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INTELLECTUAL TOOLS FOR THE YEARS AHEAD

## *The Pattern on the Stone*

W Daniel Hillis, Basic Books 1998

Many years ago as a physics postgraduate I heard some stories about Daniel Hillis, the *wunderkind* who created the massively parallel computer the Connection Machine and co-founded Thinking Machines Corp. One story has it that the night before a final physics exam Hillis asked his college roommate what the required textbook was. Aghast, the roommate said, 'There's a final tomorrow!' gave him the book and continued to study his notes. Soon, Hillis started asking questions. 'From the first couple of questions, I knew Danny was in trouble. As time passed and the questions changed, I knew *I* was in trouble!' The next day, Hillis scored an 'A' and his roommate a 'B'.

Another story has it that he once built a wetsuit with an outboard motor on it so that he could power across a lake standing upright. From the shore it would look like he was walking on water.

Whether or not these stories are true (and even if they are not they *should* be), they engagingly encapsulate the unorthodox approach of Daniel Hillis, especially to computers and computing. He is one of the world's leading computer scientists, so his book is a great opportunity to see what is on, and in, his mind.

*The Pattern on the Stone* is a compact, highly readable book about computers, written for people who are interested in the essential *ideas* involved in computing, not how to use, program or build them. Part of what makes this book so readable is the way in which Hillis takes sometimes complex ideas making them understandable without over-simplifying. He has the assurance of someone with an in-depth knowledge of his subject and can think, operate and explain it at any level, while preserving the essence. Also, it is a great deal of fun! There are numerous anecdotes scattered throughout, most of which are very instructive, and all of which are enjoyable.

The book begins with the story of his childhood attempt to build a robot. After a while he could get it to move and make noise, but he didn't know how to get his machine to think. So he read a book by the 19th century logician George Boole (*An Investigation into the Laws of Thought*) which so fired his imagination that he has pursued the goal of getting a machine to think ever since. From this beginning, he takes us in stages through most of the essentials in computer science — Boolean logic, programming languages, compilers, interpreters, Turing machines, algorithms, information theory, quantum computing, neural nets, parallel computers and self-organising systems. Rather than go into great detail he shows how these topics all fit together, and that is the strength of the book. If you have ever wondered about computers and how or why they work but wanted to avoid reading academic textbooks, then this is a book for you.

There are nine short chapters in all, each dealing with some essential aspect of computing, and each building upon the previous one. A couple of these are a little abstract but, in all, the material is easy to follow. It is remarkable that in a very short time we go from his descriptions of a computer he built out of sticks and strings (chapter 1), to designing (and teaching) computers which are able to learn from their mistakes (chapter 8).

Hillis is very keen on the power of parallel computing. Essentially, this means that instead of having just one processor carry out instructions one at a time, many processors are linked together (parallel to each other) and work in concert. The power that can be unleashed is astonishing, and these days it seems a very obvious thing to do. But originally Hillis had tremendous difficulty getting funding to build his first large parallel computer (with 64,000 processors) because people kept shooting the idea down without thinking it through. Today, his Connection Machine is used far and wide in universities, government and industry whenever *serious* speed is needed. There is a lesson here. Novel solutions and quantum leaps do not come from orthodox thinking, nor do they come from those who fail to look beyond the obvious and

easily extrapolated. The future belongs to those who are willing to seriously look into it.

Parallel computing need not have all the processors in the one machine either. Hillis notes (p 120), for example, that the computers networked together via the internet have 'a potential computational ability that far surpasses any individual computer that has ever been constructed'. Since the book was written last year, this idea has reached fruition: the University of California, Berkeley, is currently undertaking a planet wide parallel computing project. Hundreds of thousands of people across the internet have downloaded and use a simple screen saver program to analyse (in otherwise idle computer time) sections of data coming from a radio telescope in order to search for possible intelligent signals from deep space. This is an inspired use of massively parallel distributed computing across the internet, and an equally inspired and brilliant way for the general public to get involved in big science.

In the last chapter, we come to a discussion of some of his current research — the forward looking work that is the essence of science. Instead of simply trying to *write* better programs (something which Hillis believes is a losing game), he is experimenting with *breeding* better programs — using random mutations and quasi-Darwinian selection to produce competing populations of problem focused computer software. The most successful in each generation are allowed to have children. These are usually better at solving a specific problem than their parents were, and so on down through the generations. Some of the resulting software has been found to perform better than anything purposely designed by humans. Hillis believes this demonstrates that the current method of engineering computer programs is inherently too limited and that we need a radically new approach to creating them — more biological than technological.

So the book returns to the theme established at the beginning, and what has been the driving force behind his career: how to build a machine that can think. Hillis believes that the best hope for doing so is to *evolve* such a machine — hence his interest in simulated evolution — and he is optimistic that ultimately we will do so. It might take time, he says, but (p 151):

Should we ever manage to evolve a machine that can understand language, we would be able to skip ahead rapidly, by taking advantage of human culture. I imagine that we would need to teach an intelligent machine by much the same process that we would teach a human child, with the same mixture of skills, facts, morals, and stories. Since we would be incorporating human culture into the machine's recipe for intelligence, the resulting machine would not be an entirely artificial intelligence but rather a human intelligence supported by an artificial mind. For this reason, I expect that we would get along just fine.

Overall, I found *The Pattern on the Stone* to be a fascinating and entertaining book. If you want a short book on the essential ideas of computer science, written by a leading expert with a highly original perspective, then this book is certainly a must read. ●

*Reviewed by: Dr Joseph Voros*

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### ***The Weightless World: Thriving in the digital age***

Diane Coyle, Capstone, 1999

Traditionally, output and trade have been measured by weight (how many tonnes of steel, kilos of wool, bushels of wheat) so that even in 1985 'the volume of computers imported into the UK was assessed by weighing them'. 'Within less than another decade,' states Diane Coyle in this mindset-breaking book, measuring by weight 'had become an absurdity. Computers had simultaneously become so much smaller and so much more powerful that their weight was meaningless.'

For Diane Coyle, the economics editor of *The Independent*, this statement about weightlessness is the focus of her thesis (she does say that Alan Greenspan, the chair of the US Federal Reserve Bank, was the first to describe the economy as increasingly weightless but she goes on to give it substance).

But if so much of the output of the developed world is increasingly becoming dematerialised, very few of our institutions have yet got the hang of it. This applies even to our statistics keeping — so that there is a lag in everything from trade to unemployment figures; this explains some of the ‘puzzling’ data.

But there is nothing puzzling in the case that the author presents. It’s a pleasure to read the clear and creative prose (not the usual comment on an economics book). And it is illuminating to follow the arguments.

Diane Coyle describes the economic shift from physical output to the knowledge economy and then traces the various implications: what it means when the links between production and place are disappearing; what value we place on the intangible acts of communication which are the new forms of wealth.

She goes on to show how classic economic theory is being turned on its head. Value, she says, was once determined by rarity, but this doesn’t work with weightless products. For ‘if it costs virtually nothing to transmit a TV programme to an extra million people, or copy a computer programme over the internet, or copy a fashion design, how on earth is anybody going to charge for it?’ This puts pressure on us to redefine the framework of intellectual property and all its possibilities for wealth creation.

Issues of anxiety and uncertainty are raised — in the face of such overwhelming change, so many people feel so helpless, and while there is much rhetoric about providing better access to better education, this is not yet the reality, according to the author. One reason that the population is so disenchanted with politicians is that governments can no longer deliver ‘safe havens’. (Diane Coyle turns government on its head, along with economics, when she says that ‘the priority for policy makers must be to equip people better to deal with change and uncertainty’). This is along with defining international standards.

Each chapter — indeed, just about each page of this book — pushes the conceptual boundaries.

And this is no futuristic state that the author is describing; it’s the here and now, but with a very different slant on our society. It’s where work is increasingly attached to a person, rather than a place (which helps to explain why we are working longer hours with laptops, mobiles etc and have fewer work boundaries).

It’s where the old tax system is breaking down — as companies simply ‘move’ their financial base across borders, perhaps to Ireland where ‘the government would be more likely to subsidise an inward investor than to tax them’. (Not that the author sees a GST as a solution!)

One intriguing scenario that is introduced is the increasingly important role played by cities. So much for the rural idyll and the telecommute — it will be the city that holds the attractions. Not just because of the need for cultural interaction (weightless!) but because it is in the social economy ‘composed of people-to-people services ... where most of us will find work’.

City politicians (not national governments) will be better able to organise information — and this is the secret to success in the weightless world. As Diane Coyle points out: ‘The weekly *TV Guide* in the US in some years makes bigger profits than the four major networks combined. Guiding people round information is more valuable than producing information: knowledge is more or less free but time is money.’

This is a thoroughly sensible book. It’s also highly readable — a testimony to the premise that books (which are not weightless) still have value. And one of the most refreshing aspects of the author’s style is her frankness and ambivalence. The move to digital is inevitable — but the problems are deeply disturbing. Inequality is more and more pronounced with ‘the earnings of British men’, for example, being ‘more unequal now than they have been at any time since 1870’. This is totally unacceptable to Diane Coyle.

‘I find myself torn between the convictions that flexibility (the rationalisation for work and pay) is essential in the weightless world, and a distaste for the inequality and unhappiness that are its results.’ This is why *The Weightless World* is a critique as well as an explanation. ●

*Reviewed by: Dale Spender*

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