

Mechatronics

Laboratory: Solid modelling and assembly design

Goal of the exercise: To learn the methods used in solid modelling and the advantages of modeling in an assembly context.

1. Introduction

Solid modeling is a fundamental aspect of modern engineering design, enabling the creation of precise and fully defined three-dimensional representations of mechanical components. Unlike wireframe or surface modeling, solid modeling provides a complete definition of an object, including its volume, mass properties, and geometric constraints. In practical applications, individual components rarely function in isolation; they are typically part of a larger mechanical system. Assembly design in CAD facilitates the integration of multiple components into a cohesive system, ensuring proper fit, motion, and functional compatibility. By using constraints and parametric relationships, designers can simulate real-world interactions between parts, detect potential interferences, and optimize the overall design before physical prototyping. This approach enhances efficiency, reduces manufacturing errors, and supports iterative design processes.

2. Solid modeling

Solid modeling is one of the basic CAD techniques used to design three-dimensional objects with defined geometry and physical properties. It allows for precise definition of shapes, dimensions and tolerances. Solid modeling works best for elements with clearly defined geometry that can be described by volume operations, primitives (e.g. cuboid, cylinder, sphere) and logical operations (e.g. addition, subtraction, intersection).

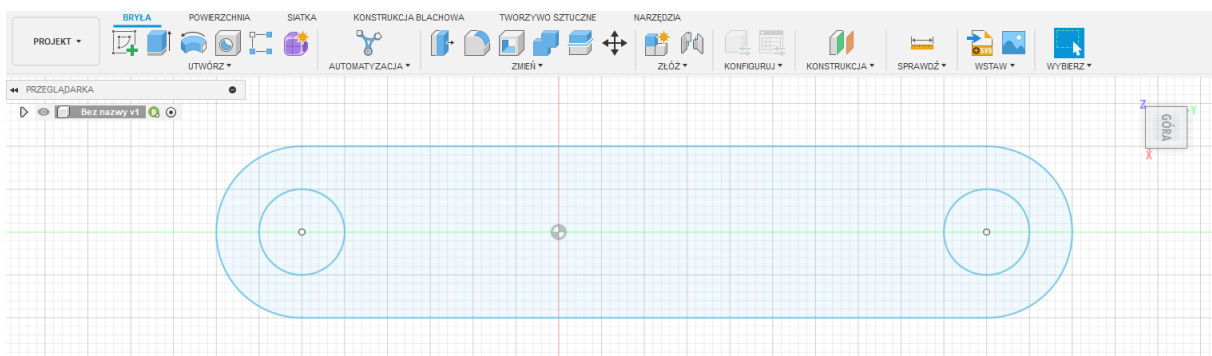


Fig. 1 Sketch 2D.

The 2D sketch is the foundation of solid modeling in CAD systems. It is a flat geometric drawing that can be transformed into a solid using 3D operations.

2D sketch operations in solid modeling are used to create 3D models. Extrude allows you to transform a sketch into a solid by extending it along a path, which is used for simple shapes such as blocks or shafts. Revolve allows you to create solids of revolution, such as shafts and bushings, by rotating the sketch around an axis. Sweep allows you to create features, such as pipes or channels, by moving the sketch along a trajectory. Loft allows you to create solids with smooth transitions between profiles. Cut with a sketch is used to remove parts of a solid, such as creating holes or pockets.

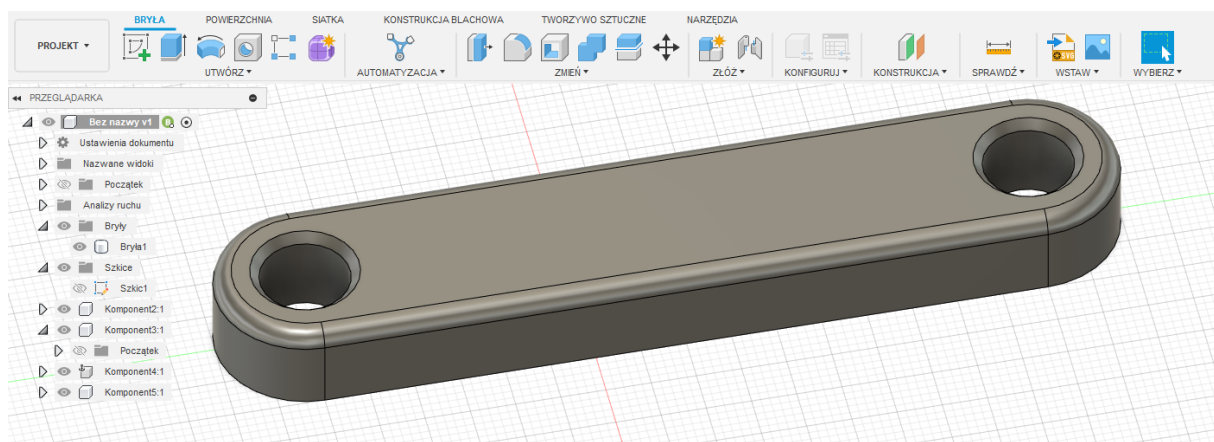


Fig. 2 Volume operations on solids and finishing.

Finishing operations in solid modeling are used to give the finished model its final shape and detail. They are used to improve the appearance, functionality, or prepare the part for production. The most common finishing operations include filleting, chamfering, and adding threads or grooves. These operations remove sharp edges, facilitate assembly of parts, or improve mechanical strength by eliminating places that can become a source of stress.

Draw the geometry as in Fig.2, then save it in 3 copies of different lengths by modifying the parameters in the Change Menu → Change Parameters. Create a fourth element with the longest length and a third hole in the center.

3. Assemblies

Modeling in the context of the assembly allows you to design components in their real environment, which significantly simplifies the design process. Thanks to this we avoid collisions, we can check on an ongoing basis whether elements do not overlap, eliminating errors before the part is manufactured. Maintain parameterization, dimensions and relations between parts can be dynamically related, which facilitates later modifications. Design more efficiently, instead of creating parts independently, We can model them in relation to existing elements, which saves time and improves fit.

Better collaboration, engineers can work on different parts simultaneously, with the certainty that the final assembly will be consistent.

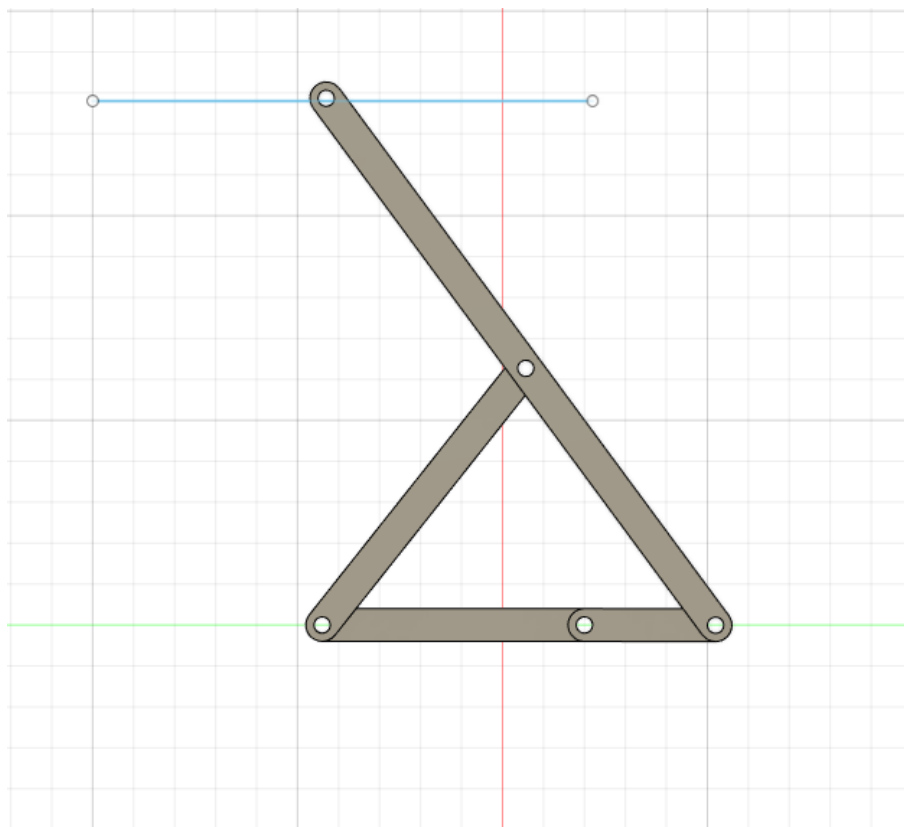


Fig. 3 Chebyshev lambda linkage.

Design a Chebyshev linkage so that there are no collisions between the elements. Choose the lengths of the links so that the segment marked in blue is a straight line.