5 Organising/Disorganising the Breakthrough Motif: Dolly the Cloned Ewe Meets Astrid the Hybrid Pig

NIK BROWN

The 'breakthrough' motif today serves as one of the most pervasive temporal abstractions for describing key events in science and medicine. Of late, it has come to refer to commemorative moments including the introduction of penicillin, antibiotics, x-rays, vaccination, radiation therapy, transplantation, new genetics and much more. And every breakthrough has its towering 'heroes' and 'pioneers': Pasteur, Fleming, Florey, Jenner, Curie, Crick and Watson, etc. As such, breakthroughs signify unequivocal disjunctures in the overall temporal shape of innovation and science, designating all the major 'steps forward' of grand progress narratives (Lyotard, 1984). It is therefore, probably one of the most routine cultural methods available for making tacit sense of the dynamics of change and the relevance of 'the new' to the future.

This is not to imply that breakthrough is unambiguously favourable to those who use it most. Both scientific institutions and popular science writers express competing points of view. The metaphor is sometimes derided by both constituencies as an overused cliché that inflates hopes and creates promises which too often go unfulfilled (Palevitz and Lewis, 1998; MacNair, 1995). A good example of this is a recent meeting between senior scientists and correspondents at Cold Spring Harbor entitled '*Breakthrough! How News Influences Health Perception and Behaviour*'. Illustrating the ambivalences embedded in breakthrough, during the course of the meeting, the metaphor was quickly abbreviated to the pejorative 'B-word'. In a review

of that meeting by two of its attendees, both scientists, these tensions were expressed as follows:

> The Use and Abuse of the 'B' word
> The 'B' word - breakthrough - divides scientists and journalists as no other… no word better signifies the crosscurrents and undertows that can sink the communication process. And none better reveals the cultural divides that separate the two professions. Is the B word abused, to the extent that its impact is diluted? (Palevitz and Lewis, *The Scientist*, 20.7.98)

Yet, the metaphor is also valued for the very reason it is derided. It is held to be a convincing vehicle for disseminating findings, generating future patronage and legitimating funding (Kent, 1997). In another skirmish, a *British Medical Journal* author publicly criticised a press release she had received announcing 'a breakthrough for sufferers of Noonone Syndrome', taking issue with the press release's 'loss of perspective as to the importance of the discovery of the gene' (MacNair, 1995). The Director of a prominent patient advocacy organisation, the Genetic Interest Group (GIG) protested at this, writing:

> I hope that Macnair's views regarding the press release announcing a 'major breakthrough for Noonan Syndrome' are not representative of those held at the *BMJ*. The discovery of a gene… is a major breakthrough for those at risk... It shows that progress is being made and provides hope for the future… If the release had been headed 'Minor advance for those with obscure disease - not many interested' I doubt that many people would have been moved to read it. The media make the rules… the *BMJ* should not take the high moral ground if those with something to say play by those rules (Kent, *BMJ*, 1995, 310, p.672).

Now neither of these interpretations contest breakthrough as such but merely comment on its proper application. In other words, the motif is used as an ideal measure or benchmark with which to judge events as being either hyperbolic or having a real 'future'. Apparently then, it is valued highly enough to merit protection from being sullied by misapplication. As the last extract clearly illustrates, breakthrough is also evidently the axis in a distribution of blame between two reporting constituencies, science and the media. For different groups, it therefore defines the limits and boundaries of what counts as good and bad discourse about knowledge, science and the future.

This chapter is concerned with doing something quite different to determining when events properly deserve to be graced with one of

contemporary science's most cherished temporal abstractions. Instead, it sets out to open up 'breakthrough' to explore some of the rhetorical, historical and material constitutive properties of a metaphor that will always misrepresent the messy and indeterminate way in which knowledge is actually made and what it is capable of doing for the future. So unlike those constituencies described above, I am not concerned with redeeming some core breakthrough value to be preserved and held up as an ideal to which all disclosures in science and technology should aspire.

The chapter also shows how breakthrough has emerged alongside wider changes in the proprietorial, public and utility focussed character of science and, as such is intimately tied into the two-fold practical orchestration of present problems and future solutions. It identifies breakthrough as probably the most powerfully future oriented metaphor within the current disclosure repertoire of science and science journalism. In other words, it lends itself to the construction of a future in a way that other forms of disclosure representation, particularly the 'discovery' motif, do not. The importance of making sociological sense of breakthrough arises from its pervasive use in cultural discourse about science and technology and its hitherto absence as an object of analytical attention, at least in Science and Technology Studies (STS). Another compelling reason for this analysis is that despite its ubiquity, breakthrough is, as we will see, a very recent addition to scientific reportage. Addressing the metaphor in greater depth is all the more pressing since, as a number of studies have pointed out, public interest and confidence in science is seen to be most concentrated in those areas commonly considered 'breakthrough medicine' (Durant, Bauer and Gaskell, 1998).

Empirically, my argument is comparatively situated in two disclosure cases, Dolly the cloned ewe and Astrid the hybrid pig. When the Roslin Institute announced that they had produced a mammalian clone, they had no anticipation of the furore that would follow in Dolly's wake. The central problem was that Dolly came to represent a whole different universe of futures to the one that Roslin's researchers had in mind for her. As everyone knows too well, the controversy lies in the seemingly sudden capacity to create endlessly repetitious duplicates of otherwise distinctive beings. More recently though, Roslin's disclosure has also been contested in respect to whether and on what basis Dolly can legitimately considered to be a clone. In the other case, that of a hybrid pig, science's politics have been involved in different kinds of dispute arising from bodies that traverse species boundaries. Such hybrids cut through species difference with an unprecedented traffic in genes, tissues, cells, organs and even viruses. Like

clones, hybrids too occasionally rise to the dizzy heights of meriting a name. Astrid was the first female transgenic pig produced by a British firm for organ provision in human replacement surgery. The case will illustrate the work done to qualify one of the firm's disclosures as a breakthrough in the immunological similarity of 'donor' animals and 'host' humans.

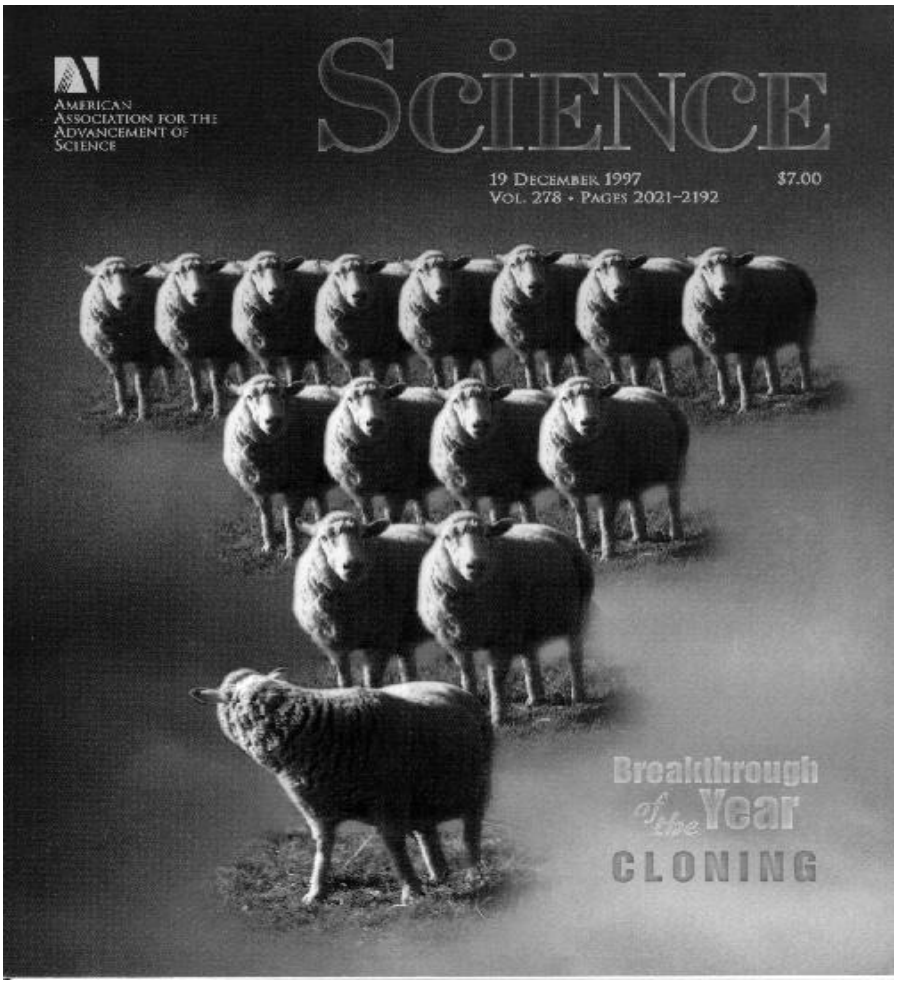

Fig 5.1. Breakthrough of the year 1997. From the cover of *Science* 19.12.97. Reprinted with permission. Copyright (1997) American Association for the Advancement of Science, and the artist, Ann Elliot Cutter.

The central problem for this analysis lies in how to make sense of the role of the breakthrough motif within contrasting contexts such as the two cases just introduced, asking: what and whose purposes it serves, what networks of activity are involved, on what basis breakthrough comes to be contested. Before exploring the Dolly and Astrid cases in more detail, there are a number of analytical approaches outlined below that will be of value in answering these questions. First, while there are no direct accounts of breakthrough in STS scholarship, there is a literature on breakthrough's near pseudonym 'discovery'. Contrasting the two terms is essential to determining what it means to invoke relatively distinct disclosure rhetorics. Second, breakthrough is inextricably wedded to the conventions of news discourse, the same conventions so frequently cited by scientists as being responsible for the ubiquity of the motif in the public communication of science. Finally, central to the construction of a breakthrough from past problems to future promise is the issue of timing. Here, I borrow on the rhetorical analytical term 'kairos', literally meaning 'the right time', asking how it is that timing contributes to the mobilisation of disclosure metaphors and futures.

Interpreting Breakthrough

Deconstructing Discovery Accounts

Woolgar and Brannigan, in separate projects, have both offered critiques of discovery episodes in which the metaphor is presented as an unstable practical-rhetorical achievement. Upon closer examination, discoveries are unstable both in respect to what really happened (Woolgar, 1976) and also the values or measures used to assess the significance of events in science (Brannigan, 1981). Woolgar's version of the 'discovery' of pulsars starts with inconsistencies between retrospective accounts by different members of the original research team based at the radiotelescopic observatory in Cambridge. These variations suggest that discovery is just one of many possible interpretations rather than being a singularly consensual description of 'what really happened' (Woolgar, 1976 p.395).[1] For Woolgar, 'discovery' implies an unrealistic commitment to 'preconceived notions of instantaneous discovery' rather than extended process, and this reduction in complexity increases as events recede further into the past. (ibid. p.417). Similarly, Brannigan critiques what he calls 'folk theories' of discovery where the idiom

is attributed to, for example, inspired genius or cultural determination (Brannigan, 1981). The second of these explains discovery as an inevitable outcome of a culture's level of development producing the same results in scientists working independently at the same historical time (ibid. p.46). Other 'folk' criteria for discovery qualification include *originality* or the perceived precedence of an event; its validity in context, meaning that not all 'discoveries' were held to be such at the time original claims were made. Likewise, successful discoveries are sometimes disqualified when their premises are subsequently contested.

At one level, 'breakthrough' and 'discovery' might be said to be similar. Both unquestionably depend on a retrospective concentration within single events rather than process and both index time by recalling prior key moments with which to compare an event. Van Lente in Chapter Three of this volume makes a similar observation regarding the historically comparative properties that are constitutive of metatemporal discourses, particularly that of 'technological progress'.

Now, despite the slippage, breakthrough and discovery metaphors differ in some very important respects. The empirical cases discussed below indicate that in the case of breakthrough, this indexing of time is also prospective in that the metaphor implies the building of suspense and momentum towards future events and new impasses. Also, the discovery metaphor is more usually used to characterise the uncovering or *laying bare* of a universal nature (*new knowledge*) whilst breakthrough tends to be associated with novel solutions to existing well-defined problems (*new technologies*).

Probably one of the most important differences between the metaphors is that unlike discovery, breakthrough has only recently entered the lexicon of science disclosure. Taking my cue from William's keywords-type analysis, there's a striking etymological history in how breakthrough comes to be attached to science and technology in the way that it does today (Williams, 1983). At the turn of the twentieth century, breakthrough largely describes military campaigns, before being used to talk about the breaching of economic barriers and the creation of new markets. But it is not until as recently as the late 1950s that it first makes its appearance as a signifier for science and technology. In a telling blend of military and scientific reference, a feature in *The Listener* in 1958 describes 'The technological break-through which allowed both the United States and the U.S.S.R. to produce H-bombs within a year of each other' (11 Sept 376/2). So the common use of breakthrough to refer to events before this time, such as those listed at the

beginning of this chapter, reveals a very recent historical revisionism of pre-mid twentieth century events in science and technology.

The significance of breakthrough's recency can not be overestimated since it registers far reaching changes in the way knowledge is represented, practised and perceived. Shifts in metaphors such as this are materially and institutionally very powerful (Lakoff and Johnson, 1980). For Fox Keller, the metaphor of nature's 'secrets' has long provided a motivation for science and the need for counter metaphors like discovery with which to 'probe' secrecy (1992). Discovery implies the chance giving up of nature's truths to the enlightenment's impartial observers, its 'modest witnesses'. In effect, this is nature doing what it normally does but now observed by scientific onlookers equipped with the experimental instruments to 'uncover' what was secret before: 'The ferreting out of nature's secrets, understood as the illumination of a female interior, or the tearing of Nature's veil, may be seen as expressing one of the most unembarrassedly stereotypic impulses of the scientific project' (ibid. p.41). The shift towards breakthrough from discovery, we might contend, signals a newly contemporary object for feminist critique. Breakthrough arguably represents a new and more aggressive repertoire. By necessity it implies the requirement of considerable force to push through a barrier of some kind: there is very little that is modest about that!

Also, the recent emergence of breakthrough certainly resonates with what Michael Gibbons and others have called the 'new mode of knowledge production' (1994). That is, actors are increasingly producing knowledge in the contexts of problem and application. To this extent, breakthrough has become the metaphorical location of values and activities whereby knowledge is rewarded and validated in relation to actual and clearly defined problems or impasses rather than, as in the case of discovery, being prized for its speculative or serendipitous character.

Deconstructing News

The deconstructing discovery story described above and embedded in the accounts of Brannigan and Woolgar tends to attribute temporal abstractions like discovery to disclosure by scientists and their institutions. But such abstractions, and breakthrough in particular, emerge in the interface with other forms of reporting too. As the disputes with which I began this chapter illustrate, it is the requirements of news discourse and the demands of the daily competition for the documentation of events that are widely seen (by

many scientists at least) to be instrumental in shaping science disclosures into spicy breakthroughs. To count as news, suggest analysts like van Dijk and Bell, information should be novel, unprecedented and recent (van Dijk, 1988; Bell, 1995). The competitive dimension also imposes certain constraints in terms of length, brevity and the accessibility of news accounts to as wide a share of the viewing/reading market as possible. Like the breakthrough and discovery metaphors, news is temporally condensed or foreshortened in response to such pressures. News also relies on a certain degree of presupposition that interpretatively prepares the audience to receive information as news. Where preparation is seen to be inadequate the story will include a brief chronology spelling out how a crisis developed or a situation became more acute until the new/s event itself either exacerbates or resolves the developing narrative.

Not surprisingly, the breakthrough metaphor lends itself neatly to many if not all of these features. For example, interpretative preparation might mean a shared understanding that breakthrough properly describes how new knowledge comes about. Now, in contrast to the cited disputes in the *BMJ* and *The Scientist* with which I began this chapter, laying responsibility for breakthrough at the door of science correspondence falls far short of being an adequate explanation for how science disclosure comes to be breakthrough news. As the Dolly and Astrid cases will illustrate, the picture is far more complicated and ambiguous. Indeed, it is the ambiguity surrounding who is responsible for the social scripting of breakthrough that allows scientific and journalistic actors to exchange ideal reporting identities and conventions when it suits them to do so.

Rhetorical Analysis and 'Kairos'

The fate of a scientific disclosure rests upon the configuration of an appropriate temporal context in which its significance can be readily understood. 'Kairos' is a classical rhetorical term through which analysts have sought to understand the temporal context of a rhetor's interjection, how it is that people simultaneously construct and respond to a temporal context in which actions either succeed or fail. Kairos literally means *the right time… what makes this the right time?* It implies an occasion for agency that is specific not to any time, but to *this time* rather than another (Smith, 1969; Miller, 1992, 1994; Kinneavy, 1986). Very often the opportunity is a consequence of a problem having led to a crisis such that, for example, a particular scientific claim might be said to be 'timely' or even overdue. Miller

has applied the term to Watson and Crick's 1953 disclosure in *Nature* of the molecular structure of DNA (Miller, 1992). She contrasts this with Oslwald Avery's claim a decade earlier in which he similarly presented research evidence pointing to DNA as the biological agent in replication (Avery et al., 1944). Even though the conclusions were in effect almost identical, their timing was quite distinct with Avery's paper floundered in a knowledge community where there were few prepared to recognise the claim as the answer to a widely asked question. Kairos points to the temporally extended processes whereby expectations are circulated and come to converge upon a particular moment. Kairotic moments, practically and rhetorically organised, represent a concentration of agency, a disjuncture, in which it becomes easy to forget or hide the many other contingencies or agents upon which a 'right time' came to depend. Let me now consider some of these analytical resources through the two cases, beginning with a 'breakthrough' in the development of transgenic animals for human replacement surgery.

A Transgenic 'Breakthrough' – Astrid the Hybrid Pig

Astrid is one of a cohort of transgenic founder stock produced by the British biotechnology firm Imutran. Her genome contains the gene for a function of the human immunological system, Decay Accelerating Factor (DAF), the idea being that upon transplantation, the organs of her kind will fail to trigger at least one rejection process involved in human immunology. This case focuses less on Astrid per se and more on a disclosure event to which she was an essential precursor. In early September 1995, Imutran invited science correspondents to join them at a press conference at the Royal Society of Medicine on the 12th of that month. With details still undisclosed, Imutran's press office hinted at 'major new findings' and 'important progress'. In this way, a special moment was chosen to disclose experimental trials in which the hearts of ten cynomolgus monkeys were excised and replaced with ten transgenic pig hearts. At the event a document was distributed to attendees and forwarded to major news agencies around the world. This extract below is taken from the technical contents of that press release:

1. Each received a transgenic pig heart and was given similar levels of immunosuppression as humans.
2. Of the 10 transplants, 2 are currently surviving at up to >60 days.
3. Examination of two monkeys on days 34 and 35 with the pig hearts still beating showed that the hearts were normal with no signs of rejection.

4. The median survival for this group is currently >40 days.
5. Control hearts survived 55 minutes.

The rest of the press release sets out to translate what this data means such that otherwise relatively obtuse technical information is put into interpretative context:

> The success of the trial… confirms that the technology could be the answer to the current organ donor shortage. Imutran believes its technology is now ready to be tested in humans and expects to begin the first trial in 1996, in the UK. Studies will be carried out at Papworth Hospital… .
>
> Imutran has overcome the major hurdle in the development of animal organs for transplantation into humans... . This contrasts with work carried out by a group in the USA... using similar technology, which recorded a maximum survival of only 30 hours... .
>
> Director of Cardiac Transplantation at Papworth Hospital added his endorsement for Imutran's *ground-breaking* work. 'This research is now well advanced and we are making excellent progress... The programme of human clinical trials planned for 1996 will be a big step forward… a genuine advance in transplantation' [my emphasis].

First, the document describes the current impasse to which these findings represent a breaching, that being an 'acceptable' level of immunological parity between a 'donor' and 'host' species. This is then used to signal the possible breaching of a still present impasse, the xenogeneic solution to the shortage of replacement tissues and organs for human replacement surgery, a future breakthrough. The press release repeatedly translates the animal trials into terms that anticipate the future clinical trials on human patients then scheduled for 1996. This 'breakthrough' is then infused with descriptions of 'genuine advance', 'big step[s] forward', 'excellent progress' and the distant prospect of the 'potential to save lives', all essential to creating the suspense around a future 'right time' a future 'breakthrough'.

In this way, Imutran's breakthrough depends on the experiment, and all that led up to it, extending over months if not years, being truncated and compressed into the terms of a momentous announcement at a press conference and through a press release. The moment of the disclosure itself is just as important. The press conference is scheduled to coincide with the annual meeting of the British Association for the Advancement of Science

such that the meeting itself is used as an additional public platform for the breakthrough:

> The announcement was described as highly significant by a leading transplant surgeon attending the British Association for the Advancement of Science annual conference… (*The Times*, 13.9.95).

In all, the announcement on September 12th translated into an evenly prominent media story. Whilst some of the coverage was scattered around the general date of the disclosure, most reports clustered on the day following, the 13th, in keeping with the recency ethos of news. In all, the immediate press response to Imutran's disclosure was invariably cast within the temporal terms of 'breakthrough'. A brief review of the content of the media coverage echoes the press release and is concentrated around several main themes. First, Imutran's breakthrough is routinely compared with other salient moments of therapeutic efficacy. In this way, analogies between historically separate events identify the current breakthrough as proportionate in significance to other breakthroughs:

> It is the most exciting breakthrough since the first heart transplant operation was performed by Christian Bernard in 1967 (*Daily Mail*, 13.9.95).

> The breakthrough is regarded as the biggest advance in transplants since the introduction of the drug that suppresses organ rejection 10 years ago **(***The Telegraph*, 13.9.95).

The metaphor can be either explicit as is the case in these extracts or implicit by being evocative of all those historical referents with which this event can be associated. It also entails a moral imperative such that if this event is as significant as 'the first heart transplant' then any opposition to the current development is proportionate to having halted the historically distant technologies from which we are currently seen to benefit. In this way, the breakthrough is intended to foster a more conducive regulatory context for a technology which might otherwise be more vigorously contested.

Secondly, the representation of the Imutran breakthrough also assumes a naturalised or 'black boxed' rendering of the xenotransplantation solution route. This effectively endorses the indivisibility of the fate of the technology and the fate of patients at the mercy of 'the critical shortage in replacement tissues and organs'.

> This week Imutran… said it had successfully transplanted pig hearts into monkeys... . [Terence English:] we still seem to be some years away from a reliable, cheap, totally implantable mechanical device that will take over the action of the human heart. It is not surprising that in the last few years there has been intense interest in the possible application of 'xenotransplantation'... (*The Guardian*, 25.9.95).

> More than half of the 5,000 people waiting for transplants die every year because no human organs are available. Answer: Pigs are now seen by many doctors as the answer to the acute shortage of donors (*The Daily Mirror*, 24.9.95).

Of course, the shortage crisis does not unproblematically equal an XTP solution. Other technologies might just as easily compete for ownership of the 'organ crisis' including some cloning technologies, mechanical devices and policy changes like the principle of presumed consent to organ donation. But naturalising the XTP solution route has been the focus of considerable promotional endeavour illustrated by announcements like this.

Finally, the xenotransplantation breakthrough is represented as a significant, but nevertheless, preparatory moment for the future breaching of a current impasse:

> Transplant patients could be given hearts within a year following a breakthrough in genetic engineering.. . Papworth surgeon John Wallwork, who is likely to perform the first operation, said: 'the programme of human clinical trials planned for 1996 will be a big step forward in the development of a genuine advance in transplantation' (*Today*, 13.9.95).

> Breakthrough could end transplant delays [headline]. Pigs' hearts could be given to humans early next year following a research breakthrough. "If trials are successful we could end the lottery for life which at the moment means some patients remain sick, some receive organs and some die," said… pioneer (*The Daily Express*, 13.9.95).

> Breakthrough enables trials to start next year [headline]. …a consultant at the Freeman Hospital… said: 'The transplant community is waiting with bated breath for the case to be proved in clinical trials…' (*The Times*, 13.9.95).

The breakthrough, then, is not simply celebrated as a single, cumulative great achievement, but rather it is put to work in the articulation of a distant temporal horizon - the creation of suspense. It is represented as an ordinal

position in time that remembers and constructs past and future breakthroughs. As it happens, the clinical trials set for 1996 were poorly timed to coincide with the height of the BSE/CJD crisis and general anxiety surrounding the risks of transpecies disease arising from this and similar technologies. To date, this has arrested the technology and shifted the locus of the impasse from immunological parity to overcoming viral pathogenic risk.

A Cloned 'Breakthrough' - Dolly

Dolly did not begin her public life until seven months after her birth when Ian Wilmut and fellow researchers published their article in *Nature* (Wilmut et al., 1997). As is the wont of scientific reportage, the paper was in all respects a dry technical retrospective account of the reproductive process leading to Dolly, cloned from the nucleus of a ewe's udder cell. It was not until much later that number 6LL3 would be renamed Dolly, a schoolboy reference to her somatic origins and the ample bosom of a US Country Western singer! Notwithstanding the joke, there are deep ambivalences in this substitution of signs. The giving of a name in the place of a number, as laboratory ethnographers note, makes relationships with research animals more tolerable, even socially satisfying (Lynch, 1988; Arluke, 1988).

Now Dolly was far from being any ordinary breakthrough. In a rather odd reframing of the beauty contest, she was actually voted 1997's 'Breakthrough of the Year' by *Science,* the journal of the American Association for the Advancement of Science (278, pp.2071-2192). The cover of the issue depicts Dolly standing in the foreground with a pyramid of her replicants receding into future time and space behind her. In effect, the temporal composition of the image represents Dolly glancing back over her shoulder to the future exponential duplication of her nuclear genome (see Fig 5.1). The honour itself was represented as something of a breakthrough by observers noting the rarity with which non-US-based achievements find their way into *Science's* 'top 10'.

> Sheep clone tops list of year's firsts in science [Headline]
> DOLLY the sheep has gone to number one in the list of top ten breakthroughs of the year, beating the Mars Pathfinder mission into second place. Heading the list as 'Science's 1997 Breakthrough of the Year' is Dolly, the world's first cloned adult mammal. The cloning of Dolly provoked the questions: do ethical concerns outweigh the possible social benefits of cloning? Can human cloning be far behind? (*The Daily Telegraph*, 19.12.97)

Whilst there is no mention of the breakthrough metaphor in the paper published in *Nature* by Wilmut et al., their engagement with wider publics and the press in particular is shot through with reference to the breakthrough significance of mammalian cloning by nuclear transfer. The following extract is taken from the press release sent out by the Roslin Institute and its commercial arm PPL Therapeutics. Note the standard use of the embargo preventing any accredited recipient pre-empting the carefully timed simultaneity of the disclosure before exactly 19.00hrs on 26.2.97. The use of the embargo is a routine way of making sure that the press has time to prepare copy whilst also coordinating the exact timing of the disclosure to coincide with some other event. In this case, the embargo anticipates, by no more than twelve hours, the issue of *Nature* in which Wilmut and colleagues publish their findings:

News Release

EMBARGOED UNTIL 19.00 HRS GMT, 26 February 1997
released 24 February 1997

Scientists at the Roslin Institute Publish
Scientific Breakthrough

ability to clone sheep through nuclear
transfer from somatic cells

However, Dolly presents a number of problems to the breakthrough ideal. Like Astrid, she is embedded in temporal processes extending heterogeneously through many experimental episodes and across many different animal bodies. She was in fact the 277th attempt at producing a clone by nuclear transfer. Her timed introduction into the spectacle of public life on a specific date and at a particular chosen moment in the duration of Roslin's experimental activities abbreviates many of the contingencies and modalities that might otherwise disturb her breakthrough status. We might think of this as a truncation of time that squeezes experimental process into the breakthrough abstraction. And yet very little of this concentrated timing,

this removal from modality, has been enough to protect the breakthrough from closer scrutiny, upon which we find that Dolly is indeed far from being the clone we all took her to be.

Dolly embodies the genetic attributes of multiple originals and is *not* exclusively a copy of one animal alone. To understand how, we have to go back the claims made in the original disclosure. In their paper, the Roslin Institute set out to explain how they had replicated a 6-year-old adult ewe by means of nuclear transplantation. That is, the nucleus of a somatic udder cell was taken from one ewe, treated to 'forget' its specific cell function and then transferred into an enucleated egg (oocyte) from a second ewe. The developing animal was then gestated in vivo in a third ewe before being brought to full term in fourth, Dolly's second surrogate parent.

Whilst it was relatively widely accepted that Dolly had inheriting the genetic attributes of the nuclear donor, it quickly transpired that she had also inherited the mitochondrial genome of the egg donor. The mitochondrion of a cell is responsible for making cells function properly and is located outside the nucleus. As such it has a separate genome to the nucleus and for this reason it is inherited matrilineally during fertilisation whether by heteroreproduction or nuclear transfer in this case (Evans, 1999). So Dolly inherits the mitochondial DNA of the egg donor and not the nuclear donor. In addition, she has also inherited genetic attributes and immunological properties from her two different *in vivo* surrogates.

As with the XTP case, the whole process of maintaining Dolly's breakthrough is ongoing. Probably one of the most striking illustrations of her ambiguous status revolves around claims that her genome is expressing internally different rates of aging. The proteins that protect the ends of her chromosomes (tolemeres) are shorter, in effect older, than they should be. The theory is that these structures continue to shorten throughout an organism's life eventually instructing cells to die. The length of Dolly's tolemeres seem to be inconsistent with her own age but consistent with that of the nuclear donor suggesting that she is simultaneously four and nine years old (*Nature*, 27th May 1999). This destabilises the whole discourse of biological 'copying' because Dolly does not *take after* the nuclear donor but in effect *is literally* the nuclear donor and thus subject to the same processes of aging and decay.

All of these factors have tended to undermine this event's precedence by extending the processual contingencies embodied in Dolly and reflected in the innovation history of the Roslin Institute and PPL Therapeutics. In another example, in the year preceding Dolly, the Roslin Inst. announced that it had

produced two other cloned ewes, Megan and Morag, this time by dividing embryo cells ('blastomere separation'). Here, the (undifferentiated) cells (blastomeres) of a fertilised egg are separated to continue developing normally and separately. In fact, this form of cloning was used as early as 1992 in experimental human assisted conception but without allowing the embryos to continue developing (Hall et al., 1993). The research team at Roslin were as bewildered at the absence of excitement surrounding Megan and Morag as they were at its intensity surrounding Dolly. What distinguishes Dolly from the techniques of embryo splitting lies in intention. Split embryos are not intentional replicants of an already known animal because they still combine the gametes of two parents. Although, in fact, even the possibility of 'deliberate intention' must surely be questioned given all the grounds upon which Dolly is now suspected of not meshing with what the troubled word 'clone' is taken to mean.

These ambiguities around whether Dolly is conventional or novel and the connection with known intention are rife in what became the Dolly debate. It leads to whole different terms of reference. In avoiding the potentially pejorative term 'clone', the National Bioethics Committee of the US, refers to Dolly as the 'delayed genetic twin of an adult sheep'. Further illustrating the importance of intention, another analyst observes that 'Dolly was a deliberate copy of an adult animal, brought into being after her genome source had fully developed as an adult, this seems an inappropriate use of the term twin. Replicand seems more accurate…' (Baird, 1999 p.181).

Essentially, what these disputes illustrate is the perniciousness of the breakthrough as its modalities are opened up for detailed examination by participating constituencies. But as we all know, the instability of the breakthrough status was nothing by comparison to the controversy generated as the disclosure left the technical pages of Wilmut's paper in *Nature* and entered wider public debate where it quickly translated into a rehearsal of monstrous human reproductive futures.

Probably most significant here was the marked absence on the part of the Roslin team of any expectation that their research would lead to these kinds of questions. Rather, in the narrow framing of Roslin's innovation agenda, Dolly's meant nothing more than an empirical application of the theory of replication by nuclear transfer for the purpose of producing research and farm animals in a more efficient and exacting manner.

Much to the surprise of Roslin's researchers, this breakthrough 'science of similarity' has been widely taken to breach a political and cultural commitment to individual difference (a 'politics of difference'). The debate

was, and is, infused with sanctions against improper substitution. In an dazzling blend of individualisation and geneticisation, the taboo prescribes that 'individuals' must be valued in their own right and that they should not bear the value (specifically in this case the genetic value) of another. Of course, the rest is history, albeit a continuing and fractious history.[2]

Broken Breakthroughs: Agency, Attribution and Blame

Cases like these raise a number of interpretative tensions in the analytical repertoire we use to interpret breakthrough in modern science and technology. Key questions centre on how we make sense of its textual and practical orchestration or contestation and how we conceive of the changing relationships between different reporting constituencies. Evidently, this is largely a problem of the attribution of agency, begging the question whose agency is reflected in the way the breakthrough metaphor comes to be attached to a particular event or technology? In other words, how is it that breakthrough comes to act a little like an agent itself by mediating the force and inertia of an innovation agenda (see also Deuten and Rip in Chapter Four)? Another property of these cases highlights the usefulness of interpretative ambiguity which allows reporting constituencies to apportion responsibility to one another and shift identities when, as often happens, disclosures fail to match the ideals embedded in breakthrough.

Breakthrough as Scientific Representation?

The interpretative ambiguity of agency and attribution is inherent in the analytical repertoire of STS itself. The deconstructing discovery literature of Brannigan and Woolgar leads us towards the representations of scientists as the authors of breakthrough. For example, Imutran enrol the press to address a much wider 'public' audience than they would otherwise have had access to. They achieve their breakthrough by compressing the extended vagaries of laboratory practice into the spectacular performance of the press conference. The Dolly breakthrough too is a consequence of the Roslin Institute presenting a truncated narrative of experimental process reported in *Nature*.

Both cases clearly illustrate the temporal reporting requirements of science. Take for example, the use of delay and deferral separating experimental events from journal publications and embargoed press releases. This is a characteristic property of scientific representation and an essential

temporal tool in the production of certainty and therefore prestige and patronage by removing the situated modalities and process of knowledge production (Nelkin, 1995, 1996). Scientific news is therefore invariably old news made new for the purposes of reducing contingency and creating suspense toward some future horizon of action.

This discussion also highlights breakthrough as a distinctive motif in the broader repertoire of science disclosure and communication, particularly in contrast to discovery. Breakthrough is shot through with a problematised future in the way the discovery is not. It presupposes what Gibbons has called the problem context, or rather, the metaphorical shift towards a need to represent science as an instrumental knowledge activity solving applied problems (1994). Discovery on the other hand is linked more closely to serendipitous 'blue skies' ideals of what scientific knowledge creation should look like.

The centre of the axis between the motifs is the difference between *biology* and *biowealth*, that being the discursive requirements of 'knowledge for itself' discourse as opposed to proprietary discourse respectively. In his study of two research scientists, Myers observes their adaptation from the language of discovery in writing journal articles to learning the skills and language of invention in patent claims (Myers, 1995). Discovery is, loosely speaking, the province of the scientific article, a recognition of something already in nature whereby 'the scientist' is rewarded with a prize, continued funding or a fellowship in the Royal Society. Breakthrough is, again loosely speaking, the province of invention, application, utility, non-obviousness, the creation of a novel thing whereby 'the inventor' is rewarded with a patent, commercial sponsorship and perhaps an appointment to the executive board of a small British biotechnology company called either Imutran or PPL Therapeutics. In the former context, there is a problematised present or a natural anomaly that betrays the existing theoretical models of how something should in nature behave but does not. In the latter context, there is a problematised future, an impasse which the application's innovators promise to breach through inventive skill not found, *indeed must not be found*, in nature. Dolly and Astrid are not presented as something 'already out there', if that were so then it would undermine the claims to invention embedded in the discursive requirements of *biowealth* as opposed to *biology*. Neither of these identities or discourses is necessarily mutually exclusive, but can be deployed strategically and usually simultaneously to satisfy the requirements of different audiences.

Both cases neatly illustrate the requirement for a clearly defined connection between the innovation solution and widely accepted problems. The difficulty in the Dolly event was that her solution value was far from immediately obvious. She was not the answer to wider social questions about how to resolve a specific and agreed upon problem. Instead, the Roslin Institute were responding to questions confined within the expert scientific community about the hitherto theoretical but unproven feasibility of replication by nuclear transfer from an adult somatic cell. In the absence of 'a problem' her future was ambiguous and in the event swung easily from a fixed utility agenda to the potential application of nuclear transplantation to human reproduction. It was after the firestorm of debate had already begun that the Roslin Institute began to grasp the need for Dolly's practical value to be widely disseminated. In the case of Astrid, the connection between problem and the value of the experimental trials as a solution could not have been more obvious and went largely uncontested even if, at a later date, the promise became unsettled. So the mobilisation of breakthrough depends upon a successful problem definition that applies equally between the expectations of an expert or technical constituency and widely held cultural understandings of the utility value of risky innovations. Where there are significant differences between scientific and cultural definitions of the relationship between problems and solutions in the modern biosciences, acute moral questions are sure to arise.

Breakthrough as Cultural Representation?

On the other hand, the Imutran and Roslin disclosures are enrolled into the purposes of the press. Clearly, we need to supplement scientific representation with the temporal requirements of news discourse. Evidently, breakthroughs do not necessarily imply a relationship of mutual collusion between science and the press. There are important areas of conflict. Scientific communities blame news broadcasters for inappropriately presenting findings as breakthrough. Then again, science correspondents often complain of not having sufficient resources to screen press releases to present more cautious readings when promises subsequently go unfulfilled. These tensions were particularly evident in the Dolly case illustrating the complete inadequacy of Roslin's scientific breakthrough reporting to inoculate itself from its very own cultural politics. The technical character of the disclosure in *Nature* entirely failed to contain or police the technique's application to human rather than nonhuman futures.

Whilst certainly appealing to scientific groups, breakthrough often interferes with the ability of research communities to revoke findings later without losing trust (*Nature*, 393, 97, 1998). Revocability is built into the reproduction of the need for new knowledge but is clearly at odds with the definitive requirements of news discourse and the putative appetite for consistency both amongst political actors and publics at large (Yearley, 1989, 1995; Nelkin, 1995).

Now like the repertoires of science as invention and science as discovery, neither of these forms of representation belongs either to the media or science alone. Instead, they serve as ideal reporting values to which actors can lay claim to fulfil specific and situated disclosure needs. Scientific institutions and science correspondents routinely evoke the breakthrough motif when seeking to attract the interest of wider audiences. In so doing both lend credence to a culture which they may subsequently criticise when claims are revoked or judged to be hype. So, while clinging precariously to the idea of separate reporting values, the ambiguities of authorship allows different constituencies to blame each other when breakthroughs renege on promises or represent ethically difficult futures.

Breakthrough Subverted - From Textualisation to Socio-Materiality

Yet the discourse of breakthrough is implicated in other kinds of ordering besides those of the two reporting constituencies just discussed. We have to

consider what kinds of socio-material timings or temporalities are being produced and how commensurate or incommensurate they are with one another. Breakthrough is a specific sort of time, or rather it is a product of a particular kind of sorting. To borrow Bruno Latour's maxim 'it is the sorting that makes the time, not the time that makes the sorting' (Latour, 1993 p.76). So other sortings can just as easily unmake breakthroughs or translate them into unintended or unforeseeable outcomes.

'Kairos', whilst emphasising the rhetor in the construction of a 'right time', also points to the broader socio-material heterogeneity in which breakthroughs are orchestrated. So it is far from adequate to account for the fate of breakthroughs in the terms of the textualised reporting conventions of science and the media alone. The foresworn clinical trials of Imutran clearly clashed head on with the timing of other kinds of sorting, particularly those of transpecies pathogens including CJD, BSE and even speculation on the origins of HIV. Breakthroughs are therefore rarely protected by the truncation of process and the removal from contingency. Dolly's inheritance is heterogeneous (or 'heterogenus' rather) and not 'monogenus'. Her production is uncertain and leads in many contrary directions. Astrid genetically embodies only one signifier of human immunity and there are many more both known and unknown involved in the rejection of tissues and organs, not to mention relative rates of aging between source and host species.

So in all, both science institutions and science correspondents are often responsible for presenting knowledge in the form of a metaphor that misrepresents the extended processes and contingencies involved in the production and value of experimental findings. Understanding the temporal dynamics around breakthroughs points to extended process over time and operating to different temporal principles rather than singularly momentous commemorative histories. It also demonstrates the tensions and opportunities present in the temporal terms of reference of different reporting constituencies in materially heterogeneous contexts of process. Finally, in keeping with the fine tradition of word-playing on pigs and sheep in contemporary biopolitics, I might plausibly be forgiven for concluding that:

Dolly udderly isn't a breakthrough clone and
pig's won't fly even if ewe say they can!

Acknowledgements

I would like to thank participants in two conferences where previous versions of this discussion were presented: *On Time, History, Science and Commemoration*, The British Society for the History of Science annual conference, University of Liverpool, 16-18 Sept 1999; *Making Time/Marking Time*, British Sociological Association annual conference, University of York, 17-20 April 2000. Fig 5.1. is reproduced with permission from AAAS and the artist, Ann Elliot Cutting. Thanks also to fellow editors of *Contested Futures* and colleagues in the Department of Sociology at the University of York.

Notes

1. Deuten and Rip, writing in Chapter Four of this volume, also address the way reductions in complexity and contingency are superimposed onto historically distant objects (a GMO product in their case) through retrospective story telling.
2. For an excellent discussion of the way the Dolly debate has been conducted in the press and popular scientific commentary, see Franklin, 1999.

References

Arluke, A. (1988) Sacrificial Symbolism in Animal Experimentation: Object or Pet? *Anthrozoos*, 2, 97-116.

Avery, O.T., Macleod, C.M. and McCarty, M. (1944) Studies on the chemical nature of the substance inducing transformation of pneumococcal types. *Journal of Experimental Medicine*, 79, 137-57.

Baird, P.A. (1999) Cloning of Animals and Humans: What should the Policy Response Be? *Perspectives in Biology and Medicine*, 42, 2, 179-193.

Bell, A. (1995) News Time. *Time and Society*, 4, 3, 305-328.

Brannigan, A. (1981) *The Social Basis of Scientific Discoveries*, Cambridge University Press, Cambridge.

Dijk, T.A. van (1988) *News as Discourse*, Lawrence and Erlbann Associates, Holland.

Durant, J., Bauer, M.W. and Gaskell, G. (1989) *Biotechnology in the Public Sphere. A European Sourcebook*, The Science Museum, London.

Evans, M.J., Gurer, C., Loike, J.D., Wilmut, I., Schnieke, A.E., and Schon E.A., (1999) *Nature Genetics*, 23, 1, 90-93.

Franklin, S. (1999) What we know and what we don't about cloning and society, *New Genetics and Society*, 18, 111-121.

Gibbons, M (ed) (1994) *New Production of Knowledge: Dynamics of Science and Research in Contemporary Societies*, Sage, London.

Hall, J.L., Engel, D., Gindoff, P.R., et al. (1993) *Experimental cloning of human polyploid embryos using an artificial zona pellucida*. The American Fertility Society, co-jointly with the Canadian Fertility and Andrology Society, Programme Supplement, [Abstract of the Scientific Oral and Poster Sessions, 0-001, SI].

Keller, E.F. (1992) *Secrets of Life Secrets of Death*, Routledge, New York.

Kent, A. (1997) Letters: press release of the week. *The British Medical Journal*, 5, 310, 672.

Kinneavy, J.L. (1986) Kairos: A neglected Concept in Classical Rhetoric. In Jean Dietz Moss (ed), *Rhetoric and Praxis: The Contribution of Classical Rhetoric to Practical reasoning*, Catholic University of America, Press Washington DC, 79-105.

Lakoff, G. and Johnson, M. (1980) *Metaphors We Live By*, University of Chicago Press, Chicago.

Latour, B. (1993) *We Have Never Been Modern* (trans. C. Porter), Harvester, Wheatsheaf, London.

Lynch, M. (1988) Sacrifice and the transformation of the Animal Body into a Scientific Object: Laboratory Culture and Ritual Practice in the Neurosciences, *Social Studies of Science*,18, 265-89.

Lyotard, J-F. (1984) The Postmodern Condition (1979) (trans. G. Bennington and B. Massumi), Manchester University Press, Manchester.

MacNair, P. (1995) Medicine and the media. Press release of the week. *The British Medical Journal*, 5, 210, 67.

Miller, C.R. (1992) Kairos in the Rhetoric of Science. In Witte, S.P., Nakadate, N., and Cherry R.D., (eds). *A Rhetoric of Doing: Essays on Written Discourse in Honour of James L. Kinneavy*, Southern Illinois UP, Carbondale.

Miller, C.R. (1994) Opportunity, Opportunism and Progress. Kairos and the Rhetoric of Technology, *Argumentation*, 8, 1, 81-96.

Myers, G. (1995) From Discovery to Invention: The Writing and Rewriting of Two Patents. *Social Studies of Science*, 25, 57-105.

Nelkin, D. (1995) *Selling Science: how the press covers science and technology*, 2nd ed. W. H. Freeman, New York.

Nelkin, D. (1996) Medicine and the Media: An uneasy relationship, *The Lancet*, 347. 1600-03.

Palevitz, B.A. and Lewis, R. (1998) The use and abuse of the 'B' word, *The Scientist*, 12, 15.

Smith, J.E. (1969) Time, Times and the 'Right Time': Chronos and Kairos, *The Monist*, 53, 1-13.

Williams, R. (1983) *Keywords.* Oxford, University Press Oxford.

Wilmut, I., Schnieke, A.E., McWhir, J. et al. (1997) Viable offspring derived from foetal and adult mammalian cells, *Nature*, 385, 810-13.

Woolgar, S. (1976) Writing an Intellectual History of Scientific Development: The Use of Discovery Accounts, *Social Studies of Science*, 6, 395-422.

Yearley, S (1989) Bog standards: science and conservation at a public enquiry. *Social Studies of Science*, 19, 421-438.

Yearley, S (1995) The Environmental Challenge to Science Studies. In Jasanoff, S., Markle, G., Person, J. and Pinch, T. (eds) *Handbook of Science and Technology Studies*, 457-79.