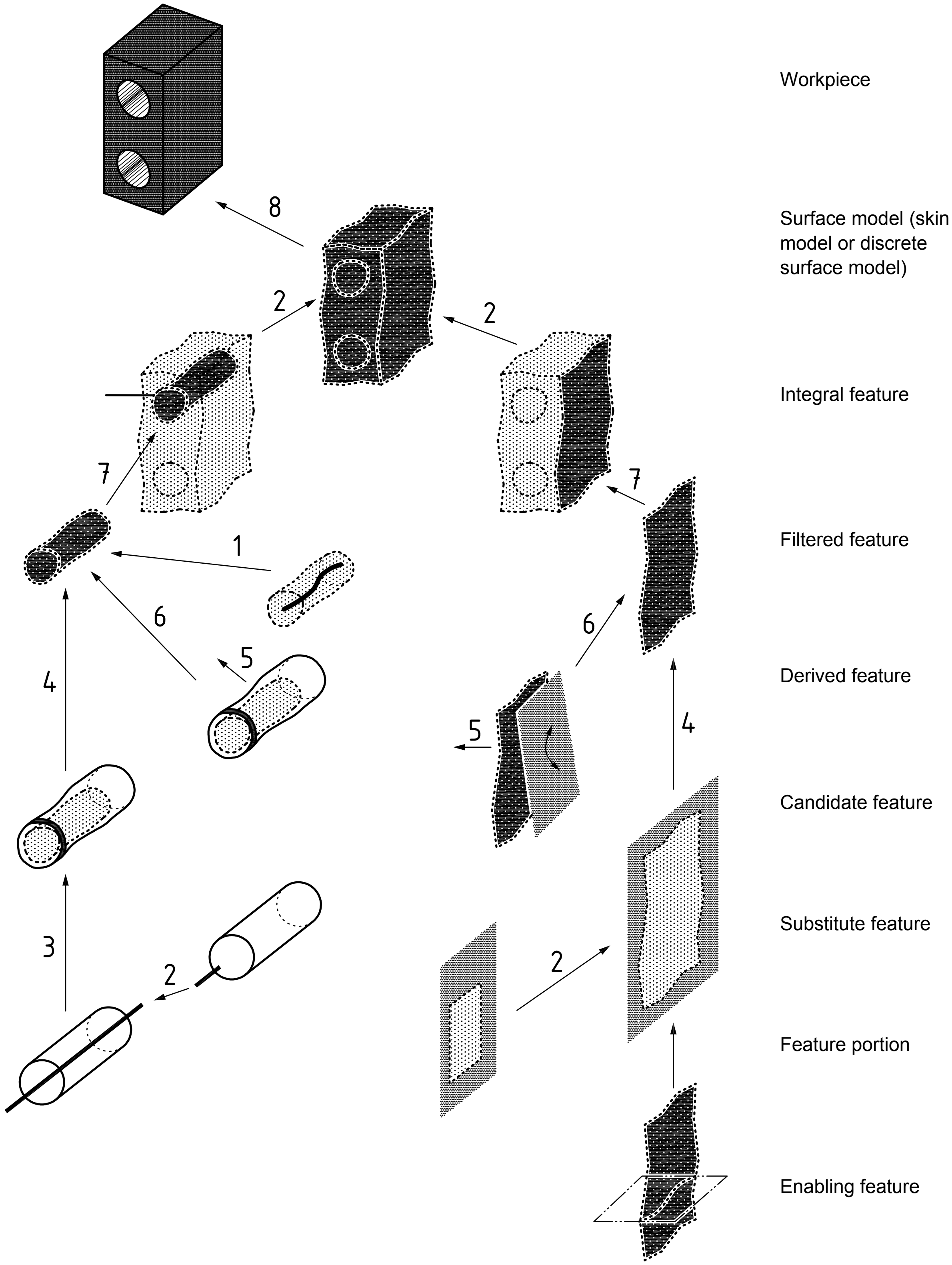
Figure B.1 — Nominal features



Key

1 set of operations
2 part of
3 locating
4 representing
5 material
6 respecting constraint with respect to
7 filtration of
8 non-ideal representation

Figure B.2 — Specification features



Key

1 set of operations
2 part of
3 locating
4 representing
5 material
6 respecting constraint with respect to
7 filtration of
8 measurement

Figure B.3 — Verification features

Annex C
(informative)

Relation to the GPS matrix model

C.1 General

For full details about the GPS matrix model, see ISO/TR 14638.

The ISO/GPS Masterplan given in ISO/TR 14638 gives an overview of the ISO/GPS system of which this document is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this document and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this document, unless otherwise indicated.

C.2 Information about this International Standard and its use

This International Standard defines the general terms and types for the geometrical features used for the geometrical specifications of workpieces.

C.3 Position in the GPS matrix model

This International Standard is a global GPS standard, that influences all the chain links of the chains of standards in the general GPS matrix, as graphically illustrated in Figure C.1.

Fundamental GPS standards

Global GPS standards

General GPS matrix						
Chain link number	**1**	**2**	**3**	**4**	**5**	**6**
Size	X	X	X	X	X	X
Distance	X	X	X	X	X	X
Radius	X	X	X	X	X	X
Angle	X	X	X	X	X	X
Form of line independent of datum	X	X	X	X	X	X
Form of line dependent on datum	X	X	X	X	X	X
Form of surface independent of datum	X	X	X	X	X	X
Form of surface dependent on datum	X	X	X	X	X	X
Orientation	X	X	X	X	X	X
Location	X	X	X	X	X	X
Circular run-out	X	X	X	X	X	X
Total run-out	X	X	X	X	X	X
Datums	X	X	X	X	X	X
Roughness profile	X	X	X	X	X	X
Waviness profile	X	X	X	X	X	X
Primary profile	X	X	X	X	X	X
Surface defects	X	X	X	X	X	X
Edges	X	X	X	X	X	X

Figure C.1 — Position in the GPS matrix model

C.4 Related International Standards

The related International Standards are those of the chains of standards indicated in Figure C.1.

Bibliography

[1] ISO 2692, *Geometrical product specifications (GPS) — Geometrical tolerancing — Maximum material requirement (MMR), least material requirement (LMR) and reciprocity requirement (RPR)*

[2] ISO 8015, *Geometrical product specifications (GPS) — Fundamentals — Concepts, principles and rules*

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[4] ISO/TS 16610-1, *Geometrical product specifications (GPS) — Filtration — Part 1: Overview and basic concepts*

ICS 17.040.01

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