Preliminary Design Review

MISCE project

Mechatronics for Improving and Standardizing Competences in Engineering

Competence: Mechanical Engineering

Workgroup: Universidad de Castilla-La Mancha

This document is the Preliminary Design Review of the technical competence ‘Mechanical Engineering’. It briefly contains the experimental platform analysed in MISCE project, to be designed and standardised for improving the acquisition level of this competence on engineering degrees.

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Index of contents

Index of figures

Index of tables

1 Competence and skills

The conceptual design presented in this document is referred to the technical competence:

C6. Mechanical Engineering

which related skills are (see Table I):

Table I. Skills of Mechanical Engineering

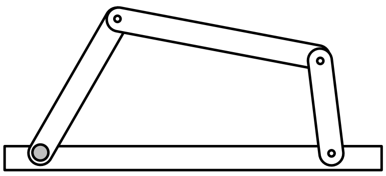
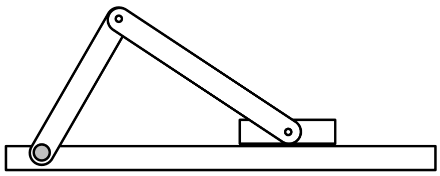
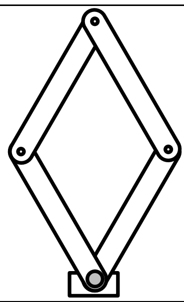
S6.1.	To understand mechanism fundamentals
S6.2.	To be able to analyse and understand the kinematics of linkages
S6.3.	To be able to synthetize planar mechanism
S6.4.	To know how to model and simulate mechanisms
S6.5.	To be able to apply mechanisms as engineering solutions

The different conceptual designs presented in this document have been analysed to ensure that can improve the acquisition level of the aforementioned competence.

2 Experimental proposals

For this competence, MISCE project proposes the joint use of the devices in Table II, together with their corresponding teaching materials.

Table II. Proposed devices for 'mechanical engineering' competence

		
Four-bar mechanism	Crank and slider	Deformable parallelogram

In the following sections each device is detailed explained.

2.1 Four-bar mechanism

A four-bar linkage consists of four rigid bars connected in a loop by four rotary joints. When one bar is driven by a motor (the crank), it transmits motion through the coupler to the output bar (the rocker), producing a wide variety of planar movements depending on the lengths of the links.

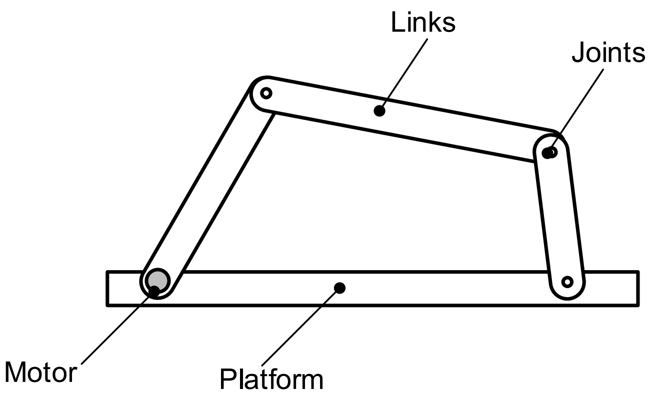


Figure 1. Four-bar mechanism

This proposal requires of the electronics and control devices that allows to control the angular position or velocity of the motor, which drives the attached link.

If the length of the four links is reconfigured the behaviour of the mechanism can change. The main advantage of this platform is that this is the most extended mechanism analysed in mechanism theory.

2.2 Crank and slider

A crank and slider mechanism consists of three main components: a crank, a connecting rod, and a slider (see Figure 2). The crank, driven by a motor, rotates around a fixed axis and is connected to the slider via the connecting rod. As the crank rotates, it converts rotary motion into the reciprocating linear motion of the slider. This mechanism is commonly used in engines and compressors due to its ability to generate smooth linear displacement from continuous rotary input.

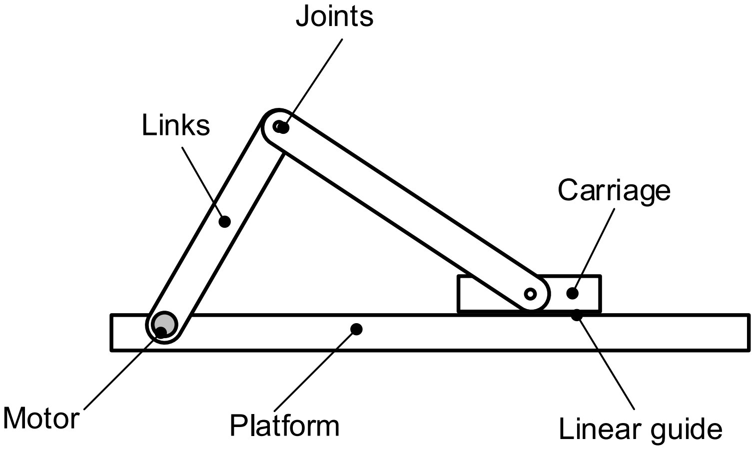


Figure 2. Crank and slider mechanism

This device requires the electronics and control equipment capable of precisely reach the desired angular position or velocity of the motor that drives the crank. By adjusting the lengths of the crank and connecting rod, the stroke and kinematic behaviour of the mechanism can be modified.

The primary advantage of this platform is its simplicity and its widespread use in practical applications where rotary-to-linear motion conversion is required.

2.3 Deformable parallelogram

A deformable parallelogram mechanism consists of four rigid links connected by four revolute joints (see Figure 3), forming a closed-loop in the shape of a parallelogram. Unlike a rigid four-bar linkage, this mechanism allows controlled deformation of the parallelogram shape while preserving the parallelism between opposite links. When actuated, typically by a motor driving one of the joints or links, the mechanism enables synchronized, planar motion with consistent orientation of the moving platform or end-effector.

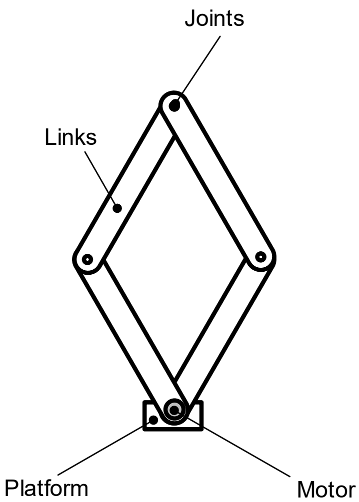


Figure 3. Deformable parallelogram

As outlined in previous examples, this proposal requires the integration of electronic and control systems capable of accurately controlling the position or velocity of the actuator. This ensures precise manipulation of the mechanism's deformation.

By modifying the lengths of the links or the actuation strategy, different motion profiles and working spaces can be achieved. One of the main advantages of this platform lies in its ability to produce simple and predictable movements while preserving the orientation of the moving element, which makes it particularly valuable in applications such as robotics and reconfigurable tooling systems.

3 Competence and skills analyses

Table III summarises the competence and skills analyses of the proposed experimental platforms attending to the contribution of acquisition of the technical competence 'mechanical engineering' and their corresponding skills in Table I.

As conclusion, the 3 experimental platforms will be developed, starting with the four-bar mechanism and going on with the other ones.

Table III. Contribution of each proposed platform to mechanical engineering competence and its corresponding skills

Platform	S6.1	S6.2	S6.3	S6.4	S6.5	**Overall competence contribution**
Four-bar mechanism	★★★★★ Demonstrates transformation of rotary into complex planar motion via rigid links. Supports intuitive understanding of energy flow and motion characteristics.	★★★★★ Enables analysis of link dimensions, joint placement, and constraints. Encourages practical understanding of motion range, transmission angles, and coupler curves.	★★★★☆ Facilitates exploration of design parameters to achieve specific motion output. Highlights how link proportions affect mechanism performance.	★★★★☆ Enables simulation of velocity, acceleration, and torque distribution. Supports modelling of closed kinematic chains with variable configurations.	★★★★★ Shows real-world application in devices like wipers or suspension systems. Demonstrates torque transmission and mechanical advantage through experimental testing.	★★★★★ 4.6
Crank and slider	★★★★★ Provides insight into rotary-to-linear motion conversion. Simplifies mechanical concepts through intuitive movement.	★★★★☆ Allows observation of how crank length and stroke influence linear output. Supports understanding of velocity profiles and acceleration curves.	★★★★☆ Useful for synthesizing compact systems requiring reciprocating motion. Aids in understanding how to design efficient energy conversion mechanisms.	★★★★☆ Facilitates modelling of displacement, stroke optimization, and force balance. Encourages dynamic simulation with variable geometries and boundary conditions.	★★★★☆ Demonstrates common use in engines and compressors. Highlights interaction of rotary and linear forces in practical applications under varying load conditions.	★★★★☆ 4.2
Deformable parallelogram	★★★★☆ Illustrates coordinated mechanical motion with preserved orientation. Helps understand energy flow in closed-loop, deformable structures.	★★★★☆ Encourages analysis of symmetry and joint coordination. Suitable for studying consistent planar movement of end-effectors or platforms.	★★★☆☆ Supports synthesis of mechanisms for parallel, synchronized movement. Useful in the design of reconfigurable robotic systems.	★★★★☆ Promotes modelling of deformation behaviour, actuator positioning, and motion limits. Ideal for simulating structure-preserving transformations.	★★★★☆ Demonstrates applications in robotics, pick-and-place systems, and reconfigurable tooling. Shows the impact of geometry and actuation on stability and repeatability.	★★★★☆ 3.8

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