Charis Thompson

Designing for the life sciences: the epistemology of elite life science real estate

Article (Published version) (Refereed)

Designing for the Life Sciences: The Epistemology of Elite Life Science Real Estate

Charis M. Thompson
University of California Berkeley

Abstract: In this article trends in the design of iconic elite life science buildings is discussed. Four main elite life science buildings of the new century are considered. The buildings reflect things going on in and around elite contemporary life science today, including changing ideas about the relation between the public and science, and about the relation of science to the market. Reading trends in the design of science buildings is a way to follow the evolving epistemology of the life sciences and changing demands of science policy.

Keywords: Design; architecture; STS; Life Sciences; buildings.

Corresponding author: Charis M. Thompson, UC Berkeley Sociology Department – 410 Barrows Hall, Berkeley, CA 94720-1980 – Email: charis@berkeley.edu

1. Introduction

In the current era, it is common for elite life science buildings to be designed by top architects, and to win prizes and acclaim for their design. These imposing buildings concretize the valuation and values of the life sciences. Their layouts are literal interpretations of evolving ideas about how best to do science: who should have what kind of access to whom and to what, what activities should happen where, and what relations there should be between what goes on inside the building and its various publics. In some ways, this is nothing new. The architecture and design of elite scientific buildings has always reflected contemporary ideas about how science is best done and known, who pays for it, and what purposes it serves. The Ancient Library of Alexandria, built in the 3rd century BC, was reputedly designed to gather the world's written knowledge, to dis-

T/S TECNOSCIENZA
Italian Journal of Science & Technology Studies

play and aid the exercise of power by rulers, and to attract the greatest scholars of the day and thereby promote more research and knowledge.

These same elements of gathering and housing data; service to power (whether rulers or other paymasters) and publics; and attracting the best scholars and facilitating the best research continue in various combinations to characterize the design of elite scientific buildings. The specific forms this takes, however, mirror evolving epistemic and social aspects of knowledge production. In this paper I consider an iconic elite life science building from the beginning of the revolution in molecular biology, the 1962 Salk Laboratory in San Diego. I then look at four elite 21st century life science buildings: Singapore's 2004 Biopolis Phase One, UC San Francisco's 2010 Dolby Regeneration Medicine Building, Cambridge, UK's 2011 Sainsbury Laboratory, and London's 2015 Francis Crick Institute[1]. Certain themes of the Salk's design, such as the emphasis on design itself, and the provision of basic lab bench needs as part of a flexible but inbuilt infrastructure have continued to characterize these buildings. Newer design elements, such as the explicit incorporation of a translational arc from "bench to bedside", and the incorporation of data management into the infrastructure, are evident. So, too, are changing ideas about innovation in the life sciences and its uses, dangers, and relations to its publics.

2. Science and Technology Studies and Design

Since its inception, Science and Technology Studies (STS)[2] has emphasized the places where science is carried out as part of its commitment to showing what is social and what is situated about knowledge that functions rhetorically as natural and un-situated (see Thompson 2005, 31-53; Shapin 2010). STS has also always paid attention to material culture and to the empirical, technology-mediated and spatialized ways in which epistemological judgments are possible (Latour 1999, 24-79; Lynch 1985; Prentice 2013; Suchman 2007; Thompson 2005, 79-116). Geopolitical spaces, from citizen science to regions and nations to circuits of knowledge, facts, materiel, and scientific personnel, have been elucidated as part of the sine qua non of modern science (Haraway 1984; Jasanoff 2004; Livingstone 2003; Mukerji 2010; Nelson 2011; Thompson 2013, 68-149). And the actual sites where science is carried out, from the field site to the lab, and from the Early Modern to the Contemporary era, have

[1] My choice of buildings is idiosyncratic, and reflects paths that my own research has taken. Although these buildings cannot be said to be representative of new life science research buildings in general, I suspect that the characteristics to which I draw attention are not only evident in these particular buildings.

[2] I use STS to refer to cognate work from the history, sociology, anthropology, and philosophy of science, as well as from STS "proper" (STS as a discipline).

long been thematized in STS, as microcosms of the self-contained case-study method, and as materially relevant to the science produced (Galison 1997; Latour and Woolgar 1986; Rudwick 2014; Thompson 2013). This paper draws on all these strands of STS.

Michel de Montaigne's C16th Tower has come to symbolise the tension between the ways one's environment can structure and nurture one's work, and the ways in which it stifles or corrupts the imagination and the intellect. Today, amidst the boom in elite science real estate, this tension is still evident. The start-up stereotype eschews the real estate of established science, and is populated, in the US imaginary, with under-socialized and vitamin D-deficient young predominantly affluent White males in basements and garages. The freedom from the trappings of professionalized science is equated with creativity and innovation. In fact, the necessary equipment, regulation, and data are all big science today, and only a very well connected Silicon Valley garage would be fit for purpose. Even within establishment science, individual scientists and specific breakthroughs are still the things that are venerated and credited with genius in a system of positive feedback by which the leaders pull away from the rest. This individualism and star system continues to flourish even though the sciences are in many ways ever more collective and interdependent. To design a building for contemporary life science, it needs to be seen as allowing for, or actively fostering, individual creativity. The new elite life science real estate has incorporated elements of these enduring ideas about the nature of innovation and of genius into its novel design[3].

3. The Life Sciences

The life sciences stand on the brink of being able to re-engineer molecular life in purposive ways. In this lies the potential to manufacture a new generation of bioweapons, and a corresponding need to make many branches of the life sciences secret as part of national and international security apparatuses. At the same time, never has the scope and depth of public implication in the life sciences from agricultural biotech to biomedicine been so great: our lives, our food, and our governance are part of a biotech mode of (re)production (Thompson 2005, Ch. 8). Life science real estate displays this tension between a heightened need to be accountable to and involve the public, and security needs that re-impose *cordons sanitaires* and limits to transparency and public access.

Life science today also characteristically proceeds according to new combinations of public and private funding, captured in the bench to

[3] The pedigree of these ideas, and their tension with how science is actually done, can be traced in the work of Steven Shapin (1991). See also Livingstone (2003).

bedside promise of translational biomedicine. The public is asked to support open-ended basic science, while private capital is tasked with its translational uptake, in an aspirational cycle of innovation and trickle down wealth creation. This rise of what could be called the research-industrial complex, in a parallel to the military-industrial complex of the C20th, imposes its own tensions. The extent of public non-military research funding carries with it demands for accountability and participatory science, and for visible, equitably distributed public goods flowing from research. The private sector money, on the other hand, brings its own legal and business rationales for keeping knowledge proprietary. This tension manifests at every level of the life sciences today from crises of reproducibility, to the open-access publishing movement, and unprecedented pressure for academic scientists to publish in high impact journals and engage in technology transfer and corporate spin-off. The buildings I consider below demonstrate their mixed public-private funding, and in some cases, their interior design attempts to address these tensions and remedy the problems of the heavily capitalized private versus public faces of contemporary life science.

4. The Salk Institute

The Salk institute was built in 1962 and designed by architect Louis Kahn, in collaboration with Jonas Salk, famous for developing the polio vaccine. It is one of the world's most iconic science buildings: starkly masculinist and framed by the frontier landscape of Southern California's Pacific Coast. The basic design has two rows of rectangular parallel laboratories running parallel to the coastline over which it is perched, on either side of a travertine marble courtyard. The courtyard is dissected by a straight line of water running, infinity-pool style, toward the cliff edge, and continuous to the eye with the Pacific Ocean. At sunset, the courtyard frames the setting sun. On the inside courtyard side of the laboratories are hemi-chevron shaped offices, blending wood with the warm cement mix of the labs. There are separate towers at the East end of utilities, and three of the six floors of the laboratory portion is given over to heating, ventilating, gas, electricity, and other support systems by then essential to bench science. See image 1 for the vista, and image 2 for the offices, seen from the ocean side. In 1992, the Salk received a 25-year award from the American Institute for Architects.

The labs themselves have no internal walls and have lighting units that can be moved, as well as the easily accessible, flexible support systems made possible by the service floors. These features were designed to support maximum collaborative potential, as well as to be easy to maintain and to leave open for the future exactly what configuration of working would best serve the science being conducted in the building. The Salk remains one of the most productive and perhaps the single most illustrious life science facility in the world, in terms of its current researchers and many Nobel and other prize winning alumni. This speaks to the continuing attractiveness to researchers and funders, and scientific efficacy and longevity of the design.

Image 1 – The iconic view of the Salk Institute (reproduced from: http://pic.pimg.tw/leecocoa/1327583338-3916316003.jpg).

Image 2 – The hemi-chevron offices of the Salk Institute, seen from the ocean side (photo by Jim Harper/Wikimedia Commons).

The principle of building collaboration into the laboratory design so as to promote scientific discovery and innovation has continued in newer elite life science buildings. Nonetheless, the version of collaboration the Salk embodies is not the same as that more commonly seen today. The Salk is an austerely beautiful building, a scientific retreat of the most aestheticized modernist kind, frequently described as monastic. It is characterized by its symmetry and precision, and its interior spaces remains the sole preserve of scientists and researchers themselves. The collaboration is among scientists. The public is not part of its design, although the Salk was from the start a monument to science in the service of the human race, having been designed at the dawn of the molecular biology revolution, in the duel context of eradicating the greatest diseases of mankind and the Cold War. It has played a highly significant role in the life sciences from plant biology to neuroscience ever since. More recent life science buildings design the pros and cons of collaboration differently, incorporating a participatory relation to the public, rather than serving in a salvational relation to a greater humanity from which it is separate.

4. Fast forward to the 21st Century

By the twenty-first century, the Cold War, if not nuclear (dis)armament, was behind us, and the life and biomedical sciences had grown and capitalized dramatically. We worried about global warming, not nuclear winter. Our concerns with empirical science were more likely to stem from big data's lack of intelligence or justice, than from the gap between non-falsifiability and truth. Epistemological crises of science as an institution, such as failures of reproducibility, and their apparent causes in excesses of market and competitiveness, all threatened the life sciences' special relation with democracy. Could it be that the life sciences were contributing to a world caught up in increasing inequality rather than serving as the place from which to "speak truth to power"? The new iconic life science buildings displayed the concerns of the era, from spaces designed to mitigate excessive competitiveness to those designed to acknowledge a public who talks back. Like the Salk in its time, these concerns were literally part of the design of these labs, showing in another instantiation the claim made by Science and Technology Studies that science is co-produced with the social order of its time and place.

The new building design, then, reflected how people were thinking about science in the early twenty-first century, from innovation to ethics to participation to sustainability to interdisciplinarity to markets and security. Although all these elements are evident in all of the buildings I discuss below, for the sake of clarity and brevity, I am focusing on only certain particularly striking aspects of each building. I take the buildings in the order in which they were opened. For Singapore's 2004 Biopolis, I emphasize flow between the public and private sectors and between disciplines and nations; for UC San Francisco's 2010 Dolby Regeneration Medicine Building, I emphasize innovation and sustainability as rationales for public funding and private profit; for Cambridge, UK's 2011 Sainsbury Laboratory, I emphasize good science and the new monasticism against threats to reproducibility and excellence in science; and for London's 2015 Francis Crick Institute, I emphasize the invitation in and containment and management of publics.

5. Singapore's 2004 Biopolis Phase One

Singapore's Biopolis Phase One is a seven-building biomedical research compound that was built in 2003-4. Like the Salk, it was designed by a world famous architect, but one very much of the turn of the new century rather than the mid -20th century, the Iraqi-British architect, Zara Hadid. Hadid was the first Muslim and first woman to win the Pritzker Architecture Prize, in 2004, and she has also won the Stirling Prize. Her buildings are known for their flamboyant curves, and their futurism, conjuring up artificial natures rather than being at one with, or sustainable within, a threatened nature. Hadid's dual heritage betokening her global citizenship, and her familiarity with designing for new wealth-attracting global cities, made her a good choice for Biopolis. The names of the seven buildings of Biopolis, Chromos, Helios, Genome, Proteos, Centros, Matrix, and Nanos, made no secret of their life-science ambition to repurpose nature and re-master life itself, and Hadid's buildings reflected that. The buildings *are* the landscape, rather than built into the landscape.

Biopolis has something in common with such places as Silicon Valley's Googleplex in that it is governed by a view of innovation that is near totalizing. Many aspects of life are encompassed within the complex itself; you can eat, drink, get your hair cut, attend arts programs and drop off your kids and your dry cleaning. There are also nearby residential facilities for scientists and their families to live. The ethos – at least when I toured it – was not at all the Peter Pan-like one that I experienced at Googleplex, but rather, professional and urbane, and translational. Biopolis emerged as a microcosm for the city-state of Singapore trying to position itself in the knowledge economy as a global and regional hub for international life science.

The seven Biopolis Phase One buildings themselves are connected via sky bridges, again emphasizing the literal links between areas of specialization. Some of the buildings contain privately funded laboratories, and others are publicly funded; some of the research is basic, but it is imaged in connection to translational research. The built environment links them as a single manufactured landscape of research. Some of the labs are set up so as to facilitate collaboration among scientists coming from different national science traditions, having different kinds of experimental conditions built into the infrastructure, and thereby facilitating attracting the best and the brightest ex-patriate scientists as well as Singapore's next generation of knowledge workers4. All in all, Biopolis Phase One designed into being a world of life science research that was flexible, internationally co-operative, and intrinsically translational, or "bench to bedside". The brain drain to Biopolis, and subsequent disillusioned exit of, several internationally recognized life scientists spoke to the tensions inherent in this model between basic, creative university science and science too explicitly in the service of the economy.

Image 3 – The landscape of Biopolis Phase One and its Sky Bridges (reproduced from: http://upload.wikimedia.org/wikipedia/commons/4/43/Biopolis-Singapore-20080712.jpg).

6. UC San Francisco's 2010 Dolby Regeneration Medicine Building

I turn next to the Ray and Dagmar Dolby Regeneration Medicine Building at UCSF, which houses the Eli and Edythe Broad Center of Re-

[4] In *Good Science* (Thompson 2013), I described Biopolis as "internationalist" in its layout, labs, and epistemology, while being very much a product of Singapore, with its city-state merging of private capital and government agencies, literally connected by sky bridges.

generation Medicine and Stem Cell Research. This building was designed by the New York firm, Rafael Vinoly Architects, and was paid for by a combination of private funds and taxpayer money awarded for stem cell facilities by the California Institute for Regenerative Medicine. It won an American Institute of Architects Design Award in 2011, among other recognition, and is widely regarded as a beautiful building.

The Dolby Regeneration Medicine Building is credited with four striking properties. First, it was built very quickly. Second, it is seen as an engineering feat, having been built on a 60% slope, curving horizontally along the Parnassus Heights hillside. Adding to the engineering prowess, the Nabih Youssef Association of engineers gave it remarkable seismic properties. The building was constructed on a steel framework with isolation bearings that reputedly would be able to move over two feet sideways and even vertically by an inch or two in the event of an earthquake. Everything about the building is innovative.

Third, the building was designed to receive Energy and Environmental Design for New Construction (LEED-NC) Gold level certification. Unusually for laboratories, it maximizes natural light, and it was built using many kinds of energy conservation methods. The building itself is also blended in with the environment, and aims to minimize its contribution to greenhouse emissions not just through energy conservation, but also through using the roofs of its various levels to grow native grasses. The Salk was designed in such a way that it aggrandizes its natural setting and vice versa. The Dolby is also an impressive building that fits its natural setting and affords splendid views, but it is more about energy and environmental sustainability and not disrupting its habitat than it is about grandeur and monumentality of nature inside and outside the lab.

Finally, the Dolby Regeneration Medicine Building, like Biopolis, was explicitly designed to foster connections between the public and the private sector. Its collaborative design was different than that of Biopolis (or the Salk), however. Biopolis was designed to connect different subdisciplines to serve the growth of an international economy. The Dolby Regeneration Medicine Building, on the other hand, was built to connect sub-disciplines so as to facilitate and stage an interplay of ideas, the sharing of new techniques, and the growth of knowledge. This in turn was to speed the translational trajectory from basic research funded by the public all the way to clinical therapies, via commercialization and clinical trials. The economic benefit was implied in the translational design but it was secondary. Cures from stem cell research and regenerative medicine were the primary goal of the building's design[5].

At the Salk, the offices were off to one side. In the Dolby Regeneration Medicine Building, the offices and meeting and lounge spaces were

[5] In *Good Science* (Thompson 2013) I characterized this as "pro-curial" science, concerned with cures, and with the procurement and curation of life tissues and data.

placed in the areas that were directly between different labs. Getting to and from one's lab required interaction with personnel from other labs. In this way, walking, talking and thinking, were designed to be spontaneous and interactional. Research funded by public and by private sources would come into serendipitous contact in this interactive flow of minds and bodies through the building's layout. The building bears a literal signature of this collaboration in the 140-foot long, 90 foot above-ground, glass enclosed steel bridge which serves as the building's main entrance. In this entryway, the eponymous private donors are named and matched by a commemoration of the tax-payer and the innovative voter initiative, California's Proposition 71, that also provided funding.

Image 4 – The Dolby Regeneration Medicine Building's curving hilltop design. (reproduced from: http://buildipedia.com/aec-pros/featured-architecture/ucsf-institute-regenerative-medicine).

7. Cambridge, UK's 2011 Sainsbury Laboratory

Cambridge University's 2011 Sainsbury laboratory was funded by David Sainsbury's Gatsby foundation, and designed by the architects Stanton Williams. In 2012, the building won the Royal Institute of British Architects Stirling prize, a prestigious architecture prize awarded for the building that contributed the most to British architecture in the last year.

The Sainsbury laboratory is a plant biology facility, and was designed with containment facilities for known pathogens. In other ways, though, it was designed with a high degree of openness and flow from the outside to the inside and among its inside spaces. Those working in the biomedical branches of the life sciences work in buildings designed for the unique challenges of animal research and human subjects (and in the case of stem cell research, embryos). As I discuss below, openness in biomedicine building design is constrained by the containment of animal rights activism and by privacy and property and propriety claims of human subjects. Openness means something different when human and animal subjects are not at stake. Those working in plant genetics encounter a not always supportive public, especially around the GMO question, but in general they can afford to be less concerned with dealing with the public actually or metaphorically inside their research premises than those working in biomedicine. Openness as a design feature functions differently. It still fosters research creativity and productivity by encouraging researchers to interact and share information and findings through working in shared spaces with few walls. Instead of a means of collating and containing the public, however, openness provides visibility and accountability. This is turn can encourage a research culture designed to avoid the pitfalls and temptations of hyper-competitive closed science.

The Sainsbury laboratory is situated in Cambridge University's Botanic Gardens, and is strongly connected to the botanic gardens, not just through its core mission of working to discover the mechanisms of growth regulation of plants, but also in its design. Although the laboratory is concerned with plant genetics and development at least in part so as to address the grand social challenges of food security and climate change mitigation, the building was built to emphasize the ethos of fundamental science, including the herbarium and covered growing area and the flexible lab benches and non-hierarchical layout of the lab. The pressures that might be associated with highly commercialized fields were counted in elements of the design. Only the laboratory's director has a proper office, and all other researchers of all ranks must do their meeting and working in shared spaces that overlook the garden and are contiguous with the lab space itself. Like the Dolby building, this building's design made interaction inevitable. The arrangement of space highlighted intellectual contribution rather than rank.

The Sainsbury laboratory building was built with a serene and calming combination of stone, cement, and wood, and was explicitly conceived of as monastic by the architects. This is a new monasticism since the Salk, however. The space is not public, but the public is able to enter the auditorium and the café and herbarium and the botanic gardens in which the building is set. The monasticism comes not so much from being a separate citadel from the world in which humanity is at risk, as in the Salk, but from the designed rigor required to pursue scientific excellence and truth in the face of politicized and capitalized applications for the science at hand. The space both ensures that the work is relevant to the pressing global challenges of the day (food and climate), while steering a path that avoids the excesses of competitiveness, temptation to fame, and proprietory or secret behavior that might be expected to attend elite science at Cambridge, as well as science of value to the agricultural biotech private sector and the politically contested areas of climate change and GM crops. The pressures that threaten to corrupt science and scientists, hierarchy and competitiveness and secrecy, are designed to be as minimal as possible in the building. The new monasticism stands for good science in both the ethical and intellectually significant senses of the expression. Where Salk was aesthetic, the Sainsbury laboratory, for all its beauty, embodies a certain intellectual and organizational asceticism.

Image 5 – The Sainsbury Laboratory, Cambridge, UK, in its new monastic serenity (reproduced from: http://www.stantonwilliams.com/data/projects/372/img2.jpg).

8. London's 2015 Francis Crick Institute

The Francis Crick Institute for Medical Research and Innovation, in London, UK, is slated for completion in 2015. I toured it while it was still a building site, and was able to see the extraordinary engineering and design that went into the basic services housed in its basement. From gas and air, ventilation and cooling, clean and contained human and animal and pathogen handling facilities, and on-site data storage and back up, the Crick was the largest scale building and the most comprehensively serviced of the buildings. The Salk's innovation of having service systems built into the design and infrastructure of science buildings so as to promote sustainable unpredictable research and collaborations is alive and well in all these 21st century buildings. A growing need for quality control, biosafety, and big data storage and management have all intensified the needs these needs for built in service infrastructure. The fact that the biological is beginning to yield new kinds of fundamental knowledge that can bridge the data-human-animal divides is mirrored in the facilities that need to be designed to permit this fungibility.

The Crick is a massive edifice, not remotely monastic, but instead positioned in the heart of the King's Cross development area of London, and explicitly engaged with its more and less local publics. The once-religious motives are not gone, for the basic design of the building is a giant cross. But it is an active and secular congregation that is beckoned. There is a team involved in public participation, and the public relations surrounding the building emphasize the public good to which the science inside is to be directed. Unlike the other buildings discussed in this paper, the public is to be invited into the belly of the beast, having access to much of an enormous ground floor atrium. In the emphasis on public engagement and the way the atrium has been designed, the Crick evokes a 21st century hands-on science museum more than a conventional laboratory space. There is a café, and a cinema pod in which demonstrations and films will be shown. Exhibits will be geared toward topics that are of interest and good to the public living in the areas that surround the building.

Image 6 – The public part of the soaring central atrium of the Francis Crick Institute (reproduced from: http://www.hok.com/uploads/2012/03/23/francis-crick-st05.jpg).

It has become a commonplace of science today to pay some heed to public engagement and participation in science, rather than simply seeking to educate the public. The Crick manifests this. It also manifests starkly the limits to public engagement in science, corralling the public in the central atrium, rather than in areas where the core science of the building is happening. The active research part of the building – the sides, top, and back of the building – are secured from public entry, so as to protect scientists from potentially dangerous animal rights activists (so I was told), and from others who might unwittingly or not disrupt the business of doing cutting edge science. Public participation, then, is more hands on than the earlier idiom of the public understanding of science, and no doubt, having the public in the building will serve to remind scientists of the centrality of the public good to their mission as scientists. Nonetheless, it is a far cry from the citizen science or crowd-sourced experimental space many of us have imagined might be the next design phase of 21st century life science.

9. Concluding Thoughts on the New Design

The iconic new buildings for the life sciences are like the Salk in that they continue to be award-winning not just as architecture, but as architecture in the service of research. They continue to design "the basics" into the infrastructure, but their design shows that the basics have expanded to include animal and data storage, and cooling and freezing capacity, and clean and efficient interfaces between human, animal, and data. Changing or blurring boundaries between human, non-human animal, and data are emblematic of the biomedical contemporary life sciences and are embodied in the design of these buildings. In layout the new buildings are: a) bench to bedside, including public and private funding in a single research trajectory, and affirming the link between basic and translational research; b) in touch with their environments, and even award-winningly green; c) participatory, but with strict limits; and d) designed for "good science" that would promote translation and spurs to innovation without falling prey to the excesses of "publish or perish," or the corrupting influences of the market. Reading elite science buildings is a way to follow the evolving epistemology of the life sciences and changing demands of science policy.

Applied to these elite science buildings, the STS claim of the co-production of science and society requires some further discussion. I have argued that the buildings reflect several rather different kinds of things going on in and around elite contemporary life science. For example, the buildings reflect changing ideas about the relation between the public and science, or about the relation of science to the market, which seem on the face of it to be science policy issues. The buildings also display a new relation to the cityscape or to the environment in the age of global warming that seems to be taken from wider culture. In addition, the buildings display current interpretations of certain ideals of science, such as openness, good science, and the fostering of creativity through interaction, which might or might not reflect much about how science actually proceeds. The question arises, then, as to whether these phenomena have anything to do with scientific knowledge itself, or whether they just concern the cultural context of science[6]. As I tried to indicate above, the cultural context and the science itself cannot in fact be that cleanly separated, even though the entanglements between these things are different for each issue. So, although the buildings reflect changing (and in some cases, persistent) ideas about science to be found in the wider culture, they also reflect, and in turn help produce, changing scientific knowledge. For example, translational biomedical science aimed at finding cures needs to produce knowledge that survives translation from an animal model to humans, from proof of concept to scaleability, and this requires developing instrumentation, regulation, characterization, and different and tougher standards of reproducibility, among other things directly part of the science itself.

Contemporary science buildings' relations to the environment reflect the rhetorical role of science as evidence-based reason in naming and in mitigating global warming. The buildings, by mitigating climate change, impart that reason to what goes on within them. But elements of climate friendly design such as open plan and natural light are part of encouraging an interactive and transparent approach to science that guards it from becoming corrupted by excessive money and competition, and that ensures that creativity is constantly catalysed. This is true whether the openness literally renders everything visible and whether spontaneous open plan interactions actually cause more creativity, or whether those ideas function rhetorically as an ideal; in either case, the knowledge is produced and judged according to those standards. Likewise, the role of the public in the buildings' designs, whether as an absent guarantor of good science, or as present and participating in parts of the building, makes the scientific knowledge itself something that must be accountable to the public in certain ways. The public can talk back to science, appropriate it for its own ends, demand regulation, refuse a standard of proof, and many other things that affect what constitutes scientific knowledge and who is qualified to make that determination. In conclusion, then, the design of new elite life science real estate tells us about changing ideals of science, about contemporary issues in science and society, and even about some changing aspects of scientific knowledge itself.

---

[6] I am grateful to Paolo Volonté for correspondence on this matter.

References

Galison, P. (1997) *Image and Logic: A Material Culture of Mycrophysics*, Chicago, University of Chicago Press.

Haraway, D. (1984) *Teddy Bear Patriarchy: Taxidermy in the Garden of Eden, New York City, 1908-1936*, in "Social Text", 11, pp. 20-64.

Jasanoff, S. (2004) *Science and Citizenship: A New Synergy*, in "Science and Public Policy", 31 (2), pp. 90-94.

Latour, B. (1999) *Pandora's Hope: Essays on the Reality of Science Studies*, Cambridge, MA, Harvard University Press.

Latour, B. and Woolgar, S. (1986 [1979]) *Laboratory Life: The Construction of Scientific Facts*, Princeton, NJ, Princeton University Press.

Livingstone, D. (2003) *Putting Science in Its Place: Geographies of Scientific Knowledge*, Chicago, University of Chicago Press.

Lynch, M. (1985) *Discipline and the Material Form of Images*, in "Social Studies of Science", 15 (1), pp. 37-66.

Mukerji, C. (2010) *The Territorial State as a Figured World of Power: Strategics, Logistics and Impersonal Rule*, in "Sociological Theory", 28 (4), pp. 402-425.

Nelson, A. (2011) *Body and Soul: The Black Panther Party and the Fight Against Medical Discrimination*, Minneapolis, University of Minnesota Press.

Prentice, R. (2013) *Bodies in Formation: An Ethnography of Anatomy and Surgery Education*, Durham Duke University Press.

Rudwick, M. (2014) *Earth's Deep History: How It Was Discovered and Why It Matters,* Chicago, University of Chicago Press.

Shapin, S. (1991) *"The Mind Is Its Own Place": Science and Solitude in Seventeenth Century England*, in "Science in Context", 4 (1), pp. 191-218.

Shapin, S. (2010) *Never Pure: Historical Studies of Science as if It Was Produced by People with Bodies, Situated in Time, Space, Culture, and Society, and Struggling for Credibility and Authority*, Baltimore, Johns Hopkins University Press.

Suchman, L. (2007) *Human-Machine Reconfigurations: Plans and Situated Actions*, Cambridge, UK, Cambridge University Press.

Thompson, C. (2005) *Making Parents: The Ontological Choreography of Reproductive Technologies,* Cambridge, MA and London, The MIT Press.

Thompson, C. (2013) *Good Science: The Ethical Choreography of Stem Cell Research*, Cambridge, MA and London, The MIT Press.