



## About the Author

Why should I have been the person to write this book? Well, I seem to have accumulated the right mix of experience and qualifications over the last 25 years. I graduated in mathematics and natural science from Cambridge (England) in the 1970s, and got a qualification in computer engineering; my first proper job was in avionics; and I became interested in cryptology and computer security in the mid-1980s. After working in the banking industry for several years, I started doing consultancy for companies that designed equipment for banks, and then working on other applications of this technology, such as prepayment electricity meters.

I moved to academia in 1992, but continued to consult to industry on security technology. During the 1990s, the number of applications that employed cryptology rose rapidly: burglar alarms, car door locks, road toll tags, and satellite TV encryption systems all made their appearance. As the first legal disputes about these systems came along, I was lucky enough to be an expert witness in some of the important cases. The research team I lead had the good fortune to be in the right place at the right time when several crucial technologies, such as tamper resistance and digital watermarking, became hot topics.

By about 1996, it started to become clear to me that the existing textbooks were too specialized. The security textbooks focused on the access control mechanisms in operating systems, while the cryptology books gave very detailed expositions of the design of cryptographic algorithms and protocols. These topics are interesting, and important. However they are only part of the story. Most system designers are not overly concerned with crypto or operating system internals, but with how to use these tools effectively. They are quite right in this, as the inappropriate use of mechanisms is one of the main causes of security failure. I was encouraged by the success of a number

## **xxxiv About the Author**

---

of articles I wrote on security engineering (starting with 'Why Cryptosystems Fail' in 1993); and the need to teach an undergraduate class in security led to the development of a set of lecture notes that made up about half of this book. Finally, in 1999, I got round to rewriting them for a general technical audience.

I have learned a lot in the process; writing down what you think you know is a good way of finding out what you don't. I have also had a lot of fun. I hope you have as much fun reading it!



# Acknowledgments

A great many people have helped in various ways with this book. I probably owe the greatest thanks to those who read the manuscript (or a large part of it) looking for errors and obscurities. They were Anne Anderson, Ian Brown, Nick Bohm, Richard Bondi, Caspar Bowden, Richard Clayton, Steve Early, Rich Graveman, Markus Kuhn, Dan Lough, David MacKay, John McHugh, Bob Morris, Roger Needham, Jerry Saltzer, Marv Schaefer, Karen Spärck Jones and Frank Stajano. Much credit also goes to my editor, Carol Long, who (among many other things) went through the first six chapters and coached me on the style appropriate for a professional (as opposed to academic) book. At the proofreading stage, I got quite invaluable help from Carola Bohm, Mike Bond, Richard Clayton, George Danezis, and Bruce Godfrey.

A large number of subject experts also helped me with particular chapters or sections. Richard Bondi helped me refine the definitions in Chapter 1; Jianxin Yan, Alan Blackwell and Alasdair Grant helped me investigate the applied psychology aspects of passwords; John Gordon and Sergei Skrobogotov were my main sources on remote key entry devices; Whit Diffie and Mike Brown on IFF; Steve Early on Unix security (although some of my material is based on lectures given by Ian Jackson); Mike Roe, Ian Kelly, Paul Leyland, and Fabien Petitcolas on the security of Windows NT4 and Win2K; Virgil Gligor on the history of memory overwriting attacks, and on mandatory integrity policies; and Jean Bacon on distributed systems. Gary Graunke told me the history of protection in Intel processors; Orr Dunkelman found many bugs in a draft of the crypto chapter and John Brazier pointed me to the Humpty Dumpty quote.

Moving to the second part of the book, the chapter on multilevel security was much improved by input from Jeremy Epstein, Virgil Gligor, Jong-Hyeon Lee, Ira Moskowitz, Paul Karger, Rick Smith, Frank Stajano, and Simon Wiseman,

while Frank also helped with the following two chapters. The material on medical systems was originally developed with a number of people at the British Medical Association, most notably Fleur Fisher, Simon Jenkins, and Grant Kelly. Denise Schmandt-Besserat taught the world about bullae, which provided the background for the chapter on banking systems; that chapter was also strengthened by input from Fay Hider and Willie List. The chapter on alarms contains much that I was taught by Roger Needham, Peter Dean, John Martin, Frank Clish, and Gary Geldart. Nuclear command and control systems are much the brainchild of Gus Simmons; he and Bob Morris taught me much of what's in that chapter.

Sijbrand Spannenburg reviewed the chapter on security printing; and Roger Johnston has taught us all an enormous amount about seals. John Daugman helped polish the chapter on biometrics, as well as inventing iris scanning which I describe there. My tutors on tamper resistance were Oliver Kömmerling and Markus Kuhn; Markus also worked with me on emission security. I had substantial input on electronic warfare from Mike Brown and Owen Lewis. The chapter on phone fraud owes a lot to Duncan Campbell, Richard Cox, Rich Graveman, Udi Manber, Andrew Odlyzko and Roy Paterson. Ian Jackson contributed some ideas on network security. Fabien Petitcolas 'wrote the book' on copyright marking, and helped polish my chapter on it. Johann Bezuidenhout made perceptive comments on both phone fraud and electronic commerce, while Peter Landrock gave valuable input on bookkeeping and electronic commerce systems. Alistair Kelman was a fount of knowledge on the legal aspects of copyright; and Hal Varian kept me straight on matters of economics, and particularly the chapters on e-commerce and assurance.

As for the third part of the book, the chapter on e-policy was heavily influenced by colleagues at the Foundation for Information Policy Research, notably Caspar Bowden, Nick Bohm, Fleur Fisher, Brian Gladman, Ian Brown, Richard Clayton — and by the many others involved in the fight, including Whit Diffie, John Gilmore, Susan Landau, Brian Omotani and Mark Rotenberg. The chapter on management benefited from input from Robert Brady, Jack Lang, and Willie List. Finally, my thinking on assurance has been influenced by many people, including Robin Ball, Robert Brady, Willie List, and Robert Morris.

There were also many people over the years who taught me my trade. The foremost of them is Roger Needham, who was my thesis advisor; but I also learned a lot from hundreds of engineers, programmers, auditors, lawyers, and policemen with whom I worked on various consultancy jobs over the last 15 years. Of course, I take the rap for all the remaining errors and omissions.

Finally, I owe a huge debt to my family, especially to my wife Shireen for putting up with over a year in which I neglected household duties and was generally preoccupied. Daughter Bavani and dogs Jimmy, Bess, Belle, Hobbes, Bigfoot, Cat, and Dogmatix also had to compete for a diminished quantum of attention, and I thank them for their forbearance.



## Further Acknowledgments for the Second Edition

Many of the folks who helped me with the first edition have also helped update the same material this time. In addition, I've had useful input, feedback or debugging assistance from Edmond Alyanakian, Johann Bezuidenhout, Richard Clayton, Jolyon Clulow, Dan Cvrcek, Roger Dingleline, Saar Drimer, Mike Ellims, Dan Geer, Gary Geldart, Wendy Grossman, Dan Hagon, Feng Hao, Roger Johnston, Markus Kuhn, Susan Landau, Stephen Lewis, Nick Mathewson, Tyler Moore, Steven Murdoch, Shishir Nagaraja, Roger Nebel, Andy Ozment, Mike Roe, Frank Stajano, Mark Staples, Don Taylor, Marc Tobias, Robert Watson and Jeff Yan. The members of our security group in Cambridge, and the Advisory Council of the Foundation for Information Policy Research, have been an invaluable sounding-board for many ideas. And I am also grateful to the many readers of the first edition who pointed out typos and other improvements: Piotr Carlson, Peter Chambers, Nick Drage, Austin Donnelly, Ben Dougall, Shawn Fitzgerald, Paul Gillingwater, Pieter Hartel, David Häsäther, Konstantin Hyppönen, Oliver Jorns, Markus Kuhn, Garry McKay, Joe Osborne, Avi Rubin, Sam Simpson, M Taylor, Peter Taylor, Paul Thomas, Nick Volenec, Randall Walker, Keith Willis, Stuart Wray and Stefek Zaba.





## Legal Notice

I cannot emphasize too strongly that the tricks taught in this book are intended only to enable you to build better systems. They are not in any way given as a means of helping you to break into systems, subvert copyright protection mechanisms, or do anything else unethical or illegal.

Where possible I have tried to give case histories at a level of detail that illustrates the underlying principles without giving a ‘hacker’s cookbook’.

### **Should This Book Be Published at All?**

---

There are people who believe that the knowledge contained in this book should not be published. This is an old debate; in previous centuries, people objected to the publication of books on locksmithing, on the grounds that they were likely to help the bad guys more than the good guys.

I think that these fears are answered in the first book in English that discussed cryptology. This was a treatise on optical and acoustic telegraphy written by Bishop John Wilkins in 1641 [805]. He traced scientific censorship back to the Egyptian priests who forbade the use of alphabetic writing on the grounds that it would spread literacy among the common people and thus foster dissent. As he said:

*It will not follow that everything must be suppressed which may be abused. . .  
If all those useful inventions that are liable to abuse should therefore be  
concealed there is not any Art or Science which may be lawfully profest.*

The question was raised again in the nineteenth century, when some well-meaning people wanted to ban books on locksmithing. A contemporary writer on the subject replied [750]:

*Many well-meaning persons suppose that the discussion respecting the means for baffling the supposed safety of locks offers a premium for dishonesty, by showing others how to be dishonest. This is a fallacy. Rogues are very keen in their profession, and already know much more than we can teach them respecting their several kinds of roguery. Rogues knew a good deal about lockpicking long before locksmiths discussed it among themselves . . . if there be harm, it will be much more than counterbalanced by good.*

These views have been borne out by long experience since. As for me, I worked for two separate banks for three and a half years on cash machine security, but I learned significant new tricks from a document written by a convicted card fraudster that circulated in the U.K. prison system. Many government agencies are now coming round to this point of view. It is encouraging to see, for example, that the U.S. National Security Agency has published the specifications of the encryption algorithm (Skipjack) and the key management protocol (KEA) used to protect secret U.S. government traffic. Their judgment is clearly that the potential harm done by letting the Iraqis use a decent encryption algorithm is less than the good that will be done by having commercial off-the-shelf software compatible with Federal encryption standards.

In short, while some bad guys will benefit from a book such as this, they mostly know the tricks already, and the good guys will benefit much more.