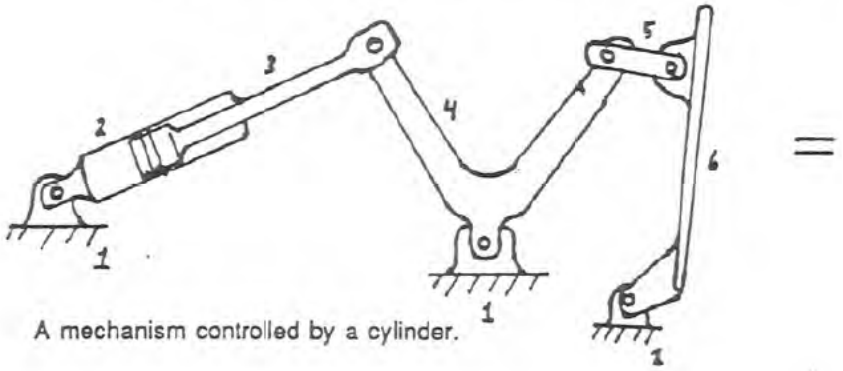
ME 5243:
ADVANCED MECHANISM DESIGN

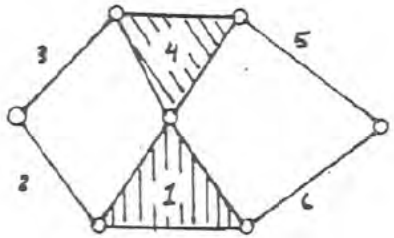
Class #4

Type Synthesis &

Project Intro



A mechanism controlled by a cylinder.



- Type Synthesis
  - Example Application
- Project Discussion
- Team Forming & Project Planning

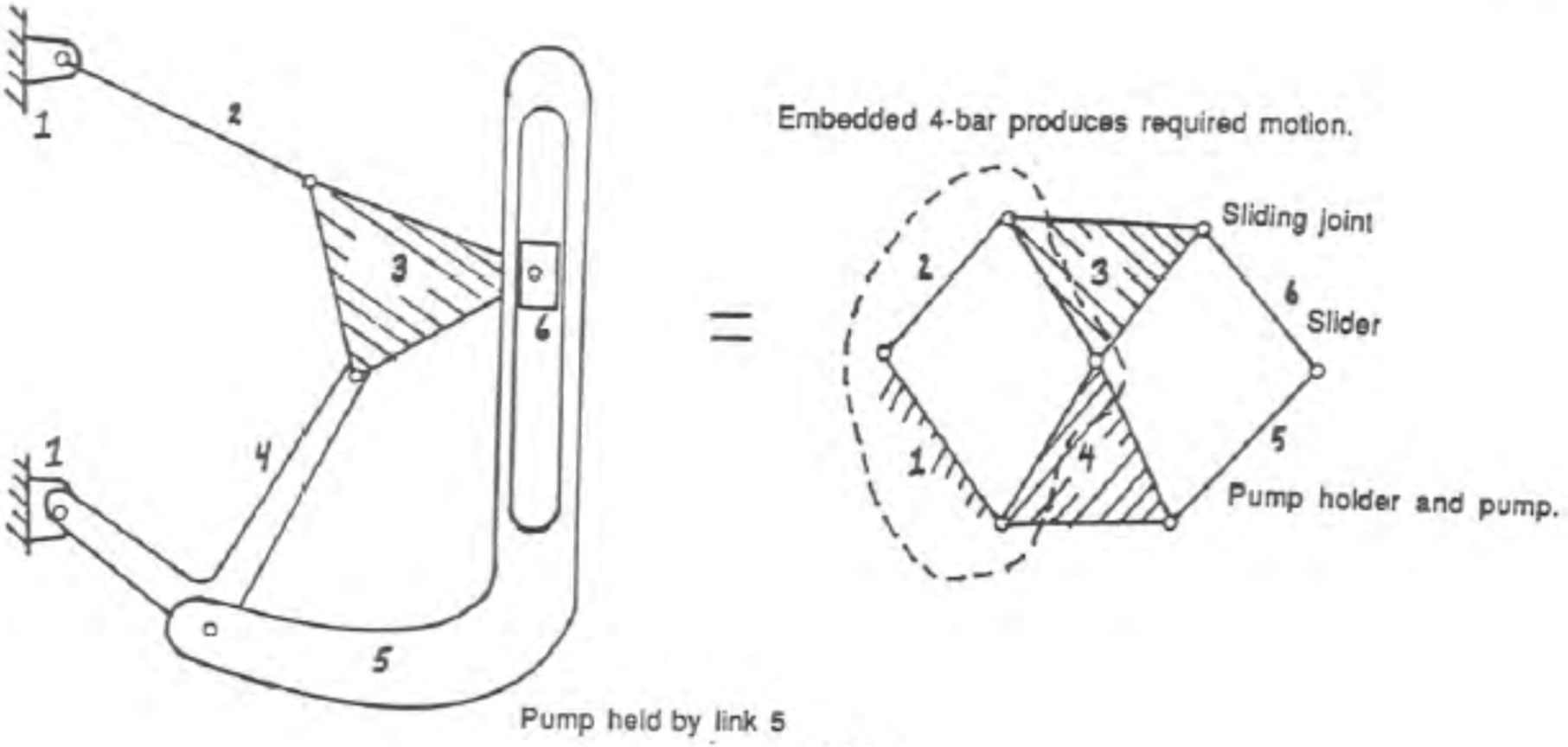
Notes

- Bring drawing tools Tuesday
- TA (Ryan) Office Hours
  - Thurs 1-2pm, ME 2121B

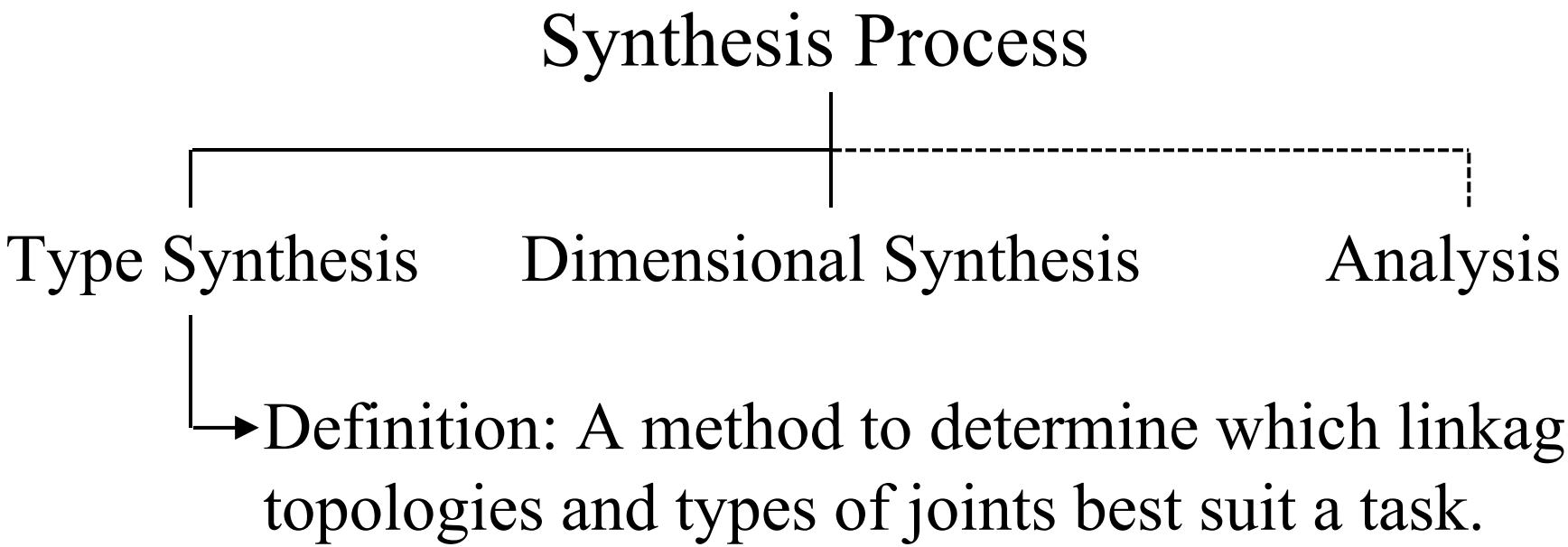
Questions from Video / Reading?

- Design Process & Synthesis Overview

- Type Synthesis



Synthesis Steps



Definition: A method to determine which linkage topologies and types of joints best suit a task.

Type Synthesis

Purposes:

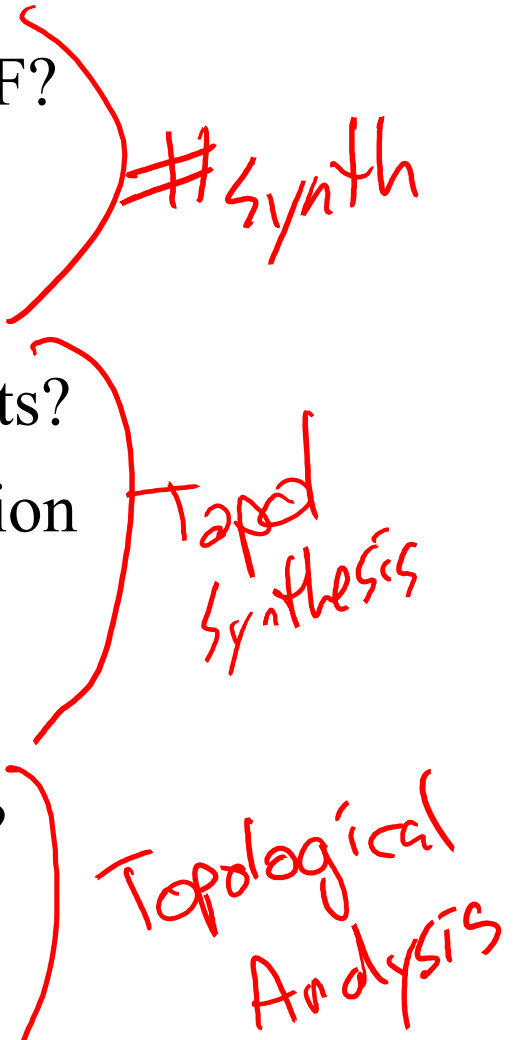
1. Finding best mechanism type for task specs
2. Patent recognition / Work arounds

Steps:

- Number Synthesis
- Topological Synthesis
- Topological Analysis

Type Synthesis Questions

1. How many links and joints for desired DOF?
2. What are the link types and # required?
3. What link sets satisfy desired DOF?
4. How many linkage topologies from link sets?
5. Which topologies meet the "DOF distribution criteria?"
6. What inversions exist?
7. What inversions are best suited to the task?
8. Possible joint substitutions?
9. What links can serve as input?

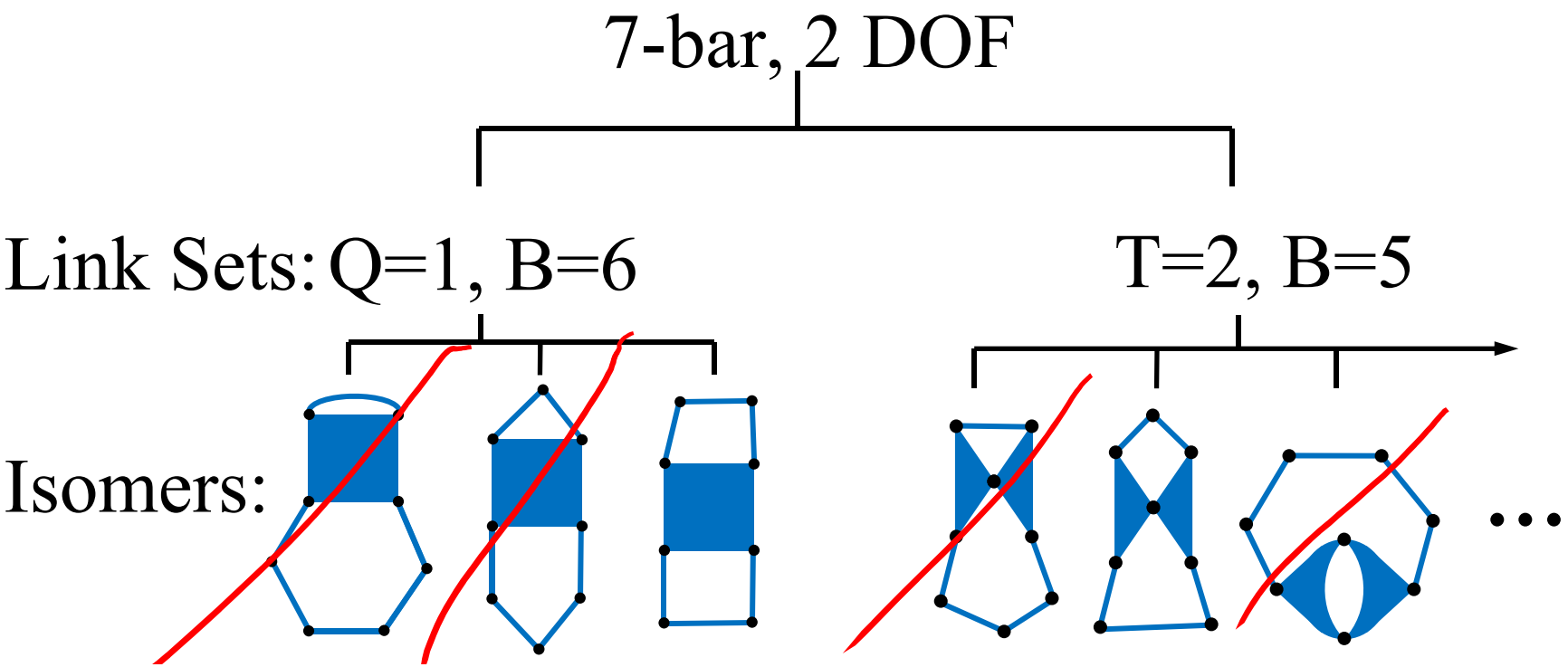


Number Synthesis

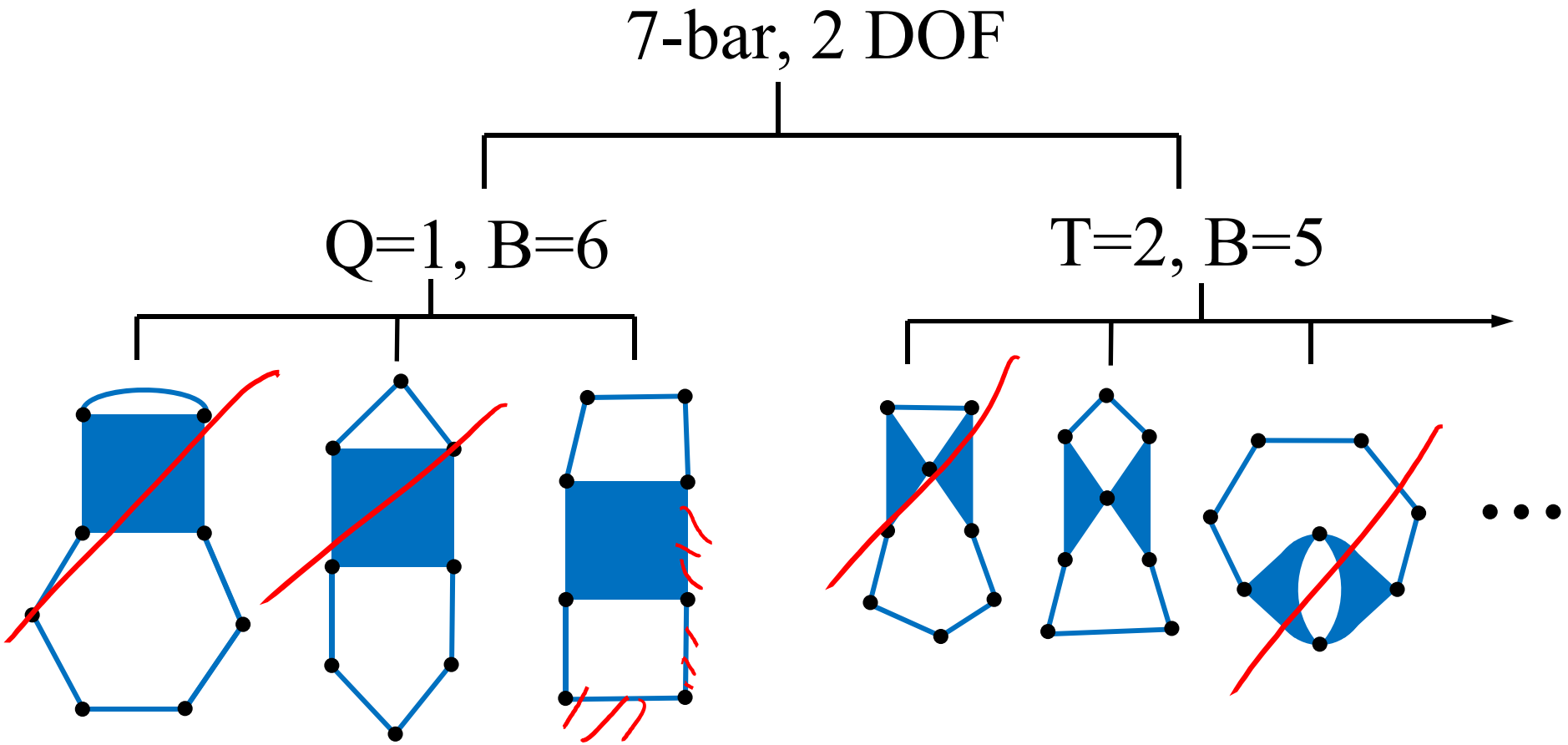
Number Synthesis

In Groups of 2-3: $n - F - 3 = T + 2Q + 3P + \ldots$

- Find all 7-bar "Link Sets" with 2 DOF
- Sketch the Isomers



Topological Synthesis



Topological Analysis

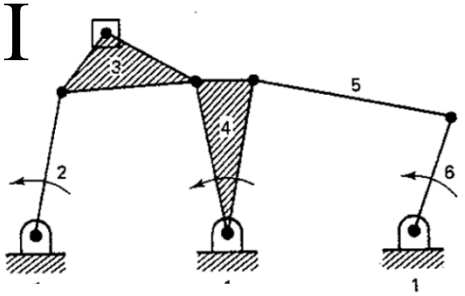
7. What inversions are best suited to the task?
   - Sub-questions
     a) Motion, Path, or Function Generation?
     b) How will it be driven?
     c) How much space available for ground pivots?
     d) Is high stability required?
     e) Is a long reach required?

Topological Analysis

7. What inversions are best suited to the task?

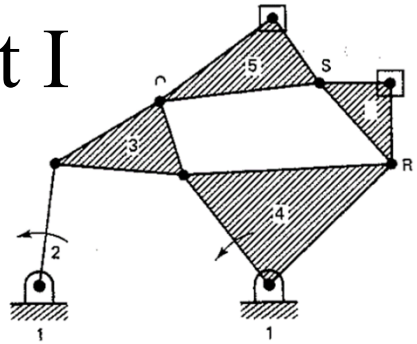
<u>6-Bar Generalizations</u>

- Watt II



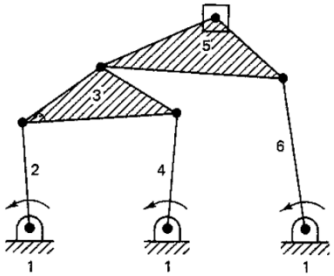
Fcn Gen

- Watt I



Long Reach
// motion

- Stephenson III

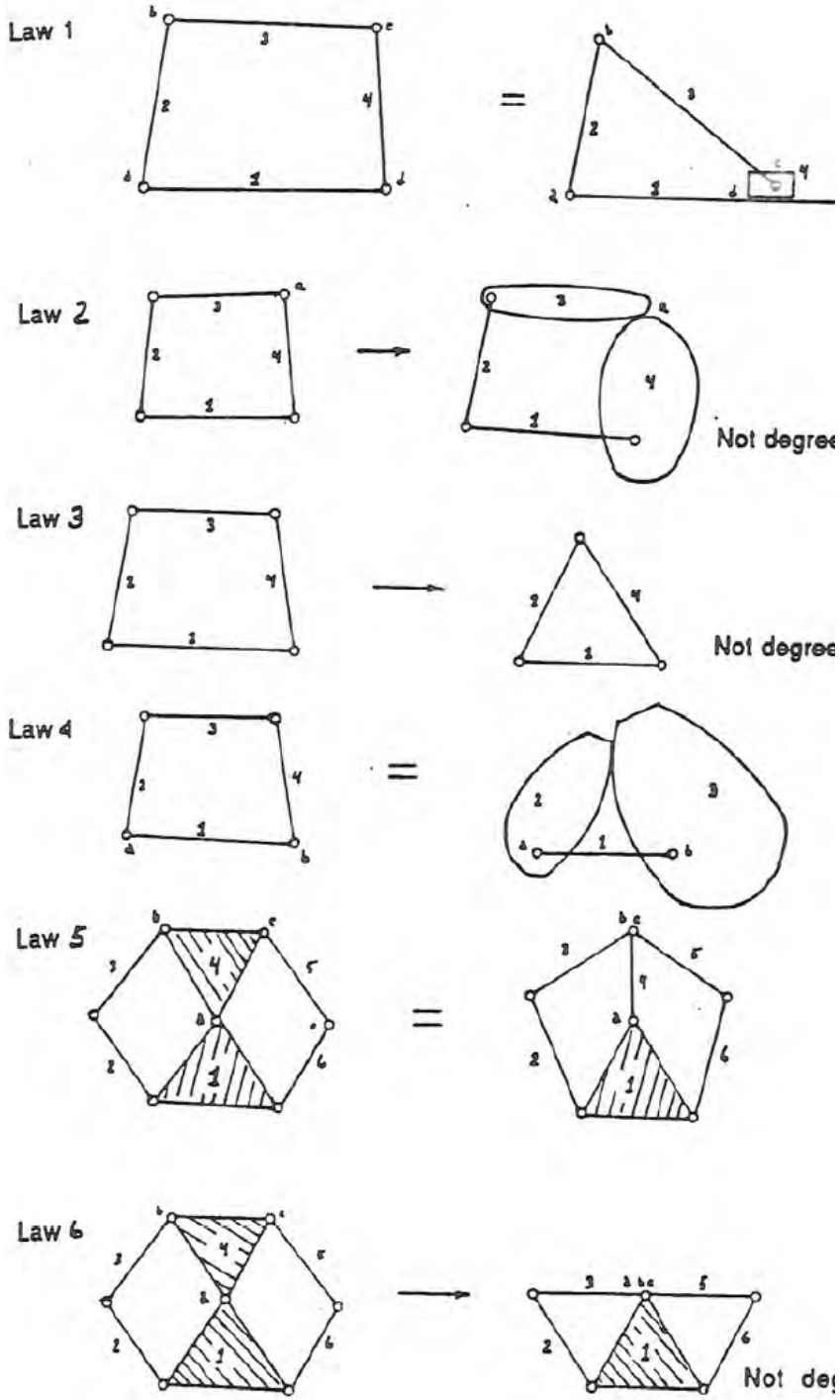


high stability
high trans Ls

Topological Analysis

Transformation Laws:

1. Slider and Pin Directly Interchange
2. Substitute higher-pair joint = +1 DOF
3. Remove binary link = -1 DOF
4. 2+3: Can remove binary and replace with higher-pair joint
5. Partial link shrinkage creates multiple joint, same DOF
6. Total link shrinkage creates multiple joint and -1 DOF



General "Rules of Thumb"

- Pin joints preferred to sliders or high-pair joints
- More complex linkages = More complex motion
- Multi-Task Machines: Try to design multiple tasks into a single mechanism

Type Synthesis Example

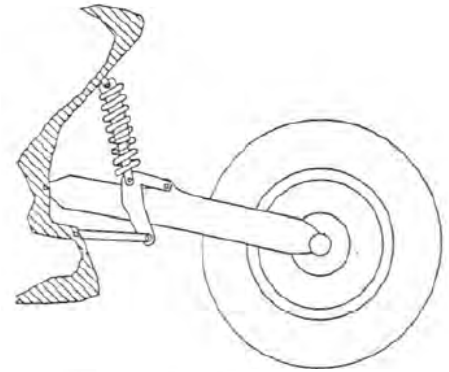
Motorcycle Rear Suspension - Swingarm

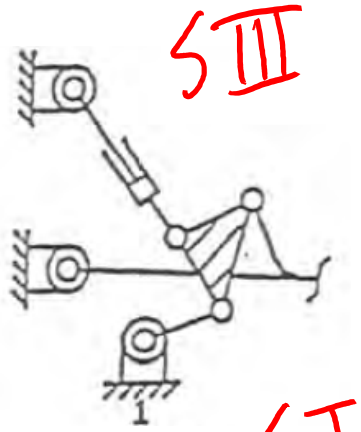
Problem: Need Large Travel with Variable Lever Ratio

Type Synthesis Example

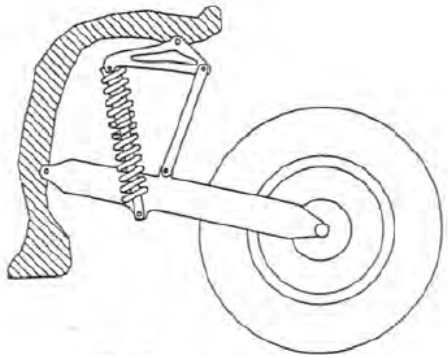
The Competitors:

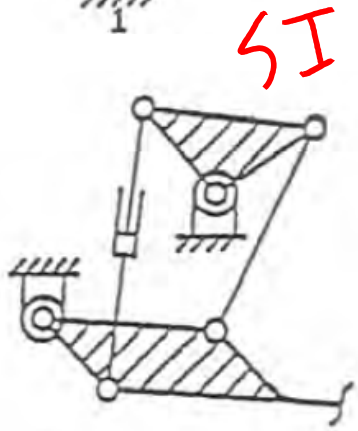
- Honda “Pro-Link”



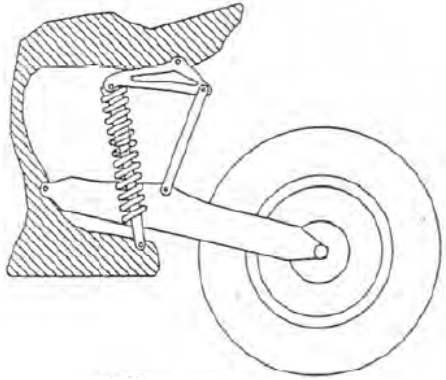


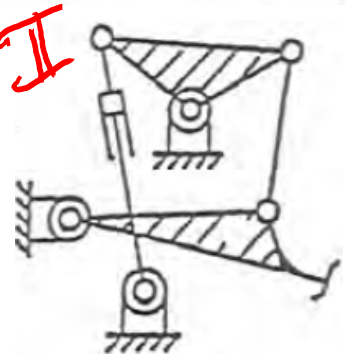
- Suzuki “Full-floater”





- Kawasaki “Uni-trak”





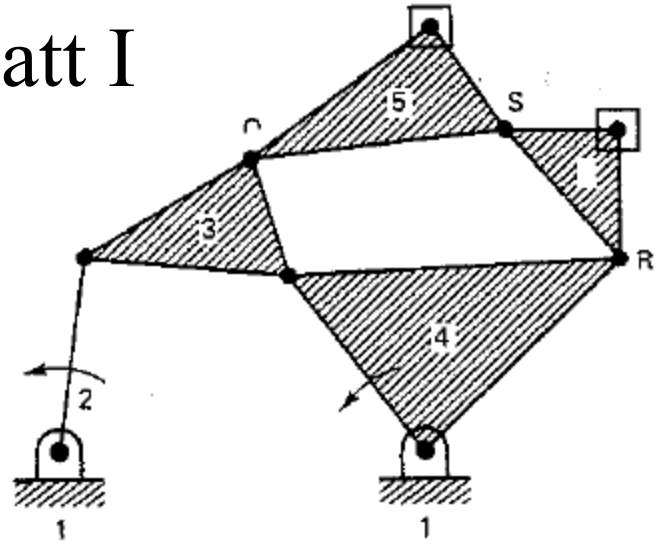
Motorcycle Suspension

Linkage Requirements:

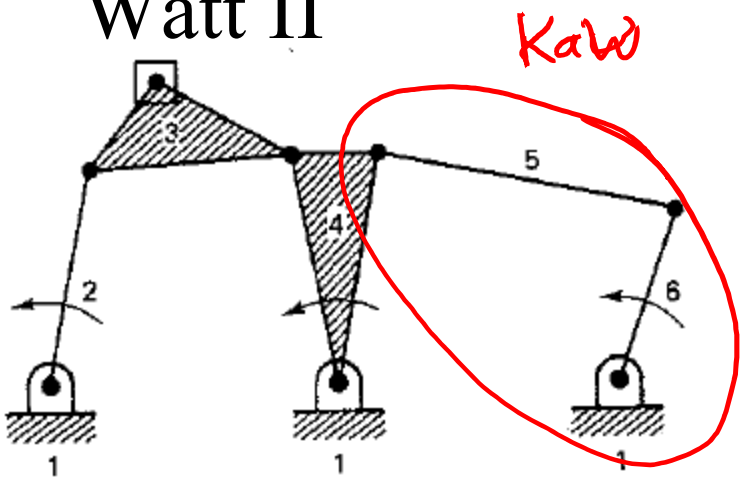
- 1 DOF
- Space constraint / compact
- Swing arm pinned to gnd - large travel
- Shock absorber - binary dyad

Motorcycle Suspension
6-bar Topology Options

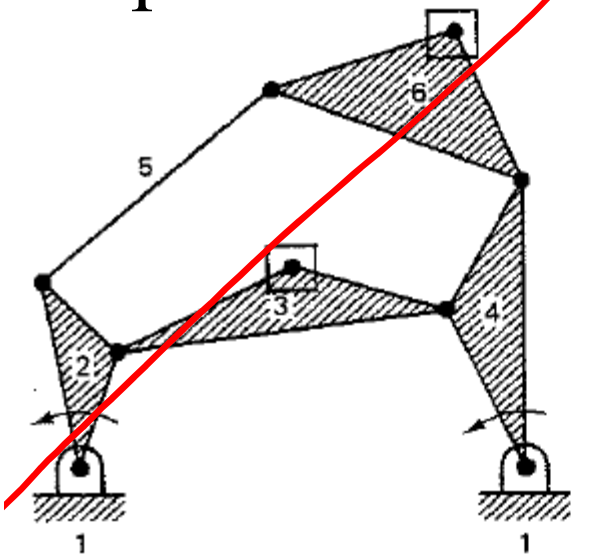
Watt I



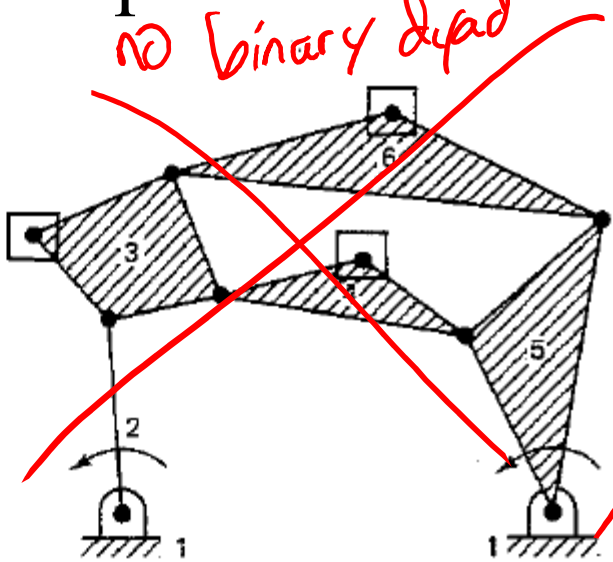
Watt II



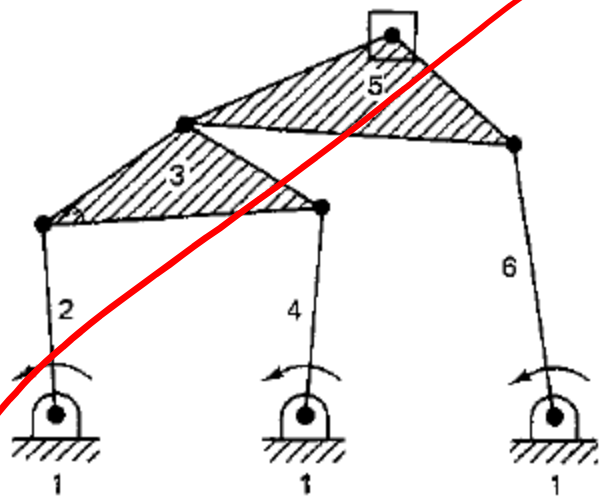
Stephenson I



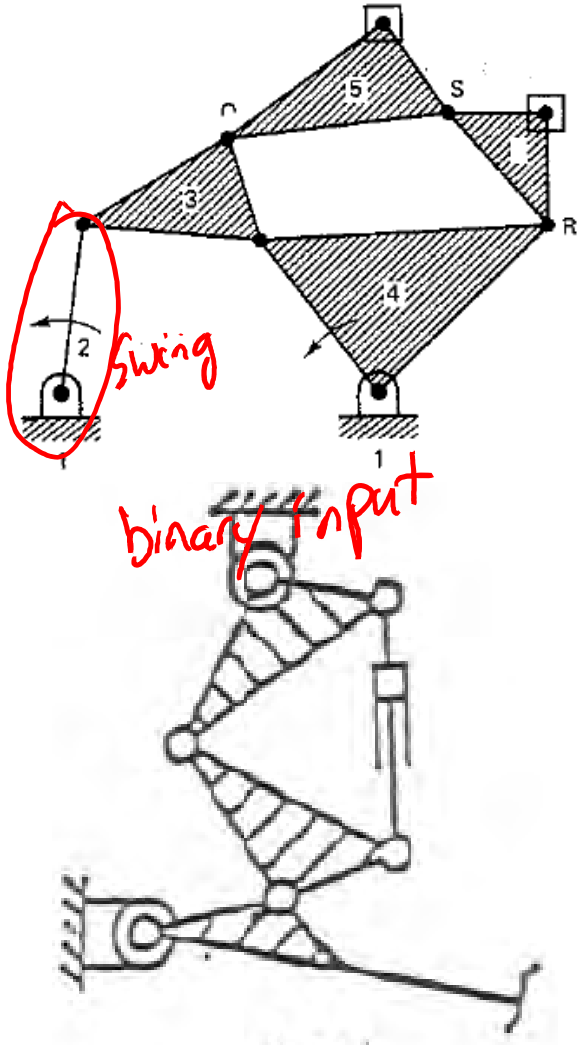
Stephenson II

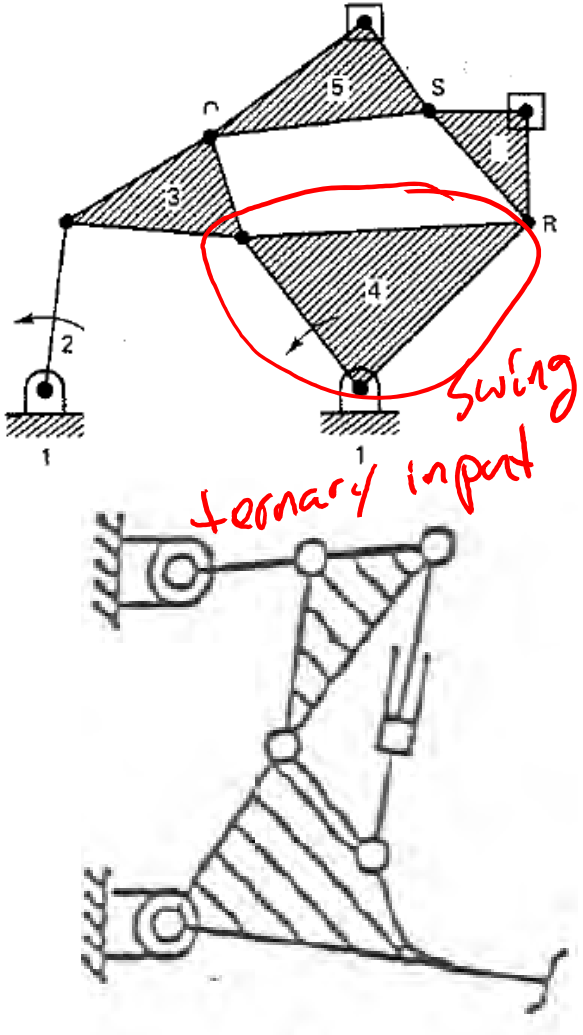


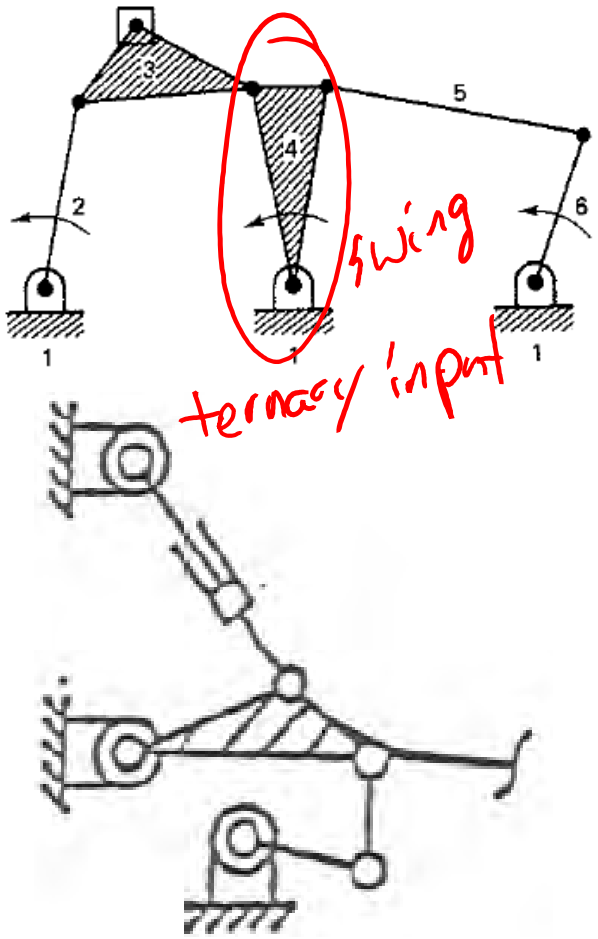
Stephenson III



Motorcycle Suspension
Kinematic Drawing of Solutions







Project Discussion

- Application of Linkage Synthesis to a Real-World Problem
  - Topic of Your Choice
- Includes Full Design Process
- Evaluated: Progress Reports, Final Report (peer reviewed), and Oral Presentation
- Construct a Functional Prototype

Project Advice

- Use the Design Process – it works!
- Take advantage of incubation – start it now!
- The better you define the problem, the better will be the result.
- Don't jump to a premature solution.
- The more concepts you generate, the better.
- "Invention is 1% inspiration and 99% perspiration." *Thomas Edison*

Suggestions to Get Started:

- Do research before trying to solve the problem!
  - Explore similar products and motions
- Don't "shoot from the hip." Engineer it.
- Utilize a variety of synthesis methods.
- Consult coupler curve atlases.
- Cardboard models and programs such as LINCAGES, Solidworks, Pro-Engineer, ADAMS, and Working Model make designing much easier.

Project Due Dates

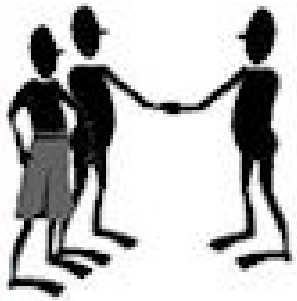
Deliverables	Due Dates
• Project Proposal	9/21/2017
• Progress Report 1	10/12/2017
• Progress Report 2	11/7/2017
• Report Draft for Peer Review	11/30/2017
• Peer Reviews Completed	12/7/2017
• Oral Presentation	12/5-7/2017
• Final Report & Revision Letter	12/12/2017

Project Questions?

Team Forming & Project Planning Workshop

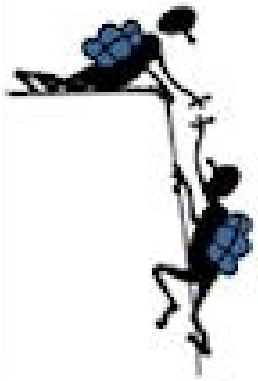
Teamwork Plays a Large Role in Project

Forming
Team acquaints and establishes ground rules. Formalities are preserved and members are treated as strangers.



Storming
Members start to communicate their feelings but still view themselves as individuals rather than part of the team. They resist control by group leaders and show hostility.

Norming
People feel part of the team and realize that they can achieve work if they accept other viewpoints.



Performing
The team works in an open and trusting atmosphere where flexibility is the key and hierarchy is of little importance.

Adjourning
The team conducts an assessment of the year and implements a plan for transitioning roles and recognizing members' contributions.

Image source: http://sites.psu.edu/leadership

Classic Team Problems

1. Someone didn’t do their work
2. People don’t get along
3. Somebody isn’t participating
4. Somebody’s schedule is impossible to plan around
5. Somebody is running the whole show

Effective meetings are not by chance…

- Always Have a Purpose – If Not, Don't Meet
- Develop & Distribute Agenda
- Establish Roles & Rotate
- Encourage Discussion – Multiple Points of View
- Keep Discussion on Target
- Develop and Review Action Items
- Distribute Meeting Minutes Promptly
- Start and End on Time
- Establish Ground Rules

Activity:

Team Forming & Project Planning Meeting

1. Select temporary team roles
2. Team introductions
3. Establish team policies
4. Organize your project
5. Select next meeting time