Tips When Doing CAD Collaboration

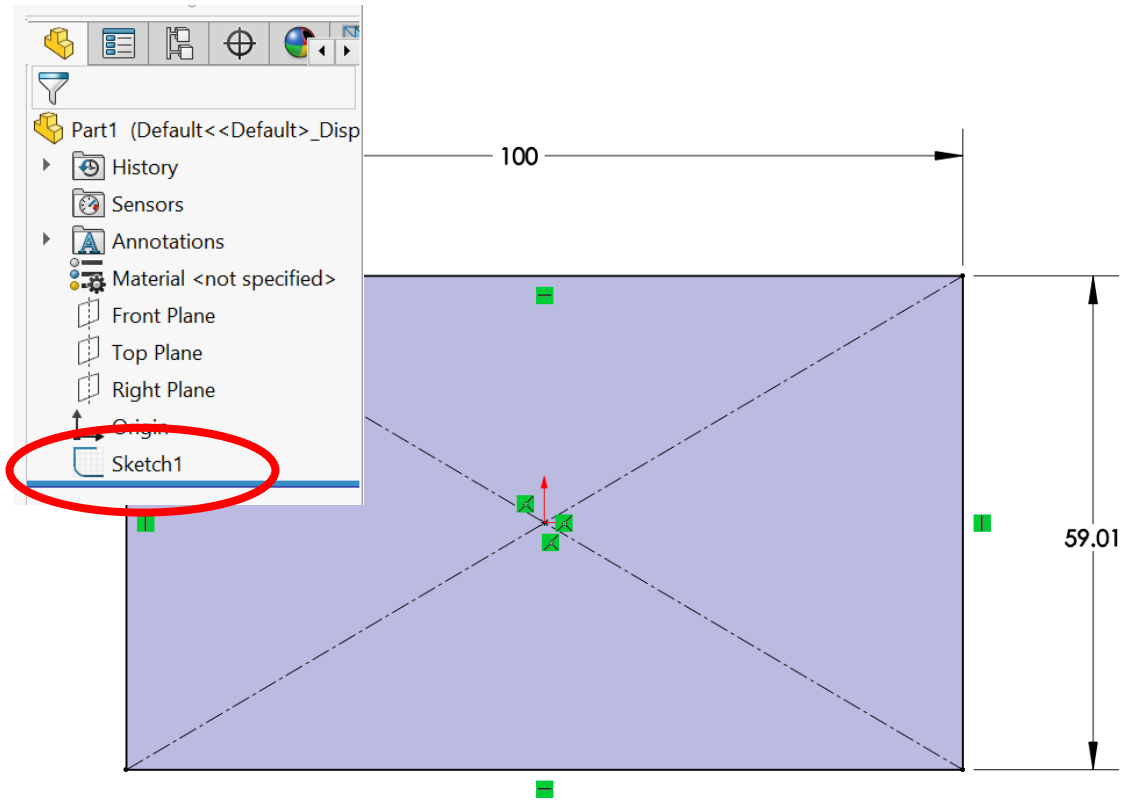
李岱峰，17机器人工程

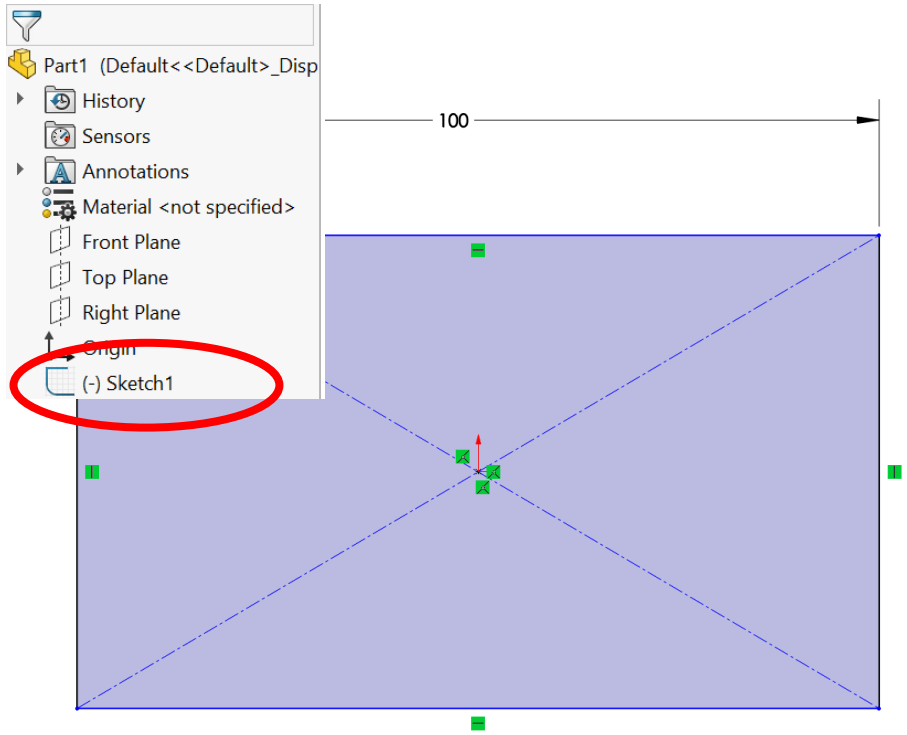
2020.07.22

Sketches

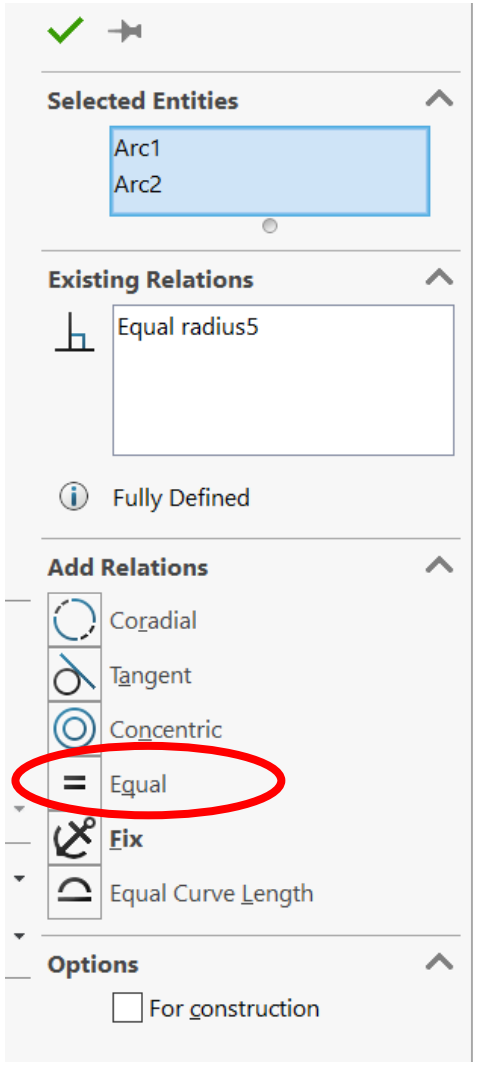
- Fully define sketches. All **BLACK**, no **BLUE**.
  - DO NOT use “Fully Define Sketch” button
- Use equations, relations, and general variables
  - Use relation definitions (for example, “=”), or define variables
- Dimension rectangles from the edges, not the corner
- Make separate features in separate sketch unless it’s master sketch from top-down
- Use symmetrical relations
- Put origin at a mounting location (or center point)
- Use construction lines to help define sketch (less unnecessary trim)
- 3D Sketch - 2D first then having 3D sketch come off of that

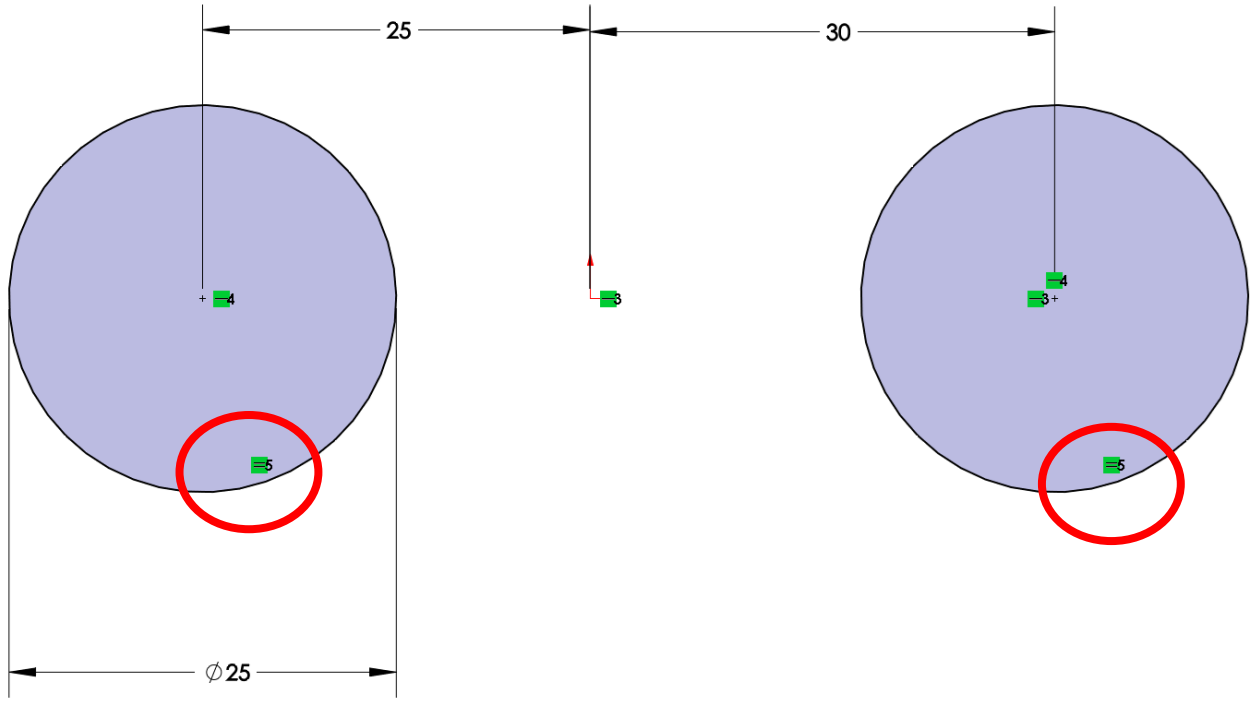
Sketch - Fully Define Sketches





Sketch - Combine Common Dimensions



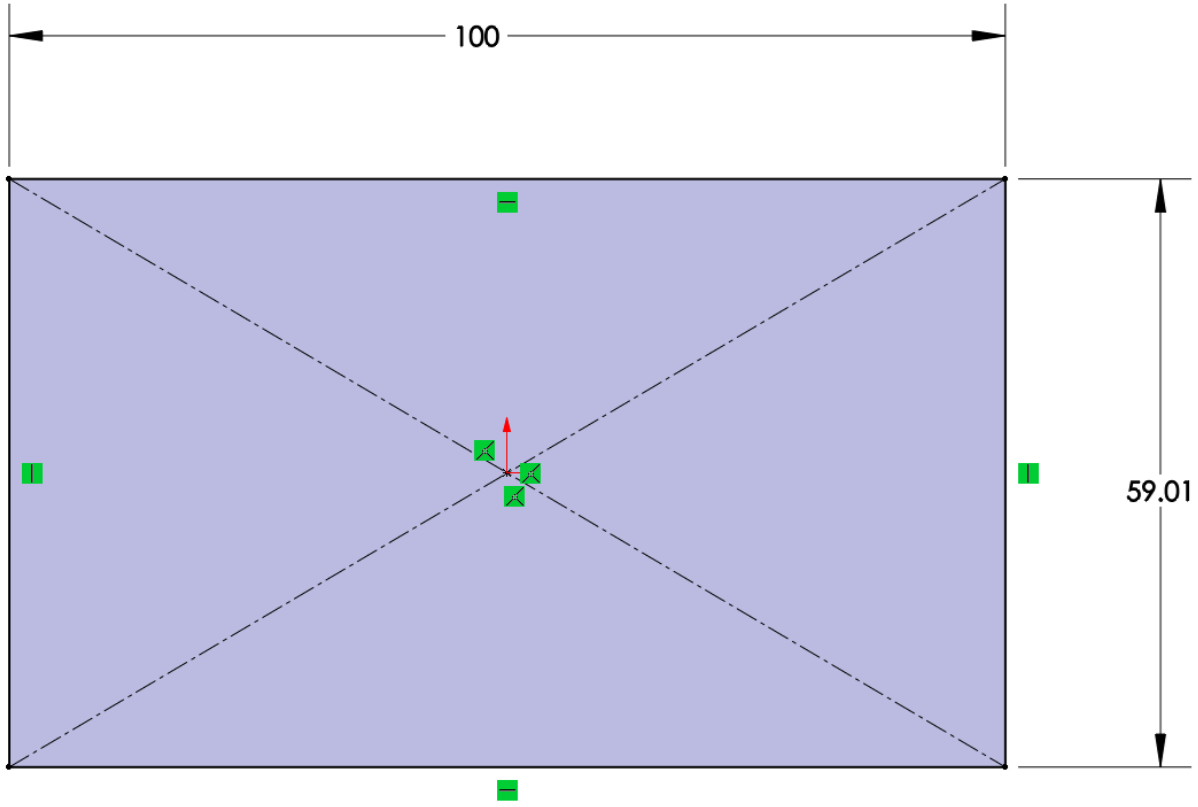


Sketch - Dimensioning Rectangles

Demonstration

Use Construction Lines

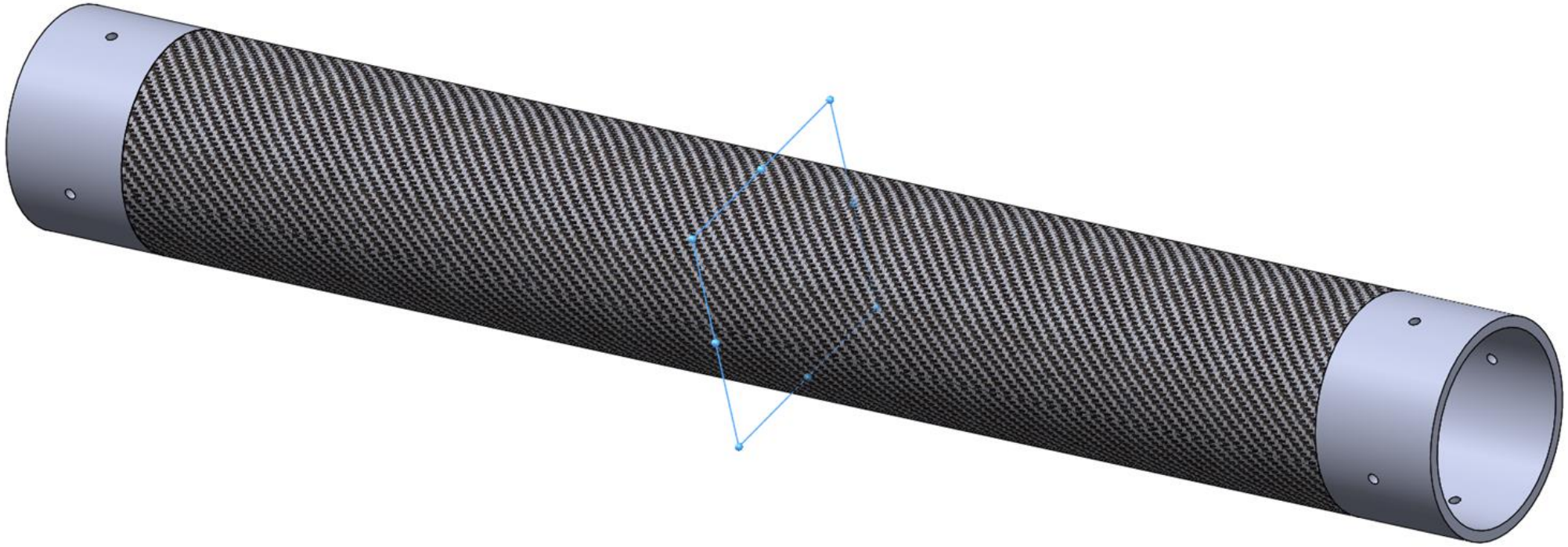
Also:
-Symmetrical Relation
-Origin



Parts

- Use symmetry whenever possible
- Use configuration when possible
- Make features like when it’s being machined
- Name useful dimensions and features
  - Especially when those dimensions are referenced
- Make several simple features instead of one complicated feature. (More robust and easy to edit)
- Use fillet features instead of sketch fillets
- Apply cosmetic fillet and chamfer last

Use Symmetrical Relations

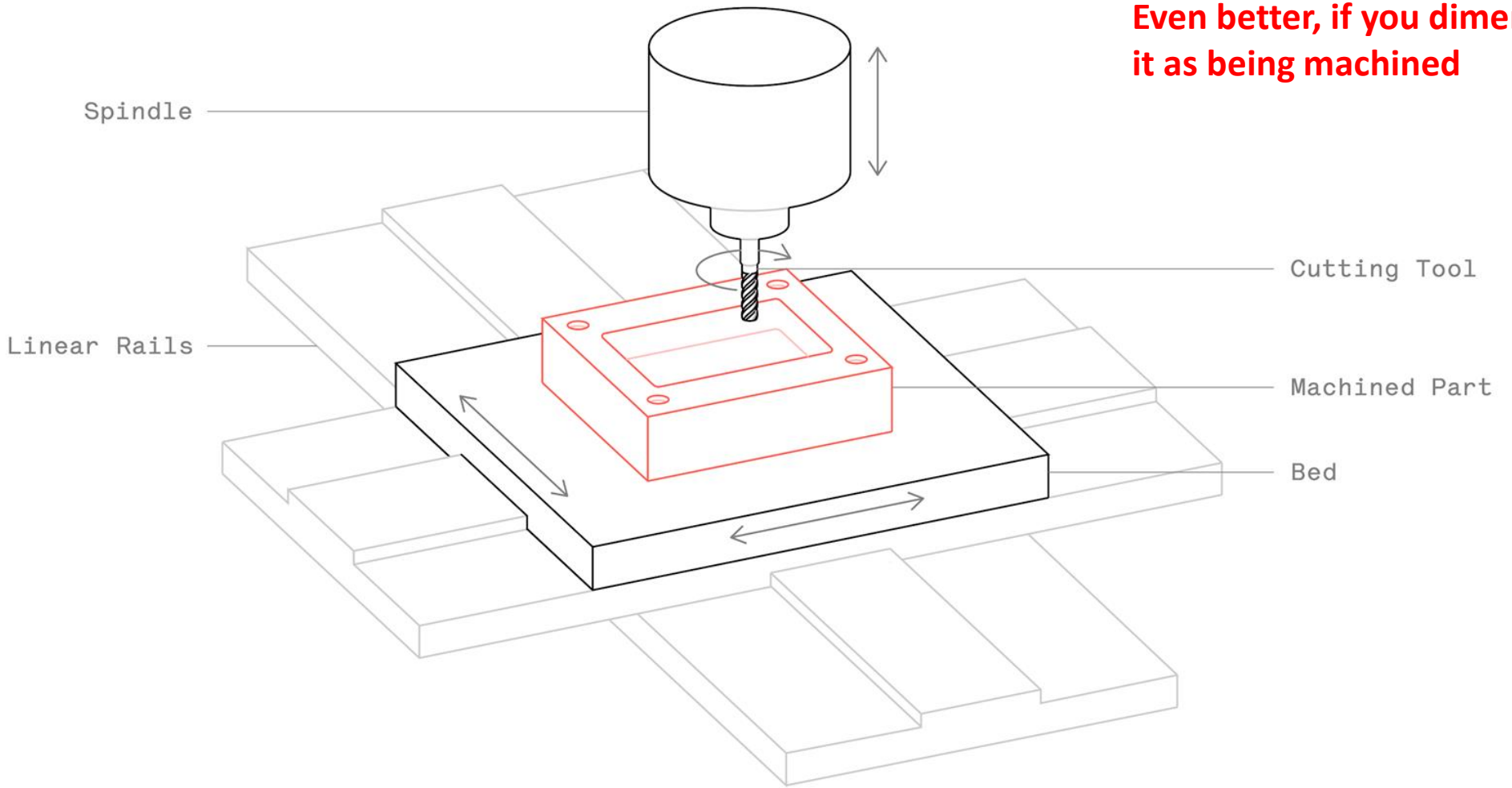


Use Configuration

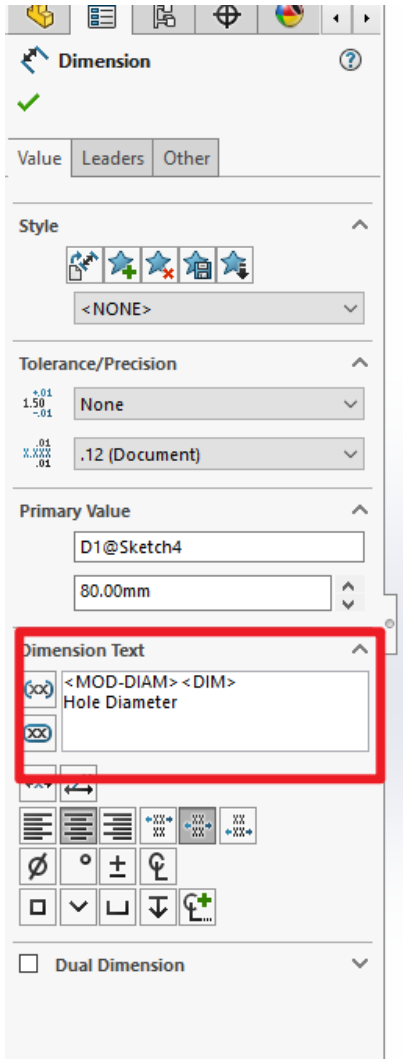
Demonstration

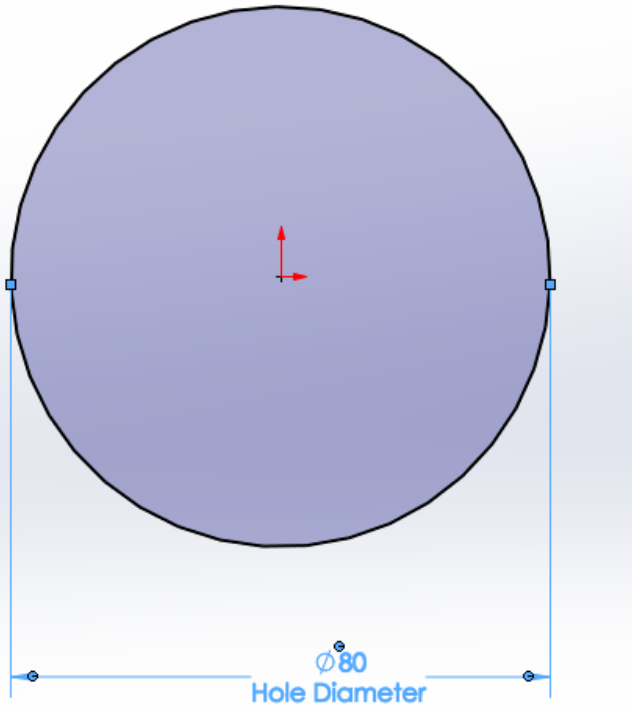
Make features Like Being Machined (not necessary for you now)

Even better, if you dimension it as being machined

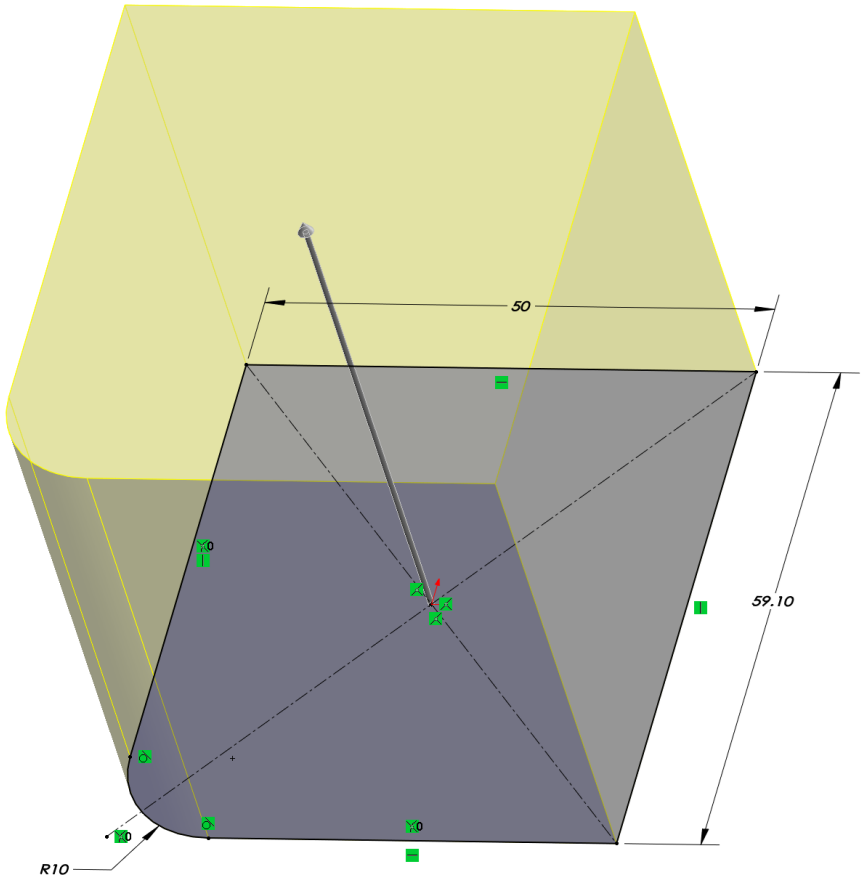


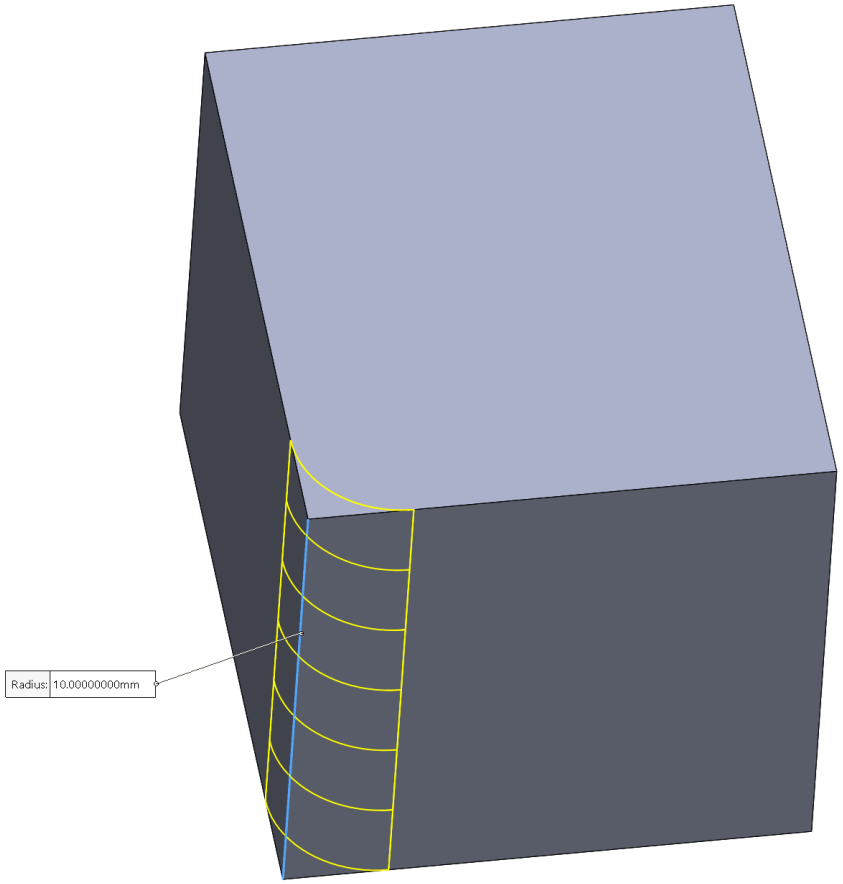
Label Important Dimensions





Fillet in Feature Not Sketch if Possible

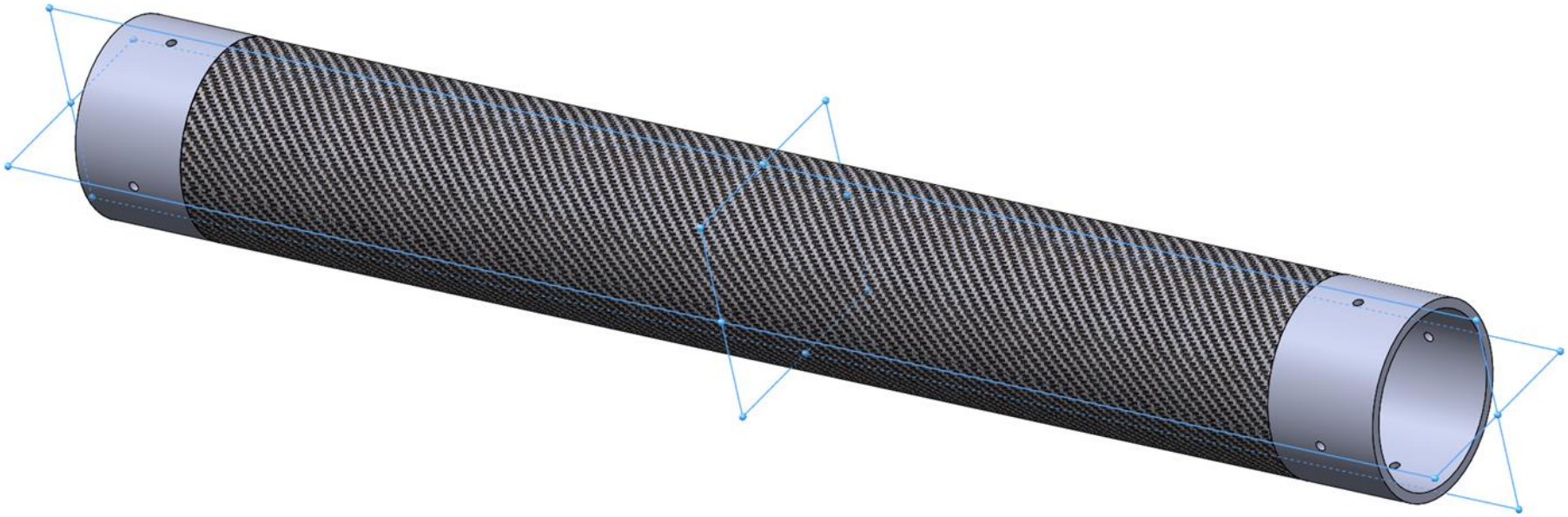




Assembly

- Origin plane mates (especially first part)
- If possible, mate all components to one or two fixed references
  - Long chains of components take longer to solve and more likely to get errors.
  - Do not create loops for mates
- Fully define the position of each part in assembly, unless visualization of motion needed for certain parts
  - Option: use mechanical mates
- Patterns, not multiple same parts if possible (greatly reduce computing power needed)
- Lock rotation on cylindrical mate if you don't need rotation

Put Origin as Mount Location



Use Component Patterns

Demonstration

Small trick for assembling: Copy with mates

Demonstration

Reference

- http://help.solidworks.com/2018/English/SolidWorks/sldworks/c_Best_Practices_for_Mates_SWassy.htm?verRedirect=1
- https://blog.alignex.com/10-large-assembly-best-practices-in-solidworks
- https://forum.solidworks.com/thread/183132
- https://petercad.com/category/solidworks-best-practices/
- https://www.solidsolutions.co.uk/solidworks/tutorial-videos/top-down-modelling-best-practice.aspx
- Robotics Institute, CMU. Design & CAD Best Practices

Gear Basics

李岱峰

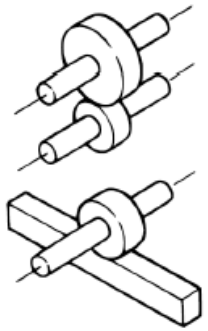
2020.07.22

Content

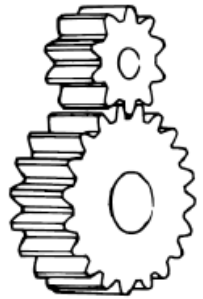
- Types of gear
- Calculate gear transmission
- 渐开线 Involute curves
- Nomenclature/Terminology
- SW TOOLBOX
- 插件

Types of Gears

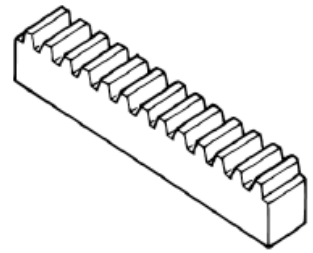
Parallel Axes



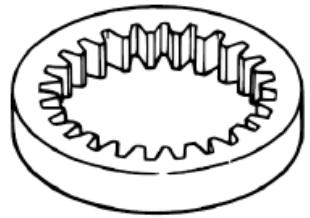
Spur Gear



Rack

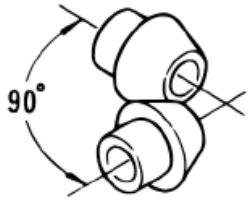


Internal Gear

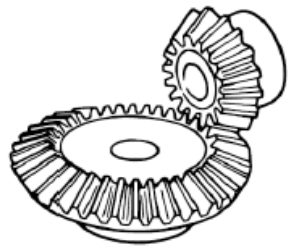


Helical Gear

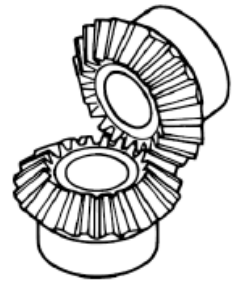
Intersecting Axes



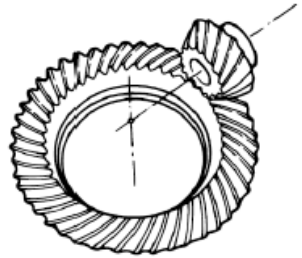
Bevel Gear



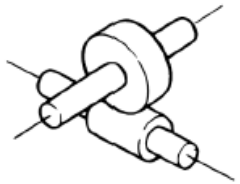
Miter Gear



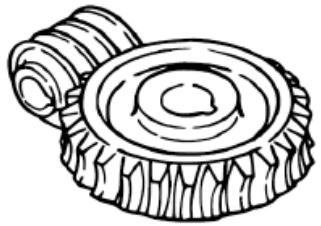
Spiral Bevel Gear



Nonparallel, Nonintersecting Axes



Worm & Worm Wheel



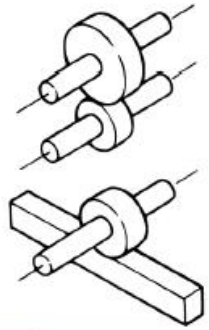
Screw Gear

AncoraSIR.com

SUSTech
Southern University of Science and Technology

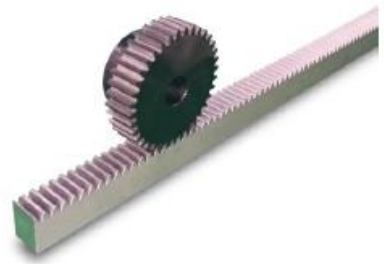
Types of Gears

Parallel Axes



Spur Gear

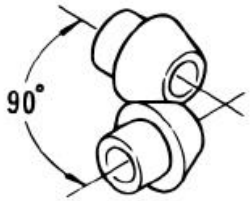
Rack



Internal Gear

Helical Gear

Intersecting Axes

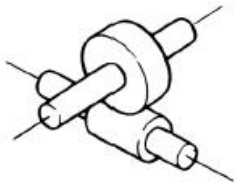


Bevel Gear

Miter Gear

Spiral Bevel Gear

Nonparallel, Nonintersecting Axes



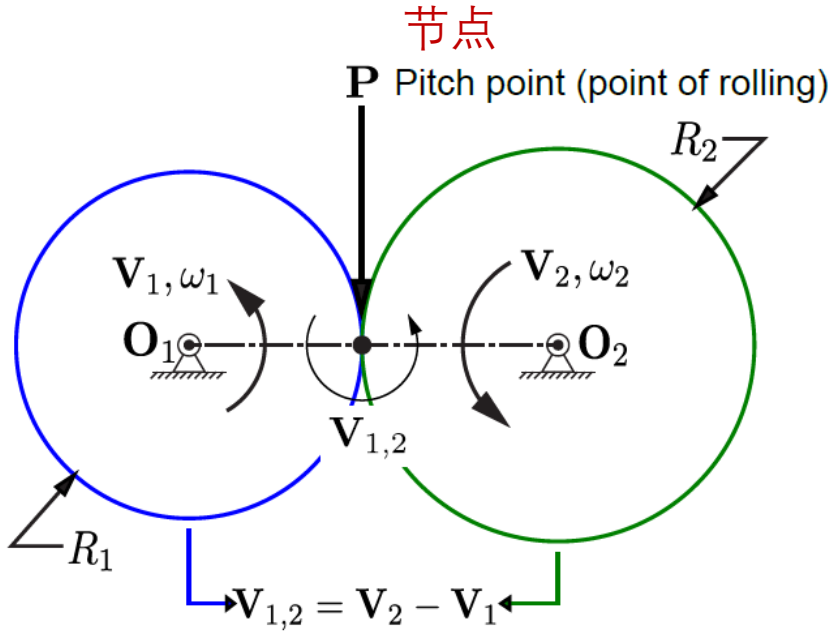
Worm & Worm Wheel

Screw Gear

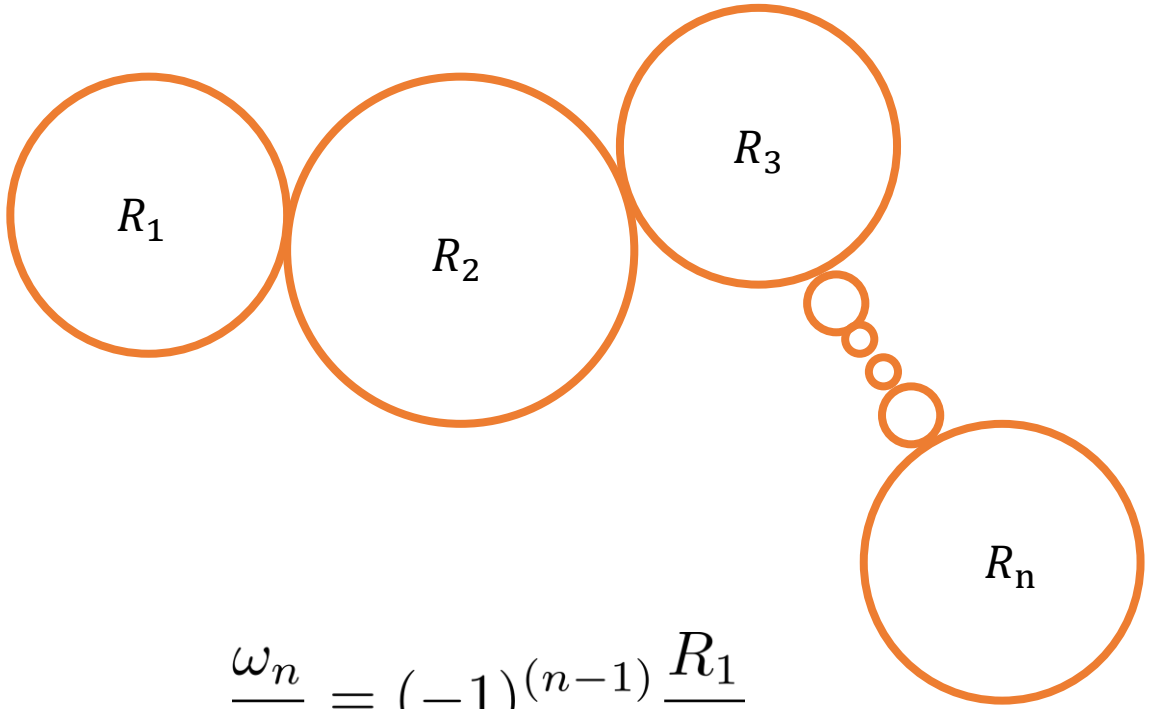
AncoraSIR.com

SUSTech
Southern University of Science and Technology

Calculate gear transmission



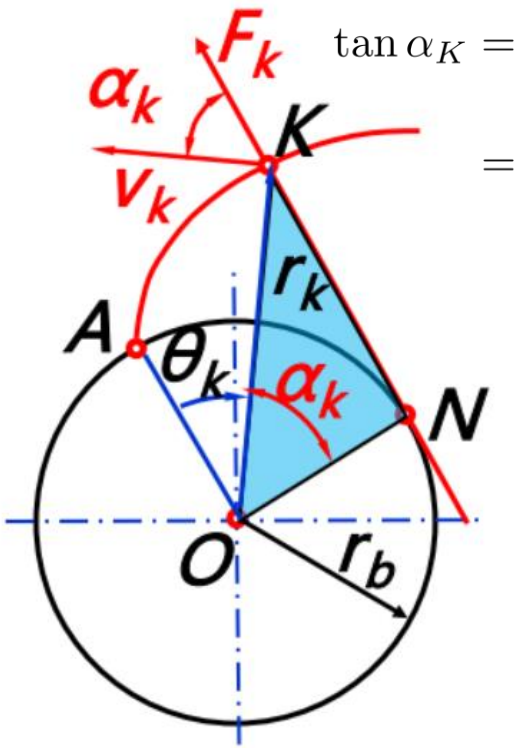
$$\frac{\omega_2}{\omega_1} = -\frac{R_1}{R_2}$$



$$\frac{\omega_n}{\omega_1} = (-1)^{(n-1)} \frac{R_1}{R_n}$$

If the pitch point moves, then the angular speed of the driven gear changes

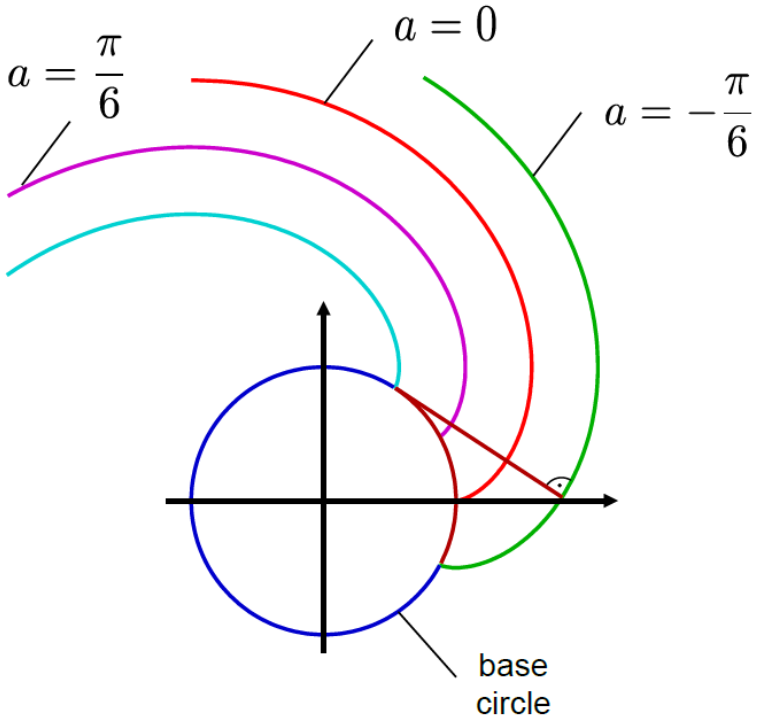
渐开线 Involute curves



$$\tan\alpha_K = \frac{\overline{KN}}{r_b} = \frac{\overline{AN}}{r_b} = \frac{r_b(\alpha_K + \theta_K)}{r_b} = \alpha_K + \theta_K$$

$$\begin{cases} \theta_K = \tan\alpha_K - \alpha_k = inv\alpha_K \\ r_K = \dfrac{r_b}{\cos\alpha_K} \end{cases}$$

极坐标方程
其中：invα_k称为渐开线函数

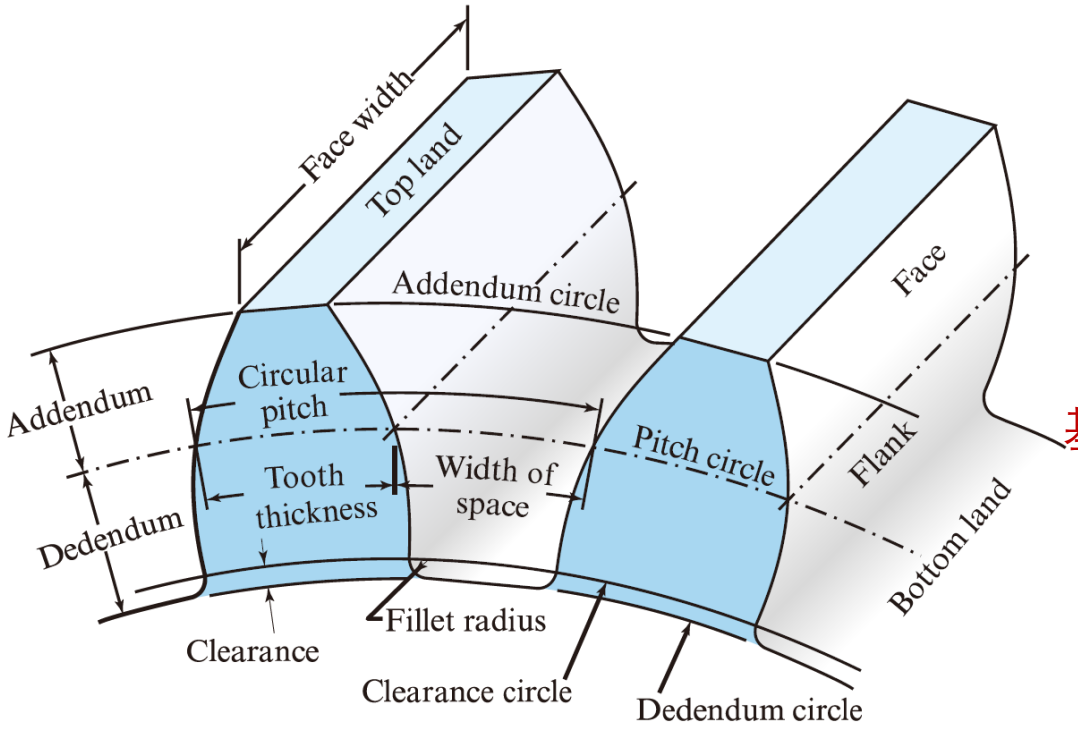


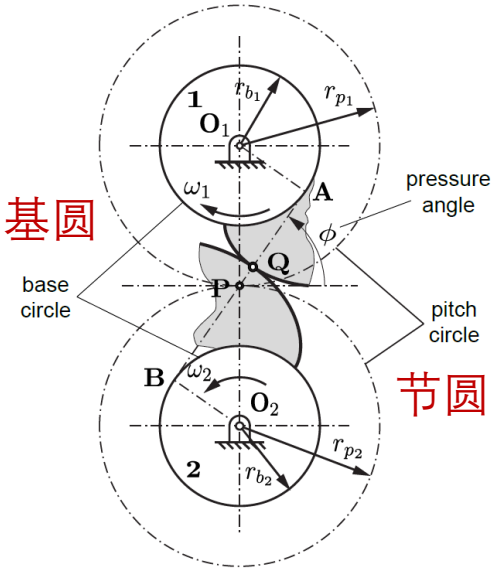
$$X_a(t) = r(\cos t + (t-a)\sin t)$$

$$Y_a(t) = r(\sin t + (t-a)\cos t)$$

笛卡尔坐标系方程
a代表起始位置

Nomenclature/Terminology





基圆

节圆

- **Circular pitch 齿距** p_c

$$p_c = \frac{2\pi r_{p_1}}{N_1} = \frac{2\pi r_{p_2}}{N_2} \Rightarrow \boxed{\frac{\omega_2}{\omega_1} = -\frac{r_{p_1}}{r_{p_2}} = -\frac{N_1}{N_2}}$$

N_1, N_2: teeth number of gear 1 and 2.

压力角 • **Pressure angle** ϕ (usually 14.5° or 20°)

基圆齿距 • **Base pitch** $p_b = p_c \cos\phi = 2\pi r_{b_1}/N_1 = 2\pi r_{b_2}/N_2$

模数 • **Module** $m = 2r_{p_1}/N_1 = 2r_{p_2}/N_2$

齿顶高 • **Addendum** a (usually chosen to be m or $0.8m$)

齿根高 • **Dedendum** d (usually chosen to be $1.25m$ or m)

空隙 • **Clearance** $d - a$

齿厚 • **Tooth thickness** (usually $0.5p_c$)

- **Width of space** (usually $0.5p_c$; always larger than tooth)
- **Backlash** = width of space − tooth thickness

Standard modules m (SI, mm/tooth; larger is bigger)

Preferred	1, 1.25, 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10, 12, 16, 20, 25, 32, 40, 50
Next choice	1.125, 1.375, 1.75, 2.25, 2.75, 3.5, 4.5, 5.5, 7, 9, 11, 14, 18, 22, 28, 36, 45

演示：SW Toolbox和今日制造插件

Reference

- 中国大学MOOC，西安交通大学，机械设计基础：https://www.icourse163.org/course/XJTU-1001595002?tid=1206706204
- SUSTech ME303 Introduction to Mechanical Design, Chaoyang Song: https://ancorasir.com/?page_id=2159
- SUSTech SDM232 Mechanical Design and Manufacturing, Yuanqing Wu.
- SW插件，今日制造下载：http://www.maidiyun.com/download/softinfo.aspx?id=1&tdsourcetag=s_pctim_aiomsg。相关介绍on bilibili：https://www.bilibili.com/video/BV1dT4y1J7eM?t=110&tdsourcetag=s_pctim_aiomsg