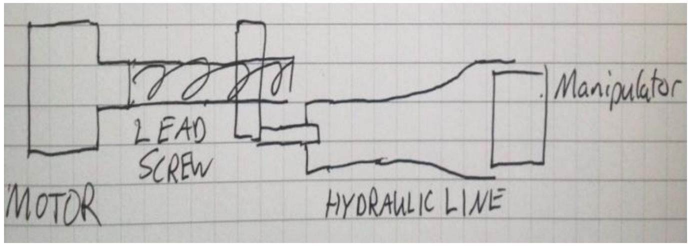
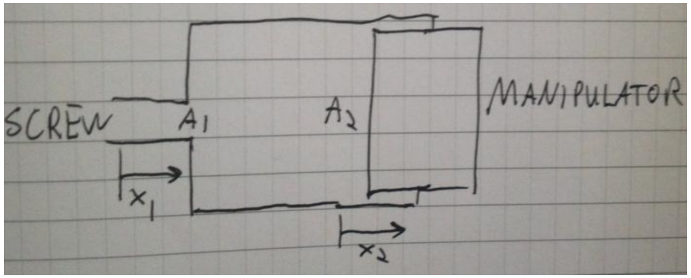
Feasibility Analysis: Resolution Considerations





- Configuration of the following yields sub 100 NM resolution
  1) Motor capable of 1.8 degree resolution
  2) Lead Screw with 0.635 mm lead
  3) Hydraulic area ratio of 1:64, or 80 mm inch to 8 mm diameters ratios

- Motivation: Determine Resolution of entire system. Develop relation between Motor θ and output X

From conservation of mass:

$$X1A1 = X2A2$$

$$X2 = \frac{A1}{A2}X1$$

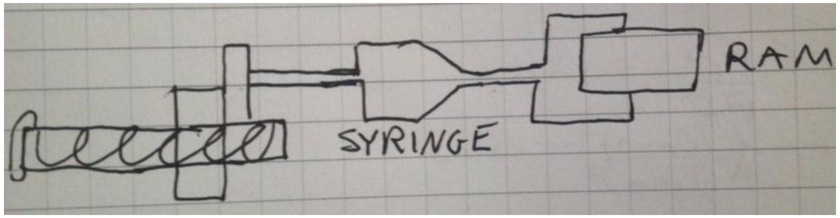
- Lead Screw
  - 1 turn X1 moves the screw lead
  - Therefore, $X2 = \frac{A1}{A2}l$
  - Manipulator Position= $\frac{A1}{A2}l * \#turns$

$$X2 = \frac{A1}{A2}l * \frac{\#degrees}{360}$$

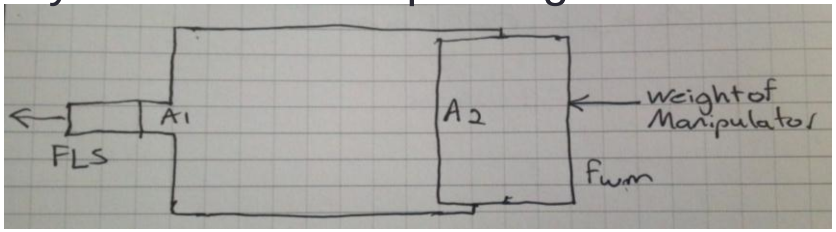
$$100e - 9 = \frac{A1}{A2} .635 \left(\frac{1.8}{360}\right) \longrightarrow .0314 = \frac{A1}{A2}$$

Feasibility Analysis: Motor torque Requirements

Motivation: Estimate Motor torque to pump system.



Worst case loading is actuation of stage in vertical axis.
Hydraulic force req = weight of device



Internal pressures equal. Therefore,

$$f_{LS} * A1 = f_{wm} * A2$$

$$f_{LS} = \frac{A1}{A2} f_{wm}$$

Lead Screw Torque Estimation

$$T_{LS} = \frac{F_{dm}}{2} \left(\frac{L + \pi\mu dm}{\pi dm - \mu L}\right)$$

F = force req = fls
dm = mean diameter = 6.35mm
μ= coef of friction = .25
L = lead = .635 mm/rotation

Area ratio 64:1
Force estimated at 9.8 N

$$T_{LS} = \frac{64}{1} * \frac{1*9.81*.25}{2} * \frac{.635+\pi 6.35*.25}{\pi 6.35-6.35*.635} = 0.508\ N*m = 72\ in*oz$$

Typical motor produces 25 to 200 in*oz

- Conservative estimates a require motor torque of no more then 72 in*oz
- This is well with in the usual operating range of normal motors