KILLER BEES 33

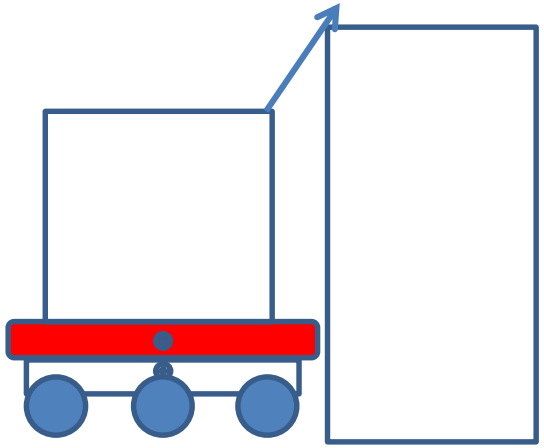
Notre Dame Prep High School
Auburn Hills, Michigan

FIRST

Hanging Concept Development

Team 33 Killerbees

Concept Development



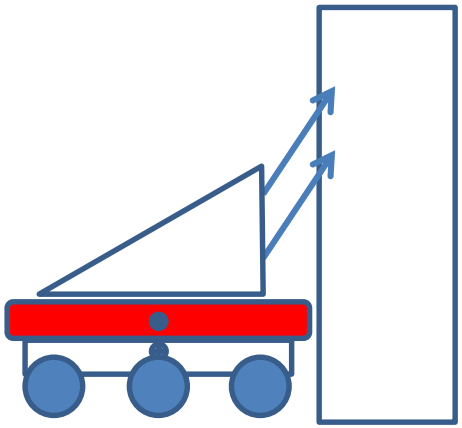
Hang off Cross bar with frame for others to hang:

Pros:

- Simple
- Possible 8 point play (hang+2 suspsend)

Cons:

- High CG frame
- Would have to hang early to maximize others time to hang on you
- Possible damage from other machines
- Could get crowded out



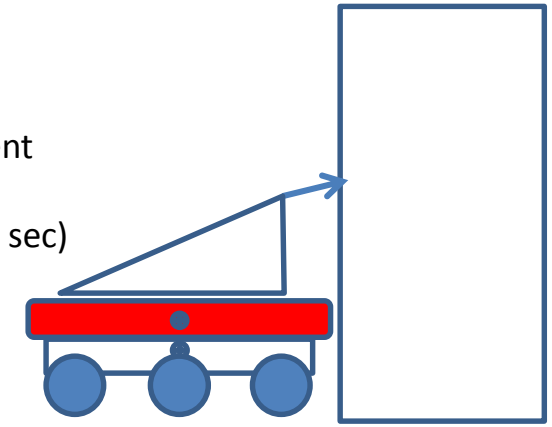
Hang from vertical bar with 4-bar:

Pros:

- Can hang from 4 different Positions
- Fast operation (under 5 sec)

Cons:

- Moderate CG frame
- Poor Packaging



Hang from vertical bar with single arm:

Pros:

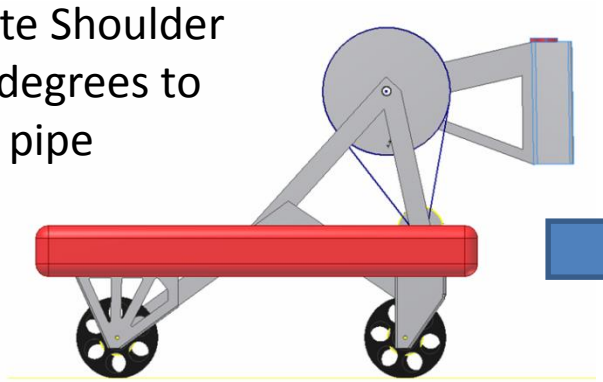
- Can hang from 4 different Positions
- 1 joint
- Fast Operation (under 5 sec)
- Lower CG frame

Cons:

- Higher stress

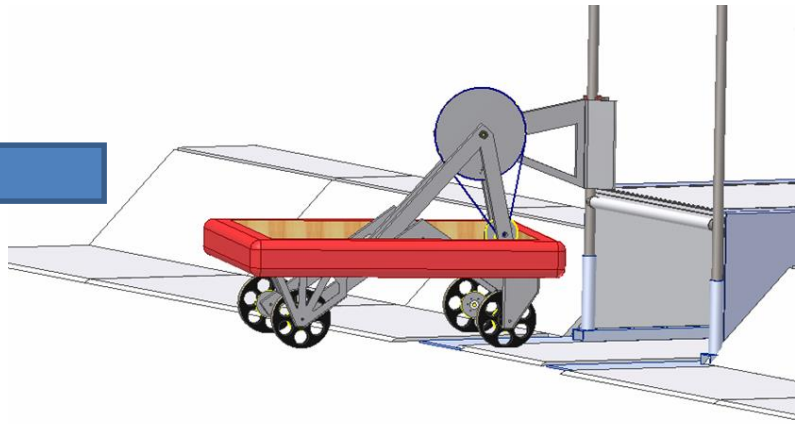
Single Arm Docking Operation

Rotate Shoulder 180 degrees to grab pipe

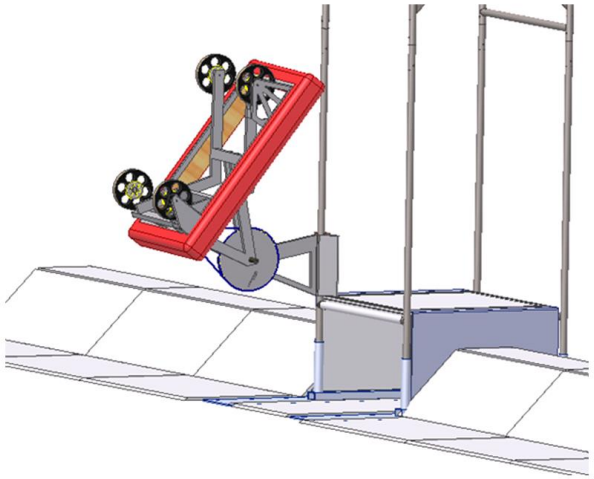


Robot can easily dock to pipe at up to 45 degree angle

Plan view of tower and ramp

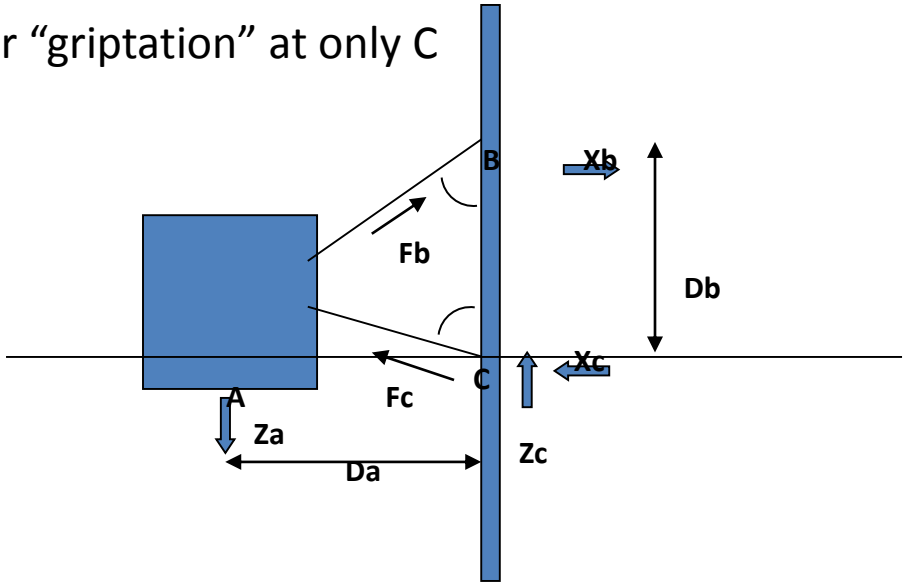


Robot performs simple 120 degree articulation to invert entire machine. (self cleaning, dumps out shavings every match)



Proving the Physics

For “griptation” at only C



Za=Zc

Xb=Xc

Zc=Xc*Muc

Za*Da=Xc*Db

Fc=sqrt(Zc^2 + Xc ^2)

Substitute:
Za= Xc*Db/Da = Xc*Muc

So: Db/Da= Muc for a static case (if distance ratio exceeds available Mu, slipping occurs)

Therefore, if Mu is constant, as Da decreases, Db must get smaller

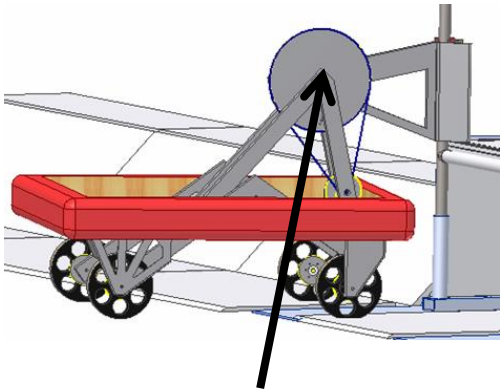
Number time:
Assume: Za=150pounds Da=18 inches MuC=.5

Db=9 inches max
Xb=300 pounds
Xc=300 pounds
Zc=150 pounds
Fb= ?
Fc= 335 pounds

Calculations for Bending At the Shoulder Joint

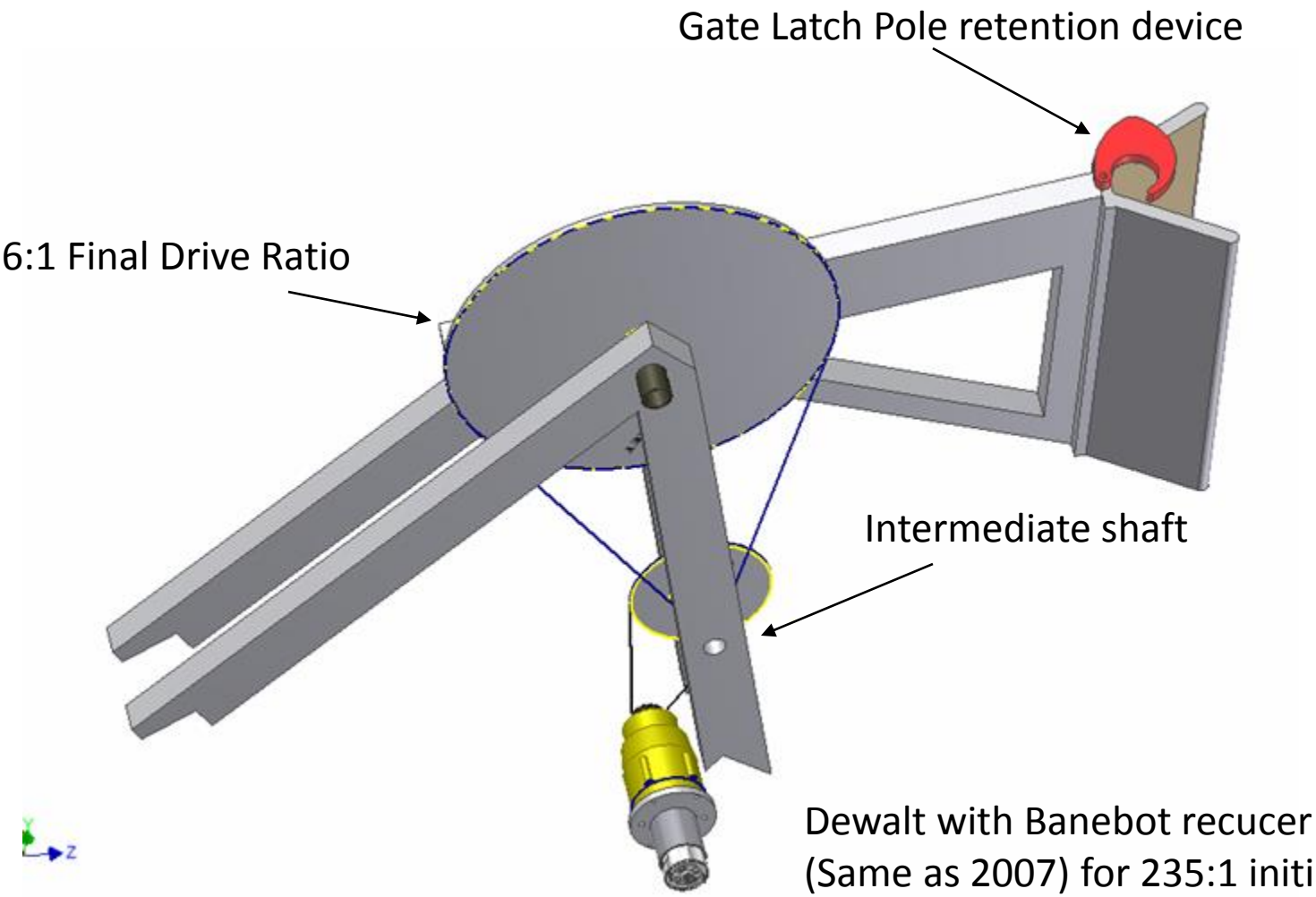
									E (Modulus of Elasticity)	1.04E+07					
					Force	150			I (Section Inertia)	0.332					
		Distance (in)	18						A (Section Area)	0.688					
									C	1.000					
										Wall	0.125	1.75		0.75	
											Height	Height Inner	Width	Width Inner	
			Length (in)	24						Rectangle Tube	2	1.75	1	0.75	
	Position	0	d/2	d	D+(L-d)/2	l				Area	0.688				
	Position	0	9	18	21	24				I	0.332				
	Shear (force)	150	150	150	0	0				C	1.000				
	Moment	2700	1350	0	0	0									
Bending Stress	M*c/I	8140	4070	0	0	0									
Shear Stress	F/A	218	218	218	0	0									

	Aluminums		Yield (Kpsi)	Ultimate (Kpsi)	Fatigue @ 5E8 Cycles
	Modulus (E)	1.04E+07			
	1100	Annealed	5	13	
		cold-rolled	22	24	
	2024	Annealed	11	26	20
		Heat Treated	42	64	
	3003	Annealed	6	16	
		cold-rolled	27	29	
	5052	Annealed	13	28	
		Heat Treated	37	42	
	6061	Annealed	8	18	
		Heat Treated	40	45	14
	7075	Annealed	15	33	
		Heat Treated	73	83	14



Load analysis at the shoulder Joint

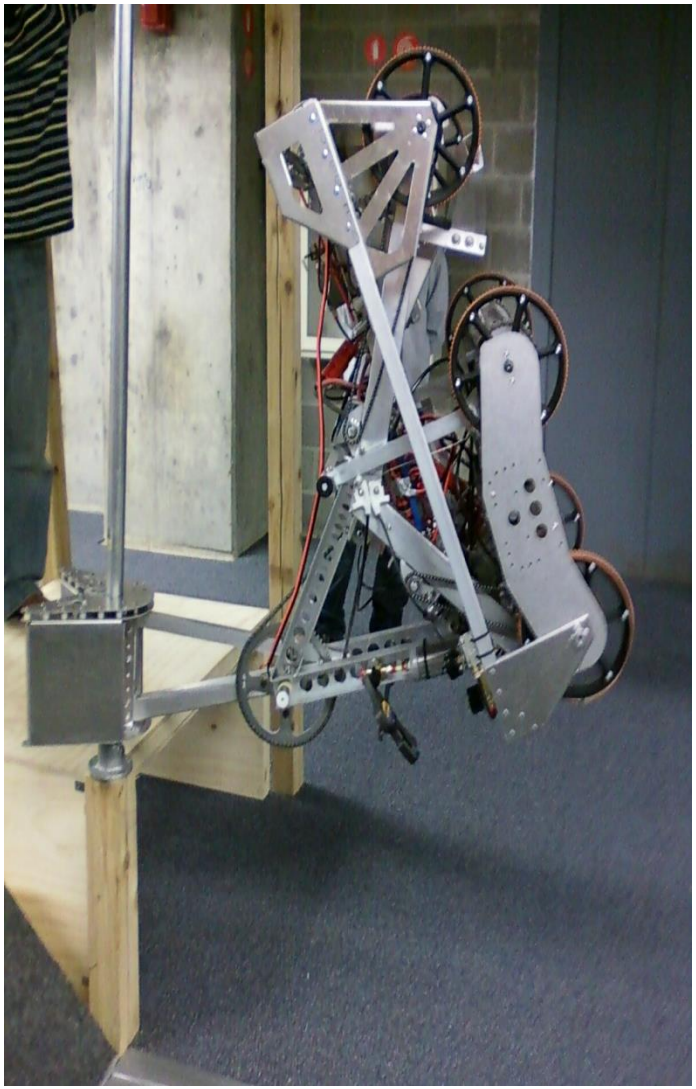
Modular design docks onto existing chassis
Over 3000:1 Total Reduction is possible with this design



Apparatus Testing

- Arm and Tower Assembly with functional gearbox
- 150 lbs of sand-bags attached to simulate robot weight
- Validated Arm capabilities before installing it on the main robot

Final Product



- Can hang off of any vertical pole
- Fast operation (5 sec)
- Allows for cleaning up home zone before hanging
- Keeps the CG low
- Bonus: Arm pushes middle wheel down for improved maneuverability (Drop center 6x6)