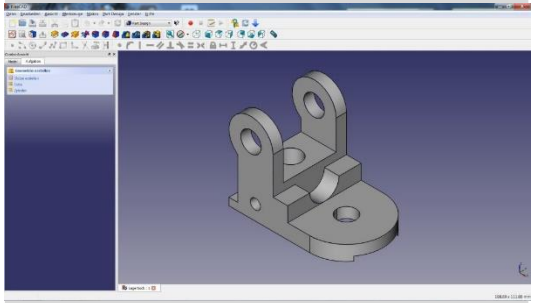
Goal:

Development of a Design-for Manufacturability tool for FreeCAD

CIKONI composites innovation

FreeCAD



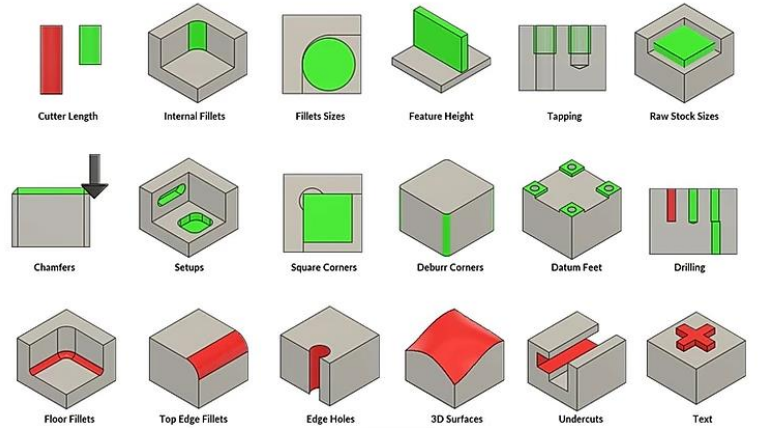
FreeCAD is a open-source 3D-Computer-Aided Design software, which we use for the design of mechanical components. It is based on Open Cascade Technology and other Open Source software.

We mostly use FreeCAD for cnc machined components and we need a fast „design for manufacturability checker“ and report functionality

https://i.materialise.com/blog/en/freecad-tutorial-review

Check design for…

DFM



https://www.adambender.info/post/design-for-cnc-milling

https://help.fictiv.com/en/articles/2270888-optimizing-part-design-for-cnc-machining

Desired functionalitites for a first version

CIKONI composites innovation

The script/macro/plugin should be able to:

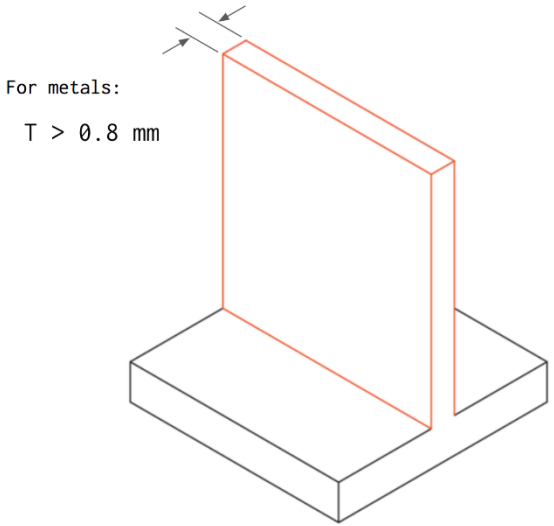
1. Detect small wall thickness areas
2. Sharp internal corners
3. Detect length to diameter relationships of holes
4. Detect unreachable areas
5. Detect threads (specific diameters)
6. **Visualize detected DFM issues** and generate a report with visualizations of the effected areas

The script does currently not need to (of course if would be great if this could be implemented too, but it is not a priority):

- Detect necessary flips of the workpiece for machining

1. Thin walls

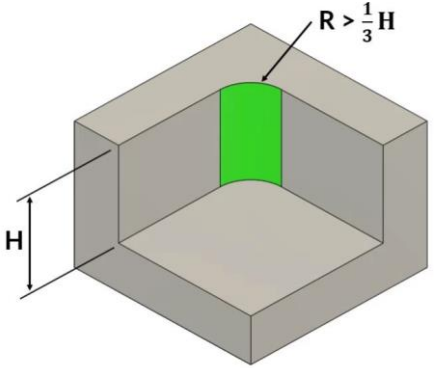
- We are looking for a way to detect very small wall thickesses which are defined as a parameter (e.g. 0,8mm etc.)
- For reporting the areas which are too thin should be colored/highlighted

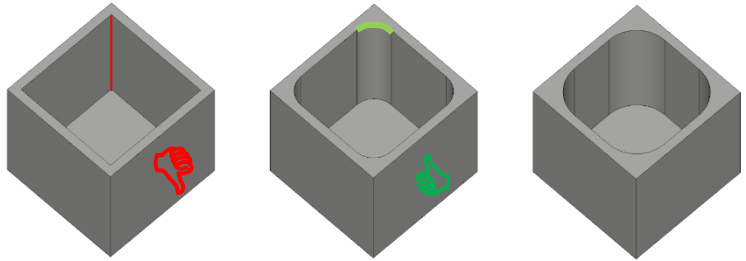


2. Sharp internal corners

- Internal sharp corners are not easily machined and should be detected.
- We are looking for both a minimum radius (for example 1mm) and ideally for a relationship of radius to height

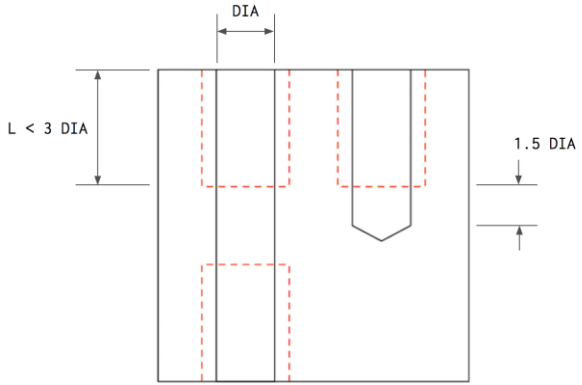
- For the report, too small radii or sharp edges should be highlighted (red line or similar)

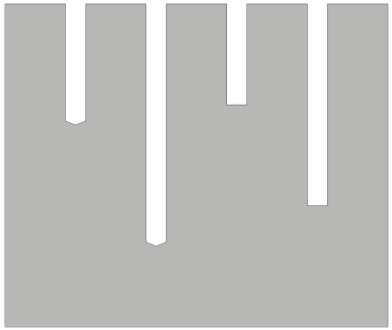




3. Length to Diameter relationship

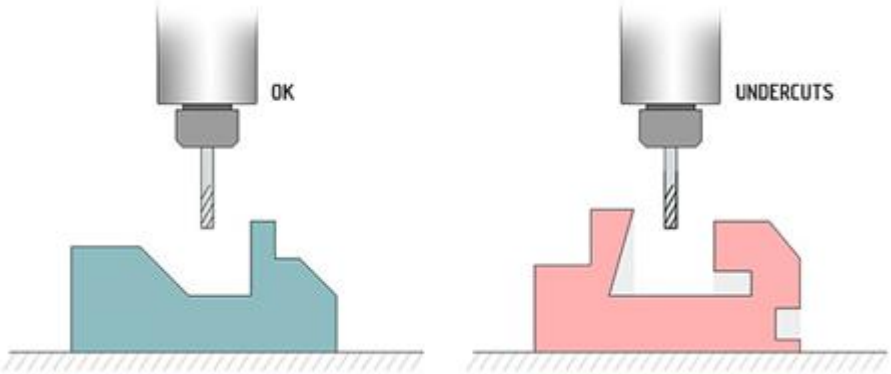
- Holes should have a limited depth of L >3 x Diameter
- For the report, too deep holes should be highlighted/colored



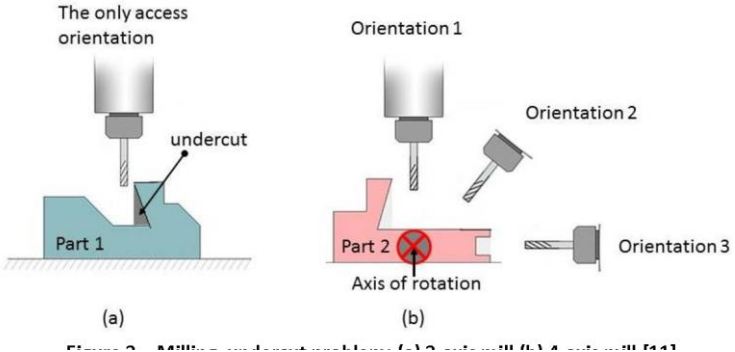


4. Unreachable areas („undercuts“)

- Undercuts are usually hard to machine if only a 3 axix machine is used for cutting
- It would be desirable to detect areas, which are hard to machine, even though 4- or 5-axis machining might be able to solve the manufacturability
- The undercut should ideally be highlighted for the report



Additional 4th axis:



https://www.semanticscholar.org/paper/axes-of-rotation-for-4-axis-CNC-milling-machine-by-Hou/3ab44298b2dd24d1a60331cd6857e65fd1ab8f44

5. Detect threads

- Standard DIN13 threads are modelled in the CAD modell as either a standard tapping drill holes (yellow) and/or a matching thread diameter (Green).
- These would be ideally reported and visualized if found

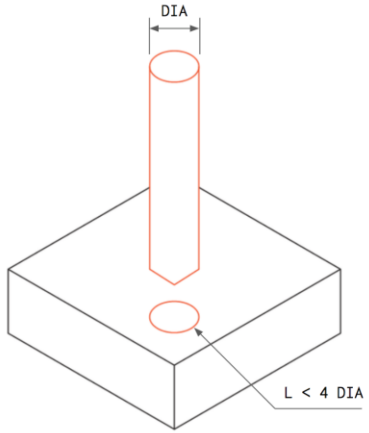
Metrisches ISO-Gewinde DIN 13, T1

Gewinde	Kernloch-bohrer Æ	Steigung	Sechskant-Schlüsselweite	Durchgangsloch für Schrauben		Mutternhöhe
				fein	mittel	
M 1	0,75	0,25		1,1	1,2	0,8
M1,1	0,85	0,25		1,2	1,3	0,9
M1,2	0,95	0,25		1,3	1,4	1
M1,4	1,1	0,3		1,5	1,6	1,2
M1,6	1,3	0,35	3,2	1,7	1,8	1,3
M1,8	1,5	0,35	3,2	1,9	2	1,4
M2	1,6	0,4	4	2,2	2,4	1,6
M2,2	1,8	0,45	4,5	2,4	2,6	1,8
M2,5	2,1	0,45	5	2,7	2,9	2
M3	2,5	0,5	5,5	3,2	3,4	2,4
M3,5	2,9	0,6	6	3,7	3,9	2,8
M4	3,3	0,7	7	4,3	4,5	3,2
M5	4,2	0,8	8	5,3	5,5	4
M6	5,0	1,0	10	6,4	6,6	5
M8	6,8	1,25	13	8,4	9	6,5
M10	8,5	1,5	17	10,5	11	8
M12	10,2	1,75	19	13	14	9,5
M14	12	2	22	15	16	11
M16	14	2	24	17	18	13
M18	15,5	2,5	27	19	20	15
M20	17,5	2,5	30	21	22	16
M22	19,5	2,5	32	23	24	17
M24	21	3	36	25	26	18
M27	24	3	41	28	30	20
M30	26,5	3,5	46	31	33	22
M36	32	4	55	37	39	28
M42	37,5	4,5	65	43	45	32
M48	43	5	75	50	52	38
M56	50,5	5,5	85	38	62	44
M64	58	6	95	66	70	50

6. Non standard hole sizes

For diameters < 8 mm it would be good to:

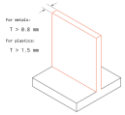
- Visualize diameters of holes which are not multiples of 0,5mm (0,5; 1; 1,5; 2; 2,5; …)
- Are smaller then 1mm



7. Visualize effected areas in a report

- Ideally the report should

[Partname] [Date]

Issue Nr.	Issue type	Picture of affected area
1	Thin walls	
1.1		
1.2		
2	Length to diameter	
2.1		
2.2		
⋮	⋮	⋮

Further information

- We use STEP Format for our 3D-CAD files

Further quick reads

- https://wiki.imal.org/howto/good-cnc-design-practice
- https://www.adambender.info/post/design-for-cnc-milling

Samples of CNC machined parts