Engineering

Chris Stephenson

Department of Computer Science
İstanbul Bilgi University

Last compiled on October 17, 2014

"An engineer is someone who can do for ten cents what any damn fool can do for a dollar"
Henry Ford

"An engineer is someone who can do for ten cents what any damn fool can do for a dollar"
Someone else (not Henry Ford)

"Do not believe every quotation you read on the internet"
Alexander the Great

Scientific laws applied in the real world to help humanity.

The story of the refrigerator door.

A brilliant engineering solution to two problems.

A puzzle. Why do refrigerator doors stick?

A little video I made earlier

$$\frac{PV}{T} = c$$

A puzzle. Why does my tea taste better in a bone china mug?

A puzzle. Why is my bone china mug thinner than my other mug?

Where else is this principle applied?

$$Reactiontime \propto 2^{0.1T}$$

If it is not counterintuitive, it is not worth knowing.

Who said that?

- All science would be superfluous if the outward appearance and the essence of things directly coincided.
- If the way things really are was the same as they look, then science would be unnecessary.
- Karl Marx, edited by Engels, Capital, Volume III (1894), Chapter 48, section III

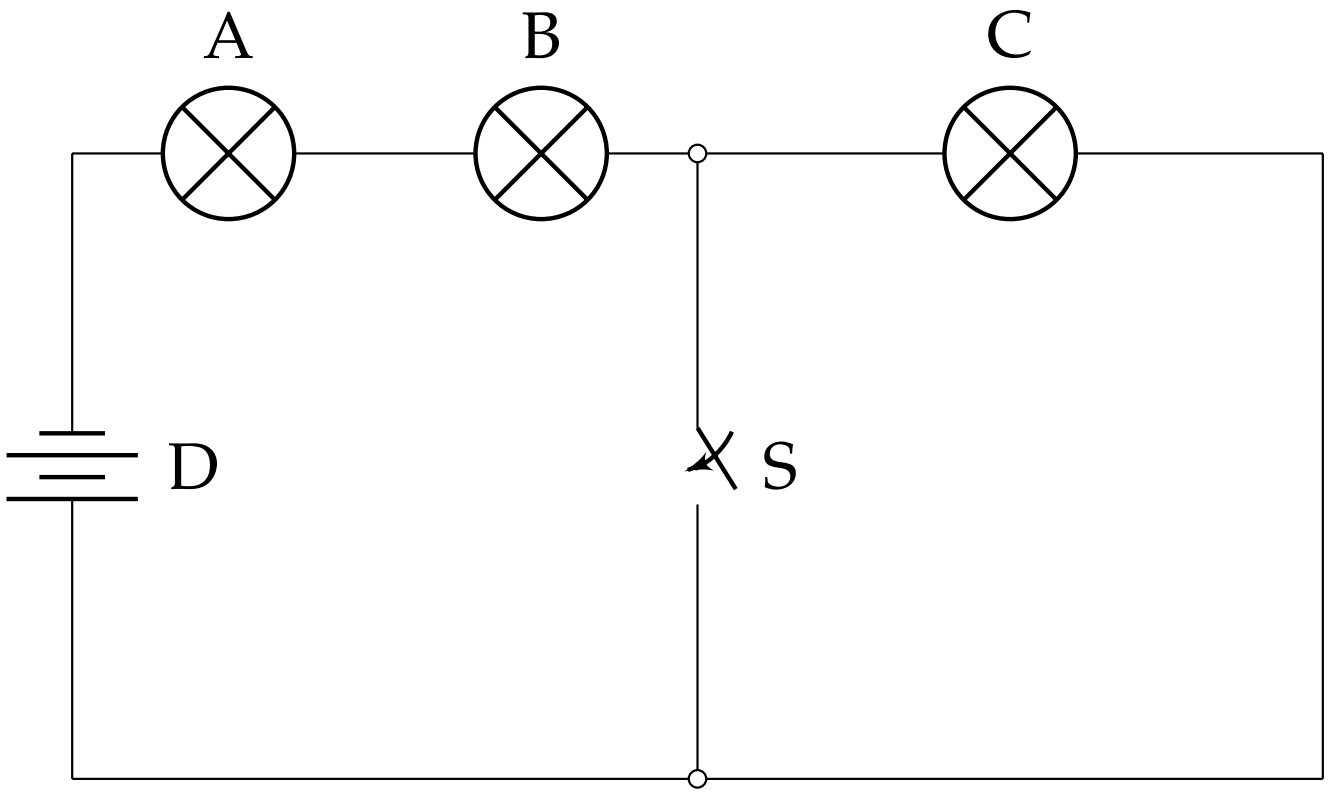
- All science would be superfluous if the outward appearance and the essence of things directly coincided.
- If the way things really are was the same as they look, then science would be unnecessary.
- Karl Marx, edited by Engels, Capital, Volume III (1894), Chapter 48, section III

- All science would be superfluous if the outward appearance and the essence of things directly coincided.
- If the way things really are was the same as they look, then science would be unnecessary.
- Karl Marx, edited by Engels, Capital, Volume III (1894), Chapter 48, section III

Let's check out our physical principles (Thanks to Physical Concepts Inventory)

Big truck hits little car head on. Which exerts the bigger force on the other?

1. Truck on car?
2. Car on truck?
3. Equal?

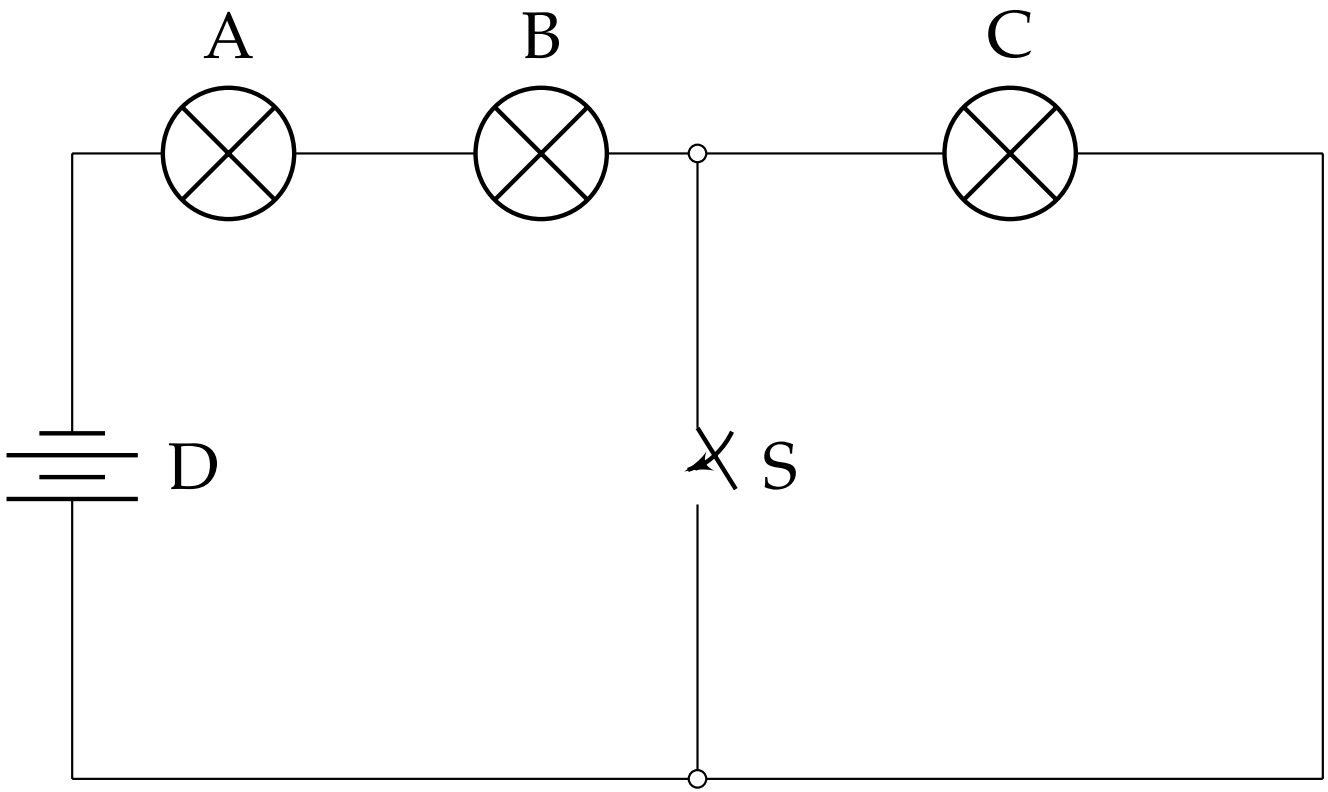


We close the switch:
The brightness of lamps A and B

(a) Increases

(b) Decreases

(c) Stays the same

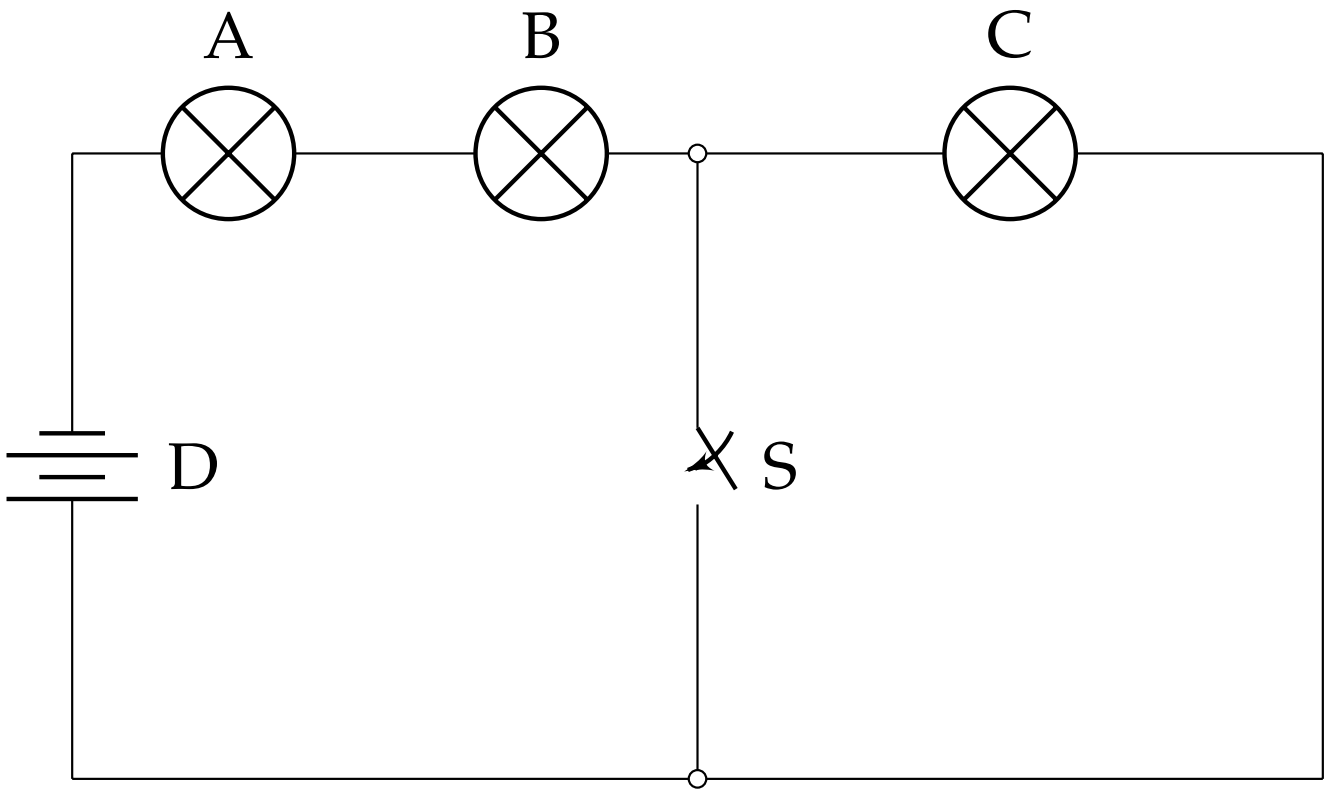


We close the switch:
The brightness of lamp C

(a) Increases

(b) Decreases

(c) Stays the same



We close the switch:
The total power being dissipated in the circuit

(a) Increases

(b) Decreases

(c) Stays the same

Is the Steam Engine important?

Who invented the Steam Engine?

Who invented the Steam Engine?

How did he invent the Steam Engine?

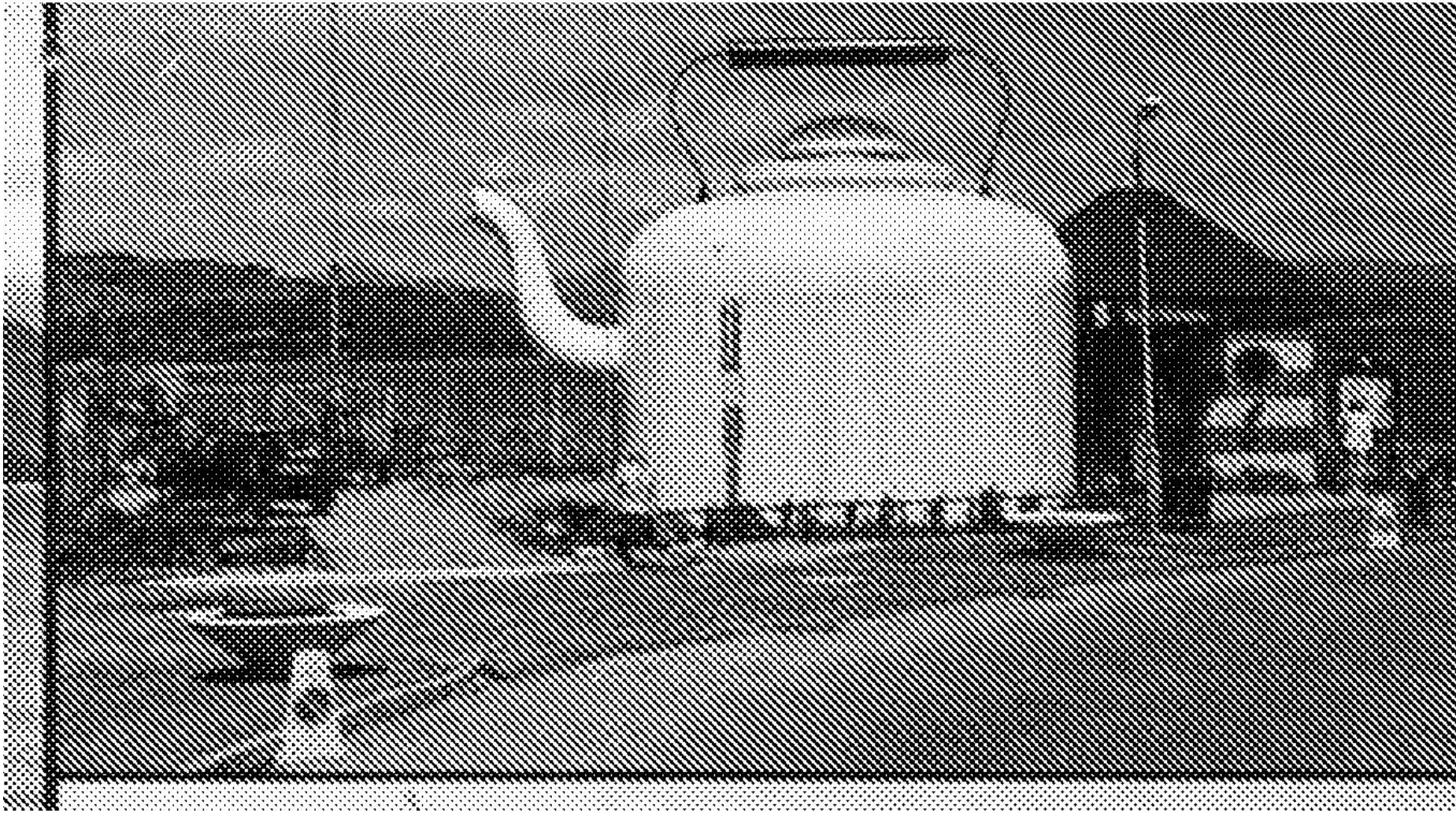
How did he invent the Steam Engine?

How did he invent the Steam Engine?

How did he invent the Steam Engine?

How did he invent the Steam Engine?

How did he invent the Steam Engine?



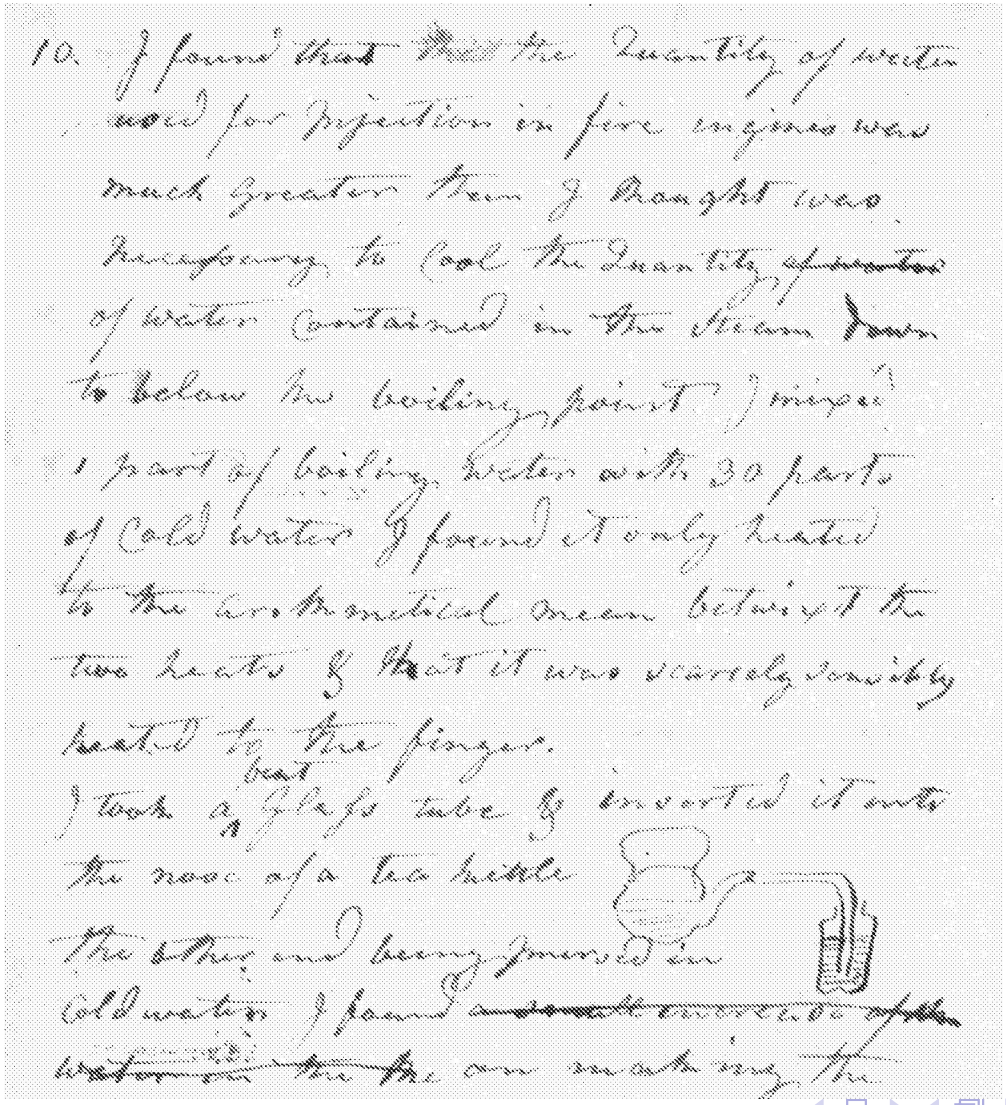
What is the boiling point of water?

Heat a pan of water to 100 degrees. Why doesn't it all turn into steam at once?

"My attention was first directed in the year 1759 to the subject of steam-engines by the late Dr Robinson . . .

He goes on to say that he conducted some experiments on the force of steam "about the year 1761" - by which time he was 25.

The latent heat of steam.



The latent heat of steam.

A Table of the particulars of the foregoing Experiments

No. of Experiment	Quantity of Cold Water in Grains	Temperature of the Cold Water	Weight of the Condensed Steam in Grains	Temperature of the Hot Water	Increase of Heat	Total Quantity of Heat	Latent Heat
1.	17500	43.5°	760	89.5°	46.5°	1159.5°	947.5°
2.	17500	46.5°	708.	86.5	42.5	1136.9	924.9
3.	17500	44.5	899.	98.	54.	1149.1	937.1
4.	17500	44.5	467.5	73.5	29.5	1175.6	963.6
5.	17500	44.5	369.	67.25	23.	1158.	946.
6.	17500	47.5	642.	87.	40.	1177.3	965.3
7.	17500	49.	588.5	84.5	36.	1185.	948.
8.	17500	47.	675.	87.5	41.	1150.5	938.5
9.	17500	48.	682.5	86.5	42.	1166.5	954.5
10.	17500	47.	664.25	85.5	41.	1165.66	953.66
11.	17500	48.	975.	102.	57.5	1134.	922.
1	2	3	4	5	6	7	8

Santral: What do these pictures have in common?

Santral: What do these pictures have in common?

Santral: What do these pictures have in common?

Santral: What do these pictures have in common?

Why 3?
Why not 2 or 4?
Why are the insulators so long?

$$V = IR$$
$$W = VI$$
so
$$I = \frac{W}{V}$$

We want to transmit W watts.

so

We choose to do this at V volts

$$I = \frac{W}{V}$$

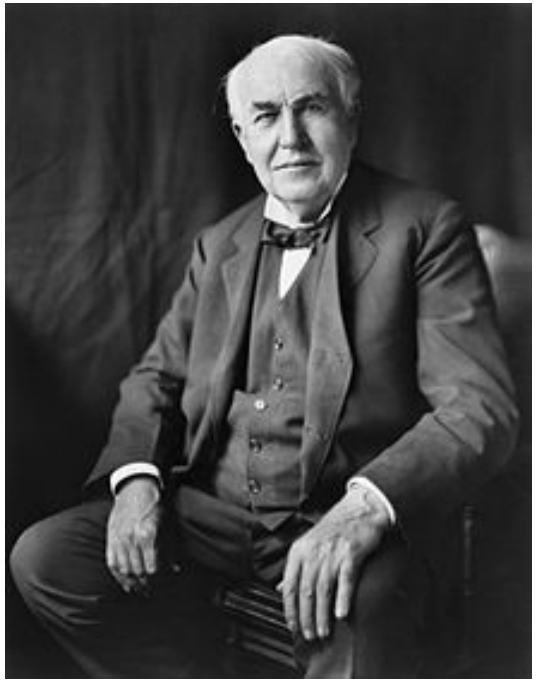
The resistance of our cable is R, so our transmission loss, w, is

$$w = IR = \frac{WR}{V}$$

More volts, less loss.

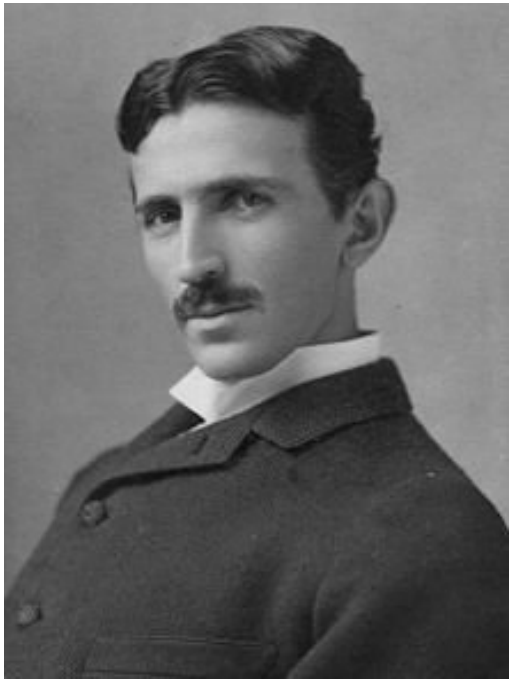
AC/DC
The war of the currents.

AC/DC
The war of the currents.



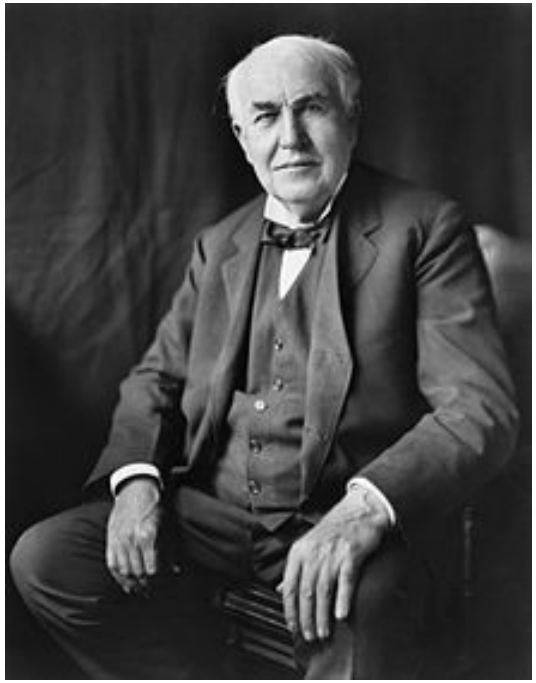
Thomas Edison
Mister DC

AC/DC
The war of the currents.



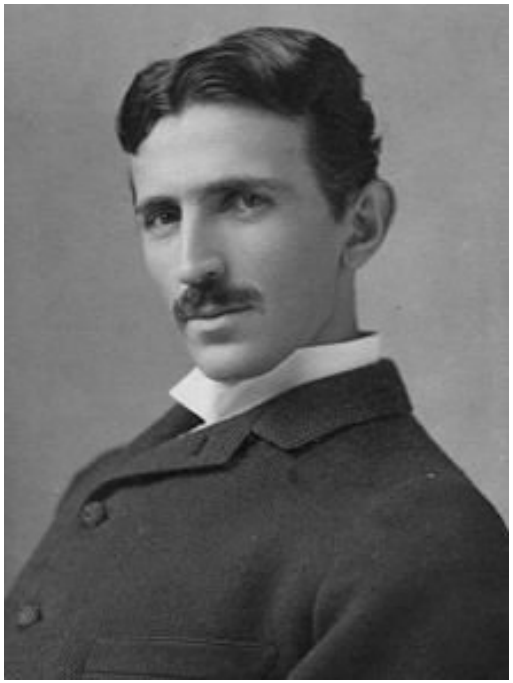
Nikolai Tesla
Mister AC

AC/DC
The war of the currents.



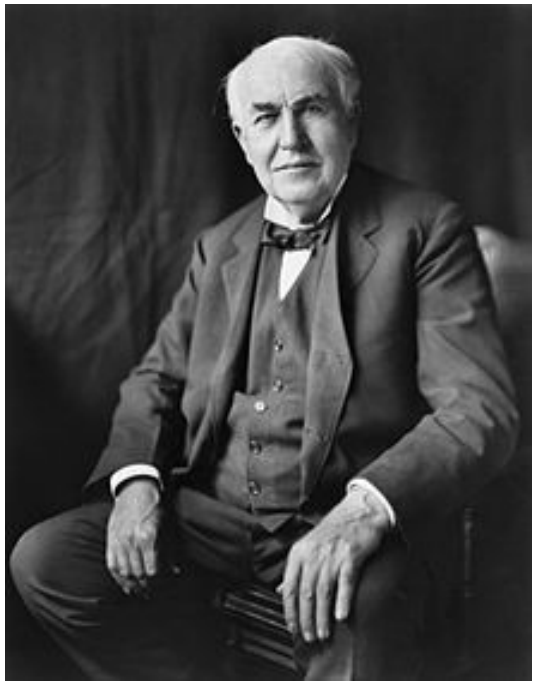
Thomas Edison:
"Solve this problem and I will give you 50,000 dollars"

AC/DC
The war of the currents.



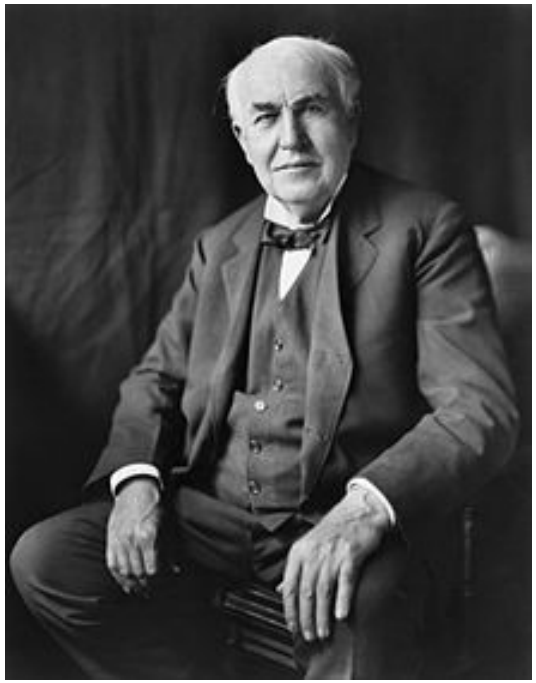
Nikolai Tesla:
"Solved. Where's my money?"

AC/DC
The war of the currents.



Thomas Edison:
"You don't yet understand the American sense of humour"

AC/DC
The war of the currents.



Thomas Edison:
The fate of dogs, cats, Topsy the elephant and William Kemmler.

$$sin(x) + sin(x + 120) + sin(x + 240) = ?$$

Even in 1980, there was still DC generation in the US and the UK.

A beautiful piece of engineering

The Bosphorus Bridge.

A beautiful piece of engineering

The Bosphorus Bridge.
What about its social utility?

What motivated computer hardware design?

1980:
Berkeley RISC project ve DARPA VLSI project.

1985 ARM: “Acorn Research Machines”

ARM: “Acorn Research Machines”
When the first chip was tested, it appeared to be drawing zero current.

ARM: “Acorn Research Machines”
The first chip drew only 0.5 watt

A modern ARM System on a Chip (SoC) -STM32L

- Ultra-low-power mode: 280 nA with backup registers (3 wakeup pins)
- Ultra-low-power mode + RTC: 900 nA with backup registers (3 wakeup pins)
- Low-power run mode: down to 9 μA
- Dynamic run mode: down to 177 μA/MHz

So why are all our computers CISC?

So why are all our computers CISC?
Intel was richer.

ARM: “Acorn Research Machines”
Then “Advanced RISC Machines”.
(Acorn went bust long ago.)
Now ARM

Chips and devices

To date ,
50.000.000.000
ARM processors have been produced

This is a lot more than Intel. Maybe 10 times, Maybe 20. Who knows?

Chips and devices

In 2013
10.000.000.000
ARM processors were produced

Chips and devices

Many of these are “Systems on a Chip”

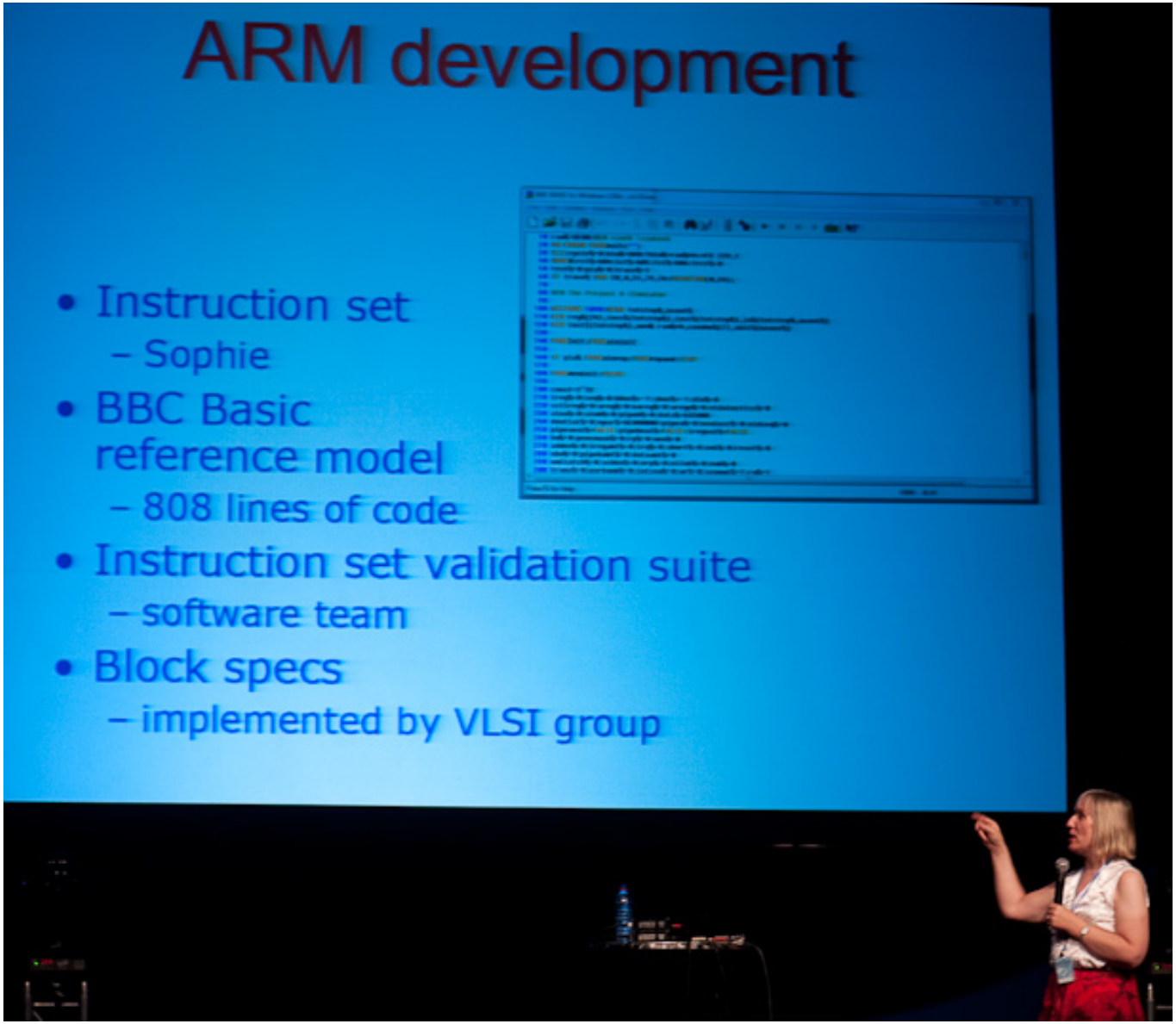
Chips and devices

Which engineer designed

- the original ARM instruction set?
- the very first SoC?
- the Firepath processor in almost every ADSL modem?

Chips and devices

Chips and devices



Good engineering and bad engineering.

Equality

"Equal" games are not always equal.

Equality

"Good engineering" is not an objective criterion in an unequal society..