

CONTENTS

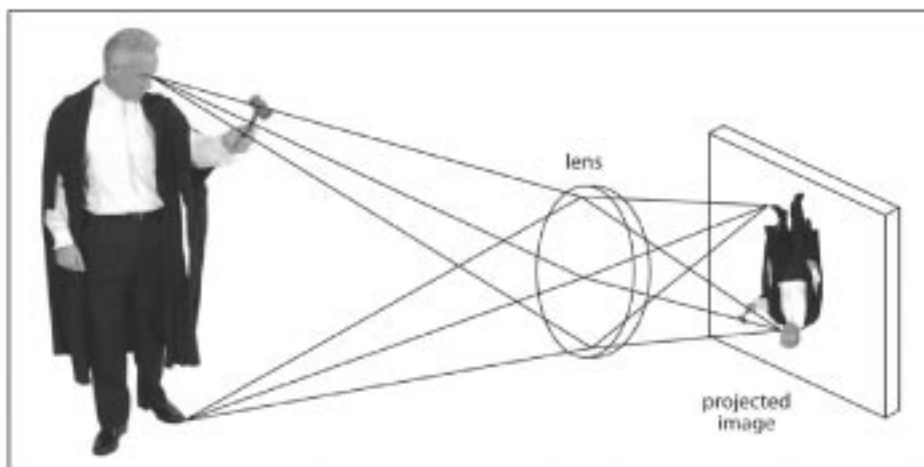
About the Author	4
Foreword	5
Introduction: A brief history of design	7
Chapter 1. Eyes and sight	23
Chapter 2. Other senses	41
Chapter 3. Colours and patterns	53
Chapter 4. Flight	63
Chapter 5. Navigation and orientation	83
Chapter 6. Catapults	95
Chapter 7. Stickiness	105
Chapter 8. Magnificent materials	113
Chapter 9. Plant power	125
Chapter 10. Motors	131
Chapter 11. The origin of life	147
Chapter 12. What about 'poorly designed' things?	191
Chapter 13. Why are there 'bad things' in nature?	219
Chapter 14. Objections to design	225
Chapter 15. Cosmic design	237
Chapter 16. Who is the Designer?	241
Index	247

CHAPTER 1

EYES AND SIGHT

One of the most important senses is sight: it is our main means of sensing objects at a distance and quickly analyzing a wide area of our surroundings. The organ of sight is of course the eye, and this has long been popular as a design argument. This chapter shows how eyes both parallel our own optical instruments, and surpass them. New discoveries of the information processing in the eye itself, before the brain even receives the image, add to the complexity. Also, there are a number of very different ways that organisms form images of their surroundings. Finally, evolutionary scenarios are addressed.

EYES AND CAMERAS



Focusing with a lens: light from any one point of the object corresponds to just one point of the image.

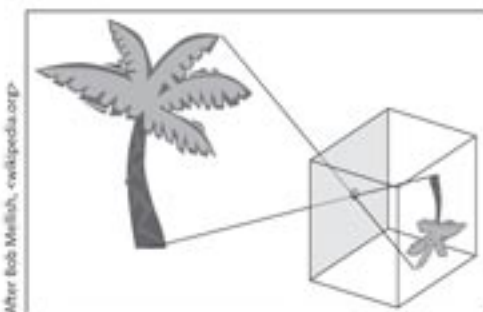
William Paley, in his classic *Natural Theology*,¹ compared the eye to obviously designed instruments such as the telescope and camera.² Their function is to produce an image, where *every point has a one-to-one correspondence with a point on the object* (see diagram above). If one point on the object links to more than one point on the image, the image is blurred.

In a camera, there is an *aperture* to admit light, an *iris diaphragm* that can change the size of the hole to control the amount of light entering, a *lens* to focus the light, and the *film* to capture the image. Similarly, our eye has a *pupil* to admit light, an *iris* to enlarge or

1. Paley, W., *Natural Theology; or, Evidences of the Existence and Attributes of the Deity*, ch. 3, 1802; <www-personal.umich.edu/~emcarley/paley.htm>.

2. Actually, he discussed the *camera obscura* (Latin for 'dark room'), a forerunner to our camera and the reason for the name. This comprised a darkened chamber or box, into which light is admitted through an aperture and focused by a double convex lens. This forms a temporary image of external objects, on a surface of paper, glass, etc., so in this respect is closer in design to our eyes.

contract the pupil to control the amount of light, a *lens* to focus the light on the *retina*, which is full of photoelectric cells that convert the image to electrical signals. The lenses are somewhat different; the camera focuses (varies the focal length) by moving the rigid lens, while our lens has a fixed position and its shape is changed to vary the focal length.



After Bob Mullish, wikipedia.org

Focusing with a pinhole camera.

A simpler design is the *pinhole camera*. This achieves the one-to-one correspondence simply because the hole is tiny enough so that light from a point on the object is in a straight line only to one point on the screen. This phenomenon has been known since ancient times—Aristotle (384–322 BC) and Euclid (fl. 300 BC) wrote about

the sharper images seen through naturally occurring tiny holes, such as the slits in wicker baskets.

However, because the tiny hole cuts out so much light, the pinhole camera requires bright light. Enlarging the hole to admit more light blurs the image, by allowing light from one point to travel to more than one point on the screen. Hence the camera and eye combine variable opening with a variable lens.

However, as will be seen, the eye has very many complex features that leave the camera far behind. After all, the eye must also be able to repair itself and be connected to an *information processing system*. Also, the living world reveals many ingenious solutions both to the problem of forming a clear image, and processing the information.

The next section will cover some of the design features of the individual components of the eye; followed by some case studies of design in nature; and concludes with analysis of evolutionary scenarios.

THE EYE'S COMPONENTS

Cornea: amazing transparency

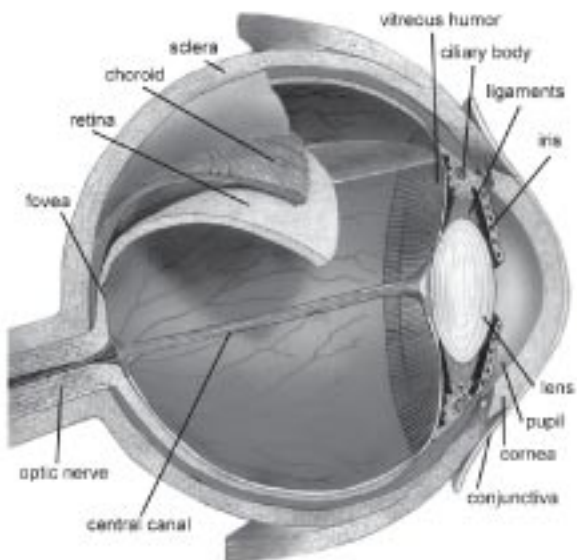
Essential for the eye to work is the *transparent window*. Not surprisingly, this is easy to overlook, since we take it so much for granted. However, it is not so easy to make something highly transparent from biological materials. It is especially important, because the cornea also provides about $\frac{2}{3}$ of the focusing, while the lens provides only $\frac{1}{3}$, but this is variable while the cornea is fixed.

The cornea is of a unique tissue type: it has no blood supply, so nutrients are supplied by the tears. It obtains its oxygen by direct contact with the air—this is why contact lenses should be permeable

to oxygen. It has one of the highest nerve densities of any tissue in the body, hence its great sensitivity to touch.

The best explanation for the cornea's transparency is *diffraction theory*, which shows that light is not scattered if the refractive index³ doesn't vary over distances more than half the wavelength of light. This in turn

requires a certain very finely organized structure of the corneal fibres, which in turn requires complicated chemical pumps to make sure there is exactly the right water content.⁴ This ceases at death; hence the eyes then become cloudy.



Light detection

Many evolutionary accounts, starting with Darwin, basically commence by saying, 'Assume a light-sensitive cell'. However, Behe has shown that even a 'simple' light-sensitive spot requires a dazzling array of biochemicals in the right place and time to function. He states that each of its 'cells makes the complexity of a motorcycle or television set look paltry in comparison'. His following description, although written for a semi-popular audience, describes a small part of the eye's complexity:

'When light first strikes the retina a photon interacts with a molecule called *11-cis-retinal*, which rearranges within picoseconds to *trans-retinal*. (A picosecond [10^{-12} sec] is about the time it takes light to travel the breadth of a single human hair.) The change in the shape of the retinal molecule forces a change in the shape of the protein, rhodopsin, to which the retinal is tightly bound. The protein's metamorphosis alters its behavior. Now called metarhodopsin II, the protein sticks to another protein, called transducin. Before bumping into metarhodopsin II, transducin had tightly bound a small molecule called GDP. But

3. The refractive index (n) of a substance is given by $n = c/v$, where c is the speed of light in a vacuum, and v the speed of light in the substance.

4. Gurney, P.W.V., *Dawkins's Eye Revisited*, *J. Creation* 15(3):92-99, 2001.

At last, a definitive work on design by a leading biblical creationist

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