The Cybernetic Prediction: Orchestrating the Future

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This chapter argues that we need an intellectual history of prediction, a concept which is curiously absent from the indices of the many volumes dedicated to the history of modern anticipatory governance.[1] Throwing light on different understandings and uses of prediction would be of great benefit to academic but also public debates, where the term prediction tends to be conflated with the certainty of knowledge. Indeed, social scientists and humanities scholars have long criticized the ways in which governments and business use predictions as a highly problematic strive for social control.[2] At

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[1] The term is used but not problematized in Jens Beckert, *Imagined Futures: Fictional Expectations and Capitalist Dynamics* (Cambridge (USA): Harvard University Press, 2016); Philip Mirowski, *Machine Dreams: Economics Becomes a Cyborg Science* (Cambridge and New York: Cambridge University Press, 2002); Liam P.D. Stockdale, *Taming an Uncertain Future: Temporality, Sovereignty, and the Politics of Anticipatory Governance* (London and New York: Rowman and Littlefield, 2016). However, a more extensive reflection can be found in Louise Amoore, *The Politics of Possibility: Risk and Security Beyond Probability* (Durham and London: Duke University Press, 2013) and Jenny Andersson, *The Future of the World: Futurology, Futurists, and the Struggle for the Post-Cold War Imagination* (Oxford University Press, 2018).

[2] Nick Montfort, *The Future* (Cambridge (USA): MIT Press, 2017); Sebastian Franklin, *Control* (Cambridge (USA): MIT Press, 2015), 41–2; Peter Galison, 'The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision', *Critical Inquiry* 21, no.1 (1994), 228–66. Even Timothy Morton casts cybernetics and systems analysis as deterministic epistemologies that are not appropriate to deal with high complexity (Timothy Morton, *Dark Ecology: For a Logic of Future Coexistence* (New York: Columbia University Press, 2016)).

the same time, exact mathematical scientists, neuroscientists, AI theorists and computer modelers regard prediction as an indispensable tool for coping with uncertainty in the production of new knowledge and technology.[3] Moreover, some philosophers of science have recently proposed that the epistemology of prediction should be re-introduced as a central feature of scientific reasoning.[4] As a result, prediction emerges as a contested concept.[5]

To explore these issues, this chapter reviews an influential conceptualization of prediction that was created by the 'father' of cybernetics, the US mathematician Norbert Wiener in the 1940s–60s. In 1948 Wiener outlined a new theoretical agenda for understanding control

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[3] Andy Clark, *Surfing Uncertainty: Prediction, Action and the Embodied Mind* (Oxford University Press, 2016).

[4] Heather Douglas, 'Reintroducing Prediction to Explanation', *Philosophy of Science* 76, no. 4 (2009), 444–63; Robert Northcott, 'Why Are Purely Predictive Models Best?', *Disputatio* 9, no. 47 (2017), 631–56.

[5] For recent work that focuses on the history of prediction see Jamie Pietruska, *Looking Forward: Prediction and Uncertainty in Modern America* (University of Chicago Press, 2017); Matthias Heymann, Gabrielle Gramelsberger and Martin Mahony, (eds.), *Cultures of Prediction in Atmospheric and Climate Science* (London: Routledge, 2017). Prediction has been addressed in histories of future studies: Ariel Colomonos, *Selling the Future: The Perils of Predicting Global Politics* (London: Hurst, 2016); Eglė Rindzevičiūtė, 'The Struggle for the Soviet Future: A Birth of Scientific Forecasting in the Soviet Union', *Slavic Review* 75, no. 1 (2016), 52–76; Eglė Rindzevičiūtė, 'The Future as an Intellectual Technology in the Soviet Union: From Centralised Planning to Reflexive Management', *Cahiers du monde Russe* 56, no. 1 (2015), 111–34; Elke Seefried, *Zukünfte. Aufstieg und Krise der Zukunftsforschung 1945–1980* (Berlin: De Gruyter, 2015); Jenny Andersson and Eglė Rindzevičiūtė, (eds.), *The Struggle for the Long Term in Transnational Science and Politics: Forging the Future* (London and New York: Routledge, 2015).

mechanisms under the name of 'cybernetics', a term which he derived from the Greek word *kubernētēs*, that means 'steersman' or 'governor'.[6] Cybernetics defined the problem of control as a problem of communication, whose mechanism was based on probabilistic prediction. As a result of its ambition to predict (and imitate) behaviors of animals, humans and machines, the cybernetic theory of control has been widely applied to analyze, model, and engineer automation-based technologies, but also to different social organization systems.[7] In turn, cybernetic control enabled the spread of automation, which has been criticized by such influential philosophers as Martin Heidegger and Hannah Arendt, for posing a risk of dehumanizing and de-politicizing social action by rendering social action (what they regarded) as a purely technical problem. Heidegger, for instance, stated that 'cybernetics was the form of technology replacing philosophy', whereas although Arendt rarely used the very term cybernetics, she widely critiqued automation that is based on cybernetics, for instance, in her *The Human Condition* (1958).[8] In these and similar critiques, as Debora

[6] Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society* (Boston: Da Capo, 1954), 15.
[7] Niklas Luhmann, *Social Systems* (Stanford University Press, 1995 [1984]); Stafford Beer, *Decision and Control: The Meaning of Operational Research and Management Cybernetics* (London: Wiley, 1966); Karl Deutsch, *The Nerves of Government: Models of Political Communication and Control* (New York: The Free Press, 1963).
[8] Martin Heidegger, 'Nur noch ein Gott kann uns retten', *Der Spiegel* 23 (31 May 1976): 193–219, cf from Brian Simbirski, 'Cybernetic Muse: Hannah Arendt on Automation, 1951–1958', *Journal of the History of Ideas* 77, no. 4 (October 2016), 589–613, 595, 597.

Hammond put it, ‘cybernetics tends to be seen as primarily mechanistic and deterministic in its approach, despite its rootedness in the recognition of contingency and indeterminacy that came out of nineteenth-century work on statistics and probabilistic systems’.[9]

Today, as John Johnston has noted, cybernetics emerges not just as a historical curiosity, but ‘a moment that should now be considered essential to the history of our present’, a ‘historical nexus’ out of which developed the late modern epistemology and technology of governance.[10] This is reflected in the growing scholarship on heterogeneous legacy of cybernetics. For example, historians have examined how the transfer of the cybernetic notion of predictive control based on feedback loops from electronic engineering to managerial, public policy and cultural discourses discerned cybernetic control has been employed to enhance certainty, rationalization and centralist direction in different political contexts.[11] Although the term cybernetics went out of common use from the 1970s, the cybernetic model

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[9] Debora Hammond, *The Science of Synthesis: Exploring the Social Implications of General Systems Theory* (Boulder, CO: University Press of Colorado, 2003), 64.
[10] John Johnston, *The Allure of Machinic Life: Cybernetics, Artificial Life, and the New AI* (Cambridge (USA): MIT Press, 2008), 25.
[11] Slava Gerovitch, *From Newspeak to Cyberspeak: A History of Soviet Cybernetics* (Cambridge (USA): MIT Press, 2002); Eden Medina, *Cybernetic Revolutionaries: Technology and Politics in Allende's Chile* (Cambridge (USA): MIT Press, 2011); Benjamin Peters, *How Not to Network a Nation: The Uneasy History of the Soviet Internet* (Cambridge (USA): MIT Press, 2016), Thomas Rid, *Rise of the Machines: The Lost History of Cybernetics* (London: Scribe, 2016)

of predictive control has continued to underpin understanding of behavioral systems, leading to the development of *Manichean sciences*, or sciences that sought to span control of societies in the name of rationality and efficiency, but also Cold War struggle between the great powers and, later, neoliberal competition.[12]

Cybernetization of the social was also understood as part of Cold War militarization: this was analyzed in the histories of rational choice theories focusing on the link between cybernetics and intellectual models of competition and choice, as well as in the histories of media and the economy focused on the concept of information.[13] More recently, environmental humanities scholars began to historicize population and ecology where the key concern is with prediction of system change, governed by feedback loops.[14] However, in this whole body of work the central notion of prediction is insufficiently examined. While the many historical studies of cyber-sciences usefully examine the translation of cybernetic ideas of teleology and control into different areas of knowledge and practice, they do not historicize or problematize the cybernetic notion of prediction. For instance, in his discussion of the cybernetic notion of

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[12] Eglė Rindzevičiūtė, *The Power of Systems: How Policy Sciences Opened Up the Cold War World* (Ithaca: Cornell University Press, 2016).
[13] See a useful review by Jamie Cohen-Cole, 'Cybernetics and the Machinery of Rationality', *British Society for the History of Science* 41, no. 1 (2008), 109–114.
[14] Paul Erickson, *The World Game Theorists Made* (University of Chicago Press, 2015).

control, Seb Franklin does not scrutinize prediction, referring to it as an outcome of statistical forecasting.[15] In contrast, Jens Beckert considers the epistemological apparatus of prediction at some length, concluding that prediction has no objective purchase on the social reality. Here Beckert points to the many examples of failed predictions made by economic forecasters, arguing that instead of revealing the 'true future', economic predictions play a political role in the shaping of expectations. For Beckert, prediction of the future equals a fairly certain, even if probabilistic, knowledge of what is going to happen. Prediction thus conceived is juxtaposed with what Beckert describes as uncertainty, a condition that is fundamentally 'unpredictable'.[16] Beckert is not alone to take the meaning of prediction as a certain knowledge for granted: even in his magisterial work on cyborg-sciences, Mirowski, somewhat surprisingly, does not dwell on prediction.[17] Prediction is predominantly considered as merely a technical notion, a cog in the intellectual machinery of the future thinking

By contrast, I propose that prediction is a complex concept that has its own history. Prediction can be embedded in different epistemologies and ontologies of order and control and, as a result, elevated, stigmatized, demonized or cast away as irrelevant. This chapter begins with a brief

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[15] Seb Franklin, *Control: Digitality as Cultural Logic* (Cambridge (USA): MIT Press, 2015), 46–54.
[16] Beckert, *Imagined Futures*, 218–36.
[17]Beckert, *Imagined Futures*; Mirowski, *Machine Dreams*.

discussion of the role of prediction in modern science and then offers a presentation of Norbert Wiener's approach to cybernetic prediction. It discusses how his post-positivist theory of prediction was embedded in the uncertainty-friendly epistemology, as expressed in the idea of limited determinism.

What is a Scientific Prediction?

First, a few words on the scientific understandings of prediction should be helpful in this context. Attempts to predict—to foretell the future—are an old human practice that combines the functions of lay and expert knowledge, but also of magic and social control.[18] While making predictive claims is not restricted to science, the scientific use of prediction is very different from the common sense one. In what follows I introduce an internalist scientific approach to prediction which has been lucidly explained by the quantum physicist and philosopher of science David Deutsch, who draws fairly strongly on Hempel's and Oppenheim's theory of

[18] Donald McCloskey, 'The Art of Forecasting: From Ancient to Modern Times', *Cato Journal* 12, no. 1 (1992), 23–43; Leo Howe and Alain Wain, (eds.), *Predicting the Future* (Cambridge University Press, 1993), Chapters 6–8.

prediction and explanation.[19] According to Deutsch, modern science has a particular take on prediction: prediction is understood as a fundamental part of an epistemological mechanism that takes the production of knowledge beyond classification and description of sets of rules or laws. This is because predictive claims cannot be taken at their face value (e.g. a statement that the apple will fall to the ground), but call for explanation of an underlying mechanism (the law of gravity). However, without the element of prediction, explanatory scientific knowledge would not 'work'.[20]

Deutsch discerns two different types of predictions: the ones which are accompanied with robust explanation and the ones without. The most widespread, common sense predictions are based on 'familiar and uncontroversial' knowledge and do not call for explanation. Such common sense-, or 'background knowledge'-based predictions are known as a rule of thumb: people trust such predictions to work although they do not necessarily have an explanation as to why they should work.[21] In contrast to common sense predictions, according to Deutsch, in modern science different explanations can be given to identical predictions. The arrival at

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[19] I thank Clifford Siskin for drawing my attention to David Deutsch's work. Carl G. Hempel and Paul Oppenheim, 'Studies in the Logic of Explanation', *Philosophy of Science* 15 2 (1948), 135–75.
[20] David Deutsch, *The Beginning of Infinity*: *Explanations that Transform the World* (London: Penguin, 2012).
[21] Deutsch, *The Beginning of Infinity,* 16.

better explanations of predicted phenomena drives the progress of scientific knowledge, rather than the other way around.[22]

Accordingly, prediction is never the end result of scientific knowledge, but rather a starting point where a search for explanation begins. This is a crucial moment in what Deutsch sees as the infinite development of knowledge.[23] Although scientific prediction can be defined as guess-work in a probabilistic world governed by chance, scientists ‘seek not random truths but good explanations’.[24] As Deutsch usefully points out, both Russian roulette and the world future are unpredictable, but for different reasons. While Russian roulette is random, the world future is ‘unknowable’, because to predict the future would entail predicting consequences of as yet nonexistent innovations. This is not possible: ‘no good explanation can predict the outcome, or the probability of an outcome, of a phenomenon whose course is going to be significantly affected by the creation of new knowledge’.[25] The reach of scientific prediction is therefore limited: according to Deutsch, prediction can be defined as ‘conclusions about future events that follow from good explanations’, whereas ‘anything that purports to know what is not yet knowable’ is prophecy.[26] Prediction in

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[22] Deutsch, *The Beginning of Infinity*, 112–13.
[23] ‘[i]n order to make progress in any field, it is the explanations in existing theories, not the predictions, that have to be creatively varied in order to conjecture the next theory’ (Deutsch, *The Beginning of Infinity*, 113).
[24] Deutsch, *The Beginning of Infinity*, 189.
[25] Deutsch, *The Beginning of Infinity*, 197, 198.
[26] Deutsch, *The Beginning of Infinity*, 198.

modern science, in this way, is linked with knowability, but this knowability is not based on certainty, but guess-work and ever-continuing search for better explanations.

While Deutsch's thought must be placed in its own context of quantum physics and a particular belief in the progressive accumulation of knowledge, his presentation of the role of scientific prediction as a starting point rather than the end result is important for the following discussion of cybernetic prediction. The next section outlines the way in which Wiener established the potential and limits of the predictive guesswork of cybernetics that may drive progress—make scientific knowledge work—in the context of probabilistic epistemology.

Cybernetic Prediction beyond Militarized Cold War Culture

Norbert Wiener's cybernetics grew out of the World War II defense effort and its military connotations are therefore not surprising. Wiener's key contribution to control science was the smoothing of statistical time series theory which he developed with an aim to improve the automated tracking and targeting functions in an anti-aircraft predictor (although Wiener's work was never applied to the actual predictor at that time, because technology lagged behind his mathematics).[27] However, this research laid the ground for what would become Wiener's cybernetics theory. Predictive control process was broadened into a wider philosophical undertaking in the interactions with different scientists gathered at the Macy conferences on cybernetics (1946–1953). Extending his scientific engagement to a wider philosophy about the changing character of control in the thermodynamic world and its societal impacts, Wiener drew on J. Willard Gibbs's statistical physics, which pointed to the contingent character of the universe, where 'order is least probable and chaos is most probable'.[28] In such a universe, one could not rely on stationary laws of Newtonian mechanics. New types of mechanisms for the understanding of emerging order and adjustment to it had to be developed. Cybernetic theory of feedback-based control was one of the answers to this call; the other key component was the fast developing radar and computer technology.[29] Computer-powered cybernetic prediction could make knowledge work: fly and shoot planes, schedule transport

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[27] Ronald Kline, *The Cybernetics Moment*, 19–21; Steve J. Heims, *John Von Neumann and Norbert Wiener: From Mathematics to the Technologies of Life and Death* (Cambridge (USA): MIT Press, 1980); Pesi Masani, *Norbert Wiener, 1894–1964* (Basel: Birkauser, 1990); Flo Conway and Jim Siegelman, *Dark Hero of the Information Age: In Search of Norbert Wiener, the Father of Cybernetics* (New York: Basic Books, 2009); Lars Ingelstam, *System: Att tänka över samhälle och teknik* (Eskilstuna: Energimyndighetens förlag, 2012); Thomas Rid, *Rise of the Machines: The Lost History of Cybernetics* (London: Scribe, 2016); Leone Montagnini, *Harmonies of Disorder: Norbert Wiener, a Mathematician-Philosopher of Our Time* (Berlin: Springer, 2017).

[28] Norbert Wiener, *The Human Use of Human Beings*, 12.

[29] Wiener, *The Human Use of Human Beings*, 153.

logistics, but also operate electronic prosthetic limbs and machine translation systems.

So what does it mean to predict cybernetically? For Wiener, prediction has a very particular meaning that builds on statistical extrapolation, but is not limited to it.[30] Prediction is a key informational process in a mechanism of cybernetic control that combines gathering real-time information and extrapolating a most likely trend to the future. This prediction process is powered by information feedback loops. Feedback is a control mechanism that governs the machine on the basis of its 'actual performance' rather than 'expected performance': for example, a feedback mechanism built in a lift would not let the lift doors open if the cabin is not in place.[31] In this way, the feedback mechanism is about simultaneity and effective adaptation to the environment. Feedback is a method of control of an engineered system, but also a form of learning, where learning is defined as a process which occurs when feedback can change 'the general method and pattern of performance'.[32] In other words, even in engineering terms, prediction can have a transformative effect on a device, able to track and

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[30] For a good discussion of how prediction operates in statistical theory, see A. S. C. Ehrenberg and J. A. Bound, 'Predictability and Prediction', *Journal of the Royal Statistical Society,* Series A 156, no. 2 (1993), 167–206.
[31] Wiener, *The Human Use of Human Beings*, 24.
[32] Wiener, *The Human Use of Human Beings*, 61.

feed back the actual data and initiate learning, such as machine translation system.[33]

It is also important to consider Wiener's take on information: for Wiener, information is not a mechanical sorting of number values, as in a classical statistical device, but rather a probabilistic detection of patterns. Prediction as such is an informational process, which takes place through decoding an order of what Wiener calls 'events' or 'messages':

> The message is a discrete or continuous sequence of measurable events distributed in time - precisely what is called a time series by the statisticians. The prediction of the future of a message is done by some sort of operator on its past, whether this operator is realized by a scheme of mathematical computation, or by mechanical or electrical apparatus.[34]

In this passage Wiener emphasizes that prediction is a particular activity, which is based not on the recognition of stationary laws, but on the registration, conjecture, and projecting of a sequence of events. Wiener further claims that the world that is subject to prediction is changing and changeable: as the world is evolving, it cannot be completely foreknown in advance. Prediction, in turn, is adapting and thus changing alongside with

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[33] Wiener, *The Human Use of Human Beings*, 61–2.
[34] Norbert Wiener, *Cybernetics: Or Control and Communication in the Animal and the Machine* (Cambridge (USA): MIT Press, 1965 [1948]), 8–9.

the world or the environment. Cybernetic prediction, in this way, is principally part of an open, evolving system.

While this probabilistic and statistical description of prediction is not innovative in itself, perhaps the most powerful part of Wiener's theory was the placing of feedback-based prediction as a driving engine of an open-ended, adaptive behavior rather than a deterministic function of an automaton. In this way Wiener's model of prediction introduces an additional epistemological layer to statistical forecasting by aligning a statistical predictor with goal steering. For Wiener statistical prediction is but a part of what was described as a circular causality, where causes are placed in the future and not in the past. In the seminal article 'Behavior, Purpose and Teleology', co-written with Arturo Rosenblueth and Julian Bigelow in 1943, Wiener defines teleological behavior as 'directed to the attainment to the goal – i.e. to a final condition in which the behaving object reaches a definite correlation in time or in space with respect to another object or event'.[35] An important difference was made between predictive and non-predictive purposeful behavior. For example, a bloodhound following a trail merely tracks the record of traces without predicting the trail, while a cat chasing a mouse predicts the future moves of its prey. Predictive behavior of higher order can anticipate the anticipation of the

[35] Arturo Rosenblueth, Norbert Wiener, and Julian Bigelow, 'Behavior, Purpose and Teleology', *Philosophy of Science* 10, no. 1 (1943), 18–24, 18.

target.[36] It was precisely this teleological aspect of cybernetic prediction that worried positivist-inclined scientists, because the model of cybernetic control claimed to include something that materially did not exist yet.[37] However, for Wiener, Rosenblueth and Bigelow this was not a problem, because a study of teleology was concerned not with linear, functional causality, but with the mechanisms of behavior.[38] In other words, the cybernetic ontology readily embraced the unknown and non-existent.

[Figure 1 here]

Another important point argued by Wiener is that predictive teleological behavior could be automated: a man-made device could trace, register and analyze the patterns of behavior as 'sequences of events'. This aspect of Wiener's cybernetics has been widely commented upon by critics, fearing that cybernetic prediction based technology would lead to a society governed by servomechanism and AI machines. Wiener himself, however, was not particularly concerned about the prospects of cybernetic totalitarianism. Wiener doubted the intrinsic danger of 'automated government machines' as they are 'far too crude and imperfect to exhibit a one-thousandth part of the purposive independent behavior of the human being'. The real danger, according to Wiener, is in people themselves who

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[36] Rosenblueth, Wiener, and Bigelow, 'Behavior, Purpose and Teleology', 20–1.
[37] Johnston, *The Allure of Machinic Life*, 29.
[38] Rosenblueth, Wiener and Bigelow, 'Behavior, Purpose and Teleology', 24.

may adopt the idea of predictive control to control each other; he saw an expression of such application in von Neumann's game theory to the Cold War strategy.[39] Such ideas were dangerous not the least because they were ethically problematic, but also wrong in their promise of certainty: Wiener argued that any predictor, be it human or machine, was beset by errors 'of a roughly antagonistic nature' because no predictor is exempt from the laws of thermodynamics where any form of order is subject to entropy.[40] Incorporating fundamental uncertainty was part of the cybernetic culture of prediction.

The focus on prediction, in this way, led Wiener to construct an entirely new explanation of the mechanism of future-oriented behavior. In order to make prediction theory work, it was necessary to imitate naturally occurring purposeful behavior. If animals and humans can display predictive behavior without being aware of its physics and mechanics, the actual engineering of teleological machines or organizations requires appropriate understanding of the underlying physical mechanisms.[41] In Wiener's cybernetics therefore, prediction is the beginning, not the end of the process in a physical understanding.

From the 1940s to the 1960s, mathematicians, engineers, economists, and nascent management scientists from East and West, but

[39] Wiener, *The Human Use of Human Beings*, 180–81.
[40] Wiener, *Cybernetics*, 9.
[41] Rosenblueth, Wiener and Bigelow, 'Behavior, Purpose and Teleology'.

also global South pursued the idea that cybernetic prediction could be applied to any purposive, change-bound system, such as, for example, urban planning, society, or the economy.[42] However, Wiener was very clear that social statistical forecasting is a poor technique for predicting social phenomena because of two reasons. First, any reliable predictions of complex systems require very long runs of data reflecting the sequence of events in question. Second, these runs should take place 'under essentially constant conditions'.[43] This means that in order to be predictable, social phenomena must be homogenous and unfold in a smooth manner. This is obviously not the case in societal history as it evolves disruptively and is uneven from the data point of view, because of changing norms and values. Furthermore, even when some societal or economic systems might appear to be predictable at one particular moment in time they have the capacity to become unpredictable at another: for instance, the data on steel in econometric models changes their significance and meaning with every new invention.[44] In all, Wiener warned the enthusiasts of social and economic cybernetics that the advantage of long runs in social statistics, even when

[42] See, for instance, Aksel I. Berg, *Cybernetics in the Service of Communism* (U.S. Army Foreign Science and Technology Center, 1969).
[43] Wiener, *God and Golem, Inc.: A Comment on Certain Points Where Cybernetics Impinges on Religion* (Cambridge (USA): MIT Press), 92.
[44] Wiener, *God and Golem, Inc.*, 91.

available, is 'specious and spurious' at best. Using cybernetic methods for predicting societies—and economies—for Wiener was simply bad science.[45]

Another important area of the application of cybernetic prediction was the environment. However, many environmental applications of cybernetic prediction were restricted by high sensitivity to both scale and time. Wiener illustrates this point with a well-known example of the difference in predicting the future of astronomical and meteorological systems.[46] Astronomical systems comprise a relatively small number of very large particles (planets), which can differ a lot in size amongst themselves. By contrast, meteorological systems have a very large number of particles which are of similar size and are constantly interacting.[47] While accurate recording of initial positions and velocity of particles (planets) in astronomy can be done with a high degree of certainty, in meteorology this is impossible:

> [i]f all the readings of all the meteorological stations on earth were simultaneously taken, they would not give a bilionth part of the data necessary to characterize the actual state of the atmosphere from a Newtonian point of view. They would only give certain constants consistent with an infinity of different atmospheres, and at most, together with certain a priori assumptions, capable of giving, as a

[45] Wiener, *Cybernetics*, 25; Wiener, *God and Golem, Inc*., 94.
[46] Wiener, *Cybernetics*, 32.
[47] Wiener, *Cybernetics*, 33.

probability distribution, a measure over the set of possible atmospheres.[48]

Here Wiener makes a strong point that the principle of linear causality has a limited role in the predictive epistemology when applied to small scales and long-term. In highly complex systems even known causal relations can become unstable as a result of new, unprecedented interactions. As Wiener put it, using the Newtonian or any causal laws 'all that we can predict at any future time is a probability distribution of the constants of the system, and even this predictability fades out with the increase of time'.[49] Timescale, in this way, imposes important epistemological limits on prediction.

Finally, an important question for Wiener and his critics was if prediction was purely cognitive and informational or material: this question particularly bothered humanists, who were concerned that the separation of future-oriented control and body would lead to a society dominated by the values, embodied not in living beings, but in the informational, automated, and authoritarian machine.[50] Indeed, Wiener famously declared that 'the mechanical brain does not secrete thought as "the liver does the bile",' claiming that 'information is information, not matter or energy'.[51] It seems that information for Wiener was part of the physical constitution of the

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[48] Wiener, *Cybernetics*, 33.
[49] Wiener, *Cybernetics*, 33.
[50] Franklin, *Control*.
[51] Wiener, *Cybernetics*, 132.

universe; today this epistemological stance corresponds with the quantum information theory. However, some cultural theorists expressed a deep concern with the apparent conceptual split between information and matter. For instance, the emphasis on information and the binary computer logic led thinkers such as Katherine Hayles to develop her influential argument on the post-humanist effect of cybernetics. According to Hayles, the notion of non-material information leads to an erroneous conceptual divide of materiality/body and information/mind, in this way perpetuating old Western cultural hierarchies were non-cognitive activities were deemed to be existentially and socially inferior of cognitive and abstract activities.[52] A popular example of such a divide, for instance, was seen in the organization of the early AI research. AI researchers regarded the chess playing computer as a model of human brain. However, a later work on AI showed the reverse, that the game of chess requires only a partial cognitive function of human brain.[53] Although, as Kline demonstrated recently, some forms of information theory did emphasize decontextualization and disembodying of information, a close reading of Wiener's writing shows that his views on

[52] Katherine Hayles, *How We Became Post-Human: Virtual Bodies in Cybernetics, Literature and Informatics* (Chicago and London: University of Chicago Press, 1999), 54–7.
[53] Nick Bostrom, *Superintelligence: Paths, Dangers, Strategies* (Oxford University Press, 2014), 14.

materiality and information were fairly inconsistent and sometimes materiality-friendly.[54]

The question of materiality emerges in Wiener's discussion of prediction as a form of agency. As mentioned earlier, in cybernetics prediction is not a limited, built-in function of a structure, but rather a feature of an emergent behavior. Drawing on this, Wiener described prediction as the orchestration of different agencies, such as a predicting system, an observed system, and a process of interaction between the two. It is important to note here that all these agencies are not only dynamic (changing), but also materially mediated. Wiener wrote that all scientific predictions are only made possible through 'observations' of particular 'agencies': stars, for instance, are observed thanks to the agency of light.[55] In this way, there can be no direct observation and, accordingly, no purely 'informational' prediction. Instead, the world has to be materially mediated in a particular way in order to become 'predictable'. Indeed, Wiener's notion of a cybernetically predictable universe is ultimately humbling: it suggests that 'the direction of time is uniform'. This means that we can see the stars thanks to the energy that has been sent, we can see the stars as the energy is arriving, but we cannot see it outgoing, because of the irreversibility of this process.[56] To predict the future cybernetically, for

[54] Kline, *The Cybernetics Moment*, Chapter 4.
[55] Wiener, *Cybernetics*, 33–4.
[56] Wiener, *Cybernetics*, 35.

Wiener, is not to employ the abstract reason to master the world and time. It is rather to build predictive collectives that include men and machines; collectives that are guided not only by the questions 'know-how', but also by 'know-what' and ethics as they are welcoming the incremental arrival of a new form of the universe.[57]

Cybernetic prediction requires to deal actively with materiality by creating particular techniques of recording, measurement, and interpretation of data, as well as the coordination of the many actors that are in charge of them. For Wiener, cybernetic prediction is materially mediated and social, bound to physics, devices, scientific epistemologies, and social institutions.

Cybernetic Prediction and its Critics

It should be clear by now that Wiener's version of cybernetic prediction has much more to offer than has been hitherto recognized. The genealogies of cybernetic epistemology as a source for a militarized, control-seeking governmental framework that over-spilled from servo-mechanical theory into public policy and management address only one side of the story.[58]

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[57] Wiener, *The Human Use of Human Beings*, 183.
[58] Galison, 'The Ontology of the Enemy'; Paul Edwards, *A Vast Machine: Computer Models, Climate Data and the Politics of Global Warming* (Cambridge (USA): MIT Press, 2010); Hunter Heyck, *Age of System:*

While Wiener adopted a fierce, if not always consistent, anti-militaristic stance, a strong case has been made by recent historians who have begun mapping internal heterogeneity of cybernetic epistemology, as it was conducive to counterculture movements, but also the ideas of transparency and transnational cooperation in contrast to militarized tracking of an enemy.[59]

This epistemological and political complexity of cybernetic prediction must be taken seriously as prediction devices are becoming a central object of analysis in the histories of the social and the political. Whereas historians have long referred to machines as metaphors of social order, more recently science and technology studies (STS) scholars proposed a stronger theoretical program suggesting that machines are performative mechanisms generating social order. However, different types of machines do not correspond directly with different socio-political orders. For instance, Otto Mayr proposed that adaptive, feedback-guided systems that are open to the environment historically emerged as both metaphors and

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Understanding the Development of Modern Social Science (Baltimore: John Hopkins University Press, 2015).

[59] In the early 1950s Wiener cut off his relations with McCulloch, Wiesner and Pitts whom he regarded as being too closely involved in the military-industrial complex (Kline, *The Cybernetics Moment*, 65, 85–7). Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (University of Chicago Press, 2006); Andrew Pickering, *The Cybernetic Brain* (University of Chicago Press, 2008); Kline, *The Cybernetics Moment*; Rindzevičiūtė , *The Power of Systems*; Clifford Siskin, *System: The Shaping of Modern Knowledge* (Cambridge (USA): MIT Press, 2016).

models for a liberal social and political order. Mayr contrasted liberal machines, such as steam engine, with closed systems, such as mechanical clocks, which, according to him, embodied the idea of a rule-bound and completely predictable order.[60] However, as Peter Galison demonstrated, actual mechanical clocks were, in fact, a continuous source of frustration, because they rarely ran as they were supposed to, lacked precision, and, most importantly, were notoriously hard to coordinate. The chaotic character of the mechanic clock, as Galison showed, inspired Einstein to develop his theory of relativity.[61] Perhaps Mayr's proposition could be inverted to suggest that authoritarianisms are like clocks in the sense that they are chaotic.

In a similar vein, cybernetic prediction has become a target of cultural criticism as an inadequate and dangerous governmental metaphor and mechanism. The conflation of cybernetic prediction with a technical terminology at best and a politically bankrupt ambition of authoritarian informational control at worst can be attributed to the legacy of the Cold War governmentality.[62] Cold War future visions were increasingly removed away from public debate, as the futures of industrial development, social planning and foreign policy began to increasingly rely on competing expert

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[60] Otto Mayr, *Authority, Liberty and Automatic Machinery in Early Modern Europe* (Baltimore: John Hopkins University Press, 1986).
[61] Peter Galison, *Einstein's Clocks, Poincare's Maps* (London: Sceptre, 2003), Chapter 5.
[62] Paul Erickson et al., *How Reason Almost Lost Its Mind.*

predictions.[63] Those cases which criticize the uses of prediction in governance tend to invoke a particular deterministic definition and use of prediction, as a linear statistical forecast that could be applied on any area of intervention. This deterministic prediction was contrasted with alternative forms of engaging with the future, e.g. diagnosis, scenario, and normative planning.[64] One could speculate that Wiener would have had agreed with these views in the sense that statistical extrapolation is only of limited use in the organization of society. But it should not be forgotten that Wiener himself tried to overcome this limitation by pointing to the complex epistemological role of prediction beyond calculation.

In her study Louise Amoore contrasted what she describes as 'the poverty of probabilistic prediction' with new strategies of dealing with future uncertainty through pre-emption of possibilities. Amoore's study of the emerging field of risk consultancy enumerated an entire list of practices that risk assessment experts themselves claim to use instead of probabilistic prediction: 'consulting, screening, remote tracking, biometric identifying, and algorithmic profiling'.[65] However, these practices themselves rely on the cybernetic technology that is powered by predictive feedback mechanisms, they operate in the context of a wider cybernetic epistemology. I propose that preemption and preparedness can be better understood as new

[63] Colomonos, *Selling the Future*.
[64] Franklin, *Control*, 47–8, 54.
[65] Amoore, *The Politics of Possibility*, 11.

forms of what Wiener described as 'orchestration of prediction', rather than a shift to a fundamentally new epistemological and governmental paradigm. Just as cybernetic prediction still feeds into preemption and preparedness at lower scales of complexity, the need to acknowledge the necessity of guess-work and the associated scientific explanation remains salient to the resilience approach.

Conclusion

In 1959 C. P. Snow wrote about the emergence of two distinct cultures of exact mathematical sciences and humanities that are characterized by a deep misunderstanding of each other that constructs obstacles to more productive development of both types of sciences.[66] In this chapter I have proposed a case for a cybernetic culture of prediction that differs in its treatment of uncertainty from the common sense use of prediction. One culture of prediction seeks to eliminate uncertainty by maximizing the predictive capacity of future events. The key method is linear forecasting and algorithmic trees. The other culture of prediction places uncertainty at the heart of thinking about the future, calling for reflection on the multiple

[66] C. P. Snow, *The Two Cultures and The Scientific Revolution* (New York: Cambridge University Press, 1961).

material and conceptual mediators that make patterns observable and actionable upon. In Wiener's cybernetics, prediction is not the end, but the beginning of purposeful behavior.

Half a century ago Wiener emphasized the need for human foresight in the age of automation, where the creation of goal-seeking machines will ever increase as the machine reproduction of goals will evolve.[67] However, one should be cautious of 'merchants of certainty' who mechanize probabilistic prediction by taking it out of its context of use, subjecting the human development to what Deutsch described as a roulette of random truths rather than explanations.[68] For history shows clearly that cybernetic prediction culture was a transformative force in both science and governance as it forcefully introduced a new take on control as groping in the dark of entropic decay. In line with Naomi Oreskes's argument that uncertain knowledge opens up new vulnerabilities in the existing institutional practices, cybernetic prediction makes a case for vulnerabilities that in the end could bridge existing political divides.[69] Historians have begun reflecting upon culturally and historically specific versions of

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[67] Wiener, *God and Golem, Inc.*, 68.
[68] For examples of deterministic uses of predictive technology in security and risk assessment see Amoore, *The Politics of Possibility,* Chapter 2.
[69] Naomi Oreskes, 'The Fact of Uncertainty, the Uncertainty of Facts and the Cultural Resonance of Doubt', *Philosophical Transactions of The Royal Society Series A Mathematical Physical and Engineering Sciences* 373, no. 2055 (2015), 1–21.

teleology, regularity and contingency in political thought.[70] We need, therefore, a study of socio-political effects of cybernetic prediction that extends its interest beyond the Cold War politics to the different epistemologies of scientific and non-scientific predictions as they are used to cope with uncertainty.

Further Reading

Daston, Lorraine. *Classical Probability in the Enlightenment* (Princeton University Press, 1988).

Deutsch, David. *The Beginning of Infinity: Explanations that Transform the World* (London: Allen Lane, 2011).

Gleick, J. *Chaos: Making a New Science* (London: Heinemann, 1988).

Hacking, Ian. *The Emergence of Probability: A Philosophical Study of Early Ideas about Probability, Induction, and Statistical Inference* (New York: Cambridge University Press, 2006).

Wiener, Norbert. *Cybernetics: Or Control and Communication in the Animal and Machine* (Cambridge, USA: MIT Press, 1965)).

Wiener, Norbert. *The Human Use of Human Beings: Cybernetics and Society* (Boston: Da Capo, 1954).

[70] Henning Truper, Dipesh Chakrabarty, Sanjay Subrahmanyam (eds.), *Historical Teleologies in the Modern World* (London: Bloomsbury, 2015).

Illustrations

Figure 1. The types of behavior. Source: Arturo Rosenblueth, Norbert Wiener, and Julian Bigelow, ‘Behavior, Purpose and Teleology’, *Philosophy of Science* 10, no. 1 (1943), 18–24, p.21. Reproduced with kind permission of Chicago University Press.