THE FLASHLIGHT

POLYTECHNIC NOVA GORICA
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FLASHLIGHT DESCRIPTION

- The main function of a flashlight is to provide light when there is no stationary, permanent light source in the observing area, or there is inadequate light source and daylight.

TYPES OF FLASH LIGHTS

- Types of flash light can be defined by their bulb types, which are indeed sources of light:
  - Flashlights with incandescent bulbs
  - LED flashlights
  - Flashlights with fluorescent bulbs
  - Luxeon flashlights (use special, high-output LEDs)

INTRODUCTION - FLASH LIGHT TYPES

- Different types of flashlights exist with wide range of use:
  - fire/emergency
  - safety
  - household
  - law enforcement
  - military
  - sports and outdoors (camping and survival)
  - underwater
  - professional and work flashlights

INTRODUCTION /OUR FLASHLIGHT DESCRIPTION

- our flashlight serves as ordinary household flash light
- small, portable, battery powered lamp
- 20 year-old type
- manufactured by the Yugoslav company Varta

ORDINARY HOUSEHOLD FLASHLIGHT IN SLOVENIA

- There are around 2.000.000 people in Slovenia.
- Approximately every third person has a flashlight.
- People buy a new flashlight approximately every five years.
- The consumption is three batteries per year.
- The electric bulb must be replaced every two years.

PHOTOS WITH IDENTIFIED PARTS

- assembled from 11 different parts
- easily disassembled

FLASHLIGHT DISSASEMBLY

	PART	MATERIAL	MASS per part (g)	TOTAL MASS (g)
1	HOUSING	GALVANIZED STEEL	58	58
2	BUTTONS (2 PIECES)	POLYPROPYLENE	1	2
3	HOUSING FOR ELECTRIC BULB	POLYETHYLENE	4	4
4	LOWER COVERING OF THE HOUSING	POLYPROPYLENE	6	6
5	STEEL WIRE	STEEL	4	4
6	BATTERIES 1,5V (4 pieces)	METAL, PLASTICS, DIFERENT CHEMICALS	68	272
7	ELECTRIC BULB 3,5V	GLASS, METAL, GAS	0,2	0,2
8	UPPER COVERING (lamp covering)	POLYCARBONATE	6	6
9	HOUSING OF THE LAMP	COLORED POLYPROPYLENE	20	20
10	LABEL	ENGRAVED	0	0
11	PACKAGING	PAPER	10	10
12		PVC	1	1

MATERIALS MAIN CHARACTERISTICS

- POLYPROPYLENE AND POLYETHYLENE
  - Polyoleofins, simple polymer structures
  - Have the highest potential for mechanical recycling
  - Versatile and cheap, can replace almost all PVC applications
  - Good electrical and chemical resistance
  - PE is not biodegradable, contributes to greenhouse effect when incinerated
- POLYCARBONATE
  - Usually made with the high toxic phosgene derived from chlorine gas
  - Need solvents for its production
  - Suitable for wide range of products

MATERIALS MAIN CHARACTERISTICS

- PVC
  - Has high environmental and human health costs.
  - During manufacture and disposal emits toxic compounds.
  - Different persistent pollutants could be emitted into air, water and land.
  - PVC products can leach toxic additives during its use or when they are landfilled.
- PAPER
  - Paper is a substance composed of fibers interlaced into a compact web, which can then be macerated into pulp, dried and pressed.
  - PAPER CYCLE: Involved process, from the forest, to the production of paper, to the use and final recovery of the product.
  - Paper production requires high amount of water, a lot of chemicals and trees as a raw material.
  - Based upon wood, paper is biodegradable and recyclable and a source of energy after use.

MATERIALS MAIN CHARACTERISTICS

- **STEEL**
  - metal alloy with major component iron and carbon (usually less than 1%)
  - mechanical characteristics depend on the percentage of carbon
  - high recyclability potential
  - widely used in automotive and construction industries

TYPES OF ELECTRIC BULBS

- Types of bulbs: incandescent bulbs, fluorescent bulbs, LED
- Bulbs can use krypton, halogen, xenon or be HID or vacuum bulbs.
- The amount of energy consumed to warm up a cold filament is less than it would consume in one second of normal operation.
- Incandescent lights are less efficient than other types of lights (lower wattage and lower current).
- Many low-power incandescent bulbs are substantially less efficient than modern high efficiency LEDs.
- Energy consumption is based on a prediction:
  - 7.734 < energy needed for production of electric bulb < 663.400
  - Between energy needed for production of H + P material and energy needed for production of battery (less chemicals and less material needed than for battery)

TYPES OF BATTERIES

- Batteries used for flashlights are not different for any other appliance.
- The most common batteries for flashlights are Ni-Cad, Alkaline and Lithium batteries.
- Batteries for flashlights can also be rechargeable.
- Energy consumption:
  - during life time: **518,4 kJ** (of three batteries each 3V, operating approximate 48 h for electric bulb 3W),
  - in production phase: **66,34 x 10^4 kJ (** approximate calculation from data about energy needed for production of one 25 kWh automobile battery with prediction that our battery needs 100 times less energy),
  - **much higher energy consumption in production phase than during life time.**
- Energy efficiency
  - only 10% of the released energy is used for lightening, 90% is transferred into heat
- Environmental impact
  - harmful emissions during production, elevated risk of accidents
  - several harmful chemicals used
  - disposal problems (hazardous waste)

RECYCLING POTENTIAL

POLYPROPYLENE	high
POLYETHYLENE	high
STEEL	high
POLYCARBONATE	medium
PAPER	high
PVC	low
BATTERIES	none
ELECTRIC BULB	none

ENERGY REQUIRED FOR PRODUCTION
of 1 product from primary source

MATERIAL	ENERGY REQUIRED (in kJ) per 1 kg	TOTAL WEIGHT (g)	ENERGY REQUIRED (in kJ) for a product
POLYPROPYLENE	74.300	48	3.566
POLYETHYLENE	98.000	4	392
STEEL	40.000	62	2.480
POLYCARBONATE	158.000	6	948
PAPER	28.268	10	283
PVC	65.400	1	65
ALL (H +P) (without battery and bulb)	463.968	131	7.734
BATTERY	Calculated	272	663.400
ELECTRIC BULB (EB)	Assumed 7.734 < E (EB) < 663.400	0,2	200.000

ENERGY REQUIRED FOR PRODUCTION
of 1 product from recycled source

MATERIAL	ENERGY REQUIRED (in KJ) per 1 kilo	TOTAL WEIGHT (g)	ENERGY REQUIRED (in KJ) for a product
POLYPROPYLENE	42.300	48	2030
POLYETHYLENE	56.000	4	224
STEEL	18.100	62	1122
POLYCARBONATE	48.100	6	289
PAPER	15.704	10	157
PVC	29.300	1	29
ALL (without battery and bulb)	209.504	131	3.851
BATTERIES	Calculated	272	663.400
ELECTRIC BULB	Assumed 7.734 < E (EB) < 663.400	0,2	200.000

NUMBER OF PRODUCTS CURENTLY IN USE

- Statistical data
  - An average Slovenian family consists of **2,8 members** (Statistical data from Statistical office of the Republic of Slovenia for 2002)
  - Population in RS in 2002: **1.998.519**
  - Number of households in 2002: **684847**
  - Average household: **2,8 persons**
  - An average household has at least **1 flashlight (because of uncertainty we will take 1,5 flashlight per household in Slovenia)**
- Number of products currently in use:

  1,5 x 684847 = 1.027.270,5
- Estimate longevity:
  - 5 years per flash light
  - 4 months per batteries
  - 2 years per electric bulb

ENERGY FOR PRODUCTION

(for 1 product)

Total energy saved if housing and package materials from recycled source:

51,3% or 3883 kJ per 1 product

Energy needed for production per 1 product (flashlight)

- For battery : 663.400 kJ
- For electric bulb: 200.000 kJ
- For housing and package materials:

  7.734 kJ (primary s.) / 3.851 kJ (recycled s.)

WHAT DOES IT MEAN?

- For production of housing and package (H+P) materials we need **3,8 % or 1,9 %** of energy needed for production of electric bulb!
- For production of housing and package (H+P) materials we need **1,16% or 0,58%** of energy needed for production of battery!

WE SHOULD THREFORE CONCENTRATE ON REDESIGNING :

- **First, the production of the battery (energy source)**
- **Second, the electric bulb**

ENERGY FOR PRODUCTION

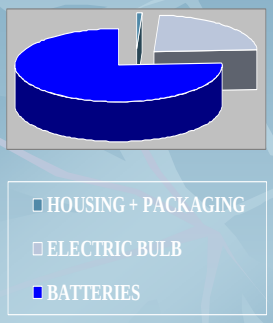
(for products currently in use)

If material (H+P) is from primary source:
7734 x 1.027.270,5 = 7.944.910.047 kJ
= energy from combustion of 184 t of crude oil

If material (H+P) is if from recycled source:
3851 x 1027270,5 = 3.956.018.695 kJ =
energy from combustion of 92 t of crude oil

BUT STILL!
Energy for production of electric bulb:
200.000 x 1.027.270,5 = 205.454.100.000 kJ
= energy from combustion of 4.778 t of crude oil

Energy for production of all batteries:
663.400 x 1.027.270,5 = 681.491.249.700 kJ
= energy from combustion of 15.848 t of crude oil



ENERGY DURING PRODUCT USE

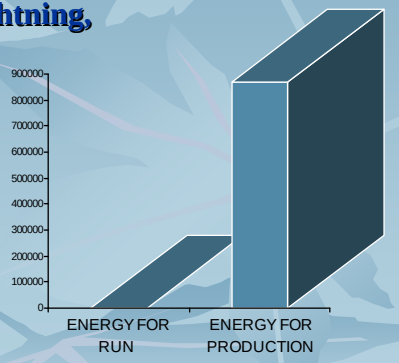
Energy needed for product to run:
518,4 kJ = 0,06% of energy needed for production of flash light (871.134 kJ)

BUT!
Only 10% of 518,4 kJ is used for lightning, the rest is waste heat!

WHAT DOES IT MEAN?

AGAIN:

WE SHOULD CONCENTRATE ON SAVING ENERGY NEEDED FOR PRODUCTION AND NOT ON ENERGY NEEDED TO USE THE PRODUCT!



ENVIRONMENTAL IMPACT OF DISPOSAL

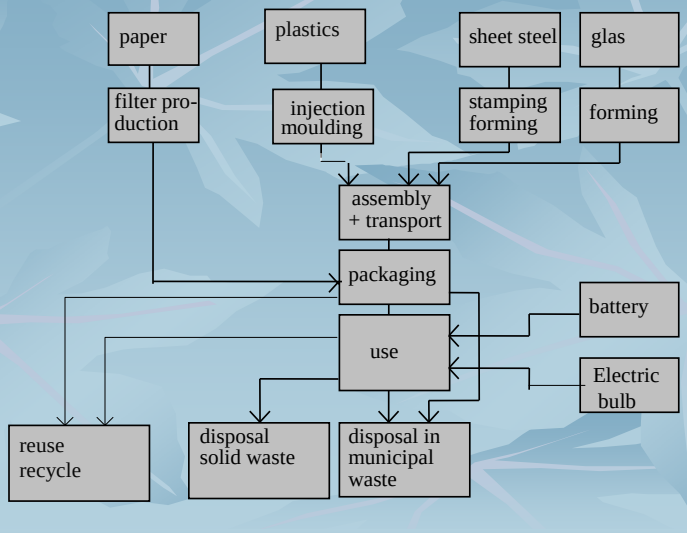
Product disposal

Major problem is disposal of batteries (hazardous waste)

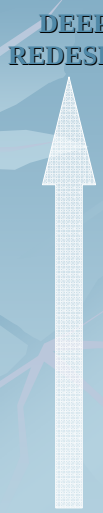
BUT!

- **Batteries are mostly collected and handled separately in environmentally friendly way.**
- **The flashlight's other parts are almost never collected separately. They usually end up with municipal waste.**

SIMPLIFIED PROCESS TREE FOR A FLASHLIGHT LIFE-CYCLE

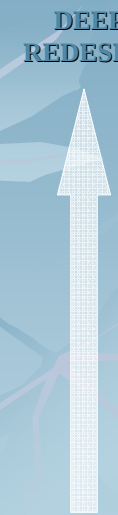


REDESIGN OF BATTERY
(production phase)



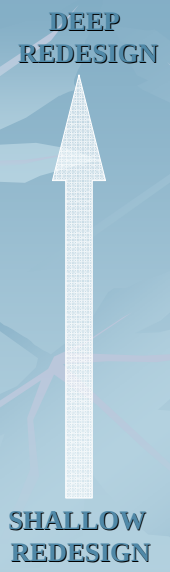
- **USE OF MATERIALS THAT ARE SELF-LIGHTNING** (avoidance)
- **USE OF SUBSTITUTE, ex.** petroleum (avoidance)
- **USE OF SMALLER MORE EFFICIENT BATTERIES,** less energy consumptive (reduction)
- **USE OF RECHARGEABLE BATTERIES** (reuse)
- **COLLECTING BATTERIES FOR RECYCLING** practice that already exists (recycling)
- **COLLECTING AND TREATING BATTERIES FOR INCINERATING** (energy recovery and treatment with removal of hazardous material)
- **SAFE DISPOSAL** (already existing practice with special collecting places)

REDESIGN OF HOUSING
(production phase)



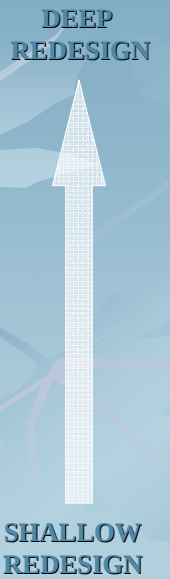
- **USE OF SUBSTITUTE ex.** aluminum or recyclable plastic (avoidance)
- **USE LESS MATERIAL** with smaller flashlight or different construction - where material is not needed for structural or protection reasons (reduction)
- **SINGLE USE FLASHLIGHT** reuse of old housing for making a new flashlight (reuse)
- **USING CLICK AND SNAP SYSTEM,** marking materials with engraving label, not using chemically bonded sticker for easier recycling and collecting housing for recycling (recycling)
- **COLLECTING AND INCINERATING** because polypropylene has lot of embedded energy (energy recovery)
- **SAFE DISPOSAL** already existing practice with special collecting places (disposal)

REDESIGN OF ELECTRIC BULB
(production phase)



- **USE OF MATERIALS THAT ARE SELF-LIGHTNING** (avoidance)
- **USE OF LASER (substitute)**
- **USE OF NEON BULB (avoidance)**
- **USE OF ENERGY SAVING ELECTRIC BULB,** more efficient electric bulb, less energy consumptive (reduction)
- **NOT USING CHEMICALLY BONDED STICKER** for easier glass recycling (recycling)
- **COLLECTING AND TREATING FOR INCINERATING** might not be recommended because of efficiency – high temperature is needed and there may be some hazardous waste (energy recovery and treatment with removing hazardous material)
- **SAFE DISPOSAL**

REDESIGN OF PROCESS
(production phase)



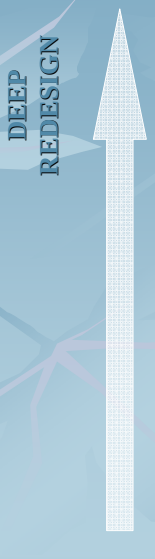
PRODUCTION OF SELF-LIGHTING MATERIALS

IMPROVED OPERATING PRACTICES

TECHNOLOGY CHANGE
- **PRODUCING ONLY SAFE MATERIALS**
- **REDUCING GENERATION OF NON-MARKETABLE BY-PRODUCTS**

INPUT MATERIAL CHANGE:
- **USE OF RECYCLABLE HOUSING RESOURCE – ALLUMINIUM instead of nonrenewable - oil (avoidance)**
- **AVOIDING TOXIC MATERIAL IN ELECTRIC BULB AND BATTERIES**

REDESIGN OF THE PRODUCT



- **OFFERING A SERVICE for borrowing flashlight whenever is needed instead of buying flashlight by every person**
- **USE OF MOBILE – PHONE WITH ADDED FUNCTION: LIGHTNING**
- **USE OF WATCH WITH ADDED FUNCTION: LIGHTNING**
- **USE OF LASER LIGHT AS ADDED FUNCTION** of key holder, for example

REDESIGN OF LIGHTNING

- **USE OF MATERIALS THAT ARE SELF-LIGHTNING** (avoidance)
- **USE OF MOBILE – PHONE WITH ADDED FUNCTION: LIGHTNING**
- **USE OF WATCH WITH ADDED FUNCTION: LIGHTNING**
- **USE OF LASER LIGHT AS ADDED FUNCTION** of key holder, for example

RETHINKING THE NEED FOR LIGHTNING

We should not pollute nature with lightning so there is NO NEED FOR NIGHT LIGHTNING because we can do our activities that demands artificial lightning DURING DAY LIGHT or in case of exploring underground caves we CAN USE CANDLES,….

CONCLUSIONS

Majority of flashlight's energy demands go to production of batteries!

SO!

Our efforts for redesign flashlight in order to achieve sustainability should go to

REDESIGN PRODUCTION OF BATTERY

or

TO INVENT NEW, ALSO ECONOMICALY JUSTIFIABLE, SOURCE OF ENERGY!

Redesign of electric bulb production and dematerialization should be the second priority.