2. Steven Pinker, *The Language Instinct*, Allen Lane, London, 1994, quoting p. 405.
3. Raymond Gaita, 'Truth and the Idea of a University', *Australian Universities Review*, 40, 2, 1997, pp. 13–18.
4. The reader might like to consult Martin Bridgstock, David Burch, John Forge, John Laurent and Ian Lowe, *Science, Technology and Society: An Introduction*, Ringwood, Victoria, Cambridge University Press, 1998.
5. 'First it was ewe 2, now meet moo 2', *Courier Mail* (Brisbane), 22 January 1998.

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Climbing Mount Improbable

Richard Dawkins

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This book lies squarely in the Darwin/Wallace/Fisher tradition. Ever since the Darwin–Wallace theory was accepted, emphasis has been placed on evolutionary change and on natural selection as the primary agent of that change. Dawkins writes within this framework, although, if we look at a broader view, it is evident that evolutionary change has been so slow that humans were unaware of it until the advent of the industrial revolution, when fossils were unearthed in ways never before contemplated. Now that we can see the 'long view', we know that change has occurred and we perhaps forget to remember that those changes occurred as the dynamic balance between life and its abiotic environment changed very slowly over time. Natural selection is an agent more of stability than of change; it operates as a negative feedback system. Evidence for this is provided by the metaphors recorded by Darwin and Wallace as having assisted them in constructing the principle of natural selection. Wallace[1] writes:

> The action of this principle is exactly like the centrifugal governor of the steam engine, which checks and corrects any irregularities almost before they become evident ... (p. 62)

Darwin cites the picture of a hundred thousand wedges all being forced into a limited surface area[2]. If one goes in further, another must come out. The problem today is that the human wedge, owing to our access to energy supplies never intended for our use, now penetrates that surface and takes up a share never possible in a proper state of nature.

Although Dawkins is mainly concerned with evolutionary change, his last chapter looks at some of the balances operating in nature.

With respect to Fisher, mentioned alongside Darwin and Wallace above, I have to say that I doubt that he would agree with Dawkins claims concerning 'selfish' genes. In his 1918 paper, R. A. Fisher showed the continuous evolution could result from a population of discrete units (genes) giving evolutionary change a statistical basis[3]. This approach is adopted by Dawkins despite his emphasis on single genes. In fact, the example of sickle-celled anaemia discredits the latter approach. A double dose of this gene is lethal, but with a proper balance, the population minimises the impact of malaria. Laurie Garrett, in her book *The Coming Plague, Newly Emerging Diseases in a World Out of Balance*, shows time and time again that nature or natural selection had minimised disease impact prior to technological interference[4].

Dawkins explains clearly that evolution is not a chance process; that only mutations occur by chance; and that the selective process is directional and leads to adaptations that are finely tuned. He uses computer models to illustrate his claims, but never fails to draw on actual real life examples as well. The illustrations (by Lalla Ward) are numerous, relevant and well worth perusing.

Dawkins' models assume random mutation for a limited set, e.g. 3 characteristics. In reality different alleles mutate at their own specific rate, or at least they did before we added radionuclides and mutagenic coal tar products to our environment.

Dawkins introduces a new term which is relevant and interesting. He describes the products of selection as 'designoid' (design-oid). They are the products of design, but not conscious design. Natural selection has been described by others as having an immanent teleology. It serves a purpose; it leads to adaptation. The 'creations' of natural selection are 'designed' by nature, because they are selected, though they depend also on the mutations available. The selective process is inherently negative; most mutations are rejected. This is not surprising and Dawkins makes this clear. 'If you start with something pretty good and change it at random, the chances are that you'll make it worse. (p. 74) If a musician playing in an orchestra plays a wrong note, most of the time the result will be disharmonious, because harmony has been sought by the composer, conductor and players. Nature selects for harmony and stability as far as possible given the dynamic nature of abiotic factors. Biotic factors serve as regulators as for instance in the nitrogen and sulphur cycles.

Although Dawkins looks at spider webs, sea shells, and axes of symmetry, his most significant chapter, for readers in a world where evolutionary theory is still challenged, details evidence concerning the evolution of the human eye. As readers of *Prometheus*, you probably accept evolutionary theory, but it may not be the case that all of those that you teach, or have contact with, do so. Dawkins shows quite clearly that eyes have evolved many times; that eyes at almost every stage of development can be found in existing species; and that each improvement moves them towards a better possible solution. Mount Improbable cannot be scaled via the cliff face, but it is easy to climb on the other side by a gradual slope along which natural selection directs the evolutionary process. If this book had no further value, its merit in this regard would ensure its importance. It should be cited to all doubters.

Both of the chapters, *Getting off the Ground* and *The Museum of All Shells*, are reminiscent of D'Arcy Thompson's *Growth and Form* and call for further puzzle solving within this paradigm[5]. Biology continues to be computerised and mathematised.

I found the chapter on the co-evolution of the fig and the wasp, on which it depends for fertilization, particularly interesting. Dawkins writes: 'The wasps depend totally on the fig for food and the fig depends utterly on the wasps to carry its pollen. Each species would promptly go extinct without the other'. (p. 274) Selection adapts the fig to the wasp and the wasp to the fig; they co-evolve and co-adapt. They form a system in balance. Contrary to Dawkins on claims (particularly in *The Selfish Gene*), it is not on genes that selection acts, but own systems. While I agree that it is genes that are selected, selection takes place at the genetic level, at the phenotypic level, at the species level, etc., and perhaps most importantly, at the ecosystem level.

If the DNA of an elephant didn't produce a phenotype that was viable, then that DNA combination would not be reproduced in elephants. As Dawkins says, each elephant gene 'plays a part in a cooperative building of the machinery that they all need for their program execution'. (p. 271). But if the combination of a sub group fails in the elephant, that same combination need not fail in a different species; that same set of genes might be present in the successful phenotype of a different species. Genes only survive in certain combinations. This argument can be extended to higher levels of organisation.

Cells can do things that proteins can't; tissues can do things that cells can't; organs can do things that tissues can't; organisms can do things that organs can't; groups can do things that individuals can't and ecosystems can do things that individual groups can't. Selection takes place at all levels.

Populations sizes within ecosystems in balance are usually stable. The ecosystem functions properly when each species is present as a particular proportion of the biomass. In the case of the fig wasps, males occur as either winged or wingless, and Dawkins recognizes here that '[w]hatever the equilibrium proportion may be, natural selection keeps pushing the population back towards it' (p. 283).

Despite this admission, Dawkins tells us that: 'A dung beetle scavenges dung and buries it for food. The fact that she and her kind thereby perform a cleaning-up and recycling service is valuable to the other inhabitants of the area is strictly incidental' (p. 246).

John Postgate[6] expressed a different view:

> ... atoms of carbon, hydrogen, oxygen, sulphur, phosphorus, calcium, iron, magnesium, cobalt, and so on would be undergoing cyclical transformations, none of which would occur in a world without living things. It is on these cycles of chemical transformation that the economy of life depends. If a step in the nitrogen, sulphur, or carbon cycle ceases to occur, as may sometimes happen in certain limited environments, the element concerned rapidly accumulates in a biologically useless form, and creatures living in such an environment either die or become dormant until conditions change. (p. 58).

Wynne-Edwards[7] makes the same point:

> In all but a few restricted ecosystems organic wastes are disposed of at the same annual rate as they are produced. This incidentally implies that organisms are debarred from synthesizing substances that none of the decomposers can liquidate. Any one that did evolve impossibly refractory or non-detoxifiable materials might eventually be smothered in its own litter. (p. 50)

What this means is that the wastes of every species within the ecosystem become the food for other organisms within that system. Everything is recycled.

Readers of *Prometheus* may be more familiar with applying systems theory to information systems than to biological systems, but biological inheritance is, in reality, the most important information system on earth.

Reference

1. A. R. Wallace, 'On the tendency of varieties to depart indefinitely from their original type', *Journal of Proceedings of Linnean Society, Zoology*, III, London, 1859.
2. C. Darwin, Notebook D, 135 e, in G de Beer *et al.*, 'Darwin's notebooks on transmutation of species, Part IV, pages excised by Darwin', *Bulletin of the British Museum (Natural History), Historical Series*, 3(5), London, 1960.
3. R. A. Fisher, 'The correlation between relatives on the supposition of Mendelian Inheritance', *Trans R. Soc. Edinb.*, 52, 1918, pp. 399–433.
4. Laurie Garrett, *The Coming Plague, Newly Emerging Diseases in a World Out of Balance*, Harmondsworth, Penguin, 1994, 1995.
5. D'Arcy Thompson, *On Growth and Form*, J. T. Bonner, Ed. Abridged Edition, Cambridge, Cambridge University Press, 1966.
6. John Postgate, 'The Sulphur Bacteria', *New Biology*, 17, Harmondsworth, Penguin, 1954.

7. V. C. Wynne-Edwards, *Evolution Through Group Selection*, Blackwell Scientific Publications, 1986.

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From Steam to Space: Contributions of Mechanical Engineering to Canadian Development

Andrew H. Wilson, (Ed.)

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As a power systems electrical engineer interested in the history of modern engineering I found this book of commemorative essays on the development of mechanical engineering in Canada, interesting and at times fascinating. In a sense the contributions by academics and engineers gave an impression of subdued religious fervour as they help celebrate the 25th anniversary of the Canadian Society of Mechanical Engineers. But then this is what it is all about, pride in one's profession and a particular discipline and the need to publicise the contribution mechanical engineering has made by way of research, education and practice to the development of Canada as a nation. It would do no harm if we in Australia followed suit to tell what engineering has achieved for this country. Those who conceived the project and brought it to fruition obviously gave it a great deal thought and effort. They are to be congratulated.

The book is divided into two parts. The first part consists of 25 essays which are in essence historical perspectives of the impact of mechanical engineering on transportation (rail, aeronautics and automobiles), agriculture, power generation and education, set in the context of the Canadian experience over some 150 years. The second part of 10 essays is concerned with the history, organisation and activities of the Canadian Society of Mechanical Engineers. Obviously I cannot comment on all these contributions much as I would like. Hence, my intention is to concentrate on the historical aspects, as in some ways it has many parallels to that of this country.

The first essay is 'a scene setter' in that it surveys the concept of engineering through the ages and the emergence of mechanical engineering as a discipline. Like Australia, the economic development of Canada was characterised by the exploitation of primary agricultural and mining products and their export to the United Kingdom and Europe with minimum processing while importing know how from them and the United States. To this end the first series of essays are of the pioneering work of the 19^{th} century engine foundries of eastern Canada in the production of marine steam engines for river and coastal boats, steam engines for the railways, and stationary engines for timber milling, mining and water pumping. Of significance is that Canada was a frontrunner in the building of steam vessels. As early as 1809, two years after Robert Fulton launched the first successful commercial steam boat, the vessel, the '*Accommodation*', of Canadian origin, was plying the waters of the St Lawrence River for trade. By 1834 the local industry was capable of producing marine engines of sufficient power to drive an ocean going steamer. The '*Royal William*', constructed in Quebec and towed to Montreal for the fitting of the engines, was the second ship to cross the Atlantic part way by steam.