

# Workshop exercises

---

SEHNENHAND v2.5 · as of 2026-10-06 · generated by the build chain from the description of the kit, do not edit by hand

**Not a medical device.** The subject is machines built from link chains for teaching, experiments and research, not for use on or in the human body.

8 exercises for the workshop in the browser (`werkstatt.html`). Each starts from a starting point that can be loaded in the workshop and ends with a check by the workshop: it shows for each criterion whether it is met. The exercises are available in the modes "Learn and practise" and "Develop and design".

The workshop calculates positions, tendon travel and guide values. It does not check strength, weight at the joint or collisions; all building blocks are drafts, calculated and not printed.

## Exercise 1: A second finger

**Learning objective.** Understand a chain as a reusable building block.

**Starting point.** Template "Test finger" (in the workshop: "Load starting point").

**Task.** Add a second, identical finger to the test finger. Each finger is to have three joints and its own drive, and everything is to be printable from the standard line.

**Hint.** The quickest way is "Duplicate chain". Then check the lateral position: two fingers 16 mm wide need at least 17 mm between them.

### The workshop checks:

- exactly two chains
- three joints per chain
- at least two drives
- printable from the standard line

**For teachers.** One possible solution is the machine "Two fingers"; on every run the build chain checks that it meets all criteria and that the starting point does not.

## Exercise 2: A short finger

**Learning objective.** See how link lengths, reach and the limits of the building blocks relate.

**Starting point.** Template "Test finger" (in the workshop: "Load starting point").

**Task.** Turn the test finger into a finger with two joints that is 60 to 70 mm long when extended and printable from the standard line.

**Hint.** Remove one joint and adjust the lengths. The last link of a chain is the end link; the standard line covers links from 24 to 120 mm.

**The workshop checks:**

- exactly one chain
- two joints
- extended length 60 to 70 mm
- printable from the standard line

**For teachers.** One possible solution is the machine “Short finger”; on every run the build chain checks that it meets all criteria and that the starting point does not.

### Exercise 3: A three-finger gripper

**Learning objective.** Arrange chains in space: attachment point, direction and pitch.

**Starting point.** Template “Short finger” (in the workshop: “Load starting point”).

**Task.** Turn the short finger into a gripper with three fingers standing 120 degrees apart.

**Hint.** Duplicate the chain twice, then set the direction of each chain (0, 120 and 240 degrees). The pitch raises the fingers; the attachment point sets where they sit on the body.

**The workshop checks:**

- exactly three chains
- directions 120 degrees apart
- printable from the standard line
- at rest and in the loaded program the chains stay apart

**For teachers.** One possible solution is the machine “Three-finger gripper”; on every run the build chain checks that it meets all criteria and that the starting point does not.

### Exercise 4: Stay within the actuator range

**Learning objective.** Weigh tendon travel, spool radius, actuator angle and force against each other.

**Starting point.** Template “Finger with a spool that is too small” (in the workshop: “Load starting point”).

**Task.** On this finger the actuator range is not sufficient. Change the drive or the joint limits so that every drive manages with reserve.

**Hint.** Tendon travel divided by spool radius gives the angle of rotation. A larger spool needs less rotation and delivers less force; the key figures show both.

**The workshop checks:**

- every drive stays within its range

**For teachers.** One possible solution is the machine "Test finger"; on every run the build chain checks that it meets all criteria and that the starting point does not.

## Exercise 5: Move to a point

**Learning objective.** Infer the position of the tip from the set value of the drive.

**Starting point.** Template "Test finger" (in the workshop: "Load starting point").

**Task.** Write a program at the end of which the fingertip of the test finger is no more than 3 mm from the point  $x = 11$  mm,  $z = -71$  mm ( $y = 0$ ).

**Hint.** Select the drive in the table and set it by hand with the slider; the view shows the position. Then write the value you found into the program.

**The workshop checks:**

- the program runs and moves at least one drive
- tip no more than 3 mm from the target at the end

**For teachers.** One possible solution: machine "Test finger" with the program

```
beuge beuger 45 in 1
```

## Exercise 6: An arm on a turntable

**Learning objective.** Recognise the boundary between existing building blocks and your own design.

**Starting point.** Template "Short finger" (in the workshop: "Load starting point").

**Task.** Build a machine in which one chain sits on another and one joint turns about the vertical axis. Check in the parts set which of this the standard line does not yet cover.

**Hint.** Create a chain with one joint about the vertical axis and select it as the carrier of the second chain. The parts set states what has no building block yet.

**The workshop checks:**

- at least one chain sits on another
- at least one joint about the vertical axis
- the parts set shows missing building blocks

**For teachers.** One possible solution is the machine "Excavator arm"; on every run the build chain checks that it meets all criteria and that the starting point does not.

## Exercise 7: An arm with two fingers

**Learning objective.** Branch chains: one chain carries others, and the carrier head follows from the arrangement.

**Starting point.** Template "Short finger" (in the workshop: "Load starting point").

**Task.** Put two short fingers on the tip of an arm with two joints so that everything can be printed from the standard line.

**Hint.** Add two chains and choose the arm as their carrier; the arm itself gets no end piece. The fingers sit beside the end link of the arm: the parts set gives the reason as long as a base or its tube would lie over the end link.

**The workshop checks:**

- at least three chains
- two chains sit on another
- printable from the standard line

**For teachers.** One possible solution is the machine "Arm with two fingers"; on every run the build chain checks that it meets all criteria and that the starting point does not.

## Exercise 8: A finger on a swivel base

**Learning objective.** Read the dimensions of a building block from the reasons in the parts set and adapt a machine to them.

**Starting point.** Template "Short finger" (in the workshop: "Load starting point").

**Task.** Build a machine in which a short finger swivels about the vertical axis so that everything can be printed from the standard line.

**Hint.** Create a chain with a single joint about the vertical axis and put the finger on it. The parts set states what the swivel base requires: length to the base, height below the plate, swivel range. Compare with exercise 6, where the base remained your own design.

**The workshop checks:**

- at least one joint about the vertical axis
- at least one chain sits on another
- printable from the standard line

**For teachers.** One possible solution is the machine "Finger on a swivel base"; on every run the build chain checks that it meets all criteria and that the starting point does not.