Handbook of Science and Technology Convergence
DOI 10.1007/978-3-319-04033-2_33-1


# Convergence with the Arts

Q1 Andy Miah*
Ethics and Emerging Technologies, Creative Futures Institute, School of Creative Industries, University of the West of Scotland, Ayr, UK

## Abstract

This chapter examines convergence in science and arts by considering two complementary trajectories over the last 25 years. First, it examines the institutional drivers behind convergence, from the perspective of governance and public value within science. Second, it explores convergence around the methodological practices of artists, which speaks to the complex political economy of knowledge generation, symbolic significance, and biomediated resistance. Finally, it considers the impact of convergence on the future of each area and what might be the opportunities and risks of further convergence.

## Introduction

> Artists such as Picasso and Kandinsky took on board the latest scientific developments, while scientists found themselves driven by questions like the relevance of aesthetics to science and what makes a scientific theory beautiful. (Miller 2014, xx–xxi)

Convergence in arts and science can be traced back for centuries, from Leonardo da Vinci's observations of human physiology in the sixteenth century to the development of photographic practice in the nineteenth century. In each case, progress in arts must be understood as having always existed within a wider knowledge economy, in which insights from all kinds of scientific and technological disciplines have shaped the creative practice of artists. This is especially true when looking closely at artists who have experimented with new media (see Reichle 2009). In this respect, more recent discussions about convergence in science and arts would be remiss if they ignored this important historical connection between these fields of inquiry, which, in the past, have enjoyed a closer relationship than may be said of them since the Enlightenment period.

Nevertheless, a contemporary theorization of the trajectories of arts and science may be offered additional to this historical interpretation, which provides insight into a new chapter in this history. As such, this chapter focuses on what has happened over the last 25 years, during which the epistemological boundaries of science and arts have been redrawn again, as a result of two principal trajectories. It examines the UK case in detail, where a series of key indicators of such change within science are apparent and where there is evidence of how this has aligned with the trajectory of new media artists – specifically, bioartists – in their pursuit of working with the materials of scientific inquiry, most notably biological matter itself.

For the sciences, their attention to the arts in recent times can be traced to the rise of public engagement with science and the broader interest in science communication from the science industries. New imperatives to make science more available to the public who are funding research have led to developments in how science is supported, what is expected of scientists as performers of scientific investigation, and what format the means of communication takes. A crucial component of this trajectory has been the

*Email: @andymiah.net

Handbook of Science and Technology Convergence
DOI 10.1007/978-3-319-04033-2_33-1


rise of modern science festivals, the first of which was born in Edinburgh in 1989 – an event that emerged out of the wider cultural shift toward an event economy. Since Edinburgh's first festival, science festivals have emerged all over the world, and the number of these programs expands even further when including events that do not formally identify themselves as science festivals, such as the recent Pioneers Festival, countless TEDx events, or even science stand-up comedy nights. Beyond the live format, the growth in mediated science communication work is indicative of the ecology of science becoming more integrated within creative practices.

Three years after Edinburgh's first science festival, in 1992, the scholarly journal, *Public Understanding of Science*, published its first issue, which reinforced the importance of the science industries' interest to consider more strategically how it connects with the general public. The journal's launch also made an important contribution to how the academy was starting to theorize public engagement with science, considering different methodological approaches to such work and generating a new cohort of scientists whose research also involved developing sophisticated evaluative tools to assess the impact of their engagement with various publics. Where previously, public engagement may have been seen as a good in itself, worthy of celebration wherever it happens, but of little import to the core drivers of scientific discovery, it was quickly becoming a form of expertise in its own right, subject to critical evaluations, along with developing a desire to advance pedagogically.

From the arts, there has also been a shift in the range of methodological approaches to creating new artistic work, which is more integrated with the science industries. While artists have always drawn on scientific ideas and principles – even using biological matter within their work – a wave of new media artists has emerged recently, who are utilizing the biological sciences to realize work, and this has led to the establishment of the new disciplines of bioart and biodesign. Bioart is redefining how arts is made, where it is made, the range of people involved, and the meaning and value it has within society. In some cases, such creative works offer a commentary on the controversies surrounding late twentieth-century biotechnology, the transgressions associated with genetic modification, and the uncertainty around nanotechnology. Alternatively, bioart may be seen as a critique of how the world orientates itself away from nature in its pursuit of technology and of its inability to resolve the crucial ethical issues that underpin scientific trajectories, but which continue apace, irrespective of public consultation. Alternatively, bioart work seeks to explore the creative potential of new matter – especially matter that is generated through novel scientific practices, which synthesize, adapt, and even create new life-forms – and aspires to break new boundaries of aesthetic potential and new ways of seeing the world.

This chapter articulates these two principal trajectories in full, noting their intersections with wider convergence within the knowledge economy. First, it examines the institutional drivers behind convergence, from the perspective of governance and public value within science. Second, it explores convergence around the methodological practices of artists, which speaks to the complex political economy of knowledge generation, symbolic significance, and biomediated resistance. Finally, it considers the impact of convergence on the future of each area and what might be the opportunities and risks of further convergence.

## Converging Institutions

While it is tempting to focus on the methods of different endeavors, when seeking to identify points of convergence, institutional change is an important dimension of documenting convergence across sectors. Indeed, there are specific indicators of convergent practice in how science and arts are produced, which speak to the underpinning shift in each of the practice communities toward each other. One key aspect of this from the scientific disciplines is the rise of public engagement work. Over the last 25 years, one can

Handbook of Science and Technology Convergence
DOI 10.1007/978-3-319-04033-2_33-1


identify changes to science funding and science policy that have been a catalyst for the production of new science activities, the purpose of which has been to engage a wider public on what science does or can do. The ideological vision behind such funding may be interpreted in at least two key ways.

From one perspective, public engagement funding seeks to bring new scientific discoveries and applications to the attention of a broader public, allowing more people to learn about science, perhaps become interested in it, or even to feel that they have a role to play in shaping its future. From another perspective, science communication work aims to fulfill a democratic obligation, which is predicated on the fact that science is often publicly funded and so should be made available to the public during its development. Each of these *instrumental* interpretations of public engagement with science coheres with the mission of science funders, which are broadly predisposed to promoting the value of science to the public. However, they do not sit neatly with critics – or artists – who want more from public engagement with science, and the emergence of such views is best articulated by examining briefly the three models of public engagement, which have come to define scholarship in this area.

Initially, critics identified the pursuit of educating the public as having the unfortunate consequence of reinforcing a power relationship between the scientific experts and the uneducated public, which rejected the intelligence of the general public and treated them as needing education. On this *deficit* model, the role of public engagement with science is to enlighten the public, with a view to helping them see its value, and to generate further support for its development. Early public engagement scholars criticized this model, arguing instead for a *dialogical* approach to such work, which instead sought to empower audiences so they may contribute to discussions about current issues in science. Yet, even this model was interrogated by theorists, who pointed out that dialogue does not ensure a bidirectional flow of power, nor an ability to assume decision-making responsibilities around science funding decisions, which is the crucial limiting factor in what the public can do to shape its scientific future. In response, critics have argued for an *upstream* approach, whereby dialogue happens before funding priorities have been made by the science industries. The upstream model aims to deliver a more effective democratization of science funding decisions, without undermining the integrity of making decisions about science. In each case, the public engagement model remains an instrumental model; it seeks to create more effectively engaged decisions about the direction of science.

In the UK, various organizations have developed programs of work to advance these models. Notably, the Wellcome Trust, the National Endowment for Science and Technology in the Arts (NESTA, established 1998), and a number of national research councils each have assumed the responsibility to deliver more public engagement opportunities with science. The Wellcome Trust alone provides £10 m for public engagement work annually, supporting a range of activities from film making to digital games creation, and receives applications from broadcasters and arts organizations, along with universities. The public engagement with *research* strategy of Research Councils UK outlines the impetus behind such funded work:

> Relevance, trust, accountability and transparency are the cornerstones of the relationship between research and society. It is vital that the public have both access to the knowledge research generates and the opportunity to influence the questions that research is seeking to address. In enriching citizenship and providing wider perspectives on research, public engagement improves the quality of research. It inspires people of all ages, firing the imaginations of our future researchers and feeding the skills and knowledge that are essential to the UK's economy.
> (RCUK, no date given)

The scope of public engagement work has also expanded beyond the conventional STEM subjects, with social science funders like the Economic and Social Research Council (ESRC) creating a UK-wide Festival of Social Science or any number of AHRC projects, such as digitizing ancient texts and making them publicly available. One key indicator of this general trend to professionalizing public engagement with science is the rise of science festivals, the growth of which may indicate the expansion of public

DOI 10.1007/978-3-319-04033-2_33-1


engagement with science and the wider institutional underpinning of funding creative, artistic work around science. Indeed, the rise of science festivals may speak to the maturity of public engagement as an investigative discipline. Taking a sample of science festivals around the world reveals the institutional underpinning of such activity. For example, India's QUARK festival – a university-led festival – receives patronage from UNESCO and the South Asia Youth Environment Network, a UNEP organization. Alternatively, the UK Manchester Science Festival operates under the direction of the Museum of Science and Industry, a common context of a number of other museum-led festivals, particularly in the UK. Also, the Cheltenham Science Festival in the UK has *The Times* newspaper as a headline partner and functions as a platform for new publishers to show their authors and promote new work.

Within the UK, these new resources to support creatively engaged public programs were reinforced by the reformation of the government's research assessment exercise in 2014 – called the Research Excellence Framework. For the first time, this evaluation attributed a percentage of the funding allocation awarded to university researchers on the basis of their impact outside of academia. Where previously academic research was assessed solely on the basis of research, the addition of 20 % dedicated to research impact has been a game-changing shift in UK research culture, providing a quantitative measure by which scientists may contribute time to such work.

These trajectories show how science is getting closer to the realm of creative and artistic practice through the institutional support for funding programs around public engagement with research. Many of the ways in which scientists have articulated their value outside of academia within the REF have been through their impact in the creative sector – either in arts collaborations or media presence. It also reveals how science has become much more aligned with the event economy, the idea that singular events can function as catalysts for political, economic, and cultural investment, typified by such mega events as the Olympic Games or even simply anniversaries. Today, science makers are much more aligned with the importance of staging science, and the production expertise that surrounds such work lends itself neatly to the kinds of skills that also operate around creativity and art. To this end, the next section looks at convergence from the perspective of the arts, to reveal how methodological changes in how artists work are bringing them closer to scientific disciplines.

## Converging Methodologies

The complement to institutional change in the sciences is located in the practice of artists who operate at the cutting edge of new media and whose work Miller describes as indicative of a "brand-new art movement" (p. 341). One of the earliest pioneers in bioart practice is the Australian performance artist Stelarc, whose work has consistently inquired into the limits of our corporeality and the trajectory it has taken in a world that is increasingly digitalized and modified by biotechnological conditions. The importance of performance within this historical trajectory is worth foregrounding, especially as performance is also a common thread within the other direction within this analysis – science being performed to a public. As Hauser (2008) notes "Bioart. . .is also attracting the interest of performance artists and those specializing in body art; structural relationships connect the two fields" (p. 90). For example, the French performance artist Orlan undergoes cosmetic surgery to alter her appearance in a way that challenges the commercial industry of body modification. In creating nonstandard modifications to her body, she invites onlookers to consider how else we might imagine our bodies to look, outside of standard notions of beauty that are typical of the fashion industry. Alternatively, John O'Shea's work on *Pig's Bladder Football* envisages the possibility of creating sustainable leisure technology by cultivating football bladders made from his own cell tissues, so as to combat the reliance on synthetic materials.

DOI 10.1007/978-3-319-04033-2_33-1


In contrast, Gina Czarnecki's *Palaces* project considers the wasted biological materials that people discard over the course of their lives, but which may be useful to people for research, repair, or exhibition. In this case, milk teeth donated by children – including teeth from her children – are used to construct a "tooth fairy palace." *Palaces* reveals how bioart need not involve utilizing body modification or technology at all, but simply utilizing biological matter that naturally separates from us. Indeed, Stelarc's early works involved inserting body hooks into his person and suspending himself off the ground. In these cases, one may advance the idea that such work explores principles that have currency in the field of physics, perhaps also the science of pain, but, like Czarnecki's work, biology is not tampered with through scientific manipulation. Nevertheless, such work contrasts with – or may be a precursor to – Stelarc's more recent *Extra Ear* (2008) project, which involves using stem cell technology to create an artificial ear on his arm created from his own tissue. The career of such artists as Stelarc may also be seen has having defined the field of bioart. Thus, while his earlier works may not be seen in this way, they may be explained as steps toward defining a now reasonably clear set of practices that bioartists undertake in their work.

Involving the artist's body or biology within bioart practice seems an obvious new chapter in the history of art. It resonates with the aspiration to locate oneself within the artistic work one produces, enabling the realization of such desires on the most intimate level, as might be said of Stelarc's (1997) stomach sculpture, for instance. It also aligns with a similar trajectory within scientific practice, as the practice of the world's first other cyborg Kevin Warwick may indicate. Warwick's insertion of a microchip under his arm, which has some functional capability, may, on first glance, seem no different from Stelarc's *Extra Ear* project, save for the fact that he may call his work science and Stelarc may call it art. Indeed, the banality of this difference is also well articulated by Eduardo Kac's GFP Bunny, which involved an albino rabbit born via transgenic expression that created a fluorescent quality to its skin. When placed under fluorescent light, the rabbit would glow in the dark. In this example, it is the specific biotechnological practice of transgenesis that defines the work, rather than any broader categorization as bioart. Yet, in this case, the role of the artist in the creation of the work is even more contested, as it appears that Kac had very little input in the creation of the rabbit, which existed as part of a scientific trial. On one level, Kac's contribution was to label the transgenic life form as art, since it was never brought out of the laboratory into a gallery nor brought into existence through any artistic or creative means. Indeed, the genetic scientist behind the project indicates that Alba – the bunny's name – was already in existence and so was not created for Kac's project (Philipkowski 2012).

The act of labeling something as arts may alone be a sufficient act to make it so; one thinks also of Rene Magritte's *Treachery of Images* as a corollary here, instead claiming the life of the rabbit as arts rather than merely accepting its value as a scientific research specimen. In this case, what is intellectually appealing about GFP Bunny is the fact that there was no scope for the artist to have the means that would allow any such artwork to be created. The act of labeling Alba as arts is the most provocative creative assertion available to the artist. In this respect, Kac's intervention may be seen as politically underpinned, as it calls into question the boundaries between science and the wider world, seeking to reveal practice that is common in science, without much awareness from the public. In this sense, GFP Bunny may also be articulated as a medium of public understanding, albeit complicated – and made richer intellectually perhaps – by the fact that a "subject" rather than an "object" is the focus of discussion, as Kac notes (cited in Osthoff 2008).

The utilization of nonhuman species in bioart performance is also a common thread within such practice, and, here, such work invites us to consider how animals are utilized in society and to what reasonable ends they might be put. For instance, in Kira O'Reilly's *Falling Asleep with a Pig* (2009), her performance involves sharing a space with a sheep for some days – spending every minute of the day side by side in a gallery – literally a "companion species" (Haraway 2003). Her work provokes onlookers to consider their relationship to nonhumans and animals, a theme that resonates with a number of

DOI 10.1007/978-3-319-04033-2_33-1


controversial scientific possibilities – such as the utilization of pig organs for human transplantation. O'Reilly's performance asks onlookers to consider how they relate to and care for nonhuman species, reminding urban dwellers of the intimacy between shepherds and their flocks that continues to exist, along with foregrounding life within more rural environments. Other artists, such as Catts and Zurr, have scrutinized the need for humanity to farm animals, at a time when environmental activists point out the vast amount of energy needed to sustain one animal life and the harmful gases generated by such life-forms. As an alternative, they have developed *victimless meat* (Catts and Zurr 2008), a new kind of food grown from cell cultures, which has the neat consequence of also attending to animal rights concerns, since there is no sentient life to speak of that is harmed by the consumption of such products.

One other defining aspect of such bioart work is its reliance on other professions to realize the work. In this sense, bioart may be understood as a set of collaborative, hybrid creative practices that disrupt conventional biological boundaries, either through the manipulation of biological matter through scientific or technological means or through situating life outside of its conventional milieu, with a view to enabling some form of aesthetic transaction between the creator and the audience. The term transaction here is admittedly fuzzy but would principally involve work that invites interpretations that have to do with questioning biological boundaries.

In short, the term bioart may be utilized to distinguish any artistic practice that involves the *resituating of biological matter* to create works that are principally forms of artistic practice. While one may argue that many forms of human-centered artwork involve a biological transaction of some kind, or a resituating of biology so as to provoke thoughts about biological transgressions, for present purposes, bioart involves either the physical alteration of biological matter or situating an artist's physical presence within the artwork so as to engage such ideas.

Bioart has been theorized from a number of different perspectives, and scholars have varying interpretations of its significance and role. In some cases, bioart work is preoccupied with imagining a future where the category of the human species ceases to exist – once humanity has transcended its species-typical functions, either through becoming enhanced or by developing new capacities. However, not all work is like this, and some extends from the sci-art discipline of making work inspired, informed, or constituted by some scientific means. As noted earlier in the Wellcome Trust evaluation, bioart – including that which is funded by science – can have subversive capacities, raising questions about the trajectory of science. For example, Dunne and Raby's (2009) *Foragers* imagines how humans may redesign themselves biologically to "maximise the nutritional value of the urban environment," in a world of nearly no resources and an inability for governments to resolve. Alternatively, Michael Burton's (2007) *biophilia* clinic builds on scientist Edward Wilson (1984) and James Lovelock (1989) to consider what kind of attachment people may have to the experience of illness, in a world where all disease has been eradicated. Burton imagines that people would check in to such clinics, just to undergo an experience where they are made more fragile and need to experience the otherwise absent forms of suffering that would describe the future of humanity. In each of these cases, one might conclude that scientific progress is something of an oxymoron, as science pushes us in directions for which we are not prepared or have yet to realize their implications for how people conduct their lives. Indeed, the inadequacy of social, ethical, or political systems to accommodate change brought about by scientific innovation is an enduring thread in bioart practice.

There is also a broader political interpretation to bioart practice, which speaks to its capacity to force society to reconsider what is required of humanity to generate original insights. Artist collectives, such as SymbioticA (Australia), The Arts Catalyst (UK), and Dunne & Raby, enact a form of biopolitics that is focused on creating collaborative relationships between scientists and artists/designers. An integral part of this praxis has been the infiltration of scientific laboratories by artists, in pursuit of creative expression and the development of new knowledge about the boundaries of biology. Yet, it is not just natural or physical

DOI 10.1007/978-3-319-04033-2_33-1


scientists whose work may engage with bioartists. For instance, the work of designers Dunne & Raby undertakes a sociological survey of the future, by working with groups to imagine what kinds of decisions they would make about their lives if certain technological opportunities were available to them. This is true of their *Evidence Dolls*, which involved participants considering how genetic testing would influence their decisions over romantic relationships (Dunne et al. 2008). This work asked people to consider whether the ability to genetically test their potential partners for a range of characteristics would lead to its use as a condition for entering into a relationship.

By envisioning new forms of biological transformation and utilization, artists' ideas become constitutive of the landscape in which debates about biological change take place. However, by utilizing sociological methods, their work demystifies the idea that insights for artistic practice rely solely on individual creative vision. Admittedly, the example may reveal the difference between how artists and designers work, but the crucial point is that bioart often involves similar kinds of consultation and empirical inquiry to inform the work. Equally, a number of bioartists are active within the field of bioethics and regularly write for ethical periodicals. This includes Natasha Vita-More (2010) whose own theorizations on transhuman arts are inextricable from the ethical contexts where decisions about their legitimacy take place. Indeed, on Zwijnenberg (2009) notes that bioartists have "claimed a task for themselves that traditionally belonged to the humanities: ethical reflection on the boundaries of science and art and on other issues involving life and death" (p. xxi).

To this end, bioart, body art, and biodesign also scrutinize contemporary bioethical issues and scientific practice, such as the utilization of embryonic stem cells or the development of transgenic species. However, it is unclear whether all artists intend to resist such processes. Indeed, some are seeking their propagation in order to make their arts possible. For example, Stelarc's own body modifications convey the body's obsolescence in an era of synthetic biology and stem cell regeneration (Smith 2005). The use of stem cells within his *Extra Ear* project is still not the end stage of the work, which next aims to implant an auditory device within the ear and for it to be remotely connected to the Internet, so web browsers can hear what the ear hears, creating a distributed auditory system. If this were not enough evidence of how bioartists may sometimes celebrate the transformative aesthetic potential of biotechnology, then consider Julia Reodica's collection of synthetic hymens, which go beyond genital piercing and tattoo, but which resonates with these similar tribal motifs. This work invites us to consider the role of virginity and its loss in the twenty-first century, a theme that may be interpreted as intimately connected to the biotechnological era, as the contraceptive pill is one of the most transformative technologies of the late twentieth century.

The work of bioartists may be seen as an attempt to disrupt the knowledge economy, as many such artists are not interested simply in their creative means drawing on the work of scientists or revealing its beautiful complexity. Rather, the expectation is that the artist will become co-creator of original knowledge, a genuine research partner in the design and undertaking of scientific studies, to such a degree that some intellectual property over new discoveries or insights may be attributed also to the artist. In this sense, the gradual occupation of artists in labs raises important questions about how society is organized and understands our own humanity. For instance, why do societies privilege scientific knowledge over, say, aesthetic, as is evidenced by the way in which funding is skewed in favor of the former? Would humanity have been better off over the last 100 years or so if it had dedicated more of its resources to the so-called softer sciences, arts and humanities? Would societies have asked different questions or sought different solutions to difficult problems? Admittedly, societies might have produced fewer technologies that would save lives and perhaps would have failed to reduce suffering as effectively as they have through medicine, but then with fewer people on the planet, it might have been more effective at distributing goods more evenly. These are impossibly speculative questions but which nevertheless

Handbook of Science and Technology Convergence
DOI 10.1007/978-3-319-04033-2_33-1


expose the claim that hierarchies of knowledge systems affect the overall wealth in the world and that the scientific method need not have produced the least amount of suffering in the world.

By implication, one may argue that these collaborative bioart works should also be credited to the scientists involved and, indeed, they often are. While this may beg the question over ownership and the right to commercialize the work or benefit from its syndication in exhibitions or private sale, like all collaborative works, decisions about this are for the artist and scientist to negotiate in advance of and during the collaboration process. There are no fixed rules about who ought to be principal author, but equally it is often true that the scientist's terrain and the artists are distinct enough for all to benefit. Indeed, in the same way that an artist is unlikely to be in a position to capitalize on the scientific work, the same is true of the scientist in relation to the artistic presentation.

## Conclusion

As the two trajectories of science and arts have shifted over the years, various tensions have emerged. Involving artists within science communication activity does not always sit neatly with the aspirations of scientific institutions. After all, the US Science Festival Alliance – which sits within MIT Museum – notes on their website that "Science festivals are community based celebrations of the fascinating world of science and technology," and yet not all artists who engage with science support this mission. Similarly, the Wellcome Trust's 10-year evaluation of its funding on sci-art projects notes that its mission was to:

- Stimulate interest and excitement in biomedical science among adults
- Foster interdisciplinary and collaborative creative practice in the arts and science
- Create a critical mass of artists looking at biomedical science and build capacity in this field.

(Glinkwoski and Bamford 2009)

Each of these is sensible aspirations for a science funder, but why should public engagement with science work just be celebratory or aim to inspire, create wonder, and develop interest? What if the science industries, in their unwavering support of science, fail to consider broader societal implications to such work that would lead to circumstances that are less favorable to human flourishing? Arguably, a more compelling mission for science communication is around developing a critical and interrogative public, capable of scrutinizing the, now, advanced capacities of scientific organizations to manage media impressions and control the narrative of public understanding. Indeed, the contribution of artists working within science is apparent in an independent evaluation of Wellcome's sci-art work, which found that

> Artists working on Sciart projects were felt to have acted as a proxy for the public, opening up scientific practices to a wider gaze. By bringing into the public domain new perspectives on the work that was being conducted in laboratories and other places of science, it was suggested that artists were, in effect, acting as the 'public's representative'. A significant aspect of the artists' contribution to 'public engagement with science' was thus as independent scrutinisers – asking questions and provoking insights that might not otherwise be possible, either from the perspective of the general public or from within the scientific community itself. (Glinkowski and Bamford, p. 9)

Early work in bioart has demonstrated the capacity of such interventions, and, in a world where institutionalized media distribution is inherently constrained due to professional codes of ethics and financial interests surrounding such institutions, it may only be artistic works that are in the business of providing these critical platforms. This may explain why some festival directors are gravitating increasing toward artistic works within their program, in part because there is a degree of disenchantment with the scientific mission to use the public realm as a space for championing rather than interrogating science.

DOI 10.1007/978-3-319-04033-2_33-1


This chapter has shown how science institutions are migrating work into the public realm and how artistic practices are moving into laboratories. There is a danger that the two will completely miss each other on the way, where, instead, there is a need for friction and tension to develop more democratically engaged, politically aware, and inclusion participation within both the practices of arts and science. While it is typically artists who seek to make science available to the public through their work, there is also a need for scientists to consider the range of ways in which their practices are creatively informed, so as to challenge conventional epistemological assumptions about what knowledge, discovery, and insight entail. The common creative process of arts and science provides far more scope for convergence than is typically offered by the manner in which contemporary educational institutions separate them. The wider rethinking of the relationships between these two knowledge systems that I have offered is crucial to embrace, to ensure that work interested in the public understanding of science reaches its potential. To return where we started, there is a need to revisit the history of arts and science and come to terms with the common ground between these different pursuits. As Miller (2014) notes, back in the sixteenth century when Leonardo da Vinci undertook his great works, back then, he "was both artist and scientist, because in his day there was no distinction" (p. 342). This seems ever true again in our brave new world of bioart.

Kuhn's (1969) conviction that, unlike art, science does not seek an audience speaks to a different era where science and arts were more separate or less aware of each other's relevance to advancement in either. It also seems neglectful of the political economy in which science is situated where the audience – far more than just a peer group – must interrogate, scrutinize, question, and support science to legitimize its worth and confirm its importance. This may be a different kind of audience, but I suspect it is no less vulnerable to the possibility of being wondered in a way that today's audiences in science festivals are. Minimally, if one accepts that the progress of science has worth only in the context of human society, then locating science in the public domain, developing thoughtful and strategic approaches to science communication, and ensuring work is done to bring scientists and artists closer together should be treated as an ethical obligation of the arts and science industries. Moreover, one might further assert a moral obligation of society at large to ensure that our pursuit of knowledge and understanding of our world utilizes the most effective tools through which to optimize such opportunities to make sense of science.

Yet, Kuhn makes a crucial point that should guide future work in public engagement with science, which gets to the heart of the present limitations in such work. He notes that "mediating institutions like the museum have no function in the professional life of scientists." It is possible that science festivals and the restructuring of scientific research evaluations, like the UK Research Excellence Framework, which foregrounds the importance of impact beyond academia, have begun to fill this void. However, a lot more work is needed to ensure that this upper limit on the investment a scientist makes on communicating and engaging with the public is not static.



## References

Burton M (2007) Biophilia clinic. http://www.michael-burton.co.uk

Catts O, Zurr I (2008) The ethics of experimental engagement with the manipulation of life. In: Da Costa B (ed) Tactical biopolitics: art, activism. pp 125–142

Dunne A, Raby F (2009) Foragers. http://www.dunneandraby.co.uk

Dunne A, Raby F, Miah A (2008) Screening for undesirable genes: the evidence dolls project. In: Miah A (ed) Human futures: art in an age of uncertainty. Liverpool University Press & FACT Liverpool, pp 62–75

DOI 10.1007/978-3-319-04033-2_33-1


Glinkowski P, Bamford A (2009) Insight and exchange: an evaluation of the Wellcome Trust's Sciart programme. Wellcome Trust, London. www.wellcome.ac.uk/sciartevaluation. Accessed 1 Nov 2014

Haraway D (2003) The companion species manifesto: dogs, people and significant otherness. University of Chicago Press, Chicago

Hauser J (2008) Observations on an art of growing interest: toward a phenomenological approach to art involving biotechnology. In: Da Costa B, Philip K (eds) Tactical biopolitics: art, activism, and technoscience. The MIT Press, Cambridge

Lovelock JE (1989) The ages of Gaia. Oxford University Press, Oxford

Miller AI (2014) Colliding worlds: how cutting-edge science is redefining contemporary art. W. W. Norton. https://books.google.com/books?hl=en&lr=&id=5a5bAwAAQBAJ&pgis=1. Retrieved

O'Reilly K (2009) Falling asleep with a pig. http://www.kiraoreilly.com

Osthoff S (2008) Eduardo Kac: a conversation with the artist. In: Miah A (ed) Human futures: art in an age of uncertainty. Liverpool University Press, Liverpool, pp 146–151

Philipkowski (2012) RIP: Alba, the glowing bunny, wired magazine. http://archive.wired.com/medtech/health/news/2002/08/54399?currentPage=all. Accessed 22 Apr 2015

Reichle I (2009) Art in the age of technoscience: genetic engineering, robotics, and artificial life in contemporary art. SpringerWein, New York, pp xiii–xxix

Research Councils UK (no date) Public engagement with research strategy. http://www.rcuk.ac.uk/RCUK-prod/assets/documents/publications/RCUKPERStrategy.pdf. Accessed 22 Apr 2015

Stelarc (1997) Hollow body/host space: stomach sculpture. Cult Values 1(2):250–251

Stelarc (2008) Extra ear, ear on arm. In: Miah A (ed) Human futures: art in an age of uncertainty. Liverpool University Press, Liverpool, p XX

Vita-More N (2010) Aesthetics of the radically enhanced human. Technoetic Arts 8(2):207–214. Intellect, Bristol

Wilson EO (1984) Biophilia. Harvard University Press, Cambridge

Zwijnenberg R (2009) Preface: art, the life sciences, and the humanities: in search of a relationship. In: Reichle I (ed) Art in the age of technoscience: genetic engineering, robotics, and artificial life in contemporary. SpringerWein, New York, pp xii–xxix

Handbook of Science and Technology Convergence
DOI 10.1007/978-3-319-04033-2_33-1


# Index Terms:

Handbook of Science and Technology Convergence
DOI 10.1007/978-3-319-04033-2_33-1


# Author Queries

| Query Refs. | Details required |
|---|---|
| Q1 | Please confirm if author name and affiliation is okay. |
| Q2 | Please provide details of Smith (2005), Kuhn (1969) in the reference list. |
| Q3 | Please provide publisher name and location for Catts and Zurr (2008). |
| Q4 | Please provide publisher location for Dunne et al. (2008). |
| Q5 | Please check if inserted publisher location for Haraway (2003). |
| Q6 | Please provide date of retrieved for Miller (2014). |