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For Your Information

About Information, the Universe, and the Modern Age

Philip Tetlow

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Preface

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The Open Group Press is an imprint of The Open Group for advancing knowledge of information technology by publishing works from individual authors within The Open Group membership that are relevant to advancing The Open Group mission of Boundaryless Information Flow™. The key focus of The Open Group Press is to publish high-quality monographs, as well as introductory technology books intended for the general public, and act as a complement to The Open Group standards, guides, and white papers. The views and opinions expressed in this book are those of the authors, and do not necessarily reflect the consensus position of The Open Group members or staff.

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About the Author

Photo: Russell Edwards/TED

Philip Tetlow, PhD, C.Eng, FIET, is an Executive IT Architect, Web Scientist, and onetime W3C member. He has been a Vice President of IBM's Academy of Technology, an IBM Quantum Ambassador, and is currently CTO of Data Ecosystems at IBM (UK).

He has more than 30 years' experience in the IT industry, specializing in the delivery of large complex IT systems centered on data and analytics, and has been a key contributor to many important discussions on data and information.

He is a Visiting Professor of Practice at Newcastle University and an Adjunct Professor of Web Science at Southampton University. In 2017, he gave the TED talk on *8 Steps to Understanding Information — and Maybe the Universe*, and he has twice won the IBM Academy of Technology's President's Award.

In 2008, his first book *The Web's Awake* won an honorable mention in the Association of American Publishers Awards. It then went on to score 9 out of 10 in a British Computer Society review and currently holds a 5-star rating on Amazon UK.

Dedications

For Barrie, John, Yorick, Peter, Sal, and all that keeps me grounded. Here's looking forward.

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On to those who've been kind enough to share their insight. That's quite a roll call in itself, containing many individuals who are exceptional in their own right. It includes the likes of David Kenyon and John Palser at Bletchley Park Museum, Professors Brian Randell and Cliff Jones at Newcastle University, Jamie Martin at IBM's archives, William Hery, now retired from Bell Labs Innovations, and my old friends John Tait, Wendy Hall, and the late Yorick Wilks. They've selflessly given their time to help with investigations and been the error checkers, the panel of experts who helped point out the weaknesses of those intent on sensationalizing many well-known historic events and scientific facts. They represent what I hope is the best available means to set the record straight. It is their compass that I have followed.

Now the friends, colleagues, and confidants who've chivvied me on and provided the space to think properly. They know who they are, but I'll call them out anyway. A round of applause please for Mark Moloney, Toby Dupont, Tadhg Murphy, John Handy-Bosma, Alastair McCullough, Peter Ford, Ken McCreash, Peter Appleby, Peter Smith, Richard Hopkins, Susan Schreitmueller, Andrea Martin, Rashik Parmar, John Cohn, Mike Hudgell, Dean Newton, Junaid Butt, Fausto Martelli, Nathan Sykes, Sergio Rodriguez, Mark Mattingley-Scott, Kugendran Naidoo, Dinesh Garg, Leigh Chase, Ed Pyzer Knapp, Nick Brönn, Kate Marshall, Barrie Thompson, Grace Brown, Chris Burton, Neal Fishman, and Charlie Drees. Where would the world be without the kinship of others.

Last, but of course not least, I simply must mention my family. Writing can be a lonely, indulgent task and I know it pulls me away from them. Yet still they stay close, always there, always supportive. I'm blessed and I know it. I love them dearly.

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Foreword

Bletchley Park was the wartime home of the Government Code (GC) and Cypher School (CS) in the UK — now relocated to Cheltenham and renamed as Government Communications Headquarters the (GCHQ). For the last 103 years, this organization has been the UK's principal signals intelligence organization. When, in 2015, I was appointed as Research Historian for the Trust, which now runs Bletchley as a visitor site, I expected to have to learn a great deal about codes and cryptanalysis. Eight years later, I do indeed know a lot about codes and, more correctly, ciphers. I can talk at length about Enigma, JN-25, FISH, and explain the intricacies of a Vernam Cipher or a One-Time-Pad.

However, the more I've studied the workings and wartime successes of GC&CS, the more I've come to believe that cryptanalysis is not the whole story. The purpose of Bletchley Park was to provide intelligence to Allied leaders and commanders; *information* derived from enemy communications. Much of this communication was indeed encrypted, but in many ways that was incidental. It wasn't important because it was encrypted, it was encrypted because it was important. At its heart, the wartime GC&CS dealt with information — data, and although the volumes of that data were tiny in comparison to the scales dealt with in the modern world, they were, for the 1940s, both enormous and groundbreaking. Bletchley Park's Hollerith machine section alone consumed over two million 80-column punch-cards per week — six tons of cards — all individually punched and processed by female operators. Intelligence data was also painstakingly recorded on millions of index cards, all ordered and cataloged to allow meaningful intelligence information to be stored and rapidly retrieved when required. Bletchley Park is famous for its machines, the Bombes or Colossi, but those machines were actually only cogs in what was an enormous human-mechanical *information system*.

Bletchley Park was also the home of a number of famous men and women, the great minds of their era, all of whom applied themselves to the various problems of reading enemy messages. Nevertheless, the great *Codebreakers* were not all the same. Some were *lifers*; men like John Tiltman, who while not a household name, was a giant in the world of cryptanalysis from the 1920s until the 1980s. Some, like Margaret Rock, came late to codebreaking, but stayed and saw out their careers with GCHQ. Others, meanwhile, were only *accidental codebreakers*; their wartime work being a short episode in careers which focused before and after the war on other things, albeit related things. In this category are Alan Turing, Bill Tutte, Max Newman, and others who form subjects of this book, along with their American counterparts, including Claude Shannon and John von Neumann. Each of these individuals was to an extent forced to interrupt their pre-war intellectual life to work on projects — either bombs or code — not of their own choosing. Each returned to their original lines of thought after 1945, but did so profoundly influenced by their wartime experience. My own

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reading about these characters led me to wonder about their wider world, the connections between them, and the influence of their wartime activities on their longer term *grander* ideas.

We had just produced a temporary exhibition about Bill Tutte, telling the story not only of his startling achievements as a cryptanalyst, but also his later influence on our modern world, when Phil Tetlow, the author of this book, arrived at Bletchley Park. Inspired in part by our exhibition, Phil took the bold step of walking up to our information desk and asking to speak to a historian. Several hours and multiple cups of coffee later, I discovered that I was not alone in my fascination with the information story at the heart of Bletchley, and with the extraordinary network of minds who worked in it and were influenced by it. Between us, we traced the threads of this story and it led us to a place 3,400 miles away: The Institute for Advanced Study (IAS) at Princeton University in New Jersey. This was housed in the 1930s in Fine Hall — then the mathematics department, now the home of the department of East Asian Studies — a beautiful Tudor-style building which is best known as one of the locations for A Beautiful Mind — the biopic of one of its later alumni, John Nash. The IAS in the 1930s was a vital nexus linking many of the characters in this book, including Turing, who worked there at the behest of Max Newman, as well as figures such as J. Robert Oppenheimer and John von Neumann, who would work on the other great intellectual endeavor of World War II, the Manhattan Project. The rolls of the IAS also include luminaries like Kurt Gödel, and of course Albert Einstein. Arguably, the meeting of these minds in the years before World War II and the interaction of these human particles, created a powerful intellectual reaction which brought about, and continues to underpin the modern post-industrial Information Age.

I'm a historian. I stopped studying mathematics at age sixteen — something I now live to regret — and while I can use a computer, I make no pretense at understanding how it works. Thus, while I'm able to recognize the intellectual phenomenon that these individuals represented, it appears in my mind rather like a misty forest viewed in the early morning sun: a vision of almost blinding light against which misty shadows are visible, but exact forms are difficult to make out. The author of this book, on the other hand, is powerfully equipped with the skills and tools of information science, mathematics, and physics to see past the light and fog and truly understand the forest. So, what this book does is to explore the thinking of each of these individually in order to draw out their powerful and fundamental ideas and call out the connections between them. In so doing, Tetlow builds a coherent history of the idea of information as it developed in the twentieth century, explaining at the same time both its power and its elusiveness as an idea which in many ways continues to resist precise definition. He therefore gives us a clear view of the role of these ideas in shaping the world we live in today.

However, he doesn't stop there. The second part of the book goes on to look deeper

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into the role of information in our understanding of the universe and the often contradictory theoretical principles we use to understand it. Tetlow, therefore, argues that the universe itself is fundamentally informational.

This is not a book for the faint-hearted. The scope and complexity of the ideas it contains is extraordinary, ranging from subatomic particles, via micro-chips, to the World Wide Web and indeed the nature of the universe itself. We meet some of the greatest minds of the last 150 years along the way and seek to understand how they too saw the world and discussed and argued over its true nature. Many of the individuals in this story are now dead, but the story itself is only just beginning. This book presents an argument but does not necessarily provide a conclusion. Rather, what it provides is an introduction, an invitation to a new way of thinking about things which I hope will absolutely not be the last word on the subject. It asks, perhaps demands, all of us to go away and ponder where we go next. It opens with a reference to the great Douglas Adams. This is entirely appropriate as the second part of the book can fairly be described as a meditation on “life, the universe, and everything”. Adams, however, went on to point out that the answer “42” was really only the beginning of a broader search, not just for answers but also questions. I was deeply flattered to be asked to write the foreword for this book, as I feel that my contribution in the process was relatively minor. Nevertheless, my journey with Phil to this point has been a fascinating and inspiring one, and yet I am sure it is not over. Like this book, it feels like just the beginning of a great quest.

Read on and get on board; you don’t want to miss it.

Dr David Kenyon, Research Historian, Bletchley Park

July 2022

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Prologue

In many ways, this is a personal story as it reflects on my career-long battle with the slippery subject of information. In other ways, not so much as it tells of something undeniably relevant to us all.

For my day job, I work at IBM® and advise big companies on how to get the most from their data. It's interesting work. I get to think hard about some fascinating problems, while meeting lots of amazing people along the way. Many of them have changed the world with their data, and I know I'm lucky to be part of that. On occasion, I also get to contribute toward some rather influential discussions. For instance, I once helped persuade those who run the World Wide Web to think differently about how data changes the way it works.

Out of that came the field we now recognize as Sociotechnical Science [1] [2] [3] [4] [5] [6], although some might know it better as Web Science [7] [8] [9] [10]. Whatever the name, and however it came about, I'm just glad that I was able to assist in my own small way. Back then, in 2005-2006, it was all very new and, to me at least, in the excitement of fresh debate, some of the ideas being discussed felt almost trivial.

How wrong I was.

The point I'm trying to make has nothing to do with self-importance. Far from it. We were just a bunch of interested practitioners shooting the breeze about electronic data. No, all I'm trying to say is that something so apparently innocuous and innocent close-up can have a massive impact at scale. It's about how data, or more importantly the idea of information, has grown to profoundly interest and influence us all. Or at least, that was the point I wanted to make when I started to write this book.

Back in those early days of Web Science, I was certainly naïve. I'd worked in and around information technology for some time and had studied the standard texts on data processing before that. So, I suppose I considered myself an expert. I thought I knew a thing or two about data and information.

Again, how wrong I was.

In truth, the warning signs were there much earlier. As an eager undergraduate, I can remember a conversation with my most senior tutor. Back then, I asked about the difference between data and information, and my question was met with a painful pause. That exchange still haunts me to this day, as I've eventually come to understand that, at the most fundamental level at least, we still don't really understand what information is.

Hence the reason for this book. I've always felt it important to question the nature of

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