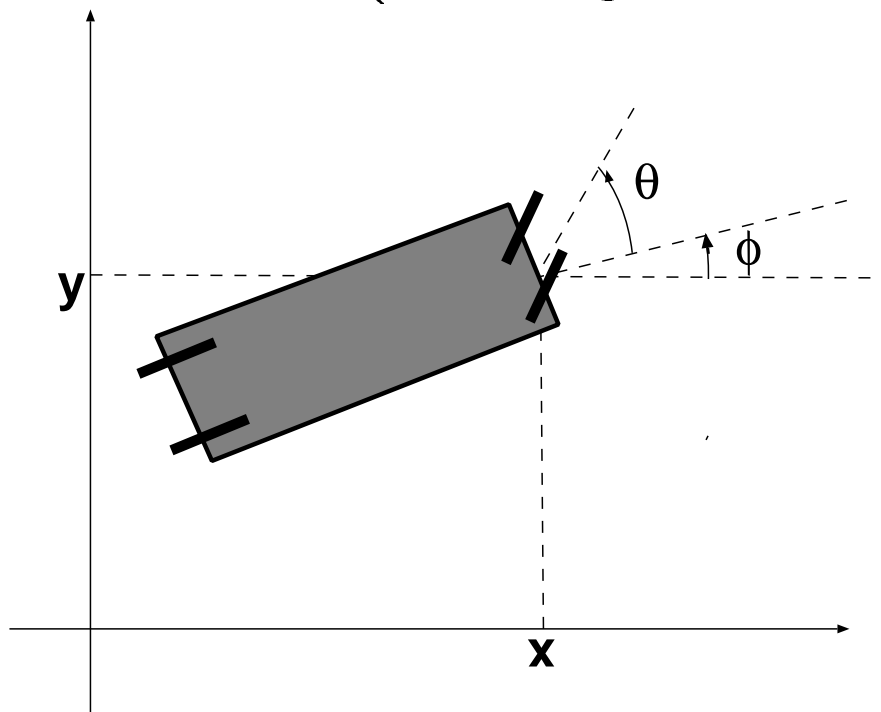


A CAR (following E. Nelson, 1967)



$$\dot{X} = u_d DRIVE(X) + u_s STEER(X),$$

$$X = (x, y, \phi, \theta)^\dagger,$$

$$DRIVE = (\cos(\theta + \phi), \sin(\theta + \phi), \sin(\theta), 0)^\dagger,$$

$$STEER = (0, 0, 0, 1)^\dagger.$$

STEER:  $\dot{\theta} = 1$

DRIVE:  $\dot{x} = \cos(\theta + \phi)$ ,  $\dot{y} = \sin(\theta + \phi)$ ,  
 $\dot{\phi} = \sin(\theta)$ ,  $\dot{\theta} = 0$ .

$$[STEER, DRIVE] = WRIGGLE$$

$$[WRIGGLE, DRIVE] = SLIDE$$

$$SLIDE = (-\sin \phi, \cos \phi, 0, 0)^\dagger,$$

$WRIGGLE = SLIDE + ROTATE$  (when  $\theta = 0$ ),

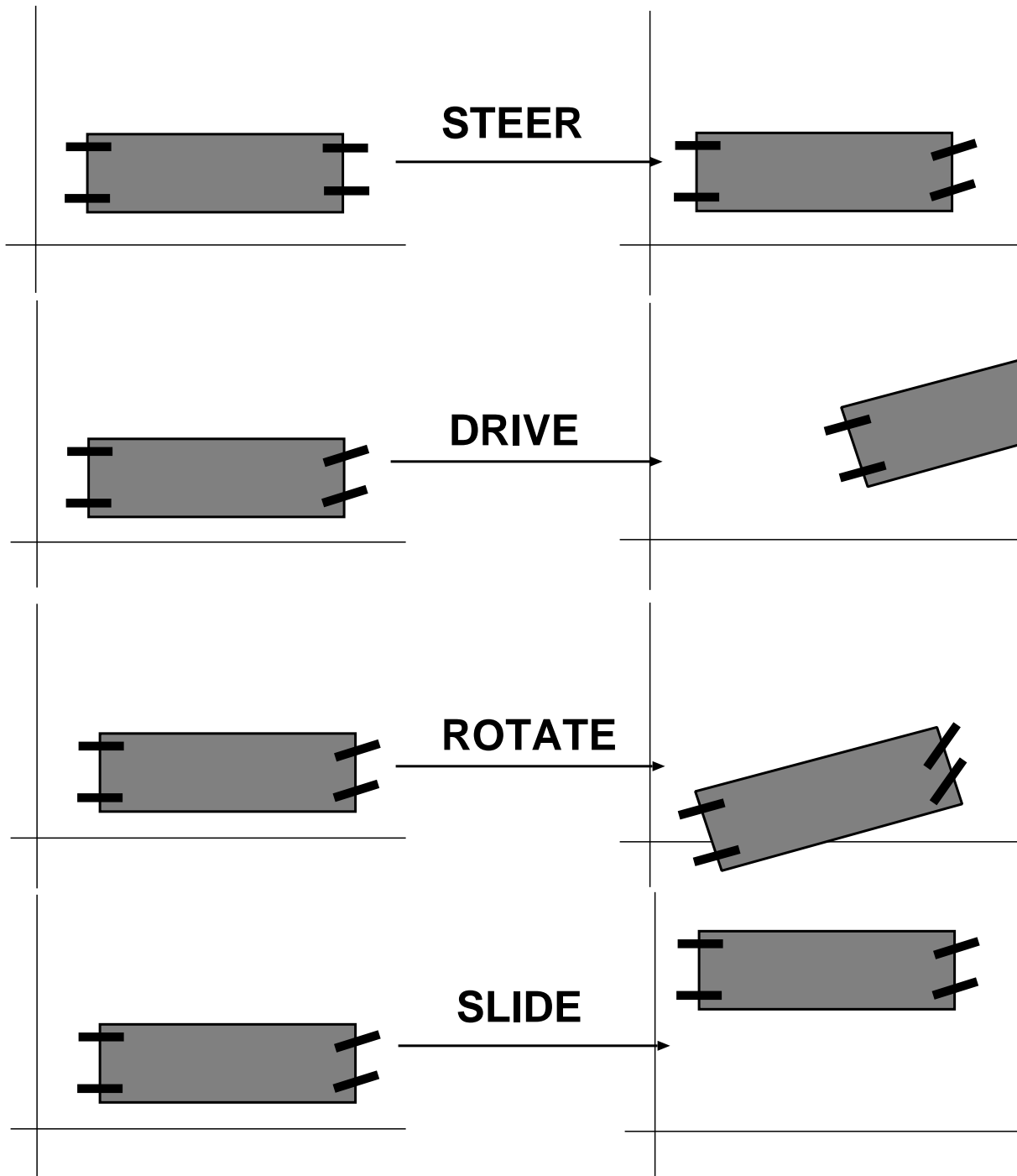
$$ROTATE = (0, 0, 1, 0).$$

- The effect of WRIGGLE is attained by doing:

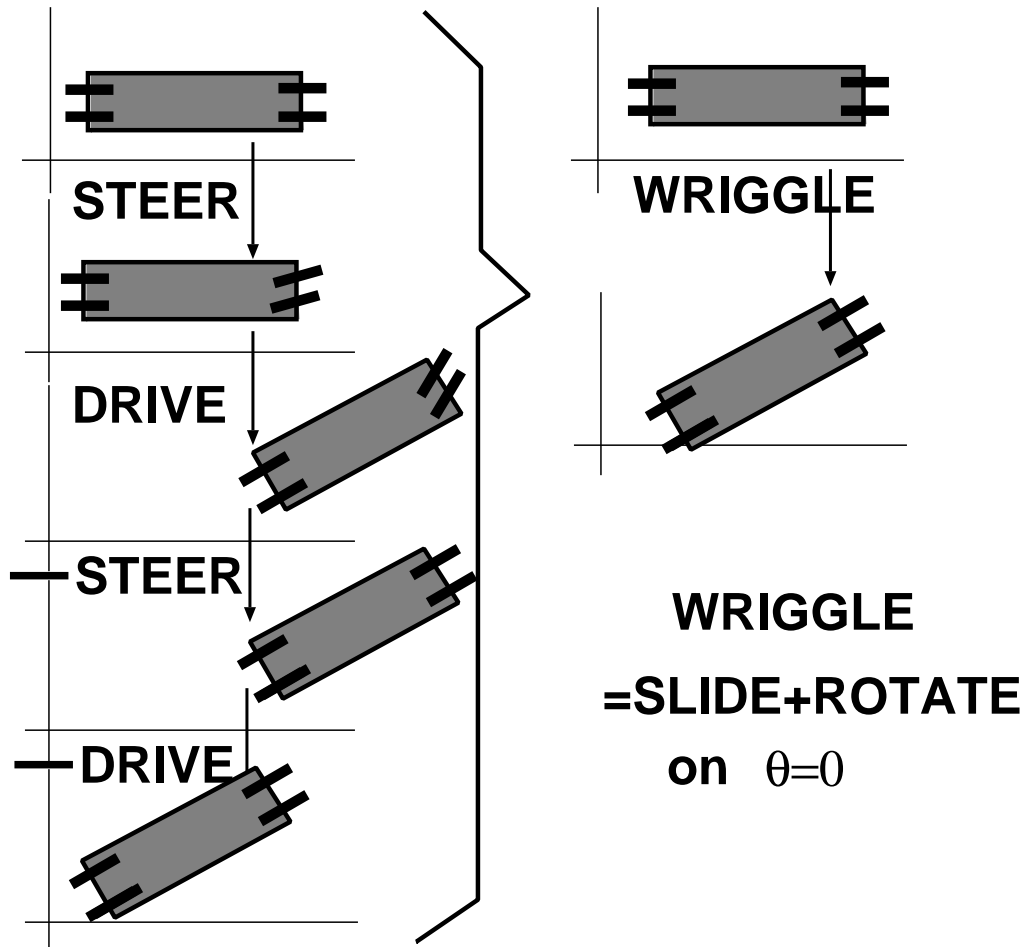
STEER, DRIVE, -STEER, -DRIVE

- The effect of SLIDE is attained by doing:

WRIGGLE, DRIVE, -WRIGGLE, -DRIVE



**[STEER, DRIVE]= WRIGGLE**



**[WRIGGLE, DRIVE]= SLIDE**

