Topology-based naming

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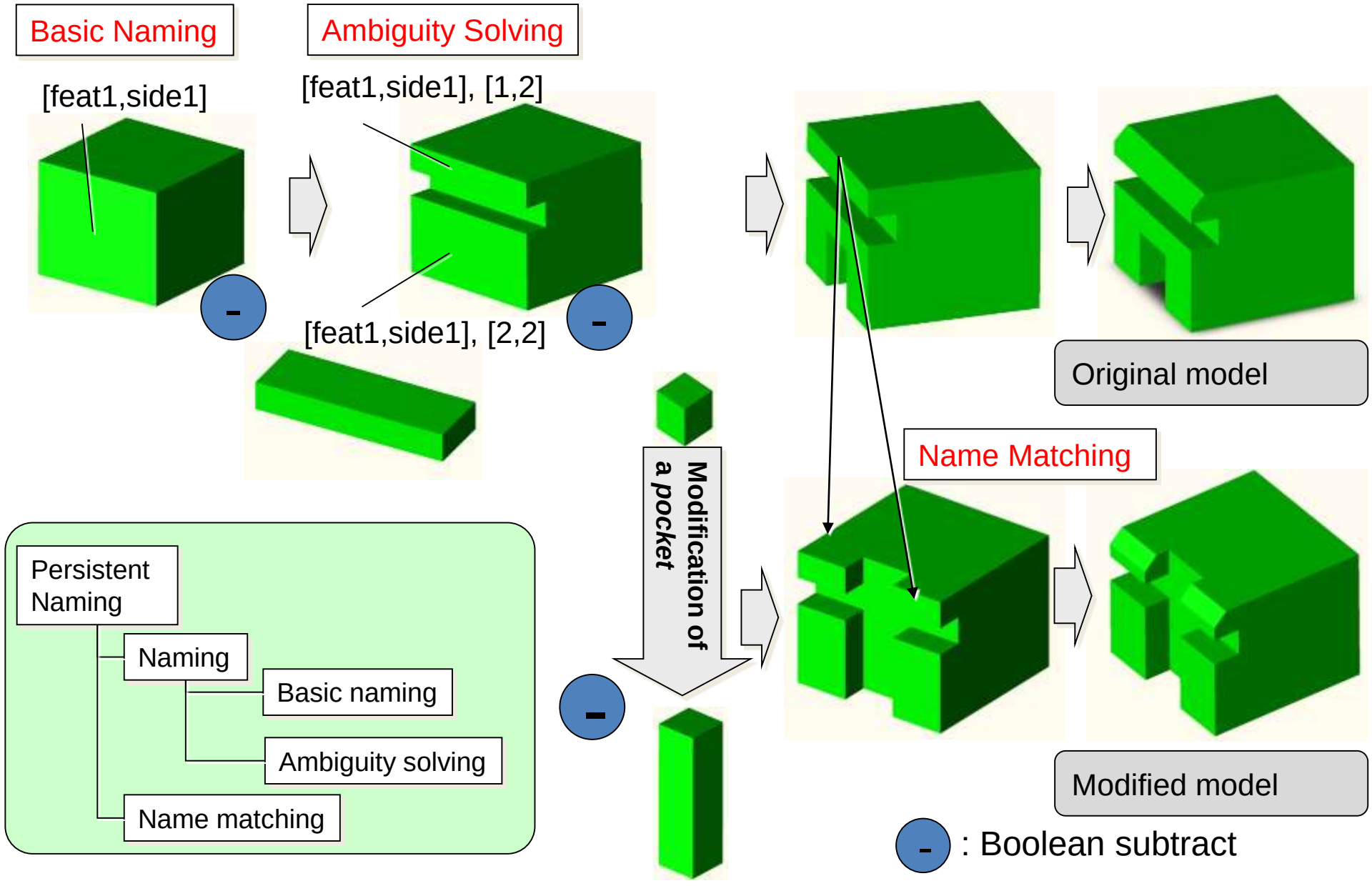
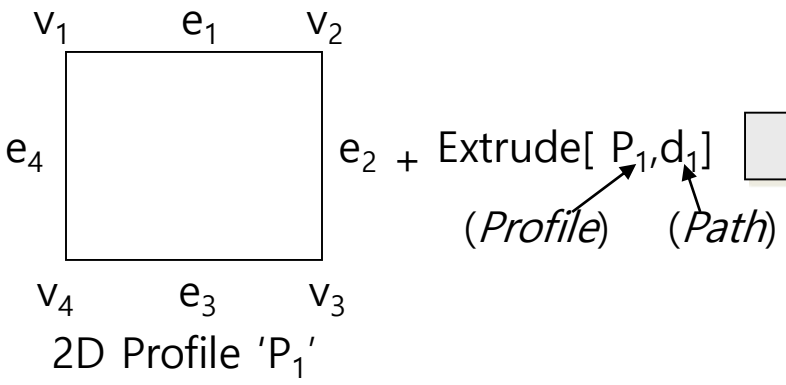
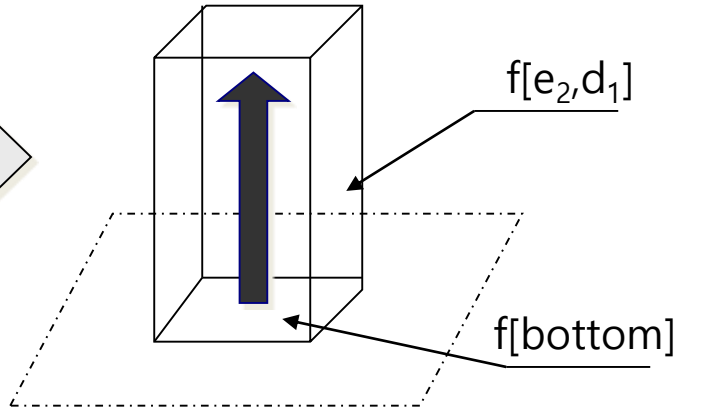
Categories of Persistent naming



Basic naming

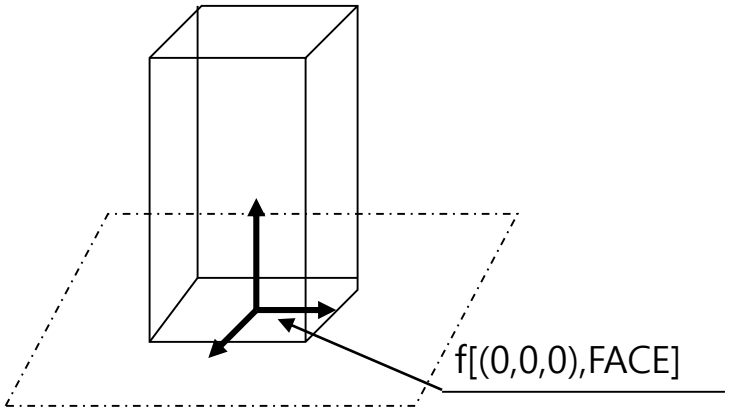
Topology based



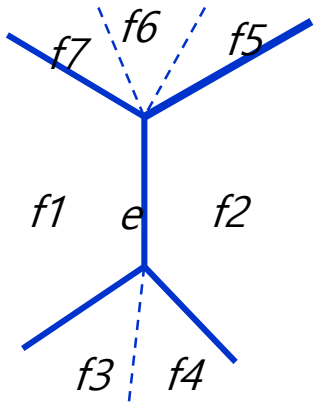


Face naming with profile and path

Geometry base

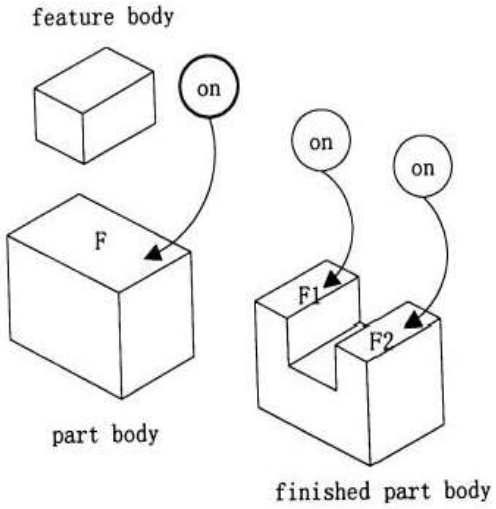


With coordinate values and type

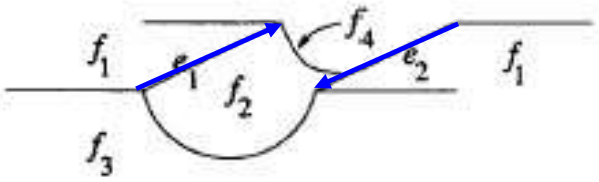


EdgeId(e) = [
adjFaceIds: <*f1*, *f2*>
endFaceIds0: {*f3*, *f4*}
endFaceIds1: {*f5*,*f6*,*f7*}
edgeIntersCode:
kAnyEdgeIntersCode]

Edge naming with adjacent face

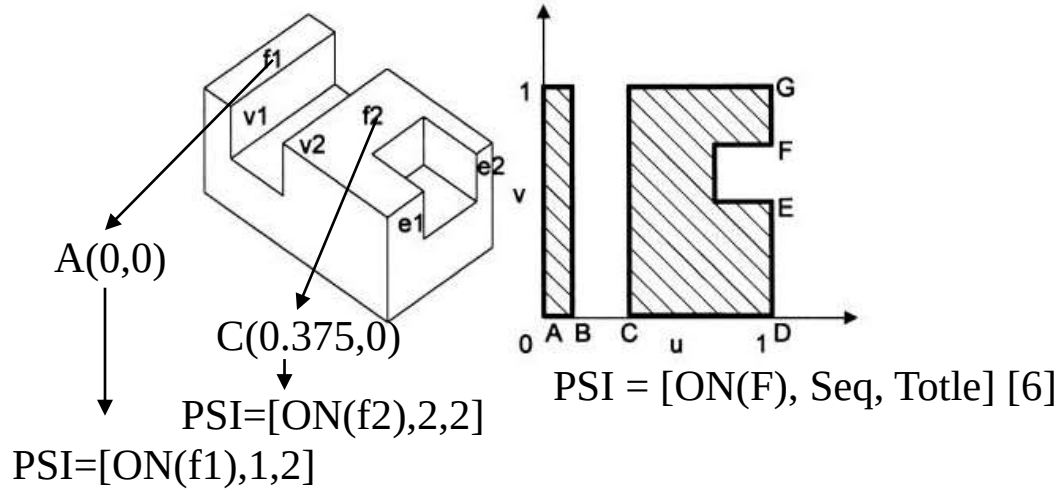


(a) Ambiguity problem [6]



L_{e1} = [f1,f3,f4]
L_{e2} = [f1,f4,f3]

(b) Solving ambiguity based on topological information [4]



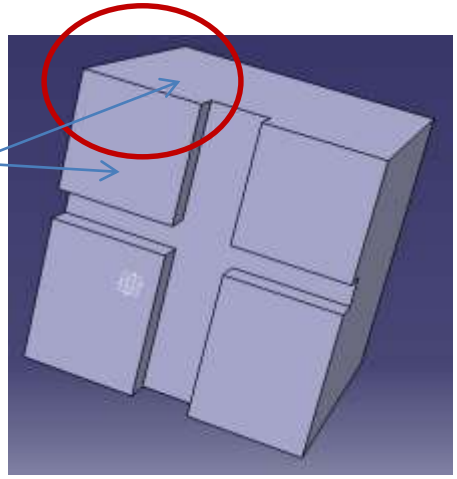
(c) Solving ambiguity based on geometric information

Fig. 4. Solution to ambiguity problem (*Problem 1.1.2*).

Naming method of CATIA V5R18

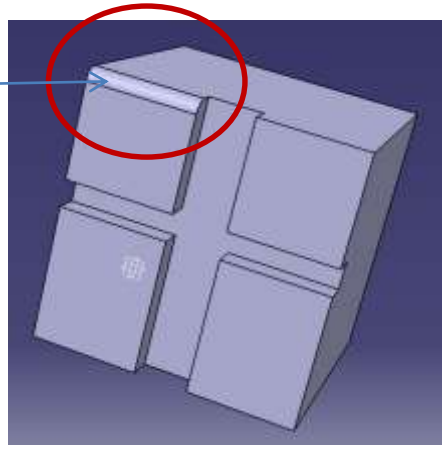
Set reference31 =
part1.CreateReferenceFromBRepName("**REdge**:(Edge:
(Face:(Brp:(Pad.1;0:(Brp:(Sketch.1;6)));
AllPartiallySharedIncluded:
(Brp:(Pocket.2;0:(Brp:(Sketch.3;5)));
Brp:(Pad.1;2);
Brp:(Pad.1;0:(Brp:(Sketch.1;4)));
Brp:(Pocket.1;0:(Brp:(Sketch.2;5))));Cf11:());
Face:(Brp:(Pad.1;2);
None:();Cf11:());
None:(Limits1:();Limits2:());Cf11:());WithTemporaryBody;WithoutB
uildError;WithSelectingFeatureSupport;MFBRepVersion_CXR15)",
pocket2)

Information of adjacent faces



Set reference2 = part1.CreateReferenceFromBRepName("**RSur**:
(Face:(Brp:(EdgeFillet.2_ResultOUT;
(Brp:(Pad.1;2);
Brp:(Pad.1;0:(Brp:(Sketch.1;6)))));
None:();Cf11:());WithTemporaryBody;WithoutBuildError;WithSelec
tingFeatureSupport;MFBRepVersion_CXR15)",
constRadEdgeFillet1)

Information of adjacent faces



Naming method in procedural modeling

1) Persistent naming can be applied to external reference of geometry?

We need to study on document of external reference of geometry, however we think that their purposes are different each other.

→

External reference of geometry: referencing the external geometry (b-rep, CSG…)

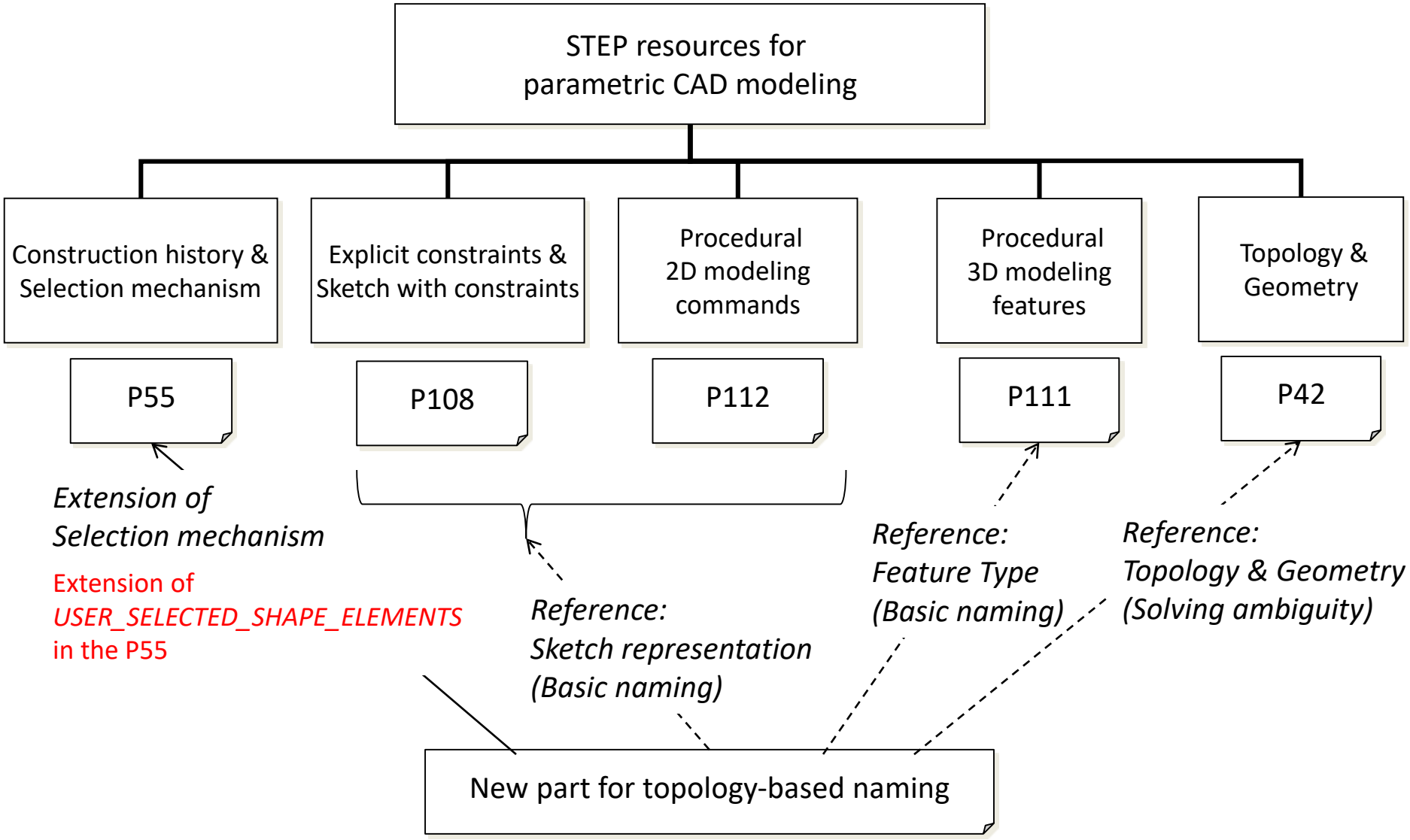
This part: to reference the topological object of design feature in the procedural modeling procedures

2) Naming the Non-parametric geometric (AP203 B-rep)?

The B-rep do not has design history, so there is no issue of naming, so that it does not need to be named

Standardization in ISO 10303 STEP

Related STEP Parts



EXPRESS Schema

```
SCHEMA topology_based_naming_schema

TYPE feature_type = ENUMERATION OF
        (sweep,
        extrude,
        revolve,
        chamfer,
        round,
        rectangular_pattern,
        circular_pattern);
END_TYPE;

ENTITY face_name
  face_basic_name : basic_name;
  face_OSI : object_space_information;
  face_SN  : secondary_name:
END_ENTITY;

ENTITY edge_name
  first_adjacent_face : face_name;
  second_adjacent_face : face_name;
  edge_OSI : object_space_information;
END_ENTITY;

ENTITY vertex_name
  adjacent_faces : LIST[1:?] OF face_name;
  vertex_OSI : object_space_information;
END_ENTITY;
```

```
ENTITY basic_name
  feature_id : STRING;
  name_id1 : STRING;
  name_id2 : STRING;
  name_id3 : STRING;
  name_id4 : STRING;
  name_id5 : STRING;
  option : feature_type;
END_ENTITY;

ENTITY object_space_information
  object_order : INTEGER;
  split_object_number : INTEGER;
END_ENTITY;

ENTITY secondary_name
  merged_faces_number : INTEGER;
  merged_faces : LIST[0:?] OF basic_name;
END_ENTITY;

END_SCHEMA;
```

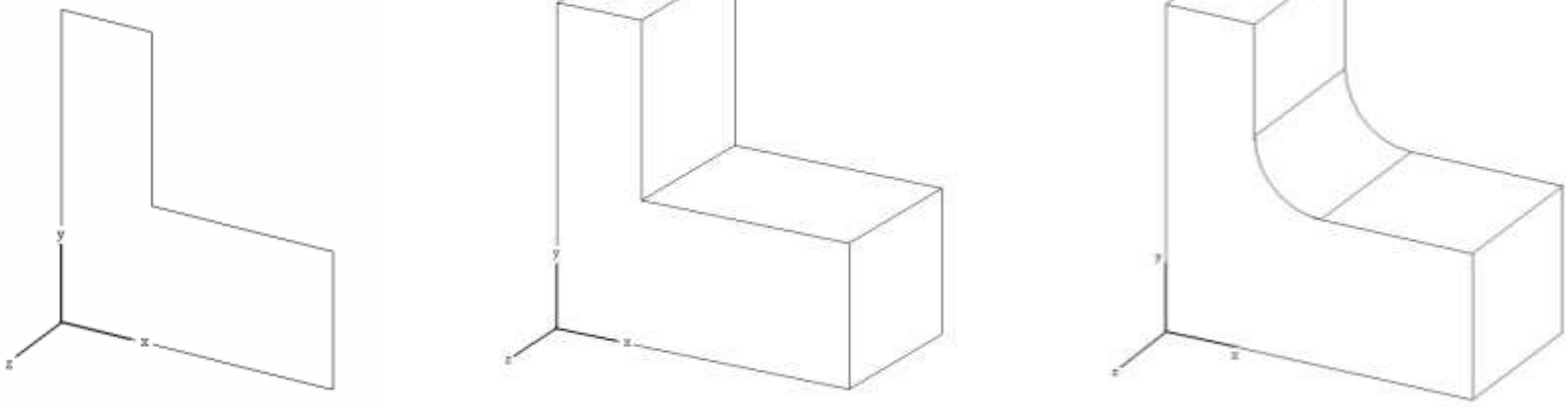
It is full set but it’s not consolidated to current STEP parts.

L-block examle

a) Sweep the sketch linearly (construction operation);

b) Select the edge to be filleted from the screen display (selection operation);

c) Fillet the edge (construction operation).



We have XML examples which do not consider consolidation with STEP.
However P21 physical file should be created after consolidation.

L-block example

#1010 = EXPLICIT PROCEDURAL SHAPE REPRESENTATION RELATIONSHIP (’’,$,#1020,#840);
#1020 = PROCEDURAL SHAPE REPRESENTATION(’FINAL OBJECT’, (#1280),#850);
#1030 = PROCEDURAL SOLID REPRESENTATION SEQUENCE(’BASIC L-BLOCK’, (#1040,#1050,#1060),(),’RATIONALE: TEXT...’);
#1040 = EXTRUDED FACE SOLID(’L-SOLID’,#1070,#1080,8.);
#1050 = USER SELECTED SHAPE ELEMENTS(’SELECTED EDGE’,(#1120));
#1060 = CONSTANT RADIUS EDGE BLEND(’BLEND1’,#1040,#1120,2.);
#1070 = FACE SURFACE(’L-FACE’, ...);
#1080 = DIRECTION(’EXTRUSION DIRECTION’,(0.,0.,1.));
/* supporting information for the **extruded face solid** #1040 */
#1120 = EDGE CURVE(.....);
/* supporting information for the **edge curve** #1120 */

To do

- Harmonize the existing Express schema to STEP P55
- Create example P21 physical files

End

Naming method of KAIST

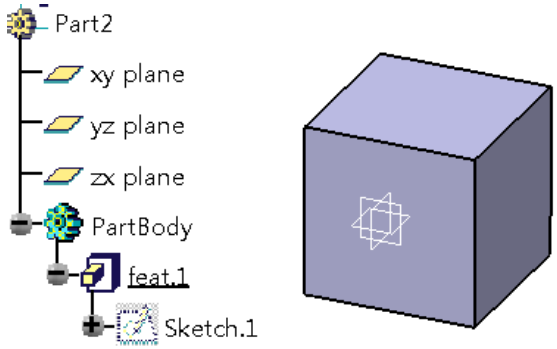
- Face name
  - EN(f) =*BN(f) : OSI : SN
    (면의 기본 명칭 정보 : 분할 정보 : 병합 정보)
  - 분할된 면이 없을 경우 OSI 에 [0,0]을 기록
  - 병합된 면이 없을 경우 SN에 [0;0]을 기록

- Edge name
  - EN(e) =EN(f1) # EN(f2) # OSI
    (인접면 f1의 이름 # 인접면 f2의 이름 # 분할 정보)

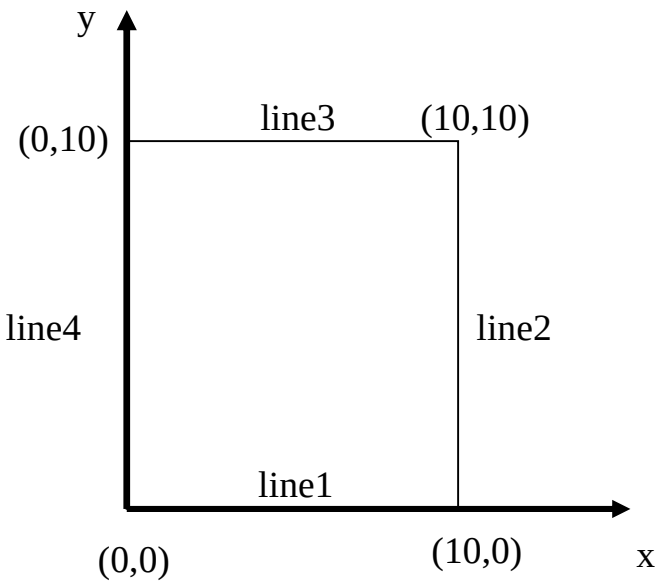
- Vertex name
  - EN(v) =EN(f1) {# EN(fi)} # OSI,
    (인접면 f1의 이름 {# 인접면 fi의 이름} # 분할 정보)

*BN(f)의 경우 [Wu01]의 방법 사용 OSI: Object Space Information SN: Secondary Name

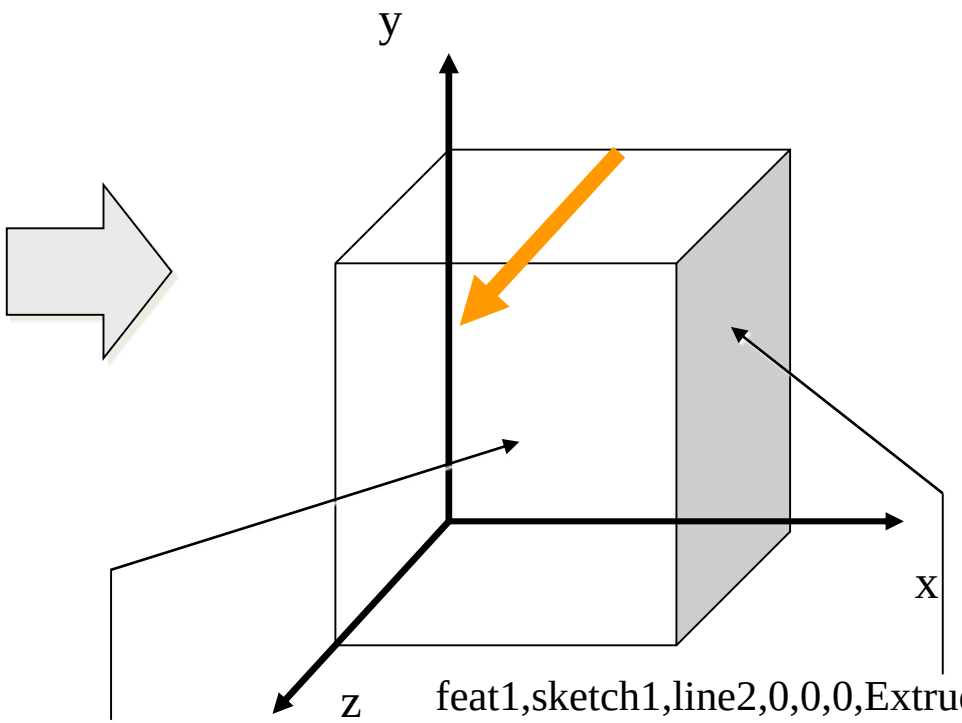
Basic name: BN(1) [Wu01]



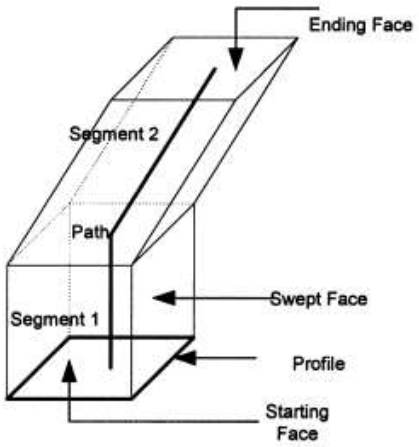
- BN(f) = [feature id, id1, id2, id3, id4, id5, option]
  - feature id: 특징형상의 이름
  - option: 특징형상의 종류
  - id1 ~ id5: 각 특징형상 별 명칭 방법에 따른 정보



feature name: feat1
sketch name: sketch1



Basic name : BN(2) [Wu01]



[Sketch-based feature]

Sweep

$$\mathrm{ON}(F) = \begin{cases} [\mathrm{FeatID}, 0, -1, 0, 0], & \text{if } F \text{ is the starting face.} \\ \mathrm{ON}_{\mathrm{side}}, & \text{if } F \text{ is a side face.} \\ [\mathrm{FeatID}, 0, -2, 0, 0], & \text{if } F \text{ is the ending face.} \end{cases}$$

$$\mathrm{ON}_{\mathrm{Side}} = [\mathrm{FeatID}, \mathrm{FeatID}_{\mathrm{p}}, \mathrm{ID}_{\mathrm{element}}, \mathrm{FeatID}_{\mathrm{Path}}, \mathrm{ID}_{\mathrm{trajectory}}]$$

Extrude

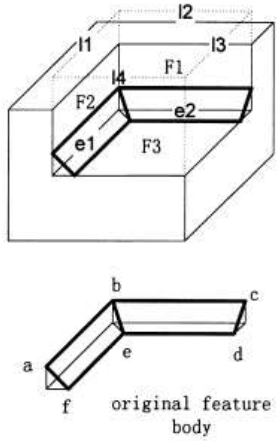
$$\mathrm{ON}(F) = \begin{cases} [\mathrm{FeatID}, 0, -1, 0, 0], & \text{if } F \text{ is the starting face.} \\ [\mathrm{FeatID}, \mathrm{FeatID}_{\mathrm{p}}, \mathrm{Id}_{\mathrm{element}}, 0, 0],, & \text{if } F \text{ is a side face.} \\ [\mathrm{FeatID}, 0, -2, 0, 0], & \text{if } F \text{ is the ending face.} \end{cases}$$

Revolve

$$\mathrm{ON}(F) = \begin{cases} [\mathrm{FeatID}, 0, -1, 0, 0], & \text{if } F \text{ is the starting face.} \\ [\mathrm{FeatID}, \mathrm{FeatID}_{\mathrm{p}}, \mathrm{ID}_{\mathrm{element}}, \mathrm{FeatID}_{\mathrm{p}}, \mathrm{ID}_{\mathrm{axis}}], & \\ & \text{if } F \text{ is a side face.} \\ [\mathrm{FeatID}, 0, -2, 0, 0], & \text{if } F \text{ is the ending face.} \end{cases}$$

* 여러 개의 프로파일이 존재하는 경우 지원 안 함

Basic name : BN(3) [Wu01]



[Transition feature]

$$ON(F) = [FeatID, FeatID_{FF1}, ID_{element}, FeatID_{FF2}, ID_{element2}].$$

Chamfer

$ON(F_1) = [6, 5, ID_{I2}, 0, 0],$

$ON(F_2) = [6, 5, ID_{I1}, 0, 0],$

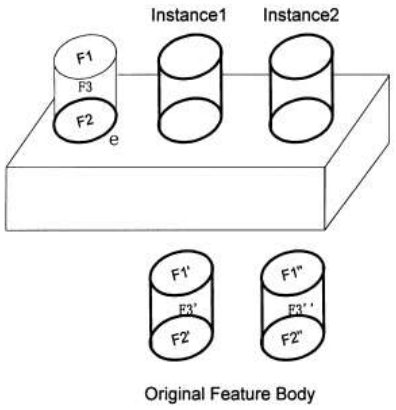
and

$ON(F_3) = [6, 5, -2, 0, 0].$

$ON(\text{face(a, b, e, f)}) = [7, 6, -2, 6, ID_{I1}]$

and

$ON(\text{face(b, c, d, e)}) = [7, 6, -2, 6, ID_{I2}].$



[feature-based feature]

$$ON(F) = [FeatID, FeatID_{P}, ID_{element}, FeatID_{path}, ID_{trajectory}, InsNum],$$

Pattern

$ON(F_1) = [6, 5, -2, 0, 0],$

$ON(F_2) = [6, 5, -1, 0, 0]$

and

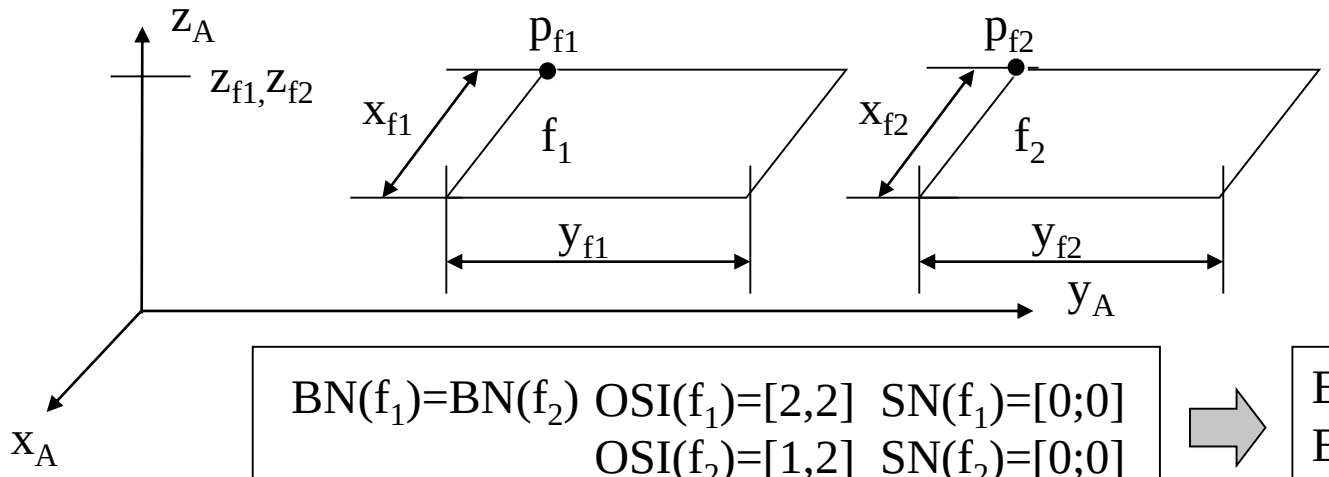
$ON(F_3) = [6, 5, ID_e, 0, 0].$

$ON(F_{1'}) = [7, 5, -2, 0, 1],$

$ON(F_{1''}) = [7, 5, -2, 0, 2],$

Split face: OSI

- OSI= [Order, Total_Num]
  - Wu가 제안한 PSI와 유사한 원리
  - PSI는 2D 파라메터 공간 상에서 참조점을 결정하나, OSI는 3D 기하 공간 상에서의 참조점 결정
- OSI 계산 절차
  - 동일한 기본 명칭 정보를 가지는 위상 엔터티들의 참조 점 결정
  - 기하공간 상에서 참조 점에 해당되는 x, y, z 값을 계산
  - x, y, z값에 따라 정렬. 큰 값을 가질수록 순위가 높다.

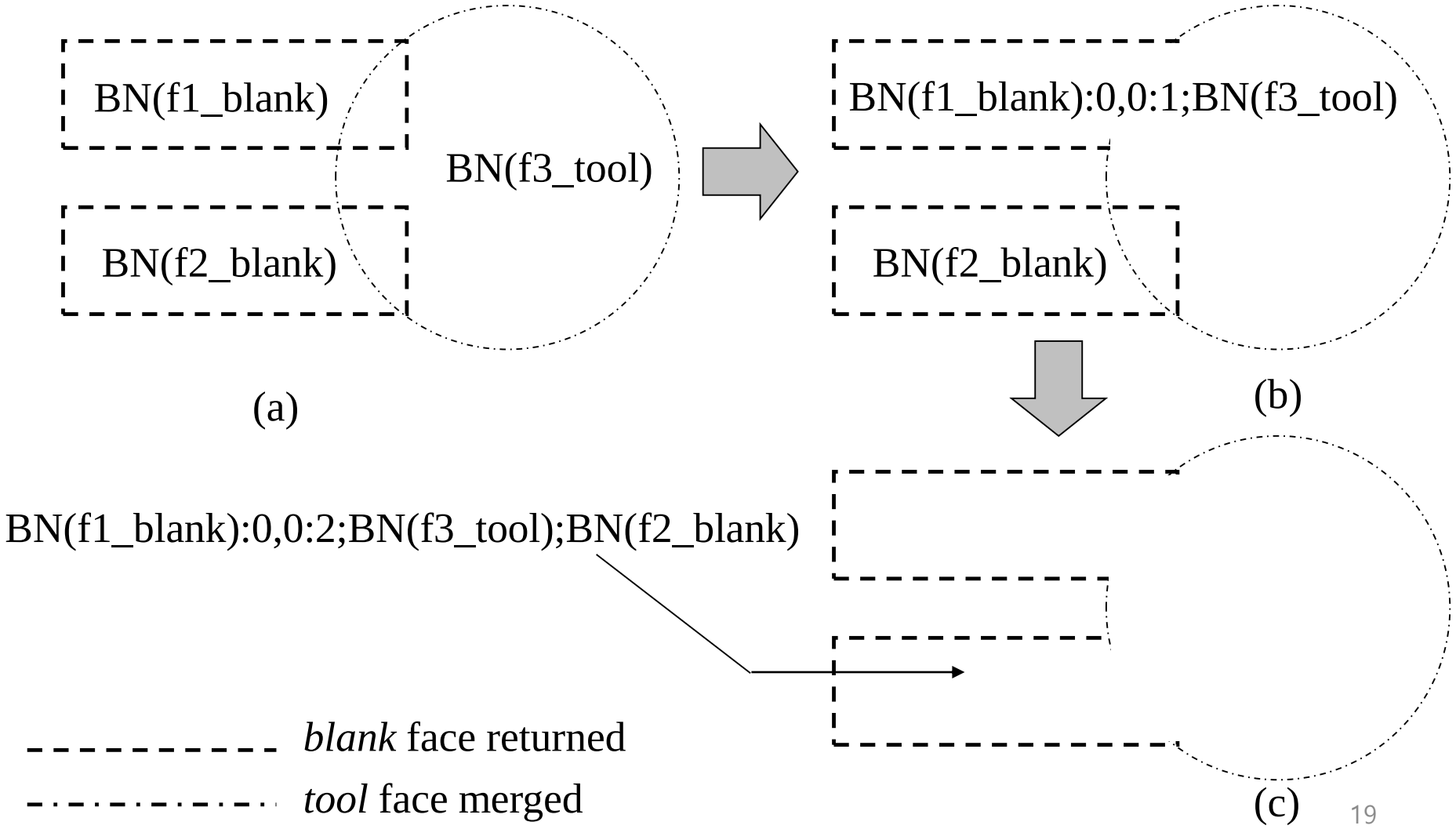


$BN(f_1)=BN(f_2)$ $OSI(f_1)=[2,2]$ $SN(f_1)=[0;0]$
$OSI(f_2)=[1,2]$ $SN(f_2)=[0;0]$

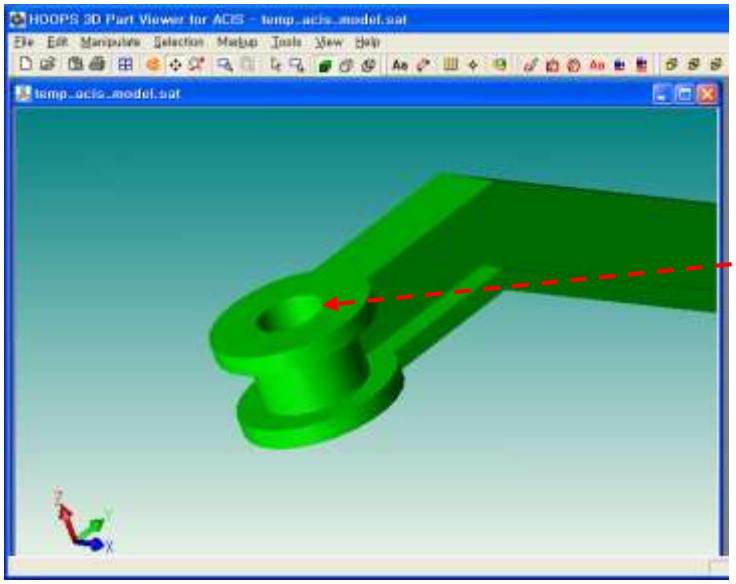
$EN(f_1)=BN(f_1):2,2:0;0$
$EN(f_2)=BN(f_2):1,2:0;0$

Merge: SN (Secondary Name)

- SN= [Total_Num, BN(f) {,BN(f)}]



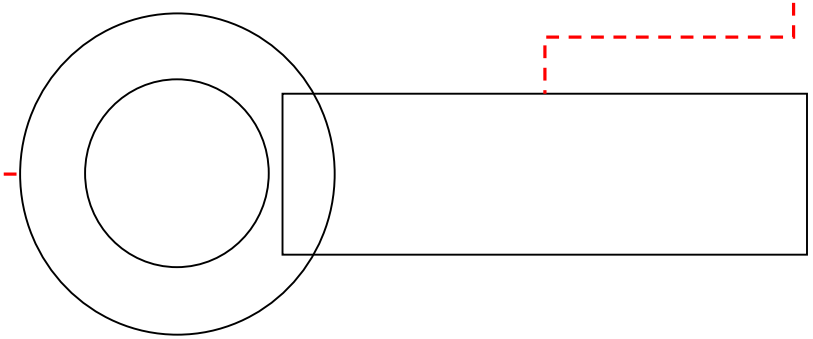
Implementation (1) – Merge of faces



rib1,sketch4,17,sketch6,9,0,Sweep_Feature:0,0:1;*shaft2,sketch7,20,0,0,0,Revolve_Feature*

shaft2,sketch7,20,0,0,0,Revolve_Feature

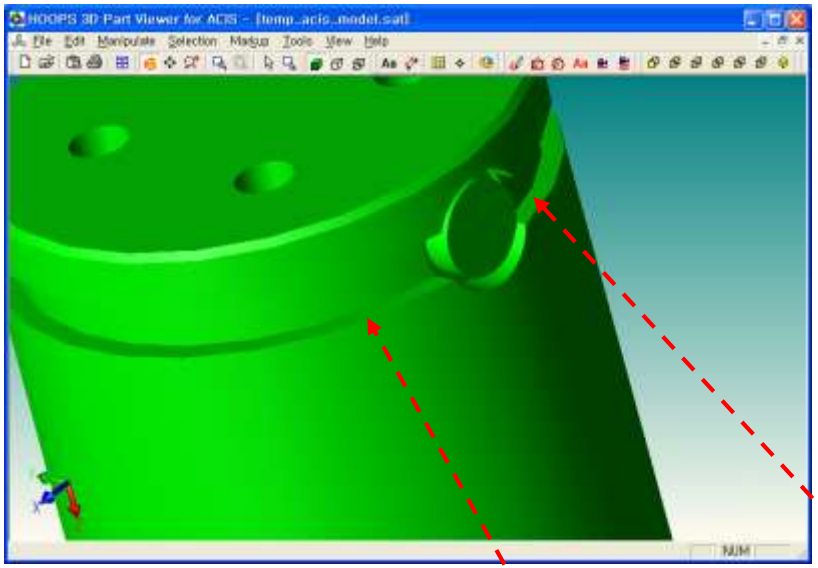
rib1,sketch4,17,sketch6,9,0,Sweep_Feature

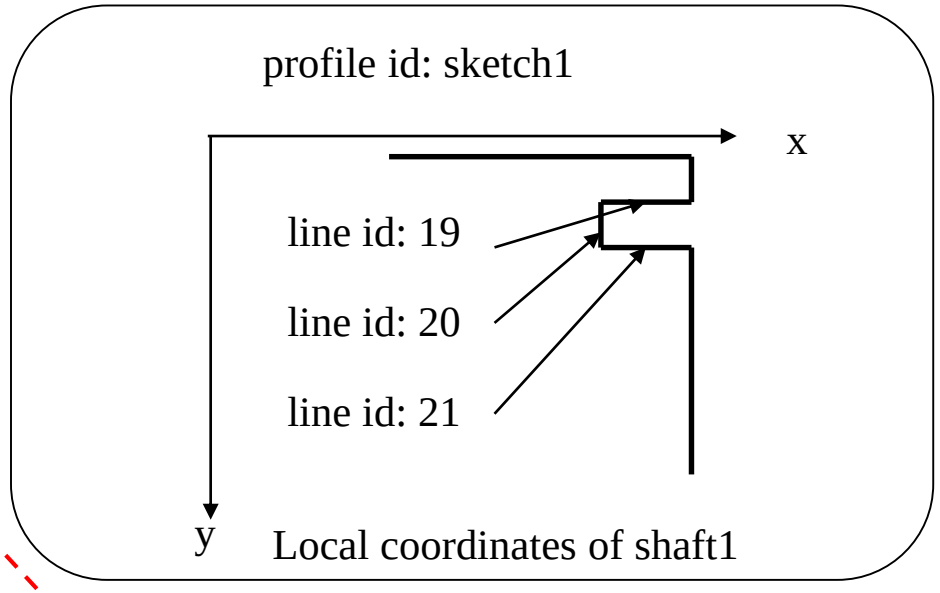


feature name: shaft2

feature name: rib1

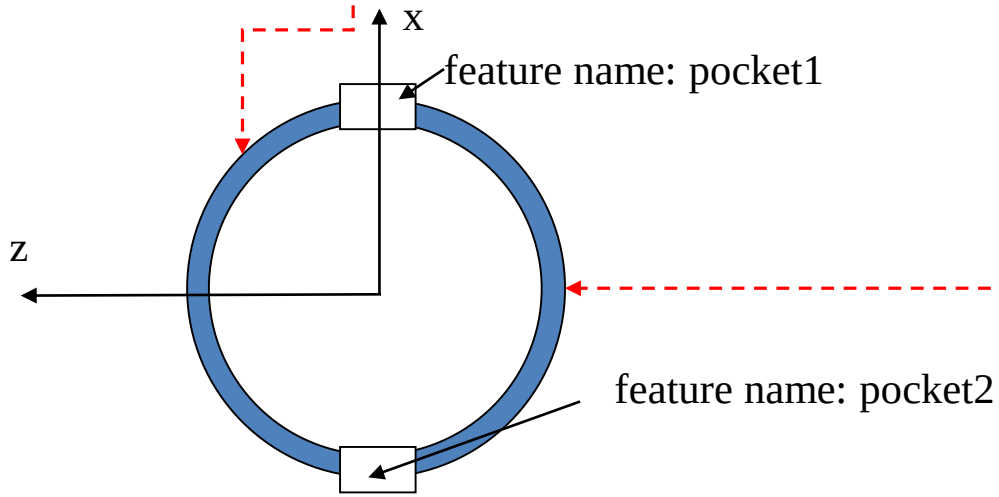
Implementation (2) – Face split





shaft1,sketch1,21,0,0,0,Revolve_Feature:1,2:0;0

shaft1,sketch1,21,0,0,0,Revolve_Feature:2,2:0;0



References

- V. Capoyleas, X. Chen and C. M. Hoffmann, "Generic naming in generative, constraint-based design", Computer-Aided Design, Vol. 28. No. 1, pp 17-26, 1996.
- J. Kripac, "A mechanism for persistently naming topological entities in history-based parametric solid models", Computer-Aided Design, Vol. 29, No.2, pp 113-122, 1997.
- Junjun Wu, Tianbing Zhang, Xinfang Zhang and Ji Zhou, "A face based mechanism for naming, recording and retrieving topological entities", Computer-Aided Design, Vol. 33, No. 10, pp 687-698, 2001.
- Duhwan Mun, Soonhung Han, "Identification of Topological Entities and Naming Mapping Based on IGM for Parametric CAD Model Exchanges", International Journal of CAD/CAM, Vol. 5, No. 1, pp. 69-81, 2005.

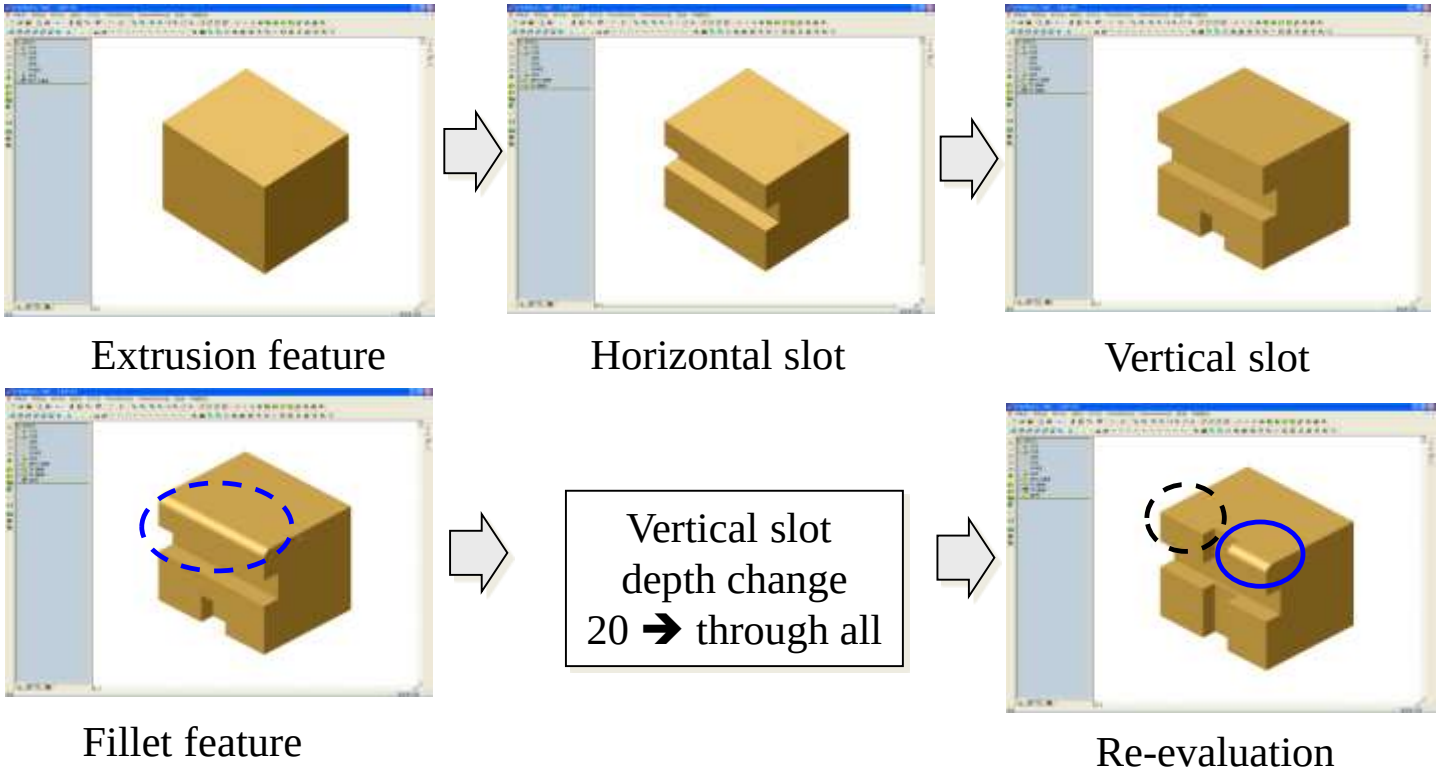


Fig. 1. The persistent naming problem in SolidWorks.

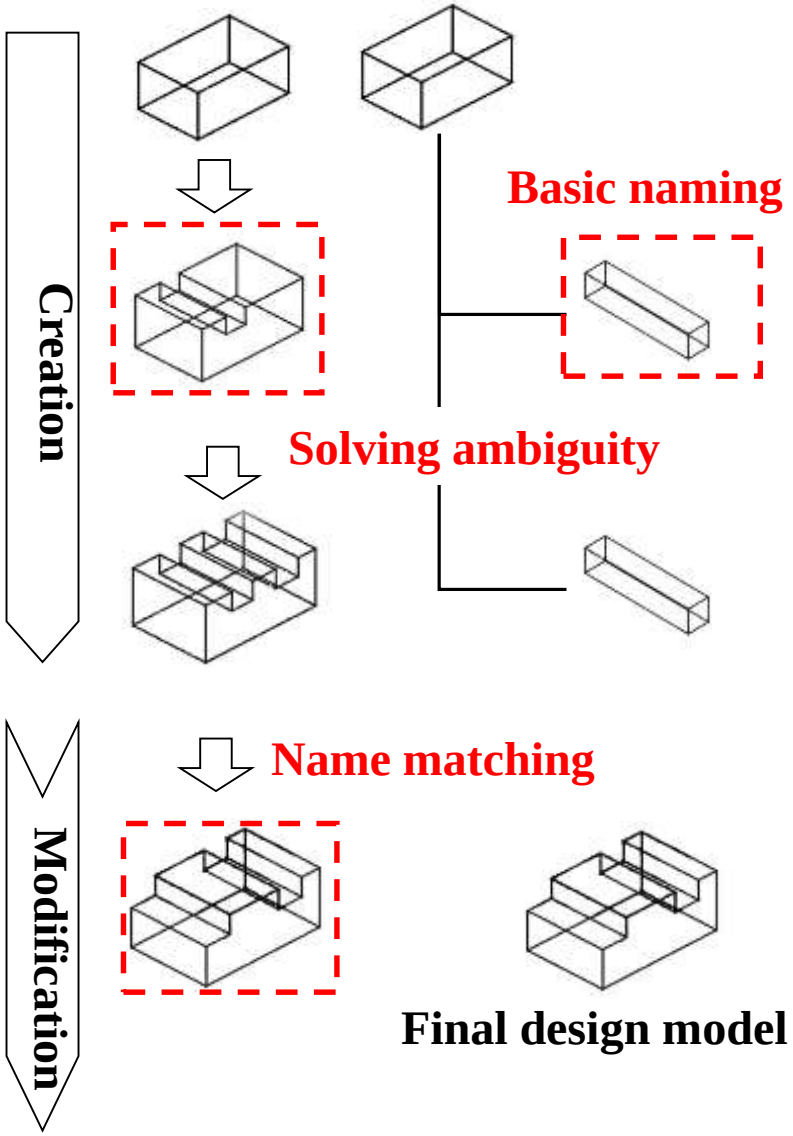


Fig. 2-2 Classification of the persistent naming problem

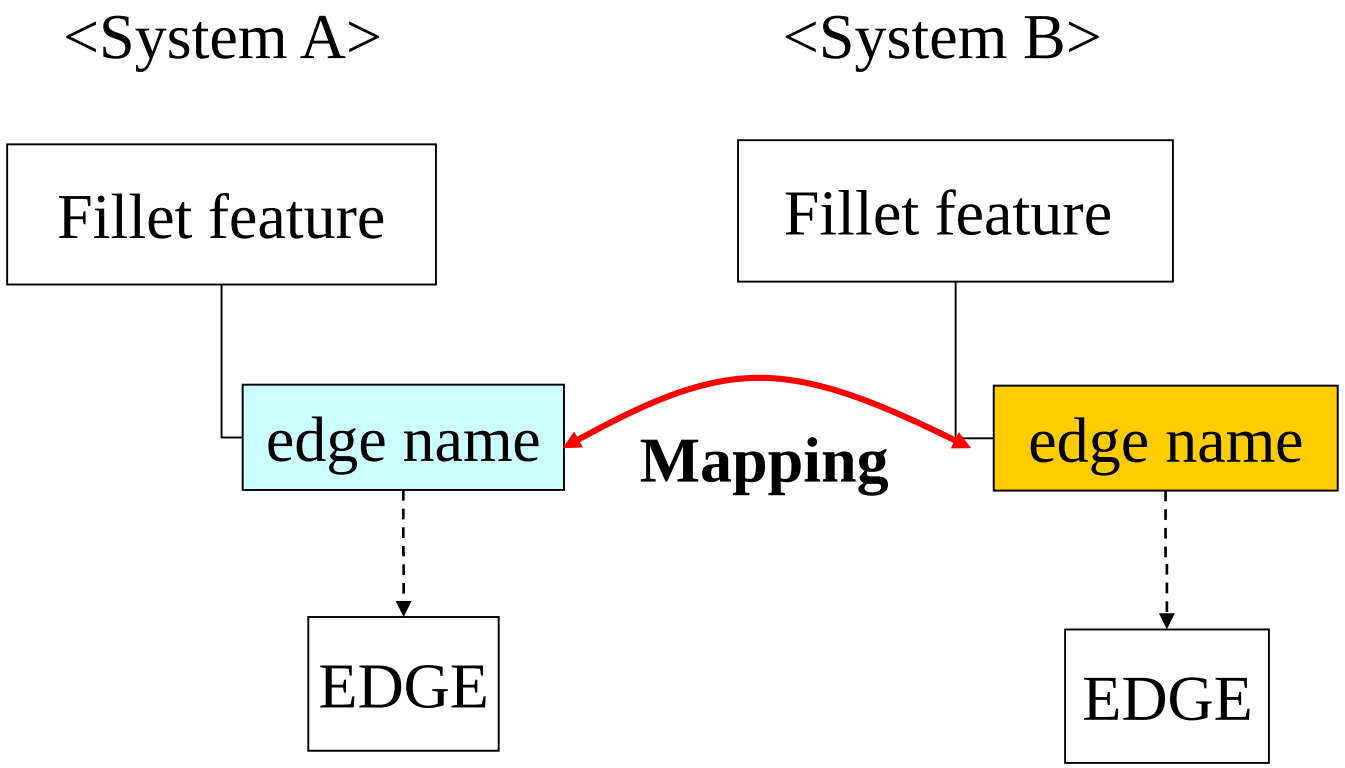
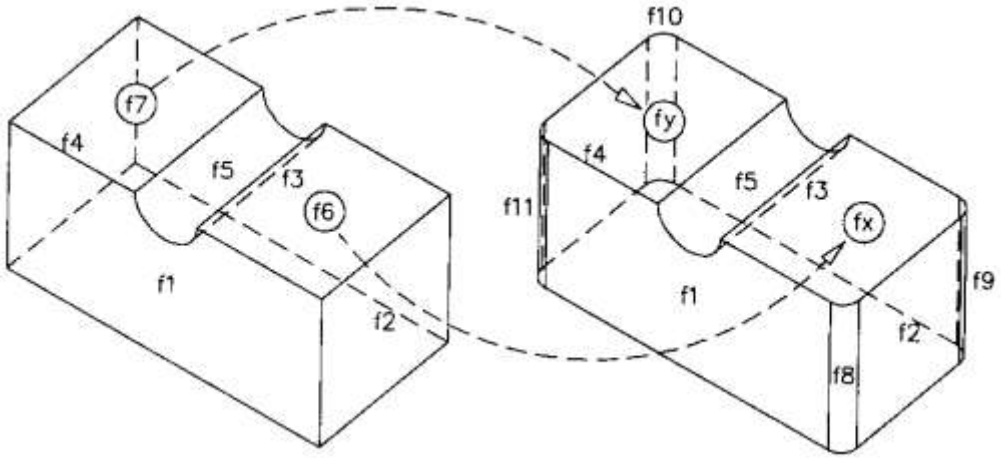
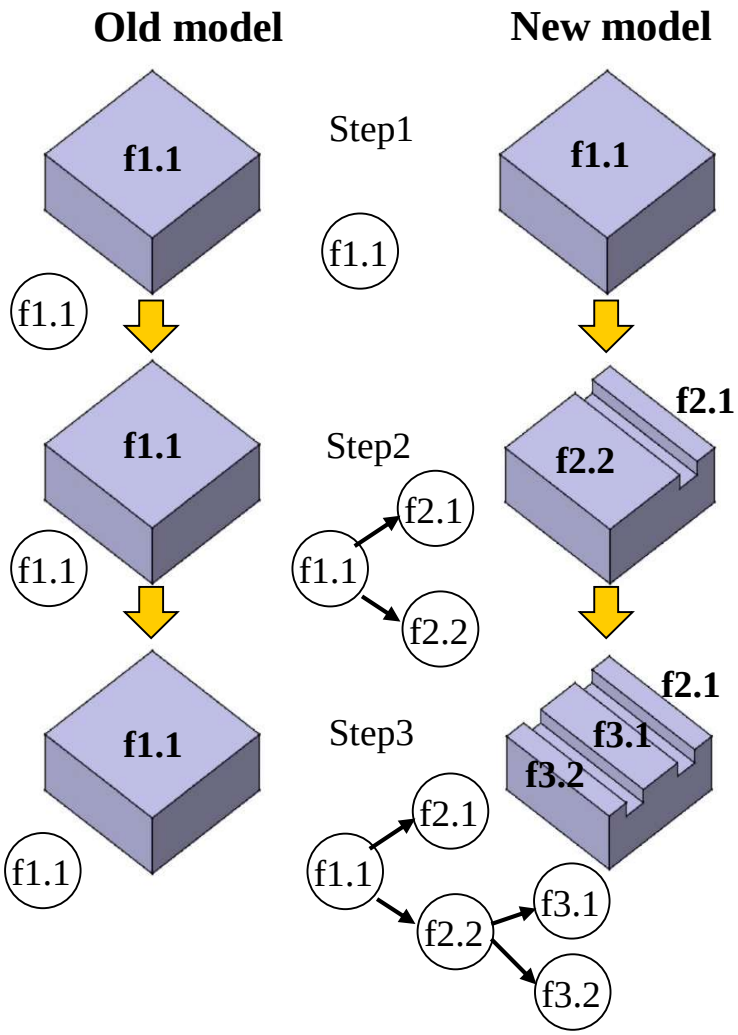


Fig. 2-2 Naming mapping problem



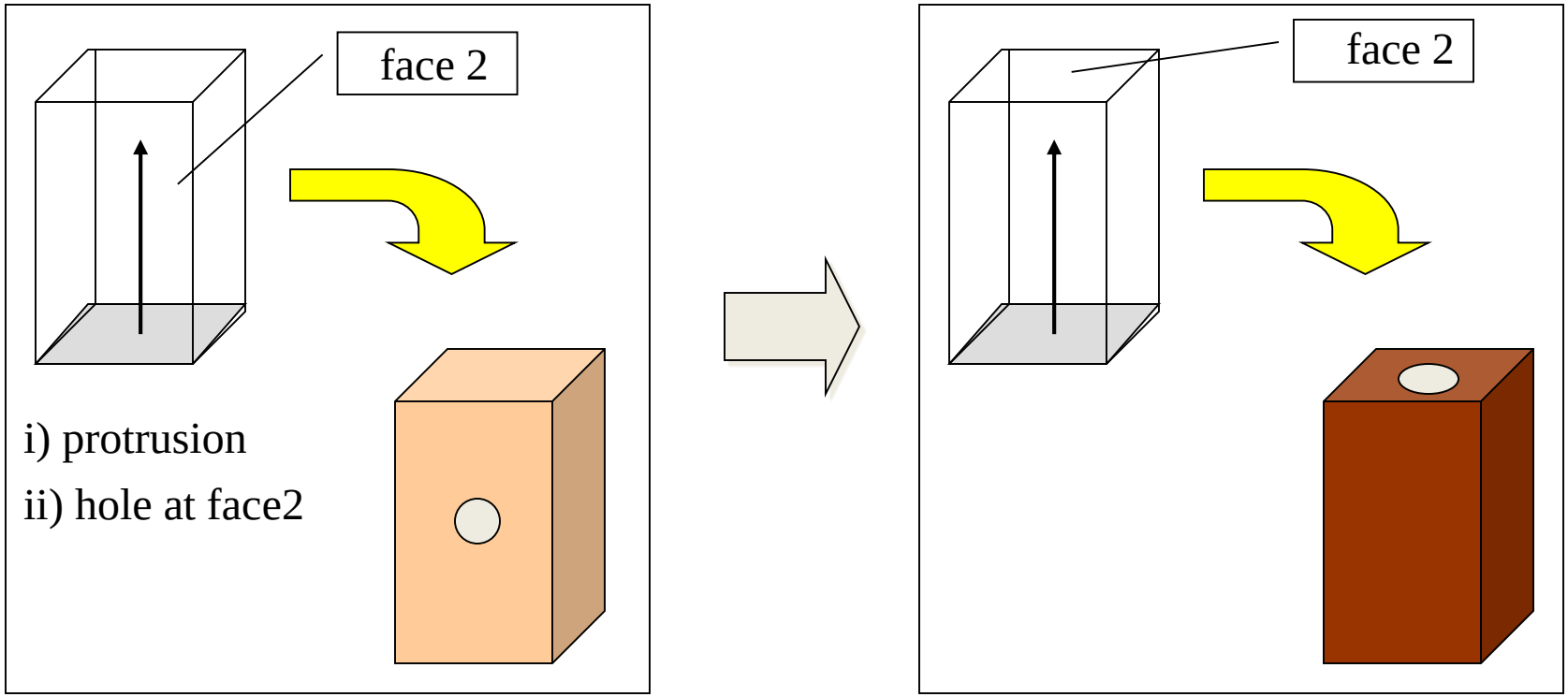
(a) Local Matching



(b) Global Matching[3]

Fig. 5. Name matching (*Problem 2*)

Fig. 6. Name mismatches arising from the different naming order



CAD system α
Naming order: start face, side faces and end face using integer

CAD system β
Naming order: start face, end face, and side faces using integer

Fig. 7. Difference in PSI (parametric space information) among CAD systems [15]

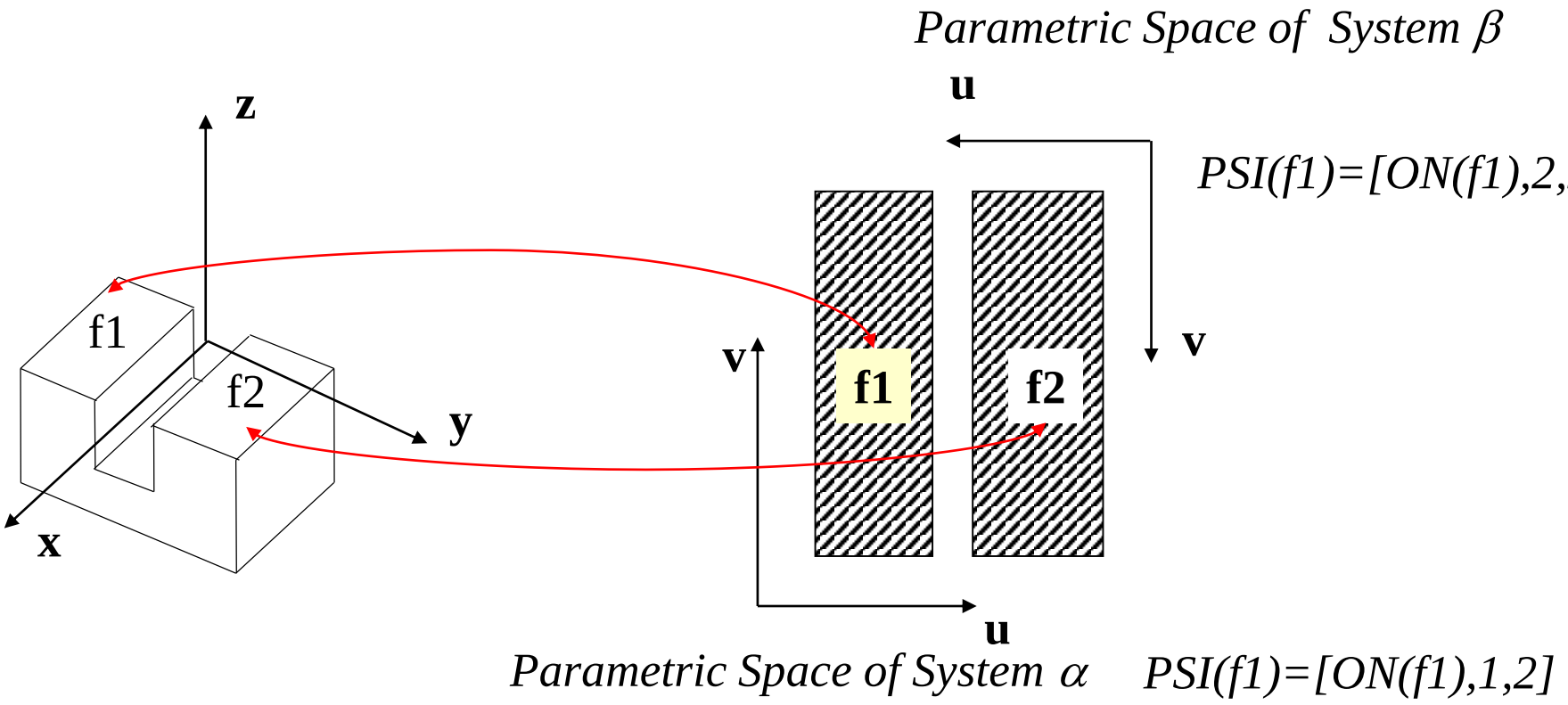


Fig. 8. Object Space Information (OSI) [15].

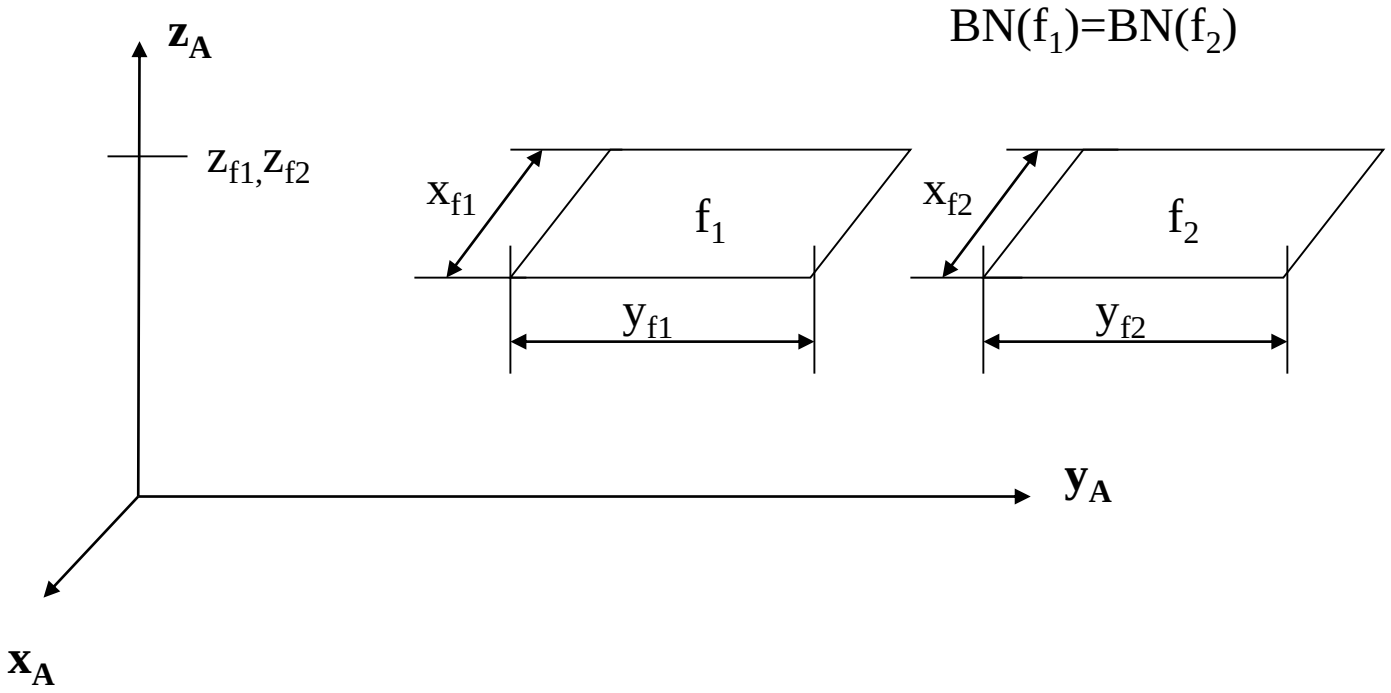
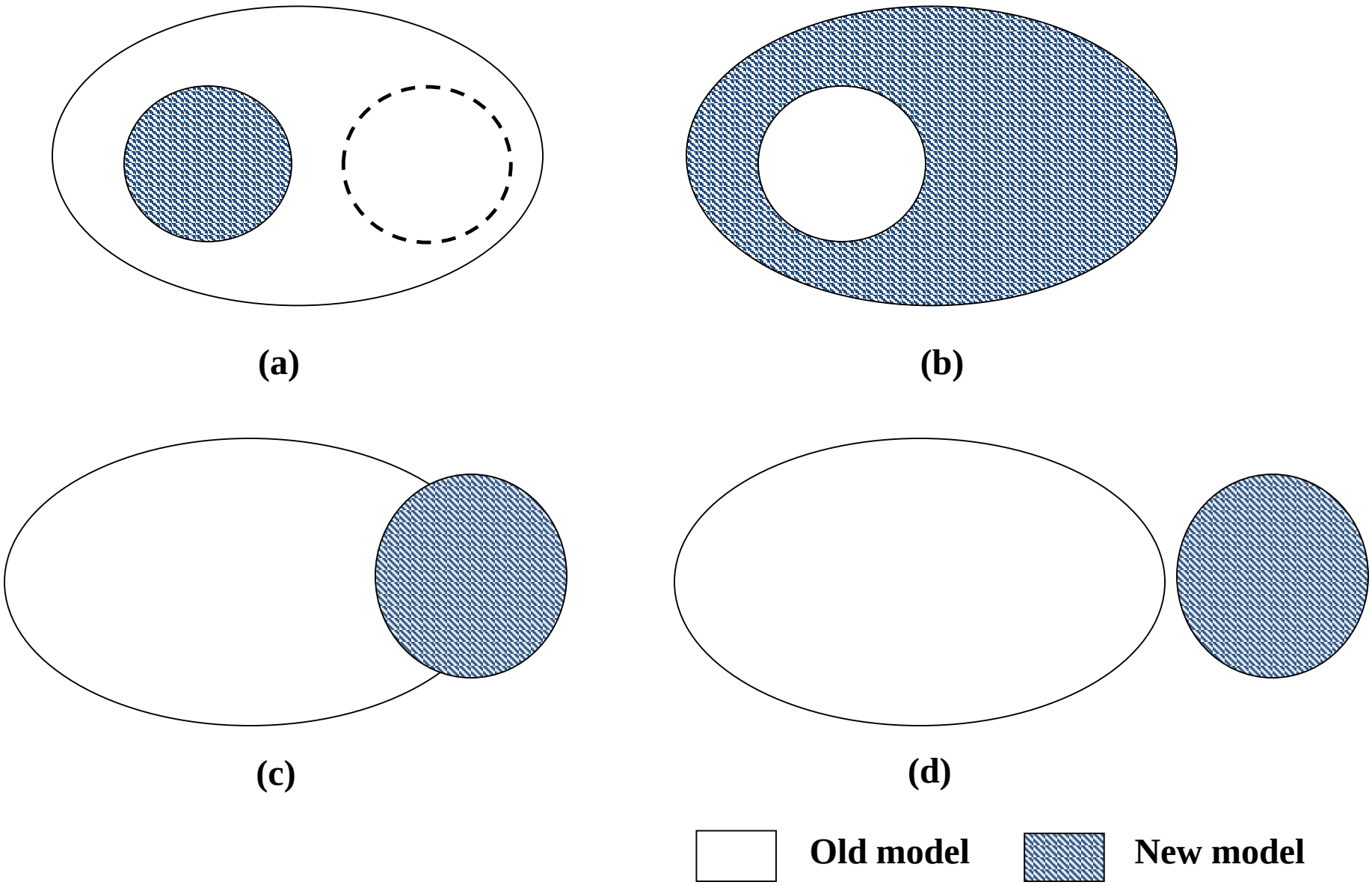


Fig. 9. Comparison between object space ranges of old model and new model [15].



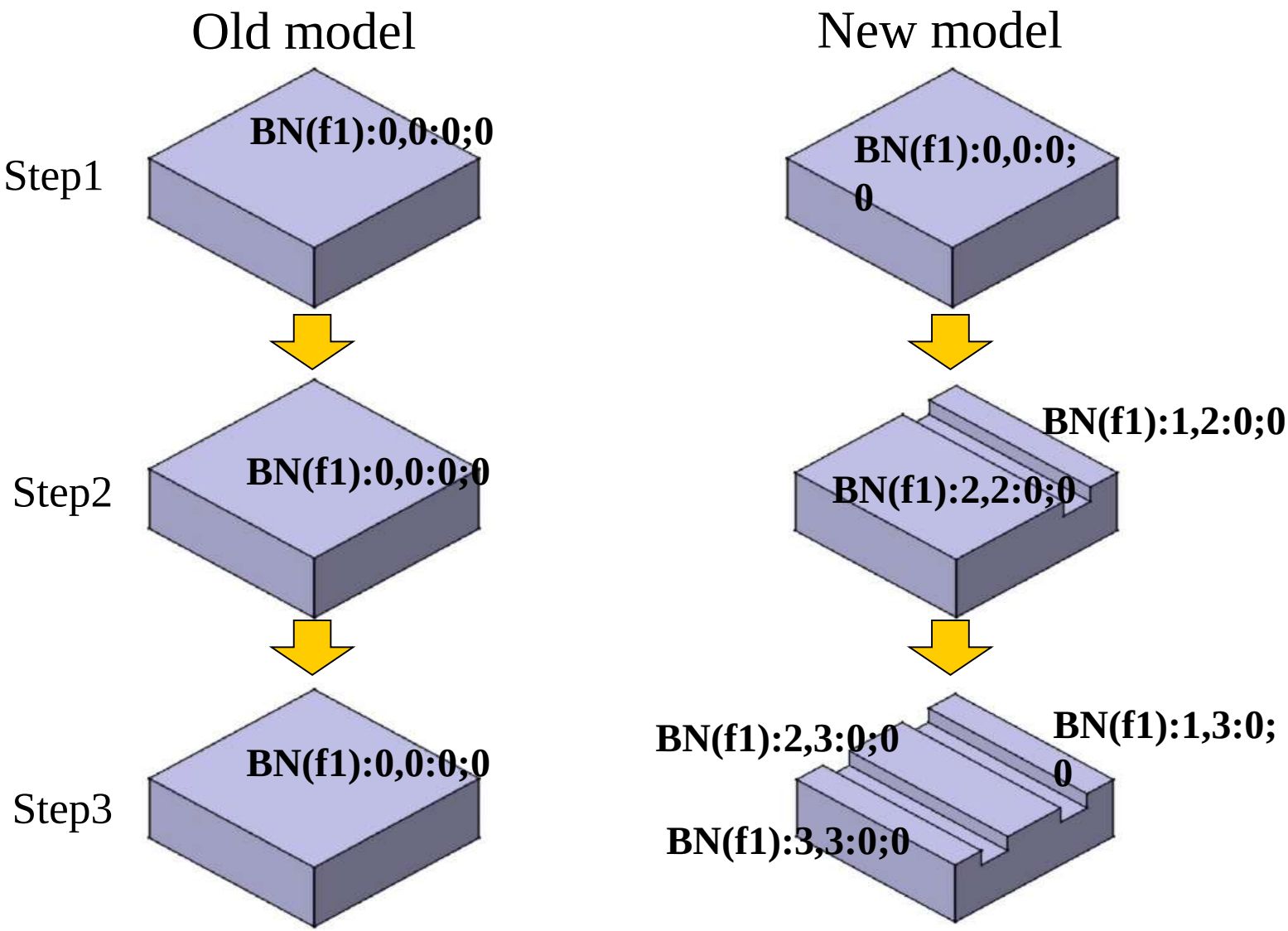


Fig. 10. Name matching problem arising from face splitting (See also Fig. 5) [15].

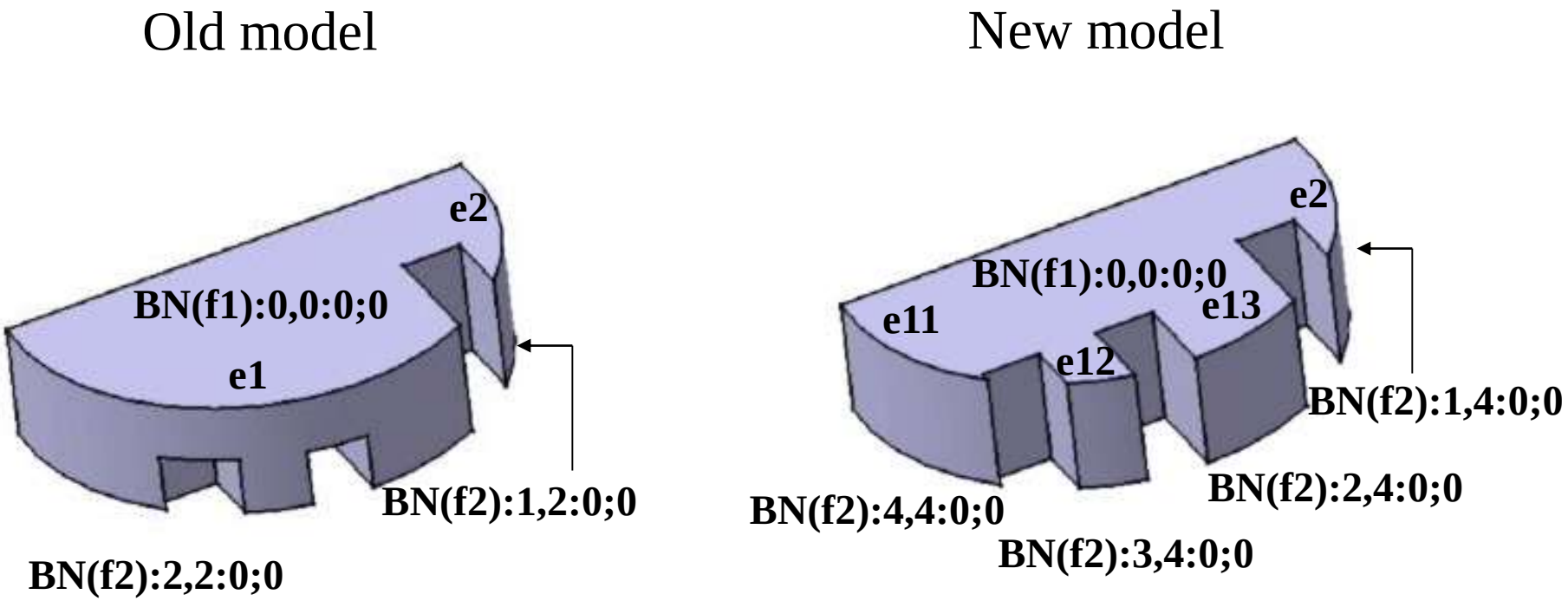


Fig. 11. Name matching problem arising from edge splitting [15].

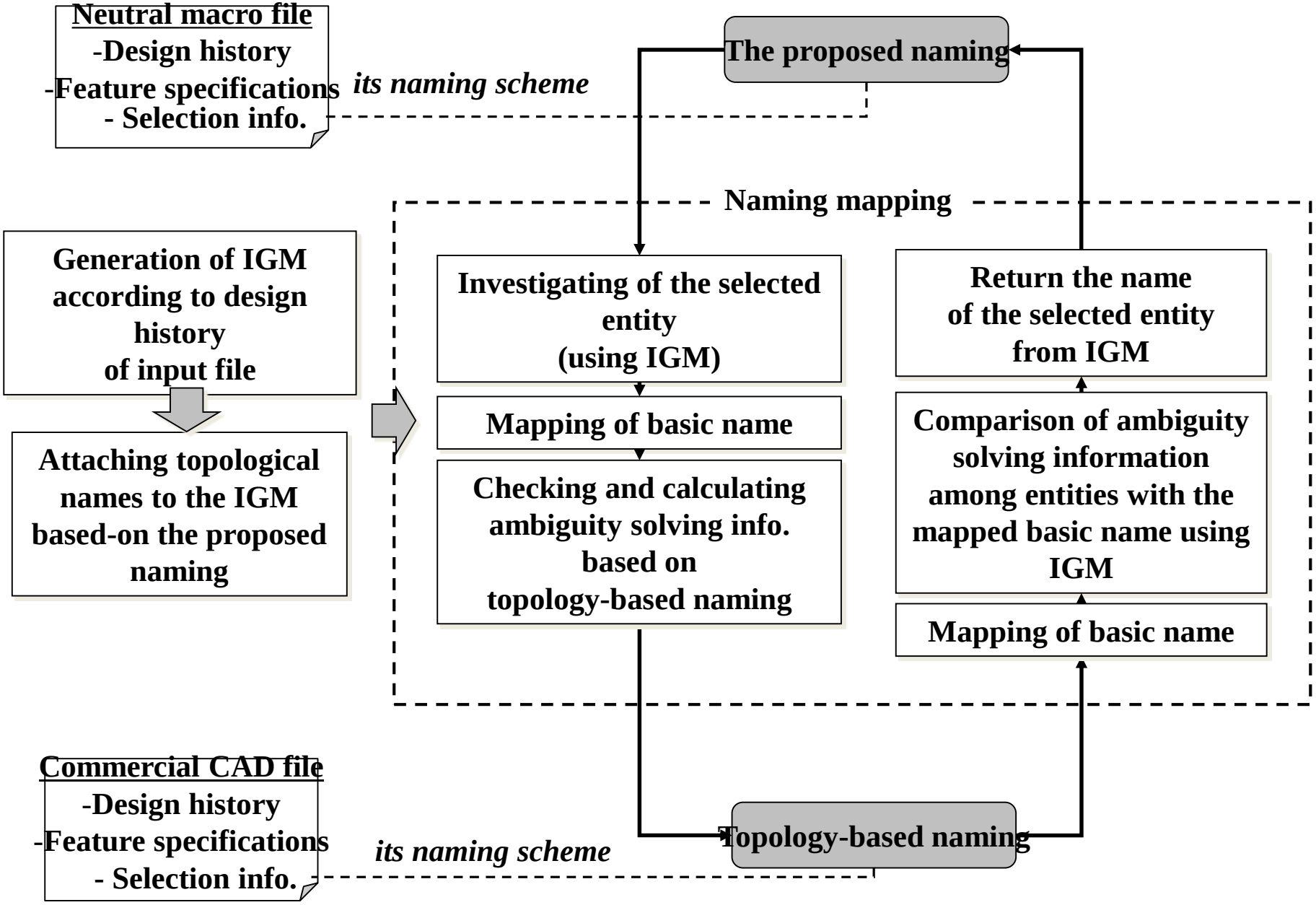
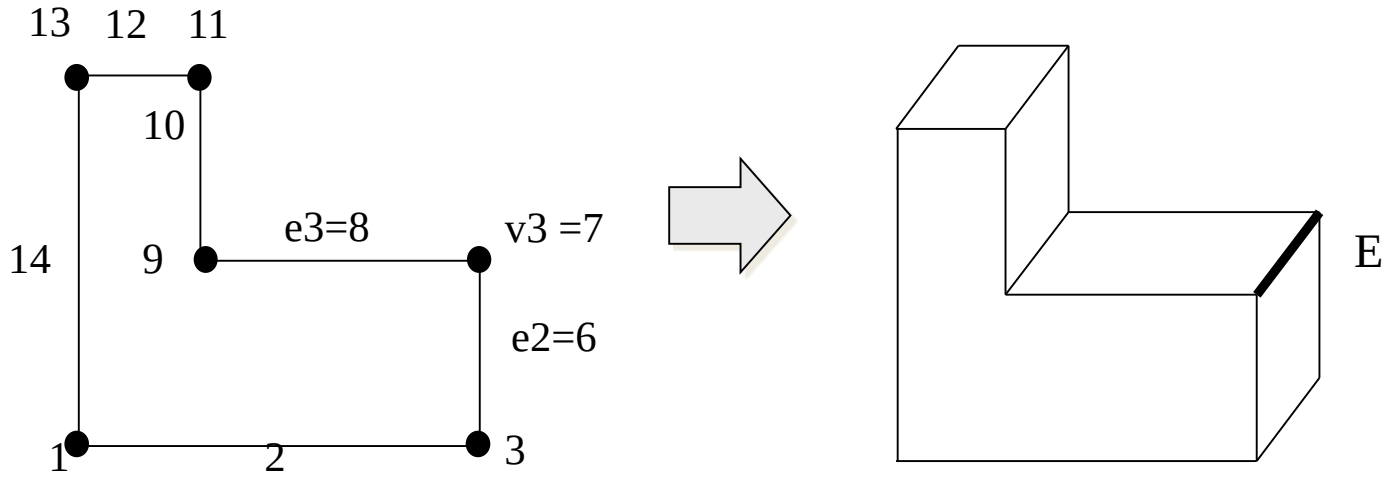


Fig. 12. Naming mapping between proposed naming and topology-based naming



Capoyleas' method : E = e (v3) ➔ e(7)

v3 = e2&e3

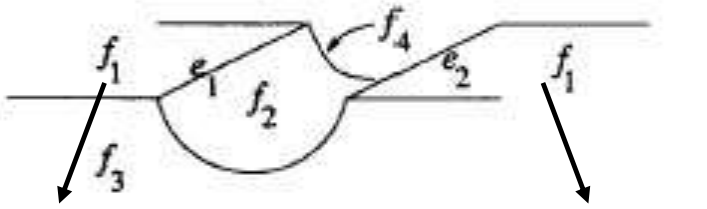
Conversion a vertex to intersection of two edges in a sketch

Proposed naming : E = f(e2)#f(e3) ➔ f(6)#f(8)

Fig. 13 Mapping of basic name

Generation of IGM and attachment of names t o the IGM based-on the proposed naming

Input naming info.: f1,L_{f1}=[f3,f2,f4]



L_{f1} = [f3,f2,f4]

L_{f1} = [f4,f2,f3]

Determination of a candidate set after mapping of basic name

Left[f1], Right[f1]

Comparison of ambiguity solving info. in the candidate set using IGM

L_{f1}=[f3,f2,f4]

Retrieving of ambiguity info. of the returned entity in the IGM

[1,2]

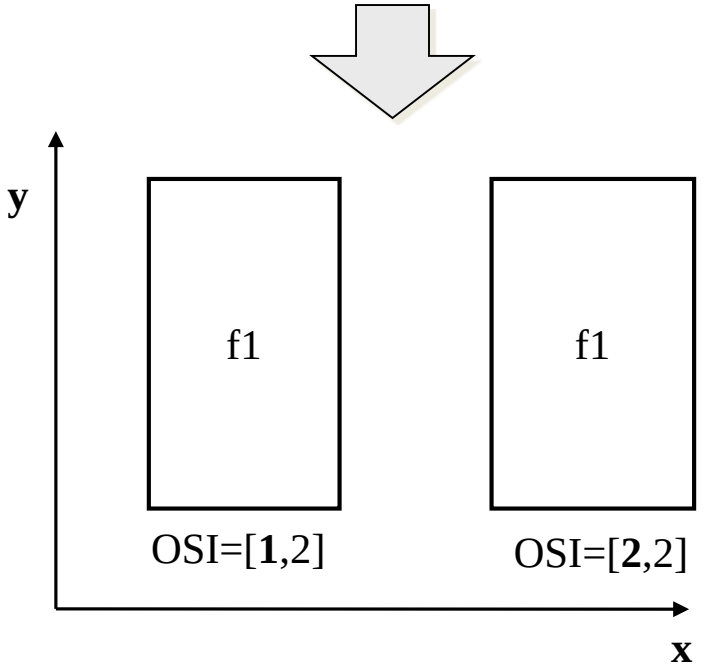


Fig. 14 Mapping ambiguity solving information

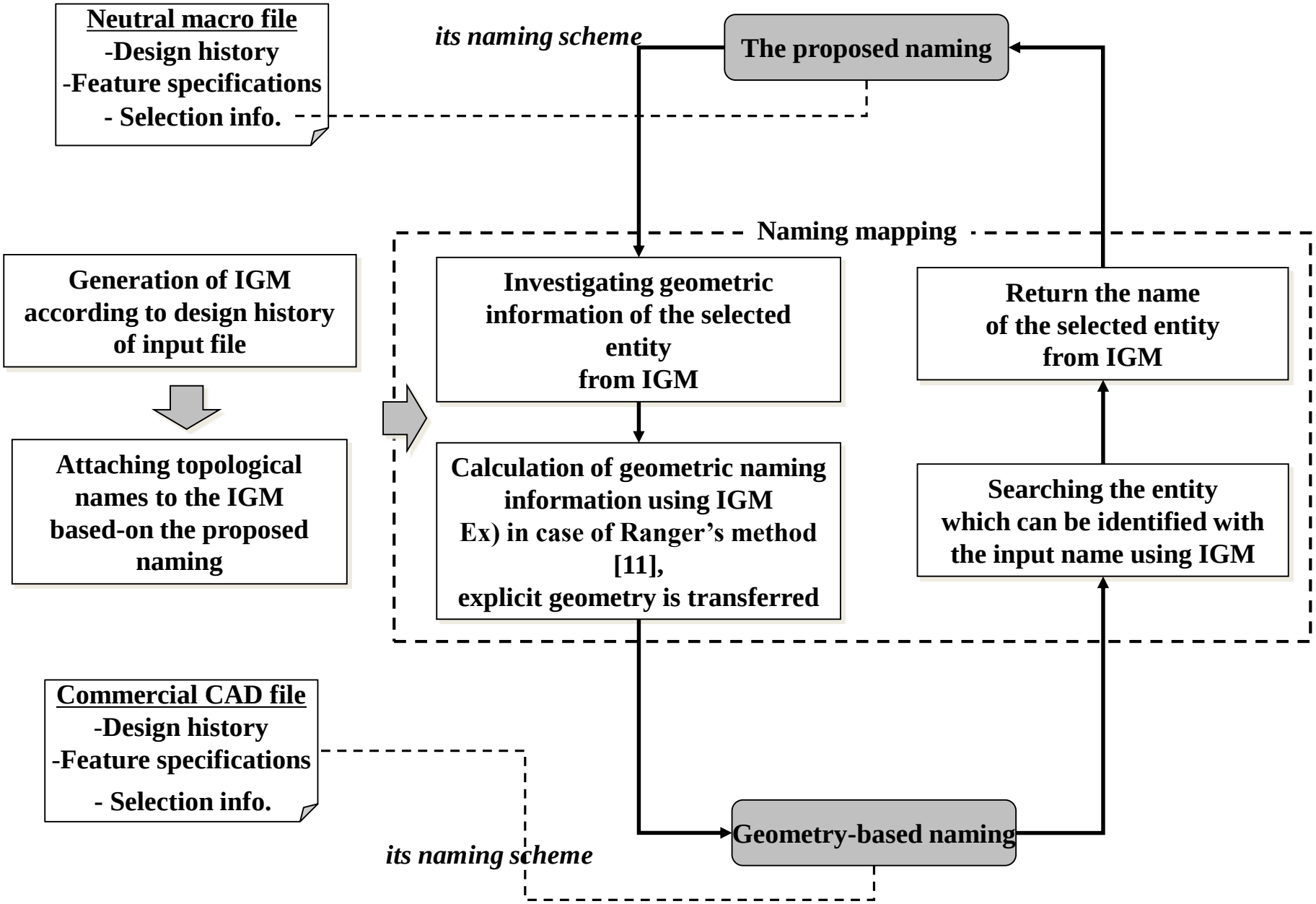


Fig. 15 Naming mapping between proposed naming and geometry-based naming

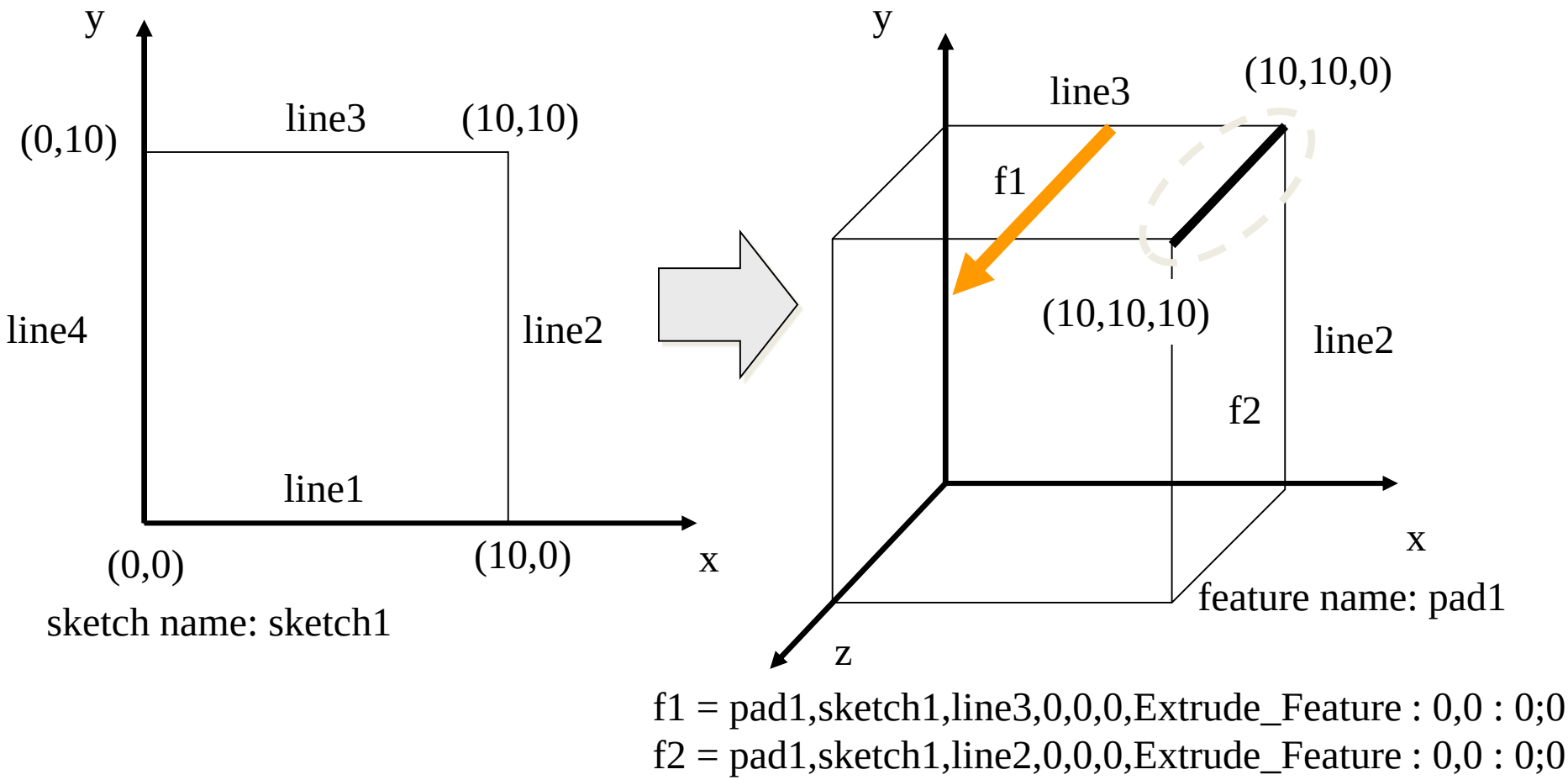


Fig. 16. Naming mapping between SolidWorks and the proposed naming