

THE ROLE OF THE POPULAR ARTICLE IN ASTRONOMY COMMUNICATION

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ABSTRACT

Over recent decades there has been a proliferation of special-interest magazines dedicated to astronomy. In spite of the undoubted market for specialist feature articles on astronomy such articles appeal to a restricted sector of the general public and rarely appear in the daily or weekly press. I argue here that, apart from television documentary programmes and series, the general public's main exposure to astronomy-related stories is in the form of news reports, which carry too much information in too condensed a form for the general reader or viewer to absorb. I propose that, apart from education, trade books and documentaries, the only way to engage the serious interest of the public in astronomy is through feature articles published in wide-circulation newspapers and magazines. I further propose a generalized model for science communication and distinguish between *outreach* (to the general public), *midreach* (to astrobuffs) and *inreach* (the raising of awareness of the importance of outreach among the research community). Much of what is currently called outreach falls under midreach.

INTRODUCTION

In a standard text for documentary filmmakers Rabiger (*Directing the Documentary*, Boston: Focal Press, p. 9, 1998) states, 'At a higher level is a discourse—and this is equally true of narrative fiction—that aims not at conditioning or diverting but at sharing something in all its complexity.' Rabiger contrasts discourse with the coercive efforts of advertisers on the one hand and "binary" communication (the non-committal coverage of "both sides" of every issue) on the other. Much of what Rabiger has to say in his general discussion of the role of the documentary can be applied to the popular article. In particular, he emphasizes the concept of authorship, the seeing of an issue through an author's eyes, as a way of engaging the audience in active discourse rather than feeding it fact after fact. "Complexity" is a tricky topic in astronomy communication. Some areas of research are so arcane that only a small group of researchers dedicated to that topic can really understand the issues. But most topics in astronomy need to be carefully explained if a general audience is to grasp the basic ideas. Astronomy communication takes place on many levels, and the intended audience must be identified and addressed in a way that is suited to its level of understanding. I begin with a review of audience types.

This conference—along with CAP I (Washington, D.C. 2003), the Arecibo meeting (2003) and the second half of the Tenerife meeting (Mahoney, T. J. [ed.] *Communicating Astronomy*, La Laguna: IAC, 2005)—has as its brief to find ways of improving our astronomical outreach efforts. To achieve this goal we need to be clear at all times at whom outreach is being aimed. To make progress it is essential to differentiate outreach from what is here called *midreach*; an outreach audience needs every technical term and concept explained, whereas a midreach audience (i.e. one that has some understanding of science in general and of astronomy in particular) will not. Hence, in popularizing astronomy, the communications techniques applied must be adapted to the level of astronomical awareness of the audience concerned.

In this paper I identify three broad audiences for astronomical communications: i) the general public, ii) the astronomically aware sector of the public and iii) the community of astronomers (professional and amateur). The three audiences are not mutually exclusive; for example, a professional astronomer will, to some extent be included in the first two groups by watching news coverage of science-related issues and reading such magazines as *Sky & Telescope* or *Astronomy Now*. I ignore audience (iii) communications, which are restricted to research papers, conference proceedings and observational reports in amateur journals, since these cannot be classified as either outreach or midreach. Instead, I shall consider this audience only as the target of inreach efforts (described below). I further identify three tasks that all of us dedicated to the communication of astronomy need to address: a) popularizing astronomy to the public (outreach), b) providing astronomical news reports and feature articles for the general astronomically aware audience (midreach) and c) convincing the community of research astronomers of the necessity to communicate the results of their work to a general audience (inreach).

At meetings like this, we talk a great deal about outreach in the sense of getting the astronomical message across to the general public. I argue here that much of what we call outreach should really be classified as midreach since it is mainly for consumption by those who already have a keen interest in astronomy. Astronomy programmes on radio and TV, planetarium shows and star parties are undoubtedly outreach since they are consciously aimed at a non-astronomical public and their treatment often presupposes no previous knowledge of astronomy, but their effect is largely transitory since they provide no lasting means of raising the general level of public knowledge concerning astronomy: that is the task of education, popular books and feature articles. I discuss here the feature article in the context of other forms of outreach and midreach.

OUTREACH, MIDREACH AND INREACH: SOME USEFUL DISTINCTIONS

OUTREACH: GETTING THROUGH TO THE PUBLIC

The term “general public” covers a wide range of audiences so it is useful to identify at least some of the subgroups that form this vast assembly of individuals. The public varies according to medium and genre. Prime-time TV programmes have a high entertainment content with an emphasis on spectacular graphics and images flashed on screen at a dizzying pace. But what about university-educated members of the public, graduates, say, in fields other than the sciences? These form a small but potentially powerful group. In the media, they will constitute the gatekeepers (Couper, H. *Communicating Astronomy*, La Laguna: IAC, p170, 2005.)—the people who decide what gets broadcast and published. They also make up the bulk of programme-makers, editors and journalists. Flashy graphics and breathtaking images alone will not impress such an audience, who will demand something to *think* about, something that challenges its intellect rather than non-stop audiovisual stimuli. For this public astronomy must be made to appeal to the mind and not merely the senses.

Whatever the kind of public, any initial interest sparked by a news report or television documentary, if it is to make a lasting impact, will need to be quickly followed up by the reading of feature articles and books, genres that allow the reader to mull over new and occasionally difficult concepts at leisure. As Rees (2001, Pantaneto, 1 <http://www.pantaneto.co.uk/issue1/rees.htm>) points out, ‘The place of science is in features and documentaries, rather than news.’ But an important point needs to be stressed here. Before the 1980s, the public depended exclusively on TV broadcasting companies and cinema distributors for the availability of audiovisual programmes and films. With the advent of the video recorder, internet and DVD recorders, the public have full control over what they view and when they view it. There are now instant pause and replay facilities; there is also software to edit and blend text, images and video sequences into personalized databases. Hence television, hitherto regarded by many as a poor information medium (Watts, H. *On Camera: Essential Know-how for Programme-makers*, London: Aavo, p. 18, 1999; Henbest, N. in *Communicating Astronomy*, La Laguna-IAC, p165, 2005), can now—by virtue of replay and editing facilities—make much more information available that can be supplemented by other media according to the viewer’s wishes. Viewing is no longer the serial experience it was a quarter of a century ago.

Members of the public who become hooked on astronomy in this way swiftly move into the midreach market, but they are a minority: for the great majority of the public astronomy outreach has but a brief impact. Increasing the general awareness of the public in science is a slow process ultimately involving the educational establishment. Outreach can enhance education but is no substitute for it.

While astronomical outreach, as defined in this article, still leaves much to be desired, I think it fair to say that what I am calling midreach has been considerably more successful, especially in recent decades. There is now a plethora of popular astronomy magazines on the market in many languages. Without a doubt, pride of place must go to *Sky & Telescope* with a global circulation of more than 100,000 (Fienberg, private communication). Since April 1987, the UK popular astronomy market has been served by Astronomy Now. Both magazines offer a similar blend of brief news items, monthly star charts and ephemerides, feature articles, book, equipment and software reviews, opinion columns and letters to the editor. Both magazines also have useful websites.

Two reasons often put forward to urge scientists to engage in outreach are the right of taxpayers to see how their contributions are being spent and the need for a scientifically literate electorate to decide on political issues involving science in a democratic society. Both reasons are praiseworthy, but neither is convincing. Taxpayers are rarely consulted on how their taxes are spent, and a scientifically literate population benefits almost any form of government, including dictatorships (to give just one example, the first artificial satellite was launched by a communist regime and was followed with great interest by the Soviet public (Kaplan, S. A. *Kak uvidyet', uslyshat' y sfofografirovat' iskusstvenniye sputniki zhemli*, Moscow: State Publishing House of Physico-Mathematical Literature, 1958)). Advocating outreach activities in the interests of good citizenship, then, will not cut much ice with overworked researchers busily seeking project funding or tenure. A completely different approach is necessary. The relatively recent exponential increase in the number of working scientists has led to the rise of overspecialization and consensus thinking (Kuhn's "normal" science; Kuhn, T. S. *The Structure of Scientific Revolutions*, 3rd edn, Chicago: UCP, 1996). Ulam (*Adventures of a Mathematician*, New York: Scribners, 1976) made the following interesting observation that could apply equally well to present-day astronomy: 'In mathematics one becomes married to one's own little field. Because of this, the judgment of value in mathematical research is becoming more and more difficult, and most of us are becoming mainly technicians.' Rees (2001) makes a similar point about the blinkered outlook engendered by overspecialization.

This tendency towards overspecialization makes it imperative for astronomers to describe their work – not only as outreach, but also in departmental reports, funding applications and even observing proposals—in terms that a non-specialist can understand. That's *midreach*! It is equally incumbent on researchers to keep abreast of what is going on in other fields related to their own and in astronomy generally. Research journals are far too specialized for this purpose, although a small number of journals, such as *Nature* and *Science* offer a fairly highbrow form of midreach.

MIDREACH: TALKING AMONG OURSELVES

INREACH: GETTING THROUGH TO THE RESEARCH COMMUNITY

No researcher's astronomical reading would be complete without regular perusals of such magazines as *Scientific American*, *New Scientist*, *Sky and Telescope*, *Astronomy*, *Astronomy Now*, etc. But unless at least a small proportion of specialists address themselves to the task of doing midreach and outreach, there is a far from negligible risk of misrepresentation or oversimplification of the science under discussion. Who better to write about cosmology, say, than a working cosmologist?

Scientists need to realize the necessity of adequately publicizing their work and passing it into the public domain; however, 'The Washington Charter' (http://www.communicatingastronomy.org/washington_charter.html) places the responsibility for providing the wherewithal, time and training to do midreach and outreach on research centres. The Charter does not distinguish between outreach and midreach as is done here, but it is essential to be clear as to the type of audience being addressed.

MARKETS FOR POPULAR ARTICLES

Popular astronomy articles for the midreach audience have a wide range of outlets, ranging from the review columns of *Nature* to popular magazines such as *Sky & Telescope* and *Astronomy Now*. The readership ranges from research astronomers wanting to keep abreast of progress in other branches of astronomy to the astronomically aware general reader. Outreach, however, is an entirely different matter. Apart from news coverage, there are relatively few outreach articles on astronomy in the periodical press (Rees 2001; Madsen, C. in *Astronomy Communication*, ed. A. Heck & C. Madsen Dordrecht: Kluwer, p. 67, 2003).

NEWSPAPERS AND GENERAL-INTEREST MAGAZINES

In a study of the coverage of astronomy and space-science in the European print media, Madsen (2003) divides astronomy-/space-related articles into four categories: i) *space articles* (mainly coverage of space missions), ii) *'bona fide'* science articles (with an emphasis on new research results), iii) *'planetarium-type'* articles (principally covering positional astronomy and celestial mechanics), and iv) *other* (scientific controversy and the interface between science and other disciplines). My main concern here is with the last category, about which Madsen makes the following illuminating comment: 'In some sense, it is in this category that science "meets" other major human activities, and it is indicative that very few articles fall in this category.' In other words, precisely those areas where science connects with other disciplines and activities is where printed media coverage is weakest: in the quality press, then, the Two Cultures seem to be as divided today as they were when Snow gave his famous Rede Lecture (Snow, C. P. *The Two Cultures*, Cambridge, CUP, 1959). The feature article has an enormously important role to play in getting astronomy and the other sciences to cross the cultural divide and earn their rightful place in mainstream

intellectual thought. I discuss this disastrously neglected issue in a later section.

In recent years astronomy has suffered the irreplaceable loss of three culturally invaluable midreach journals with the disappearance of *Vistas in Astronomy*, the *Irish Astronomical Journal* and the *Quarterly Journal of the Royal Astronomical Society*. *Vistas* was transformed into a no-nonsense refereed research journal (*New Astronomy*) and *QJ* was supplanted by its glossy successor *Astronomy & Geophysics* (later abbreviated to *A&G* – attention span diminution, it seems, has become a problem even among the learned!). The forum for the discussion of astronomical culture has shrunk correspondingly. *A&G* articles are shorter than their more expansive *QJ* predecessors, and the mission statement in the first issue of the new magazine (*A&G* 1997, 35, 5) expresses an increased demand for formality on the part of its authors and an emphasis on authoritativeness (i.e. consensus thinking) in comparison with the more relaxed requirements for *QJ* (see Bondi, H., Ovenden, M. W. & Dewhirst, D. W. *QJRAS*, 1, 3, 1960).

A small digression on the supposedly ever narrowing public attention span will provide a useful insight into the potentially destructive influence of purely profit-motivated market forces on the communications media. Once again, the type of audience must be taken into account. British television perfectly illustrates the full spectrum of programming content and style. At the top end are the excellent Open University (OU) programmes that provide audiovisual support to the OU's wide range of undergraduate courses. A maths programme, for example, might take the student through a lengthy derivation. The viewership is tiny compared to those of soaps and shows, and the audience is credited with a sufficiently long attention span to be able to follow difficult mathematical arguments.

The *Horizon* programme, the flagship of the BBC's science broadcasting, is midreach in style but has recently moved more downmarket. Scientists are encouraged to put their story across in a way that will interest their peers and appeal to a thinking lay audience at the same time. Audience attention span used not to be considered a problem, although the pace of some recent programmes has deliberately been made snappier.

Henbest (2005) informs us that a well-known American TV channel insists on a "wow" fact every 90 seconds and a stunning visual every three minutes, the reasoning being that failure to stimulate continuously will prompt the audience to zap to another channel. How justified is this assumption? It is worth pointing out (Henbest, N. in *Astronomy Communication*, p. 55, 2003) that Carl Sagan's 13-hour long *Cosmos* series, in which Sagan presents lengthy chains of verbal and visual reason-

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PUBLIC ATTENTION-SPAN ATROPHY: MYTH OR REALITY?

ing, often with not a single wow fact or stunning visual in sight, has been seen by 500 million viewers in 50 countries. Indeed the series is still available on DVD. While Henbest recognizes the continued impact of the more traditional science programme (the BBC's *Horizon* being perhaps the supreme example), he cites the pressure on makers of programmes for commercial TV from the high-impact visuals and graphics in cinema films, TV adverts and the superb images and graphics being generated by the astronomical community itself. Henbest further cites the apparent truism that television is not an information medium.

But is television really such a poor communicator of information? Soaps are among the most popularly viewed television series worldwide. Couper (1995) reports that in 2001 the average British viewer watched 99 hours of soaps (almost the equivalent to watching Sagan's *Cosmos* series seven times in a single year). There is undeniably a dearth of wow facts and stunning graphics in the average soap, yet multitudes of viewers are hooked and forget to zap. What is it that draws so many viewers to this sort of programme, but that causes them to zap continuously for others?

Couper claims that viewers are drawn by human interest stories. In soaps the plots can have many evolving story lines involving numerous individuals and events. Yet multitudes of dedicated viewers seem to be capable of following all the complexities of character and plot during individual episodes and throughout entire series. Soaps contain a wealth of information – admittedly all fictional and non-technical, but information none the less. Even so, in spite of the high fictional information content of soaps, there does not seem to be an attention span problem. Couper is undoubtedly right in her claim that television viewers are largely attracted by programmes that tell a human story. People possess an enormous store of knowledge concerning people.

Such, however, is certainly not the case for science, mathematics, economics, politics or law. Unless we pay close attention to the contents of a news bulletin, we are not very likely to retain more than a scrap of the barrage of information thrown at us in a very brief period of time (although news stories involving scandals or tragedies are more easily retained since we process them with reference to our personal experiences and knowledge of human society). Successful outreach must therefore emphasize the human interest that is inherent in the profoundly human activity of science. This was brilliantly done in the dramatization of Dava Sobel's *Longitude*, which, far better than the book itself, gave an extremely moving account of Commander Rupert T. Gould's struggle to restore Harrison's timekeepers (Gould, R. T. Q. J. Soc. Naut. Res., 21, 1935; Sobel, D. *Longitude*, London: Fourth Estate, 1996). It is important to stress that even the most elementary terms, such as light year,

must always be explained as though the reader or viewer had never heard of it before. Strong use must be made of simile and metaphor (see Rodríguez Hidalgo, I. 2005, in *Communicating Astronomy*, p. 172, for an interesting discussion of the problems of radio outreach). The distinguishing feature of outreach is that we must always start from the beginning.

News reports provide the greatest source of astronomy-related stories. The impact of Comet P/Shoemaker-Levy 9 on Jupiter in July 1994 and the transit of Venus on 8 June 2004 both produced a flurry of intense media coverage. Regular celestial events such as meteor showers and eclipses also draw considerable media coverage, which instantly dies down when the event has passed. Nearly all the coverage, although variable in quality, is sympathetic towards astronomy.

Much rarer are feature articles and programmes dealing in depth with an astronomical issue. Background stories are occasionally produced in conjunction with major celestial events such as transits of Venus. Feature articles not related to specific celestial events are very much less frequent, a recent exception being a feature that appeared in the *Sunday Times* News Review on 5 June, 2005 (Appleyard, B. *Sunday Times News Review*, 5 June, 7, 2005). The story dealt with a simulation of the formation and evolution of galaxy and quasar clusters reported in *Nature* (Springel, V. et al. *Nature*, 435, 639, 2005). The article describes the small-sample problem of cosmology (only one universe to play with) and the resurrection of Einstein's cosmological constant in the guise of dark energy. The treatment is light but a genuine attempt to put the basic scientific case across in the 1500 words of text. Unfortunately, the 390-centimetre squared colour image of the simulation has a brief one-line caption that talks about Einstein's greatest blunder possibly being his greatest triumph but does not explain the meaning of the image, which looks more like synapses linking the neurons of the brain than anything to do with galaxies or quasars. A puzzled reader might well wonder whether the editor has got the illustrations mixed up. How much more informative might the image have been had it been slightly reduced in size to allow for a quarter of a column of useful description of the way in which galaxy clusters distribute themselves into vast filaments and sheets. Sadly, in an otherwise informative and interesting article, a large, unexplained image succeeds only in conveying zero information to the general reader. The article is introduced by a trite headline ('By Jupiter, the scientists were right') and a cryptic introductory sentence ('The simulated universe has confirmed a dark truth, says Byan Appleyard'. However, these elements are designed to be eye-catching rather than informative (the same principle is used in magazines such as *New Scientist*).

According to Madsen & West (in *Astronomy Communication*, p. 3, 2003), '*In terms*

THE IMPORTANCE OF THE FEATURE ARTICLE IN BRING- ING ASTRONOMY TO THE PUBLIC

WHEN A WORD CAN PAINT A THOUSAND PICTURES

of public communication, images may sometimes be self-explanatory or at the most demand a short and simple caption. Yet astronomical images have a long tradition of misleading even astronomers. When Sir William Herschel discovered Uranus he mistook it for a comet. Herschel also discovered planetary nebulae, but at first took them to be distant congeries of stars (Herschel Phil. Trans., 75, 213, 1785): *'We can hardly find any hypothesis so probable as that of their being Nebulae; but then they must consist of stars that are compressed and accumulated in the highest degree.'* Further observations eventually persuaded Herschel to change his mind and declare planetaries to be true nebulosities (Herschel, Phil. Trans., 81, 71, 1791). Herschel was, of course, working at the limits of ocular detectability and customarily used extremely high magnifications, making his images blurred and faint. The point being made here is that even Herschel, widely recognized as the greatest telescopic observer in astronomical history, occasionally failed to interpret astronomical images correctly. The Kant's "island universe" hypothesis regarding what are now known as galaxies was not finally established until 1924 when Hubble observed Cepheid variables in three spiral "nebulae" (see Hubble, E. *The Realm of the Nebulae*, New Haven: Yale Univ. Press, p. 28, 1936). Pre-photographic telescopic observations of spirals had previously given rise to the suggestion that they might be gaseous whirlpools in the process of forming planetary systems (see North, J. D. *The Measure of the Universe: a History of Modern Cosmology*, Oxford: Clarendon Press, p. 7, 1965). Astronomical images must *a/ways* be adequately captioned and fully explained in the narrative. Images that do not receive this treatment are simply a distraction.

The basic problem with astronomical images is our lack of depth perception on the cosmic scale: what in reality occupies vast expanses of space appears to us in two dimensions with depth projected on to the flat surface of an image. To borrow a term from photography, in astronomy everything is "at infinity". In a terrestrial context, humans have a well-known capability of deprojecting two-dimensional images of three-dimensional objects and even possess the ability to rotate a projected image mentally by comparing two images of the object taken from slightly different angles (Shepard, R. N. & Metzler, J. *Science*, 171, 701, 1971). In astronomy, however, deprojection can normally only take place, and then only indirectly and not always unambiguously, with the aid of spectroscopic analysis. The position and motion of parts of an object along the line of sight are often difficult to ascertain; for example, Oort (*Ann. Rev. Astron. Astrophys.*, 15, 295, 1977) interpreted various expanding neutral hydrogen features within a few kiloparsecs of the Galactic Centre as being the result of a central explosion, although he admitted that the effect could be caused at least in part by some sort of resonance effect. Nowadays this phenomenon is generally recognized as gas streaming brought about by the gravitational potential of the Galactic Bar.

The Universe beyond the Earth's atmosphere is entirely alien in nature: the distances involved dwarf the imagination: the extremes of temperature, density and gravitational attraction are entirely beyond our everyday experience on the surface of this planet. Astronomical images can therefore sometimes be extremely uninformative (or even misleading) when presented in the absence of context. Most astronomical images – however spectacular and eye-catching they may be—will need a great deal of verbal support from a communicator if their content is to be made at all comprehensible to the public. A stunning telescopic image by itself will often convey little useful information to the uninitiated: in astronomy, it is words—not pixels—that do much of the painting.

Models are useful in understanding methods of communication. A useful model should be capable of describing a given situation and suggesting the possible results of various strategies. Several communication models are described by Madsen (2003), including Madsen's own sophisticated model, which consists of overlapping constituencies, the overlaps representing the actual communication process, set against a background of public discourse. This model may be taken further to provide a generalized model of science communication with both descriptive and predictive power. A generalized model (for which no claims to originality are made) works as follows:

Each *constituency* (astronomers, peers, funding agencies, media, public) is represented by a *node*, which is part of a *network*, and which is joined by *bidirectional channels* to all the other constituencies.

- The topological properties of this setup enable any constituency to be placed at the centre of activity, thus adding flexibility to the model and allowing communication to be viewed from the perspective of any given constituency.
- The entire network is set against a *shared cognitive background*.
- Shaded *area of activity*, or *focus*, encloses the communications activities of the central constituency, the intensity of the shading indicating the level of activity.
- The area of activity will have its own *communal cognitive background*.
- There is one *medium of communication*: language. The “media” (i.e. the commonly used term for newspapers, magazines, TV, radio, the internet, etc.) may be represented either as individual nodes or generally by a single node; they are regarded in the model as constituencies rather than channels).
- Acts of communication occur among constituencies via interlinking channels.

A GENERALIZED MODEL FOR SCIENCE COMMUNICATION

This model has the advantages of a non-hierarchical structure (i.e. it makes no pre-judgements concerning the relative importance of the various constituencies), flexibility of perspective, bidirectional flow of communication (the constituencies may be seen as sharing information), no periphery (no node is really central) and a common cognitive background for all the constituencies. The number of nodes may be varied in different studies, ranging from general outreach to detailed analysis of, say, research publishing. The common cognitive background will vary accordingly. For descriptive purposes, reality is injected into this idealized picture by placing a given constituency in the central node and adjusting the directionality of the channels. The gradually shaded area of activity describes a given constituency's communications profile for different types of communication.

Figure 1: Right: An astronomer's professional communications tasks; right: An astronomer's outreach and midreach communications tasks.

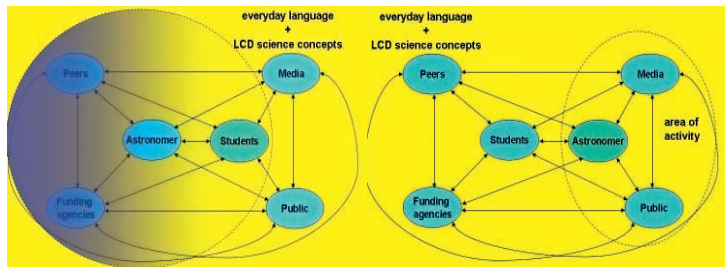


Figure 1 left shows the research communications profile of an astronomer; the area of activity indicates a large burden of research and a lighter PhD student supervisory load. The communal cognitive background will be the language and practice of astronomical research. The bidirectionality of the arrows suggests genuine communication among all the constituents. The perspective is that of the astronomer, but any other node could be made the central one to find the perspective of any given constituency (for example, from a PhD student's perspective the astronomer-student arrow might be perceived as uni-directional, indicating a little feedback to the student, a situation that would need to be remedied). If the astronomer engages in outreach and midreach, his focus will be shifted (Figure 1 right) to denote a different set of constituents (this time including the public and the media). The communal cognitive background will approximate very closely to non-numerate, non-scientific general knowledge.

The model shows why outreach and inreach are different in degree and kind. An outreach audience will need every scientific concept described afresh since the common cognitive background does not reach beyond the lowest common denominator of general knowledge in questions of science. However, for an audience educated in areas other than science, the common cognitive background will include a sophisti-

cated level of reasoning, so that the level of discourse may be correspondingly higher (as might be done, for example, in a trade book or feature article). Two examples of influential trade books aimed at this level are *The First Three Minutes* (Weinberg, S. London: André Deutch, 1977) and *The Selfish Gene* (Dawkins, R. 2nd ed, Oxford: OUP, 1976). For a midreach audience the discourse is at a higher level with a shared background of basic scientific knowledge and numeracy. The history of astronomy provides a fairly high level common cognitive background, interfacing as it does with many aspects of the humanities and is an area that could be developed much further.

A useful rule of thumb for the use of images and graphics in astronomy communication would seem to be to accompany every image/graphic with a brief explanatory caption to be followed up in detail in the body of the narrative. Uncommented imagery often mystifies readers and viewers and diverts attention from the message of the narrative. The aim of a feature article or documentary should always be to engage minds, rather than just fill the collective cranium with glitz and decibels.

The educated sector of the public is ill-served by the outreach community, as has been identified by Rees (2001). The dearth of feature articles needs to be addressed; trade books, feature articles and documentaries that tackle issues in depth and seriously would undoubtedly find a market. At least some of this outreach must come from the professional community and preferably not in the form of press releases.

The generalized model suggested here provides a flexible way of describing communication setups and identifying problem areas and will be developed in a future paper. It makes clear the necessary distinction between outreach and midreach.

CONCLUSIONS