DEEP TIME HISTORY: THE LURE OF THE BLACK BOX

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**Name**: black box. **Specific**: late Yuan to Early Ming Dynastic book box, virtual box. **Other names**: green box (qingxiang 青箱), book box (shujia 書盒). **Size and shape**: ca. 32 cm W x 32 H x 42 L. **Colour**: black, lacquered. **Behaviour**: deflecting, entrusting, obscuring, facilitating, encasing. **Habitat**: now in a collector’s household; originally it sat on desks and tables or on shelves, or travelled with scholars on mules, in carriages or boats. Now an object of the mind. **Distribution**: widespread in China during the Song (960–1279), Ming (1368–1645) and Qing (1645–1912); ubiquitous in twentieth-century households. Omnipotent in a scientist’s mind. **Migration**: from the territory’s north to south, east to west; minds to minds. **Status**: lid closed, exterior largely intact, but battered. With variable interiors. **Variations**: the deep-time history of the box shows that it spread worldwide as a useful device in knowledge production and as a performative thinking tool. The black boxes take different shapes, from the thingness of the box shown here to a modelling device and to methodological and metaphorical use across all scientific and artistic domains.

**Keywords**: ordering, hiding, unveiling, encasing, liberating, reducing complexity
After passing the civil service exam, I could never waste books and enjoyed visiting people and asking around. Hence my experience unconsciously multiplied. Time and again, I encountered issues to consider and decide, actions were accomplished and products magnificent. I recorded my thoughts as warnings and advice for later. Though loaded with trivialities and unorderly, I publish them here entitled ‘Miscellaneous Jottings from the Black Box.’

_Qing Xiang zaji 青箱雜記_
(‘Miscellaneous Jottings from the Black Box’) 
preface dated 1087 by Wu Chuhou 吳處厚 (jinshi 1055)

_IN THE MERITOCRACY OF THE SONG (960–1279), WHEN TALENTED COMMONERS SUCH AS WU CHUHOU COULD ATTAIN HIGH RANK BY HONING THEIR LITERARY SKILLS, BLACK BOXES POPULATED MOST SCHOLARLY DESKS. MADE OF A FAST-GROWING LEAFLESS WOOD (_qing_ 青 A DARK BLUE-GREEN), BLACK BOXES WERE UTILITARIAN OBJECTS WITH NO DECORATION WHATSOEVER. SCHOLARS PUT INTO THESE BOXES THEIR PRIVATE CORRESPONDENCE, THEIR POETRY OR, LIKE WU CHUHOU, THEIR RAMBLING THOUGHTS (FIGURE 20.1). OUT OF THESE BOXES CAME THIS ERA’S KNOWLEDGE AND IDEALS._

A major quality of the box was the colour black. The plain exterior protected and disguised the mechanics of this era’s most venerated skills: reading and writing texts. Though later on, black boxes would encase different services and ideas, the quotation from the Song ancestor well exemplifies the qualities that make up the allure of the black box: dealing with and managing the known and unknown. A protective utilitarian purpose goes hand in hand with the capacity to hide in plain sight. The human imagination stored inside can be accessed, though most people are entirely content with knowing only the surface and acting upon the results. Black boxes exemplify and embody changing compositions and epistemologies.

_IN THIS ESSAY I SUGGEST THAT BLACK BOXES HAVE A HISTORY REACHING FAR BACK INTO THE PAST. IT IS THIS HISTORY ON WHICH THEIR REPUTATION IS BUILT, A HISTORY IN WHICH THREE FUNCTIONS OF THE BLACK BOX ARE CONSISTENTLY ADDRESSED: (1) TO HIDE KNOWLEDGE, (2) TO REDUCE KNOWLEDGE COMPLEXITY BY DIRECTING ATTENTION TO THE IN- AND OUTPUTS, (3) TO CONTAIN KNOWLEDGE WORTH UNVEILING. THESE THREE ARE THE IDEALISED PURE FORMS, WHEREAS IN ACTUALLY VARIOUS COMBINATIONS POPULATE THE HISTORICAL WORLD AND_
human minds. This is the oscillating nature of black boxes. In such a multiplying view, we can see various caesurae taking place, either because the box’s contents or the reception of the box’s contents changed.

Historians of science tend to focus mostly on the nineteenth century, when the human imagination in the box increasingly manifested in technologies rather than texts. With this alteration, black boxes such as radios and computers moved increasingly into the public view. Scholars then also gave the black box new contours, using it as an analytical tool. Scientists and historians in particular became increasingly attracted to the box’s ambiguous effects. The action of closing the box liberated the actor by making the interior invisible and ignorable, but this created the risk of being trapped in a reductionist approach. Those who opened the box and looked inside might learn and know, and yet the action of opening the box disenchanted the magic inside.

**TYPE 1. THE MYSTERY OF BOXED-UP THOUGHTS: HIDING KNOWLEDGE**

*a) as in words and texts (…)*

Black boxes are utilitarian means, useful for storage and transportation of whatever the owners find worthwhile. During the long period when black boxes were mainly associated with the encasing of words and texts, secrecy became the boxes’ major trait.

This secrecy is epitomised by the closed lid. In the area that we now call China, philosophical schools such as the fangshi方士 lore (ca. third century BC) boxed scriptures that, for them, represented condensed yuanqi 元氣 (original qi) and that, existing prior to the world, would connect the adept to the origins of the world (Pregadio 2008: 24). Only those who understood achieved access to the boxed-up text.

Such an approach was not a prerogative of the Chinese alone. In the Black Box Inquiry of 1680 in England, it was rumoured, for example, that

Sir Gilbert Girard¹ had a black Box, in which the Marriage of the King with the Duke’s Mother was fully proved and made out; and the fear of the Duke
of York’s succession was so fix’d in Mens Minds, that the Story of the Black Box was generally divulged, and for ought I know believed by those who were fearful of the Duke of York’s succession. (Coke 1697: 544)

The documents in the box evinced who was heir to the throne. The lid kept in place a content that required containment.

Closing hence empowered the box. Like the box of the Chinese fangshi lore, the power of the Jewish prayer boxes, Tefillin, take the form of words, letters. Orthodox Jewish men attach the little black boxes to their head and arm for weekday morning prayers. In the year 1908 the theologist and philologist O. Neufchotz de Jassy connected this Jewish custom back to the worshipers of the Hindu Shadai, of Shiva, [who] put on their left arm a little receptable or a ring […]. On two sides of this receptacle the letter sheen, representing the word Shadai is embossed. It is presumable that this little box, called baith, “the house”, contained originally the same priapic emblems replaced later by the Talmudists with a few texts taken from the Bible. (Neufchotz de Jassy 1908: 128)

The Jewish prayer box, like the Chinese black box, held transformative textual powers in place.

With shifting approaches to texts, the Jews and Chinese both came to perceive the black box differently. Wu Chuhou represents a scholarly and social group (later identified as Neo-Confucians) who used black boxes mainly as repositories to collect information and food for thought in response to a political system in which literary education had become key. Wu Chuhou’s qingxiang emphasises the box as a container for the instruments that the scholar then manipulated and controlled to trigger intellectual, scientific, technological, religious, and socio-political change.

A common trait of the pre-modern black box full of words was that the power of transformation lay with the scholar who would open and close the lid to awaken minds. Zhu Xi 朱熹 (1130–1200), a leading figure of the School of Principle (lixue 理學), who rose to prominence in the later era of the Ming (1368–1645), followed Wu when he contended that, ‘if one has become
completely familiar with the text and also has thought about it carefully, the mind and the principle will spontaneously become one, and one will never forget’ (Zhu 1986: 170).

b) as in wires and cables

Black boxes as tools that transform by imagination go back into human deep time. Historians of science tend to focus mostly on the nineteenth century, when the human imagination in the box increasingly manifested in technologies rather than texts. In contrast to their deep time predecessors, ‘modern’ black boxes of the nineteenth century such as radios and computers transform the contents that pass through them quite materially. In modernity too, though scholars gave the black boxes new contours, using them increasingly as analytical tools.

Black boxes contained predominantly textual material for a long time, but by the nineteenth century they increasingly enclosed other kinds of materialisations/creations of the human mind: cog-wheels, wires, needles, or gears. Unlike their ancient ancestors, these black boxes themselves became agents of change. Running on electricity or other fuels, quintessential historical black-boxed machines such as the radio or telephone covertly morphed words into other forms, transporting them as signals and codes over great distances.

Such was also the power of the electric telegraph, the invention of which is attributed to Sir William Fothergill Cooke (1806–79). In 1843, Charles Wheatstone (1802–75) popularised a bridge circuit that, encased by a black box, was made fit for use by telephone engineers (Figure 20.2) (Morus 1998). Guglielmo Marconi (1874–1937) (Figure 20.3) sheathed conductors and Hertzian waves with a flat black box, and created wireless telegraphy:

Marconi’s inventions, modifications, and improvements fit into a small box, at that time dubbed Marconi’s “secret box” or “black-box”. (Hong 2001: 23)

Historical accounts of Marconi’s black box testify that mystery remained quintessential to black box mythology. It now addressed, however, an encased processing machine. How could these heaps of cables and a spark of electricity transmit speech and music over distances otherwise impossible to overcome:
Fig. 20.2 ‘Circuits in a Box’. The ‘Wheatstone bridge’ is the name for a simple circuit that can be used to calibrate measuring instruments by use of a long resistive slide wire. The circuit was invented by Hunter Charles, to whom Charles Wheatstone (1802–75) gave full credit when he encased the bridge circuit in the arrangement of four resistors, a battery, and a galvanometer for his needle telegraph (photo by Thomas B. Greenslade, Jr., Gambier, Ohio USA).

Fig. 20.3 ‘Transfer between Boxes’. Guglielmo Marconi (1874–1937) pictured between the spark-gap transmitter on the right and the coherer receiver on the left. Together he and Karl Ferdinand Braun were awarded the Nobel prize in physics in 1909 (source: Google-hosted LIFE Photo Archive)
There was a little black box on a table, a fascinating mystery, which had come with him from Newark. Inside it he could create a spark which baffled the scientists and which we know now to have been wireless. (Shiers 1977: 52)

Distinctively different to the pre-modern black box, the modern box’s mystique had a technical and scientific rationale that was de-mystifiable and advanced. Another difference was that people now assigned the powers of transformation to the innards of the black box and no longer to what was placed inside or taken out. As a consequence of this, approaches to knowing also changed. Knowledge no longer meant to be in charge of opening and closing the box, or utilising the contents to make transformations take place. Instead, knowledge now meant understanding the system’s composites, or why and how inputs and innards created the repeatedly observable and hence universally valid effects.

**TYPE 2. THE WORKING MACHINE AND THE BOX-EFFECT: REDUCING KNOWLEDGE — CLOSING THE LID**

The amazement that accompanied nineteenth-century black-boxed machines addressed the human ingenuity that made the machine work towards a specific effect. In Marconi’s case the simplicity of the mechanical setup still generated awe:

> When Marconi “opened” this black-box by publicizing his first patent in 1897, people were amazed and intrigued by its simplicity. The solutions appeared so simple and so obvious that many began to wonder why no one else had come up with them. (Hong 2001: 23)

Clearly though, as cameras, ‘the telephone, the television, the radio and in recent years the computer and the facsimile machine’ (Rosenberg 1994: 204) increasingly became ubiquitous, the black box functioned as a shield to protect users from contact with the electric circuits as much as from the growing complexity the box kept wrapped up inside.

Historian Elizabeth Cavicchi identifies the lived experience of the ‘working’ machine in the nineteenth and twentieth centuries as a major impetus for the conceptual development of the black box in the following decades: ‘once
an instrument operates with minimal fuss, these same properties recede into the background. It becomes a black box whose users need not understand the thing knowledge by which it runs’ (Cavicchi 2005: 244).

Historians Robert W. Smith and Joseph N. Tatarewicz show how the twentieth-century claim that the black box encased what had become ‘a well-established fact’ made it prone to become a conceptual tool in research organisation. In the planning process of the NASA space telescope, in which various people and dozens of groups, committees, and industrial organisations throughout the United States were involved, researchers utilised the black box metaphor to distinguish the ‘unproblematic object’ from that very object that they wanted to analyse and understand (Smith and Tatarewicz 1994: 102). To compartmentalise tasks, each expert community black-boxed the other’s knowledge as reliable and true; as the planning developed, provisional black boxes could be opened and their content changed.

Such conceptual black-boxing was utilitarian, in the sense that the black box encased issues in order to be able to set them aside. Setting aside was allowed because the interior was a generally accepted fact, a truth. The ambiguous role of encasing and setting aside in all these instances was the very source of the box’s function as a liberating thinking device. For this liberating effect to work, as Bruno Latour emphasises, the lid of the box had to remain closed. A closed lid ensured that scientists were able to use and users able to consume without asking why, focusing entirely on the

“working” of what was encased inside: A black box opens momentarily, and will soon be closed again, becoming completely invisible in the main sequence of action. (Latour 1999: 191)

Clearly, as Latour and Trevor Pinch have observed, scientists and engineers also wrapped up known processes to be able to mobilise their facilities, their in- and outputs, but otherwise focused on the revelation of bigger, more pressing or, simply, different concerns. Latour and Pinch both stress black-boxing as a means of dealing with complexity. Pinch points out that the box also often blackened the intricate assembly of potentially disparate elements that are made to act as one (Pinch 1992).
Such was the positivist approach. The closed box, however, with its long history of a tightly shut lid, met with a good deal of suspicion in this new era too. After all, the shield clearly separated the savant from the ignoramus who could not look inside and thus had to believe. Critics pointed out that people were left in the dark about how solutions were derived, when, instead of unravelling complexity, simple short-cuts came into use: ‘the black box effect is looming, and so the risks of a “prince-pleasing” use of the black box’, cautioned Asensio and Roca (2002: 233), referring to models that, targeting distinctive goals, are based mainly on input-output values and nothing more. Black-boxing could fall victim to ideology too, in that increasingly people also boxed up the complexity of knowledge-in-action that was otherwise not easy to explain. This form of black boxing created a knowledge category, namely the ‘tacitness’ of knowledge flows.

Such were the intentionally reductionist approaches to a ‘black box effect’ that scientists regularly encountered in their research, because they were unable to unlock the box.

Black boxes, as the very epitome of a functioning machine that produced reliable effects – similar to the pre-modern treasure trove – thus remained accessible to only a few. While people also increasingly claimed that the box contained scientifically explicable principles and truths, and no longer blind belief without rationale, this reductionism also had the potential to end in a puff of magic smoke, or fairy dust. Along these lines, the 1946 Science News, for instance, jibed that the lie detector did not require any content: ‘an empty black box, if it looks mysterious, would serve the same purpose – and has been used for it’ (Science News Letter 30 March 1946). The form alone had come to inspire enough trust all by itself, effectuating a guise that spurred people on to unveil the truth.

**Type 3. ‘Workings’ Behind the Closed Lid: Unveiling Knowledge**

What worked as a distraction for some, or raised suspicion in others, attracted still others like bees to a honeypot. Metaphorical references in twentieth-century science discourse elaborated on black boxes’ working effects as a way
to learn about microbes or DNA-stems. Historian M. J. Behe, for instance, claims that for Darwin the cell was a ‘working’ black box that he strove to unlock (Behe 1996).

The practising physician Philip M. Rosoff finds that genetic researchers regularly implement a black box effect when they attempt to relate changes in biochemical and physiological phenomena:

something was done which could be described with a great deal of detail and specificity, then many things happened about which they could only speculate, … and then the cell divided. (Rosoff 2010: 209)

Upon direct attack, quite literally the ‘lid’ of the cell firmly closes and contracts like a mussel that has been hit. Whenever this happens the innards remain opaque.

Before the era of X-rays, microelectrodes, CAT and other imaging techniques, animals and the human brain were studied as transducers that could only be understood by reference to what went in and what came out. B. F. Skinner, for instance, assumed in his model of behavioural science that

There is no doubt of the existence of sense organs, nerves, and brain, or of their participation in behavior. The organism is neither empty nor inscrutable; let the black box be opened. The body has always seemed to offer an attractive escape […]. (Skinner 1969: 280)

In this metaphorical use, all one could do with a black box was to examine the relationships between various forms of input and their respective outputs. Skinner put people into an operant conditioning box to open the black boxes that he was interested in: how to enhance social justice and human well-being. In his experimental analysis of human behaviour, as discussed in Walden Two, Skinner explored, experimentally, how individuals could be induced to behave best as far as the group is concerned:

We had already worked out a code of conduct – subject, of course, to experimental modification. The code would keep things running smoothly
if everybody lived up to it. Our job was to see that everybody did. Now, you can’t get people to follow a useful code by making them into so many jacks-in-the-box. You can’t foresee all future circumstances, and you can’t specify adequate future conduct. You don’t know what will be required. Instead you have to set up certain behavioral processes which will lead the individual to design his own “good” conduct when the time comes. We call that sort of thing “self-control”. But don’t be misled, the control always rests in the last analysis in the hands of society. (Skinner 2005: 95–96)

In Skinner’s box, humans and animals were reduced to sheer outputs and effects. The desire to enlighten blackened spots hence occasionally blacked out the innards entirely. This effect, however, also spurred the development of new techniques of observation. Scientists, curious to be offered at least a glimpse of what was inside the body-black-box, increasingly used medical imaging technologies. Magnetic resonance and image-generating radiation conquered cognitive science (Nersessian 1995). The brain was often imagined to function like a machine: brains were wired organisms, emitting electrical signals, functioning algorithmically by design.

The associations now invoked by the black box were such that the nature of the operation inside the box was mainly what these relationships revealed. Blackboxing hence became a strategy in epidemiological research, later described as risk-factor epidemiology.

In the hope of unraveling causes of diseases, associations are sought between disease and various “exposures.” “Black box” is an untested postulate linking the exposure and the disease in a causal sequence. […] The causal mechanism remains unknown (“black”), but its existence is implied (“box”). (Skrabanek 1994: 553)

‘Most important findings’ were made this way. While imaging – and thus the sights that technologies made visible inside the firmly closed box – held the doubts of the life sciences at bay, physics mobilised the black box with the closed lid with no unveiling in mind. Mario Bunge, Argentine physicist and philosopher of science, for instance, asserted that,
A black box is a fiction representing a set of concrete systems into which stimuli $S$ impinge and out of which reactions $R$ emerge. The constitution and structure of the box are altogether irrelevant to the approach under consideration, which is purely external or phenomenological. In other words, only the behavior of the system will be accounted for. (Bunge 1963: 346)

Bunge’s use of the concept of the black box was inspired by the physicist James Clerk Maxwell’s *Gedankenexperiment* (thought experiment) of how to explain that molecules do not move capriciously or irregularly, but instead according to a process of sorting. To explain the natural cause of such motion that happened in a realm too miniscule to observe, William Thompson Baron Kelvin (1824–1907) invoked the idea of a small demon who, with sophistication and care, sorted hot and cold molecules inside the box (FIGURE 20.4):^4

Clerk Maxwell’s demon is a creature of imagination having certain perfectly well-defined powers of action, purely mechanical in their character, invented to help us to understand the “Dissipation of Energy” in nature. He is a being with no preternatural qualities […] Endowed ideally with arms and hands and fingers – two hands and ten fingers suffice – he can do as much for atoms as a pianoforte player can do for the keys of the piano – just a little more, he can push or pull each atom *in any direction*. (Kelvin 1891: 144–45)

**FIG. 20.4** ‘Boxed-up Ghosts’. Maxwell illustrated with a demon how the second law of thermodynamics could be violated. The demon was the gatekeeper.
In the sciences, then, black boxes were an object of enquiry, an epistemic thing (Rheinberger 1997), and at the same time a technique and an analytical tool. As a tool and technique, the black box circumscribed and encased the given problem, and thus enabled an approximation of what can at one point be fully known. In this sense the black box also quintessentially represents the scientific values of modern times: curiosity, an explorative mind, objectivity, and empirically induced theory combined with practical approach.

OSCILLATING BOXES

This last example, however, also shows that the very nature of the black box makes it useful as a performative tool in which types of function are combined. The black box types identified above hardly ever appear in a pure form. Its changeable nature makes it attractive not only for the scientist but also for the artist – for instance, the black box in which theatre takes place (Figure 20.5).

In the theatrical world the black box holds all aspects of its ancient allure as a utilitarian and mystical space. For artists of the 1960s who turned abandoned warehouses into their studios, the black box was appealing because it was cheap to maintain and had few technical requirements apart from some simple lighting. The absence of colour on the walls, together with the lack of a set or backdrop, focused attention directly onto the performer; a darkened auditorium, susceptible to multiple configurations, enabled theatrical artists to shape relationships between the audience and stage in various ways.

At the same time, the very object (black box) turns its verbal form (blackboxing) into a tool for performing thought. The theatrical box is a liberated space, with the fourth wall – the lid – open to the imagination of the human mind, and with three blackened walls that challenge its audience to be enlightened and see. Relationships are framed on stage and thus encased, and yet simultaneously they are openly delivered and displayed.

THE CONCEPT AND THE BOX: PRACTICES UNVEILED

Historians of science and technology are studying the black boxes that were created, identified, unravelled and used, or left untouched. They look at the
creators, users, consumers, and observers of what was black-boxed and, if we follow Richard Whitley’s lead, they then also black-box the historical sciences themselves by studying the inputs and outputs (but not science itself): ‘sociologists of science are preoccupied with the producers in a way that takes little account of what is being produced, […] Ideas are taken as given […]’ (Whitley 1970: 61).

Whitley, by employing the black box, acknowledges its major role as a manager of knowledge, a tool that regulates access and distinguishes those who open the lid – and understand the principles and have the know-how – from those who mainly act upon what goes in and comes out. The utilitarian shell is thus the dividing line between the have and the have-nots of knowledge.

Criticising Merton and his followers, Whitley sees the sociology of science not only as keeping barriers intentionally in place, but also adding another black box by dividing scientific ideas from their enactment. Research hence
concentrates on the effects, while Whitley wants historians to concentrate on the very processes by which scientific knowledge is developed and evaluated in different spatio-temporal locations.

In his later papers Whitley then calls for an analysis of the relation between organisational structures and the cognitive structures of the sciences. This indicates that the box’s shell has a working function and is no longer a dividing line. Knowledge is not separated, but boxed, to grasp why and how interaction takes place when things move from the inside out.

Since ancient times, the black box has gained contours, but while its character has developed and expanded, it has remained quintessentially the same: a useful device and performative thinking tool. In the twenty-first century, black boxes have multiplied, populating the globe and the human mind. Nearly everything can be put into a black box, even vacuum space. Black boxes can also take many complicated forms, from the bookcase to micro-space.

In the deep time view the black box is an object of the sublime, an agent of fearful somethings that are greater than ourselves. Its imaginative power transcends and yet somehow affirms humanity and its lure is the versatility that contours and frames content, even as these contours are made to fade into the background. Of central significance is the lid that, with its potential to be opened and closed, makes the black box attractive for use in the arts and sciences, as well as in human daily life. Defining in- and outside, the black box shows what matters and the relational ties of the things that matter.

NOTES

1 Girrard (1587–1670) was an English politician and the first Baronet of Harrow on the Hill (Burke and Burke 1838: 217).
2 The circuit was invented by Samuel Hunter Christie (1784–1865) in 1833.
3 This notion is often implicit in the idea of magic, as discussed by William A. Stahl (1995).
4 James Maxwell speaks of a Gedankenexperiment in a letter to Peter G. Tait. William Thompson Baron Kelvin then calls Maxwell’s trigger for the sorting of cold and hot molecules a demon in Kelvin 1891: 144–47. For the original theory see Maxwell 1908.
REFERENCES


