An introduction to o*ptics* in torches

In this, and all my articles, I use the word "torches" to describe a hand held, self powered, electric lighting device.
Most people from outside of the UK would use the word "flashlight" to describe this device.
To clarify; in this context "torches" and "flashlights" are one and the same.

The word *Optics* is given to the area of physics concerned with the characteristics, behaviour and properties of light. This also includes the construction of instruments used to detect or manipulate the light.

In the context of torches, *optics* is generally understood to describe the means by which the torch manipulates the light given off from the LED or bulb into a desired beam pattern.
There are many ways of doing this depending on the beam pattern required, the size of the torch and the characteristics of LED being used.

The most common *optics* used to focus the torches beam is the *parabolic reflector*, but other lenses are frequently used for specific needs.

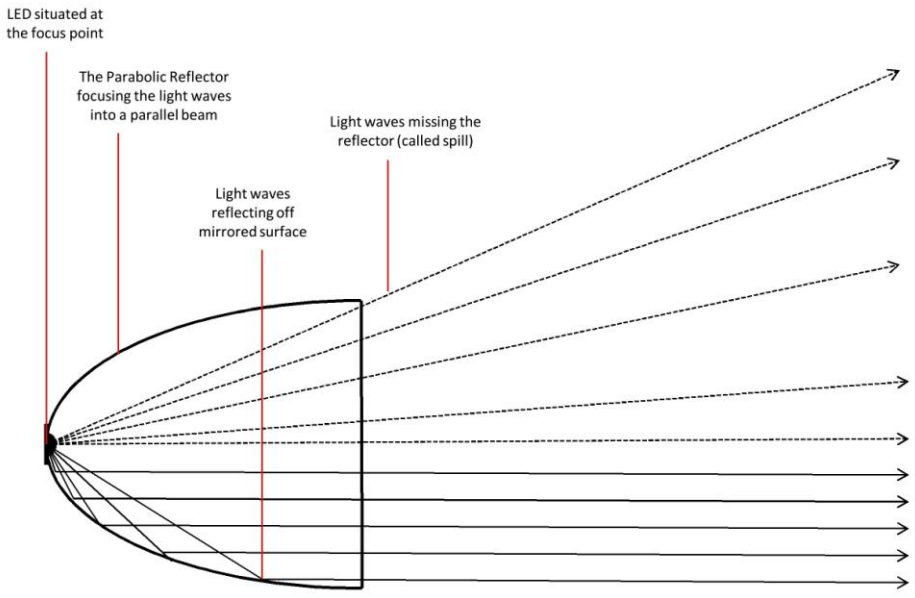
Definitions of common optics used in torches

- Lens: A lens is an optical device which captures and manipulates light waves by way of *refraction* to create a desired beam pattern.
- TIR optic: A TIR optic (or lens) is an optical device which captures and manipulates light waves by way of *total internal reflection* to create a desired beam pattern.
- Reflector: A reflector is an optical device which captures and manipulates light waves by way of *reflection* to create a desired beam pattern.
- Window: A window is a simple transparent cover which sits in front of the reflector or lens to protect it, but does *not* manipulate or affect the beam pattern.

The Parabolic Reflector

The Parabolic reflector or to give it its correct name, the *paraboidal mirror* sits behind a protective clear plastic or glass window which is intended to let the light pass through it without effecting the beam pattern.

The light waves emitted from the LED light source, at the focal point of the reflector, contacts the mirrored surface and is reflected forwards in a parallel beam pattern. The wider and deeper the reflector the more of the light waves are captured and reflected forwards (collimated). This results in a tighter beam with greater throw and less spill, which means the beam covers a greater distance with less peripheral lighting.



The top half of the reflector diagram shows some of the light waves missing the reflector and the bottom half shows some of the light waves hitting the reflector and being reflected forwards in a parallel beam pattern

The wider and deeper the reflector the more light waves are captured and reflected forwards into a tight beam pattern (colliminated). This would offer greater throw (distance) and less peripheral lighting (spill).

The surface of the reflector can vary between smooth/polished (SMO) or orange peel/textured (OP). The more highly polished the surface of the reflector, the further it will throw the light due to the beams running perfectly parallel. The textured surface (OP) will give a smoother beam pattern, blending in the hot spot, any imperfections and offer more spill, but at the cost of some throw.

The correct set up

The reflector and window need to be manufactured from quality materials and be designed and finished to a high standard to offer the best and most accurate beam pattern.
The shape of the reflector and surface finish has to be accurate or light waves won't be reflected in the correct direction. If the LED is not correctly set at the focus point, the reflector won't work as efficiently. Poor set up will result in lower lumen output, reduced throw and a poor beam pattern.

The correct light source

Reflectors are fairly forgiving which is why they are universally popular and work efficiently with both Incandescent bulbs and LEDs.

This article is not yet finished.
The TIR optic & Aspherical lenses will follow shortly