Encouraging scientific and engineering curiosity in students through IoT projects

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The authors

- Djordje Herceg, professor at the University of Novi Sad Faculty of Science, Mathematics and Infomatics
- Dejana Herceg, professor at the University of Novi Sad Faculty of Technical Sciences (Engineering)

- 24+ years of teaching experience at the University
- 19 years at the secondary school
- Courses for teachers and industry
- Research and software for the University and other customers

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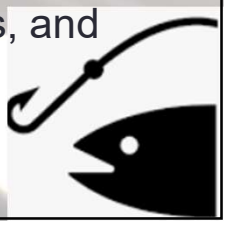
Our courses

- The IoT course at the Faculty of Science, UNS.
- The Modern Teaching Means course for future teachers (UNS)
- The EUGLOH Blended Intensive Program
- Students have little experience with electronics, and some experience in assembly programming.
- Substatial knowledge of high-level programming, databases, cloud services, etc.
- Our course is oriented towards solving real life problems, and delivering finished and complete solutions.
- The courses are elective, so we needet 'the bait'.



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The EUGLOH project

- The University of Novi Sad is a partner of a consortium of nine European universities, working on the EUGLOH project

EUGLOH
European University Alliance for Global Health

- European Universities Alliance for Global Health
- A Blended Intensive Program on IoT/3D printing will take place in Porto and Novi Sad/Szeged in 2024.
- Students from your institutions can participate!

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What is our goal?

- Bring back the 'interesting' and 'enticing' into teaching
- Promote curiosity in students
- Enable the sensation of self-achievement and develop confidence
- Cover current topics in IT and engineering
- We dedicated 3-5 weeks of the standard IoT course to attractive topics and talk points

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Can we 3D print a steering wheel?

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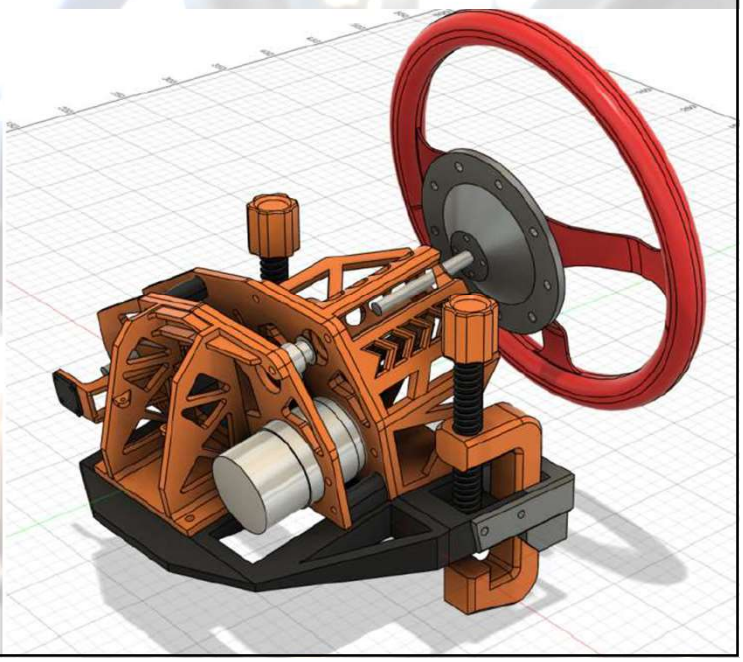
Yes, we can!

- Hall sensor for orientation
- Arduino USB acts as an USB game controller
- Electric motor for the feedback and resistance
- It just remains to work out the mechanics of the wheel



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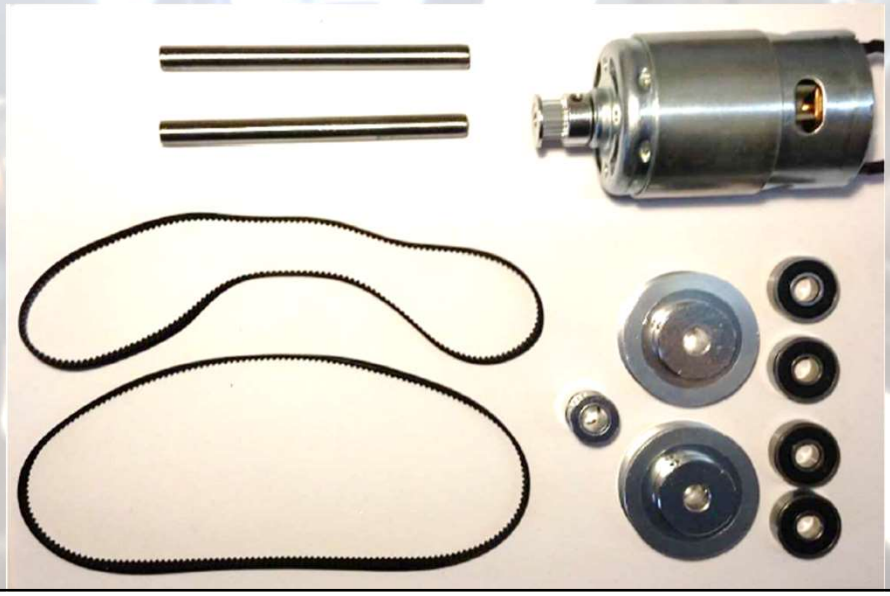
Electric motor, cogs, shafts and belts



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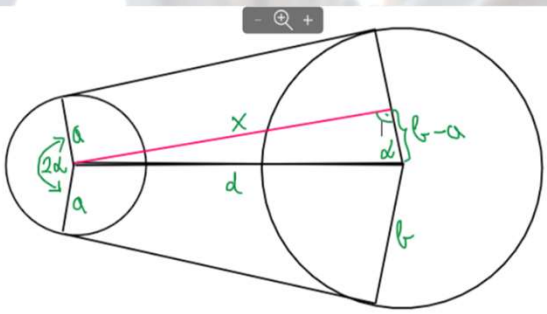
Challenge - The length of the belt

- Electric motor provides resistance and feedback while driving
- The length of the belt needs to be calculated depending on the cog sizes and their distance
- Solved numerically!



$$x^2 = d^2 - (b-a)^2$$

$$\alpha = \arccos\frac{b-a}{d}$$

$$2\alpha \cdot a + 2x + (2\pi - 2\alpha)b = \text{dužina kaiša}$$

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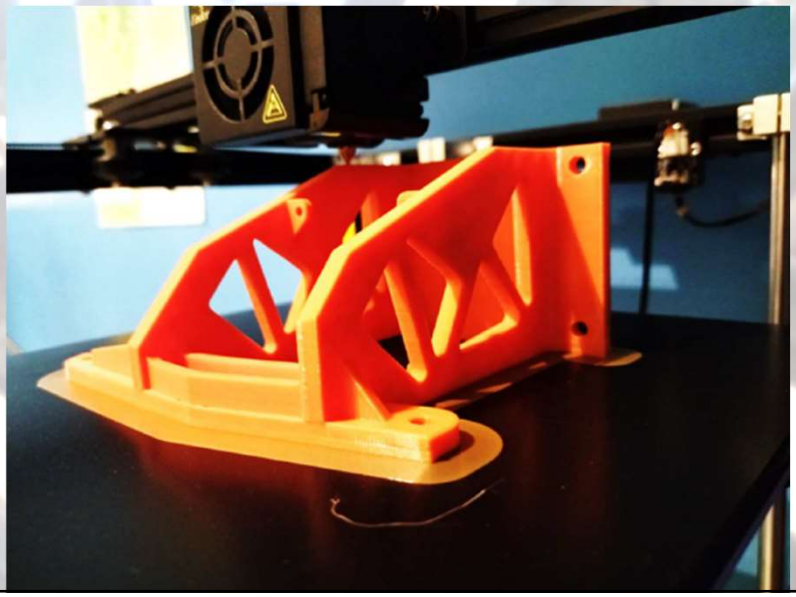
3D printing



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Theory and practice are the same thing…

- …in theory! Tensioning arms had to be added.

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The Guardian Article

Teaching

'Schools are killing curiosity': why we need to stop telling children to shut up and learn

Pupils who ask lots of questions get better results, especially those from poorer homes

Wendy Berliner

Tue 28 Jan 2020 07.15 GMT

Young children sit cross-legged on the mat as their teacher prepares to teach them about the weather, equipped with pictures of clouds. Outside the classroom, lightning forks across a dark sky and thunder rumbles. Curious children call out and point, but the teacher draws their attention back - that is not how the lesson target says they are going to learn about the weather.

It could be a scene in almost any school. Children, full of questions about things that interest them, are learning not to ask them at school. Against a background of tests and targets, unscripted queries go mainly unanswered and learning opportunities are lost.

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Why develop curiosity?

- We still teach mostly by relaying facts
- The COVID pandemic has shifted that paradigm more towards self-study
- Motivation for self-study is important
- Curiosity is a great driving force
- Validation of the effort and the sense of accomplishment
- How to praise your children? Praise the effort, not traits.

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The best way to praise kids who learn and think differently

By Amanda Morin
Expert reviewed by Elizabeth Harstad, MD, MPH

At a glance

- Praise can have a powerful effect on kids who learn and think differently.
- The right kind of praise can boost confidence and motivation.
- It's better to praise kids' efforts rather than their natural abilities.

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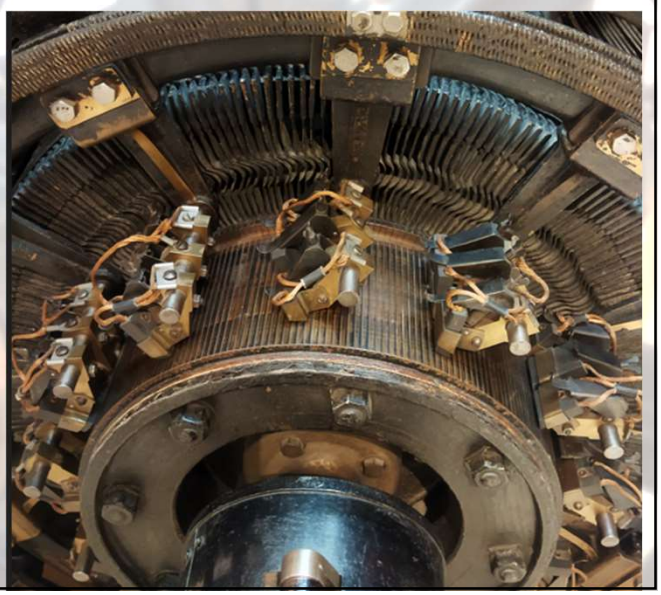
Motivational examples

- Let's look at some equipment (*from the Vienna Museum of Technology*) and note the questions that arise from there.



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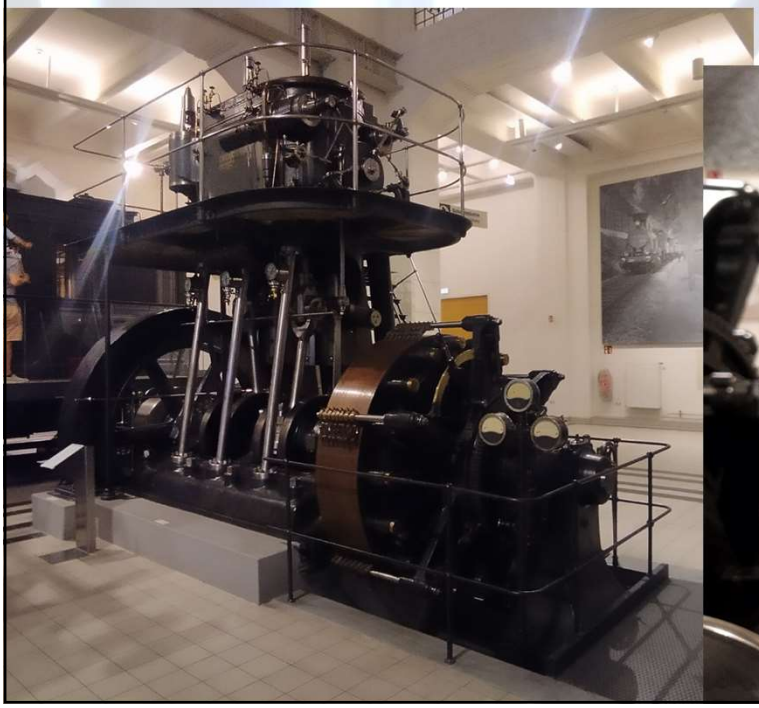

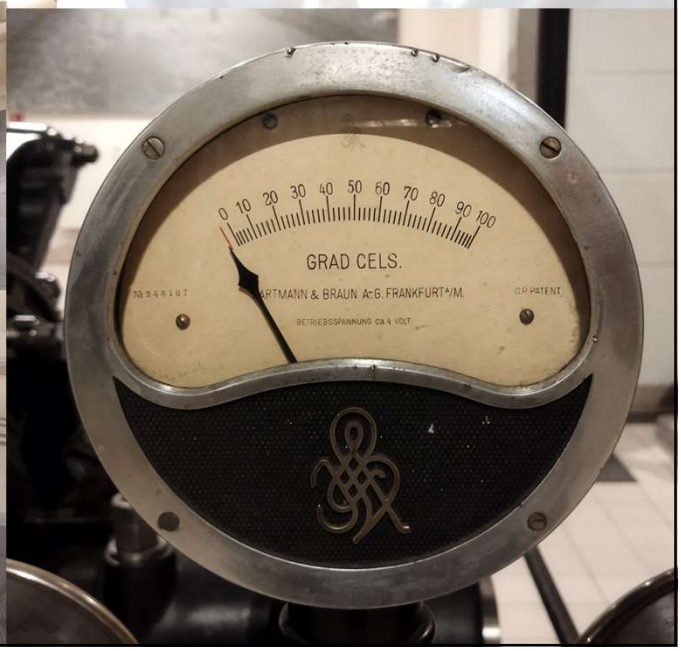

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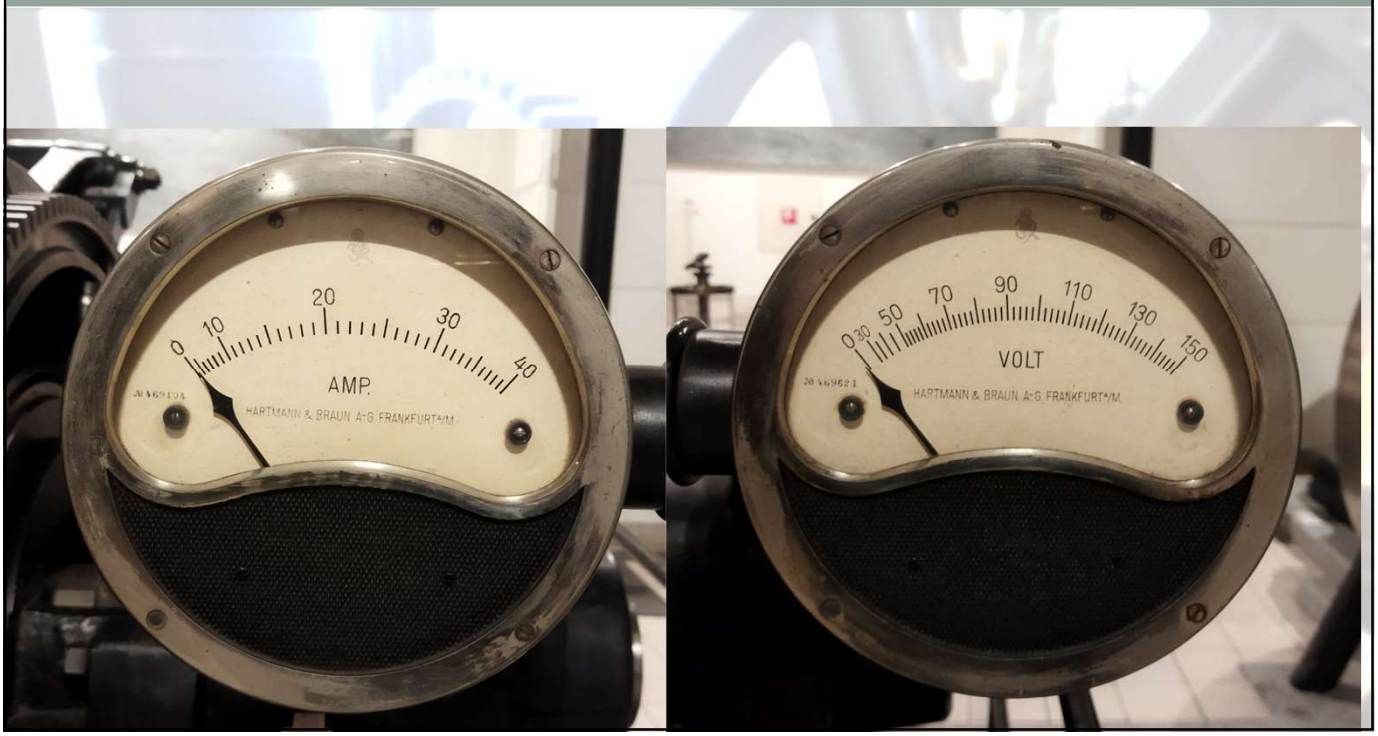

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Teacher's questions

- Can you guess what those machines do?
- Can you guess the time period they belong to?
- Can you make something similar?
- Hint: yes, we can!

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Questions from the students

- What are those?
- Are the gauges from a steampunk game?
- This is all obsolete, right?
- Why does the voltage scale go up to only 150?
- Does it still work?

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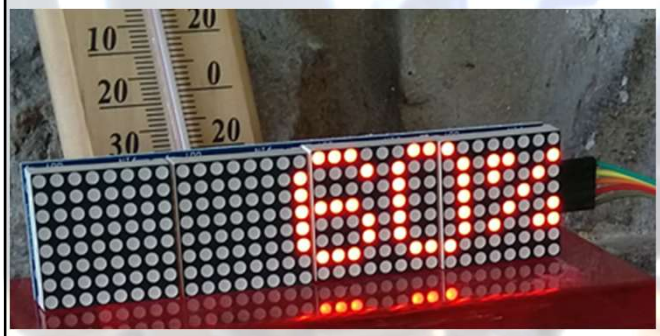
…and what do we have now?



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CINCINNATI ACRAMATIC 220
X
Y

21


100%
AUX
AUX
EDIT
1
60
70
80
40
90
20
10
6
2
0
%

22

The questions:

- Is this some kind of an old computer?
- It looks more modern than the previous machine, right?
- Can you play Doom on it?
- How does this correspond to the Von Neumann architecture model?

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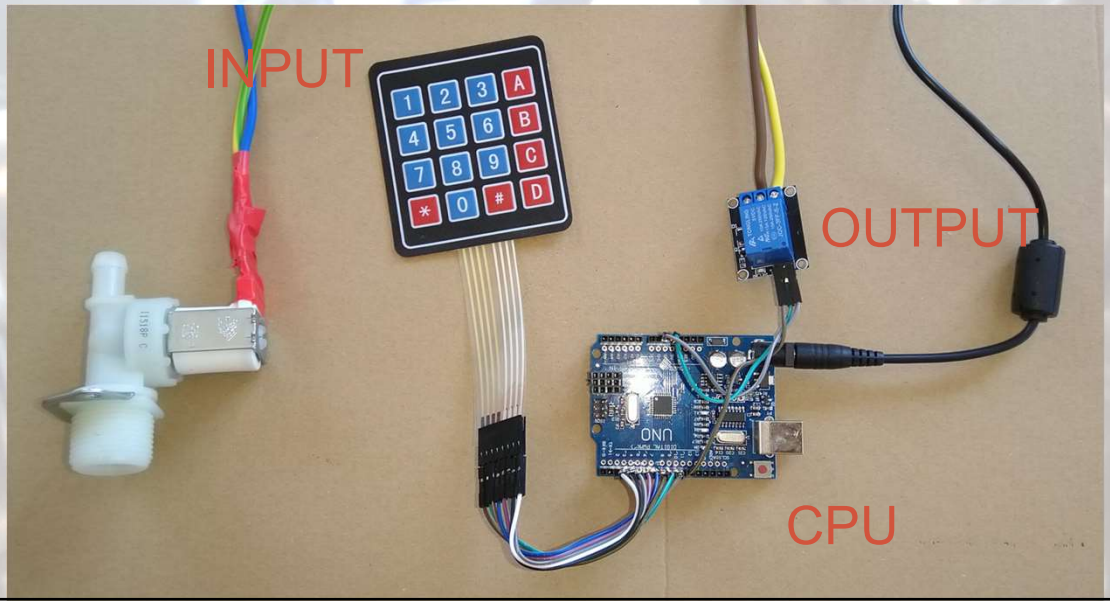
…and what do we have now?



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Presentation is 90% of success

- A significant problem with student projects is that they lack the impact on the casual audience.
- Curiously, those 'in the know' are also not immune to a well executed presentation.
- Thus, we need 3D printing.

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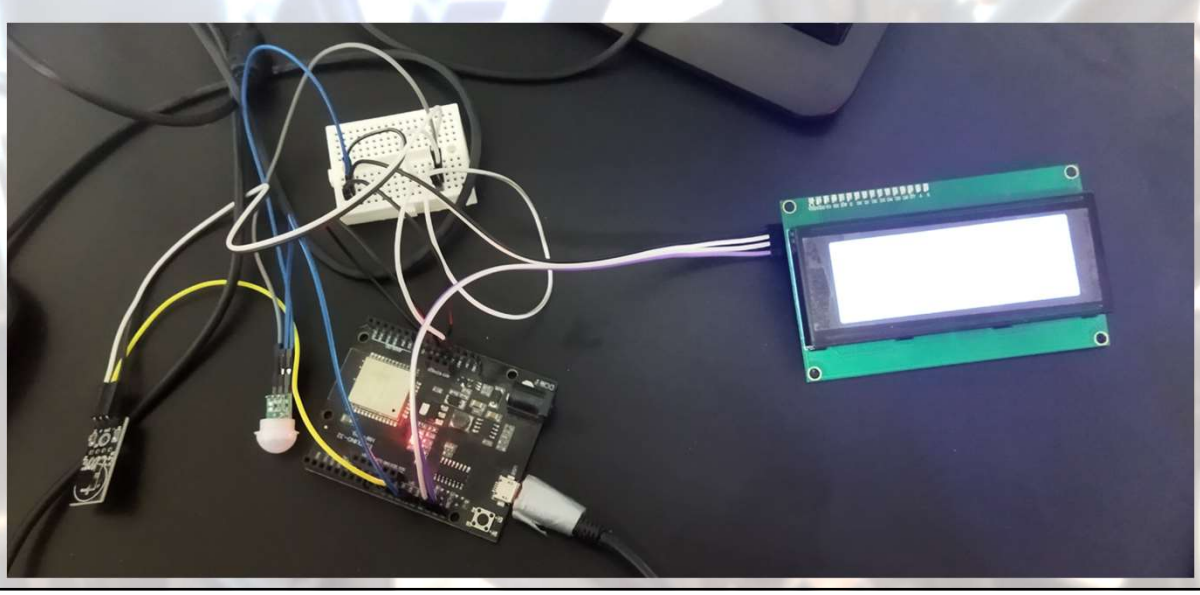
Do you prefer this…



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…or this?

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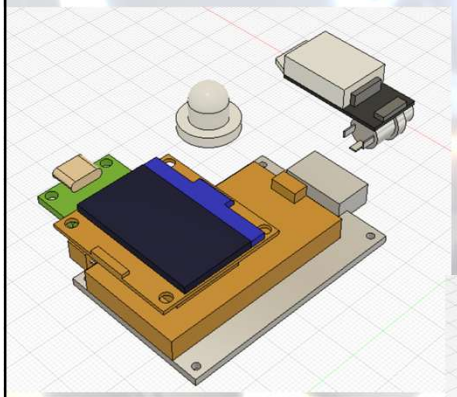
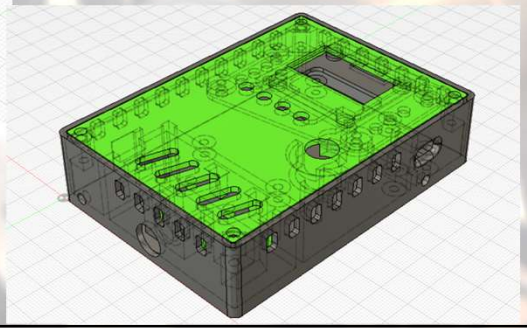
From contept to contraption





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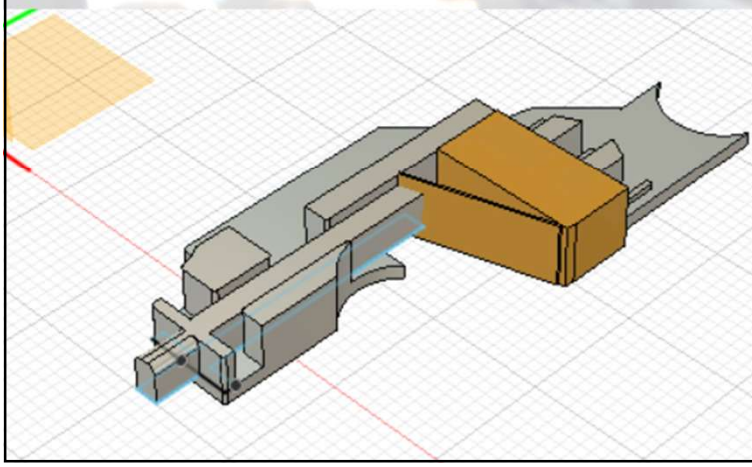
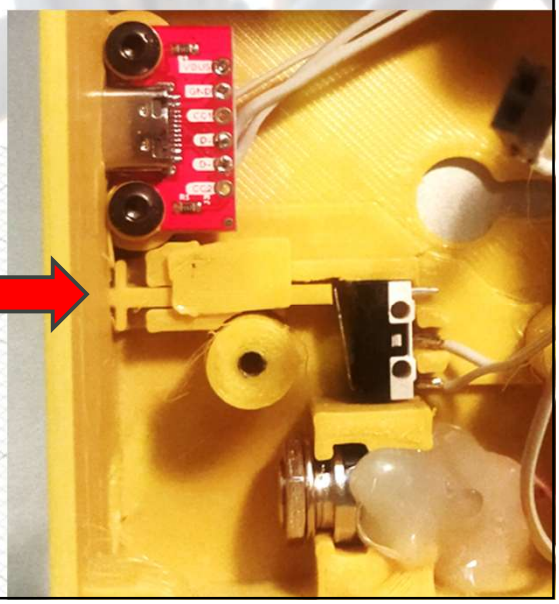
Small challenges, great victories

- How do we make a button on the casing?





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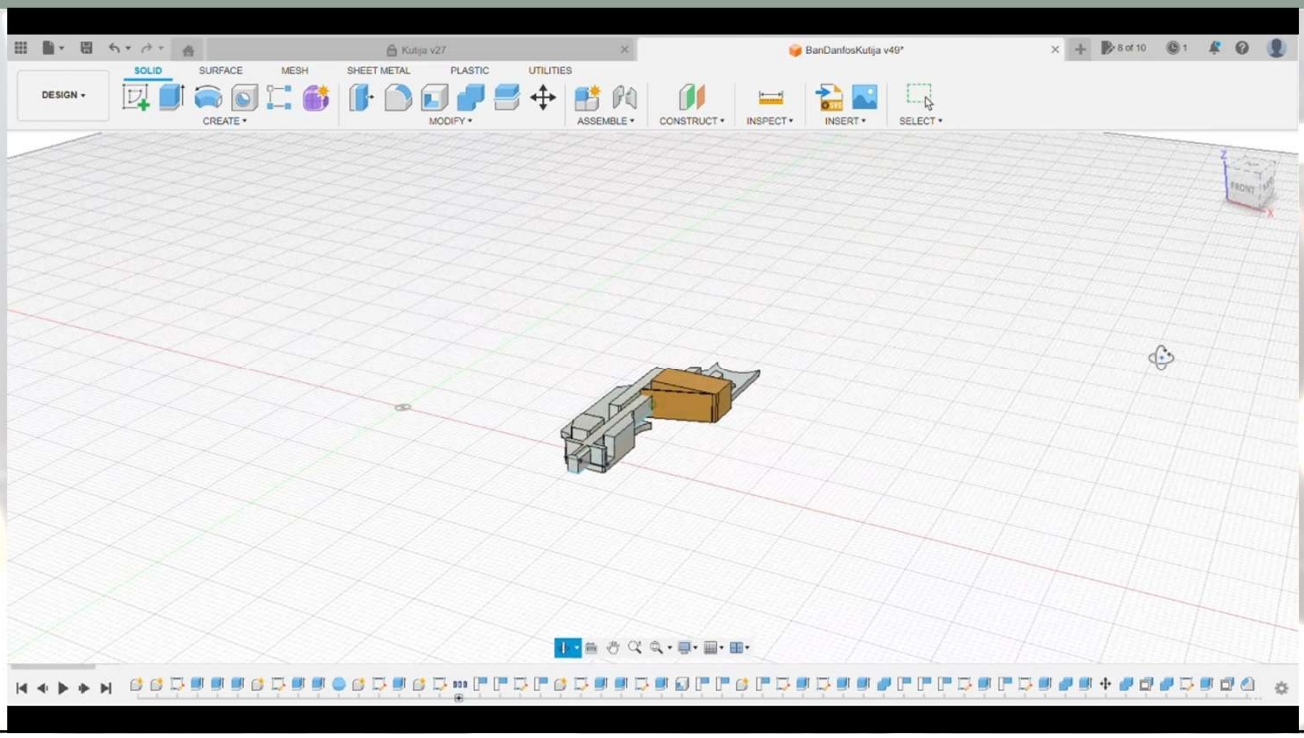

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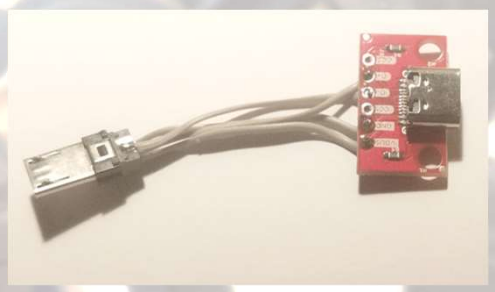
USB connector challenge

- We aim for the 'professional look' of our product.



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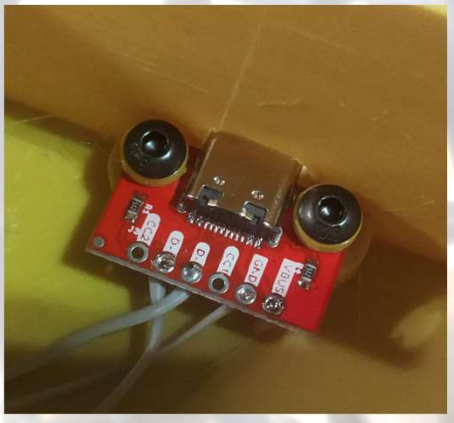

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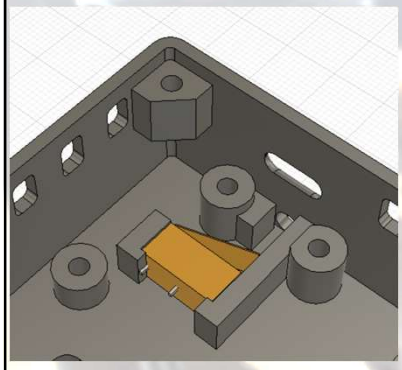
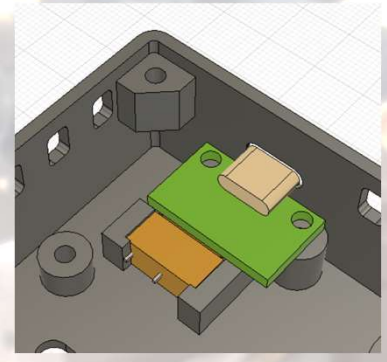
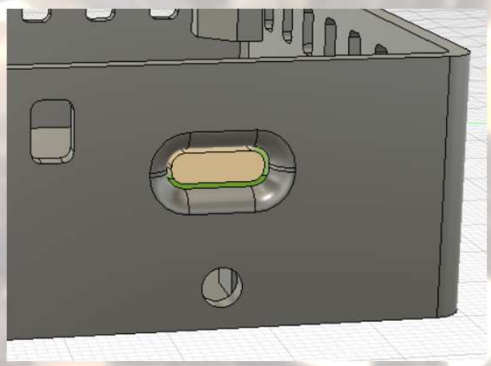
Optimization?

- Place the USB board above the switch.







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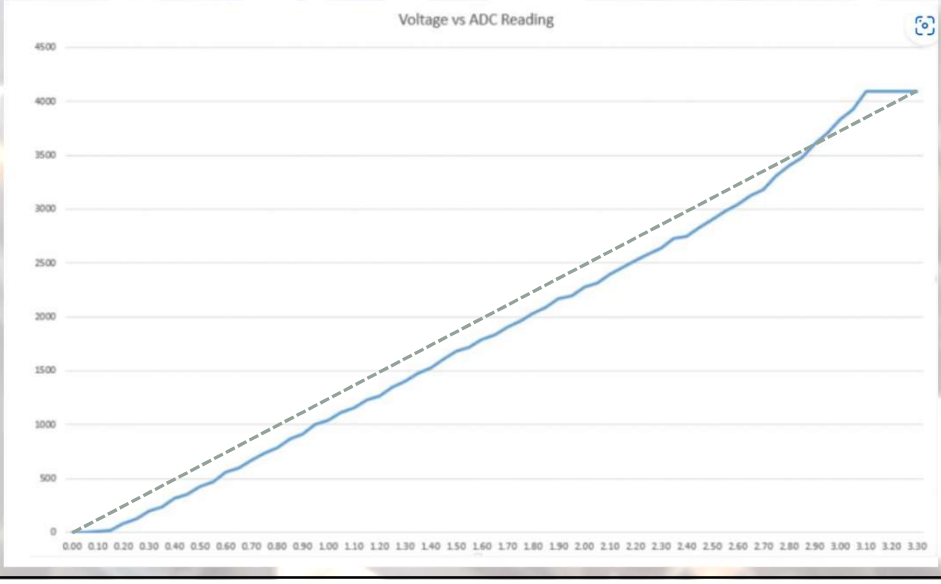
Challenge – Analog to Digital Conversion



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Student project template

- Identify a problem
- Make a preliminary specification of parts and functionalities
- Connect the components
- Write software
- Testing and tweaking
- Make a casing and 3D print it
- Success?
- Not yet! How does it perform in the real world?

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Water pressure monitor

- In a village in Northern Serbia, there is a long-standing problem of reliable water supply.
- Create a device that can measure pressure, keep a log of past measurements and help draw conclusions from the measured data.
- The resulting project is an IoT device, based on Arduino and Azure Cloud.

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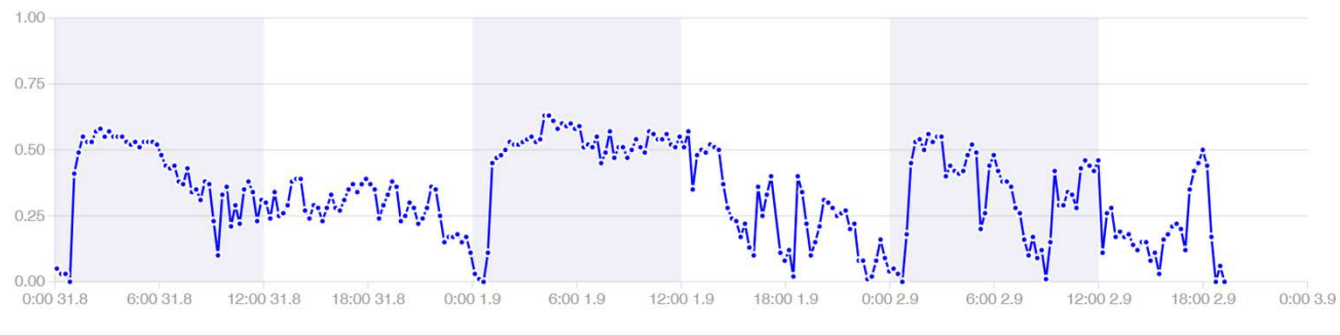
Ordinary daily variations



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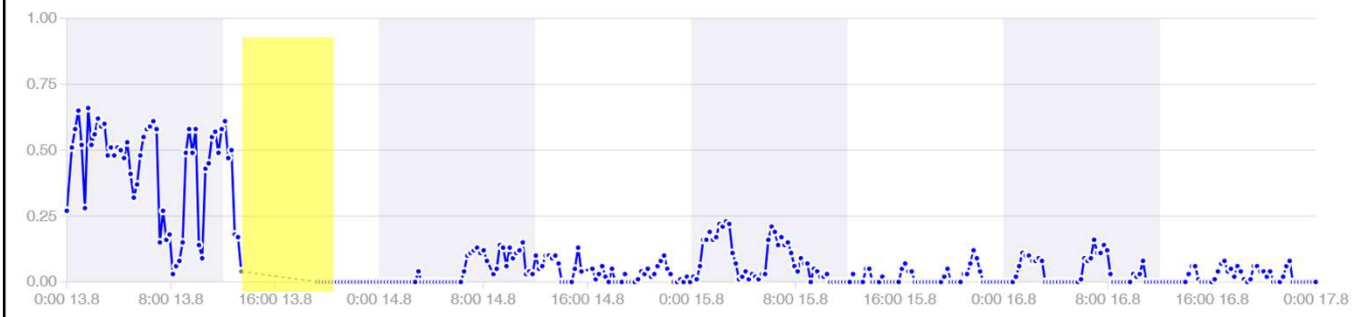
Loss of power, loss of pressure



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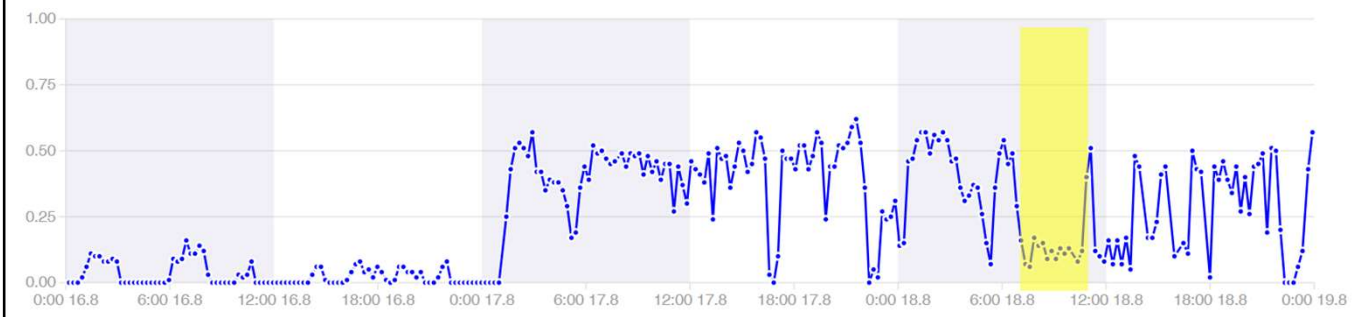
Return to nominal



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Conclusions

- We are schooling future teachers
- Show them by doing, not telling, how to promote scientific and engineering curiosity
- A sense of personal achievement is great motivation
- We've touched upon programming, electronics, numerical methods, mechanical engineering
- A good fusion of interdisciplinary skills
- Brings the fun back into the classroom

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Links

- ESP32 Analog To Digital Conversion Accuracy - IoT Kits (w4krl.com)
  https://w4krl.com/esp32-analog-to-digital-conversion-accuracy/
- 'Schools are killing curiosity': why we need to stop telling children to shut up and learn | Teaching | The Guardian
  https://www.theguardian.com/education/2020/jan/28/schools-killing-curiosity-learn
- EUGLOH European University Alliance for Global Health
  https://www.eugloh.eu/
- 3D printed Boot button for the ESP32 board
  https://youtu.be/yHo6AM-GAJQ?si=VwTBxUJim6yKBnrO

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Thank you!

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