CAVE TECH

A source of light is the most important part of a caver's equipment. In the early days of underground exploration, cavers used flaming torches. These were satisfying to use because (a) it was fire, and (b) cavemen could make one themselves. Flaming torches were unfortunately sometimes a little too exciting to use and produced lots of soot, so cavers tended to die early from passive smoking.

Eventually cavers upgraded to a different source of light, using calcium carbide – normally called just “carbide”. It's a substance which looks like a rock, but when water is added it releases flammable acetylene gas. (Demonstrations can be arranged.) Carbide was satisfying to use because (a) it was fire, and (b) cavers weren't dazzled trying to see past the light because it was positioned out of the caver's view up on their helmet. Unfortunately cavers couldn't make their own acetylene generators, and sometimes carbide was a little too exciting to use – pressurise it to twice atmospheric pressure and it spontaneously explodes. It also smells a bit like garlic and rotten eggs.

Even so, carbide continued to be used by many cavers until the relentless innovation of LED technology advanced to the point where a single LED can easily provide enough light. Very sadly it doesn't involve fire, but once again cavers are able to make their own lights... and why stop with something that only makes just enough light?

Headlamp Ingredients

- 1 LED headlamp housing from a discount variety shop.
- 2 silicone o-rings (the headlamp housing comes with the recess for them).
- 1 push-on/push-off switch.
- 1 glow in the dark button cover.
- 1 GU10 LED bulb housing.
- 3 Cree XP-G LEDs (rated 1.5 A each).
- 3 LED drivers (1 of which has a mode controller).
- A bit of hot melt glue, solder, wire, heatshrink, etc.
- 1 battery box.
- 2 cable ties.
- 4 AA Eneloop NiMH batteries.

Tools

- Pocket knife.
- Soldering iron.

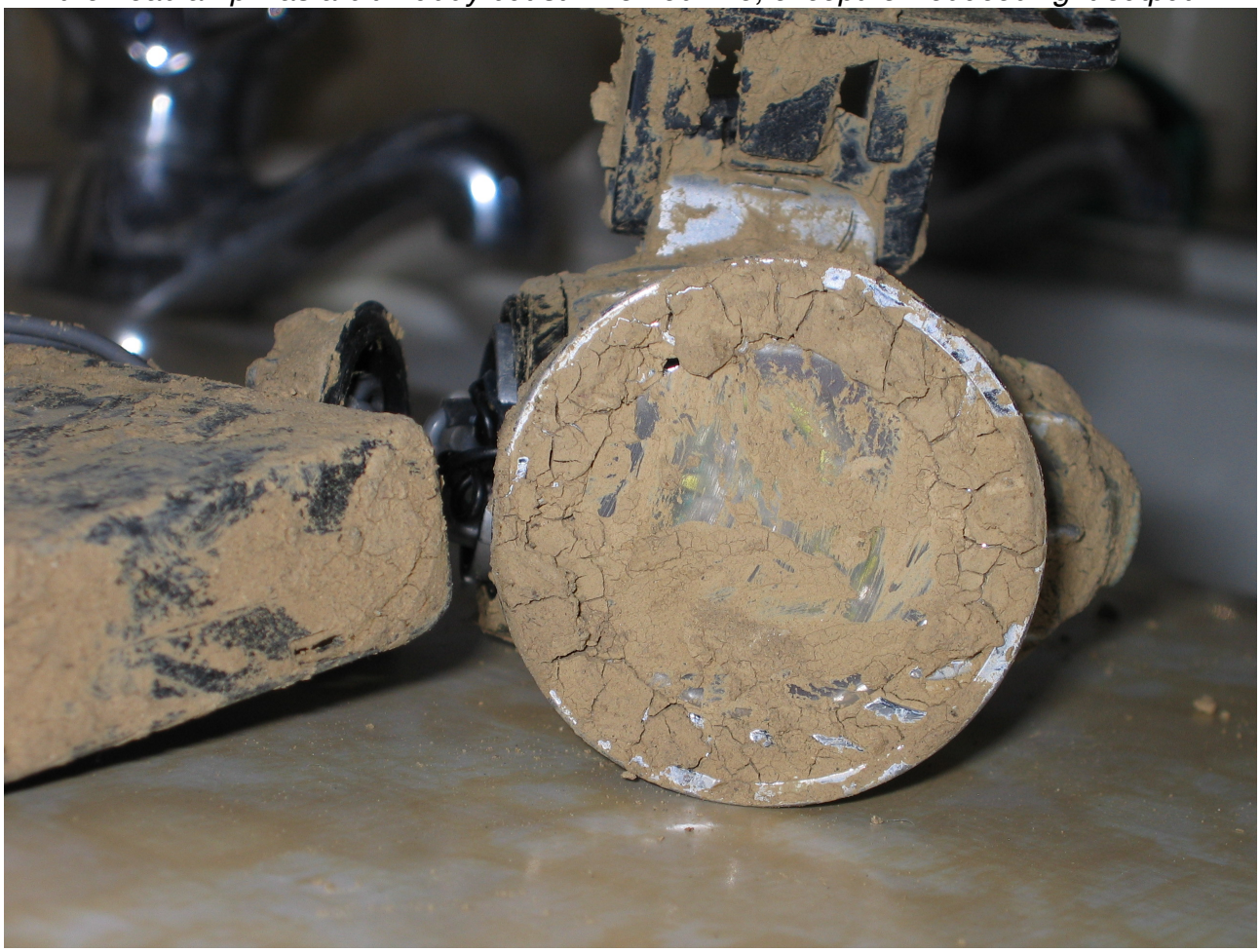
End Result

- Maximum output ≈ 1050 lumens!
- Total cost = **$67** *including batteries*.

Comparable light sources

- Single car headlight and reflector; similar light output and cost, but too big and heavy to mount on a helmet and the battery is *way* too heavy.
- Scurion 1000; similar light output but cost = **$1,408** including batteries. Um... no.

After a through-trip in the cave Bassett Road in April 2011 (typical scene pictured above) the headlamp was a bit muddy but still worked fine, except for reduced light output.



Try Me!

WARNING: BRIGHT!

Each LED has its own driver, but one of the drivers is equipped with a programmable IC and is set up as the master driver which controls the flashing modes on all three. The low and medium modes are actually powering the LEDs at full power (1 amp each) but for only 10% and 35% of the time. Because the LEDs are flashing so fast – 4,700 times a second (4.7 kHz) – our eyes see it as being steady but dimmer.

There are a total of 17 modes in three groups. Some of the modes are repeated in more than one group. Can you find them all?

To change modes turn the headlamp on, then off within 2 seconds, then on again. (The button only needs to be gently pressed, not actually clicked off.)

To change groups get into the low mode in the group then wait a few seconds for the headlamp to blink off briefly. Switch off and on again.

Group 1

- Low (10%).
- Medium (35%).
- High (100%).
- Fast strobe.
- SOS (1 set per 11 sec).

Group 2 (the group normally used)

- Low (10%).
- Medium (35%).
- High (100%).

Group 3

- Low (10%).
- Medium (35%).
- High (100%)
- Fast strobe.
- Police strobe.
- Beacon (1 flash per 3.5 sec).
- Fast beacon (1 flash per 1.4 sec).
- Slow beacon (1 flash per 11 sec).
- SOS (1 set per 11 sec).

Approximate Runtimes and Lumens

- Low ≈ 6 hours, 105 lm. This is the mode I normally use for caving. (It would be 130 lm if a 10% continuous current was used instead of the full current pulsed for 10% of the time because LEDs are more efficient with lower current.)
- Medium ≈ 2 hours, 368 lm.
- High ≈ 30 minutes, 1050 lm.

Final Thought

The programmable IC used to control the modes has more computing power than the flight guidance computer in the Apollo missions that went to the Moon. And it's in a headlamp.