Document number: NRL-SNT-TR-01-26

Issues and Usage of Turning feature model for STEP-NC

ISO TC184 SC4 Fukuoka Meeting

October 2001

Suk-Hwan Suh (shs@postech.ac.kr)

National Research Lab for STEP-NC Technology

POSTECH, KOREA (http://www.STEP-NC.com)

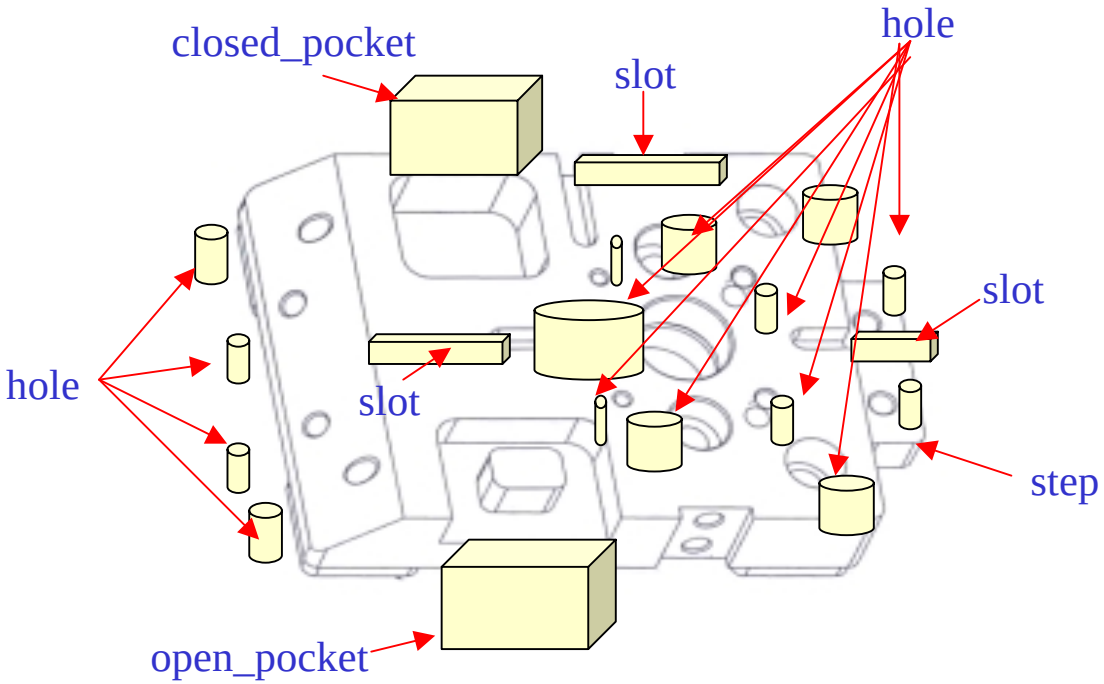
Contents

I. Issues

1. **Overview of milling-type features and usage**
2. **Characteristic of Turning-type features**
3. **Feature recognition based on finished shape**
4. **Feature recognition based on removal volume**
5. **A number of feature recognitions are possible!**
6. **Feature recognition for both rough-cut & finish-cut is necessary**
7. **In-process geometry is required**
8. **Tolerance needs to be incorporated: How?**
9. **Coverage of advanced turning center: When?**

II. Example implementation scenario

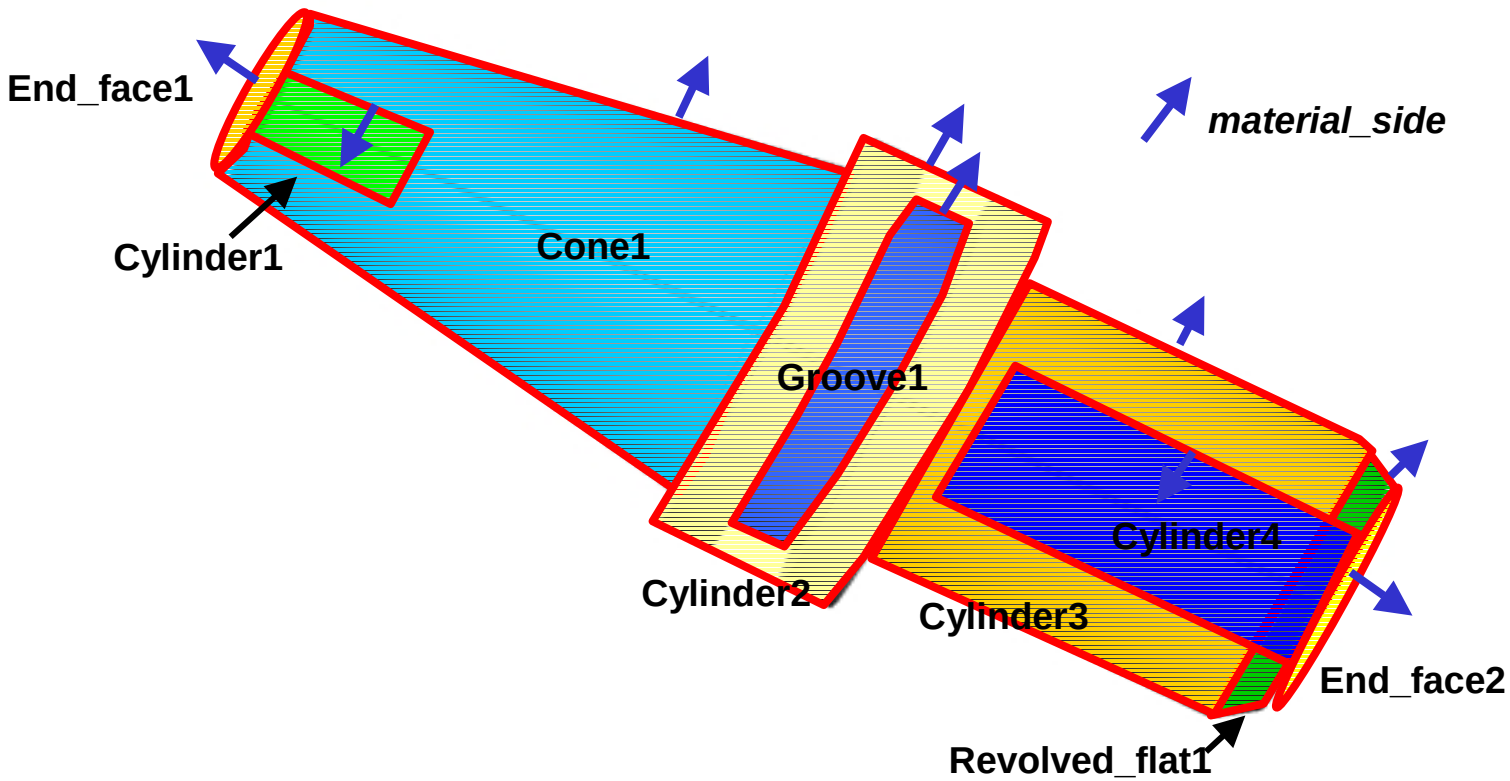
1. Overview of milling-type features and usage



- Defines material removal shape (exception: spherical_cap, boss, etc.)
- Features recognized from the finished shape can be used as machining feature by which tool path can be generated
- 1 machining operation can machine at most 1 feature

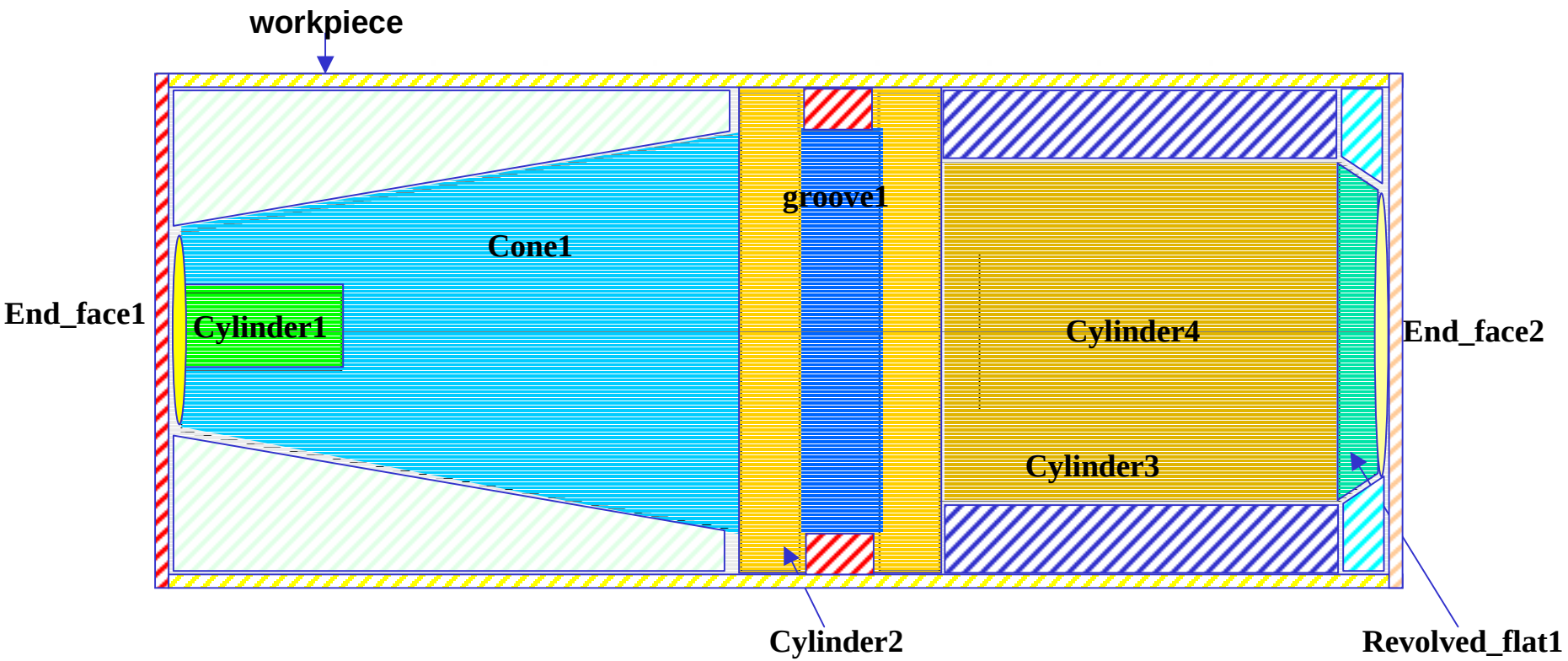
2. Characteristic of Turning-type features (1)

"Turning-type features are defining remained shape"

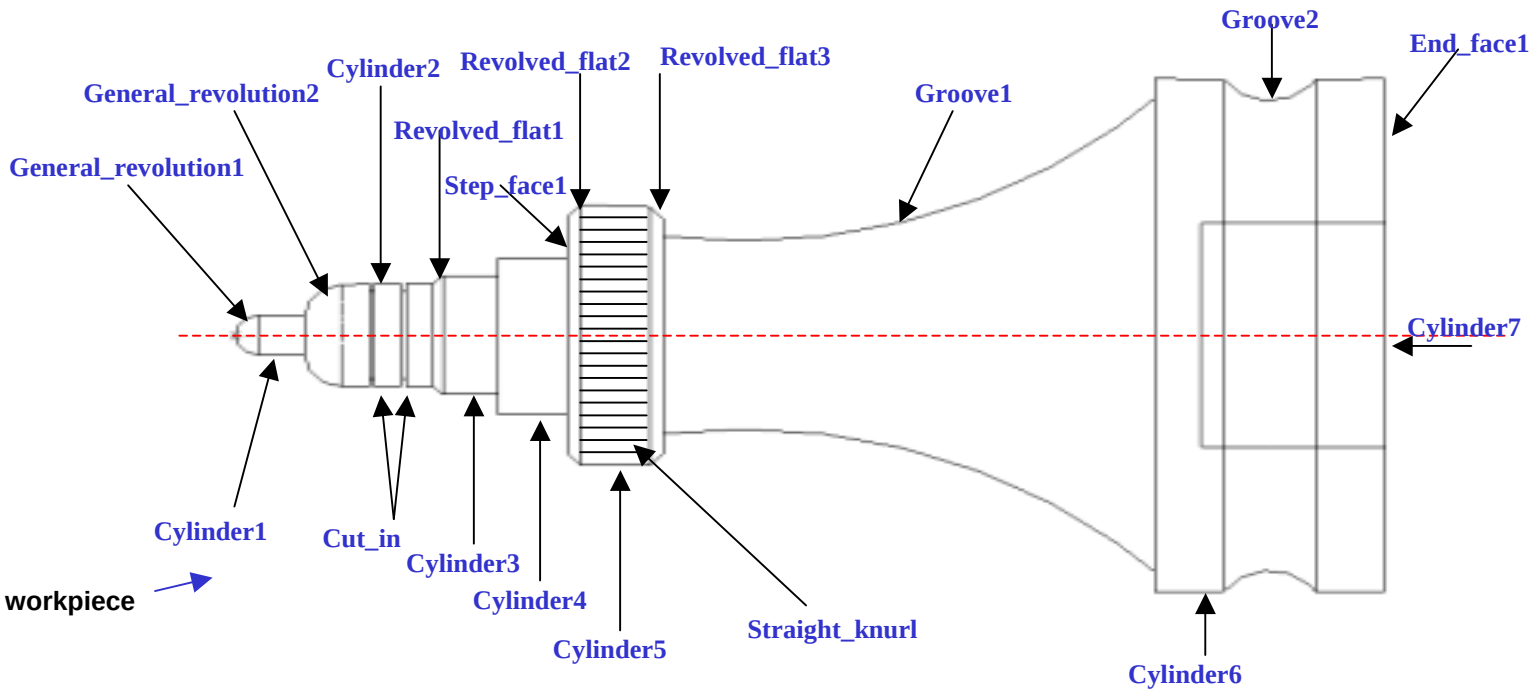


2. Characteristic of Turning-type features (2)

Removal volume in turning operation needs to be computed by boolean operation between workpiece and feature

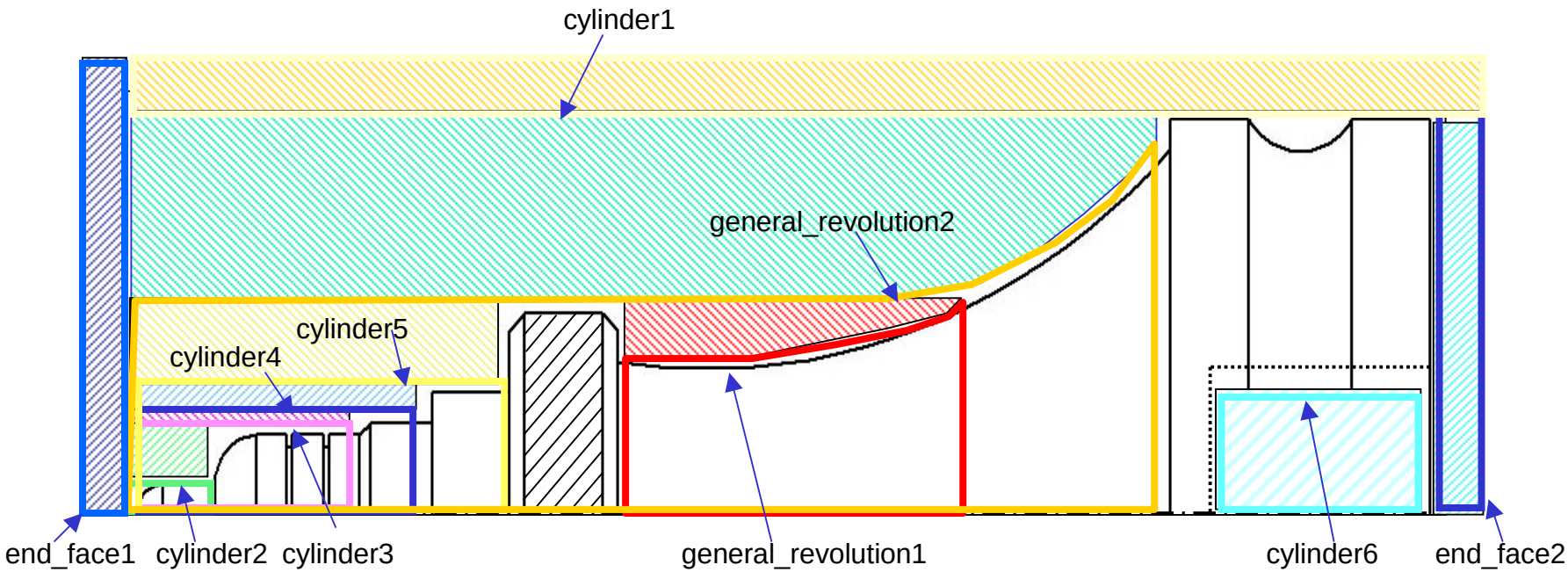


3. Feature recognition based on finished shape



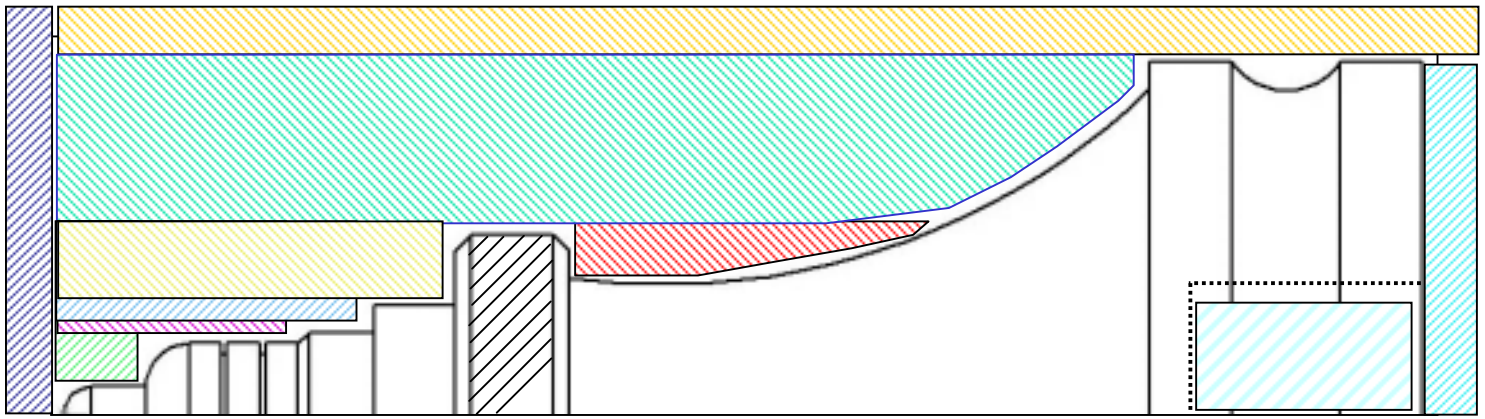
- **May be used as the machining feature for workingstep, where one operation is assigned to one machining feature**
- **But, the combined tool path of each machining feature will be inefficient !!**
- **Is it desirable to recognize machining features in this way?** **NO !**

4. Feature recognition based on removal volume

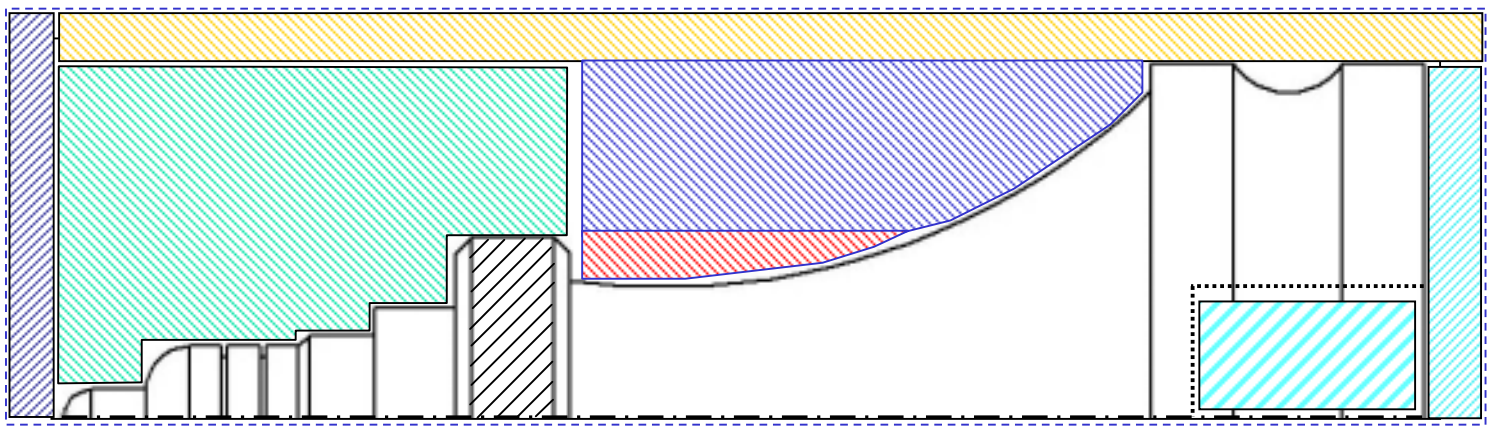


- Feature recognition based on removal volume should be used !!
- The shape of removal volume can be represented by turning features

5. A number of feature recognitions are possible! (1)

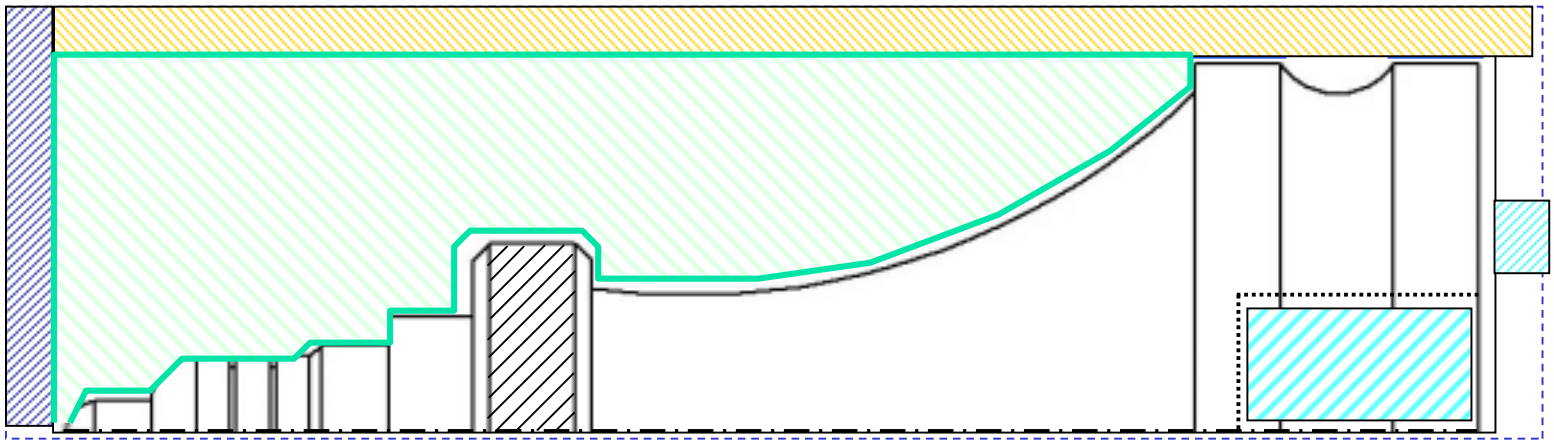


Feature recognition 1



Feature recognition 2

5. A number of feature recognitions are possible! (2)

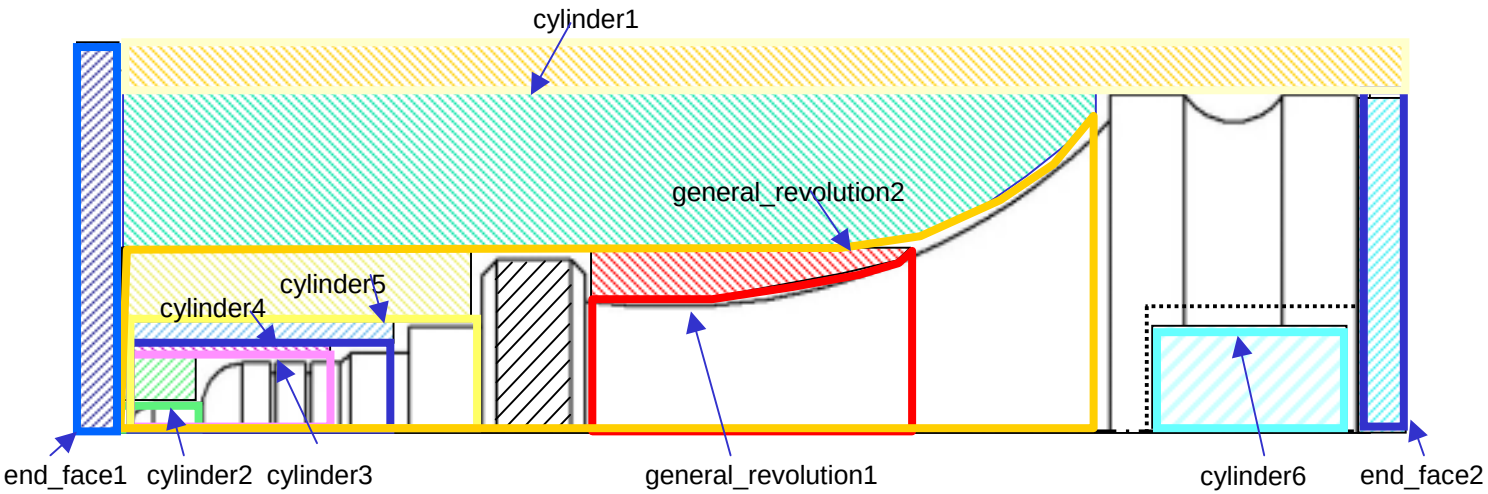


Feature recognition 3

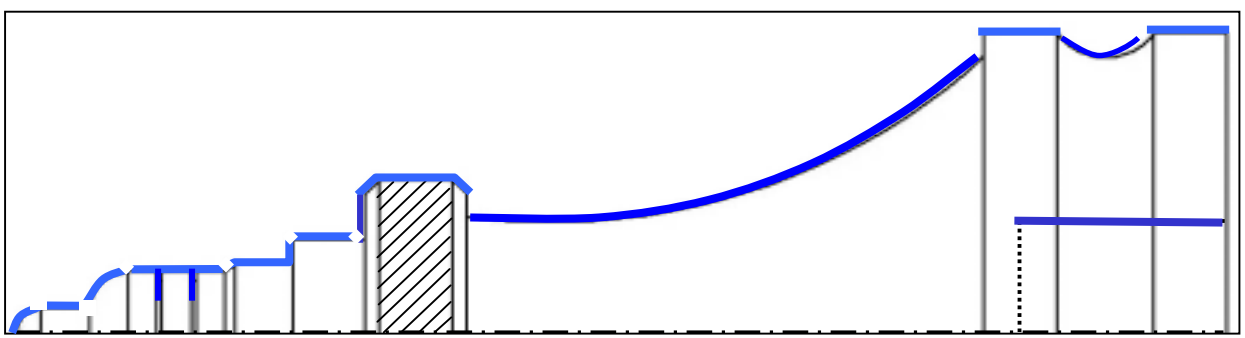
- Intelligent feature recognition algorithm considering machining efficiency (e.g., tool path, surface roughness, tolerance, cutting tool shape) will be necessary
- Desired solution among multiple solutions will be chosen by the user

6. Feature recognition for both rough-cut & finish-cut is necessary

<Feature recognition for rough-cut>

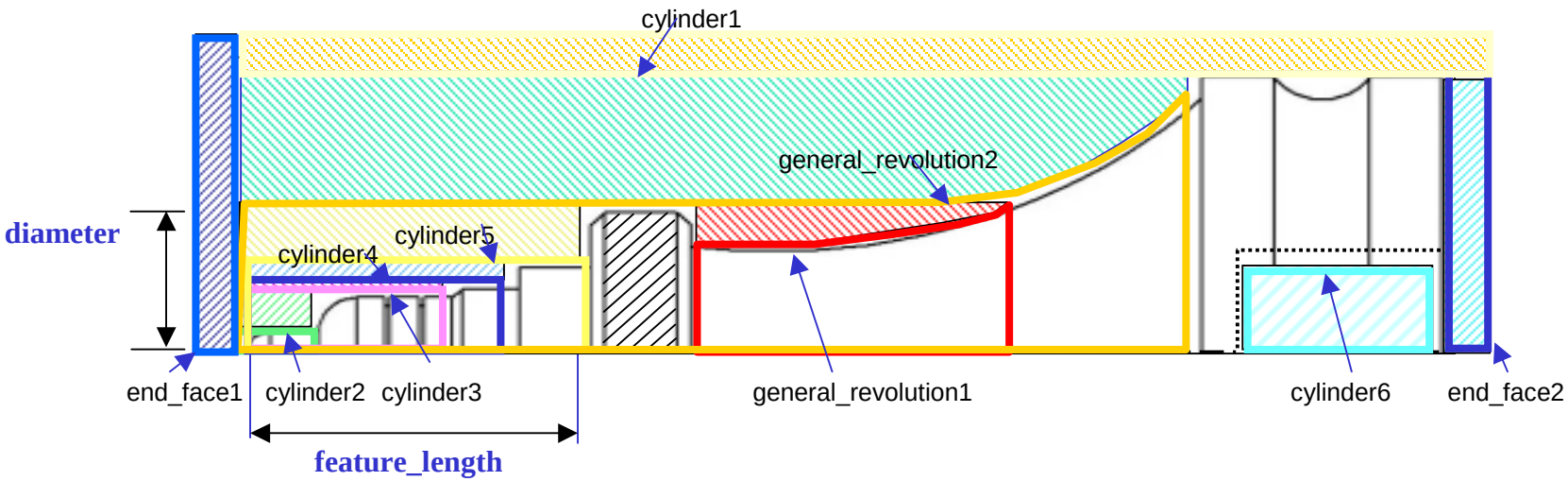


<Feature recognition for finish-cut>



7. In-process geometry is required

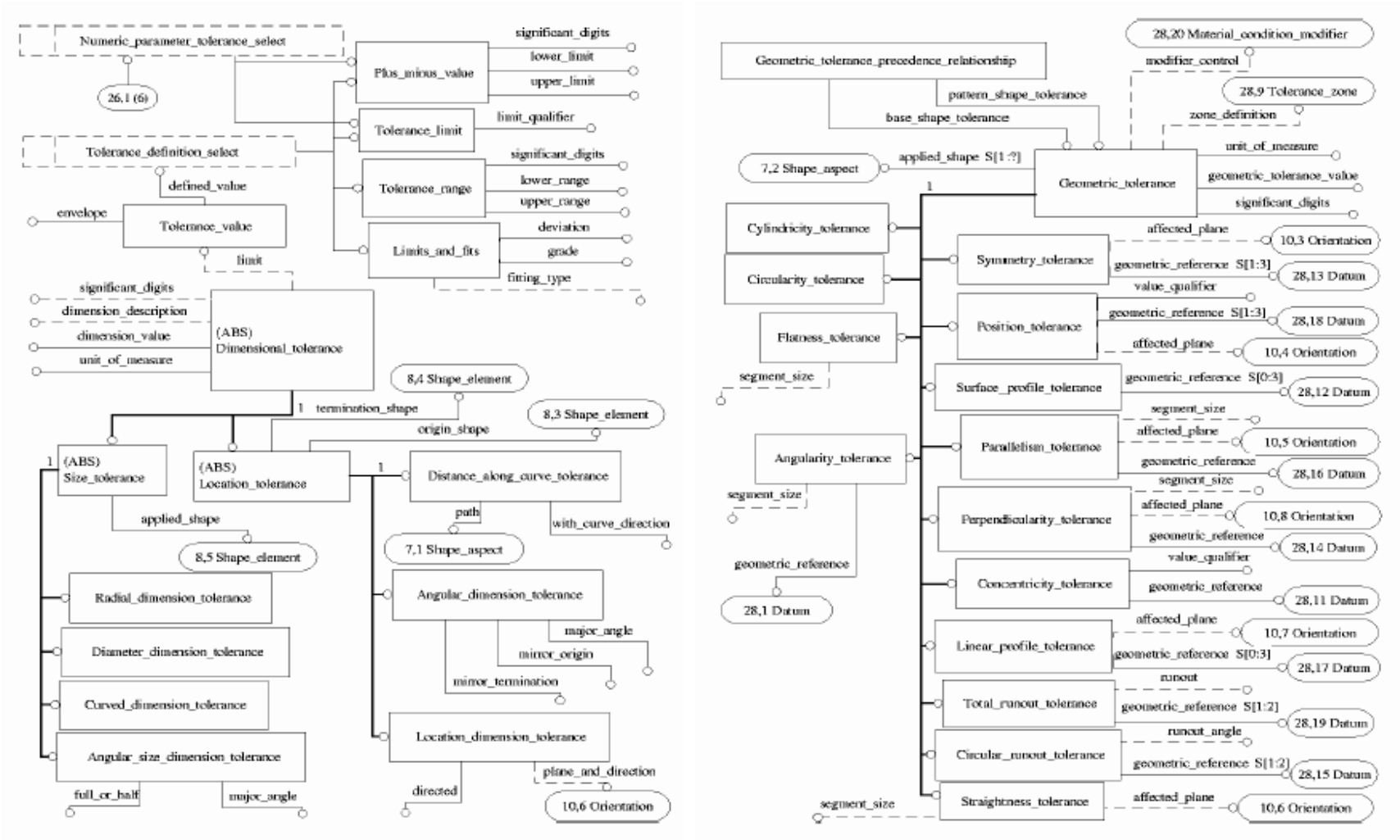
- Without following up of in-process geometry, tool path cannot be generated.
- In-process geometry needs to be included in data model
- For such a purpose, advanced B-rep (optional attribute of workingstep in Part 10) may be used
- For turning, it should be mandatory ?
- Either way, TPG of CNC should have follow up mechanism of in-process geometry !



8. Tolerance needs to be incorporated: How?

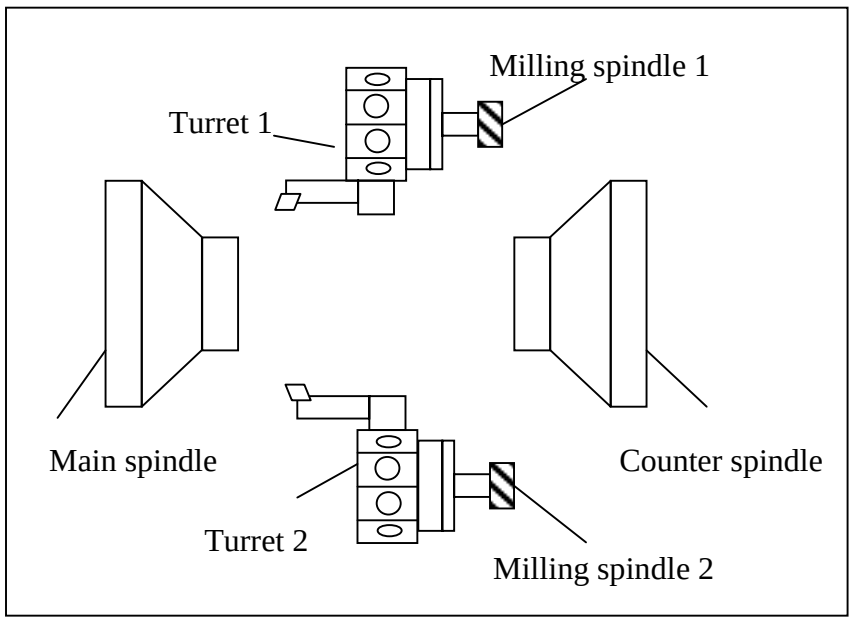
- Tolerance information such as surface finish, dimensional tolerance are very important in turning operation (It affects machining sequence, cutting conditions, ..)
- But, there are no entities to handle this information in the current ISO 14649
- In AP224, there are entities to handle many kinds of tolerance such as dimensional tolerance & geometric tolerance
- How to incorporate it ?

Informative: Tolerance entities in AP 224

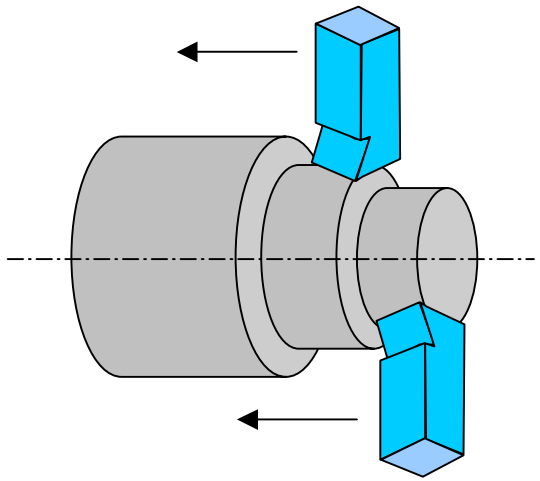


9. Coverage of advanced turning center: When?

Non-conventional turning machines for composite machining are widely used in practice



Turning center with more than one turret and spindle

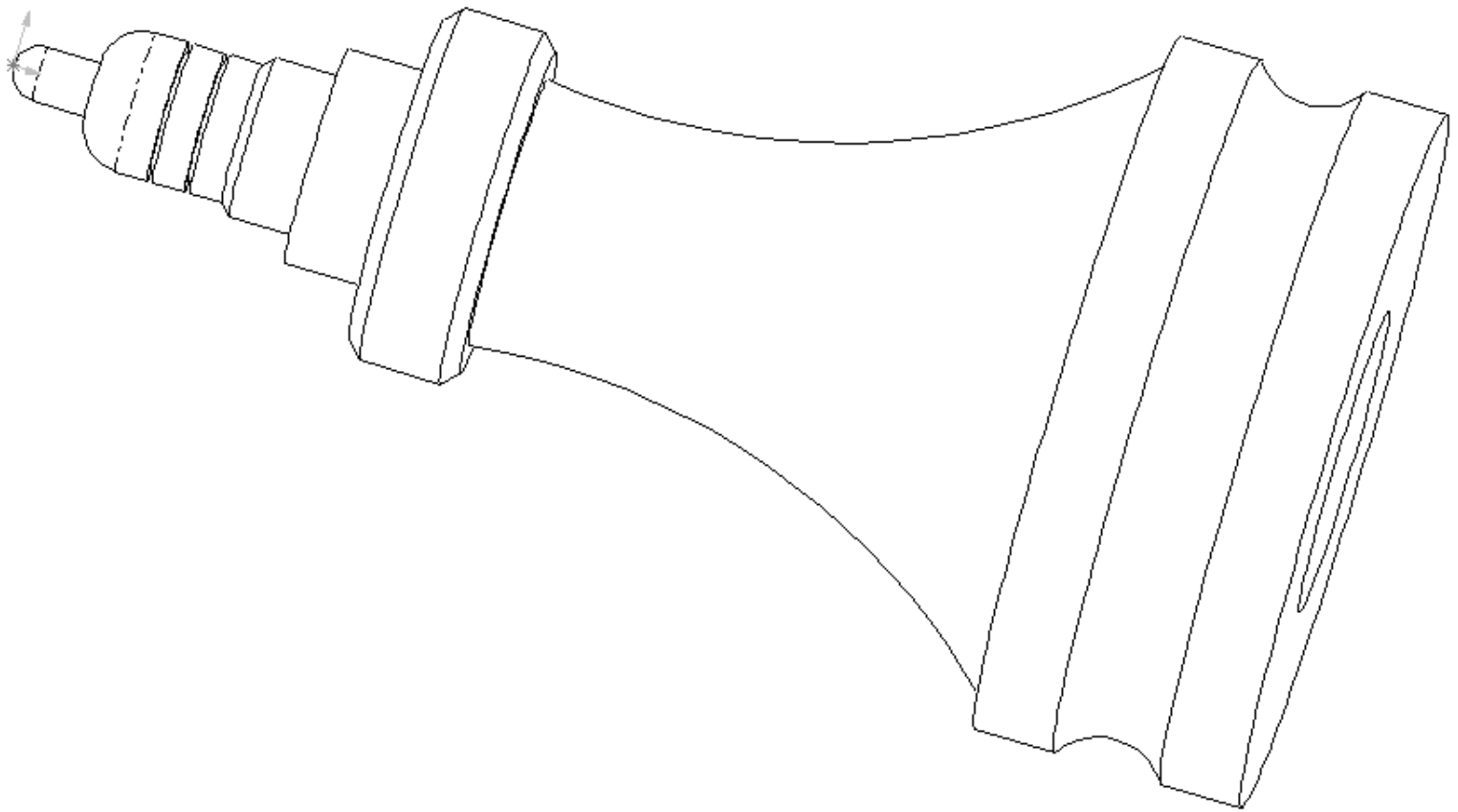


Parallel machining of the same feature

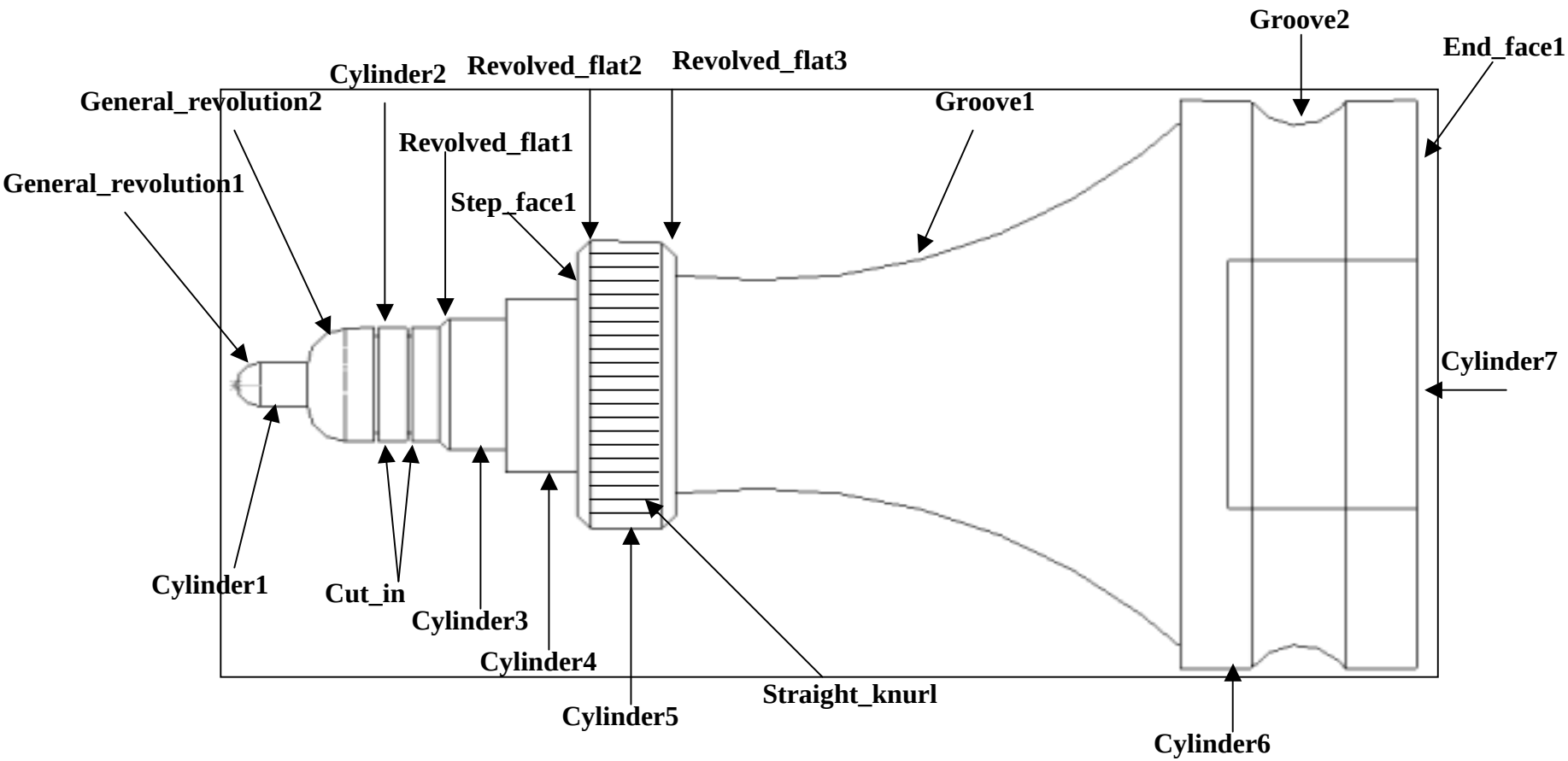
“ISO 14649 cannot represent this kind of machining”

Example Implementation Scenario

1.1 Example part shape: Input from AP203

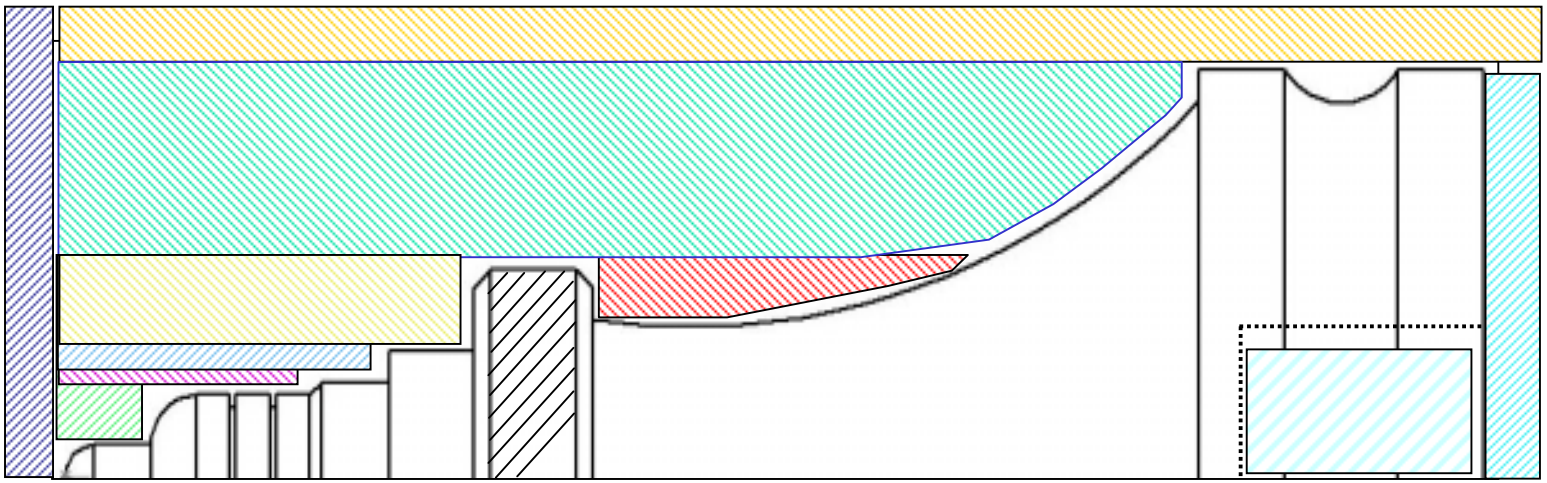


1.2 Example part shape: Input from feature-based CAD

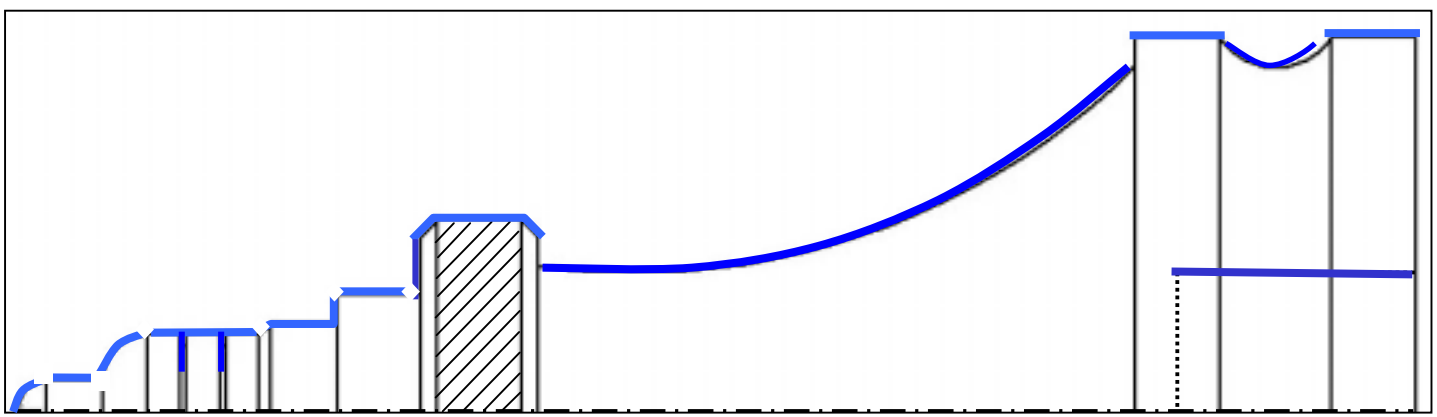


2. Recognizing machining feature based on removal volume (1)

Rough Cut-A

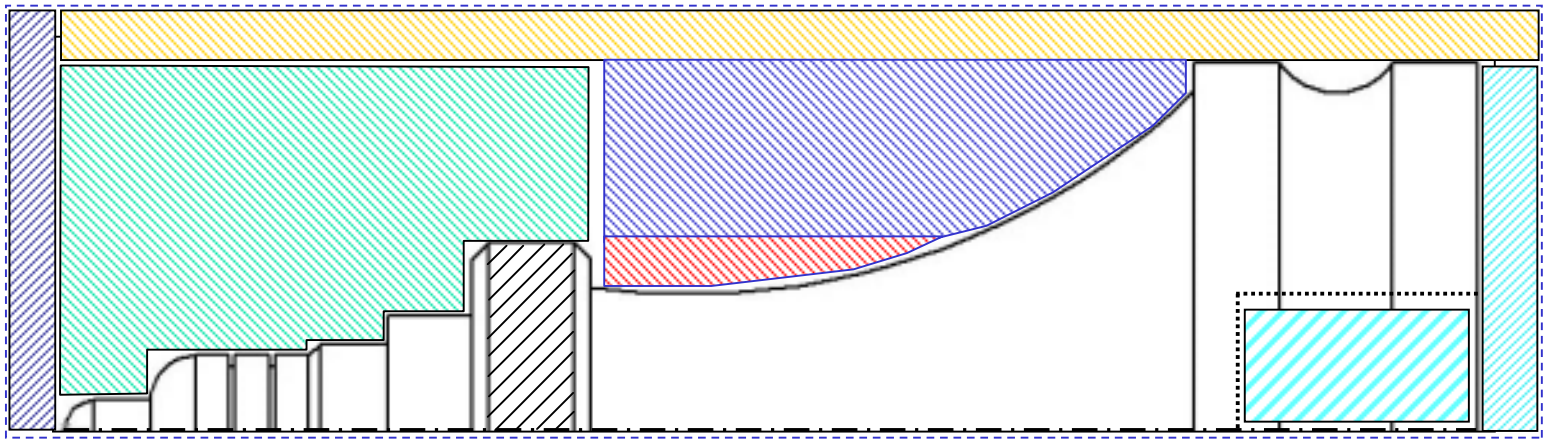


Finish Cut-A

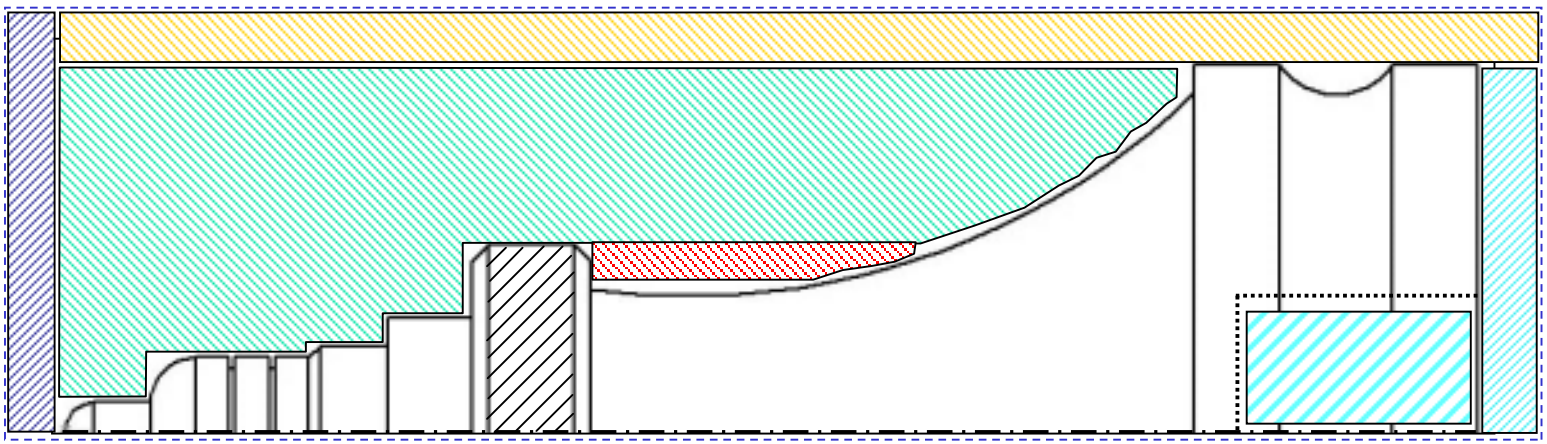


2. Recognizing machining feature based on removal volume (2)

Rough Cut-B

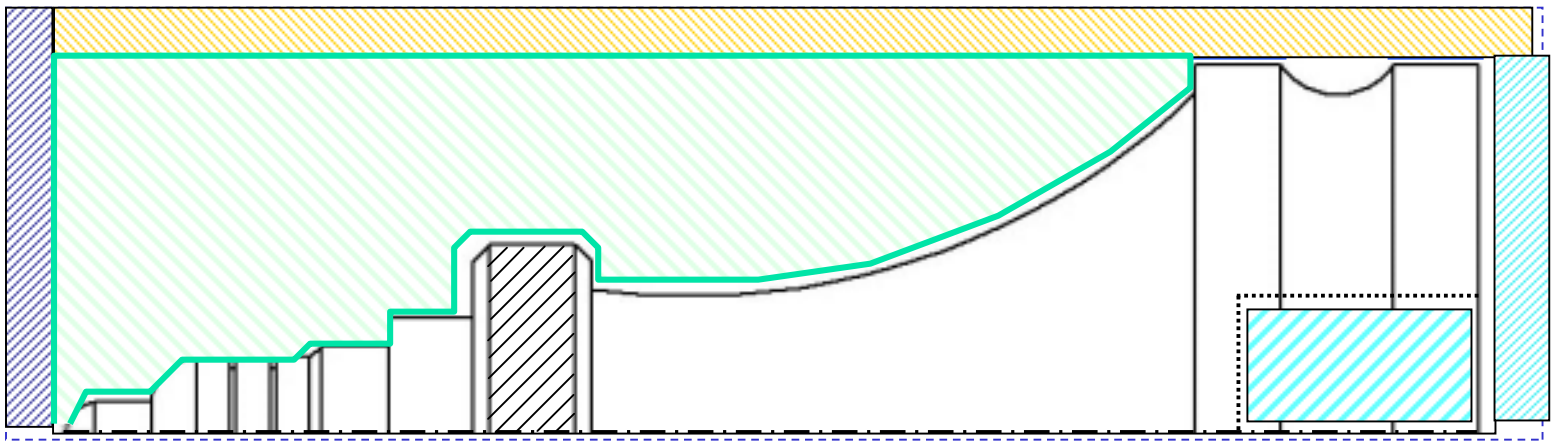


Rough Cut-C

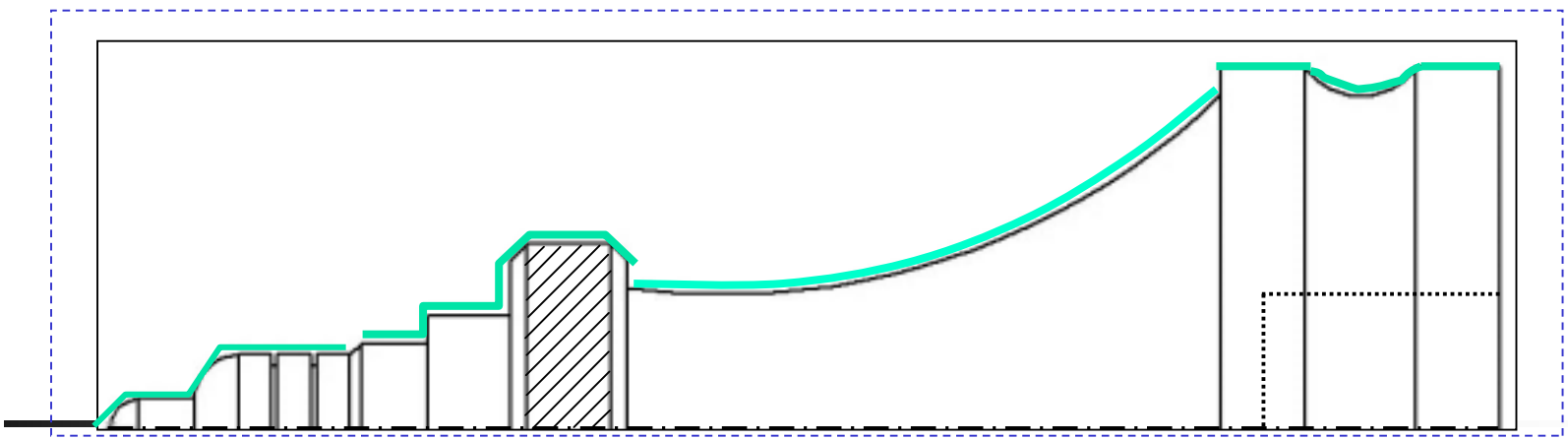


2. Recognizing machining feature based on removal volume (3)

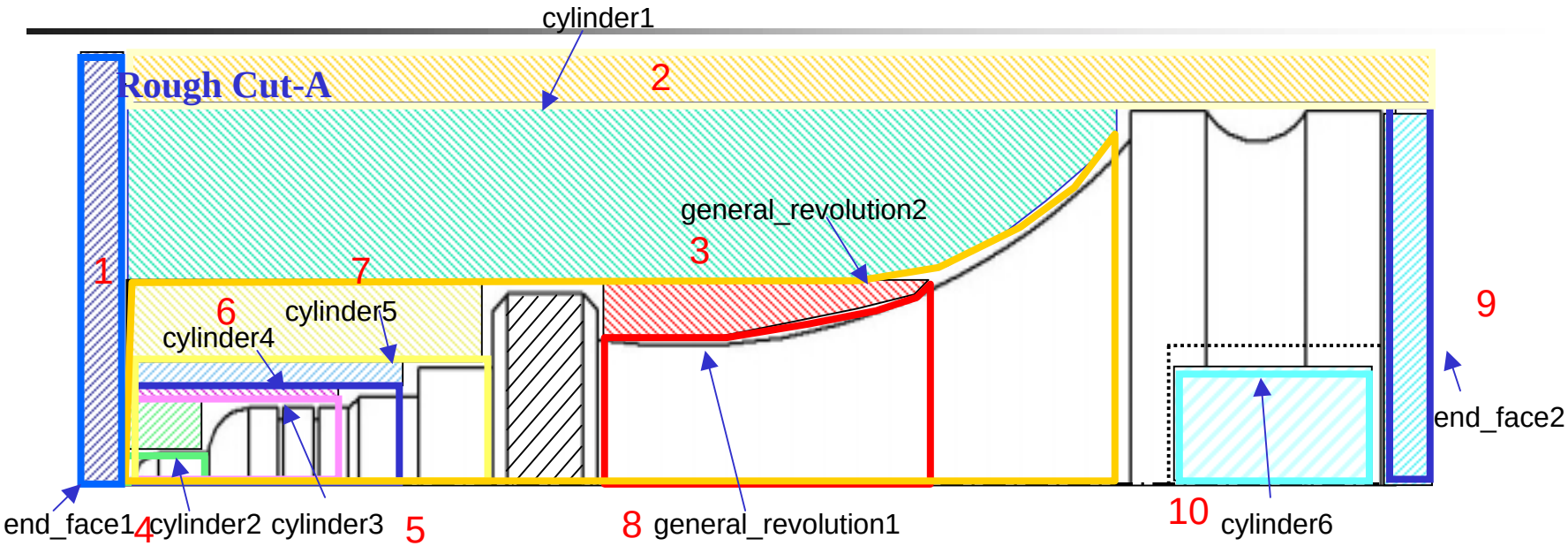
Rough Cut- D



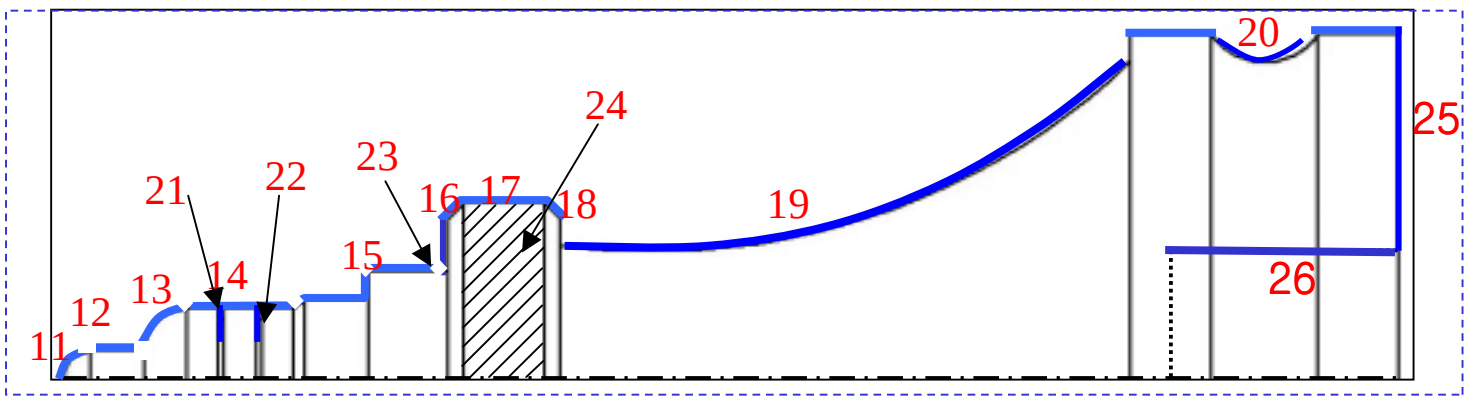
Using compound feature, Finish Cut - B



3. Assigning part 12 feature to the recognized features (1)



Finish Cut-A



3. Assigning part 12 feature to the recognized features (2)

Rough Cut-A

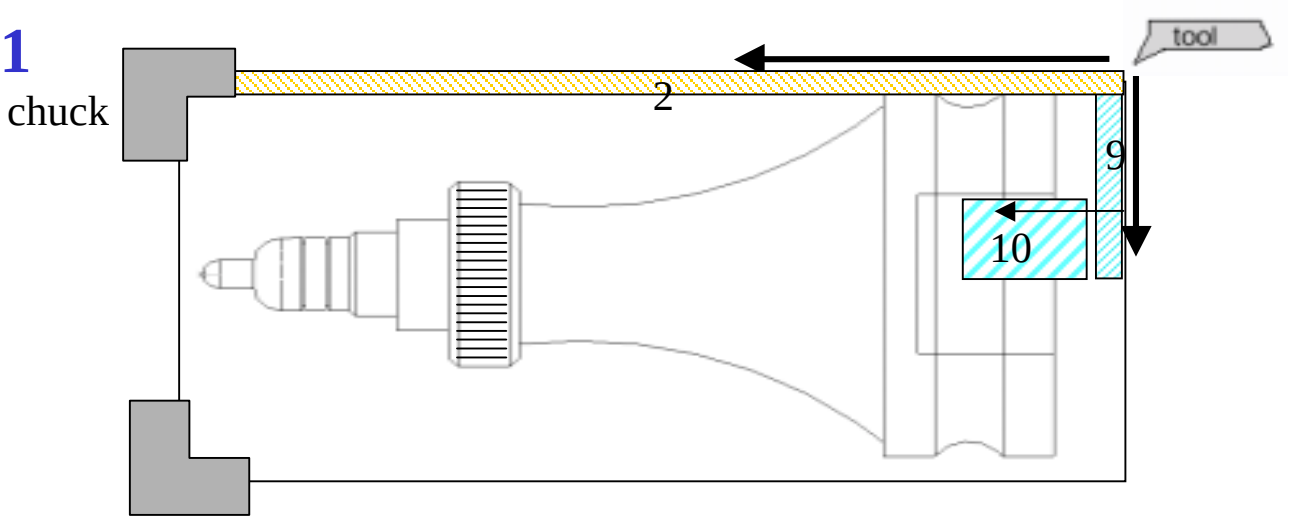
Num	Feature	name	Num	Feature	name
1	end_face	End_face1	14	cylinder	Cylinder8
2	cylinder	Cylinder1	15	general_revolution	General_revolution5
3	general_revolution	General_revolution1	16	revolved_flat	Revolved_flat1
4	cylinder	Cylinder2	17	cylinder	Cylinder9
5	cylinder	Cylinder3	18	revolved_flat	Revolved_flat2
6	cylinder	Cylinder4	19	groove	Groove1
7	cylinder	Cylinder5	20	groove	Groove2
8	general_revolution	General_revolution2	21	cut_in	Cut_in1
9	end_face	End_face2	22	cut_in	Cut_in2
10	cylinder	Cylinder6	23	step_face	Step_face1
11	general_revolutio	General_revolution3	24	knurl	Knurl1
12	cylinder	Cylinder7	25	end_face	End_face3
13	general_revolution	General_revolution4	26	cylinder	Cylinder10

4. Assigning operation to each feature

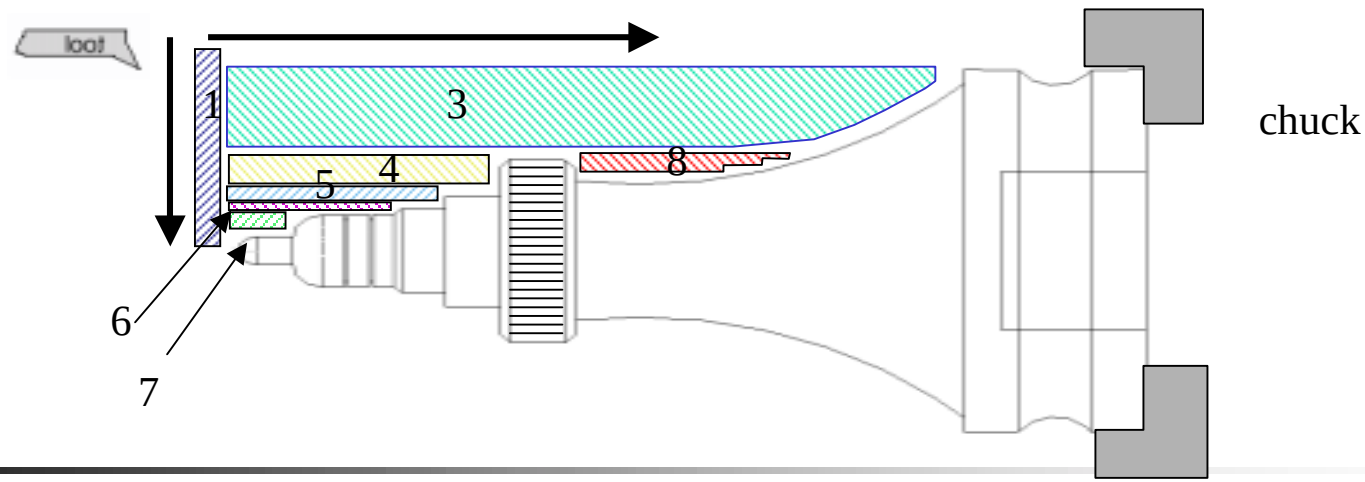
WS-num	Feature_name	Operation_name	WS-num	Feature_name	Operation_name
1	End_face1	facing_rough	14	Cylinder8	contour_finish_turning
2	Cylinder1	contour_rough_turning	15	General_ revolution5	contour_finish_turning
3	General_ revolution1	contour_rough_turning	16	Revolved_ flat1	finish_ grooving
4	Cylinder2	contour_rough_turning	17	Cylinder9	contour_finish_turning
5	Cylinder3	contour_rough_turning	18	Revolved_ flat2	finish_ grooving
6	Cylinder4	contour_rough_turning	19	Groove1	finish_ grooving
7	Cylinder5	contour_rough_turning	20	Groove2	finish_ grooving
8	General_ revolution2	contour_rough_turning	21	Cut_in1	finish_ grooving
9	End_face2	facing_rough	22	Cut_in2	finish_ grooving
10	Cylinder6	contour_rough_turning	23	Step_face1	facing_finish
11	General_ revolution3	contour_finish_turning	24	Knurl1	contour_finish_turning
12	Cylinder7	contour_finish_turning	25	End_face3	facing_finish
13	General_ revolution4	contour_finish_turning	26	Cylinder10	contour_finish_turning

5. Determining set up for each operation

- **Set-up 1**

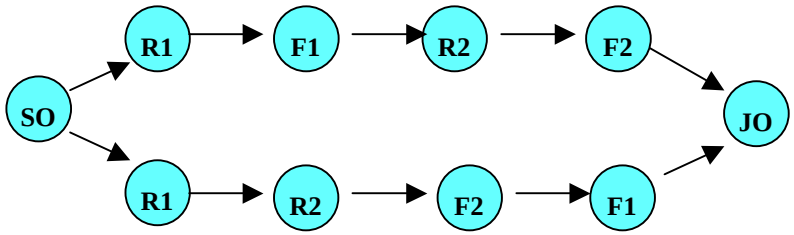


- **Set-up 2**

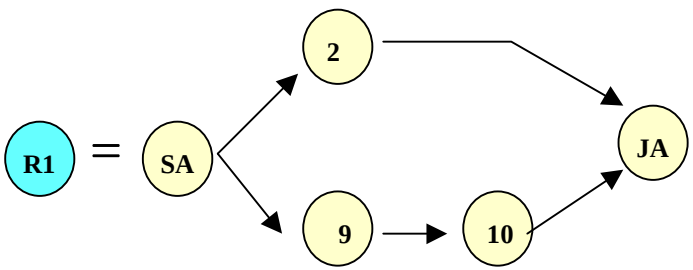


6. Determining work plan (1)

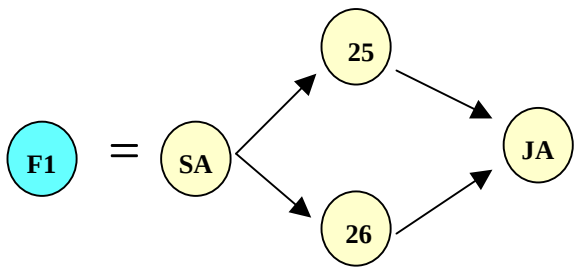
Overall work plan:



Rough cut with Setup 1

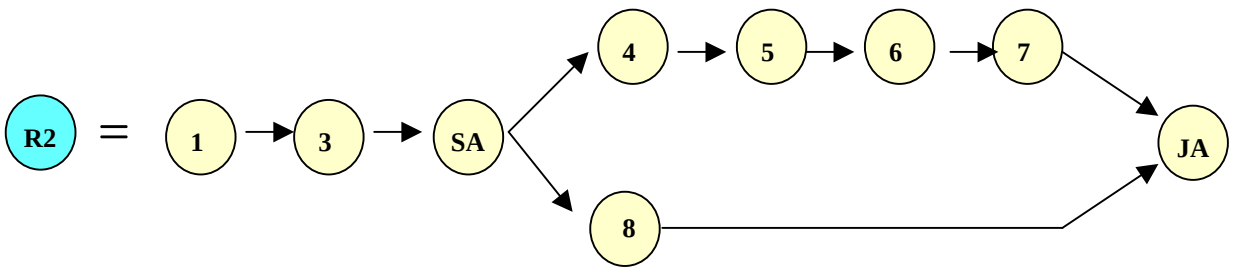


Finish cut with Setup 1



6. Determining work plan (2)

Rough cut with Setup 2



Finish cut with Setup 2