MECHANISM DESIGN

CHAPTER 3:
MECHANISM SYNTHESIS

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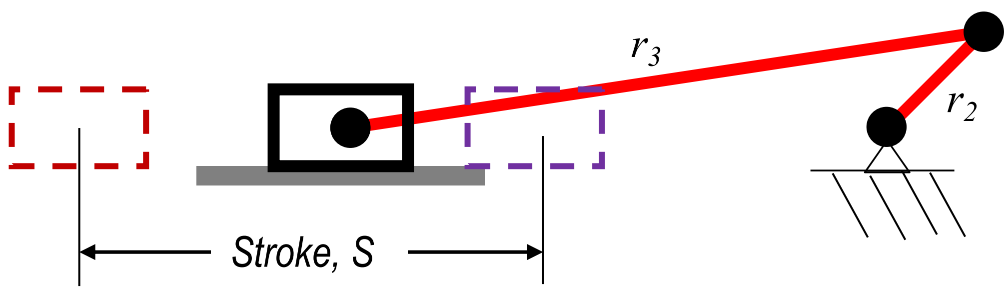
Mechanism Synthesis is the Design Phase

After we understand some analysis that are needed on mechanisms, we can now determine dimensions of a mechanism to achieve the desired motion.

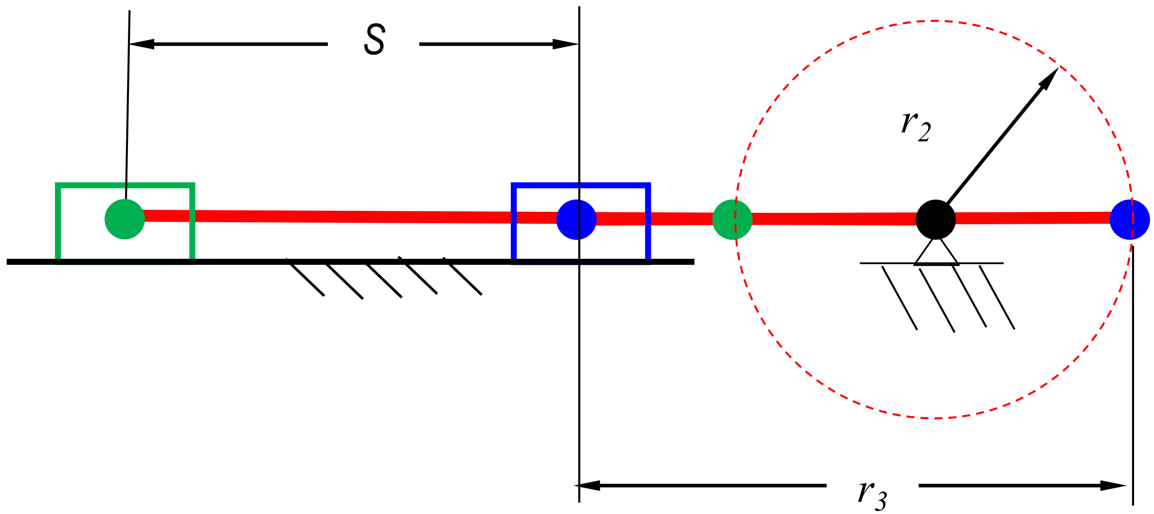
At this stage, the focus is still planar linkage mechanisms. Other types of mechanisms like gears and cams also need synthesis in order to achieve the desired motion.

1) The Inline Slider-Crank:



Here, we need to specify the appropriate r_2 and r_3

1) The Inline Slider-Crank:



- The slider moves symmetrically for inline type.

Crank radius:

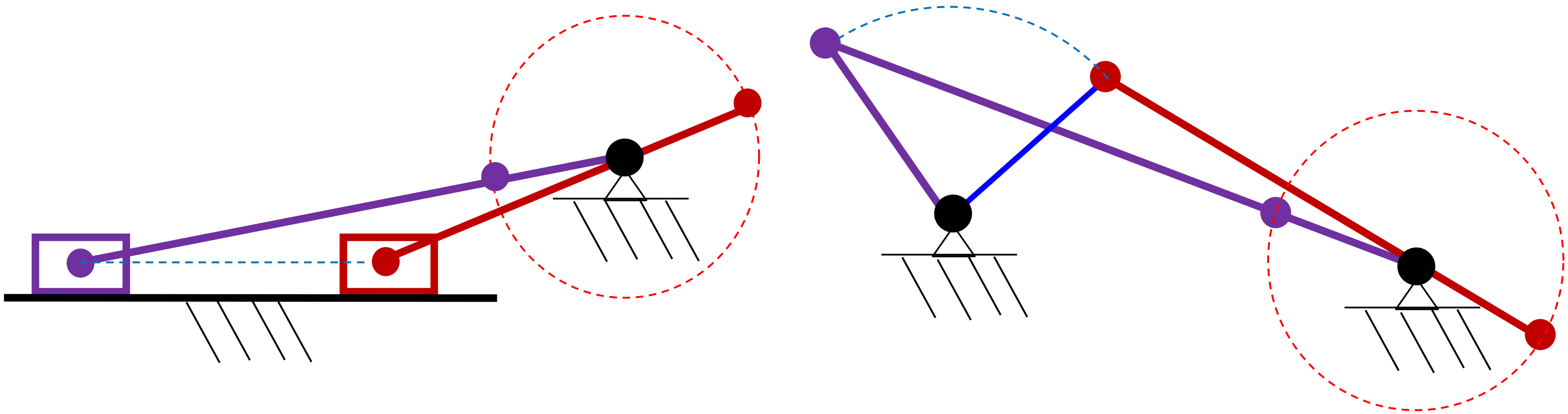
$$r_2 = \frac{S}{2}$$

- For smooth acceleration, it is recommended that:

$$r_3 > 4r_2$$

QUICK RETURN MECHANISMS

Offset slider crank, and crank-rocker four-bar mechanisms can result in a quick return action. This can be related to mechanical advantage (M.A.).



Time Ratio,

$$Q = \frac{Forward\ stroke\ time}{Return\ stroke\ time} \geq 1$$

$$Q = \frac{180° + \beta}{180° - \beta}$$

Imbalance angle:

$$\beta = 180° \left(\frac{Q-1}{Q+1}\right)$$

EXERCISE 1

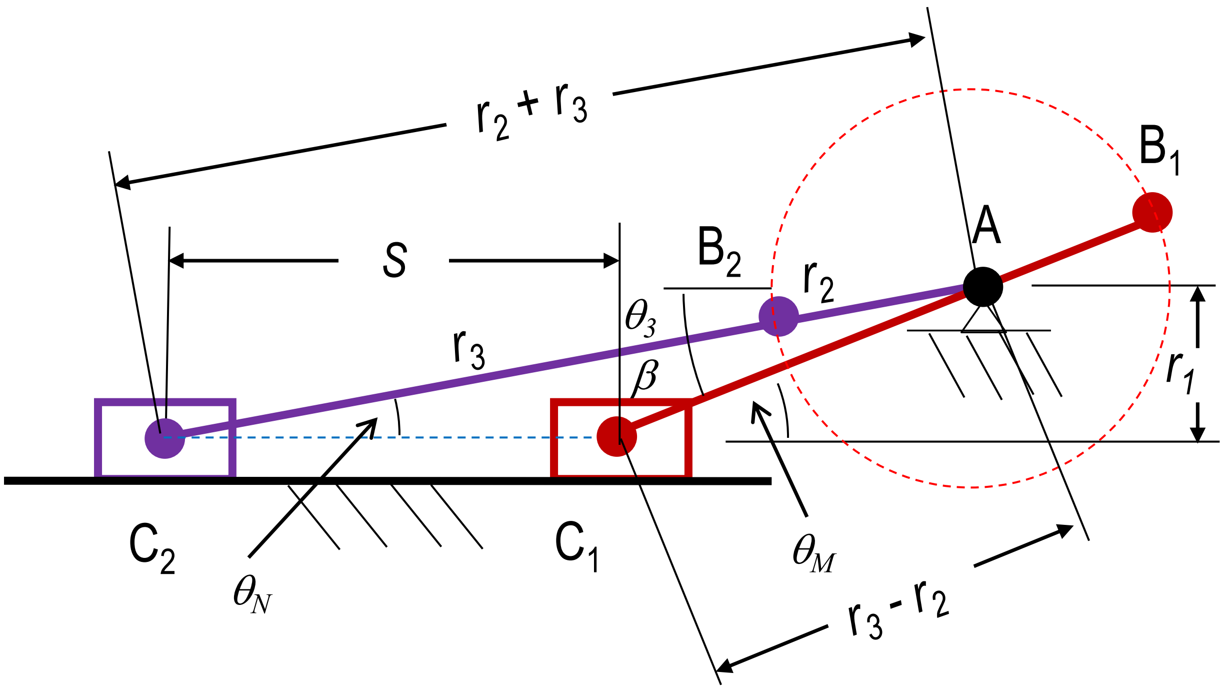
Design a quick acting mechanism in which the forward stroke takes 1.2 s while the return stroke takes 0.6 sec. Determine the following.

a) Q, the time ratio

b) β, the imbalance angle

c) ω, the speed in rpm.

2) The Offset Slider-Crank:



We may arbitrarily set angle θ_3 first. Then we may be able to locate the crank pivot.

EXERCISE 2

Synthesize an offset slider-crank that has a stroke of 50 mm. The forward stroke must consume 1.6 s and return in 0.8 sec.

EQUATIONS FOR OFFSET SLIDER-CRANK TIMING:

$$r_2 = \frac{1}{2}(AC_2 - AC_1)$$

$$r_3 = AC_1 - r_2$$

- Make a general sketch in limiting positions.
- Angle β is calculated.
- Include r_2, r_3.
- Finalize the mechanism.

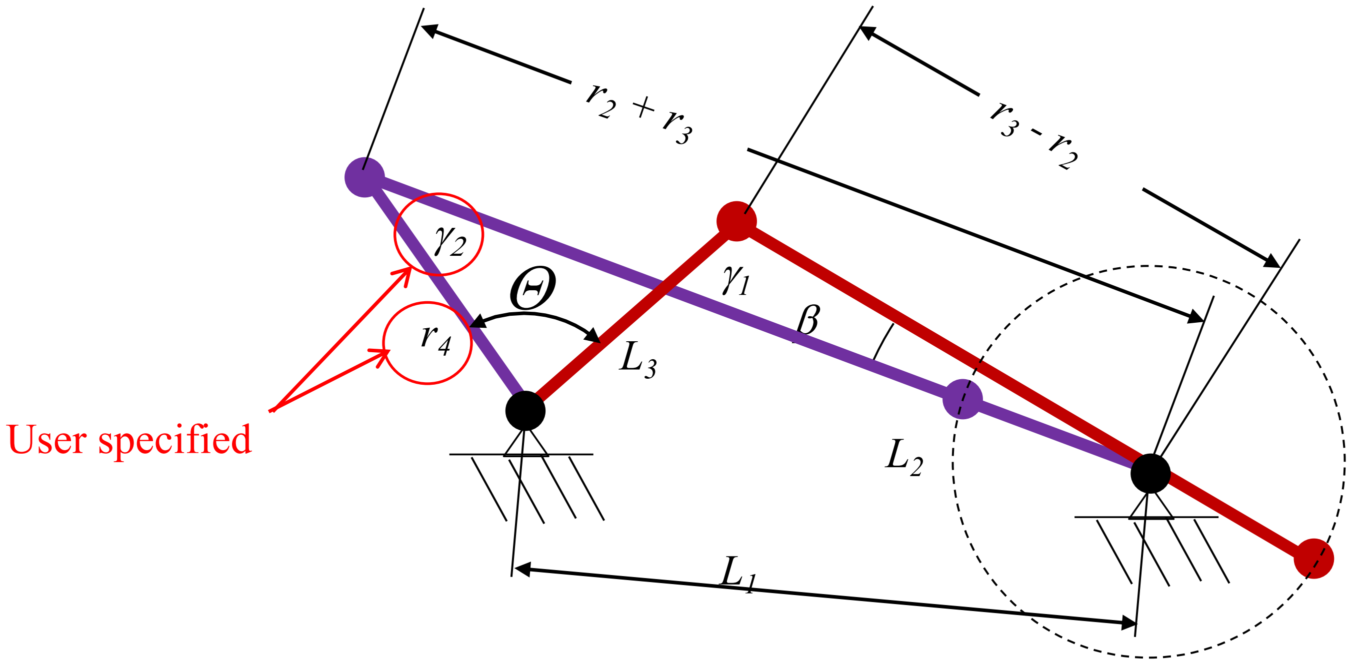
$$r_1 = S\left[\frac{\sin\theta_M \sin(\theta_M - \beta)}{\sin\beta}\right]$$

$$r_2 = S\left[\frac{\sin\theta_M - \sin(\theta_M - \beta)}{2\sin\beta}\right]$$

$$r_3 = S\left[\frac{\sin\theta_M + \sin(\theta_M - \beta)}{2\sin\beta}\right]$$

- Specify θ_M.
- Angle β is calculated.
- Get r_1, r_2, and r_3.
- Make a sketch of the mechanism.

3) The Four-Bar Mechanism: Crank-Rocker



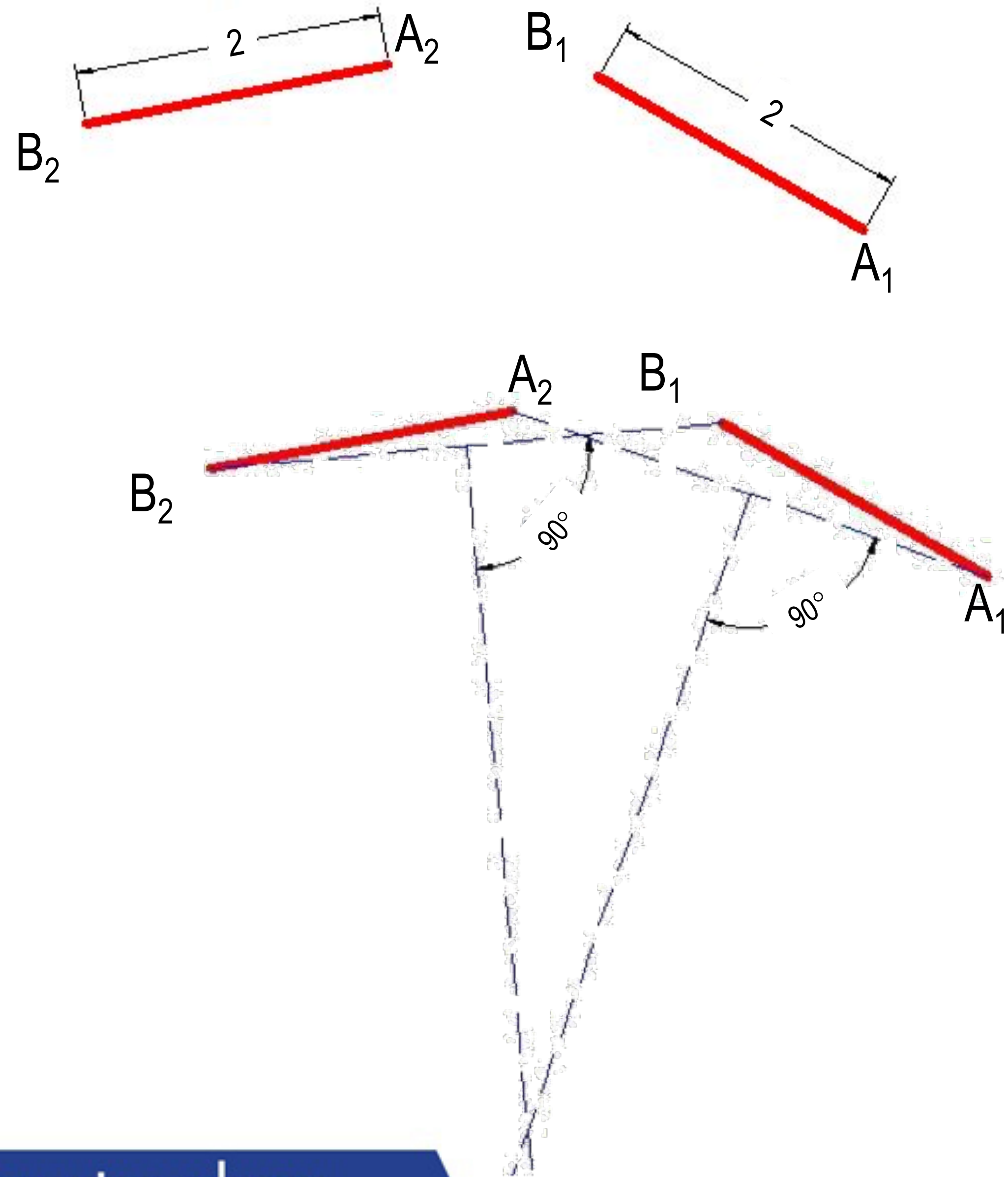
Transmission Angle (γ): $40^o < \gamma < 140^o$

EXERCISE 3

Develop a four-bar links with a throw stroke of 60°. The forward motion takes 4 s and return in 2.5 s. The space for this mechanism is 250 mm by 250 mm.

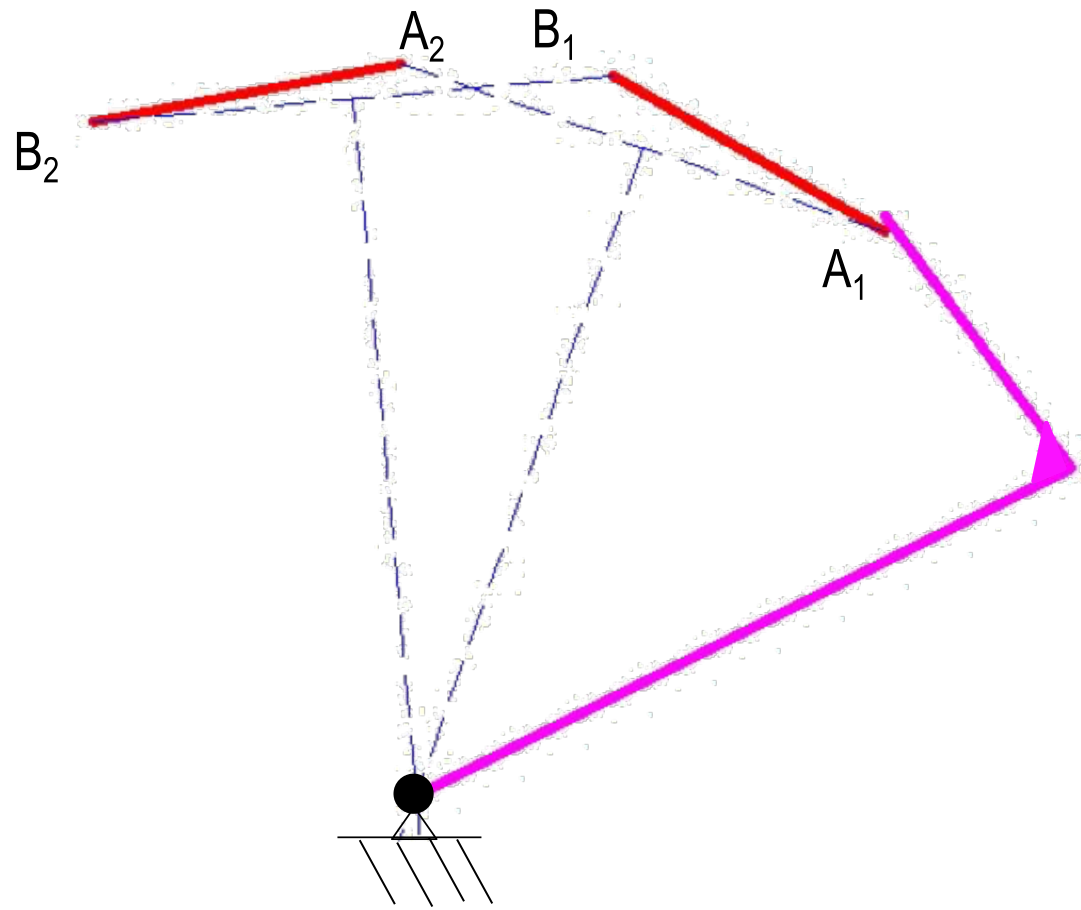
TWO-POSITION SYN

1) For four-bar mechanism with two positions, the options are either with one fixed pivot or two.
2) Connect the corresponding endpoints.
3) Get perpendicular bisectors.
4) Extend lines to get an intersection.



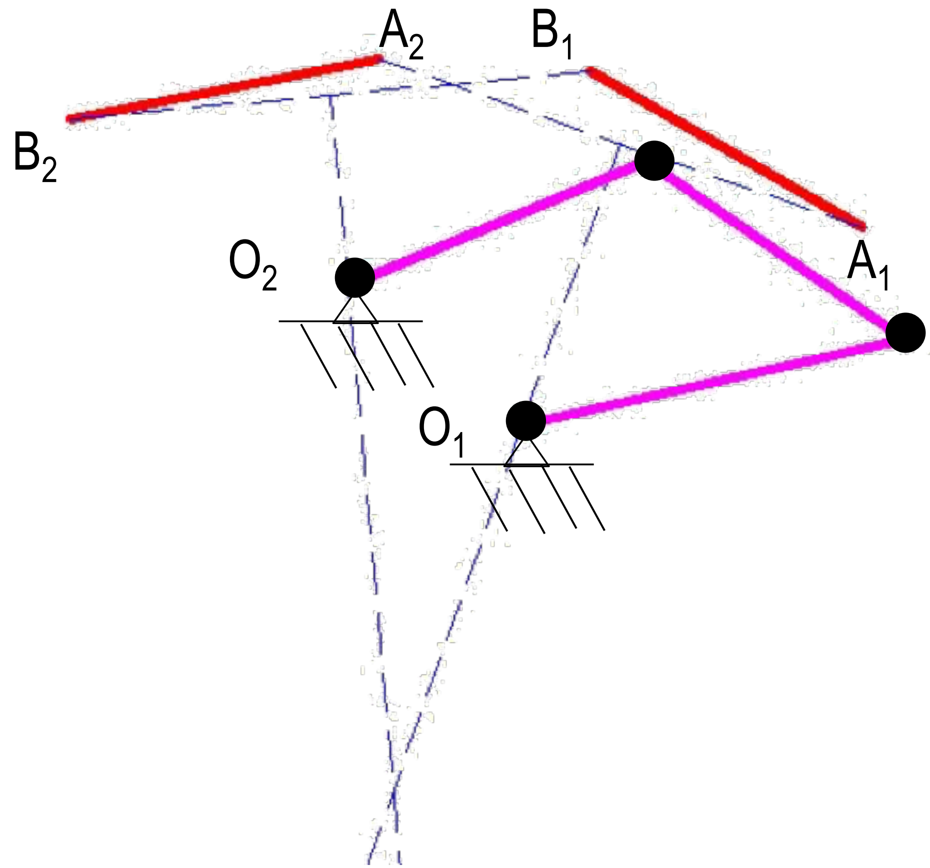
TWO POSITION SYNTHESIS

- The intersection of the bisectors is the fixed pivot if the mechanism uses just **ONE** rotating link
- Advantage: one piece mechanism.



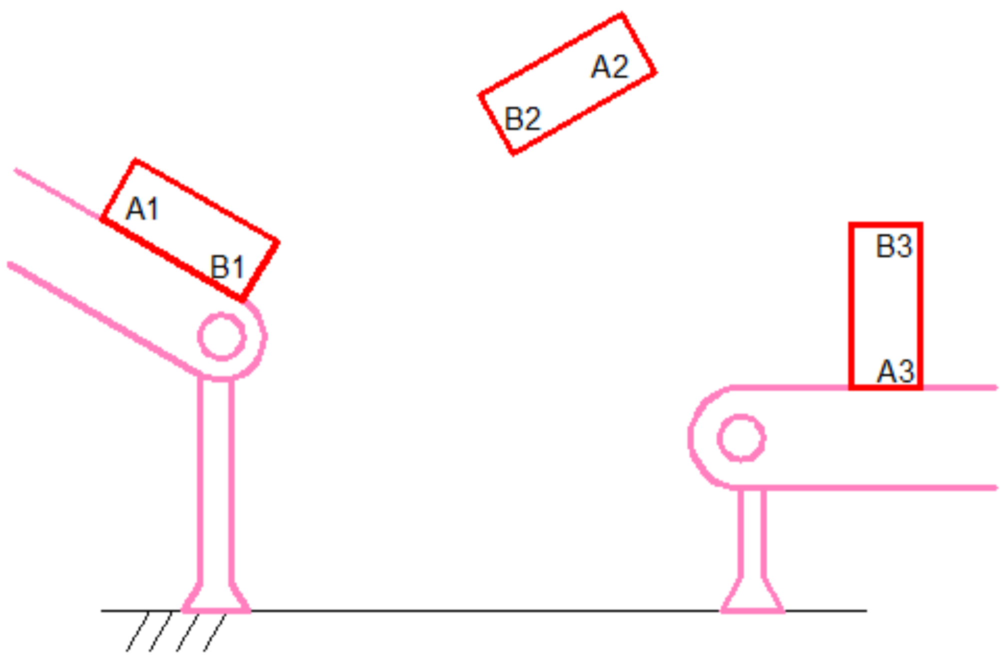
TWO-POSITION SYNTHESIS

- Choose pivots O_1 and O_2 within space.
- The pivot can be chosen at any point along each bisector line.
- This probably uses smaller space.



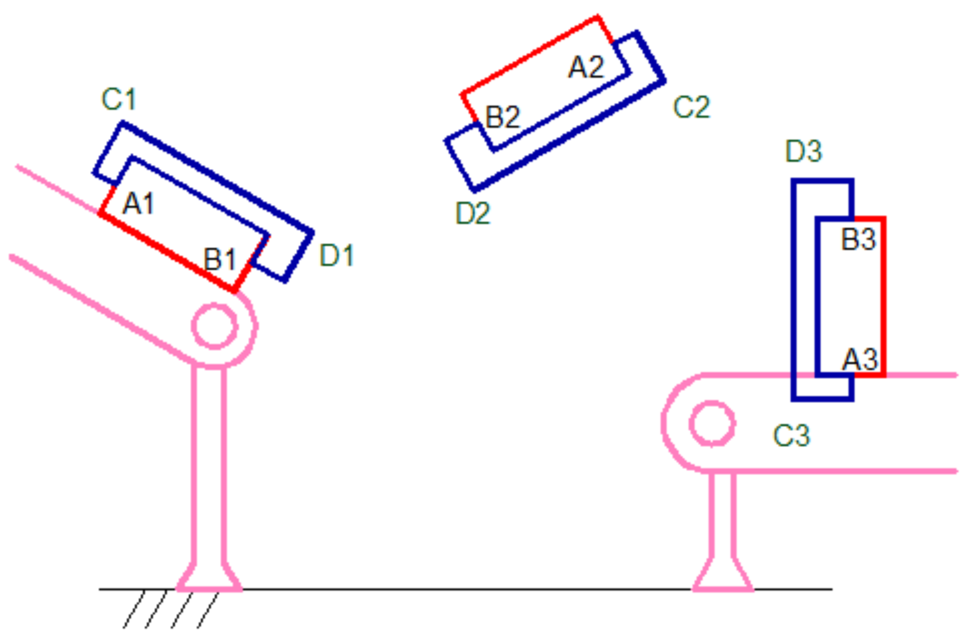
THREE-POSITION SYNTHESIS

1. Three positions of the box AB.



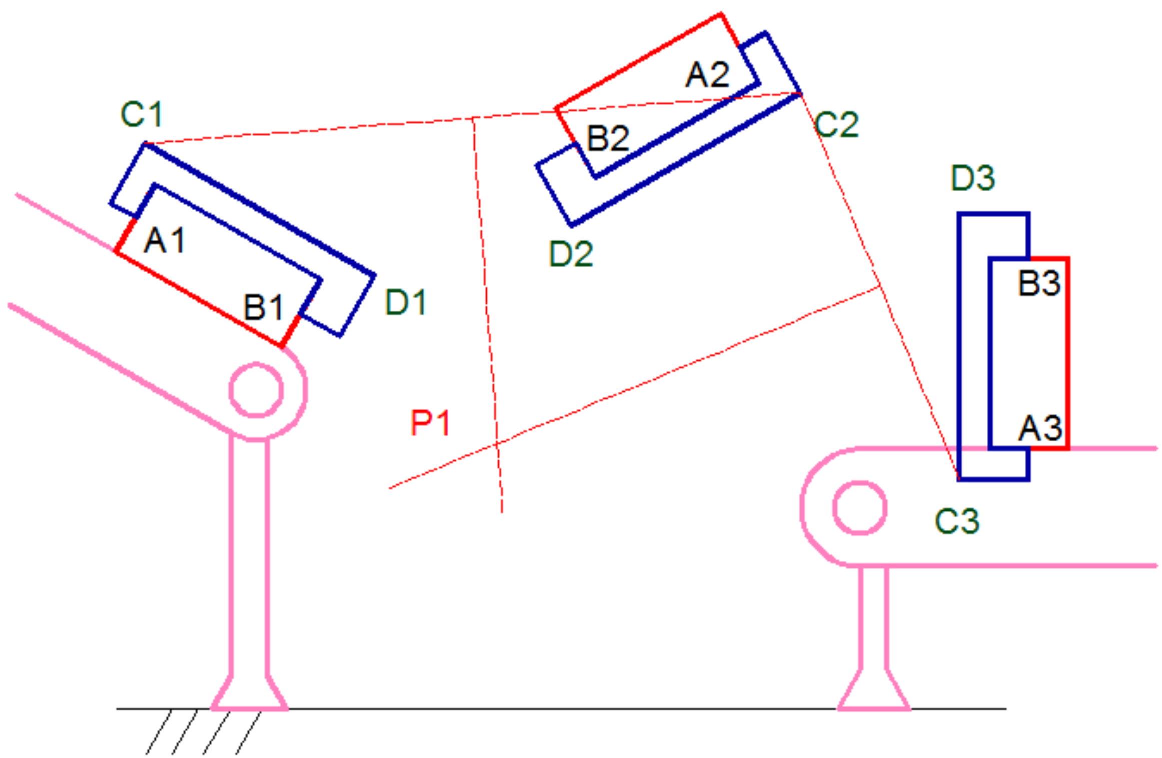
THREE-POSITION SYNTHESIS

2. Create a coupler that acts as a gripper or a holder.



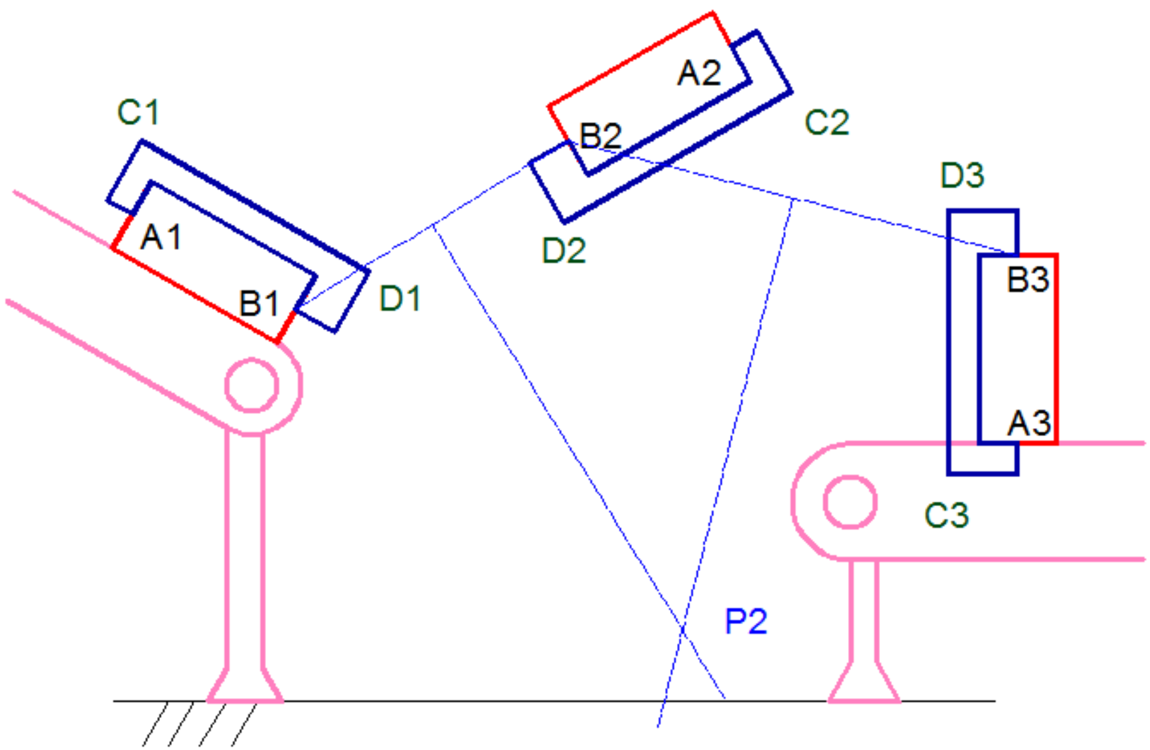
THREE-POSITION SYNTHESIS

3. Connect with lines and get perpendicular bisectors. The intersection is fixed pivot P1.



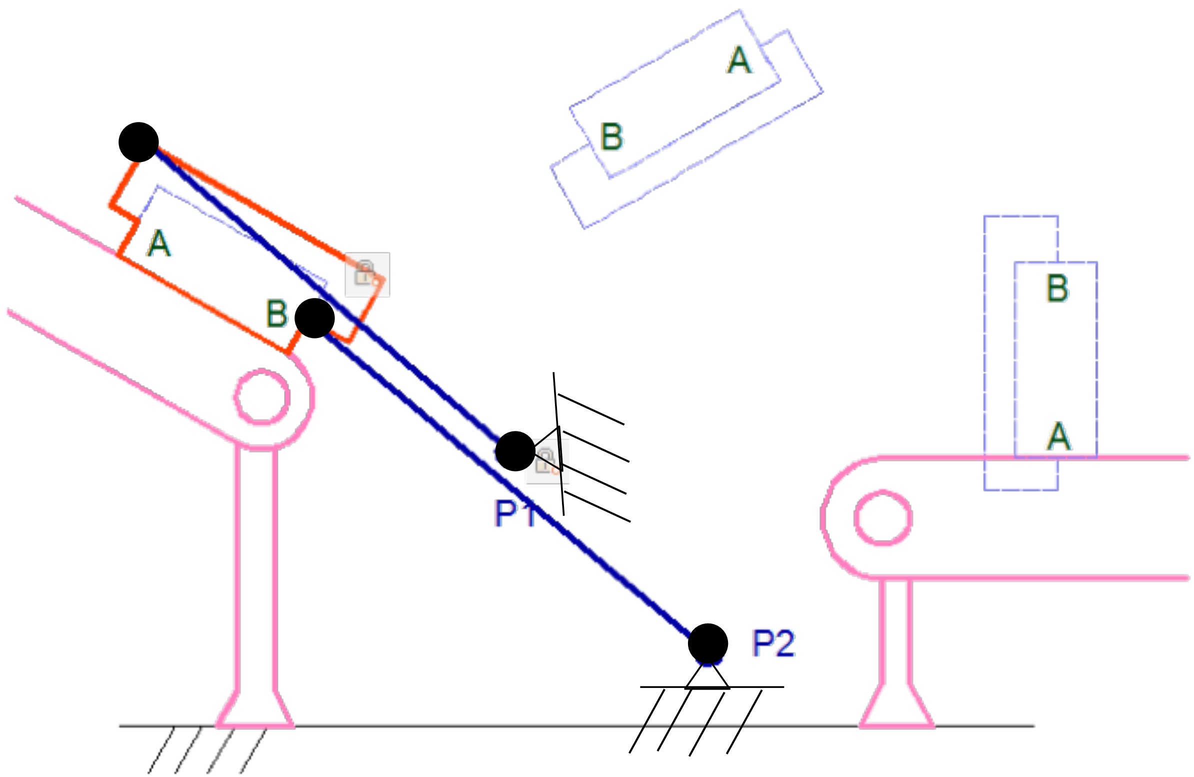
THREE-POSITION SYNTHESIS

4. Connect with lines and get perpendicular bisectors. The intersection is fixed pivot P2.

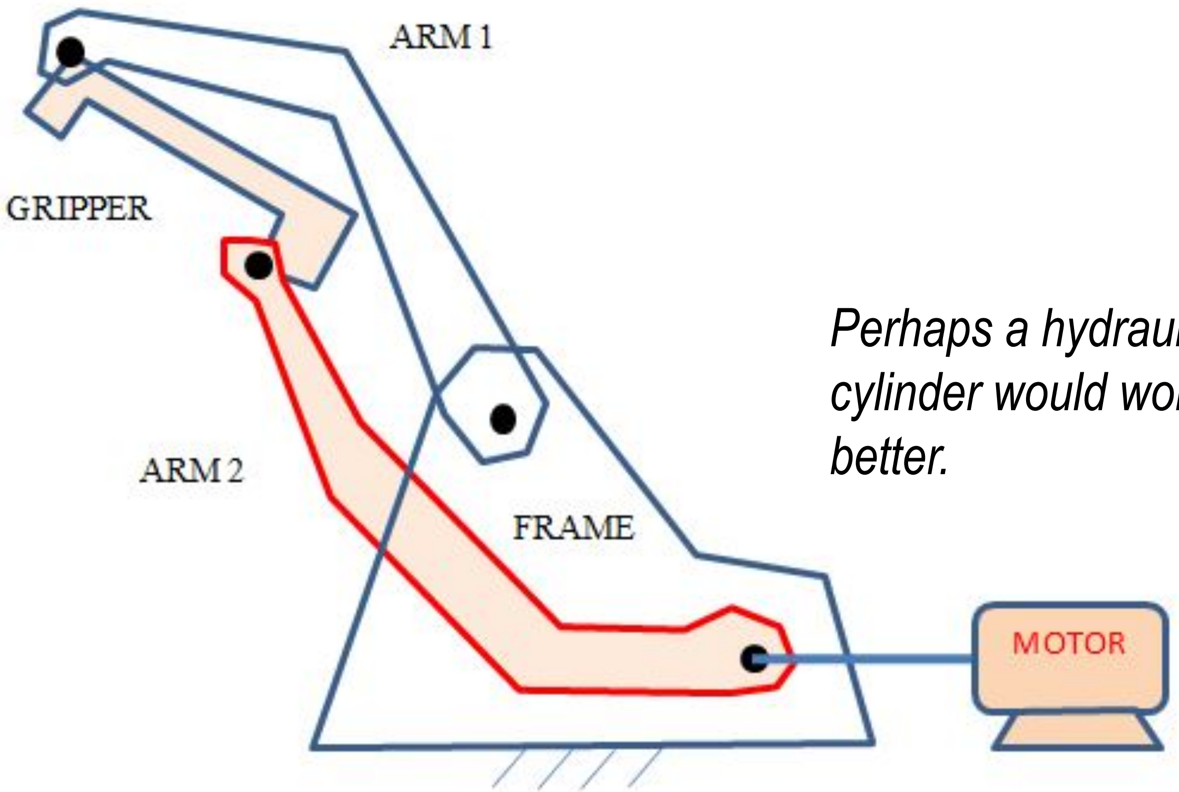


THREE-POSITION SYNTHESIS

5. Complete the four-bar mechanism and test it.

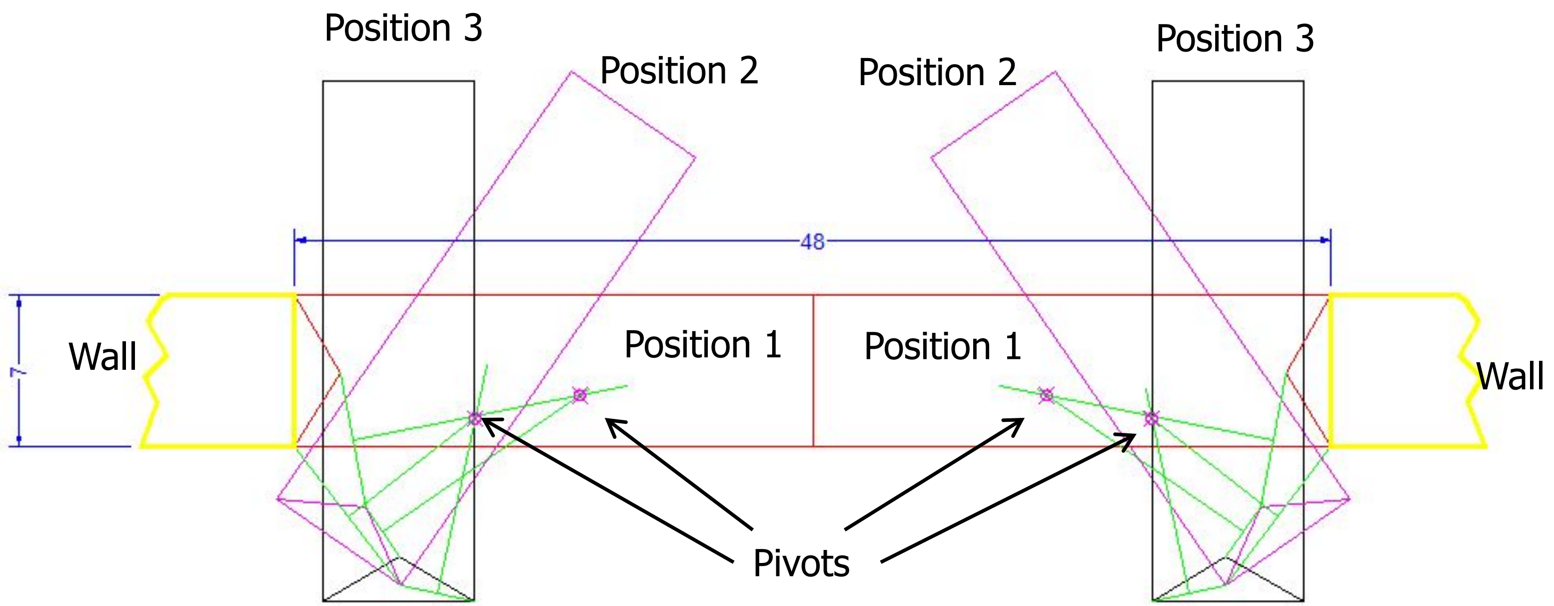


PROPOSED MACHINE

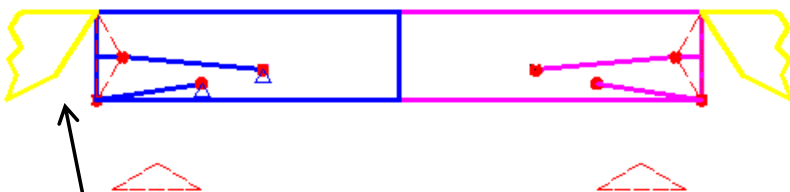


Perhaps a hydraulic cylinder would work better.

BUS DOOR MECHANISM DESIGN

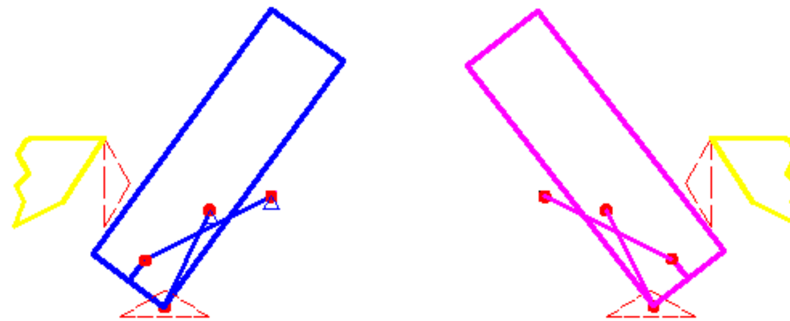


BUS DOOR MECHANISM DESIGN

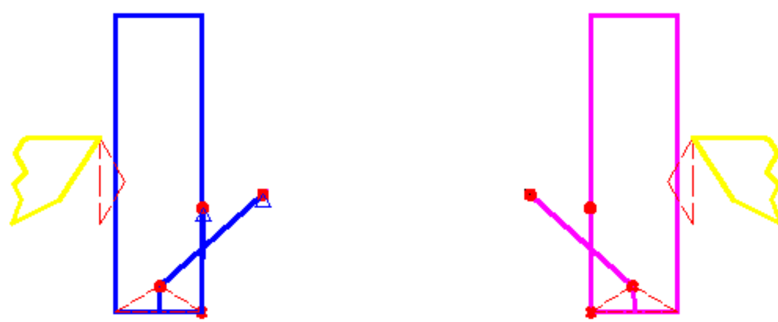


Position 1

Modification made to avoid clash



Position 2

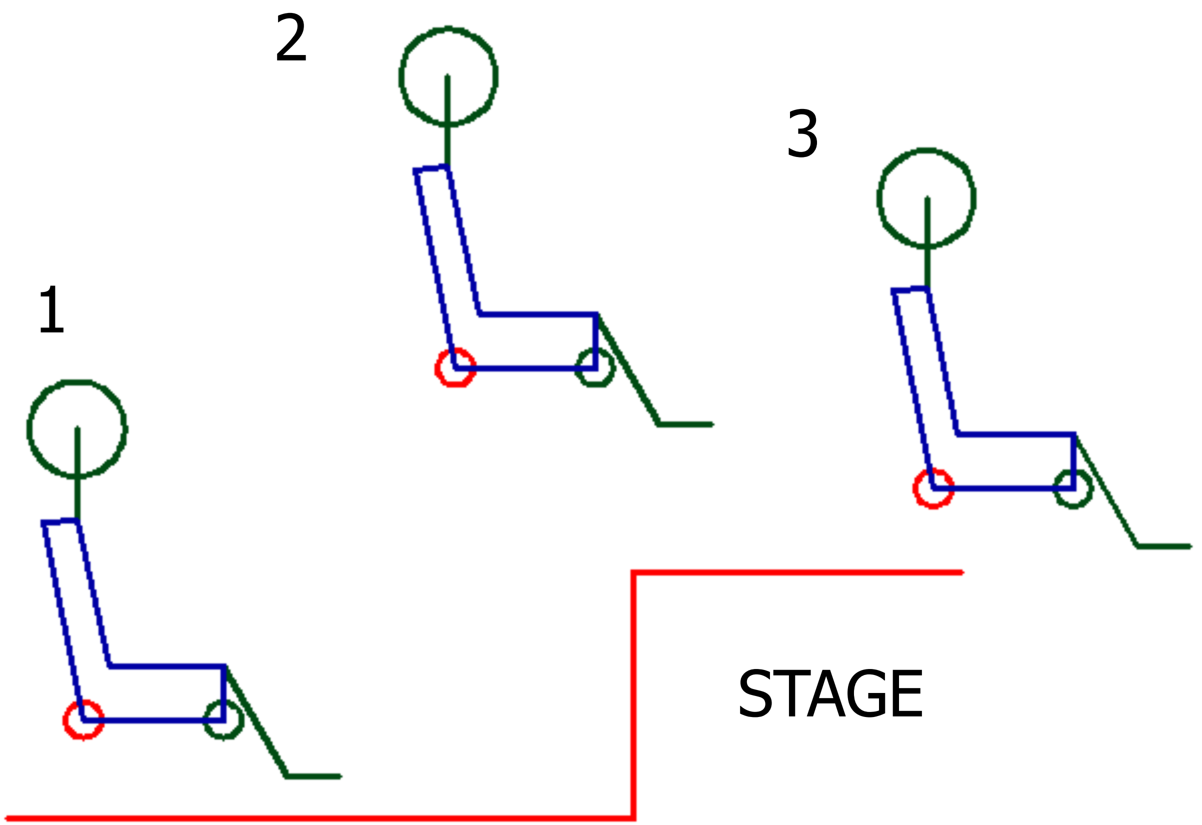


Position 3

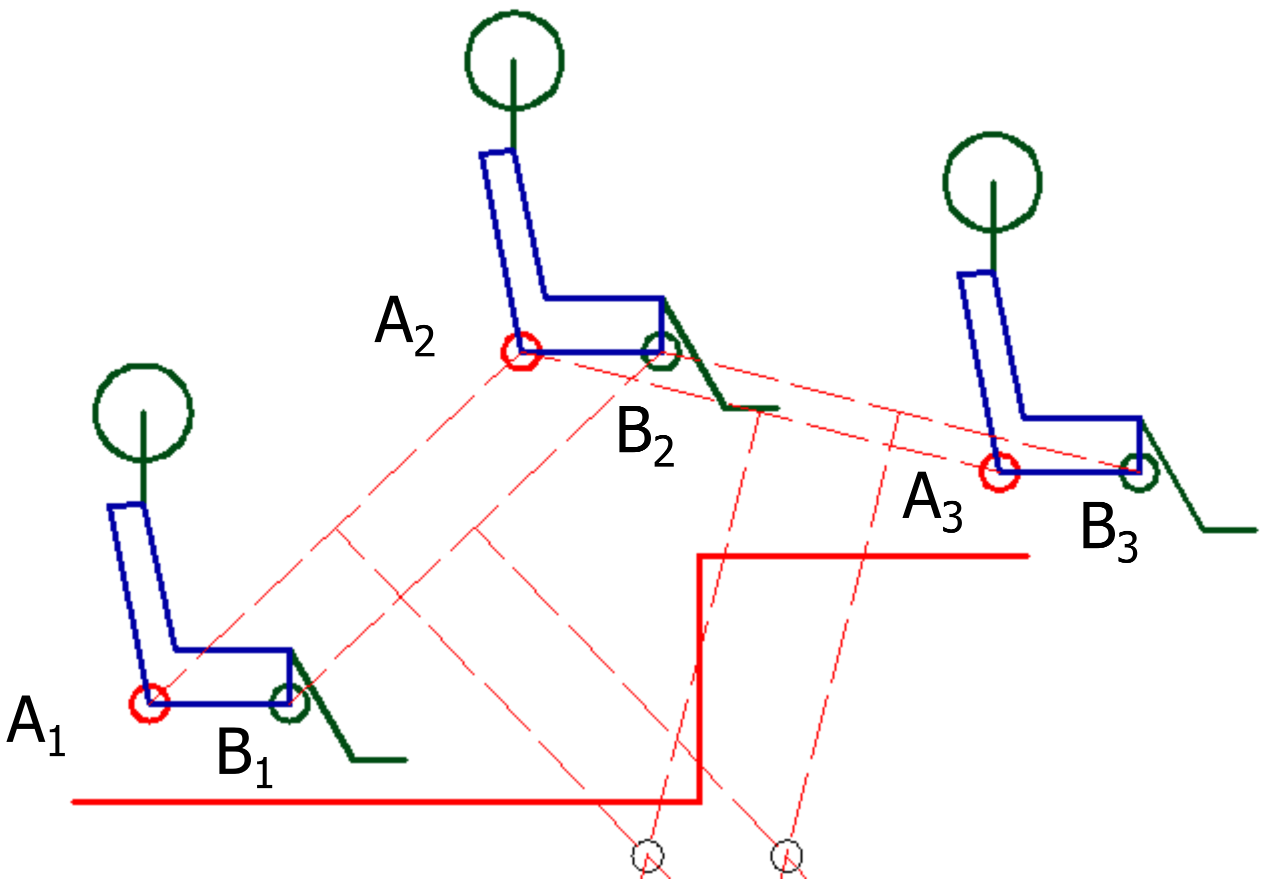
This is just one solution. It might not be the best.

MACHINE TO LIFT A DISABLED PERSON

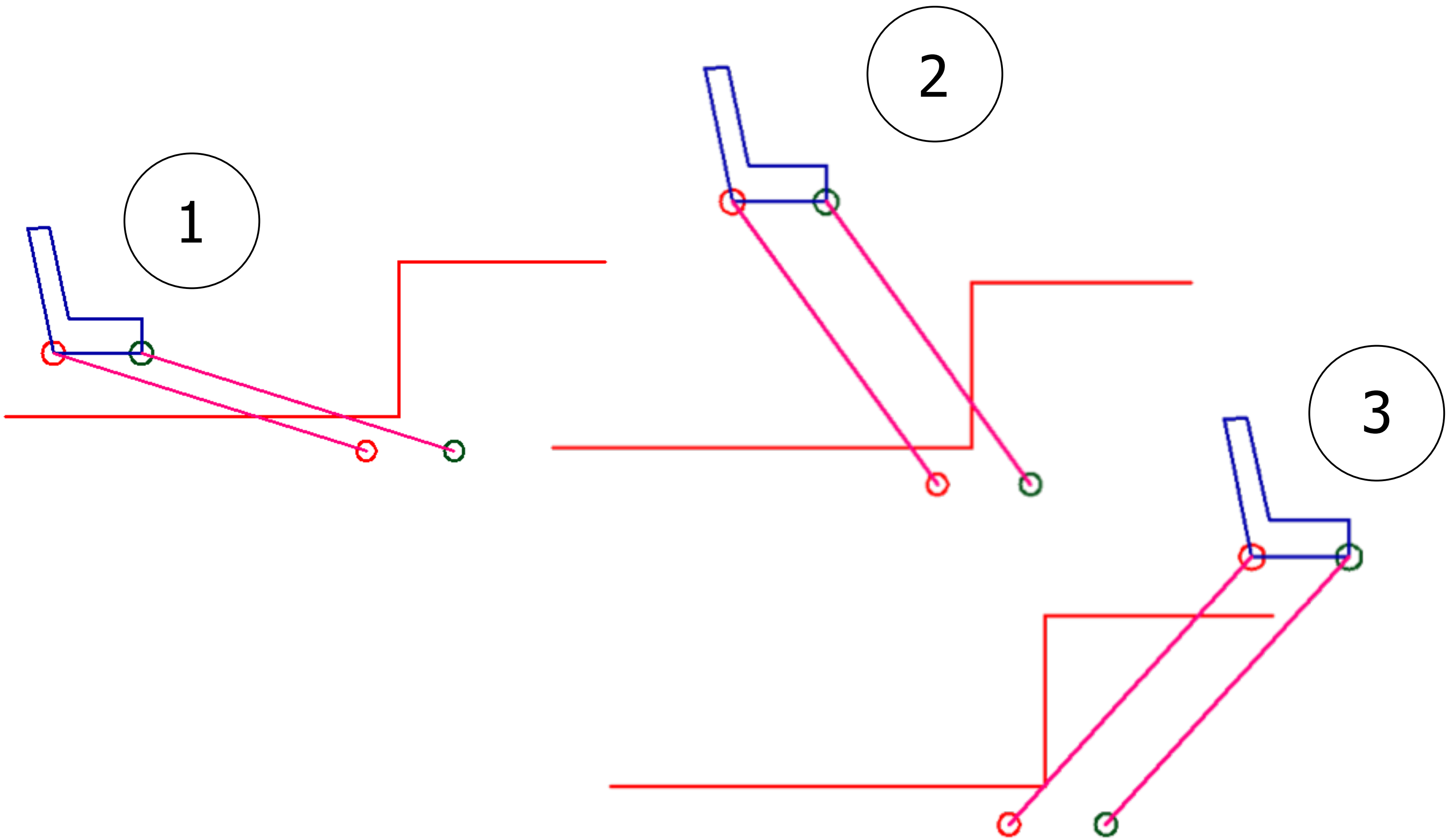
- The problem:



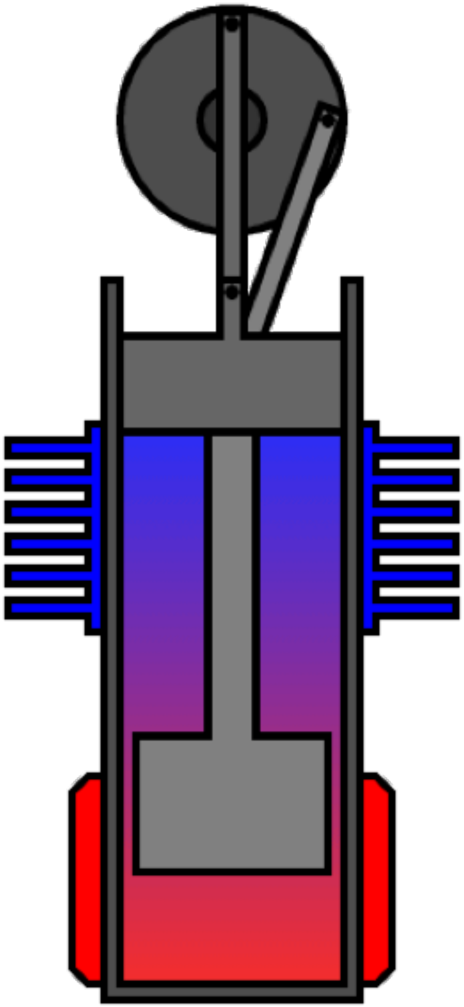
FOLLOW 3-POSITION SYNTHESIS



TESTING THE MECHANISM



THANK YOU



Main Reference:

Myszka, David H., 2012. Machines and mechanism: applied kinematic analysis, 4th ed., Prentice Hall, New York.

Source:
https://en.wikipedia.org/wiki/Stirling_engine