ELECTIVE COURSE [4]

Mechatronic-3

Kinematics Fundamentals

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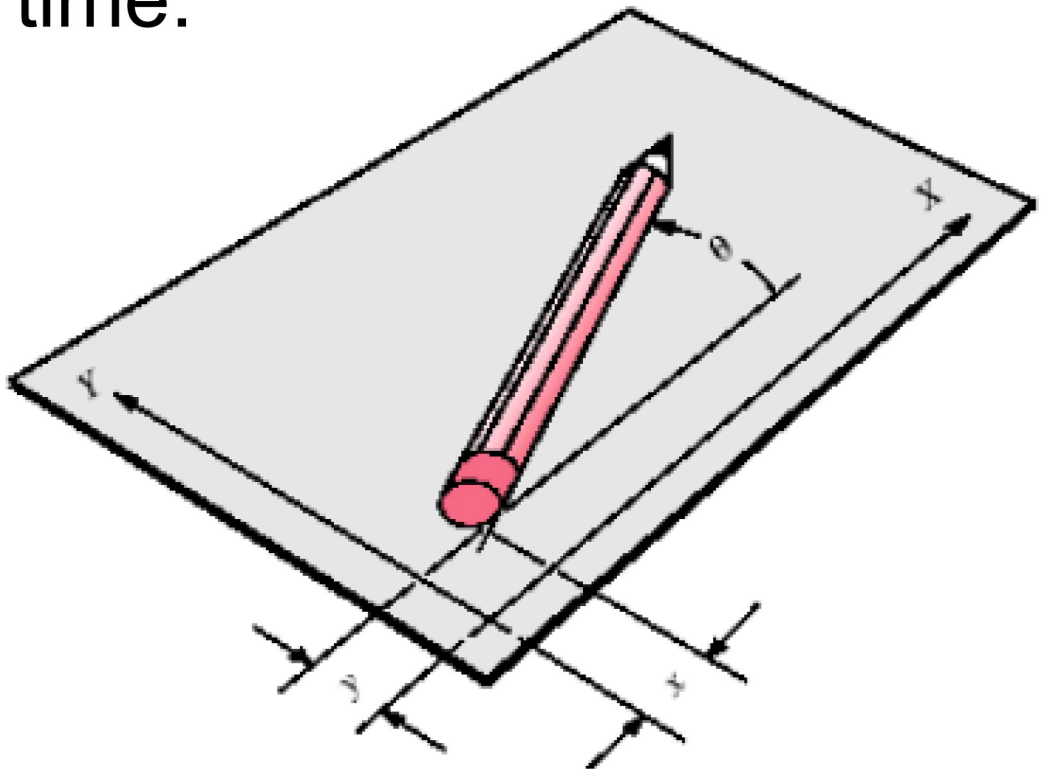
Kinematics Fundamentals

Outline

- Degree of Freedom
- Types Of Motion
- Links, Joints, and Kinematic Chains
- Examples of Planer Mechanism
- Part Design Using CATIA Software

Degree of Freedom

No. of independent parameters (measurements) that are needed to uniquely define the position of body at any instant of time.



How many DOF does a body in three-space (3-D) have?

Degree of Freedom

- ✓ Note that the particular parameters chosen to define its position are **not unique**.
- ✓ Any alternate set of three parameters could be used in this case (rigid body in a plane).
- ✓ There is an infinity of sets of parameters possible.

Degree of Freedom

- ✓ The pencil in previous example represents a rigid body, or link, which for purposes of kinematic analysis we will assume to be incapable of deformation.
- ✓ We are typically facing a blank sheet of paper at the beginning stage of the design process.
- ✓ For purposes of initial kinematic synthesis and analysis, that our kinematic bodies are rigid and massless.

Types Of Motion

For simplicity, we will limit our present discussions to the case of planar (2-D) kinematic systems.

1) Pure rotation

- ✓ The body possesses one point (center of rotation) that has no motion with respect to the stationary frame of reference.
- ✓ All other points on the body describe arcs about that center.

Types Of Motion

2) Pure translation

- ✓ All points on the body describe parallel paths.

3) Complex motion

- ✓ A simultaneous combination of rotation and translation.

Links, Joints, and Kinematic Chains

Definitions

A link is defined as:
A part in a machine that has relative motion to other parts.

A joint is defined as:
A connection between two links that is formed through direct contact between them.

A kinematic chain is defined as:

An assemblage of links and joints, interconnected in a way to provide a controlled output motion in response to a supplied input motion.

A mechanism is defined as:

A kinematic chain in which at least one link has been "grounded," or attached, to the frame of reference (which itself may be in motion).

A machine is defined as:

A collection of mechanisms arranged to transmit forces and do work.

Links, Joints, and Kinematic Chains

Definitions

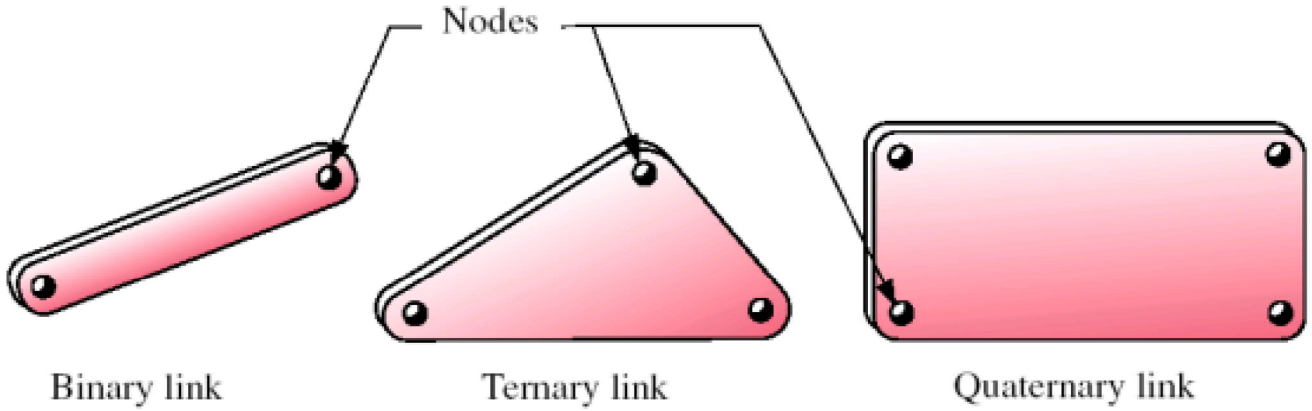
Links

- Are assumed to be rigid bodies
- Have nodes for attachment
- Can be any shape (not just those shown)
- Link order = number of nodes

Binary link - *one with two nodes.*

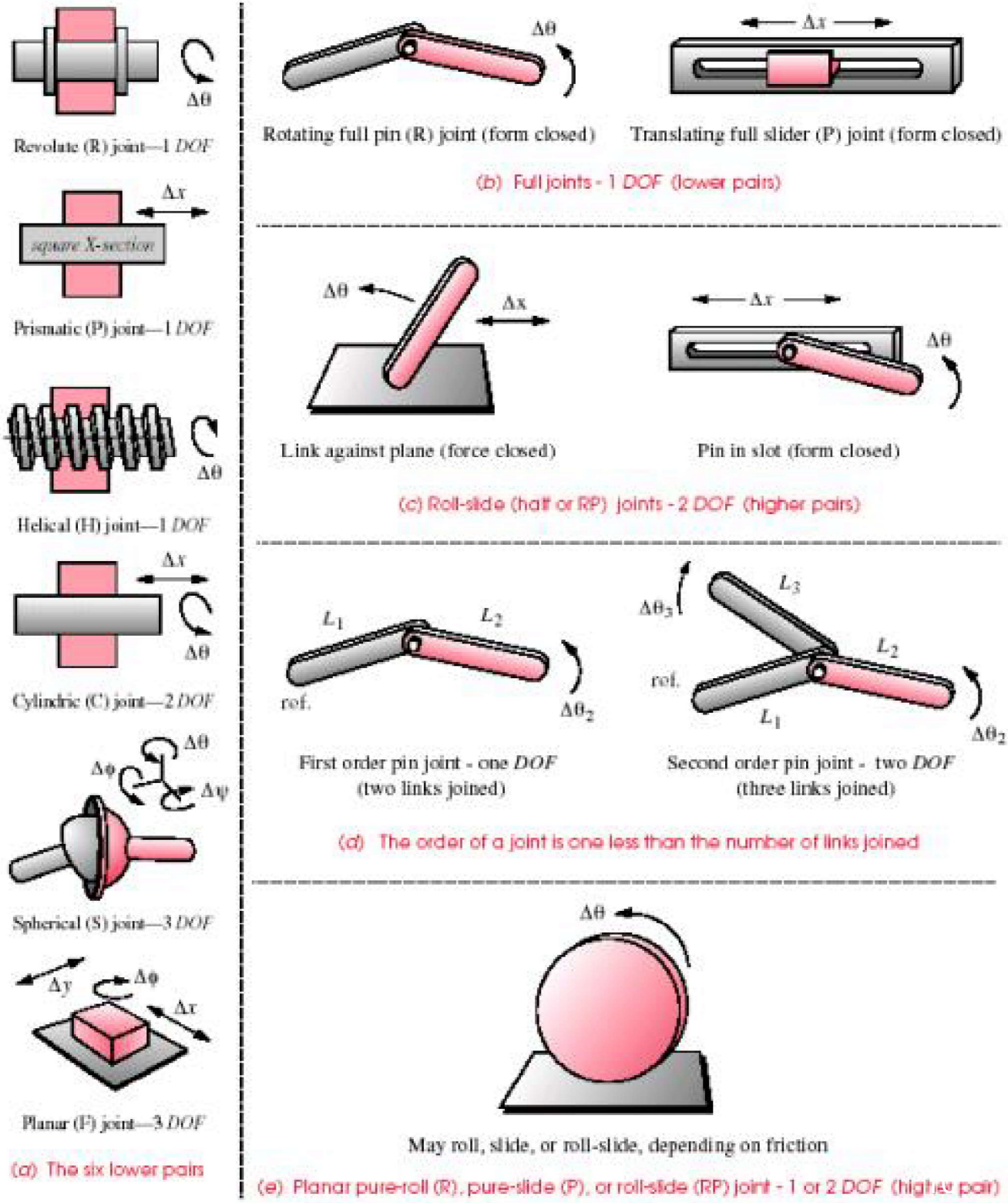
Ternary link - *one with three nodes.*

Quaternary link - *one with four nodes.*



Links, Joints, and Kinematic Chains

Joints allow DOF (motion) between links



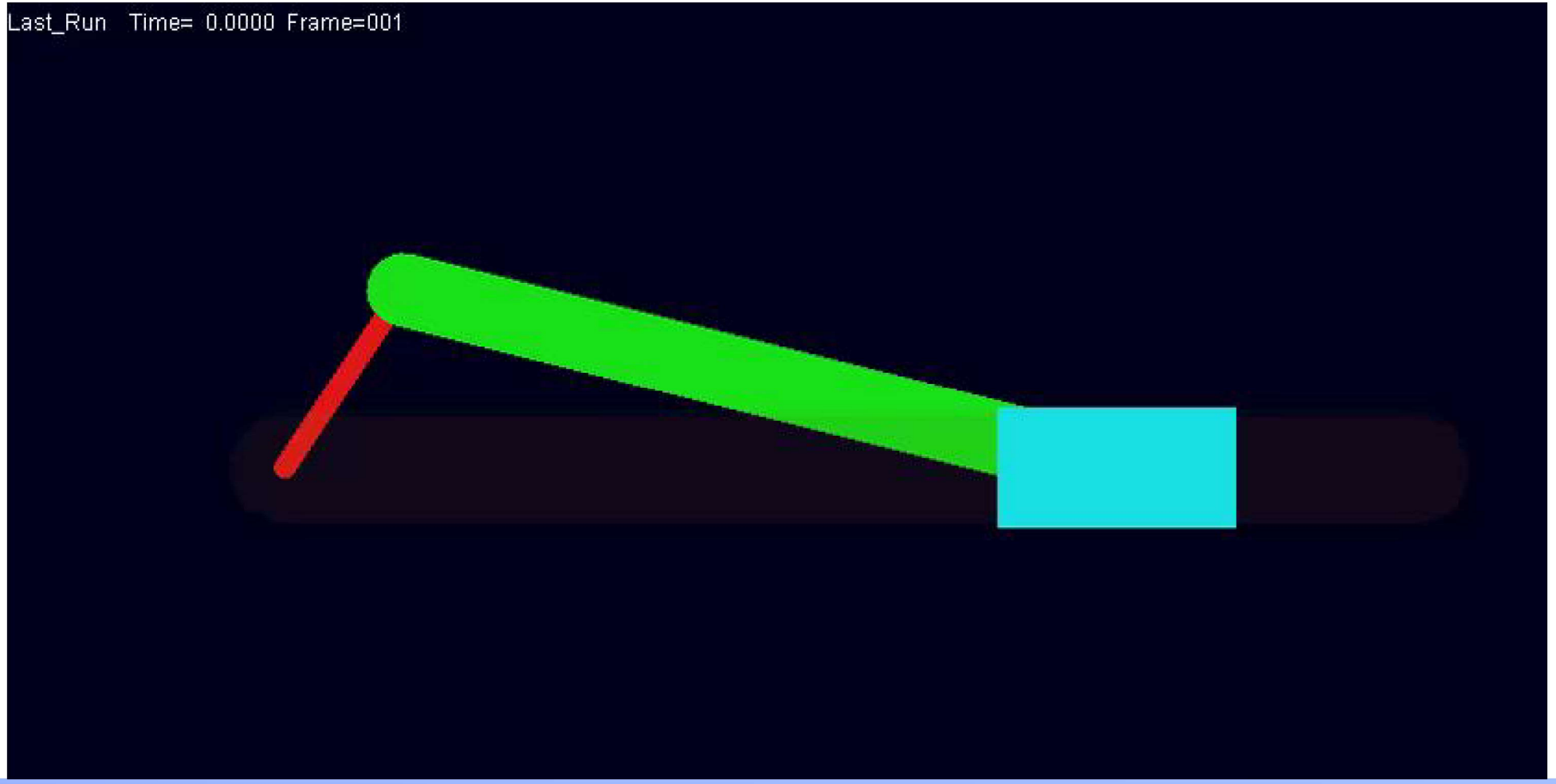
Examples of Planer Mechanism

Examples of Planer Mechanism

- Slider-Crank Mechanism
- Four-Bar Mechanism
- Quick-Return-Motion Mechanism
- Straight-Line-Motion Mechanism
- Pantograph Mechanism

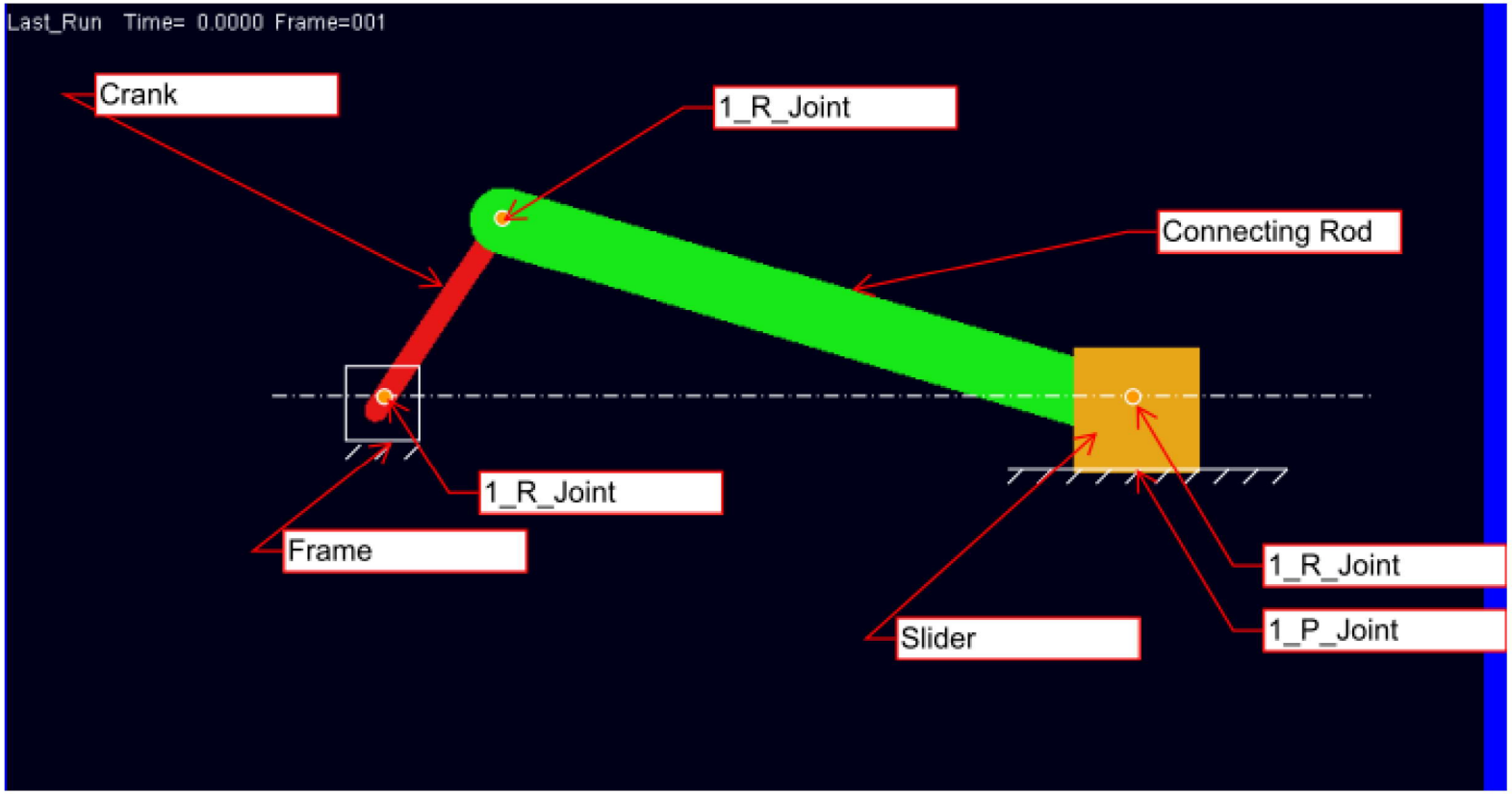
Examples of Planer Mechanism

Slider-Crank Mechanism



Examples of Planer Mechanism

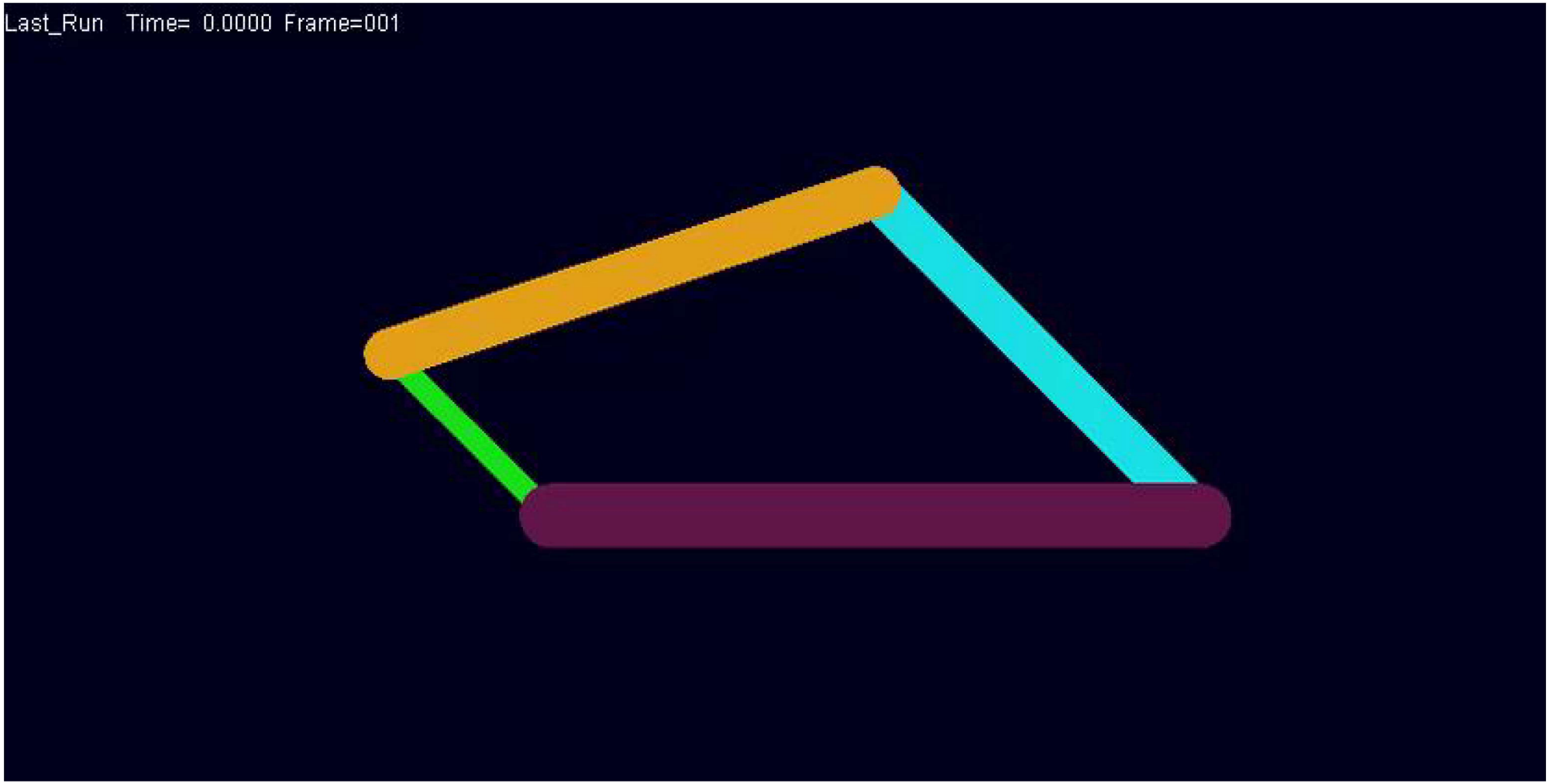
Slider-Crank Mechanism



- It consists of **4 links** (Frame + crank + connecting rod + slider) and **4 joints** (3 turning + 1 sliding). Slider has two extreme positions. Distance between them called stroke. **Stroke = 2 * crank length**

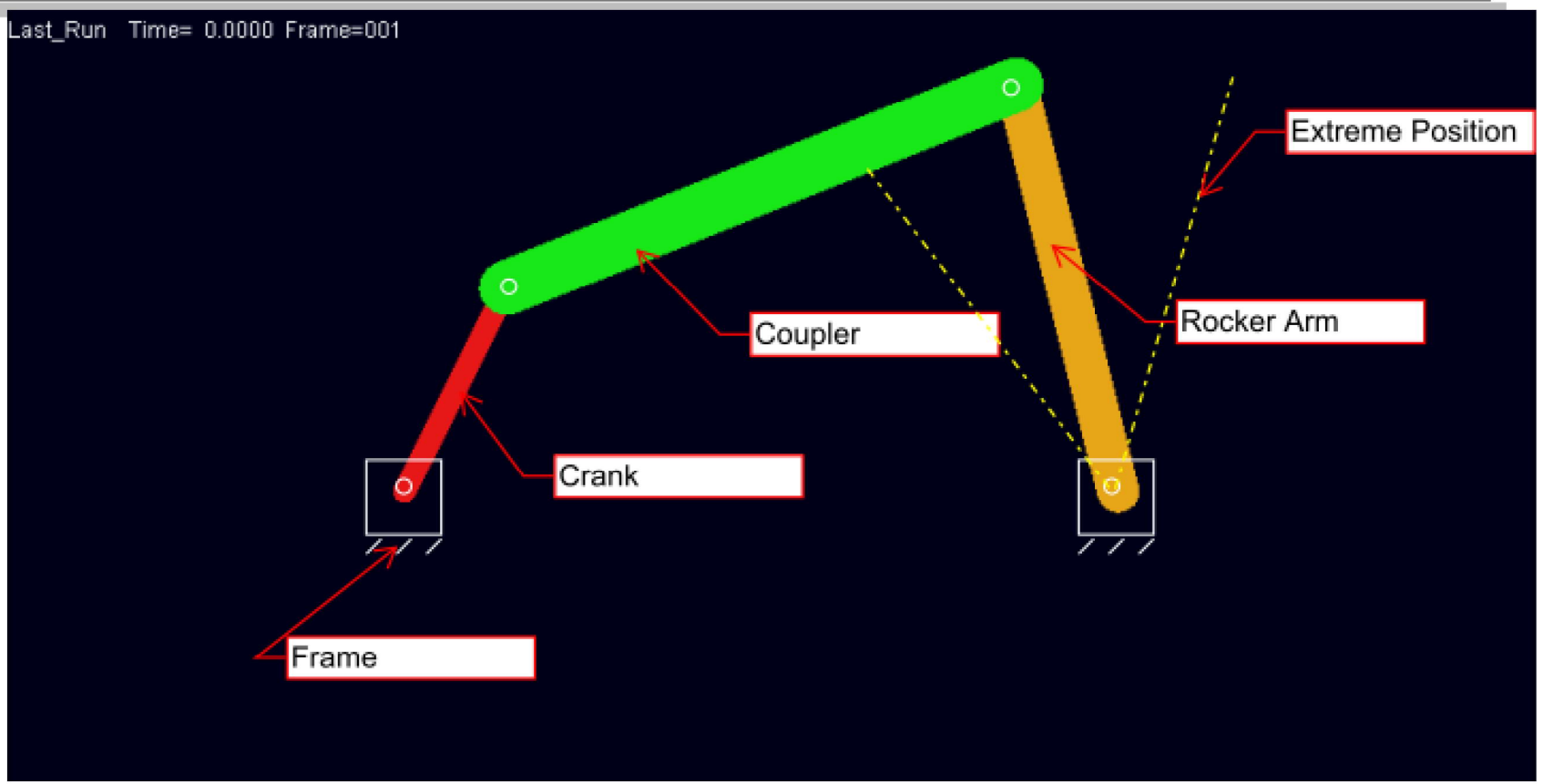
Examples of Planer Mechanism

Four-Bar Mechanism



Examples of Planer Mechanism

Four-Bar Mechanism



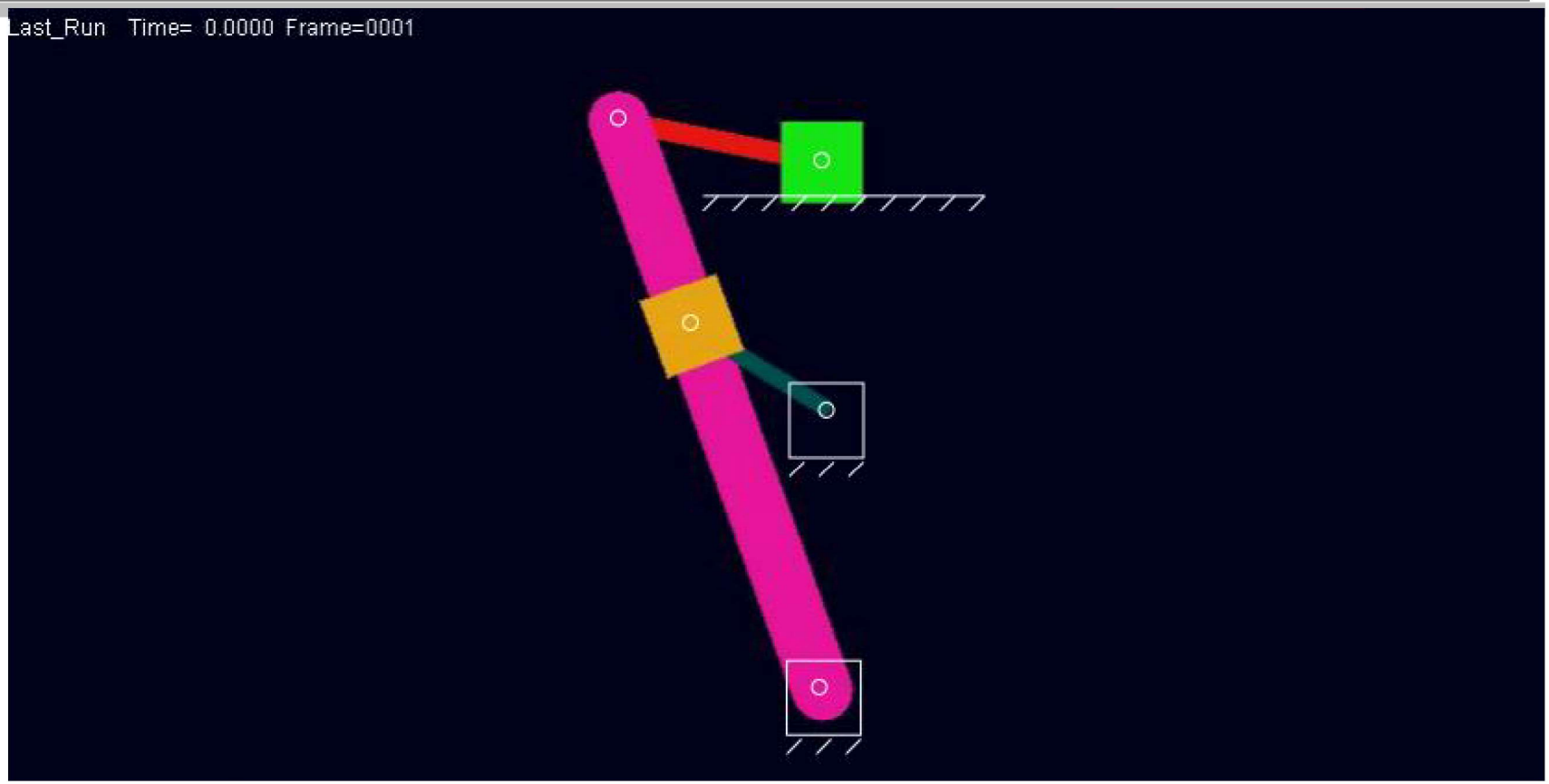
- It has many inversions. The inversion shown above is called crank-rocker. It consists of **4 links** (frame + crank + coupler + rocker arm) and **4 turning joints**. The crank rotates while the rocker arm oscillates between two extreme positions.

Examples of Planer Mechanism

- ***Crank*** is a link that makes a complete revolution and is pivoted to ground.
- ***Rocker*** is a link that has oscillatory (back and forth) rotation and is pivoted to ground.
- ***Coupler*** (or connecting rod) is a link that has complex motion and is not pivoted to ground.
- ***Ground*** is defined as any link or links that are fixed (nonmoving) with respect to the reference frame.
  - Note that the reference frame may in fact itself be in motion.

Examples of Planer Mechanism

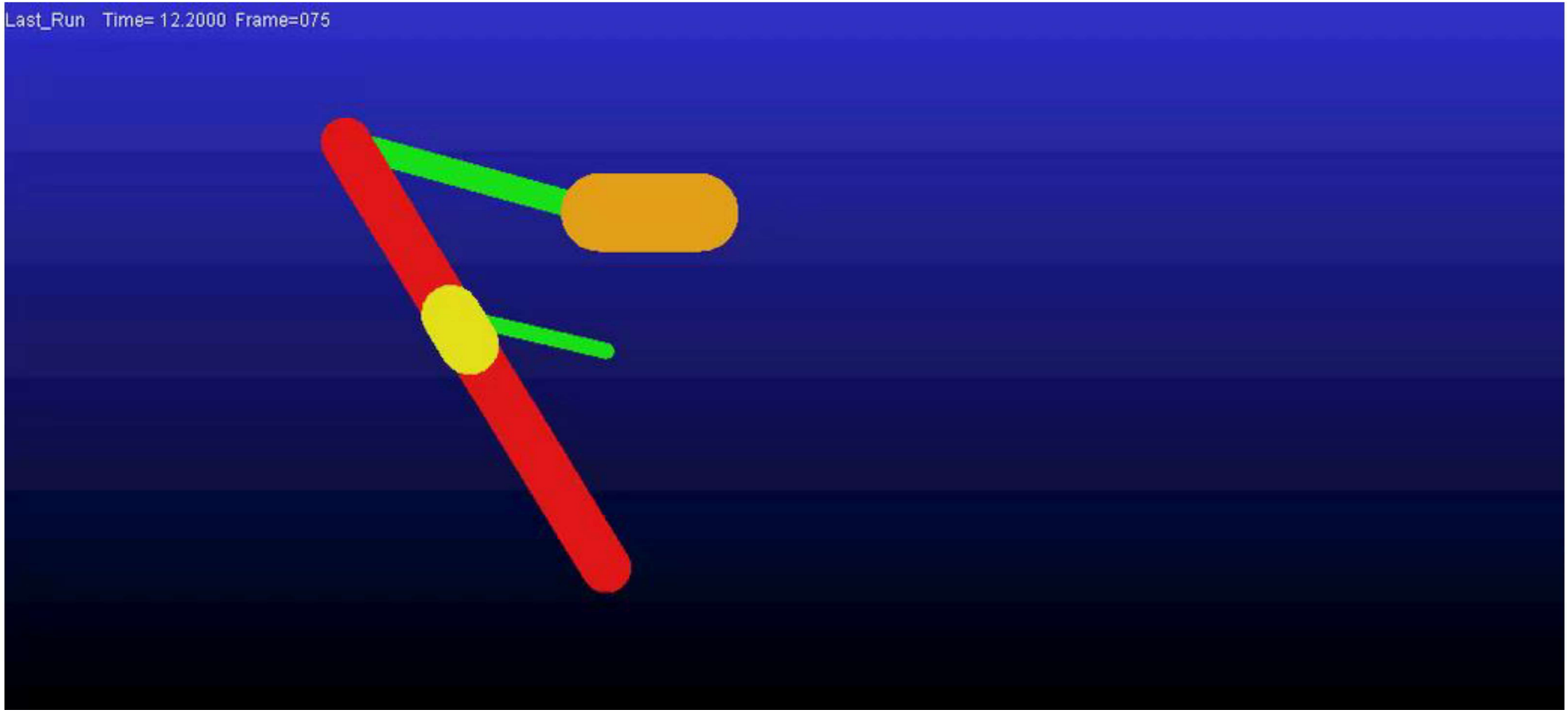
Quick Return Motion Mechanism



- It consists of **6 links and 7 joints** (5 turning + 2 Sliding). The input crank rotates while the output slider reciprocates between two extreme positions. Distance between them called stroke. The slider executes one stroke (working stroke) in longer time than the other stroke (return stroke).

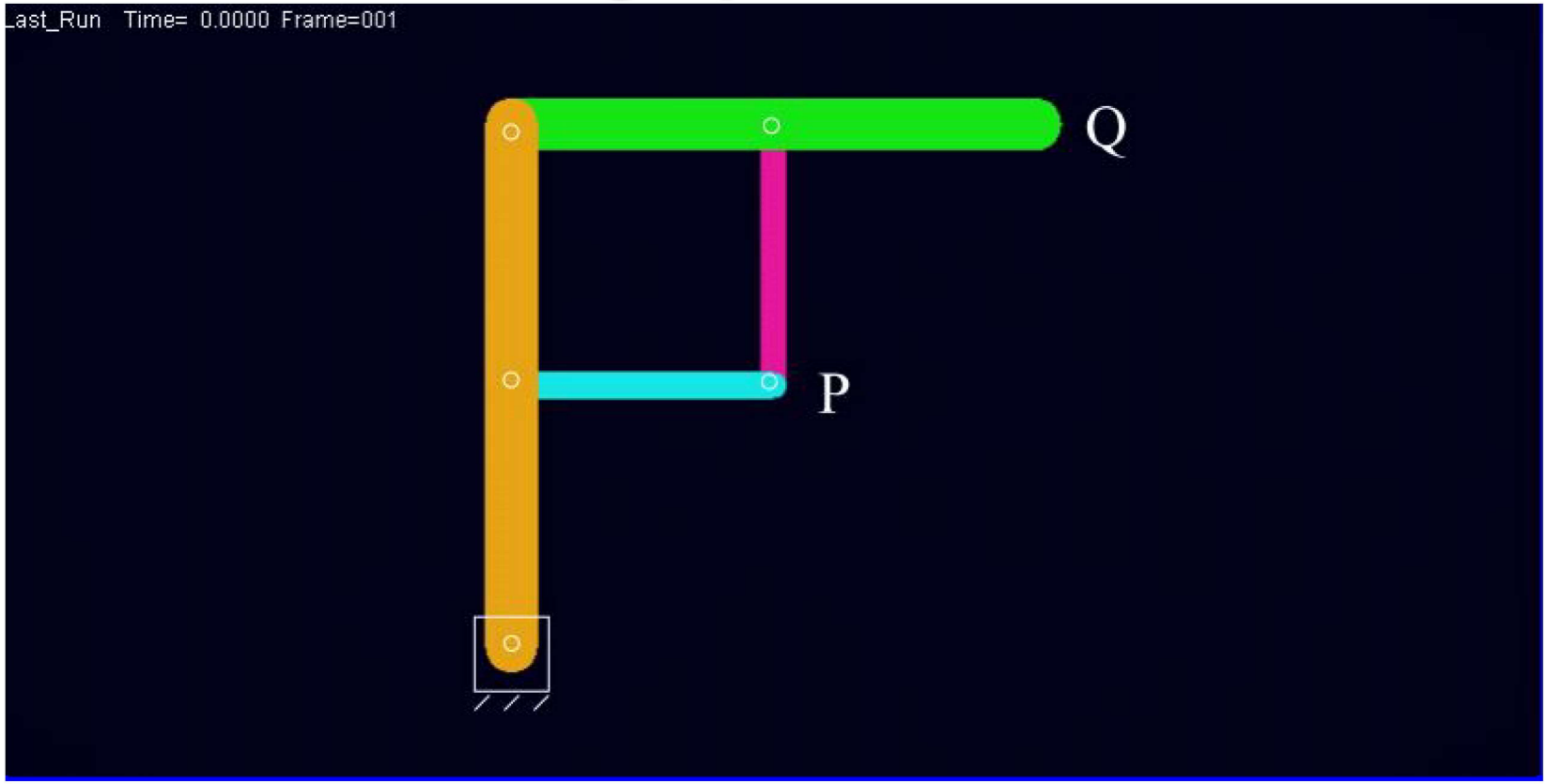
Examples of Planer Mechanism

Quick Return Motion Mechanism



Examples of Planer Mechanism

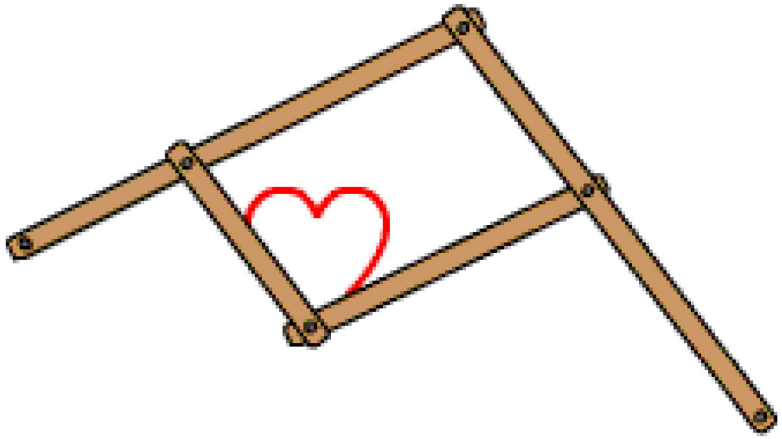
Pantograph Mechanism

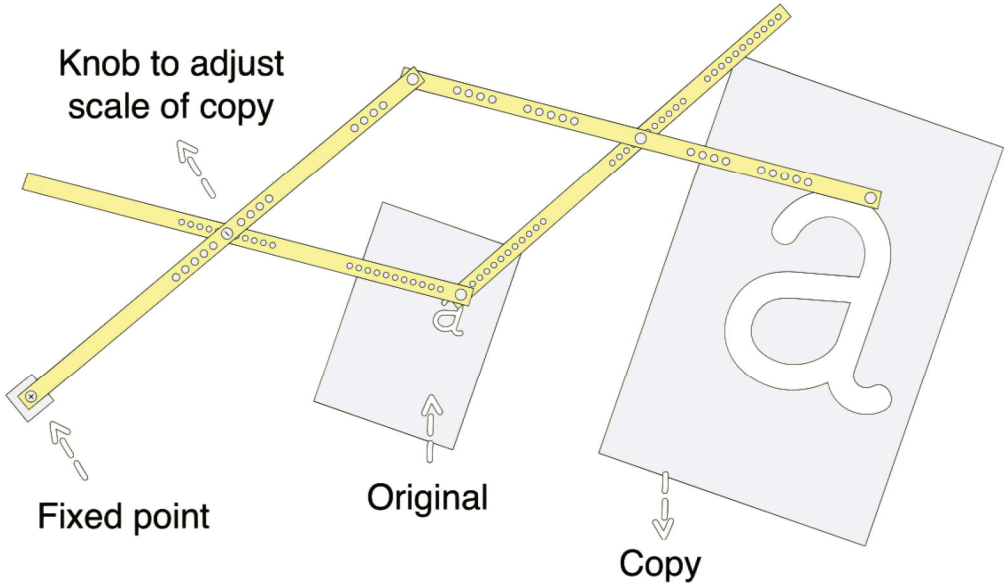


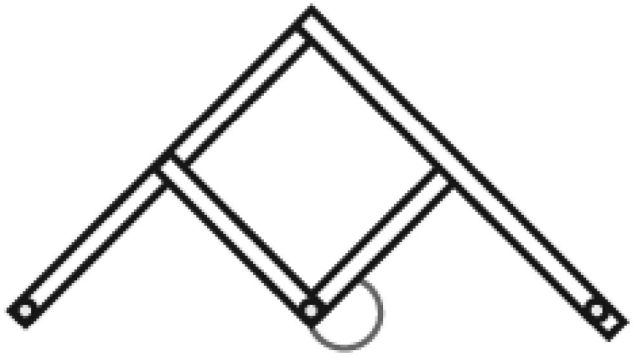
- It consists of **5 links and 5 turning joints**. When point **P** moves along certain path, point **Q** moves on similar **enlarged** path.

Examples of Planer Mechanism

Pantograph Mechanism

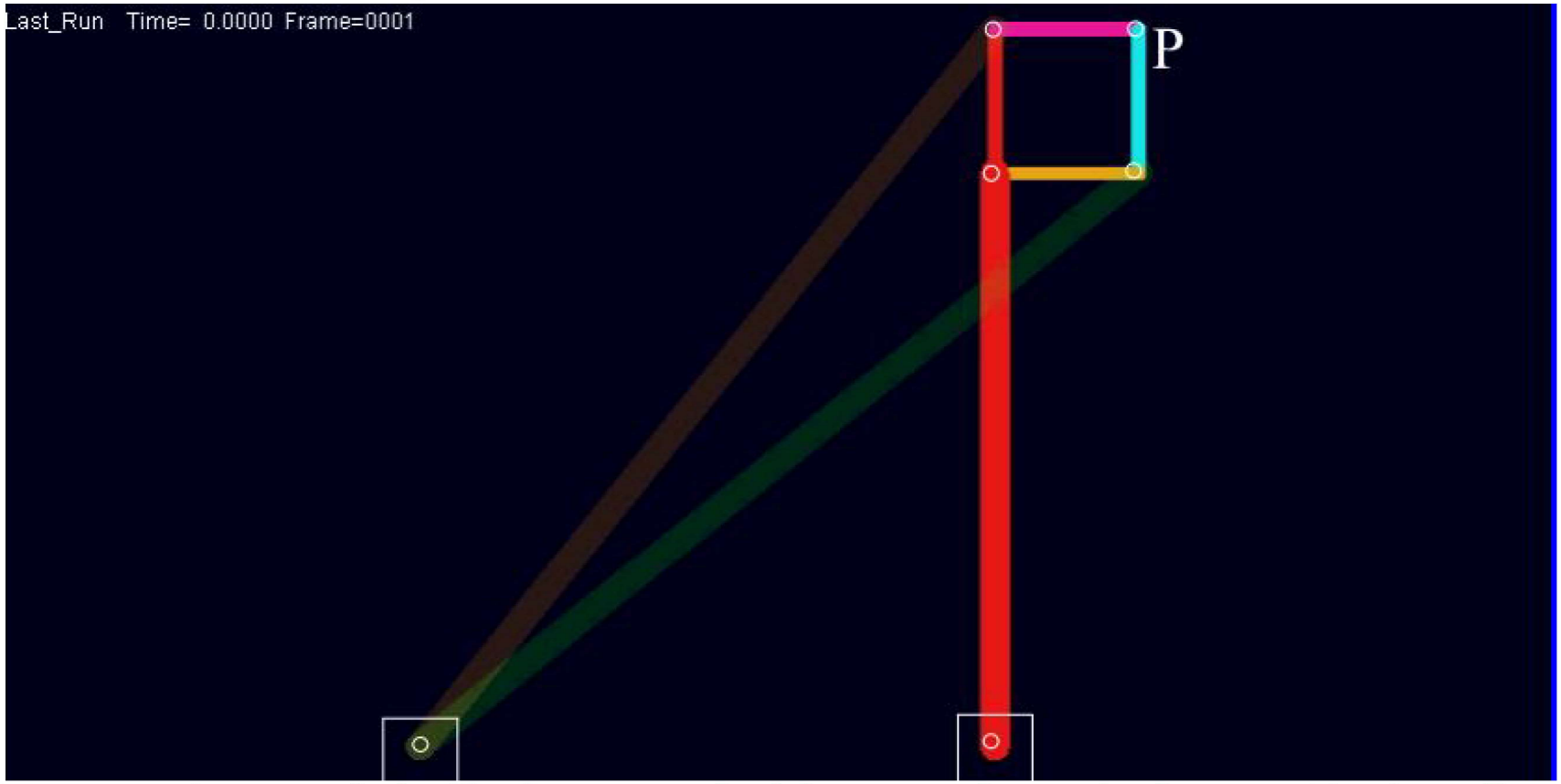






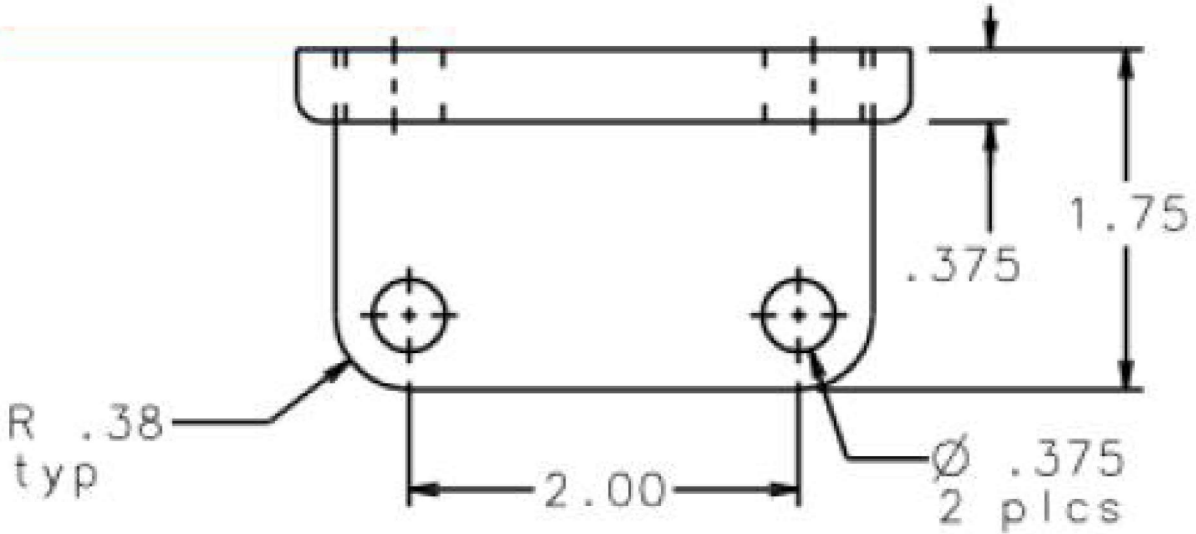
Examples of Planer Mechanism

Straight Line Motion Mechanism



- It consists of **8 links and 10 turning joints**. Point **P** on the mechanism moves on a **straight line** although there is **no sliding joint**.

Part Design Using CATIA Software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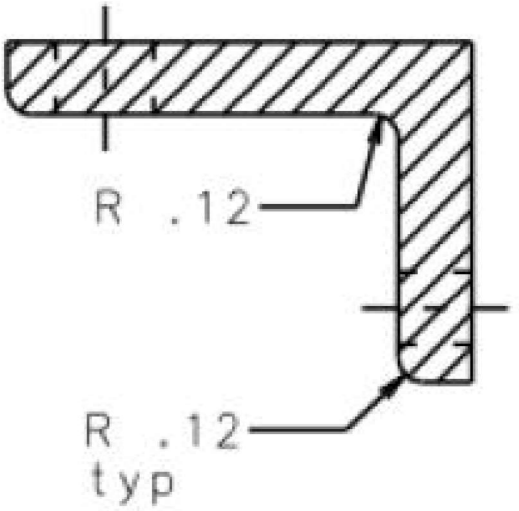
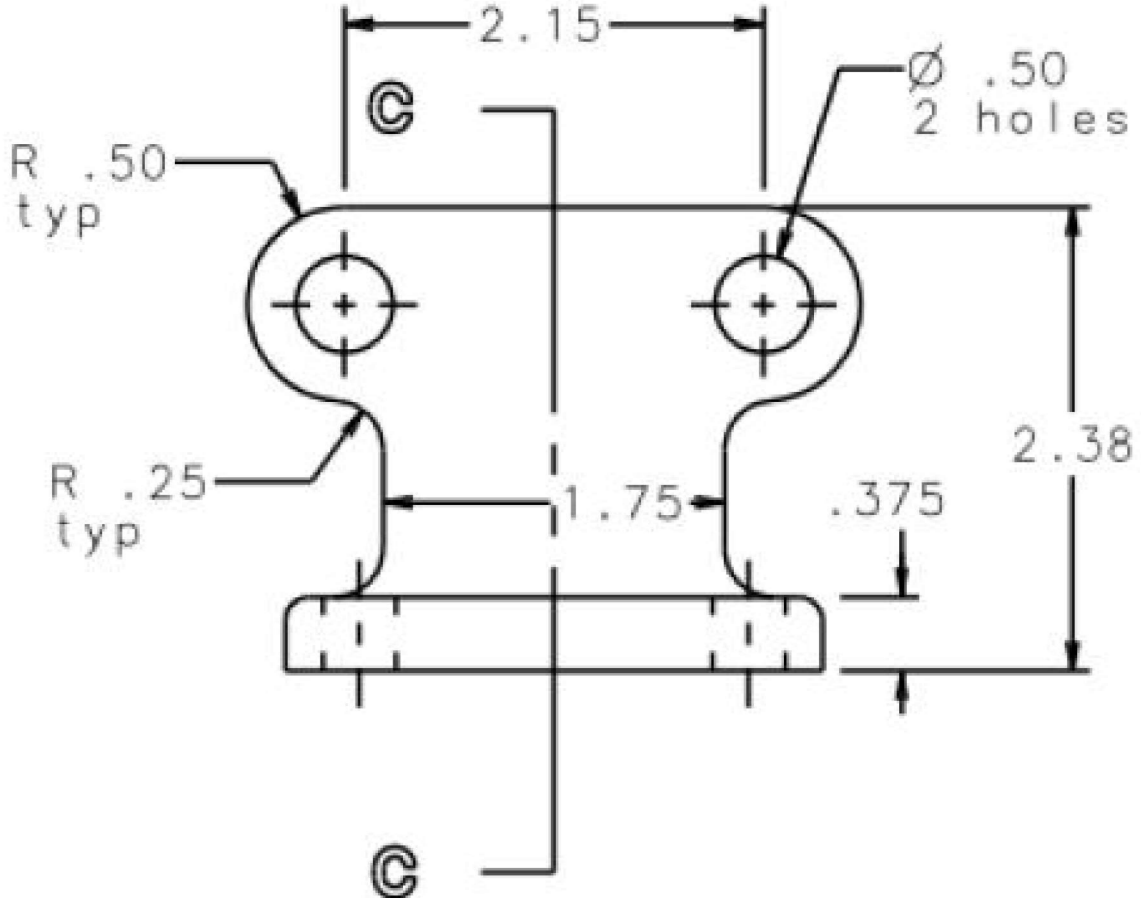
R .38
typ
2.00
Ø .375
2 plcs


R .12
R .12
typ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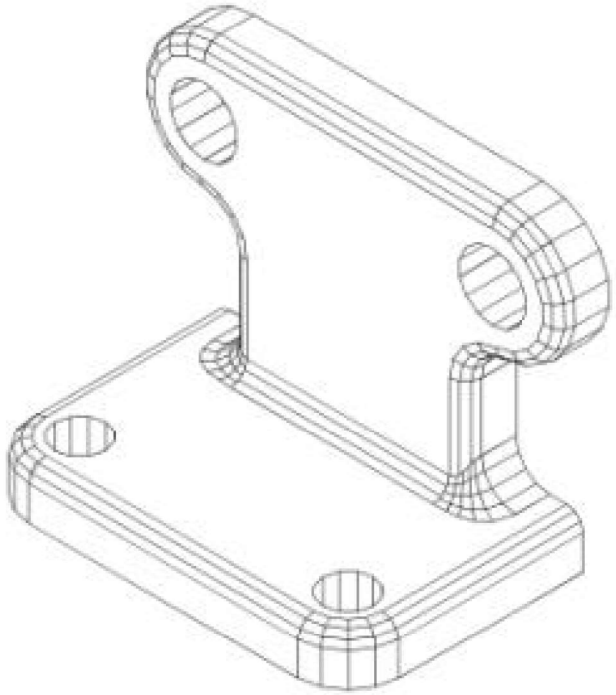
Ø .50
2 holes
R .50
typ
R .25
typ
1.75
.375
2.38



THANKS