Miracles, monsters and disturbances

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Modern science challenges many well-established borders. Genetics in particular raises the prospect of merging species, transferring DNA between species or questioning the very essence of a species. It is creating new opportunities, limited, perhaps, only by our imagination – or what we believe is acceptable: some real or potential applications of new technologies often raise a deep sense of unease. Although rational science can describe what is possible, perhaps, suggest *Elio Caccavale* and *Michael Reiss*, only the arts and humanities can truly articulate what the future might look like, by unleashing a creative process that integrates an emotional as well as a literal perspective on imagined future worlds.

The idea that there is a simple and obvious distinction between different species is deeply rooted in our culture. Yet modern biotechnology, with its ability to create chimeras (mixing embryonic cells from different species) and genetic hybrids (incorporating genetic material from different species into a particular genome), makes the self-evidence of this distinction problematic. Scientists can now manipulate the genetic information that plays a part in the developmental process of all life forms. Using sophisticated recombinant-DNA and cell-fusion processes, genetic information from unrelated species can be inserted, deleted or even stitched and fused together, creating forms of life that have never before existed. This has provoked deep anxiety among many people, an anxiety that has been variously described as a rejection of the 'unnatural' or a fear of the 'alien' or the 'dangerous'. On the other hand, from ancient times, our culture has been fascinated by creatures that combine varied features from different animals, or animals mixed with humans, such as griffins and centaurs. Such hybrids, or monstrous creatures, challenge our usual sense of categorisation and provide us with the stimulus for thinking about the truly fundamental aspects of both biological and physical human nature.

Increasingly, the news media and popular culture are alerting the public to the heated dialogue that is underway about what our near future might become. Daily, the miraculous scientific predictions and breakthroughs that were once the subject of science fiction are

announced as realities. Each new announcement triggers hopes and fears and guarantees further debate among humanitarians, profit seekers, legal experts, ethicists, politicians and the public. Science and art collaborations could have an important role in this ongoing exploration, creating images that literally give shape to intangible and complex concepts. Working with new languages and images, they raise questions about the social, cultural, ecological, economic and ethical implications of science breakthroughs. The works of many artists informed by science investigate issues and concerns triggered by the modification of nature, and provide the public with an opportunity to pay closer attention to advances in science and to reflect upon the boundaries between science and the human imagination. They consider how we shape nature to meet our desires and demands, manipulating genetic make-ups and changing the form and productivity of animals and other organisms.

Science here is seen as it operates at the frontier of knowledge, rather than in the rather ossified form it generally takes in school science lessons

This intersection of contemporary science and contemporary artistic responses to such science opens up new educational spaces. Issues to do with the crossing of species boundaries and other sorts of genetic transformation are rich in educational potential. In part this is because such issues, while current, tap into deeper fears about losing what it is that makes us human and distinguishes us from other animals. In large measure too it is simply that science here is seen as it operates at the frontier of knowledge, rather than in the rather ossified form it generally takes in school science lessons. This provides an open-endedness to science that can be attractive to many for whom science is all too often boring or irrelevant. This chapter therefore seems to explore how education about science can draw richly on practices in art and design. Such practices can help learners explore the moral and social implications of new technologies and enable all of us to reflect on what is possible and what is desirable.

Above:
Eduardo Kac with Alba.

Evitables and inevitables

Collaborations between artists and scientists in education can draw on related work in laboratories and in the cultural sector. In these contexts, science and art collaborations quite often speculate about these new parameters of life and these expressions of scientific creativity with a mixture of awe and concern. Two closely related categories of artist working on hybridity can be identified: the evitables and the inevitables. A good example of the inevitables is Chicago artist Eduardo Kac,[1] who is known worldwide for his 'GFP Bunny'. The project consists of a GM rabbit named Alba, which was created with the help of French scientists[2] who injected the DNA for green fluorescent protein (GFP) of a Pacific Northwest jellyfish into the fertilised egg of an albino rabbit. The project comprises not only the creation of the fluorescent rabbit but also the public dialogue generated by this and the integration of the transgenic animal into society. Kac had intended to take custody of Alba, but because of growing concerns for her welfare and the (allegedly) potentially devastating effect the bunny would have on the ecosystem if she were to escape and reproduce, she was not released to Kac.

The idea of taking Alba into a domestic environment places genetic engineering in a social context in which the relationship between the private and the public spheres are negotiated. In other words, biotechnology, the private realm of family life and the social domain of public opinion are discussed in relation to one another. Kac has created digital manipulated photos (photo) of the rabbit so that she appears greener than is physically possible even for the Pacific jellyfish itself. Reproductions of the photo of Kac's green rabbit have been published in newspapers and exhibited in art galleries, and have no doubt contributed to the public engagement discourse on transgenic animals.

The ecologist Ignacio Chapela[3] points out that the rabbit photographs were digitally altered and explained that rabbits cannot have green corneas. Chapela does not make this point to

comment on Kac's project, but rather to argue that green fluorescing rabbit pets are not inevitable. By pointing this out Chapela shows that the press don't mind about the veracity of an image – a digital manipulation is better if it is more sensational – and that the French scientist's refusal to release Alba from the laboratory is an example of this very sociocultural phenomenon.

The Australian artist Patricia Piccinini[4] is an example of the evitables. She creates humanoid sculptural installations to confront us with images of a future where human gene technology gives us the ability to create genetic hybrids and chimeras. One particular project shown at the Australian Pavilion at the Venice Biennale in 2003 included a variety of bizarre, genetically engineered beings that are strikingly different from what we know but, at the same time, strangely familiar. 'The Young Family' sculpture series consisted of a human sow primate with arms and legs who suckles a litter of human piglets as she lounges on a leather sofa. The mother's tarnished skin has the unsightly wrinkles, red blotches, moles and imperfections we might find on our own bodies. Her hands and feet could belong to a grandfather. Human traits aside, she looks more or less like a pig – despite the strikingly tender maternal gaze she casts upon her offspring.

While 'The Young Family' may be warning the public, it also radically overestimates the control we have over biological systems. In her art Piccinini creates organisms that cannot feasibly be produced in actuality, producing a delusion of comprehensive genetic knowledge and control. It is what we do not know that is truly dangerous. Her sculptures have the opposite effect of their intended shock-and-awe tactic; by contrast, actual images of genetically engineered organisms look banal. Think, for instance, of ordinary-looking goats produced by the Canadian biotech company Nexia Biotechnologies.[5] Nexia has spliced spider genes responsible for webs (one of the strongest fibres known in nature) into the genome of a goat. When the goat's milk is processed, the

Above:
'The Young Family' by Australian artist Patricia Piccinini.

result is BioSteel, a substance that can be spun into a thread that has the tensile strength and flexibility of a super spider web. The potential applications range from medical applications to bullet-proofing and sports equipment.

Hybridity

In our own work on hybridity, biotechnology can be seen as an experimental ground where the most advanced technological innovation clashes with more human aspects and concerns, such as ethics and social conduct, and where the evitable meets the inevitable. The myBio project[6] exhibited at the Science Learning Centre London explores the emergence of biological hybrids in biotechnologies, and our human, personal, moral, aesthetic and sociocultural responses to them. The creation of any kind of hybrid begins to challenge species boundaries – in particular, an entirely new resonance on how we learn and form categories about 'the human' and 'the animal' is brought about. Our work on hybridity builds on recent creativity and scholarship in design, bioethics and historical and anthropological studies in the human, the animal and the monstrous, providing tools for investigating our moral, social, cultural and personal responses to the strange and different in human biology and also 'transhuman' creatures. The result is an increase in teasing out and provoking discussion regarding genetically modified human–animal hybrids in existing and near future biotechnology. In particular, what is sought is an understanding of the relationship between children's learning in the categories of animal/human and the extent to which such categories can be considered merely contingent and revisable in the light of technological change.

There are two main areas of research interests that have contributed to the outcomes of our collaboration. The first investigated the emergence of biological hybrids in biotechnologies, with particular respect to the breeding of GM animals and xenotransplantation. Focusing on the implications of the techniques that have already

entered the public domain, we examined the impact of such innovations as the BioSteel goat developed by Nexia Technologies, the transgenic ornamental fish developed by Taikong Corp.,[7] the low-fat pork in pigs developed by Kinki University[8] in Japan, the transgenic pigs for xenotransplantation developed by NexTran,[9] the featherless chickens developed by the Hebrew University School of Agriculture[10] in Israel (photo) and the Enviropig[11] developed by the University of Guelph in Canada.

Above:
Featherless chickens developed by the Hebrew University School of Agriculture.

The second area of research interest focused on the educational material culture that uses the playful and abstract language of educational dolls to help facilitate children's understanding of biologically, socially and culturally complex concepts. A wide range of such dolls have been developed: sex educational dolls, race equality educational dolls, disabled educational dolls, medical condition educational dolls. As yet, though, there is a remarkable dearth of information as to the consequences of using such material. A search on Google Scholar for "educational dolls" (22 September 2007) revealed just 12 hits – all of which are for patents. Our supposition, despite the current lack of scholarly evidence for this, is that dolls may be powerful enablers of exploration and learning. We note that the value of puppets in science education is beginning to be explored.[12]

Learning from companies and organisations that produce educational dolls and using their established visual imagery, we made 12 myBio dolls that could symbolise possible biofutures and introduce children to the emergence of biological hybrids. The dolls include: myBio boy and myBio pig, which demonstrate the physical transfer of the organ from the animal to the human; myBio bunny, myBio glowing fish and myBio jellyfish glow bright green when illuminated with a UV light, demonstrating how scientists have used GFP as a fluorescent indicator for monitoring gene expression in living organisms; myBio reactor cow shows how cows can produce proteins in their milk for pharmaceutical drugs

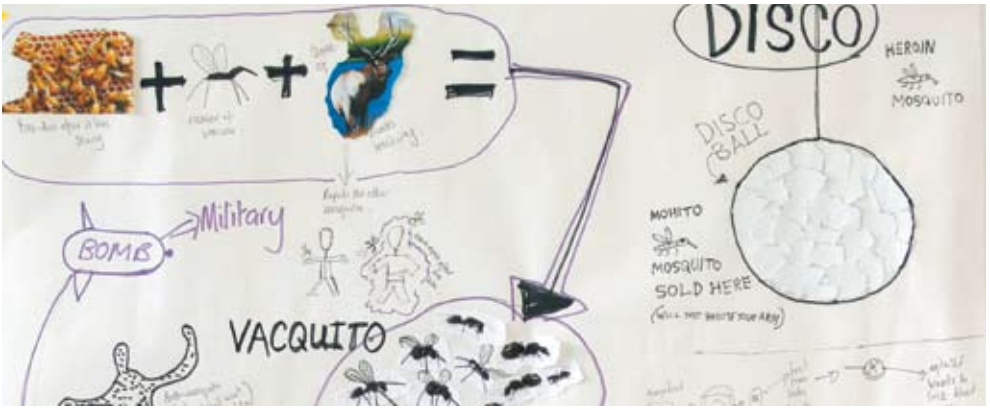
Above:
Oncology Buddy –
Shadow Buddies Foundation.

Left from top:
MyBio xenotransplant,
myBio reactor and
myBio spider goat.

(this is symbolised by the 'milk thread' attached to the cow's udders); and myBio goat has a spider web attached to the udders, demonstrating one animal making the natural product of another. We have used the myBio dolls to present scientific information through the channel of the narrative. Starting with a series of 'What if?' stories, the narrative process gives children a common language for talking about biotechnology. "Suppose that your life could be saved by a pig, what would happen to you and the pig?" or "Imagine you could have a glow-in-the-dark rabbit, would you relate to such a rabbit differently than a conventional one?"

We are particularly interested in children's responses to the impact of biotechnologies, affected as they are by the aesthetic of new scientific creations (think for instance of a glow-in-the-dark bunny) that can make the concept of hybridity exciting. Much of the academic reaction to recent biotechnological developments across species boundaries has been ethical. Careful ethical reflection and analysis is important, but we believe that artistic presentations and reactions have much to offer. In particular, they can be more open-ended, demanding much of the viewer, and then they rely on faculties other than the cerebral, thus engaging us on a greater number of levels and facilitating the tangibility of abstract concepts. Here, then, we see art not as a decoration of science but as a necessary partner if we are better to imagine how we were, how we are and how we will or want to be.

As part of the myBio project we also instituted a workshop with medical and product design students at Central Saint Martins College of Art and Design (part of the University of the Arts London). The students worked together in interdisciplinary groups. Their objective was to explore animals by proposing hypothetical hybrids and animal products. The hybrids proposed had to perform in new ways, and, as such, create new effects, phenomena and behaviours. After creating their hybrids, the groups were asked to develop hypothetical, yet feasible, social scenarios based on their



Above:
Work produced by the student hybrids workshop at Central Saint Martins College of Art and Design.

initial ideas, that is to consider what people would do with their hybrids. How would new social behaviours emerge around their hybrids? What would be the physical consequences of their hybrids? And what new points of interface would exist between the hybrids and people?

Although none of the participants knew each other prior to the event, there was free and fertile exchange of ideas and roles throughout the workshop. This led to a breaking down of traditional interdisciplinary boundaries, thereby facilitating an open and inspirational dialogue between design, art and science. The students responded positively to the workshop experience and they have expressed strong interest in being involved in other sciart workshops. We see every reason to expect that similar responses would be found in schools and colleges with students across the 11–19 age range, because it would enable them to draw on their own ideas and subsequently to reflect on these and debate them.

Miracles or monsters?

The word 'miracle' comes from the Latin *miraculum*, meaning an object of wonder. To this day the word retains its two main uses: on the one hand, a technical, theological term meaning an event that cannot be explained by the laws of nature and therefore provides evidence for some divine (i.e. supernatural) intervention; on the other, its more everyday usage simply meaning something 'remarkable' or 'wonderful'. This everyday term is nearly always understood positively, so that we say it was a miracle that a family survived a horrendous car crash, not that it was a miracle that another family sheltering under a tree in a thunderstorm was killed by lightning.

It is the everyday usage that is more important, of course, in the new technologies – we are not talking here about the formal proof of three important miracles that the Roman Catholic Church requires before the process of canonisation can be completed. However, the everyday and the eternal cannot so easily be separated; we stand in awe of non-supernatural miracles even when they are rooted in the realities of nature. Such miracles challenge our understanding and enlarge our vision.

But in many people's eyes – and one of the advantages of sciart dialogue is its shift from the cerebral and verbal to the visual and splanchnic – tomorrow's biotechnological products threaten to be monsters not miracles. Monsters, like miracles, come in various forms. But just as we see miracles as generally positive, for all the neutrality of the etymology of the term, so monsters are generally perceived to be negative. Like miracles, monsters are rare, but when perceived they shock, they terrify, they disgust.

Historically, as Harriet Ritvo argues in her suitably titled *The Platypus and the Mermaid: And other figments of the classifying imagination*,[13] only a small divergence from what seemed natural sufficed to make a monster – and the same is true today. It can be a thin line between ugliness and monstrosity. However, ugliness sits within the normal range; a monster sits apart. A naked cat may be ugly in many people's eyes but a lamb with five legs is a monster, a 'sport of nature'. It is this 'apartness' that is crucial in understanding the common, visceral reaction to that which is monstrous – a term applied not only to entities but also to actions. So slavery, child warfare and the force-feeding of geese to produce *pâté de foie gras* can (should) be described as monstrous as they sit outside our common perceptions of what it should be to be a human, a child or a goose.

As is well known, monsters fascinate. We know of the awful times Joseph Merrick, the Elephant Man, lived though because of his

Above:
Work and participants at the Central Saint Martins hybrids workshop.

deformity but while we may regard with condescension the thought of Victorian freak shows, we do well to remember the contemporary fascination with conjoined twins – e.g. Abby and Britty Hensel, Lori and George (aka Dori and Reba) Schappell – as evidenced by the many TV documentaries and newspaper and magazine articles they inspire. Such examples can be both attractive and repellent to young people; certainly, they question our existing classifications.

Broadening from unusual humans to unusual animals, monsters that failed to sit tidily within established categories caused problems for those taxonomists keen to produce an ordered classification. As is well known, the arrival of the first specimens of the duck-billed platypus (*Ornithorhynchus anatinus*) in the UK at the end of the 18th century so astonished naturalists that the specimens were widely regarded as fakes. It was presumed that someone had sewn a duck's beak onto the body of a beaver-like animal. Today we understand the platypus as one of the five extant species of monotremes (the other four are echidnas) found in Australia. Uniquely among mammals, monotremes lay eggs rather than producing live young; they also, and again incongruously, have electroreceptors to help them detect their prey. Adult platypuses are also most unusual among mammals in being venomous.

Disturbances

The more bullish of today's biologists are fond of saying that we are on the threshold of a new age; that contemporary applications of biology are about to make the same sort of difference to our ways of living that the agricultural revolutions of several millennia ago, the industrial revolution of the 19th century and the communications revolution of the late 20th century made. Analyses of such prophecies have tended to focus on whether or not such a biorevolution would be desirable. Would it lead to improved human health and increased crop yields or to new diseases and the

extinction of certain plant species? Would it result in more or less human happiness, to greater or less inequality among people? But there is another way of examining the implications of developments in today's biology, and that is to look at their meanings. What might be the effects of the widespread use of genetic engineering, cloning, stem cell technology and so on on how we understand ourselves and the rest of nature? Such questions about the significance of new technologies received a powerful articulation before the advent of genetic engineering from Heidegger, who argued that in technology we make objects according to some blueprint that we determine. We design things to satisfy our purposes rather than allow our purposes to be affected by, and find creative expression through, the qualities of the objects themselves.[14]

For this reason an approach that explores the emergence of biological hybrids in biotechnologies, and our human, personal, moral, aesthetic and sociocultural responses to them, is to be welcomed. Nowhere are these issues raised more sharply than in the new 'hybrids' of genetically modified animals. It is important to remember that not all genetic engineering entails moving genes between species. For example, the genetic engineering of yeasts to 'improve' breads and beers involves using the tools of genetic engineering to move genes between strains or varieties of yeast but still within the one species. Here genetic engineering is being used to speed up a process that could equally be carried out by conventional breeding – the essence of a biological species being that within it individuals are able to breed among themselves. Unsurprisingly, this use of genetic engineering has raised little controversy and – more importantly for the questions considered here – little disquiet.

Those instances of genetic engineering of most concern both to the general public and to members of pressure groups opposed to genetic engineering involve the movement of genes between

Above:
The Central Saint Martins hybrids workshop participants.

species, often between completely unrelated species. For example, genes from scorpions have been moved into viruses in an attempt to make such viruses more toxic to insect pests, and genes from humans have been moved into pigs in the hope that organs from these pigs might be suitable for (xeno)transplantation.

In any useful sense, moving genes from scorpions to viruses, and from humans to pigs, is unnatural. The question is, how concerned should we be at this breaching of species boundaries? Does it matter that plant crops contain bacterial or animal genes if the result is that their yields are greater? Does it matter that certain bacteria confined to fermenters in pharmaceutical factories contain human genes if the result is that life-saving and health-restoring medicines, such as insulin, are produced? Does it matter that pigs are being genetically engineered with human genes in the hope that their internal organs may be used for human transplants? And, almost irrespective of whether it matters, in some absolute sense or not (if such a perspective exists), how do we feel about the dissolutions of these boundaries?

One interesting psychological point is that as we grow up the boundaries between species help us to organise our understanding of the natural world. Children learn from their infancy about living things in their immediate environment. In particular, they learn about animals, learning both to recognise different types of animals and what their basic names are. It has been argued that the concepts ‘animal’ and ‘plant’ are fundamental ontological categories – that is, categories used by children to organise their perceptions of the world in which they live. Certainly for most

children, animals form a significant part of the world around them, whether as wildlife, pets or zoomorphic toys. It is therefore unsurprising that names for familiar animals form a large part of the vocabulary of young children.

Boundaries serve to divide entities into categories; in this way a boundary enables classification. It can make us secure and helps us structure our world. Of course, such security may be prejudiced. The strict boundaries that once divided men and women in terms of how each of us might spend our time are changing fast. Activities such as cross-dressing make little sense to some people, are deeply disturbing to others, are political statements by some and are essential to a few. One can ask whether it is wrong to eat animals that have been genetically engineered to contain human genes.[15] This question may soon become pressing as the number of animals with human genes continues to increase.

Those who object to inserting human genes into animals that are subsequently used for human consumption may argue that the parallels with cannibalism cannot so lightly be dismissed.

At one pole are those who argue that eating an animal, or a plant, into which a human gene has been inserted has nothing whatever to do with cannibalism. Cannibalism is about eating human flesh, not eating minute amounts of DNA that once came from just one of the 30 000 or so human genes and is now merely a copy of that original human gene. Further, every baby who breastfeeds eats large amounts of another human's (i.e. its mother's) DNA.

Those who object to inserting human genes into animals that are subsequently used for human consumption may argue that the parallels with cannibalism cannot so lightly be dismissed. Although Imutran, one of the companies at one point actively engaged in xenotransplantation research, has argued, "This involves changing only 0.001 per cent of the genetic make-up of the pig,"[16] it could be argued that the actual percentage of change is not of prime importance. After all, if one is unfaithful to one's spouse on only 0.5 per cent of nights, is this ten times better than if one is unfaithful on 5 per cent of nights? Reverting to traditional

anthropological concepts, one either exists in a state of purity or impurity – there are no halfway positions, no no-man's-lands gradually to be traversed. Similarly, just because a baby less than a year or so old does certain things with its mother doesn't make it right for the rest of us to do those same things with its mother.

We need new ways of exploring the meanings raised by genetic engineering and other modern biotechnologies. Rational words are needed but are not enough. This is why an approach through art and design can be so valuable. The two of us are particularly interested in the potential of such artefacts to help both students and teachers develop their thinking and, as importantly, their affective responses. Most of us now need fewer boundaries than our ancestors did. Just as symbols (e.g. blood) can be, in different contexts, either defiling or sanctifying, so a boundary can serve either to maintain order and strengthen that which it encloses or to lead to disunity. Increasingly people find themselves uncomfortable with boundaries that seem to lack a rational basis. Why shouldn't people of the same sex be able to get married if they want to? Why shouldn't women be front-line soldiers? And yet, are all boundaries to be crossed, all divisions eroded if they cannot be defended on rational grounds? Is incest between freely consenting adults to be permitted if they use reliable contraceptives? Is it morally right to move genes between species? And whether it is or is not, how do we feel about it? As Catherine Booth said, "If we are to better the future we must disturb the present."

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4 www.patriciapiccinini.net.
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6 www.eliocaccavale.com/mybio.html.
7 www.azoo.com.tw.
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