Communicating Science

Professional, Popular, Literary

In recent years governments and scientific establishments have been encouraging the development of professional and popular science communication. This book critically examines the origin of this drive to improve communication, and discusses why simply improving scientists' communication skills and understanding of their audiences may not be enough.

Written in an engaging style, and avoiding specialist jargon, this book provides an insight into science's place in society by looking at science communication in three contexts: the professional patterns of communication among scientists, popular communication to the public and science in literature and drama. This three-part framework shows how historical and cultural factors operate in today's complex communication landscape, and should be actively considered when designing and evaluating science communication.

Ideal for students and practitioners in science, engineering and medicine, this book provides a better understanding of the culture, sociology and mechanics of professional and popular communication.

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London

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore,
São Paulo, Delhi, Dubai, Tokyo

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by
Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9780521131728

First published 2010

Printed in the United Kingdom at the University Press, Cambridge

A catalogue record for this publication is available from the British Library

Library of Congress Cataloguing in Publication data
Russell, Nicholas J.
Communicating science : professional, popular, literary / Nicholas Russell.
p. cm.
Includes bibliographical references and index.
ISBN 978-0-521-11383-0 (hardback)
1. Communication in science. 2. Science–Social aspects. I. Title.
Q223.R87 2009
501'.4–dc22 2009027849

ISBN 978-0-521-11383-0 Hardback
ISBN 978-0-521-13172-8 Paperback

To Mike, to Jerry, and to Kathy, friends forced to leave the stage too early

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Part V Science in literature

Introduction
What this book is about and why you might want to read it

This is a book about the benefits and problems of communicating science, not a book about how to actually communicate. There are many useful things to say about practising science communication: writing, speaking, presenting, being interviewed, building websites, making podcasts and so on, and they are all well said in a variety of other places. This book has a different purpose.

Rather than assuming that the main problem in communicating science is that many scientists are not good at it (because they have no training or are not interested) it suggests that there are other questions to ask. Some of these are obvious; why communicate science in the first place, what science should be communicated, to whom should it be addressed and whose interests are served? Such questions are central to the analysis of any communication process and the answers (in science as elsewhere) are complicated.

It is not only the factual communication of science that is important. Fiction and other entertainment media create and reflect social attitudes towards science and scientists, so it is valuable to look at how science is presented in novels, short stories, feature films, plays, comics, graphic novels, computer games, social networking sites and so on. The range of such cultural artefacts is large and in this book there will only be space to cover fiction and drama.

The material here was originally developed for post-graduate Science Communication students at Imperial College London preparing to enter communication careers in journalism, broadcasting, work in museums and galleries or in public relations. While this book has useful things to say to such specialist students,

its main aim is to show that analysis of science communication is relevant to all students interested in the relations between science and wider culture. In particular, it is aimed at science graduates and post-graduates who are told they have a duty to improve their professional communication and to undertake science popularization.

Professional communication is covered in Part I. For graduate and post-graduate students their primary communication task is learning the conventions of professional writing, which might be less stressful if they knew something about the history, strengths and weaknesses of these conventions. It is a serious omission that communication is seldom cited as an essential element in the 'scientific method' because research articles are claims to new knowledge and the primary output of those working at the leading edge of science, while the body of scientific knowledge is set out in monographs and textbooks. The machinery for publishing science is also a mechanism of quality control (distinguishing between good and less good science and scientists) and a means of patrolling the borders of the discipline (determining who can be called a scientist and who cannot).

Popular communication of science is discussed in Parts II and III. Since the middle of the nineteenth century, science has become a closed and financially demanding profession. Scientists need specialized education, expensive spaces (laboratories) and expensive devices (instruments), and professional science communication is now intended only for other professionals. The community has had to develop a separate communication strand to popularize its work to non-scientists. This popular communication is necessary to justify science to those who fund it (governments, industry, charities and the public).

The strength of this popularizing impulse has varied but entered a particularly strong phase in the United Kingdom at the end of the twentieth century with movements for Public Understanding of Science (PUS) and Public Engagement with Science and Technology (PEST), and there has been a parallel Scientific

Literacy movement in the United States. What has characterized all these movements is the duty of scientists to explain what they do and present it in the best light. But a properly informed public must be able to critique science as well as support it. Popular science communication therefore has twin duties, to inform and educate the public about science on the one hand, but also to probe and criticize it on the other. All science is not necessarily a public good which just needs to be disseminated to invite approval.

Science in fiction and drama are examined in Parts IV and V. Scholars have revealed a great deal about the relationships between science and society from the study of real science in actual contexts, but the cultural significance of science in fiction has been relatively neglected. Part IV shows that, at certain key points in the history of science, a number of canonical plays provided insight into how science was evolving. Part V describes several further dramas, which show that long-standing ethical problems with science have persisted across the centuries and also demonstrates that readers can learn much about science and its culture from fiction.

While the chapters of the book are arranged to make sense in sequence, they can all be read on their own. Each chapter explores an element of science communication from the perspective of an author who has studied biology, taught applied biology and liberal studies in technical education, been a student of the history of science and technology, worked as a freelance science journalist and contributed to science communication teaching at Birkbeck College London and Imperial College London. These experiences determine the attitudes taken towards the three strands in this collection; another author would tell different stories with different emphases.

The book draws on a variety of sources, some of them venerable because they first set out the central issues. The book is not a comprehensive review of the academic literature; that would have demanded several monographs. Each chapter begins with a short scenario, a story (sometimes fact, sometimes fiction) that introduces

or rehearses some of the chapter themes. I hope these stimulate readers to peruse the drier material in the bodies of the chapters (though I hope this material is itself clear and easy to read).

Before the book starts there is a short Prologue setting out historical connections between the now dissimilar practices of professional science communication, factual journalism and fiction writing. There is no need to read this first, or indeed at all. Like all the other chapters it is designed to be as free-standing as possible. However, since there are connections running through the chapters, the more that are read, the greater may be the benefit gained from each one.

Everything here has benefited from discussions with, and what I have learned from, colleagues at both Birkbeck College London and Imperial College London, together with cohorts of enthusiastic students at both institutions who have been a pleasure to teach. The students have been too many to mention but I am much indebted to my colleagues who have included Wendy Barnaby, Giskin Day, John Durant, Shani Gbaja, Joan Leach, Felicity Mellor, Gareth Mitchell, the late John Newell, Rachel Souhami, Robert Sternberg, Jon Turney, Stephen Webster and Peter Wrobell. While they (and others) have all contributed to whatever may be virtuous here, they are entirely innocent of blame for tedium, error or other malfeasance.

I am also grateful to Lyn who has been tolerant for many years of energy that a teaching life demands, and to the science editors of various newspapers and magazines in the late 1980s and early 1990s (especially Tom Wilkie, then of *The Independent*) who accepted the contributions submitted in an intensive period of learning how to communicate science by doing it. My thanks as well to Andrew Hunt, who proved a stimulating colleague at the Nuffield Foundation in the early 1990s, and to Anthony Tomei, then Assistant Director of the Foundation, who gave me the opportunity to move from teaching into educational development, a change of career that contributed much to how I set about teaching science communication.

Prologue
Three orphans share a common paternity: professional science communication, popular journalism and literary fiction are not as separate as they seem

NATURE SPEAKS

The weekly magazine, *Nature*, is a strange beast. It began in the mid nineteenth century popularizing science but has subsequently evolved into a leading technical journal for the scientific profession. Its original popular remit remains in a section where specialists explain the significance of their latest work for a wide readership. But the bulk of the magazine consists of 'letters' to *Nature* where scientists announce progress in exciting or fashionable fields. These letters make few concessions to the ordinary reader. In form, language and content they are written by professional scientists for professional scientists.

Nature also carries news and editorial opinion on matters of importance to the profession. The three editorials in the 27 March 2008 issue happened to deal explicitly with the three themes of this book; the professional, the popular and the literary communication of science. Their joint appearance in *Nature* suggests that the scientific community is aware of the importance of all three genres.

The editorial on professional communication concerned a paper on adult stem cells modified by genetic manipulation to behave as if they were embryo cells. The work is exciting because such cells can be used in research and disease treatment. The

editorial worried about errors in a hastily prepared paper which the lead author admitted and plausibly explained. Cutting corners in the laboratory and in preparing documentation is a result of intense competition. In this case there were honest errors, but mistakes are hard to distinguish from dishonesty and the profession is concerned that error could shade into fraud, which is a serious professional problem. Detecting and rooting out fraud are hard; the best mechanism is rigorous policing of the channels of professional communication.

This editorial demonstrates the central role of professional communication, not only in making scientific claims, but to the quality control of science.

The second editorial dealt with popular communication and public scrutiny of science. The American Pew Research Centre's *State of the News Media 2008* reported a drop in media science coverage since 2001, partly caused by increased attention to political news following the 9/11 attack squeezing out minority concerns like science. Reduced coverage of science does not allow the media to carry out their democratic watchdog role; to check on government and business investment and responses to science, correct misrepresentations of science by non-scientific pressure groups, and expose over-enthusiastic manipulation of the media and other unethical behaviours by scientists themselves. Science should be tested for its public benefit, a principle to which *Nature* (and by implication the scientific community) subscribes. The social contract for public funding between scientists and society has to be justified by the benefits that science brings.

This editorial suggests that a healthy democracy needs a free press in which the coverage of science is as important as the coverage of politics or business.

The lead editorial was about literature; a paean of praise to the science fiction writer Arthur C. Clarke who had died aged 91. Clarke was a techno-visionary who fantasized about distant times and places when mankind could roam through the solar system

and beyond. *Nature* admired Clarke's transcendent vision of the future in a universe understood through science and explored by technology. The editorial is suffused with science as a force for progress and good, emblematic of the mind set of many in the scientific community. Science fiction and fantasy are the main literary genres where such 'scientism' is displayed and the science fiction which Clarke and others wrote stimulated many young people to take up science. Conversely, there has been an opposing trend in literary fiction of pessimism about science and its consequences.

This editorial makes it clear that the treatment of science and scientists in fiction is a key factor in the culture of science, in the making of scientists and in the forming of attitudes towards science by other professionals and by the public.

WHAT DO THESE THREE COMMUNICATION GENRES HAVE IN COMMON?

Today, the professional, the popular and the literary communication of science are different genres with different practices, but the foundations of all these practices were first articulated by one man, the seventeenth-century statesman and philosopher, Sir Francis Bacon. Bacon called for a grand renewal of knowledge, not based on the interpretation of ancient authoritative texts, but on direct observation of the natural and human worlds. This emphasis on accurate observation and reporting of events underlay the early practice of natural philosophy (science), reportage journalism and literary fiction.

Popular magazines and papers gained a foothold in England only in the eighteenth century, the first daily paper, the *Daily Courant*, appearing in 1702. Many writers for these periodicals were shadowy informers employed by the two main political factions, the Whigs and the Tories. The periodicals produced propaganda, 'spinning' news of current events to further particular political ends. But the most prolific and unscrupulous informers

founded a new profession, journalism. The most famous early exponent was Daniel Defoe, who was also a major contributor to the invention of a second genre, the socially realistic novel.

Although Defoe's novels and journalism were written in the early eighteenth century, the historian Ilse Vickers argues that his mind set was determined by his education in the previous century. His parents were Dissenters who sent him to Dr Morton's Dissenting Academy at Newington Green in the 1670s. Morton was a keen student of the ideology of Francis Bacon, and Vickers contends that Defoe embraced this Baconian philosophy, which informed both his factual journalism and his fiction.

After leaving the Academy, Defoe became a Presbyterian Minister but soon left the church to become a merchant and ultimately polemicist and spy, in which capacities he did not follow Bacon's ideal of gathering objective information. Although he was still writing polemic at the time, in November 1703 he (and all other inhabitants of southern England) witnessed the most violent storm in British history, which he reported in a piece of early reportage as *The Storm* in 1704. Defoe then continued to act as a political spy and propagandist for the Tory cause, only in 1715 beginning to write *Robinson Crusoe* and following this up with several other novels and fact-based works of proto-reportage including the famous *Journal of the Plague Year*.

The Storm marked a new departure upon which Defoe drew for all his later books. He aimed at a comprehensive factual account of events. The interpretation of these events then drew its authority from this accurate reporting. This was a fresh rhetorical strategy in journalism; starting with objective reports as opposed to the earlier tradition of news as polemic written on behalf of one or other party interested in the events. The new natural philosophers of the seventeenth century used the same technique; the reports of facts about nature were so thorough and accurate that they lent authority to the interpretations which followed. In both cases the emphasis on starting from a baseline of objective fact comes from Bacon.

Besides advocating careful observation of events, Bacon proposed two other principles; the systematic recording of data using language as plain and transparent as possible, and that natural philosophy should improve technology for human benefit. On the first principle, Defoe consciously evolved a plain style of writing and framed his fiction according to Bacon's advice on compiling 'histories'. Clarity in the communication of natural philosophy (and science) apparently has not survived into the twenty-first century but remains a central professional virtue in journalism. On Bacon's second additional principle, the scientific community has been successful in using his argument that pure science should be supported because new scientific knowledge underlies new technology.

Common elements in the practices of natural philosophy and journalism can be extended to the literary novel. Serious fiction reflects fundamental human values, otherwise only addressed by factual disciplines like philosophy, science and religion. Lamarque and Olsen, for instance, argue that great literature (like great philosophy or religion) develops these values, leading rather than simply reflecting culture. Other strands in the origin of the literary novel in the eighteenth century were factual history, on the one hand, and fantasy, fable and allegory ('romance'), on the other. Mayer argues that early novelists aligned themselves firmly with history and claimed to be as much concerned with factual truth as were non-fiction writers. In the seventeenth century historians started to compose accounts based on documents and interviews; history began to mean accounts of 'matters of fact' operating according to the same Baconian agenda that inspired early science and journalism. While serious fiction was not legitimate history, a clear boundary developed to separate it from fantasy. It claimed to be based on 'matters of fact'; fiction accurately imitated social and personal reality.

The literary novel therefore shared with natural philosophy (science) and reportage journalism a central concern with giving an objective account of the world. While this process is fraught

with problems, representing and explaining reality remain key aspirations for both scientists and good journalists. In literature, as in other high art forms, the early realistic project was first abandoned and then actively attacked. Nevertheless, fiction still deals in forms of factual and social truth, and the literary novel remains a natural communication sibling to both professional science communication and journalism.

GEORGE GISSING AND THE CONNECTIONS BETWEEN SCIENCE, JOURNALISM AND LITERATURE AT THE END OF THE NINETEENTH CENTURY

The worlds of science, of journalism and of literary fiction appear together in two late nineteenth-century novels written back to back by George Gissing; *New Grub Street* (1891) and *Born in Exile* (1893). In these autobiographical books, fictional versions of the intelligent but over-sensitive and depressive Gissing appear as the struggling lower middle-class novelist Edwin Reardon (*New Grub Street*) and the struggling lower middle-class chemist and journalist Godwin Peak (*Born in Exile*).

After the Education Act of 1870 all children could attend primary school and learn to read and write. A decade later this fed into increased publishing opportunities to satisfy these new readers. The genteel publishing world of the mid nineteenth century, dominated by three-volume literary novels and scholarly cultural periodicals designed for middle-class readers, was expanded with daily newspapers, middle and low-brow magazines and short novels breaking the stranglehold of the 'three decker' of literary fiction. As cultural and news journalism both became more populist, there were opportunities for a new cadre of practitioners not necessarily 'properly' educated in the classics nor bound by gentlemanly snobbery as to what activities should concern reporters and commentators. But the new commercialization deeply divided the educated literary community, leading to a split between journalists and novelists.

In *New Grub Street* the scholarly Reardon does not have an aptitude for the new commercial magazine world. He marries above his class and is pressured by his wife when she realizes that his literary reputation is not high and his income not adequate for a respectable life. His antithesis is Jasper Milvain, who is determined to make his living in popular journalism, where success comes from ruthless networking and a facility to write about anything from the most trivial to the most elevated. He and his type are displacing the older literary tradition of scholarly writers and editors to which Reardon hopelessly clings.

New ideas from science and continental philosophy diffused among the educated in the late Victorian period and Reardon's wife, separated from her struggling husband, reads about Herbert Spencer and Charles Darwin and the application of their ideas to society. All this also interests the populist coming man, Milvain, with whom she discusses these matters and which eventually leads to their marriage after Reardon's death. Her engagement with issues around science and philosophy is symbolic of the central cultural role played by science in late nineteenth-century society. Science had become professional and scientists addressed only each other in their books and journals. But many of them were also active in promulgating their ideas to a wider public and practised popular as well as professional science writing. Gissing's other *alter ego* in *Born in Exile*, Godwin Peak falls into this category.

If Reardon was a failed novelist, then Godwin Peak is a failed scientist. He is a lower middle-class northern boy who wins a scholarship to a thinly disguised Owens College, Manchester. Here he and his similarly underprivileged friend John Earwaker take a lot of second prizes, the first prizes going to their upper middle-class colleagues Bruno Chilvers, an extravagant and orthodox Christian destined for the church, and Buckland Warricombe, a star geology student and confirmed atheist, stereotypically combining new science with scepticism about established social conventions. Peak

and Earwaker share these rationalist attitudes and atheism with Buckland.

Throughout his studies Peak leaned towards science, stimulated by holiday work in the Moxey chemical works and childhood friendship with a retired railwayman with a passion for geology and strongly anti-religious views. Peak winds up working at a London chemical firm as an analyst, bored and resentful because he would like to devote himself to the pure science of geology. He saves money to give himself a year off to do some proper geological field work, goaded by Moxey's languid nephew Christian who also works for the same chemical firm but has the money to set up a small domestic laboratory for his own pleasure.

John Earwaker is also in London, working as a journalist and encourages Peak's freelance writing efforts on the impact of new scientific ideas. Peak controversially publishes an article, 'The new sophistry', in the radical *Critical*, in which he (anonymously) attacks philosophers and theologians trying to find compromise between the atheist implications of Darwin's ideas and a role for God and religion. Peak argues that no such compromise is possible and comes down firmly on the side of scientific atheism.

Peak is travelling to Cornwall on holiday when in Devon he re-encounters his old friend Buckland Warricombe and his sister Sidwell. He is invited into the local circle at the Warricombe estate and is smitten with Sidwell and envious of her clergyman father's life as a gentleman geologist with the resources to undertake pure research. Peak therefore lights on a path of extreme hypocrisy, he will pretend to orthodox religious belief, support old Warricombe in his pursuit of a compromise between Darwinism and Christianity, and even train for the church, all in order to win Sidwell's hand.

This hypocrisy is eventually exposed when Buckland establishes that Peak was the author of the 'new sophistry' article and Peak has to confess his devious strategy to Sidwell. Ironically, she has been moving to a more agnostic position herself and their views meet in mutual distaste for democracy among what they

regard as the semi-educated working class. In the end Peak loses Sidwell and returns to being an analyst and freelance science writer. Christian Moxey's plain but intelligent sister Marcella (who always took a shine to Peak which he never reciprocated) is killed in an accident and leaves Peak a small legacy. He determines to use it to allow him the old-fashioned gentlemanly privileges of travel and thought, but falls ill and dies of malaria in a Vienna hotel room.

Gissing's novels demonstrate that reasonably close relationships existed between the three genres of science communication, journalism and literary fiction just over a century ago. Professional and popular science communication had diverged, but it was still conventional for working scientists to write in both genres; no specialist trade of science journalism had yet emerged. Cultural journalism and serious literature are still penned today by the same hands, but the majority of cultural journalists and literary novelists tend now to be specialists in their separate activities.

The practice of science has seldom been a subject for literary fiction. Gissing was probably the one nineteenth-century English novelist, apart from H.G. Wells, who made science and scientists major fictional subjects and uniquely combined them with an examination of the lives of literary authors and cultural journalists. Gissing's two novels provide us with insightful accounts of the practices of these three trades when they were still closely connected.

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