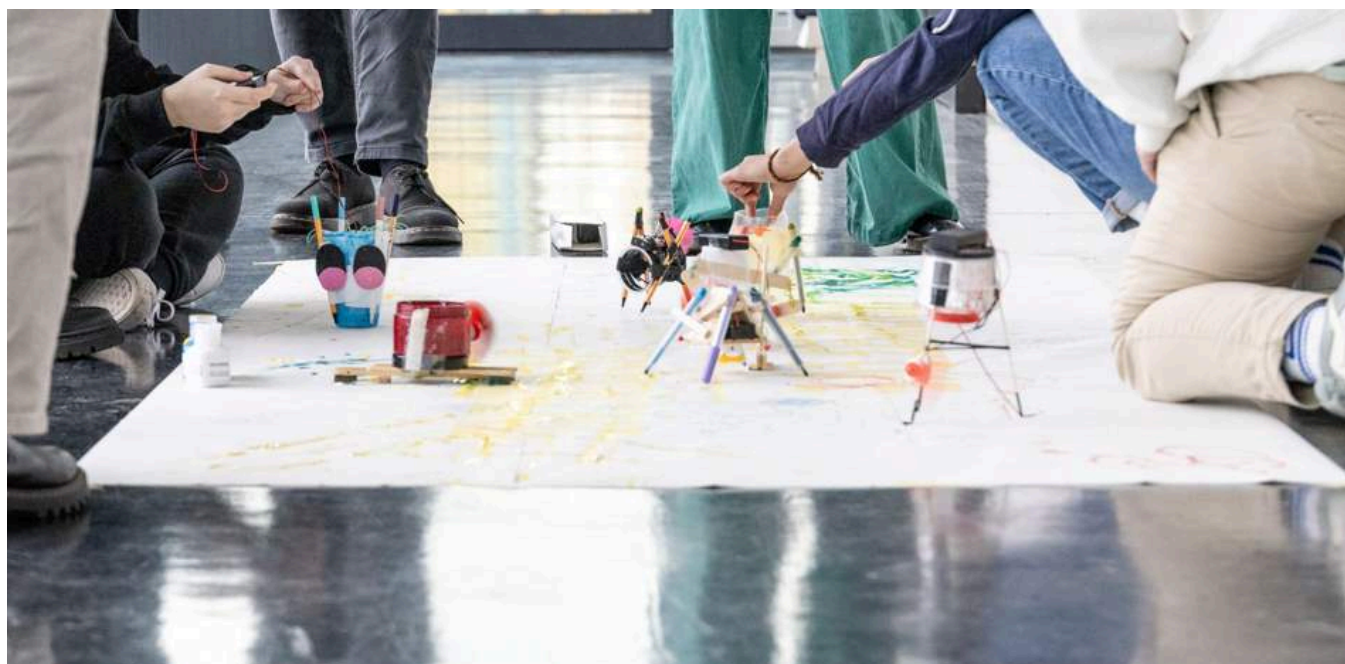


DRAWING ROBOTS



A Hands-On Exploration of Drawing Algorithms

Three days at the Werkwoche 2023 of Technische Hochschule Augsburg. No computers, no code. Just a motor, batteries, pens, paint and one idea: an algorithm is a fixed sequence of steps that turns input into output. Pia Obermaier and I built two drawing robots, tested how their variables change the drawing, and joined everyone for one big collective artwork.



FORMAT

Three-day workshop,
Werkwoche 2023

DATE

14–16 November 2023

PLACE

Faculty of Design, Technische
Hochschule Augsburg

LED BY

Steffen Mitschelen, doctoral
researcher at the Academy of
Media Arts Cologne (KHM)

TEAM

Narsis Dibaj and Pia
Obermaier, Transformation
Design

TOPIC

Algorithms and variables,
explored without computers

METHODS

Prototyping with found
materials, testing variables,
documentation

RESULT

2 robots, a series of test
drawings, one collective
drawing

WHAT WAS THIS ABOUT?

Everyone talks about algorithms: in social media feeds, in artificial intelligence, in design software. Yet few people can say what an algorithm actually is. For designers this matters. We use tools that run on algorithms every day, and we are asked to design more and more complex systems ourselves.

The workshop “**Drawing Robots – A Hands-On Exploration of Drawing Algorithms**” tackled the term without a single line of code. Instead of programming, we built small robots from simple materials, let them draw, and studied what changed the drawing.

The workshop was part of the **Werkwoche**, the international design week of the Faculty of Design at Technische Hochschule Augsburg. It was open to students of all semesters and fields, with no prior knowledge needed. Participants were asked to bring materials from home, from pens and paint to old jars, so the group had one shared collection to build with.

In our own presentation we summed it up like this: a playful exploration of robotics and programming that made algorithms and variables visible through hands-on work, with painterly results that surprised us and made us want to try more.

DAY 1 · TUE 14 NOV

UNDERSTAND AND BUILD

What is an algorithm? Then: build a robot that draws.

DAY 2 · WED 15 NOV

CHANGE THE VARIABLES

Weight, pens, fan, paint. Test, compare, document.

DAY 3 · THU 16 NOV

PRESENT AND DRAW TOGETHER

Each pair presents, then all robots draw on one sheet.



Three drawings by our robots: markers with little weight, paint with toothbrushes, markers with medium weight.

AN ALGORITHM, WITHOUT A COMPUTER

An algorithm is a clearly defined sequence of steps. It takes something in, works on it step by step, and gives something out.

Paraphrased from the definition shown in the workshop, after Cormen et al., Introduction to Algorithms.

The facilitator showed this as a simple diagram: **input** goes into a **sequence of steps** and comes out as **output**. For a drawing robot, the input is the material, the steps are what the motor makes the robot do, and the output is the drawing on the paper.

He also showed a sorting algorithm as an example, and drawings by earlier robots, each linked to one action.

ROBOT 1 · PENS

INPUT

- A jar with batteries inside
- A motor and a fan with a small weight
- Three markers as legs
- Paper



SEQUENCE OF STEPS

- Switch on: the motor spins the fan
- The weight makes the spin uneven
- The robot shakes and turns
- The markers touch the paper while it moves



OUTPUT

- Loops, circles and dotted rings
- Each marker leaves a different trace
- More weight: tighter circles

ROBOT 2 · BRUSHES

INPUT

- The same jar, motor and fan
- Bamboo toothbrushes as legs
- Red, black and yellow acrylic paint
- Paper



SEQUENCE OF STEPS

- Switch on: the motor spins the fan
- The robot turns around one brush as a pivot
- The bristles drag and smear the paint
- Big blots slow it down



OUTPUT

- Painterly circles and smears
- Dots, blots and long strokes
- More power: more lines than dots

ACTIONS THAT CAN MAKE A MARK · FROM THE WORKSHOP

DRIP

tropfen

WRAP

wickeln

PULL

ziehen

ROLL

rollen

BLOW

pusten

SMEAR

schmieren

...?!

your own



Output of robot 1: marker traces.



Output of robot 2: paint.



Detail of a marker drawing.

UNDERSTAND AND BUILD

From a definition on a screen to a robot on the table, in one day.

The morning: what is an algorithm?

The day started with a round of introductions. Everyone answered three questions: What is your name? Which programme and semester are you in? And: what is an example of an algorithm from your everyday life? A recipe, a morning routine or a way home are all sequences of steps.

Then came the theory: what an algorithm is, a sorting algorithm as an example, and the input-steps-output diagram.

The task

We formed pairs. Each pair had to build an interesting and unusual drawing robot. There was only one rule: **it must be driven by a motor and leave a pattern on paper.**

The materials

The workshop provided the technical parts. The rest came from our homes and from everyone else's collection on the long table.

PROVIDED

DC motor

Battery holder

AA batteries

Fan propeller

Heat-shrink tubing

Hot glue

BROUGHT BY US AND OTHERS

Plastic jars and lids

Markers and pens

Bamboo toothbrushes

Acrylic paint

Tape

Clothes pegs

Scissors

DAY 1 · BUILD + EXPERIMENT

THE BRIEF

1 Form pairs.

2 Build an interesting, unusual drawing robot.

Only rule: it is driven by a motor and leaves a pattern on paper.

GOAL By the end of the day, every pair has a simple drawing robot.



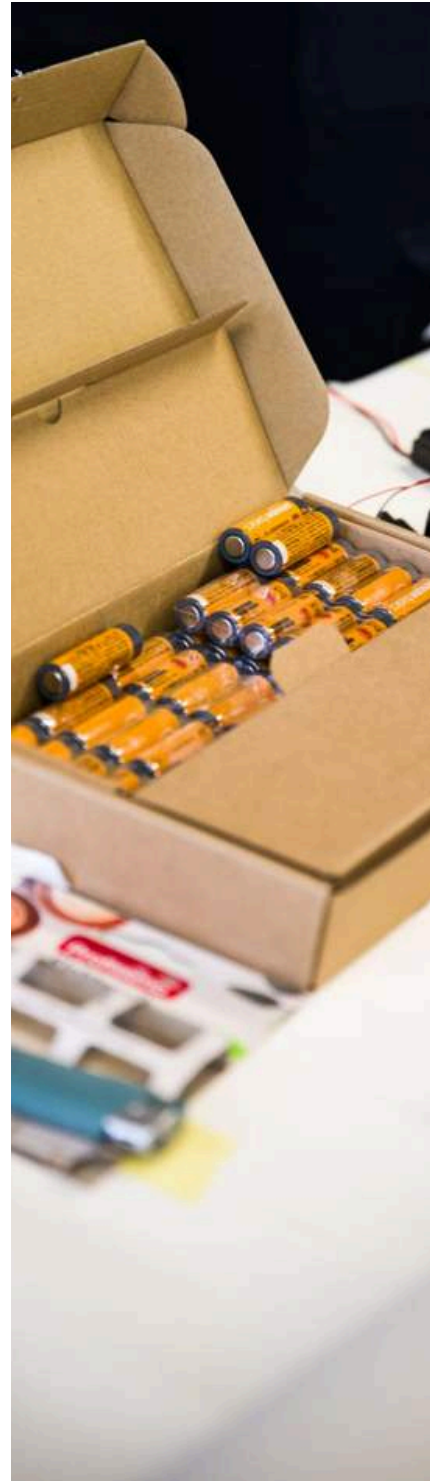
Our corner of the table at the start.



Building robot 1, side by side with Pia.

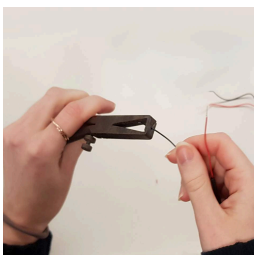


Cutting parts from what was on the table.

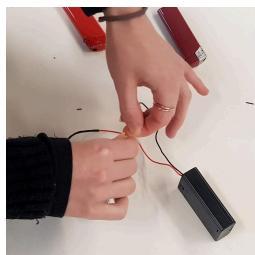


The technical parts came from the workshop kit.

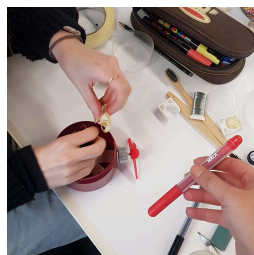
HOW A ROBOT COMES TOGETHER



1 · Strip the wires



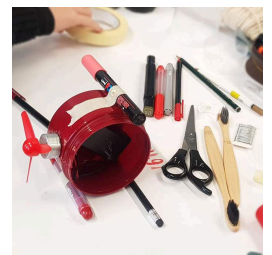
2 · Connect the motor



3 · Fill the jar



4 · Tape on the pens



5 · First version

THE JAR ON PEN LEGS

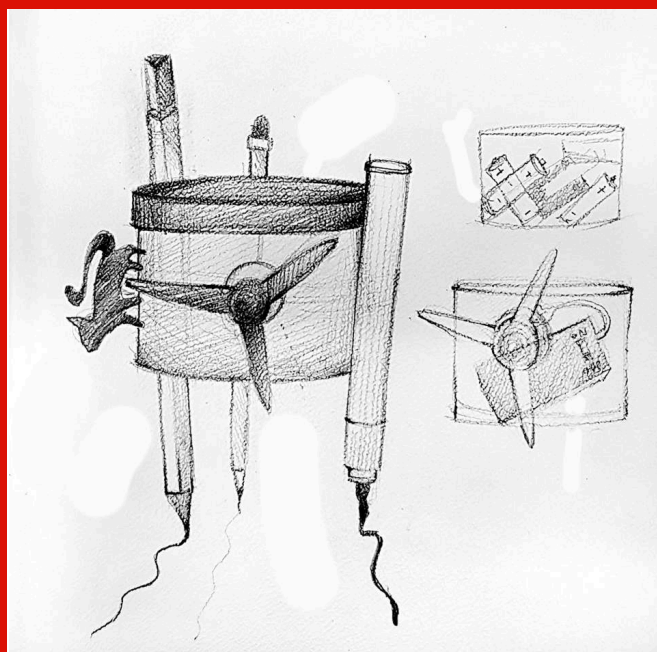
A red plastic jar, a spinning fan and three markers as legs. It shakes, turns and draws loops.



How it works

The motor sits on the side of the jar and spins a small fan. We attached a little plastic cat to the fan as a weight. It makes the spinning uneven, so the whole robot starts to shake and turn. The three markers work as legs and leave lines and dots wherever the robot moves.

- 1 Jar with lid: the body
- 2 Battery holder and extra batteries inside the jar, also used as weight
- 3 Motor with fan on the side of the jar
- 4 Plastic cat on the fan as an off-centre weight
- 5 Markers taped to the jar as legs



Sketch of robot 1 with its main parts.



Robot 1 at work. Each marker leaves its own kind of trace.

THE TOOTHBRUSH PAINTER

Same motor and fan, new legs: bamboo toothbrushes dipped in acrylic paint. The drawing turned into painting.

What changed

For the second robot we kept the principle and changed the tools. Instead of markers, bamboo toothbrushes became the legs. We dipped the bristles in red, black and yellow acrylic paint. The brushes drag and smear the paint while the robot turns, so the result looks painted, not drawn.

- 1 Jar with the battery holder inside
- 2 Motor with fan on the side
- 3 Lid of the jar as a base
- 4 Bamboo toothbrushes taped across the jar as brushes and legs
- 5 Acrylic paint on the bristles



Fixing the toothbrushes.



First runs with paint.



Paint, speed and weight in one image.

CHANGE THE VARIABLES

An algorithm has settings. Change one, and the output changes. That was the task for day 2.

Every pair first had to find the **variables** of its robot: what can you adjust to change the drawing?

For our robots, the variables were the **weight** (how many batteries), the **number of pens or brushes**, the **size of the fan** and the **kind of paint**. We ran test after test and labelled every sheet with its settings.

By the end of the day each pair had to deliver one finished presentation slide on Miro.

DAY 2 · EXPERIMENT WITH VARIABLES

THE BRIEF

- 1 Identify the variables of your robot.
What can you set to change the output? For example arm length, wheel size, weight, different colours or thinner paint.
- 2 Prepare the presentation.
One slide per robot: its name, the team, photos, a sketch or scan, and the test drawings.

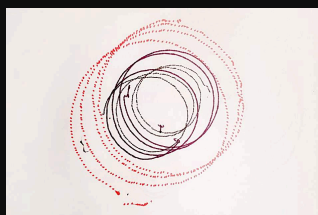
GOAL A finished presentation slide on Miro by the end of the day.

TEST DRAWINGS · ROBOT 1, MARKERS



LITTLE WEIGHT

Big, overlapping loops that shift across the sheet.



MEDIUM WEIGHT

Tight circles around one centre.



MORE PENS

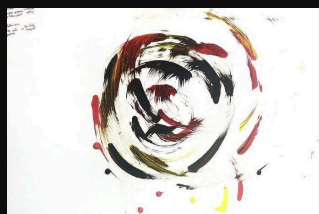
Several fine dotted rings at once.



MANY PENS LESS WEIGHT

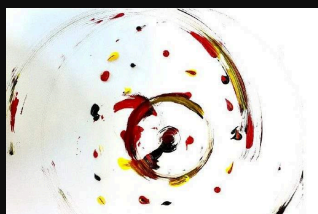
Light, open spirals with long curves.

TEST DRAWINGS · ROBOT 2, PAINT



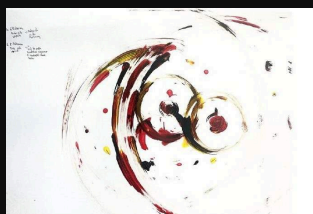
4 BATTERIES

Random paint spots. No fixed pivot point.



6 BATTERIES

Turns around one toothbrush as a pivot.



8 BATTERIES

Slows down at big blots of paint and smears them more.



6–10 BATT. BIG FAN

FLUID PAINT

Faster and stronger, no fixed pivot. More lines than dots.

Labels translated from our presentation. Each sheet was one run of the robot.

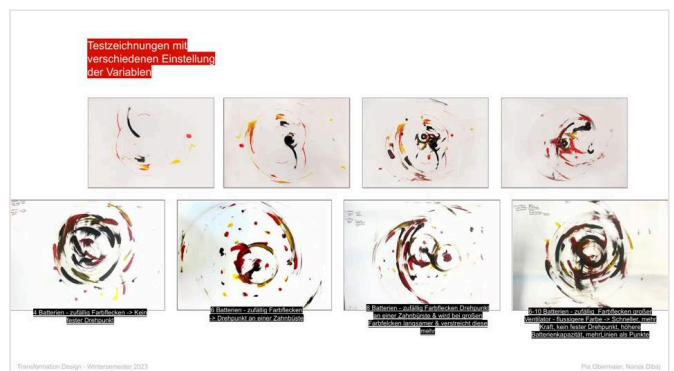
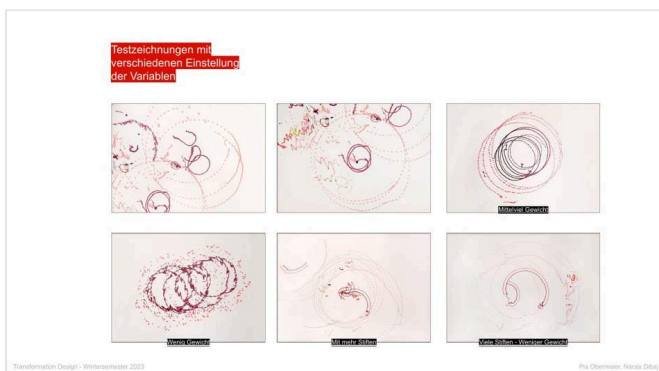
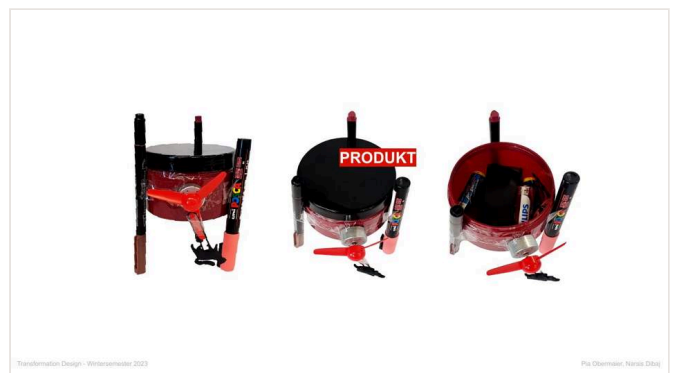
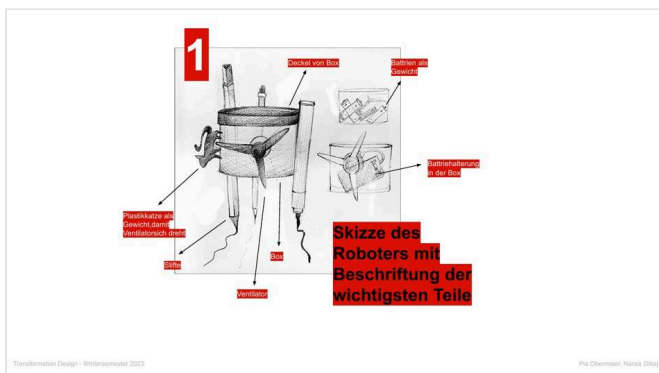
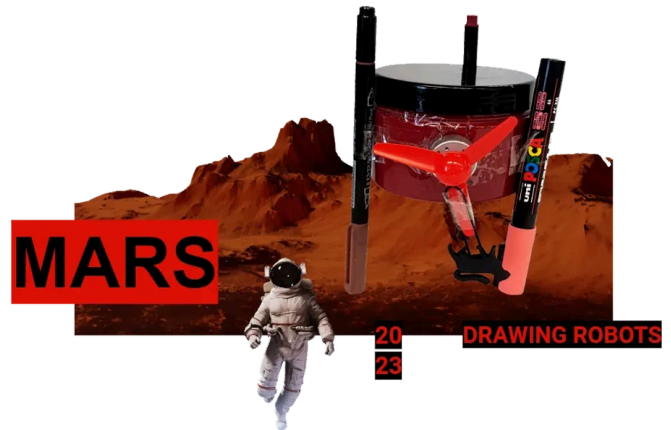
PRESENT AND DRAW TOGETHER

Every pair showed its robot. Then all robots met on one long sheet of paper.

The presentations

Each pair presented its robot to the whole group: how it is built, which variables it has, and what the test drawings showed.

For our presentation we chose the colours of our robot, red, black and white, and placed it on a Mars landscape. The title: MARS. Below are some of our slides (in German).



Six of our sixteen slides: robot 2, the two projects, sketch and product of robot 1, test drawings of robot 1 and robot 2.

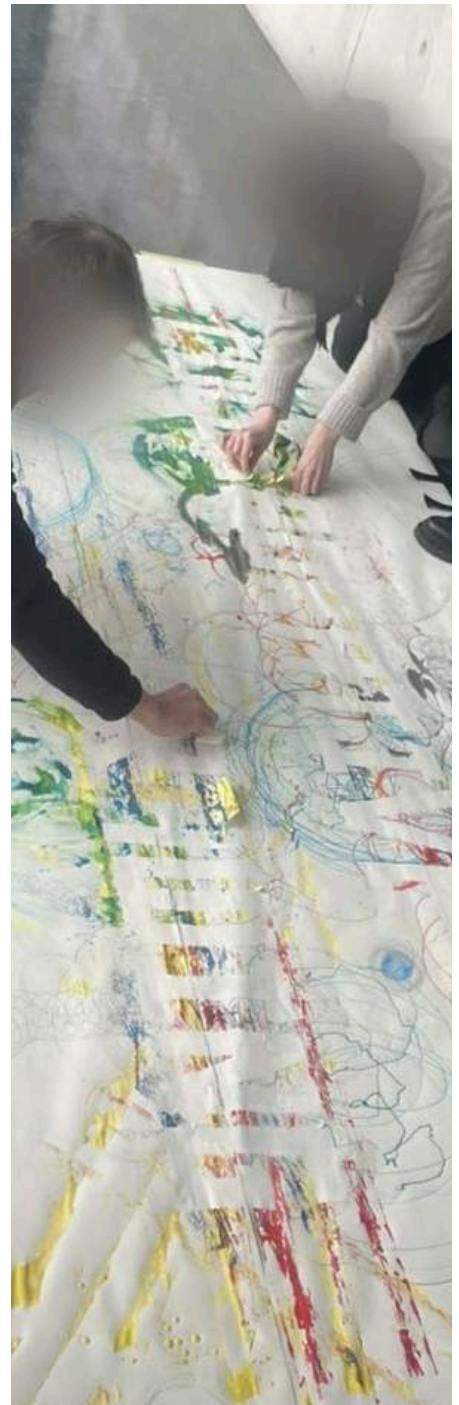
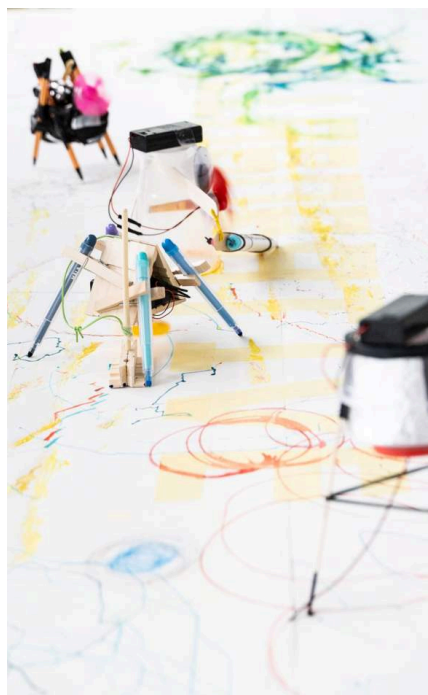
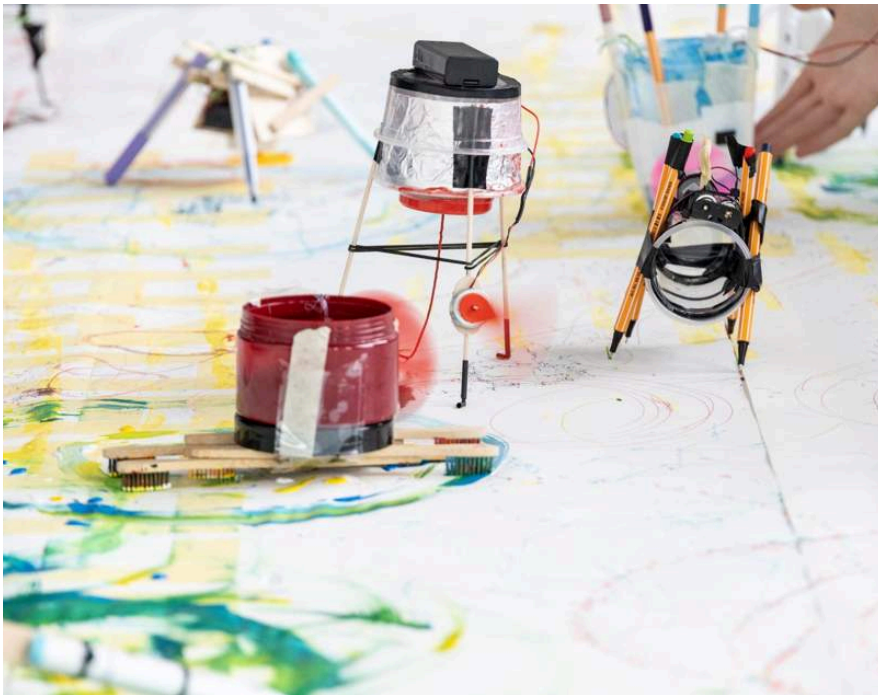
One sheet, every robot

To finish, a long sheet of paper was laid out on the floor. Everyone placed their robots on it at the same time and switched them on. Pen walkers, spinning jars, wheeled cups and our toothbrush painter all worked side by side, crossing each other's lines.

The finished sheet shows the words “**Collaborative Drawing**” in large white letters across all the traces. At the end it was hung on the wall.



The result: one drawing by all robots.



All robots on the shared sheet. Faces of other participants are blurred.

TWO PEOPLE, TWO ROBOTS

This was a team project from the first sketch to the last slide.

NARSIS DIBAJ

Transformation Design

PIA OBERMAIER

Transformation Design

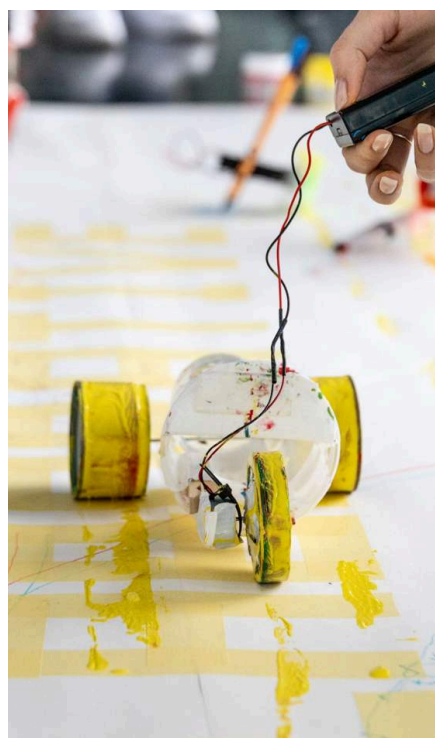
We worked as a pair on everything: choosing materials, sketching, wiring, building, testing the variables, labelling the drawings and building the presentation. We made the decisions together, mostly by trying things out directly at the table. On the last day the work became even more collective: every pair's robot contributed to one shared drawing.

REFLECTION

WHAT I TOOK FROM IT

A way to make abstract systems understandable, by building them.

01	02	03	04	05	06
Define	Build	Run	Vary	Compare	Share
Input, steps, output	Simple, fast, from what is there	Let the system work	Change a setting	Label and read the results	Present and combine



SEVEN THINGS I LEARNED

01 Every system has input, steps and output.

Once I see a process this way, I can explain it to anyone. It works for a robot, a sorting rule or a user flow in an app.

02 Make the abstract physical.

We did not need a single line of code to understand variables. A jar with more batteries that turns differently made the idea obvious.

03 Small changes, visible effects.

Adding weight or changing the paint changed the image completely. I learned to change settings on purpose and to watch the effect closely.

04 Document as you go.

Every test sheet got a label with its settings. Without that, the comparison on day 2 and the presentation on day 3 would not have been possible.

05 Accept surprise as a result.

The robots never drew exactly what we expected. Those surprising, painterly results were the most interesting part and made us want to try more.

06 Build with what is there.

A jar, toothbrushes, a plastic cat. Limited materials pushed us to find new uses for ordinary things.

07 Individual systems can create something shared.

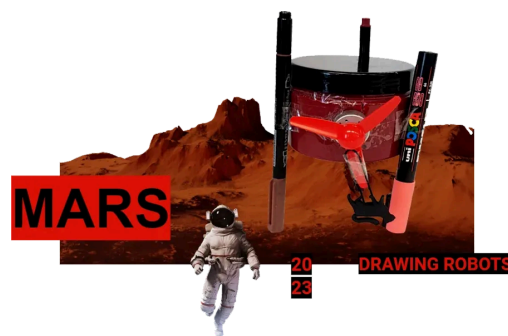
Each robot followed its own simple rule. Together on one sheet, they made a drawing none of them could make alone.



WHAT THIS WORKSHOP TRAINED

Each skill is tied to something we actually did.

SKILL	WHAT WE DID	WHEN
Algorithmic thinking	Learned to describe a process as input, sequence of steps and output, and applied this to our two robots.	Day 1–3
Rapid prototyping	Built two working robots from a jar, a motor, a fan, batteries, markers and toothbrushes. Stripped and connected wires, used tape and hot glue.	Day 1–2
Working with variables	Identified weight, number of pens or brushes, fan size and paint as variables, changed them and compared the drawings.	Day 2
Systematic documentation	Labelled every test sheet with its settings and photographed the process step by step.	Day 1–2
Visual communication	Created a presentation with its own visual concept (Mars, red and black), sketches, cut-out photos and a short video.	Day 2–3
Presenting	Presented our robots, variables and results to the whole group.	Day 3
Collaboration	Worked as a pair throughout, then contributed to one collective drawing with all participants.	Day 1–3



WORKSHOP

„Drawing Robots – A Hands-On Exploration of Drawing Algorithms“

Werkwoche 2023, Faculty of Design
Technische Hochschule Augsburg
Led by Steffen Mitschelen

SOURCES

werkwoche.de/2023/events/drawing-robots
werkwoche.de/speakers/steffen-mitschelen

Case study written by a member of the participating team. It is not an official publication of Technische Hochschule Augsburg or the workshop lead. Photos come from our own documentation and from the workshop's photo documentation; faces of other participants are blurred.