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Harry Collins and Trevor Pinch
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The Golem at Large: what you should know about technology

In the very successful and widely discussed first volume in the Golem series, *The Golem: What You Should Know About Science*, Harry Collins and Trevor Pinch likened science to the golem, a creature from Jewish mythology, a powerful creature which, while not evil, reveals a flailing and clumsy vigour. Through a series of fascinating case studies of famous and not-so-famous scientific episodes, ranging from relativity and cold fusion to memory in worms and the sex lives of lizards, the authors showed that science too is neither all good nor all bad. They debunked the traditional view that science is the straightforward result of competent theorization, observation and experimentation; they showed it is a set of fallible skills.

In this second volume, the authors now consider the golem of technology. Using the same successful format, in a series of case studies they demonstrate that the imperfections in technology are related to the uncertainties in science described in the first volume. The case studies cover the role of the Patriot anti-missile missile in the Gulf War, the *Challenger* Space Shuttle explosion, tests of nuclear fuel flasks and of anti-misting kerosene as a fuel for airplanes, economic modelling, the question of the origins of oil, impact of the Chernobyl nuclear disaster and the contribution of lay expertise to the analysis of treatments for AIDS.

The Golem series tries to build an island between the two cultures of science on the one hand and the humanities and social sciences on the other. It is an attempt to explore science as a product of social life and to demonstrate that the study of science is the proper concern of more than just scientists. This fascinating work will be of interest to readers from a wide range of science and non-science backgrounds. It could be used to give science students a humanistic interpretation of their work, but also to introduce non-scientists to the analysis of science. Anyone who found the original Golem volume of interest will want to read this latest volume.

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Harry Collins is Distinguished Research Professor in Sociology and Director of the Centre for the Study of Knowledge, Expertise and Science (KES) at Cardiff University. His books include *Changing Order: Replication and Induction in Scientific Practice* (1985, Second edition published by Chicago University Press in 1992), *Artificial Experts: Social Knowledge and Intelligent Machines* (1990), published by MIT Press, *The Shape of Actions: What Humans and Machines Can Do* (MIT Press with Martin Kusch) and, with T. Pinch, *The Golem: What You Should Know About Science* (Cambridge University Press, 1993), which won the 1995 Robert Merton Prize of the American Sociological Association. He is the 1997 recipient of the J. D. Bernal Award of the Society for Social Studies of Science. He is part way through a new study of the history and sociology of gravitational wave physics.

Trevor Pinch was born in Ireland and educated in the UK. He has degrees in physics and in sociology. He taught sociology at the University of York before moving to the USA. He is currently Professor in the Department of Science and Technology Studies, Cornell University. He has held visiting positions at the University of California San Diego, The Danish Technical University, the Science Centre Berlin and the Max Planck Institute for the History of Science, Berlin. His main research area is in the sociology of science and technology where he is the author of several books including *Confronting Nature: The Sociology of Solar-Neutrino Detection*, Kluwer, 1986; *Health and Efficiency: A Sociology of Health Economics* (with Malcolm Ashmore and Michael Mulkay), Open University Press, 1989 and co-editor of *The Social Construction of Technological Systems* (with Wiebe Bijker and Tom Hughes), MIT Press, 1987 and *The Handbook of Science and Technology Studies* (with Sheila Jasanoff, Gerald Markle and James Petersen) Sage, 1995. His book *The Golem: What Everyone Should Know About Science* (with Harry Collins) CUP, 1993 won the Merton Prize of the American Sociological Association. He also researches the sociology of markets, where he is the author (with Colin Clark) of *The Hard Sell*, HarperCollins 1996. His current research is on the history of the electronic music synthesizer.

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For

SADIE COLLINS

and to the memory of

OWAIN PINCH

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Preface and acknowledgements

With the exception of most of Chapter 1 and the whole of Chapter 3, the substantive parts of this book are largely expositions of others' work; in this we follow the pattern of the first volume in the Golem series. The full bibliographic references to the works discussed both in this Preface and the other chapters, as well as additional reading, will be found in the Bibliography at the end of the volume.

As for the substantive chapters, Chapter 1 is Collins's redescription of the argument over the success of the Patriot missile. It is heavily based on the record of a Congressional hearing that took place in April 1992, and on two papers written by principal disputants, Theodore Postol and Robert Stein; it also draws on wider reading. Though this chapter is not a direct exposition of anyone else's argument, and though it uses a new analytic framework turning on different definitions of success, it must be made clear that the account was made possible only because of Postol's prior work. Also, Postol was extremely generous in supplying Collins with much of the relevant material and drawing his attention to more. Collins has tried to make sure that the account is not unduly influenced by Postol's views and that the material on which it draws represents the field in a fair way. It will be noted that the chapter does not repeat Postol's expressed position – that no Scud warheads, or almost no Scud warheads, were destroyed by Patriot missiles – but stresses the difficulty of reaching any firm conclusion while keeping open the strong possibility that Postol is right.

Chapter 2 is based on parts of Diane Vaughan's book, *The Challenger Launch Decision: Risky Technology, Culture and Deviance at NASA*. In the context of earlier work, Pinch had previously read McConnell's book, *Challenger: 'A Major Malfunction', Report of the Presidential Commission on the Space Shuttle Challenger Accident* and Gieryn and Figert's article, 'Ingredients for a Theory of

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Science in Society'. An earlier article by Pinch on this topic can be found in the Bibliography, but Vaughan's meticulous research provides a detailed historical ethnography of the events leading up to the *Challenger* launch decision and leads to a new interpretation of them.

Chapter 3 is an exposition and simplification of one of Collins's own papers, 'Public Experiments and Displays of Virtuosity: The Core-Set Revisited' which is referred to in the Bibliography.

Chapter 4 is based on Simon Cole's article, 'Which Came First, the Fossil or the Fuel?' This article was originally prepared as a term paper for a course taught by Pinch at Cornell University. Pinch also has access to an unpublished article by Cole on the Gold affair. We thank Bill Travers and Bill Travers Jr. for reading an earlier draft of the chapter.

The substantive part of Chapter 5, 'Tidings of Comfort and Joy?', is based on Collins's reading of Robert Evans's paper 'Soothsaying or Science: Falsification, Uncertainty and Social Change in Macroeconomic Modelling'. Each quotation is taken from Evans's discussions with economists. Collins was also able to take advantage of a great deal of discussion with Evans who was a doctoral student at the University of Bath between 1992 and 1995, working under his supervision. The 'Soothsaying or Science' paper is based on this PhD, which is referred to in the Bibliography.

It should not be thought that all economists are unaware of the problems and ironies of their own discipline as the books by Ormerod and Wallis reveal. The Reports of the British Government's 'Panel of Independent Forecasters' (The Seven Wise Men) for February 1993 and February 1994 were also an important source of information for the chapter. Collins also used ideas from his own 'The Meaning of Replication and the Science of Economics'.

It should be noted that the 'Discussion' and 'Postscript' sections of Chapter 5, which include some speculations, are essentially the responsibility of the authors of this volume though most of the sceptical quotations are taken from economists.

For Chapter 6, Pinch used several articles by Brian Wynne on the effect of Chernobyl radiation on Cumbrian sheepfarmers. These articles are referred to in the Bibliography.

Chapter 7 is based upon Pinch's reading of Steven Epstein's book

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Impure Science: AIDS, Activism and the Politics of Knowledge and an article, 'The Construction of Lay Expertise'.

In the case of all chapters, both Pinch and Collins read and re-worked the drafts and take joint responsibility for the results.

We are extremely grateful for the generosity and the efforts of the authors of the works on which we have based our accounts. In every case they were unstinting with their time and effort and, by reading our versions of their work, helped us make sure that we did not stray too far from their intentions. Wiebe Bijker and Knut Sorensen read and advised on the Introduction and the Conclusion. We thank Park Doing for suggesting the words 'at Large' in our title. That said, the final responsibility for mistakes in exposition, infelicities of style, and errors of judgement or analysis, remains our own.