Mechanism

Machines are mechanical devices used to accomplish work. A mechanism is a heart of a machine. It is the mechanical portion of the machine that has the function of transferring motion and forces from a power source to an output.

Mechanism is a system of rigid elements (linkages) arranged and connected to transmit motion in a predetermined fashion.

Mechanism consists of linkages and joints.
Example of Mechanism

Can crusher

Simple press

Rear-window wiper
Example of Mechanisms

Moves packages from an assembly bench to a conveyor

Lift platform

Microwave carrier to assist people on wheelchair

Microwave oven carrier

Linear actuator
Example of Mechanisms

Lift platform

Front loader

Device to close the top flap of boxes
Example of Mechanisms

Rowing type exercise machine

Conceptual design for an exercise machine
Example of Mechanisms

Extension position

Flexed position

Six-bar linkage prosthetic knee mechanism
Four-Bar Linkage
Four-Bar Linkage Categories

Four-bar linkage: shortest link
s, longest link q, intermediate length links p
and q.

(a) Crank-rocker

s + q < p + q

(b) Double-crank

s + q < p + q
Four-Bar Linkage Categories

(c) Rocker-crank

(d) Grashof Rocker-rocker

(Full rotation of the coupler link is possible)

(e) Non-Grashof Rocker-rocker (Triple Rocker)

(f) Change-Point Mechanism in Toggle Configuration

\[ s + \ell < p + q \]

\[ s + \ell = p + q \]
4-Bar mechanisms

All inversions of the Grashof fourbar linkage

Two non-distinct crank-rocker inversions

Double-crank inversion (drag link)

Double-rocker inversion (coupler rotates)

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4-Bar mechanisms

\[ S + 1 > p + q \]

4 double rocker mechanisms
The Slider-Crank Mechanism
The Slider-Crank Mechanism

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Link 2 angle: 54.00
Link 2 length: 1.64
Link 3 length: 3.30
Slot 13 Y-Offset: -0.26
Slider-Crank Mechanism - Inversion

Slider block translates
Slider block has complex motion

Slider block rotates
Slider block is stationary

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Mechanism Categories

Function Generation Mechanisms

A function generator is a linkage in which the relative motion between links connected to the ground is of interest.

A four-bar hand actuated wheelchair brake mechanism
Mechanism Categories

Function Generation Mechanisms

A four-bar drive linkage for a lawn sprinkler
Mechanism Categories

Motion Generation Mechanisms

In motion generation, the entire motion of the coupler link is of interest (*rigid body guidance*).

New Rollerblade brake system
Mechanism Categories

Motion Generation Mechanisms

Four-bar automobile hood linkage design
Mechanism Categories

Path Generation Mechanisms

In path generation, we are concerned only with the path of a tracer point and not with the motion (rotation) of the coupler link.

Crane – straight line motion
Primary Joints

(a) Pin

(b) Sliding
Higher Order Joints

(a) Cam joint

(b) Gear joint

(a) Simple link

(b) Complex link
Motion Generation Mechanisms

Rotating a monitor into a storage position

Moving a storage bin from an accessible position to a stored position
Motion Generation Mechanisms

Moving a trash pan from the floor up over a trash bin and into a dump position

Lifting a boat out of water
Graphical Synthesis – Motion Generation Mechanism

Two positions, coupler as the output

1. Draw the link AB in its two desired positions, A₁B₁ and A₂B₂
2. Connect A₁ to A₂ and B₁ to B₂.
3. Draw two lines perpendicular to A₁A₂ and B₁B₂ at the midpoint (midnormals)
4. Select two fixed pivot points, O₂ and O₄, anywhere on the two midnormals.
5. Measure the length of all links,
   O₂A = link 2, AB = link 3,
   O₄B = link 4 and O₂O₄ = link 1
Graphical Synthesis – Motion Generation Mechanism

Adding a Dyad to a non-Grashof mechanism.

1. Draw the four bar in both positions
2. Select any point C on link 2.
3. Connect C₁ to C₂ and extend.
4. Select any location on this line for third fixed pivot, O₆
5. Draw a circle with radius C₁C₂ / 2. The radius is the length of the sixth link.
6. Measure O₆D = link 6, DC = link 5
Motion Generation Mechanisms
Graphical Solution

Two position synthesis (coupler output) with Dyad added.
**Graphical Synthesis – Motion Generation Mechanism**

**Two positions Grashof 4-Bar mechanism with rocker as the output**

1. Draw the link CD in its two desired positions, C1D1 and C2D2

2. Connect C1 to C2 and D1 to D2 and draw two midnormals to C1C2 and D1D2

3. The intersection of the two midnormals is the fixed pivot point O4.

4. Select point B1 anywhere on link O4C1 and locate B2 so O4B1 = O4B2

5. Connect B1 to B2 and extend. Select any location on this line for fixed pivot point O2.

6. Draw a circle with radius B1B2 / 2, point A is the intersection of the circle with the B1B2 extension.

7. Measure the length of all links, O2A = link 2, AB = link 3, O4CD = link 4 and O2O4 = link 1
Motion Generation Mechanisms
Graphical Solution

Two position synthesis (rocker output) – $C_1D_1$ and $C_2D_2$
2 Position Motion – rocker output
Graphical Synthesis – Motion Generation Mechanism

Three positions, coupler as the output

Same procedure as for two positions.
1. Draw the link AB in three desired positions.
2. Draw the midnormals to $A_1A_2$ and $B_1B_2$, the intersection locates the fixed pivot point $O_2$. Same for point B to obtain second pivot point $O_4$.
3. Change the second position of link AB to vary the locations of the fixed points
4. Check the accuracy of the mechanism, Grashof condition and the transmission angle.
3 Position Motion

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3 Position Motion

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3 Position Motion
Function Generation Mechanisms
Graphical Solution

Two position synthesis — Design a four-bar crank and rocker mechanism to give 45° of rocker rotation with equal time forward and back, from a constant speed motor input.

1 – Draw the rocker O₄B in both extreme positions, B₁ and B₂ in any convenient location with angle θ₄ = 45°.

2 – select a convenient point O₂ on line B₁B₂ extended.

3 – Bisect line B₁B₂, and draw a circle with that radius about O₂.

4 – Label the two intersection of the circle with B₁B₂ extended, A₁ and A₂.

5 – Measure O₂A (crank, link2) and AB (coupler, link3).
Function Generation Mechanisms
Graphical Solution

Finished linkage

Link 1
Link 2
Link 3
Link 4

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Crank-Rocker Mechanism
Slider-Crank Mechanism

The mechanism has a stroke $B_1B_2$ equal twice the crank length $r_2$.

Locations $B_1$ and $B_2$ are called the extreme positions (limiting) of the slider.

In-line slider crank mechanism
Slider-Crank Mechanism

Offset slider-crank mechanism
Straight line Mechanisms

(a) Watt straight-line linkage

(b) Roberts straight-line linkage

(c) Chebyshev straight-line linkage

(e) Peaucellier exact straight-line linkage

(d) Hooke straight-line linkage
Straight Line Mechanism
Geneva Mechanism
Linear Geneva Mechanism
Ratchet Mechanism
Straight Beam Walking Mechanism
Roller and Flat Follower Cams
Cylindrical Cam Mechanism
Gears – Rack and Pinion

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Gears

Worm Gear Sets

Bevel gears

Planetary Gear set
V-8 Engine
Type of Motion and Mechanisms

Most power sources that are readily available today are either of the pure rotational motion type, such as electric motor or hand crank, or of the pure translational type, such as pneumatic or hydraulic cylinder.

Translation to Translation

![Wedge Cam Follower: (Perpendicular)](image1)

![Wedge Cam Follower: (Perpendicular)](image2)

![Wedge Cam Follower: (Skew)](image3)

![Wedge Cam Follower: (Skew)](image4)

![Double-slider: (Perpendicular)](image5)

![Double-slider: (Skew)](image6)
Type of Motion and Mechanisms

Rotational to Rotational

- Spur Gear: (Parallel)
- Bevel Gear: (Perpendicular)
- Worm Gear: (Perpendicular)
- Friction Rollers Pair: (Parallel)
- Crank-rocker: (Parallel)
- Double-crank: (Parallel)
- Pulley Belt: (Parallel)
- Sprocket and Chain: (Parallel)
- Noncircular Gear: (Parallel)
- Geneva Wheel: (Parallel)

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Type of Motion and Mechanisms

**Rotation to Translation**

- **Rack-pinion:** (Perpendicular)
- **Screw Mechanism:** (Parallel)
- **Cam Follower:** (Perpendicular)
- **Slider-crank:** (Perpendicular)
- **Six-bar Dwell Linkage:** (Perpendicular)
- **Cylindrical Cam Follower:** (Parallel)
References

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• **Machines and Mechanisms** by Myszka, Prentice-Hall, 1999