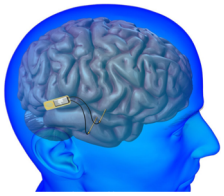
LUNDS UNIVERSITET
Lunds Tekniska Högskola

ETIA06 Electrical Engineering: Possibilities and Limitations

ANDERS J JOHANSSON 2019

Who am I?

- Anders J Johansson, Docent in Radiosystems,
  Department of Electrical and Information Technology
  - How to design and build a radio system that *"works"*.
  - Applications ranging from brain implants to particle accelerators (μW to MW).



www.medgadget.com

www.essscandinavia.se

Course outline

- Lectures/seminars
- One workshop
- One project
  - Two persons per group

- Final report, video and demo!

Course schedule part I

3/9 *Tuesday* **Lecture** Course information and introduction to concepts.
6/9 *Friday* **Lecture** What is a computer? And what is electronics?

10/9 *Tuesday* **Laboration** LittleBits.
10/9 *Tuesday* **Seminar** Programming Playground Express.
Register project groups.
13/9 *Friday* **Cancelled**

17/9 *Tuesday* **Seminar** Interactive programming with Playground Express.
17/9 Tuesday **Seminar** Connecting external sensors.
Project groups present their project name, ideas and propose a material list.
20/9 Friday **Lecture** Arduino/other prototyping platforms

24/9 *Tuesday* **Lecture** Connecting motors and LEDs, and some parts on colour and movement.

Course schedule part II

27/9 - 15/10 Project group meetings

18/10 *Friday* ***Lecture*** *Design for manufacturing*

26/10 *Friday* 24.00 **Deadline for the report**.

W44: **Presentation** of projects.

9/11 *Friday* **Deadline for components and movie**.

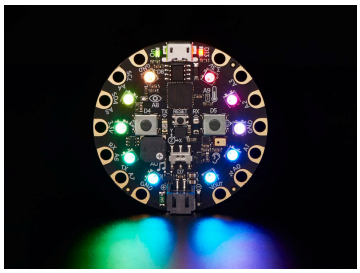
Course requirements

- Needed to pass course:
  - Attend workshop
  - Attend and give project demo.
  - Project report (More details later, but necessary parts include: parts list, estimated cost, block and circuit diagram, photos of quick and dirty, functional, and final prototypes.
  - Project video (1 minute)
  - Hand back parts

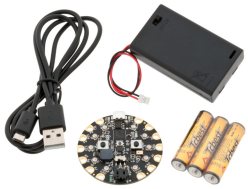
Course "literature"

learn.adafruit.com/adafruit-circuit-playground-express/overview

- Circuit Playground Express
  - *Not* classic.
  - Ca. 280:- sek
- Programming cable (USB)
  - *Not* charging cable!



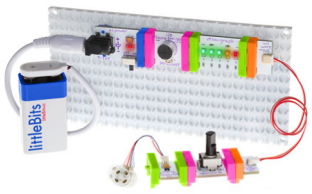
- www.electrokit.com
- www.lawicel-shop.se
- shop.pimoroni.com (UK based)



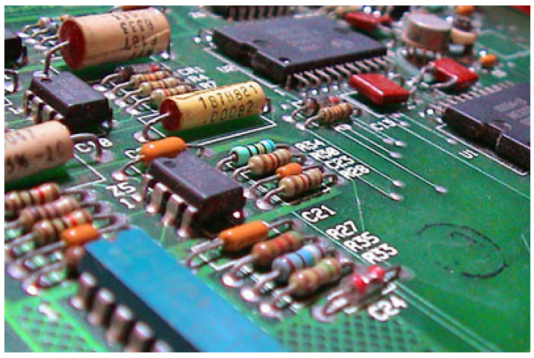
Base kit

Workshop

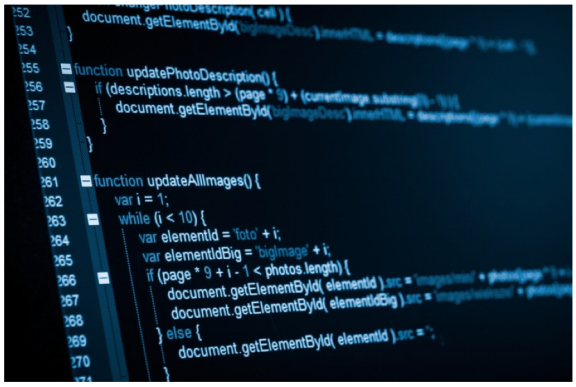
- LittleBits



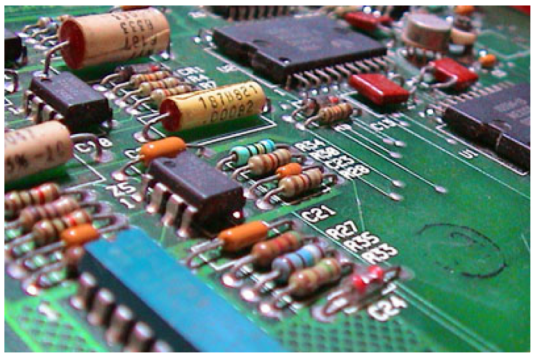
Electrical engineering basics



Programming basics



Electrical engineering basics



Flashligt demo

- www.tinkercad.com

"Laws"

- Kirchoffs current law
  - The sum of currents in a point is zero
- Kirchoffs voltage law
  - The sum of voltages in a loop is zero
- Ohms law
  - U=R*I ([Volt]=[Ohm]*[Ampere])
- Power law
  - P=U*I ([Watt]=[Volt]*[Ampere])

Energy and power

- Energy is measured in Joules, J
- Power is measured in energy per second, J/s

- But batteries are measured in mAh (milli-ampere-hours)?

Linocell Powerbank 7800 mAh
Extrabatteri för mobil och USB-enheter

- Smidigt format
- Upp till 3 A
- USB-C och dubbla USB-A-portar

The mystery of mAh as a unit.

Linocell Powerbank 7800 mAh
Extrabatteri för mobil och USB-enheter

- Smidigt format
- Upp till 3 A
- USB-C och dubbla USB-A-portar

U=5V
7800 mAh

=> 140 kJ

Batteri typ Stiga 900
Ersättningsbatteri för robotgräsklippare

- Hög kapacitet (7000 mAh)
- Kompatibelt med många modeller

U=25V
7000 mAh

=> 630 kJ

- I*V=P ([A]*[V]=[W])
- P*t=E ([W]*[s]=[J/s]*[s]=[J])

Tesla battery

Tesla Series 3

Battery capacity: 75 kWh

Battery voltage: 350V

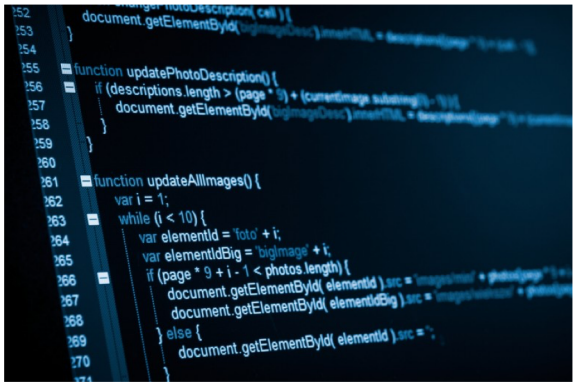
Energy content : 94 500 MJ

Explosive comparison: 2.3 kg TNT

Electronic basics

- We need closed circuits.
  - Current can only be controlled and directed, not lost.
- Voltage will be divided between serial loads.
- (Essentially) all power used will become heat.

Programming basics



SARA

- Sequence
- Alternative
- Repetition
- Abstraction

- Analog programming

PROGRAMMING – UNPLUGGED!

SEQUENCE

```
STAND
SIT
STAND
WAVE
”HEJ”
”HEJ”
”HEJ”
TURN
SIT
```

REPETITION

```
STAND
SIT
STAND
WAVE
repeat (3)
   {”HEJ”}
TURN
SIT
```

ALTERNATIVE

```
STAND
if BLACK SHOES
then
        TURN
else
        JUMP
SIT
```

ABSTRAKTION

```
Def HELLO=
WAVE
repeat (3)
   {”HEJ”}
```

```
STAND
SIT
STAND
HELLO
TURN
SIT
```

SARA

Prototype basics

3D systems

Prototypes

- Different kind of prototypes
  - Quick and dirty
  - Functional (Proof of concept, Working)
  - Look and feel (Visual/Tactile)
  - Integrated (User experience/Functional)
  - Production

Where prototyping would have been good:

Hummer H1

Interior space

Quick and dirty

Quick and Dirty

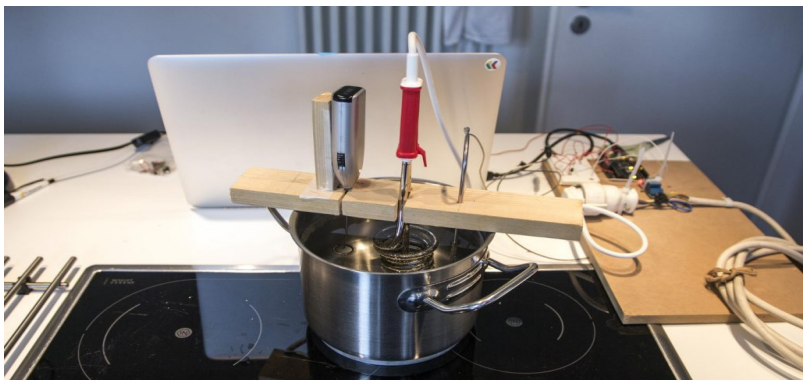
- The quick and dirty prototype
  - Facilitates communication
  - Gives a first idea of look and feel
  - Test/roleplay experience

Illustrative “Idea”: Home Souse vide!

Idea in head:

Quick-and-dirty prototype

Functional electric prototype

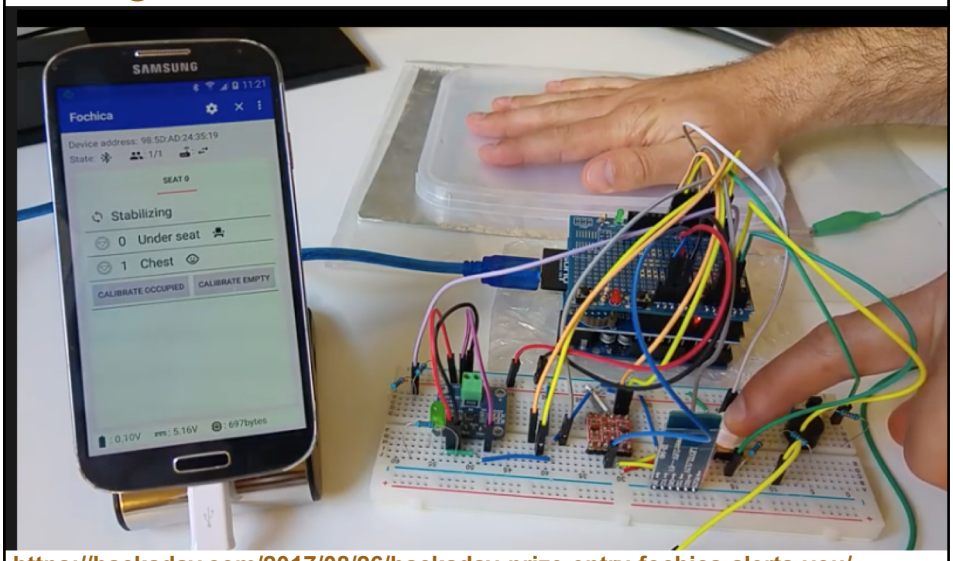


(Not my kitchen, found the picture on the web….)

Functional (electrical) prototype

- All electric components present
- Test functionality
  - Does motors, lights etc. turn on and off as intended?
  - Does displays give the right message?
  - Do the inputs and sensors work?

Forgotten-kid-in-car-seat-alarm



https://hackaday.com/2017/08/26/hackaday-prize-entry-fochica-alerts-you/

Next steps

In some order:

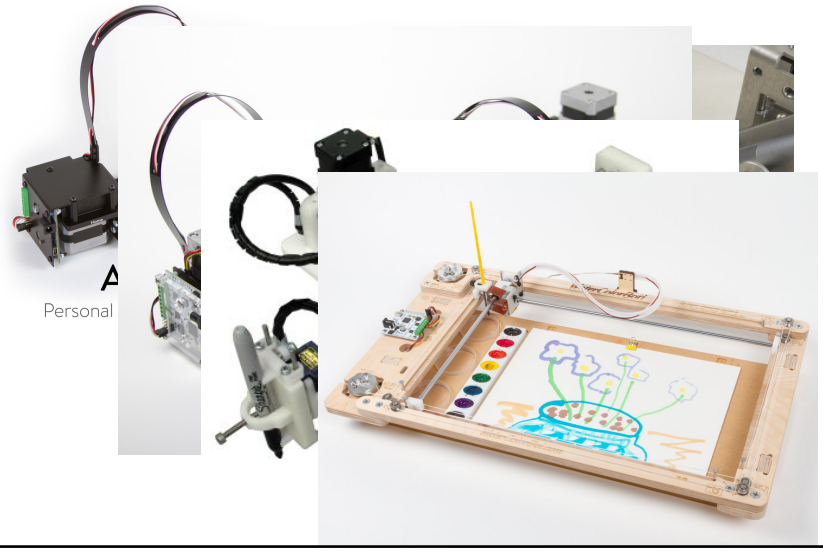
- Look and feel
  - Handmade
  - CAD/3D-printed mockup
  - Etc.
  - Possible to “fake” functionality
- Integrated prototype

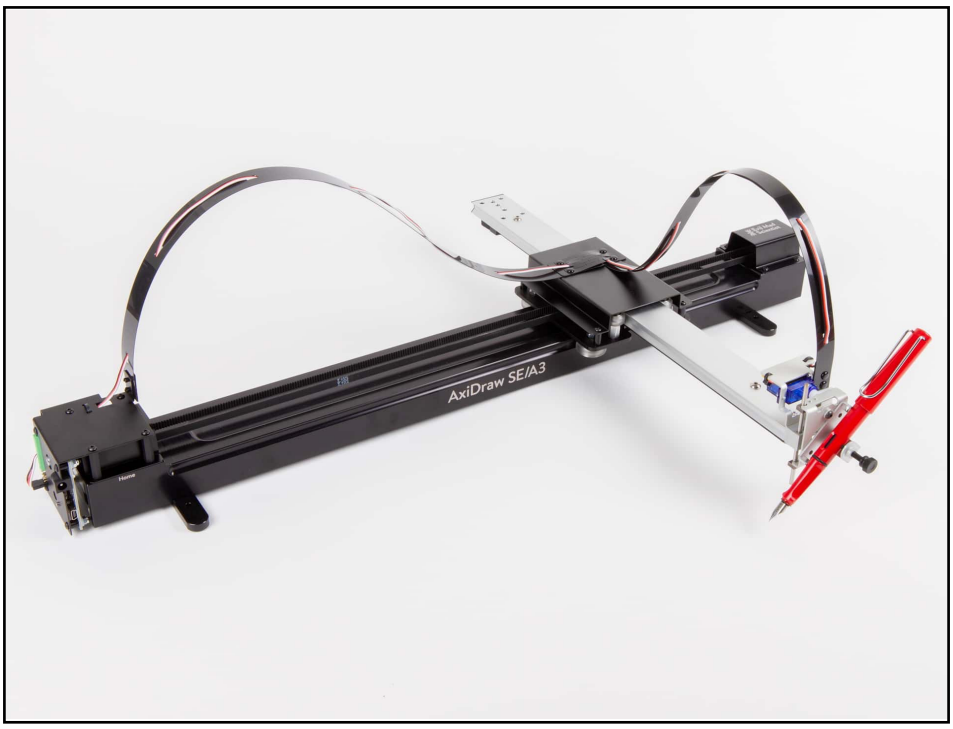
Then:

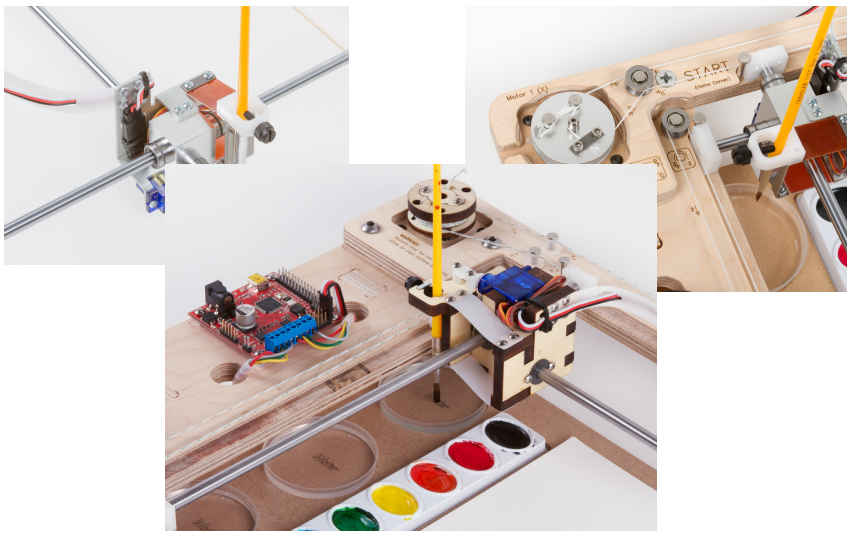
- Production prototype

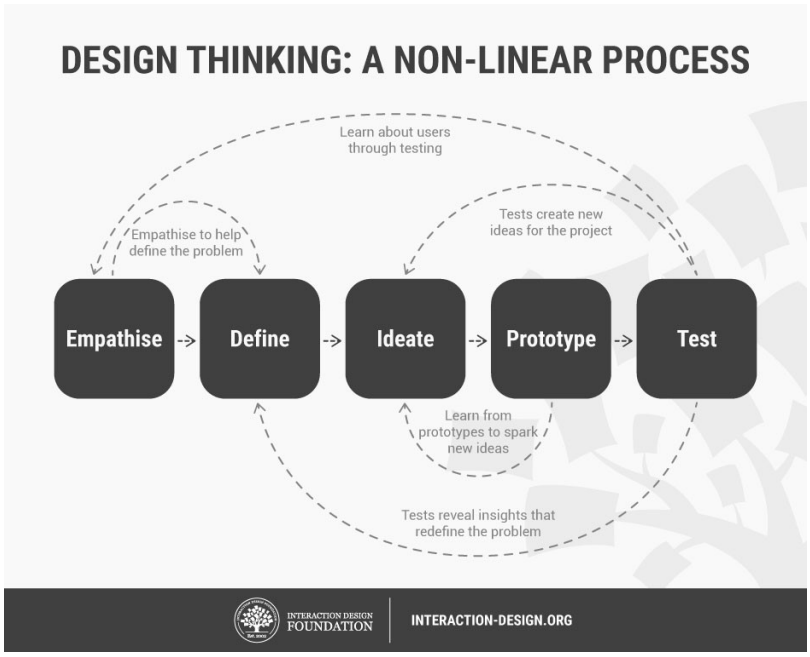
- Refinements…

Prototype/product generations
Example: AxiDraw




AxiDraw SE/A3





www.interaction-design.org/literature/article/stage-4-in-the-design-thinking-process-prototype

”THE FIRST ONE IS ALWAYS A PROTOTYPE”

Course “literature”

- Circuit Playground Express
  - *Not* classic.
  - Ca. 280:- sek
- Programming cable (USB)
  - *Not* charging cable!

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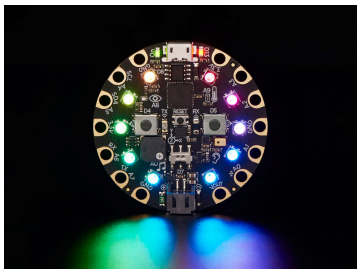
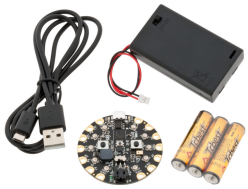
- www.lawicel-shop.se

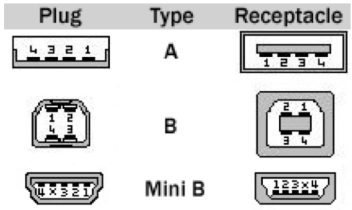




Base kit

Why different types of cables?

- USB connection diagram.



Pin	Signal	Color	Description
1	VCC		+5V
2	D-		Data -
3	D+		Data +
4	GND		Ground

First assignment:

- The project will be done in pairs, find a partner before Tuesday!
- Start thinking about ideas, but don't get stressed / locked in yet: the labs are intended to give inspiration!

Some resources

- Adafruit
  - learn.adafruit.com/category/projects
- Sparkfun
  - www.sparkfun.com/news
- Makezine
  - www.makezine.com

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