



ارائه شده توسط:

سایت ترجمه فا

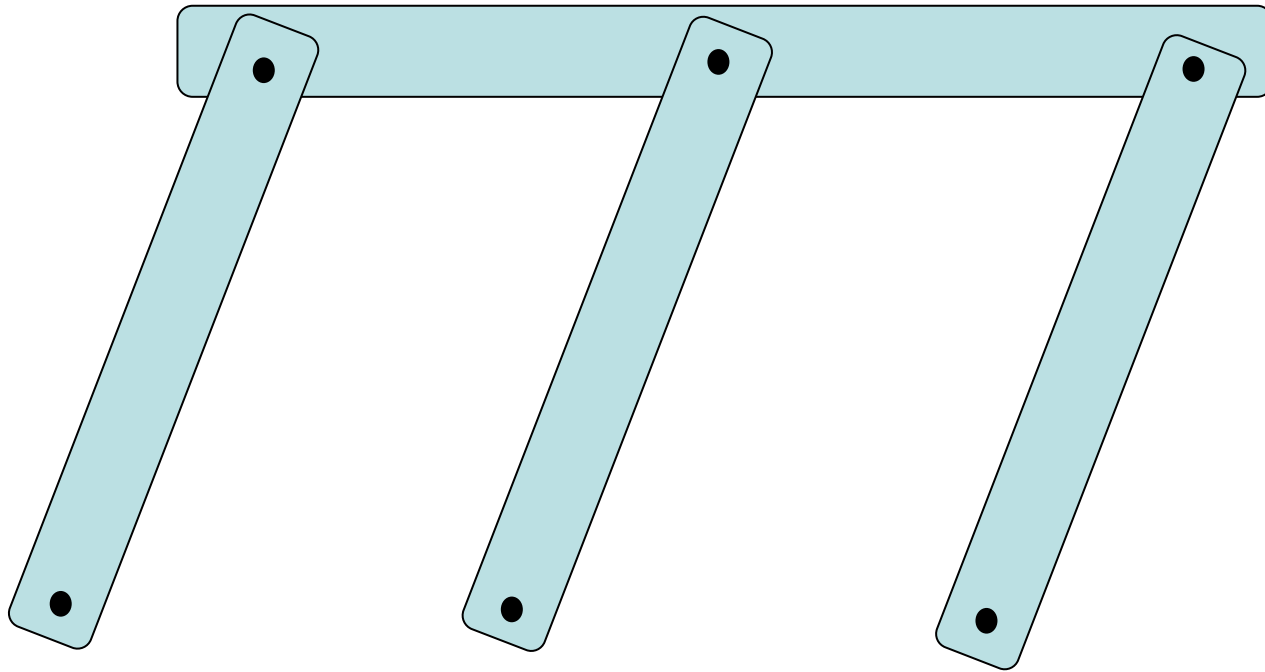
مرجع جدیدترین مقالات ترجمه شده

از نشریات معتبر

# 3D Mechanisms: Mobility, Analysis, Synthesis

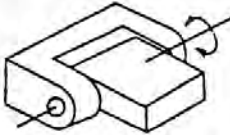
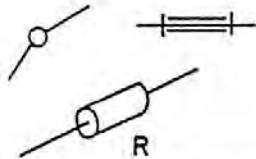
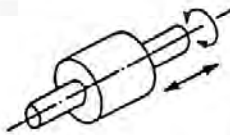
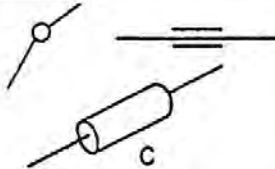
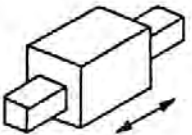
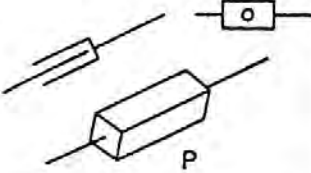
# Concept Question


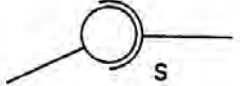
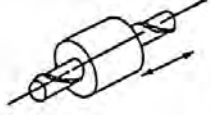
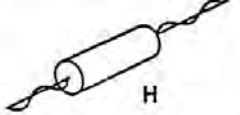
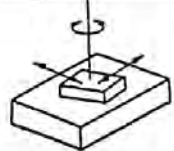
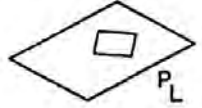
- How many DOF does this mechanism possess?



1) 1    2) 2    3) 0    4) I don't know

# Types of Kinematic Pairs

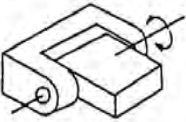
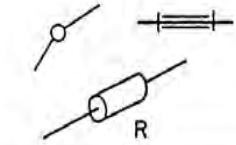
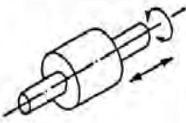
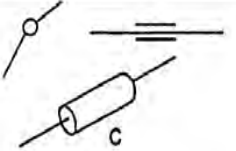
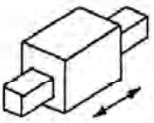
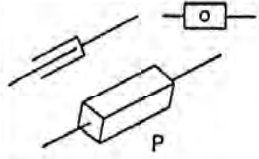


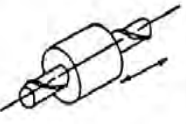
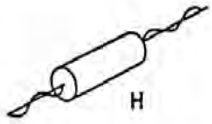
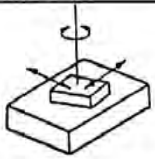
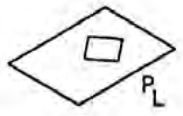
Name of pair	Mechanical joint forms of pairs	Schematic Representations
1. Revolute (R)		
2. Cylinder (C)		
3. Prism (P)		

4. Sphere (S)		
5. Helix (H)		
6. Plane (P <sub>L</sub> )		

Source: Figure 4 in Suh, C. H. *Computer Aided Design of Mechanisms Part B*. Self-published book, 1992. Courtesy of Dr. C. H. Suh. Used with permission.

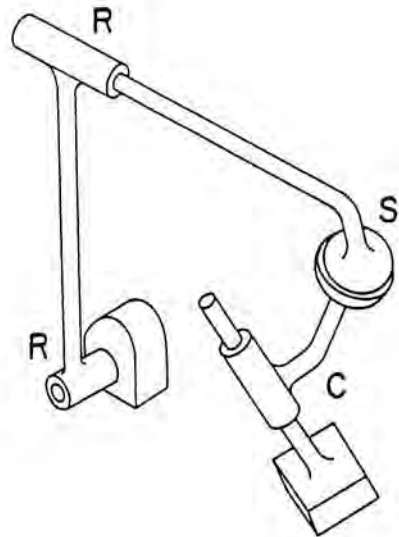
# Mobility Analysis

- Each body has 6 DOF
- Different joints remove different #s of DOF
  - R – 5
  - C – 4
  - P – 5
  - S – 3
  - H – 5
  - $P_L$  – 3

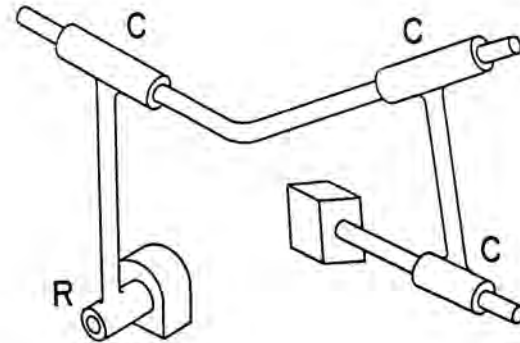
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5. Helix (H)		
6. Plane ( $P_L$ )		

Source: Figure 4 in Suh, C. H. *Computer Aided Design of Mechanisms Part B*. Self-published book, 1992. Courtesy of Dr. C. H. Suh. Used with permission.

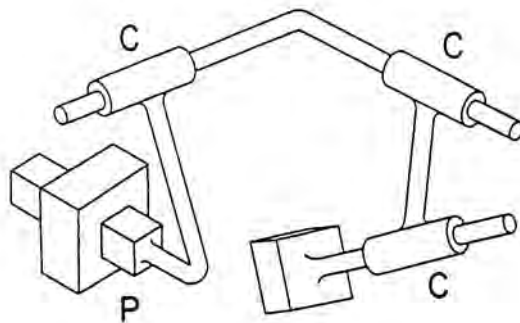
# Some 4 Bar Spatial Mechanisms



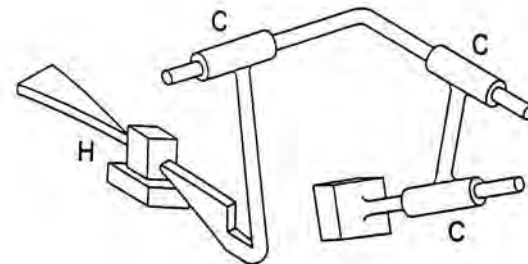
a) RRSC mechanism,  $F = 1$



b) RCCC mechanism,  $F = 1$



a) PCCC mechanism



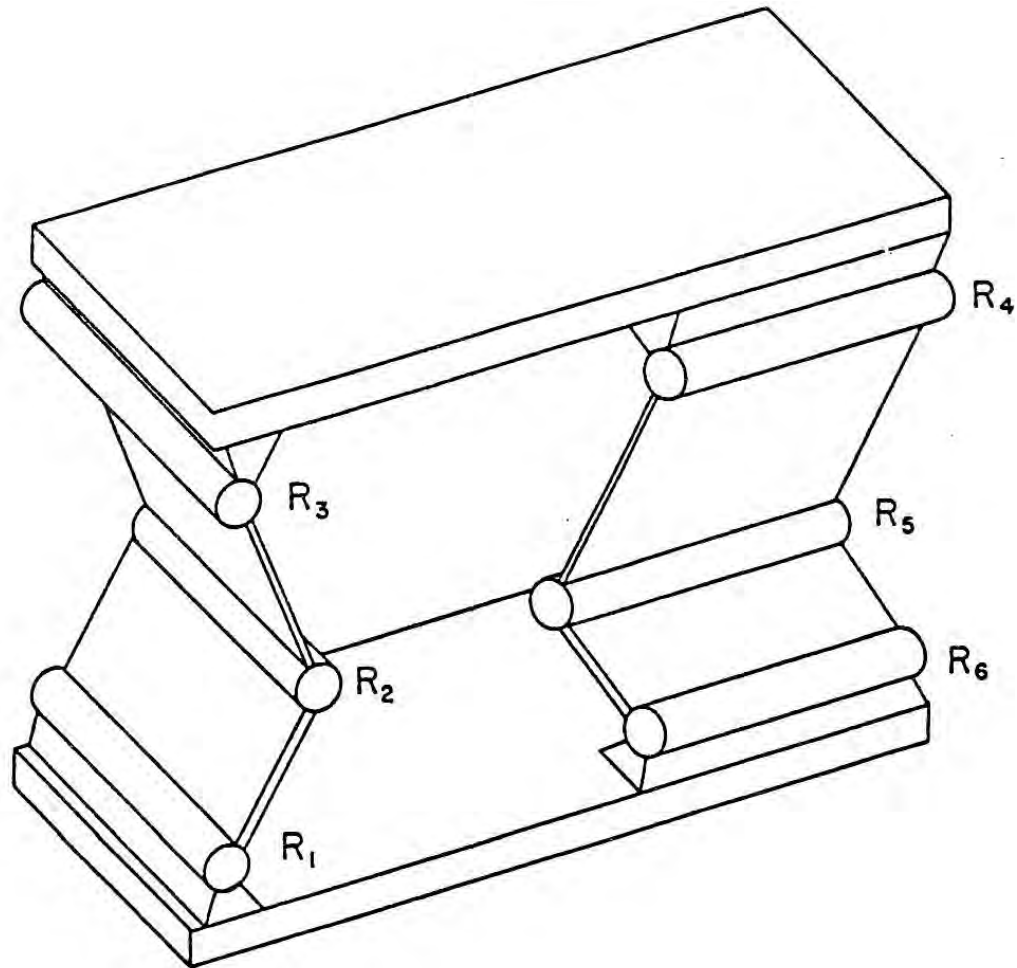
b) HCCC mechanism

Source: Figure 7 (top) and Figure 8 (bottom) in Suh, C. H. *Computer Aided Design of Mechanisms Part B*. Self-published book, 1992. Courtesy of Dr. C. H. Suh. Used with permission.

# Challenge

- Compute the DOF of the generic RRRR mechanism
- Sketch an RRRR mechanism that has one DOF as a matter of fact

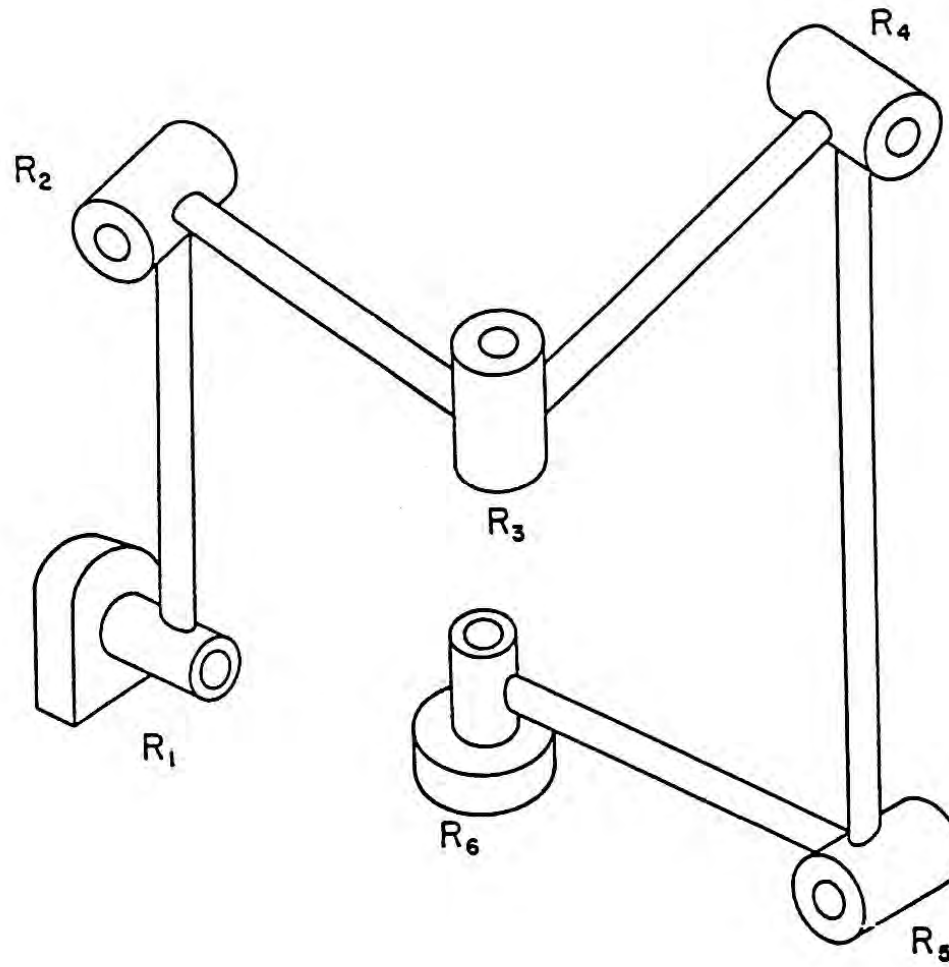
# Sarrus Mechanism



Source: Figure 16 in Suh, C. H. *Computer Aided Design of Mechanisms Part B*. Self-published book, 1992. Courtesy of Dr. C. H. Suh. Used with permission.



# Franke Mechanism



Source: Figure 17 in Suh, C. H. *Computer Aided Design of Mechanisms Part B*. Self-published book, 1992. Courtesy of Dr. C. H. Suh. Used with permission.

# Stewart Platform

7 Bodies

12 S Joints

How many  
degrees of  
freedom  
(assuming the  
legs have a  
fixed length)?  
Where are the  
DOF?

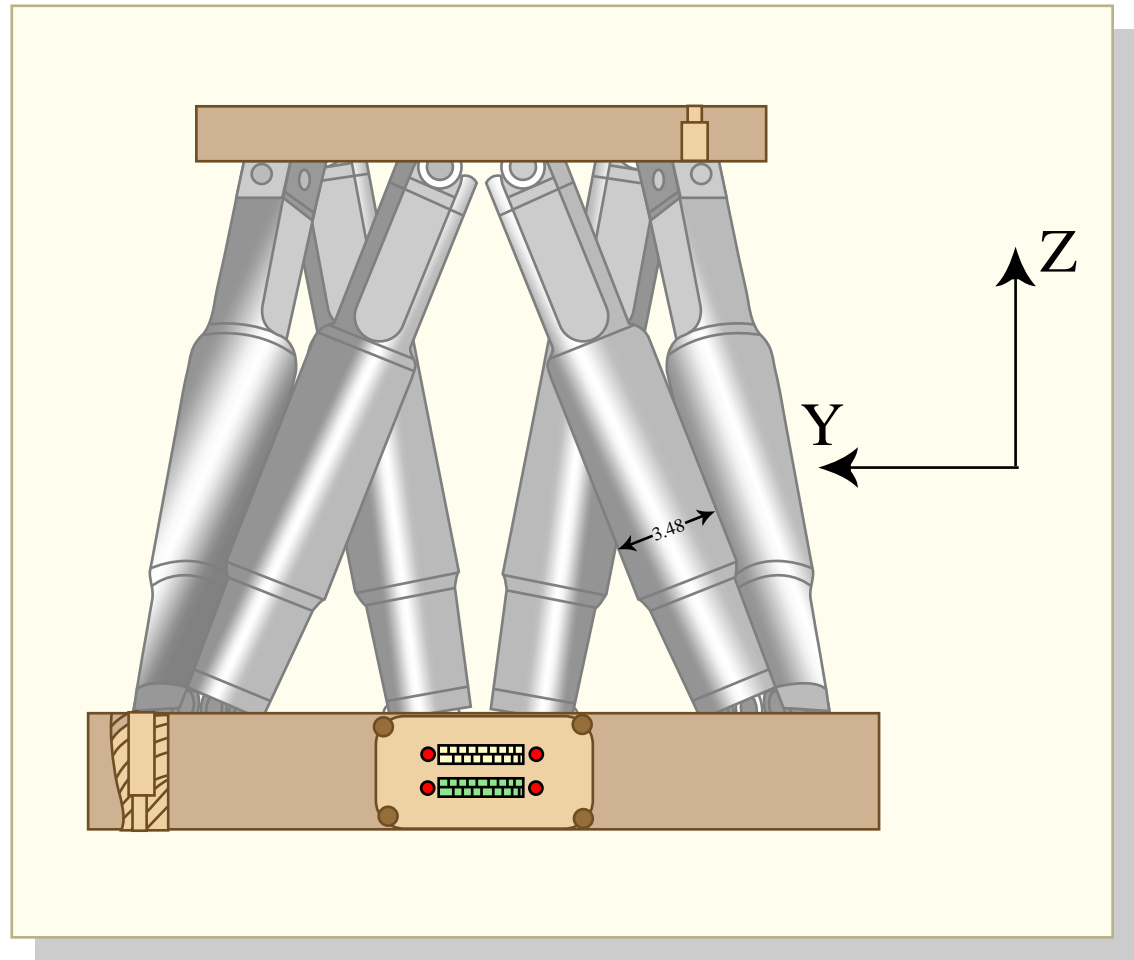


Figure by MIT OCW.

# Double Wishbone Suspension

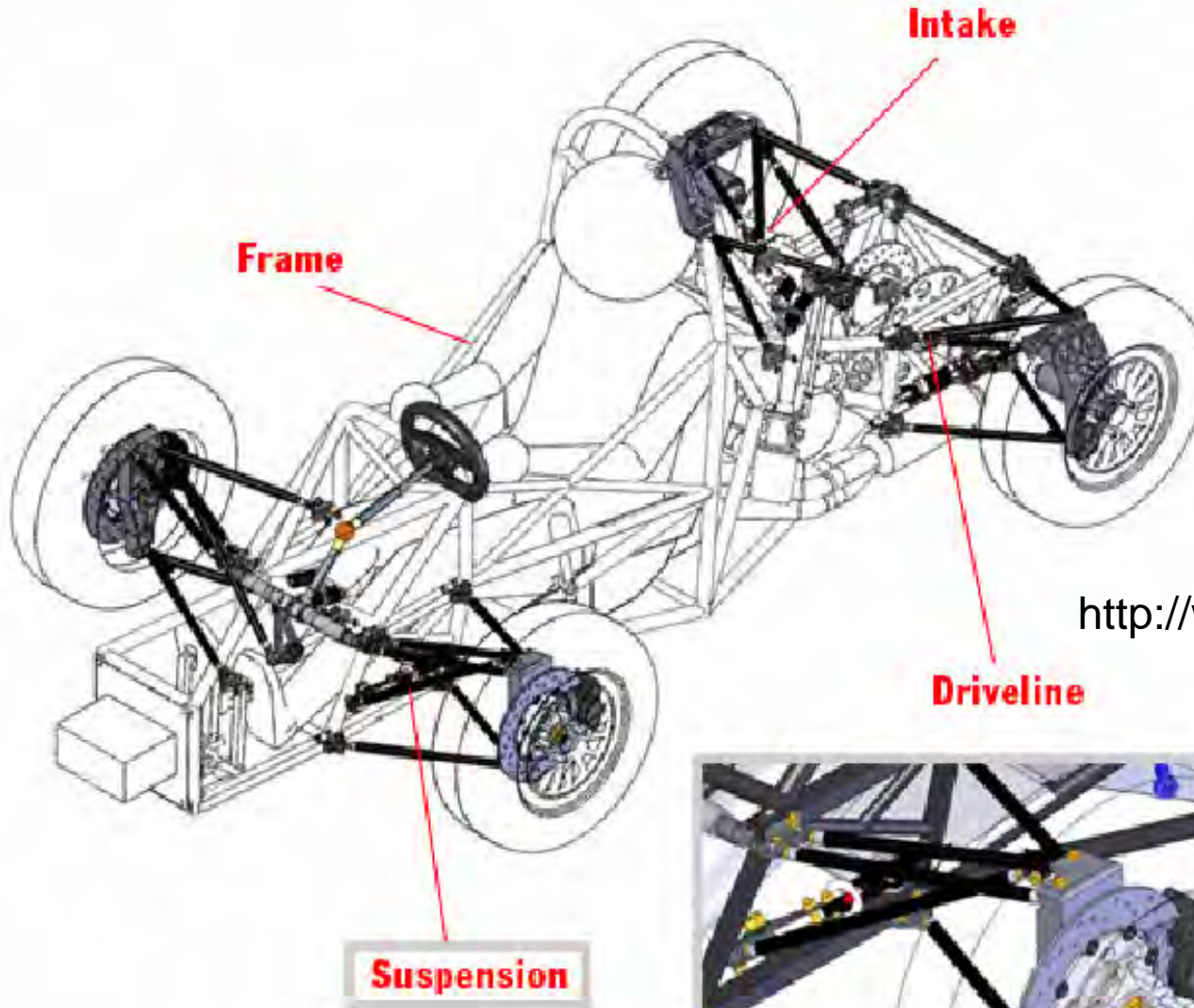
Figure removed for copyright reasons.

Exploded component view of AH Sprite/MG Midget Suspension and Steering.

# Challenge

- Make a schematic of a double wishbone suspension showing all rigid bodies (you may exclude the springs and dampers)
  - Upper wishbone
  - Lower wishbone
  - Kingpin
  - Knuckle
  - Wheel
  - Tie rod
- See if you can determine its mobility (how many DOF and where?)

# Formula SAE Suspension



<http://web.mit.edu/fsae/concept/>



Courtesy of MIT Motorsports. Used with permission.

# Challenge

- Make a schematic of just
  - the lower two arms
  - the upper two arms
  - the knuckle
- Is it equivalent to a double wishbone, kingpin, and a knuckle?
- Prepare an argument one way or other and be ready to “defend” it

# Multi-Link Suspension

- ? Bodies
- ? S Joints
- ? R Joints
- ? C Joints

Figure removed for copyright reasons.  
Honda Accord suspension.

How many  
DOF?  
Where are the  
DOF?

# McPherson Suspension

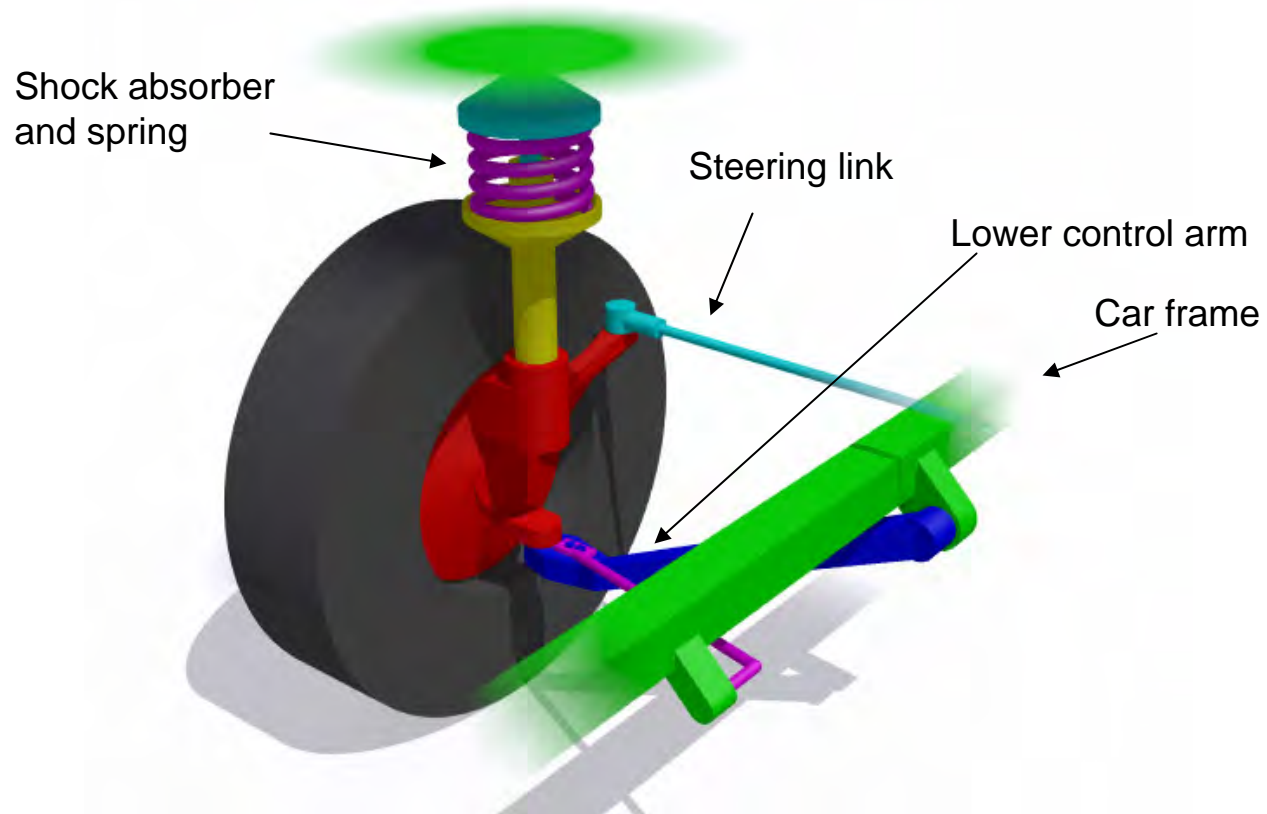


Figure courtesy of "Casito." Source: Wikipedia.



# HTMs in 3D

Rotation about the x axis

$$R_x(\varepsilon_x) \equiv \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\varepsilon_x) & -\sin(\varepsilon_x) & 0 \\ 0 & \sin(\varepsilon_x) & \cos(\varepsilon_x) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Rotation about the y axis

$$R_y(\varepsilon_y) \equiv \begin{pmatrix} \cos(\varepsilon_y) & 0 & \sin(\varepsilon_y) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin(\varepsilon_y) & 0 & \cos(\varepsilon_y) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Rotation about the z axis

$$R_z(\varepsilon_z) \equiv \begin{pmatrix} \cos(\varepsilon_z) & -\sin(\varepsilon_z) & 0 & 0 \\ \sin(\varepsilon_z) & \cos(\varepsilon_z) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Translation in all 3 directions

$$T(\delta_x, \delta_y, \delta_z) \equiv \begin{pmatrix} 1 & 0 & 0 & \delta_x \\ 0 & 1 & 0 & \delta_y \\ 0 & 0 & 1 & \delta_z \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

# Simulating an R Joint

$$\mathbf{R}_{\mathbf{u}}(\mathbf{u}, \phi) \equiv \begin{bmatrix} (u_1)^2 \cdot (1 - \cos(\phi)) + \cos(\phi) & u_1 \cdot u_2 \cdot (1 - \cos(\phi)) - u_3 \cdot \sin(\phi) & u_1 \cdot u_3 \cdot (1 - \cos(\phi)) + u_2 \cdot \sin(\phi) & 0 \\ u_1 \cdot u_2 \cdot (1 - \cos(\phi)) + u_3 \cdot \sin(\phi) & (u_2)^2 \cdot (1 - \cos(\phi)) + \cos(\phi) & u_2 \cdot u_3 \cdot (1 - \cos(\phi)) - u_1 \cdot \sin(\phi) & 0 \\ u_1 \cdot u_3 \cdot (1 - \cos(\phi)) - u_2 \cdot \sin(\phi) & u_2 \cdot u_3 \cdot (1 - \cos(\phi)) + u_1 \cdot \sin(\phi) & (u_3)^2 \cdot (1 - \cos(\phi)) + \cos(\phi) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\mathbf{R}_{\mathbf{p}\mathbf{u}}(\mathbf{p}, \mathbf{u}, \phi) \equiv \mathbf{T}(\mathbf{p}_1, \mathbf{p}_2, \mathbf{p}_3) \cdot \mathbf{R}_{\mathbf{u}}(\mathbf{u}, \phi) \cdot \mathbf{T}(-\mathbf{p}_1, -\mathbf{p}_2, -\mathbf{p}_3)$$

# Next Steps

- Lab Friday 10 MAR
- Next session Tuesday 14 MAR



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لیست مقالات ترجمه شده رایگان ✓

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