Causal Layered Analysis as Pedagogy in Studies of Science and Technology

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Abstract

Science and technology embody a number of key metaphors and at least one central myth, one that was articulated by a founder and champion of scientific method, Francis Bacon. Through the dissection and reconstruction of nature, a new technologically improved nature will be the inevitable result. Causal Layered Analysis (CLA) opens a pathway for students to understand how such a myth came into being and take hold, not so much as a matter of public imagination or belief, but as an unconscious, continuing commitment to science. CLA as pedagogy is not directed towards to establishing the truth or falsity of Baconian propositions, or to proselytise for another version of science or an alternative belief system, but rather to enable students to examine the pervasiveness of such underlying myths in contemporary technological settings (for example the classroom), and to create a critical distance from which to engage with science as myth rather than as a set of unquestionable and therefore unthought assumptions. The project is to create a bridge between the sciences and the humanities, a place where dialogue might occur.

Introduction

This paper deals, not with the *mechanics of teaching* in studies of science and technology, but with communicating Causal Layered Analysis (CLA) as an activity of building with and beyond scientific knowledge, enabling the creation of value towards the future. In undergoing a process of unpacking the genealogy of science, creating a critical distance from hitherto unquestioned assumptions, problematising and re-ordering what was previously taken as knowledge, alternative futures are no longer mere possibilities, they are made present in the transformative space that is created through the sheer activity of thinking that CLA summons forth. This concept of CLA as pedagogy will involve, for some, a change from a conventional idea of pedagogy as requiring teacher-maintained control over students' learning processes in which the aim is to give students mastery over an already articulated discipline such as one of the sciences.[1] In conventional technology-based pedagogies, the idea of pedagogy is that it is a means to an end, the end being the possession of a definitive body of knowledge, and the means specifying the proper use of learning-materials and resources. CLA does not have such an end; rather CLA is open-ended. Neither is CLA a mechanical process. CLA offers a con-

ceptual structure without specifying how that structure is to work in the creation of new knowledge and value. In being non-prescriptive, CLA subverts and transforms the conventional binary of pedagogical value in which learning is either an end in itself (intrinsic value) or a means to an end (instrumental value). In these modes of valuation, value is familiar, because both means and end are presumed as items of disciplinary knowledge. Compared to a range of technologies that *prescribe* and *define* outcomes for the body for instance – medicines for maintaining normalcy in health, vehicles for moving the body around, dwellings for its shelter and comfort – CLA promotes strangeness vis-à-vis such knowledge rather than familiarity with it. In CLA there is also a sense of a meeting point (rather than endpoint) in dialogue between those who recognise each other as strangers and, because of this, need to work constructively within a context of unfamiliarity. Whilst we might *then* say that CLA is a *hermeneutical tool* – an aid to understanding – it is actually something quite profoundly more than that. CLA promotes an open-ended category of value – which I shall term future-constitutive value – signifying a future that is constantly being challenged to undergo renewal within this transformative space.

When it comes to teaching in science and technology studies, the matter is not about preparing students to be technically proficient. It is about preparing students to be practically wise in a world that is already suffused with the applications of science and technology. It is important, at the outset, not to be misled by the conjunction 'and' into believing that there are two quite distinct disciplines, science *and* technology. If science is thought by some to be the search for truth, and technology the utilisation of that truth, then the matter has been greatly misrepresented. Without technology, there could be no science as exists today. Science is indistinguishable from technology. As Albert Teich notes "Technology is more than just machines. It is a pervasive complex system whose cultural, social, political, and intellectual elements are manifest in virtually every aspect of our lives."

No more compelling an invocation of such a system, already in place at the time of the writing, has there been given than that by Francis Bacon in the 17th century. After having noted "the immense difference" between European culture and that of "any wild and barbarous region of the new Indies" Bacon claimed with Eurocentric pretension that "man may be said to be a god unto man". Thus said, he urged

> *Again, we should notice the force, effect, and consequence of inventions, which are nowhere more conspicuous than in those three which were unknown to the ancients; namely, printing, gunpowder, and the compass. For these three have changed the appearance and state of the whole world.*[2]

Indeed nothing short of changing the appearance and state of the world would suffice the Baconian vision. Maintaining that truth and utility are perfectly identical[3] and that "nature is only to be commanded by obeying her"[4] Bacon set out to show that

> *To generate and superinduce a new nature or new natures, upon a given body, is the labour and aim of human power: whilst to discover the form or true difference of a given nature... or source from which it emanates... is the labour and discovery of human knowledge.*[5]

In science and technology studies, one challenge for teachers and students alike is in comprehending the pervasive influence of Baconian science. One way to appreciate this influence is to first understand the extension of science and technology as a process involving the grasping of tools, not literally, but metaphorically. The metaphor of the tool is essentially an abstraction; it is the means by which one tool, in its essential idea, is transferred to and transformed within another setting. Abstraction for Bacon is a necessary but inadequate means to the end he requires; the end is mastery over nature, penetrating its secrets. At the root of Baconian science is the metaphor of nature as mechanism. There is no real distinction between nature and technology. Body organs, the senses, are all mechanisms. The eye is a tool of sight, but in its unaided

form it is an inadequate tool for the purposes of science; ordinary seeing is limited by the surfaces of things and the haziness of the eye's images due to distortions. But by using the telescope and the microscope[6] as instruments of "light as that which is originally visible, and confers the power of seeing", scientific vision becomes a matter of seeing into things, getting beyond – penetrating – the surface appearances. The eye is no longer the passive receptor of obscure images; by extolling the knowledge that is gained by sight, which "holds the first rank among the senses"[7] the mind is freed from its 'idols'.[8]

As Michel Foucault has noted, taking Bacon seriously, the tools of science are not merely used at the behest of an arcane pursuit of knowledge; they are tools of power.[9] The eye, aided by a more precise technology of vision, begins to take nature apart. There is an inherent violence towards nature in this approach, for noting that "The human understanding is, by its own nature, prone to abstraction", Bacon declared, "it is better to dissect than abstract nature; such was the method employed by the school of Democritus, which made greater progress in penetrating nature than the rest".[10] Nature henceforth would be laid bare under a relentless and ceaseless scrutiny, made ever more penetrating by the powerful tools that men in the 20th century boasted as their greatest achievements.

The most widely distributed technology is the sharp instrument – any tool which makes dissection possible – the essential idea of this tool is to lay nature bare into precisely defined and discrete components. Yet Bacon metaphorically extends dissection from the specific uses of sharp tools to encompassing the whole of his methodology. Printing, gunpowder and the compass are likewise not merely tools; they contain the essential ideas of Baconian Progress, and henceforth they are metaphors that are instrumental to the aim of dissecting nature. Dissection requires a map of a surface to be inscribed and excised; a map requires tools of guidance. Printing is the metaphor of inscribing an outline and making a template for its replication and widespread distribution; the compass is the metaphor for the process of 'obeying nature' or being directed by it in its own mapping and discovery; gunpowder the metaphor of the blowing away of barriers to the progress of discovery. The instrument of dissection presupposes the primary conceptual tool of division – in the making of categories of difference – and the inscription of those categories in the formation of objects of knowledge; thereafter follows the cutting through of flesh, and earth, and political impediments; the means of the destruction and disposal of that which is considered waste products.

From the idea of the printing press has been created far more effective tools of inscription: the etching of images and impressions including political, religious and economic ideologies into the minds of young and old. From the idea of gunpowder has been created far more effective tools that harness the power latent in nature: the forcible separation of atomic particles and the unprecedented release of energy. From the idea of the compass has been created far more effective tools of guidance: from weapons systems to systems of surveillance. The tools of dissection have legitimised these other tools, becoming the central focus of all who seek power. 'The surgeon' has become the metaphor for examples as seemingly disparate as the removal of diseased parts of an organism, including genes, the removal of military targets, and the removal of dissidents or unwanted people. Science and technology is all about imprinting and dissecting nature (then rewriting and recoding it) in the hope of creating a new nature.

The pedagogical problem is this. As teachers and students alike, we are the ones that have been imprinted with a particular knowledge, having first been dissected out or blown away by forces of change from among various peoples and rewritten into certain establishments. The 'regimes of truth' of which Foucault speaks have brought us to this place, and this time. The world is suffused with Baconian science and technology and we are – if well trained in any of the requisite disciplines – its most proficient instruments. The most likely scenario at an individual level is that any particu-

lar person's understanding of the global upheaval created by technology is obscured by an immersion in local or immediate concerns. The pedagogical aim is that students might be awoken from various dogmatic slumbers about where we are situated historically and geographically: the question is about where we are headed into the global future. The aim of using CLA in science and technology studies is to understand the assumptions and projects that contribute to the pervasive uptake of science and technology in almost any aspect of life we might care to mention. In order not to be enslaved by such assumptions and projects, we must find ways to identify and examine them critically. This is not to propose that any of us can, in some ultimate sense, be emancipated from an entrapment in scientific and technological ways of knowing. It is to say that we can become more aware and make wiser decisions about how we are to live in the future.

This is a vastly different undertaking than simply trying to learn about science and its applications, and how to perform the requisite tasks. The difference in approaches is mirrored in a distinction taken from ancient Greek philosophy, between *techne* and *phronesis*. *Techne* is the technical skill necessary for the proper use of tools. *Phronesis* is the practical wisdom that considers the use of tools from the perspective of their place in the world, and what this requires is an understanding of 'world', including both its natural and cultural aspects. From the point of view of a learning experience, CLA is aligned with *phronesis* insofar as CLA enables students to undertake a conceptual journey from spaces in which science and technology dominate into a space in which there is an opportunity for reflection and for projection of alternative thoughts into the future. The emphasis in CLA is not on tools, neither is it on empirical knowledge; it is on providing a level of practical *understanding* from which the future can be re-imagined, re-experienced, and renewed. What this understanding entails is that science and technology are part of the foreseeable future; the only question is whether such a future is a master/slave relationship or whether through thought, empathy and imagination a space is maintained in the context of that future into which science and technology have no possible entry except as the subject of a critique. Such a space exists as a space of creative thinking and dialogue; the pedagogical challenge is to create a learning situation for it to be actualised. The pertinent point though, is that such a space is not to be or become scientific, and the reason why this must be so can be detected in Thomas Gieryn's characterisation of what science is and how its authority is achieved. Science is

> *Nothing but a space, one that acquires its authority precisely from and through episodic negotiations of its flexible and contextually contingent borders and territories. Science is a kind of spatial "marker" for cognitive authority, empty until its insides get filled and its borders drawn amidst context-bound negotiations over who and what is "scientific." Put another way, the authority of science is reproduced as agonistic parties fill in the initially empty space with various selected and attributed characteristics, creating a cultural map that, if accepted as legitimate, advances their interests.*[11]

According to Gieryn science is about establishing the authority to advance particular interests that are founded (in a circular fashion) on the claim that promoting such interests is scientific. Gieryn's insight merely echoes the Baconian establishment of science as the one and only legitimate method of establishing knowledge, thus continuing to enshrine it as a colonial power, despite any internal conflicts and divisions. The upshot is no matter what the outcome it will always be 'scientific'. What counts as a legitimate interest is thus established by taking control of the cognitive domain of what is and what can be claimed to be scientific. As part of taking such authority, courses are established and classrooms are filled with the means by which science maintains its authority: the tools and techniques by which knowledge is gained and mastered.

The problem that faces students is that classrooms are thoroughly suffused with these technological applications (the learning materials) and quite often students do not recognise

that the materials are not substitutes for thinking through what is at stake in the world. But technology supplies part of the means by which technology can be shown the limits of its own domain, a limit when science comes to a halt and thinking continues. This paper is written to provide a visible trace (a record) of such a process of thinking; it is provided not as an example to follow (that would be to turn it into a technology) but as a critical underpinning and supplement to a whole variety of classroom-and-study experiences. Grasping the ever-renewing characteristic of thought that must occur in order to engage in an (avowedly technological) act of writing such as this, one then grasps how CLA contains at its centre a space that connects such thought to the future in a way that manages to elude capture by the technological juggernaut of science.

Adopting CLA as the approach, our investigation concerns the interrelationship of nature and culture, how that relationship is being changed through the influence of science and technology, and how we might be enabled to more intelligently enter into a critical but constructive response. The future of nature, and our own future, is on the line.

Nature, culture and the future

Writing about the future of nature, Rosaleen Love notes some "ambivalent public perceptions about what nature is becoming."[12] She writes,

> *On the one hand, a highly technologised 'nature' promises wonderful new medical cures, foods and vaccines we can eat in bananas. Better than the real nature, which gives us plagues and droughts and bodily decline.*
>
> *Critics are doubtful. They want their nature to be what it was, back before the ravages of industrial revolutions, back before human populations exploded at the expense of plants and animals. If nature is to be renovated, as one renovates a house, if nature is to be 'made over' as in Burke's backyard, then by all means let's do it but in the best kind of way. Let's create a brand new world, one in which there will be new values and priorities, and nature will be 'better', but better in terms of the whole biosphere.*
>
> *There's a catch though. Nobody knows how to do it.*[13]

Not knowing how to do it though, has never been an insoluble problem for science, not for those following after Francis Bacon's vision of a new scientifically produced nature described in *Novum Organum* and *New Atlantis*, and using the methodology of trial and error and codification in axioms. Once the scientific project has been raised to the status of the supreme destiny of humanity, any errors along the way are simply part of the learning process. The future of humanity and of nature is the future of science and experimental ways of knowing, that of *forcing* nature to give up its secrets. The Baconian vision has had over three hundred years to mature and is now well established in the mainstream scientific community as unquestionably the most complete method of gaining knowledge to emanate from the accumulated culture of humans.

For students in contemporary humanities however, nothing, not even this doctrine, is unquestionable. A sceptical question remains over science and technology: is what has been forced from nature, in any sense, its ultimate secrets? Has science forced nature to give up completely that which underpins its appearances? Might rather it be, as Hannah Arendt proposed, acknowledging both Kant and Heisenberg on the matter, that when we try to go beyond the limitations of sensual experience, we "deal only with the patterns of our own mind"?[14] If what we are dealing with – past, present or future – are patterns of the mind, a relentless question remains: might those patterns be disrupted, and if so, might disrupting them be done not to create immorality[15] (as Socrates' accusers charged him of doing) but to free the mind to think about what is of value, about what is actually known, and who or what it is that values and knows? What are the pedagogical implications of this disruptive project for the future?

Implications of adopting CLA as pedagogy

Whereas Baconian science takes dissection and 'penetrating nature' as its central metaphor, CLA reverses this trend. The aim is of creating appropriate *distance* from reliance on techniques of dissection. The point is not to force nature to reveal its secrets but to allow the hearing of what has not been spoken and the seeing of what has been disallowed as thought. The idea is that language and culture create layers of practice and ideology that suppress various creative myths that lie dormant in society like seeds in the earth waiting for winter to thaw. The aim is to make *the future* open to alternative myths and metaphor, rather than to force nature open through technical power based on one myth of seizing and transforming nature to suit human needs; the promethean myth. The CLA myth is that of encouraging the future in many dimensions, drawing out possibilities, not to take command over it with one ruling idea or dominant mode of discourse.

The litany

Litany is a visible or auditory mode of social power, manifest in language, positioning an agent or agents in public and private spaces. It is not a one-off event but is repeated, often incessantly. Frequently encountered litanies are of complaint or desire, fear or hope, tragedy or triumph, failure or success, regress or progress, lies or truth. The litany simply expresses itself unquestioningly as one of these modes of thought. The point of starting a pedagogy about science and technology from the level of litany is that this is where the social power is most felt, but this does not mean it is always evident or widely acknowledged, let alone understood. Because humans are vulnerable and sometimes deceitful, so the power may be privatised or secretive. An important usual characteristic of litany is that it is not uttered in a spirit of negotiation or reflexivity. The litany, when it is not merely a technique for being noticed, usually demands immediate action. The question we face is what enables such events to become a litany and how are we to respond? This question places students in a mode of conducting their own inquiry, not using tools of dissection, but rather of deconstruction, which is simply the most recent name given to a method at least as old as Socrates of showing how one statement claimed as truth covers up or hides another truth. There is always more truth already embedded in language than any instance of it (any utterance or saying) can reveal or be intended by a speaker or an audience.

The idea of progressively uncovering what lies embedded in language and culture is central to CLA. One of the most frequent litanies circulating regarding science is that scientists have been misunderstood, or are being misrepresented by their critics. Perhaps there has been insufficient attention to the language being used by those who want to be understood only in a certain way but not in another. The assumption of science is that language is clear and that words represent, at core, quite simple ideas and self-evident truths. Yet language studies show otherwise. At the level of litany students may uncover numerous examples of how language used to promote science can be used to state what seems at first to be an undeniable truth, whilst covering over another truth that proponents of science would rather not have stated. Students might for example note how scientific descriptions of what scientists say and do, usually exhibit the scientist as committed to objective truth and doing so from altruistic motives rather than as a self-interested career person or an egotistical reward seeker. Or students may examine how the burgeoning technologies applied to human health or to the military are represented as a response to core values like 'human need' or 'freedom' or 'safety'. Using deconstruction, students can appreciate how 'need' tends to be extracted from 'want', 'freedom' is appropriated by creating 'control' or 'regulation', 'safety' comes about by exposing people to more an more risk. Thus the language of the litanies in which science is promoted is shown to be opaque, covering over at least part of the actual situation, rather than as clear, open and non-deceptive.

The social causes

Science and technology promise a secure pathway to the future. As social practices they are widely regarded as the most reliable means by which a better future can be achieved than would otherwise be if 'nature' were left to run its own course. The word 'causes' in the 'social causes' level of CLA implies a claim that given certain conditions, certain other things will necessarily follow. For those promoting science and technology as a cause of the future, what they want is a ready explanation for how things got to be the way they are in order to propose a remedy to a problem. Models are needed. A typical model or metaphor for the causal analysis is a dam impeding the flow of a river. Take away the impediments or barriers and the river will flow. The social causes may be understood as barriers, thwarting the desires of people wanting to make progress. An alternative metaphor is that the river contains wasted potential. Build a dam and the potential is stored. In thinking about social causes, the question is whether the cause (in both cases the dam wall) is an impediment to flow or means of storing potential.

At the level of social causes we come face to face with Baconian science, the social sciences having taken up the idea with alacrity. In Baconian science, having gained some desired territory using technology (we may think here of the metaphors of printing, gunpowder and the compass as metaphors of discovering, acquiring and securing territory) the quest is to store potential and then distribute the flow of resources efficiently. What society requires is the storage and regulated distribution of power. There is no such thing as free flow (unless of course something escapes the system). All flow is to be regulated. The knowledge of social causes is knowledge concerning the efficient regulation of society. Knowledge of social causes enables – it is presumed – the means of the regulation of power. The assumed datum of Baconian science, applied to society, is that through determining the causes of human need and then commanding nature to supply the requisite resources, the whole system being rigorously maintained and applied, there will necessarily be improvements made in the living conditions of humans. Technology causes progress. The future will necessarily be made better through science and technology.[16] This is the 'received' worldview of science and technology.

The discourse/worldview

The question of 'what causes what' can be subsumed into an inquiry about whether anything proposed for the future is *necessarily so*. This inquiry is not at the same level of analysis as those making claims concerning the efficacy of science. The level is the CLA level of discourse/worldview, and here there is a critical question about methods of inquiry. Each discrete method involves a particular discourse or *episteme*. Students need to understand the strengths and limitations of various methods of epistemology.

One method of inquiry familiar to many students is methodological scepticism, which as an empirical mode of discourse asks a language user to 'look and see' if something being asserted as a cause or as an effect is necessarily so. If something is necessarily so, it must be possible to *literally* see what makes it so. But as David Hume noted in *An Enquiry Concerning Human Understanding*, the familiar of conjunction of what we term 'cause-and-effect' reveals no observable power or quality that binds effects to a cause.[17] There is *no necessary connection* that we can perceive in what we already experience. Even the empirical method adopted by scientists cannot prove the Baconian assumption of technological progress, by observation or *perception* alone.

Empirical seeing is rather limited. If that were all we were capable of, there would be no point reading anything. But the words of any text point beyond themselves to something we do not literally see at that moment. The text projects beyond itself to an idea: that may or may not be the same for different readers. This understanding forms the basis for *interpretive inquiry*. Given that people have different interpretations of what is real, their visions for the

future are coloured by those interpretations. Interpretations are not merely misunderstandings (as is believed by strict empiricists) but are the means by which we make sense of our world; in making sense we contribute to making the world. Sense making is world making. This is not to say, as did Wittgenstein early in his philosophical career, "The limits of my language mean the limits of my world".[18] The very idea of one person's language creating a world is for all practical intents and purposes, incoherent. The practical idea of a world is the place of abode of many, and no one person's language or system of making sense will suffice to describe this. Interpretive inquiry is demanded when the boundaries of many language systems intersect, for example between science and the humanities. Science of itself cannot describe the world because science is only one of the language systems in the world, albeit a powerful one, partly constituting it. Interpretive inquiry projects beyond any one mode of representing or constituting the world in language. Interpretive inquiry is inherently sceptical when it comes to dealing with those who presume to describe the world, or even some aspect of it, completely.

What scepticism does not extinguish, however, is the possibility for the *projection* of thought into the future, and everyone who acts according to a previous thought does this. The two modes of thought – sceptical and visionary – are not incompatible. One thought (of the inductive variety) might be 'it worked last time so this time it will work as well.' A sceptic rightly insists, *don't be so sure*. (Take off those rose-coloured glasses.) Whilst scepticism exercises a powerful deterrence against adopting received dogmas, including any inductive reasoning concerning the progressively improved effects of technology, *visioning* opens the future to alternative possibilities.

The difference between visioning and dogma is this. Whereas dogma says, 'this is what will happen', visioning is the place where happenings are conceived. Visions are endlessly modifiable, particularly in their detail; dogmas specify the very content of what must be believed. Though visioning and dogma are different, there are some points of contact. Visioning includes the possibility that something of value resides, perhaps even in those ancient texts and oral traditions so derogated by those Enlightenment and post-Enlightenment philosophers who, following Bacon's lead, have so forcefully recommended science as a complete, and in fact the only reliable way to understand life. But scepticism may be turned against the dogmas of empiricism. Even if something (for example what a tradition promotes) is not necessarily so, that does not mean that it may not be so with respect to the creation of values, particularly if its adherents find themselves bound to that thing through love and linguistic continuity. As WVO Quine's 'Two Dogmas of Empiricism' indicates, for example, many modern philosophers have a sense of attachment towards modern physics that they do not feel towards Greek mythology. But Quine acknowledges this is their particular preference; it is not a necessary truth about the universe that physics and not Greek mythology is descriptive of it. Ontology, thinks Quine, is about cultural preference; it is a culturally relative matter. But there is another possibility, opening up an alternative way of understanding both modern and ancient ontology, enabling a different appraisal to that offered either by relativists wedded to empiricism, or relativists who reject it. The possibility is to be a relationalist, making connections with different modes of thinking, enabling the critical appreciation of sources of value inherent in them. One may be both sceptical of a dogma and constructively open to a future in which the dogma continues to attract adherents. We realise we must both think and act in such a future, doing both together if possible; the aim is to *think what we are doing*.[19]

Thinking what we are doing involves both projection and reflection. What we are doing cannot be known just in an instant, in a moment of thought. It takes a *critical inquiry* to discover this. For example, projects of emancipation that depended on overthrowing a previous dominant order have *afterwards* been subjected to critique. As Jean-Francois Lyotard noted, the grand narratives of history all pro-

moting some form of emancipation, have been from the perspective of his own time and place and mode of thinking, a failure. The organisation of the past (by people in the past) has been to produce ideas which by now have a questionable history, for example Christianity, the Enlightenment, Capitalism, Marxism. This sort of critique is based not on scientific assumptions but on the assumption that we do not *intimately* know anything of *value* unless we are already part of making or using it – or are complicit in being made by it – and can review what has been accomplished so far. This sort of value cannot be understood fully either as intrinsic value, or as instrumental value, for there is no end in sight. It is part of constituting the future, of preparing for it in thought, and thus might be termed *future-constitutive* value. Intimacy (close involvement, being part of something) is what is called for. Projection (in order to act) and reflection (on what happened) are both essential elements. All this takes place is great cycles of time, not in the activity of thought of only one person. But by being positioned between the reflection and the projection, we can take what we cherish from the past, and disown what we do not, projecting that thought into the future.

The myth/metaphor

Next comes the level of CLA that encompasses all the other levels: the myth/metaphor. In the same way that the *Aleph*, which is Jorge Luis Borges' name for a mythical sphere that simultaneously contains all places within the universe[20], the myth/metaphor level of CLA is a moment of time and the presence in space that theoretically contains all other times and spaces. It includes what Edward Soja terms Thirdspace:

> *the space where all spaces are, capable of being seen from every angle, each standing clear; but also a secret and conjectured object, filled with illusions and allusions, a space that is common to all of us yet never able to be completely seen and understood, an "unimaginable universe".*[21]

This is the myth that encompasses and contains the whole of CLA. The 'moment' of CLA is here both positioned *between* reflection and projection, and encompassing both of these modes of thought. CLA is thereby open to *enabling* or *the making of* connections not approachable through purely scientific investigation. One pertinent myth, for example, is a mode of thinking that is based on the idea of renewal, or incorporating Arendt's thought, it is about natality, understood metaphorically as a moment of rebirth. Arendt says, describing such a moment, "With word and deed we insert ourselves into the human world, and this insertion is like a second birth, in which we confirm and take upon ourselves the naked fact of our original physical appearance."[22] These are *practical* and *imaginative* matters of philosophy and ethics that provide a critical entry point to challenge a wholesale reliance on scientific understanding.

Theoretical reasons for adopting CLA as pedagogy in studies of science and technology

One theoretical attraction of CLA is that it enables the articulation of understanding without demanding complete philosophical justification (i.e. positing metaphysical certainty concerning the existence or otherwise of the entities involved in the discourse) before making assumptions or engaging in or with particular discourses or their associated worldviews. It is part of a hermeneutical turn towards understanding discourse as a contingent, historically evolving phenomenon that *frames* various possibilities for exploring life. 'Framing' is an important word because it speaks of the boundaries around a picture, this being a metaphor for the limitation of all kinds of understanding. But framing contains infinite possibilities for creating boundaries, for making multiple frames of meaning, obliterating the distinction between 'the thing' and 'the thing as framed'. Framing is what produces 'things'.[23] This leads to the insight that discourses, as the linguistic environment in which meanings are produced, give to each 'thing' a meaning; the thing and its meaning are the same. Different discourses frame

things differently.

Science is one of the possible framing discourses, for example when accounting for life in terms of atoms and molecules and coded information (the gene). But in so framing it, other modes of understanding are left out. CLA does not reify any particular discourse, opening the future to spaces in which alternative discourses and other modes of relational being are potentially valorised. All apparent certainties are treated as myth, thus levelling the playing field at the outset. Sometimes this levelling process, which CLA performs a priori, occurs also as the result of empirical and associated conceptual investigations. For example, the gene, once regarded as containing "the code of codes" (Kevles & Hood 1993), the supposed blueprint for life in its entirety, has been relegated by other scientific investigations to the status of myth. By 'myth' is not meant, necessarily, 'an outright fiction'. What it does mean is that the boundaries between 'real' and 'fictional' are blurred, because framing as the precondition for language with its endless supply of possible terms, is also the precondition for reality. CLA sets out to integrate all possible framings, not to create one composite picture, but to make the whole process of picturing (or visioning) strange. We cannot picture (let alone produce) only what our visions tell us because simultaneously, there are alternative visions.

The story of the gene is apposite, to give an example of this process of estrangement.

Over time the concept of what the gene is and what it does has changed, and is undergoing a process of change in contemporary biology. Paul Griffiths and Karola Stotz lend support to a representation of the gene as "a concept in tension". They argue that at different poles of the tension, the gene is what it was traditionally, before molecular biology, "an intervening variable, defined by the inheritance patterns it enables us to follow", or it is a material entity, "the molecular gene", or it is an abstract, hypothetical construct designed to suit a particular researcher's needs, "the nominal gene" (Griffiths & Stotz 2005). The difficulty is that whereas the gene as a material entity might be understood as the complete repository of coded information – the blueprint for life – the gene postulated as a nominal entity contains the idea that whatever the code is that biologists decipher, it may just be one part of an overwhelmingly complex pattern of coded messages, and any one particular interpretation is only a reflection of a biologist's prior interests. What was thought to be a blueprint may only be variously interpreted transcripts of particular messages, none of them giving away any ultimate 'secrets' of what life is about.

A hermeneutics of CLA

CLA may be understood as a journey through three spaces, only two of which are strictly compatible with scientific discourses. The litany is typically a space of personal or communal complaint or satisfaction vis-à-vis science. The second and third layers are spaces that are devoted to the exploration of science and its various contestations over what is to count as a legitimate interest. The fourth layer is avowedly metaphoric, claiming no basis in an empirical order apposite to science. Truth is being truthful or faithful to a vision or an ideal (for example of what constitutes a good life), not in uttering propositions that correspond to the facts of an undisputedly 'external' reality. Here science takes its place merely as one of the many possible myths.

The complete significance of the fourth (or central) layer of CLA (what its strengths and limitations are) has not as yet been fully explored, and in order to enable students to better understand the process in which they are engaged, a 'meta' inquiry concerning CLA as a mode of discourse must go hand in hand with more practical applications. This 'meta' inquiry is hermeneutics – taking the place of what used to be called metaphysics – and involves making ones assumptions available to others for critical engagement. The primary assumption of CLA is that metaphor and myth, involving uncertainty and incompleteness, stands instead of certainty and complete clarity as an epistemological basis for making an inquiry. Outlines are posited; possibilities are negotiated; the future is connected to thinking now rather than exclusively based

on making predictions about what will be empirically real. The difference is one of saying: 'this is how I/we presently think' rather than 'this is what is real for all comers and all times'. The assumption that the future is layered is a metaphor *regarding thought* that is implicit in the approach. We work our way down through the layers to talk about the various myths and then reconnect this discussion to the litany. Also implicit in the analysis is that using myth and metaphor we may approach the future in terms of *intentionality*, making a *claim* to the future. This claim is represented or *projected in thought* as a space, enabling cognition about what has been claimed and also allowing for an integral part played by the unconscious. We may also use a metaphor of *extensionality*: the future is something we 'approach', 'reach towards' and 'create' using techniques of prediction, visioning, critique, and action learning. Unpacking the metaphors we might say that this mode of futures inquiry, in incorporating both intentionality and extensionality, is both about laying a personal claim to the future and extending the boundaries of the claim towards others, attempting to make it accessible to them, opening it for their critique or their acceptance. Because futures inquiry is both personal and open to others, it is inherently relational. This relational aspect is what I have elsewhere termed a third moral space, privileging neither individuals nor extant communities, but potentially reaching out inclusively, for example, towards the unborn, the currently marginalised and other species and their environments.

CLA's most important assumption is that such projections towards the future are *not* knowledge claims of any sort about the future. Knowledge claims can be assessed given the understanding that they arise in a variety of contexts: empirical, interpretive, critical, and transformative, using action research. Whether a particular knowledge claim is maintained as holding good for the future depends on how dialogue concerning the future progresses. What we must understand to begin with, particularly in a university learning environment, is that empirical approaches are often assumed as the sine qua non of knowledge *as if knowledge was the supreme value, given its supremacy by being linked to reality*. "Empirical discovery: now that's real research. That's doing science." as a colleague once put it. This assumption of reality is not however demonstrable by empirical methods; it is the one inevitable supra-empirical assumption upon which science is based, thus undercutting its own claim that the only knowledge of reality is through science. The lack of certainty regarding this assumption opens up the future to alternatives that are not based on science. But the study of science and technology is not devoted to those alternatives, privileging them, as if to find something to turn the tables on science. It is devoted to investigating the legitimacy of scientific discourses and the claimed right of the sciences to dominate on the world stage, given that they cannot ever be the only discourses available. Even if those alternatives remain as sub-dominant discourses, their mere existence may tell us more about the structure of reality than any putatively scientific claim ever could.

The future: a worldview

The futures problem facing both teachers and students of contemporary science and technology studies is this: On the one hand remains the still-dominant Baconian-scientific worldview, colonising and subjugating what is left of the cultures of the world, leaving their treasures in ruins; On the other hand is the subdominant worldview of the artist, selecting artefacts from the cultural debris, in order to frame a moment of reconstructive activity. This artistic activity is something that is an alternative to, even as it is a projection from, an experience of grief from having lost a lasting sense of cultural connectivity. Creative artists often become in part an antidote to the scientific worldview; a means of restoring and retaining a sense of meaning in life when otherwise there would be the death of that meaning. Marcus Bussey notes Picasso saying the function of art is to 'give spirits form' quoting the artist, "Something holy, that's what it is. That's the word you ought to be able to use, only people would get it wrong, give it a meaning it doesn't possess." (Bussey 1999) The

point here is that alternatives to the scientific worldview tend to be religious, and art often uncomfortably finds itself being appropriated for religious purposes. Contemporary art, seeking to avoid being made into a religion, uses artefacts taken from technology to reconstruct a sense of meaning that was lost when science abolished the idea of 'spirit' from its discursive canon. ('The wind', speaking metaphorically, still blows where it is inclined to do so.) Art is the creation of alternatives to technological progress; it violates the linearity of such progress, making space for dreaming rather than technological functionality. But neither the colonising activity of science nor the reconstructive activity of art can give life a completely satisfying sense of meaning for all times and all occasions. A continued loss of a sense of meaning also attends much of the reconstructive activity of art. Art, like science, can give a sense, in part, of what we are made from (in the case of art, it is 'spirit') and what we may do creatively with that. Neither art nor science can tell us finally who we are. As Hannah Arendt suggests, finding this is an ongoing project we must undertake in relating to others in the 'interhuman' space of the world. This is a moral and political activity, even when it connects to scientific and artistic impulses. It is also a philosophical activity, as demonstrated by Martin Heidegger, whose approach as a thinker was to reflect back to those who tried to turn thought into some kind of technique or skill, the sheer emptiness of work that reduces everything to a 'standing reserve' of materials made available for the technological process.[24] Thought refuses this emptiness, creating meaning for itself where previously there was only the loss of some important meaning.[25] The loss of meaning associated with science and technology becomes a locus for the re-creation of meaning through an activity of reconnecting in dialogue with those who may proclaim science as an ultimate authority. The philosophically inclined inquirer may speak with and to the purveyors of science, neither as its objects nor merely as recyclers of its artefacts, but as those who find it puzzling that science should try to maintain dominion. How can that which fails to answer our most searching questions be an ultimate authority? In speaking with and to science, in insisting on asking questions that science cannot answer, those who philosophise give back to science a sense of its failure to defeat the quest for meaning.

One final metaphor: the bridge

This series of reflections brings us to the pedagogical value of using CLA in the context of the studies of science and technology: it promotes interaction and dialogue at many levels of understanding. Using CLA, we are on a quest for alternative sources of meaning, a goal not obtainable through doing science as its original practitioners envisioned. We may however invite those doing science in the old way into a new dialogue. This is doing science in a contemporary way, a hermeneutic mode of building bridges in which the boundaries between science and the humanities are continually being crossed. This 'new dialogue' is nevertheless the continuation of a much older one, and in such an engagement a path of resistance is maintained against a particular activity of mind: that which takes discrimination to its absolute limits. "The activity of mind... will no longer consist in *drawing things together*, in setting out on a quest for everything that might reveal some sort of kinship, attraction, or secretly shared nature within them, but on the contrary, in *discriminating*, that is, in establishing their identities..."[26] Students, one may begin to hope, may come to realise that there is a path of resistance to *sheer discrimination* and thus to the enshrinement of *a totality of differences*. This is where many more thinkers in the future might become positioned: between science and the humanities, not as these are ordinarily practiced as discrete, self-sufficient, self-identifying and self-stultifying disciplines, but on a bridge with a sign saying 'those seeking understanding may cross here'.

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Notes

1. I am assuming in writing this paper, some prior acquaintance in my readers with CLA. The paper by Sohail Inayatullah that describes it is accessible at http://www.metafuture.org/Articles/CausalLayeredAnalysis.htm
2. Bacon, ibid, First Book, Section 129.
3. Bacon, ibid, First Book, Section 124.
4. Bacon, ibid, First Book, Section 129.
5. Bacon, ibid, Second Book, Section 1.
6. Bacon, ibid, Second Book, Section 39."... microscopes, which exhibit the latent and invisible minutiae of substances and their hidden formation and motion..."
7. Bacon, ibid.
8. Bacon, ibid, First Book, Section 39. "Four species of idols beset the human mind... the tribe... the den... the market... the theatre." These metaphors respectively relate to shared cultural values; individual dispositions; any reciprocal, language-based relations that lead to making inept generalities; and lastly, any tradition-based dogmas and systems of philosophy or the arts. In one fell swoop Bacon sought to discredit all possible sources of value, except those derived from his own method.
9. Michel Foucault. 1989. *The Order of Things: An Archaeology of the Human Sciences*. (Translated from the French) London: Routledge. P.133. Foucault indicates the purgative, disciplinary qualities of this power: "To attempt to improve ones power of observation by looking through a lens, one must renounce the attempt to achieve knowledge by means of the other senses or from hearsay."
10. Bacon, ibid, First Book, Section 51.
11. Thomas F. Gieryn. 1995. "Boundaries of Science" in Jasanoff et al. *Handbook of Science and Technology Studies*. Sage. Pp. 393-443, at pp. 405, 406.
12. Rosaleen Love. 2004. "The Future of Nature." *Journal of Futures Studies*. February. 8(3):25-32.
13. ibid, at P. 25.
14. Hannah Arendt. 1998 (1958). *The Human Condition*. Chicago and London: The University of Chicago Press. P. 286. Arendt, I believe, is neither an Idealist, nor a subjectivist, nor an irrealist in making this remark. She is what I would term a constructive realist: someone who deals firmly with realities, acknowledging human complicity in creating them. Thanks to Fred D'Agostino for questioning me on this point.
15. I am assuming that disruption for disruption's sake, for the sake of producing as much chaos as possible, without forethought or care for the future, is immoral.
16. See Teich op. cit. for an extended discussion of this claim.
17. Sect. VII Of the Idea of Necessary Connexion.
18. Ludwig Wittgenstein, *Tractatus Logico-Philosophicus*. 5.6 .
19. See Arendt op. cit. P. 5.
20. See Soja's use of that idea, below.
21. Soja, Edward W. 1996. *Thirdspace: Journeys to Los Angeles and Other Real-and-Imagined Places*. Cambridge, Mass.: Blackwell. P. 56.
22. Arendt *The Human Condition*, op. cit. P. 176.
23. This to me is the essential meaning the Heidegger's term 'Enframing'.
24. Martin Heidegger op. cit. p. 24: "The essence of modern technology starts man upon the way of that revealing through which the real everywhere, more or less distinctly, becomes standing-reserve."
25. In his essay on technology, Heidegger discusses the loss of meaning of the Rhine river – the river of the German romantic poets – once it had become set aside for the production of hydro-electric power.
26. Foucault, op. cit. P. 55.

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_____ First Book, Section 39.

_____ First Book, Section 51.

_____ First Book. Section 129.

_____ First Book, Section 124.

_____ Second Book, Section 1.

_____ Second Book, Section 39.

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