

Wiener's Cybernetics: 50 years of evolution

Cybernetics' 99

Extended Abstracts

Edited by

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Norbert Wiener's Cybernetic Critique of the Information Society - An Update

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Extended Abstract

In the last chapter of his path-breaking book 'Cybernetics or Control and Communication in the Animal and the Machine' (original edition) Norbert Wiener (1948) discusses information, language, and society. Applying his cybernetic method to social systems, forces Wiener to characterize the special features of these systems. Obviously (in his words) it is the complexity of the intercommunication of the society's members which distinguishes human beings from animals: While the latter react on stimuli with highly standardized behavioural traits, human societies develop more or less sophisticated languages, whereby "*social animals may have an active, intelligent, flexible means of communication long before the development of language*".

As Wiener points out, the transmission of information defines the extension of a community. In the course of this argument he stresses the importance of the relation of observable behaviour and information. In other words he underlines the close link between the semantic and the pragmatic dimension of communication. As a consequence he focusses on the very interesting aspects of homeostatic processes with respect to communal information. Homeostatic processes are defined as feedback mechanisms inducing measures to keep systems continuing. Applied to social systems this means that their homeostatic processes guarantee the existence of the community, whereby Wiener criticizes the lack of homeostatic processes in politics. In particular he expresses his doubts on the economic view of free markets stating that the individual selfishness of the

bargainers will result in a stable dynamic of prices. He finds the game-theoretic approach of von Neumann and Morgenstern more appropriate to describe social systems, even though he mentions the likely emergence of instability if many players are involved.

Especially in connection with available information Wiener points out the importance of the control of the information space in a society: Mass media, pseudo sciences, opinion samplings and the like are instruments to support the interests of those in power: *"It is only in the large community, where the Lords of Things as They Are protect themselves from hunger by wealth, from public opinion by privacy and anonymity, from private criticism by the laws of libel and the possession of the means of communication, that ruthlessness can reach its most sublime levels."*

The triple constriction of the means of communication are a) the elimination of the less profitable means in favor of the more profitable; b) the fact that these means are in the hands of the very limited class of wealthy men; and c) the fact that - as one of the chief avenues to political and personal power, they attract above all those ambitious for such power. Thus, while communication channels could be the main mechanism to perpetuate homeostasis, these tendencies lead to the opposite: Anti-homeostatic elements get into power.

In short, these are the major lines of Wiener's argument. The final paper will elaborate them in more detail and will try to update them considering the import of fifty more years of development of the information society.

In particular it can be shown how the contemporary use of the concepts of information and knowledge fits into Wiener's cybernetics. Recent approaches of 'adaptive autonomous agents' which use models are an important ingredients in describing the semantic dimension of information and knowledge.

General equilibrium theory as well as game theory were in their infancies when Wiener wrote his book. Since then both have experienced a tremendous enhancement. Thus an actualization of their meaning for Wiener's statements is indispensable.

Another important element has been the drive towards distribution of information technologies as omni-present commodity for mass consumption, a development which has definitely to be assessed in the light of Wiener's perspective.

As briefly sketched the main purpose of the paper is to show that even with the necessary updates and corrections Wiener's main thrust in his chapter on information and society seems to be still valid.

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Abstract:

In 1948 Norbert Wiener published his path-breaking book 'Cybernetics or Control and Communication in the Animal and the Machine'. This paper focusses on the chapter on 'information language and society'. The interdependence between communication, transmission of information and power becomes ever more important in the recent boost of the so-called information society. To appreciate the continuing relevance of Wiener's contribution it is necessary to see how 50 more years of research in general equilibrium theory and game theory as well as the contemporary use of information and knowledge modify his perspective. Furthermore the importance of distribution of information as expressing power structures is emphasized as a reiteration of Wiener's argument.

Introduction

In the last chapter of his path-breaking book 'Cybernetics or Control and Communication in the Animal and the Machine' (original edition) Norbert Wiener (1948) discusses information, language, and society. Applying his cybernetic method to social systems, forces Wiener to characterize the special features of these systems. Obviously (in his words) it is the complexity of the intercommunication of the society's members which distinguishes human beings from animals: While the latter react on stimuli with highly standardized behavioural traits, human societies develop more or less sophisticated languages, whereby "*social animals may have an active, intelligent, flexible means of communication long before the development of language*".

As Wiener points out, the transmission of information defines the extension of a community. In the course of this argument he stresses the importance of the relation of observable behaviour and information. In other words he underlines the close link between the semantic and the pragmatic dimension of communication. As a consequence he focusses on the very interesting aspects of homeostatic processes with respect to communal information. Homeostatic processes are defined as feedback mechanisms inducing measures to keep systems continuing. Applied to social systems this means that their homeostatic processes guarantee the existence of the community, whereby Wiener criticizes the lack of homeostatic processes in politics. In particular he expresses his doubts on the economic view of free markets stating that the individual selfishness of the bargainers will result in a stable dynamic of prices. He

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Especially in connection with available information Wiener points out the importance of the control of the information space in a society: Mass media, pseudo sciences, opinion samplings and the like are instruments to support the interests of those in power: *"It is only in the large community, where the Lords of Things as They Are protect themselves from hunger by wealth, from public opinion by privacy and anonymity, from private criticism by the laws of libel and the possession of the means of communication, that ruthlessness can reach its most sublime levels."*

The triple constriction of the means of communication are a) the elimination of the less profitable means in favor of the more profitable; b) the fact that these means are in the hands of the very limited class of wealthy men; and c) the fact that - as one of the chief avenues to political and personal power, they attract above all those ambitious for such power. Thus, while communication channels could be the main mechanism to perpetuate homeostasis, these tendencies lead to the opposite: Anti-homeostatic elements get into power.

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In particular it can be shown how the contemporary use of the concepts of information and knowledge fit into Wiener's cybernetics.

General equilibrium theory as well as game theory were in their infancies when Wiener wrote his book. Since then both have experienced a tremendous enhancement. Thus an actualization of their meaning for Wiener's statements is indispensable.

Another important element has been the drive towards distribution of information technologies as omni-present commodities for mass consumption, a development which has definitely to be assessed in the light of Wiener's perspective.

As briefly sketched, it will be possible to show that even with the necessary updates and corrections Wiener's main thrust in his chapter on information and society seems to be still valid.

Cybernetics of Social Systems

In Wiener's view social systems can be distinguished from other biological organisation forms by the following property:

'The degree of integration of the life of the community may very well approach the level shown in the conduct of a single individual, yet the individual will probably have a fixed nervous system, with permanent topographic relations between the elements and permanent connections, while the community consists of individuals with shifting relations in space and time and no permanent unbreakable physical connections.' (Wiener, 1948, p.156).

What replaces these permanent physical ties in a community is a basically new phenomenon - *communication*. Communication often is thought to be equivalent to the use of *language*, but Wiener carefully insists that other forms of intercommunication, e.g. transmission via odors, do exist as well. But even without a common set of signals with intrinsic content two social entities can communicate:

'The ability that he (the sender, H. H.-E.) has to pick out the moments of my (the receiver's, H. H.-E.) special, active attention is in itself a language as varied in possibilities as the range of impressions that the two of us are able to encompass.' (Wiener, 1948, p.156).

Since communication is the characteristic property of social systems a closer look at the way it takes place is of primordial interest. Of course, communication usually is not uni-directional, it is an ongoing exchange of information. This leads us to the interesting question of the long-run outcomes of these mutual interactions, in Wiener's terminology the question of *homeostasis* in social systems. These dynamic processes of communicating social entities imply emergence and change of *power and control* structures. Each of these aspects will be dealt with in what follows.

Language

In the last 50 years a considerable amount of research concerning the origin of human language has been done. As (Casti, 1989, p.213) points out each of the 2796 identified languages of the world shares the following features:

1. Formation of a large number of meaningful symbols (words) from a small set of basic sounds (phonemes).
2. Formation of an unlimited number of sentences by logically combining words using a finite number of grammatical rules.
3. The sentences are used for socialized actions.
4. Any normal child has the ability to learn to speak the language.

No known system of animal communication shares all these features. Languages used by human societies thus seem to be a unique device of human communication. A special role might be attributed to the ability of humans to abstract from semantic content. Indeed, mathematics can be interpreted as a language cleaned from any semantics. While other languages owe their flexibility partly to their lack of rigidity, mathematics owes it to its missing semantics. And flexibility is mandatory for a communication tool. Indeed, as research showed (Chomsky, 1969, p.115), it is this power of abstraction that distinguishes human language from those animal communication systems that Wiener still included. Taking Chomsky's work into account, cybernetics should study human communication not as arising out of animal behaviour but as a phenomenon governed by its own, proper principles.

Why is flexibility so important? Because it is the essence of model building and model use in human individuals and social entities formed by them. In human languages words and sentences refer to perceptions outside the world of language, to physical or mental objects. As psycholinguistic work showed (Miller, 1976, pp. 690-707) flexibility in this case not only means that the elements of a language have to refer to whole classes of instances - if the word 'chair' would refer only to the perception of one physical thing by one specified entity at a specified moment in time it would be pretty superfluous - flexibility also means that the entities communicating have their inner sets of connotational relations of this element. Since these related elements again might refer to non-language elements, spoken languages are always to some degree situated in their non-language environment. An interesting by-product of different environments of human societies thus is a *certain* variety in languages and therefore in ways of thinking. Nevertheless it must always be kept in mind that *within a given human community* language can function as communication tool precisely because this variety can be overcome.

The language of mathematics and algorithms constitutes an extreme case. Here any reference to non-language elements is erased. The words of this language are pure variables and their sentences are pure relations. As is the case with spoken languages, the smaller elements, the variables (words), only gain importance within the larger elements, the relations (sentences). In particular, it often is a set of relations (a set of sentences), a system or program, that is of special interest, because it guides the behaviour of the social entity. In other words, social

entities use models and the difference between spoken language models and formal models mainly consists in the fact that the former are to some extent nested in a non-language environment, while the latter sway freely in meaningless spheres.

In his time Norbert Wiener certainly was correct to emphasize the pragmatic dimension of language. He went so far to even collapse the semantic and pragmatic aspect into his definition of information:

'Whatever means of communication the race may have, it is possible to define and to measure the amount of information available to the race and to distinguish it from the amount of information available to the individual. Certainly no information available to the individual is also available to the race unless it modifies the behavior of one individual to another, nor is even that behavior of racial significance unless it is distinguishable by other individuals from other forms of behavior.' (Wiener, 1948, p.157)

It must be remembered that in doing so he actually took a position complementary to Claude Shannon's, who at the same time developed his famous information theory from the perspective of electrical engineering, void of all semantics and pragmatics (Shannon and Weaver, 1949). Wiener did so, well aware that they both started from the same position:

'To cover this aspect of communication engineering (statistical mechanics, H. H.-E.), we had to develop a statistical theory of the amount of information, in which the unit amount of information was that transmitted as a single decision between equally probable alternatives. This idea occurred at about the same time to several writers, among them the statistician R.A. Fisher, Dr. Shannon of the Bell Telephone Laboratories, and the author.' (Wiener, 1948, p.10)

Cybernetics of social systems thus was conceived as a theory that provides an alternative view of information, a view where *biological feedback loops* stimulate behavioral adaptation via language. Knowledge, the stock variable of which information was the time derivative, was implicitly introduced and attributed to social entities. This approach was not opposed, but certainly complementary to Shannon's, and it was deeply rooted in the emerging paradigm of 'system science'. As a consequence one of its central concepts was that of *homeostasis*, defined biologically by Bertalanffy:

'There is indeed a large number of biological phenomena which correspond to the feedback model. First, there is the phenomenon of so-called homeostasis, or maintenance of balance in the living organism, the prototype of which is thermoregulation in warm-blooded animals.' (Bertalanffy, 1968, p.43)

Homeostatic Systems

For Norbert Wiener capitalism was not a homeostatic system.

'There is a belief, current in many countries, which has been elevated to the rank of an official article of faith in the United States, that free competition is itself a homeostatic process ... Unfortunately, the evidence, such as it is, is against this simple-minded theory.' (Wiener, 1948, p.159)

He mentions John von Neumann's work on the theory of strategic games and though he seems to prefer this approach, he mistakes it as being unable to deal with incompletely informed players. Von Neumann's pivotal contribution had been published (v. Neumann and Morgenstern, 1943) and after half a century of further research most of Wiener's critique has been developed as *part* of modern game theory.

Similarly the view of capitalism criticized by Wiener in 1948 has been developed to a full-fledged mathematical theory of economics, general equilibrium theory, only in 1959 (Debreu, 1959). Though the term homeostasis is not mentioned, the general equilibrium approach aims at the same outcome: Competitive market capitalism is a self-regulating, stable system with welfare properties that imply its superiority over all conceivable alternatives. Because general equilibrium theory (GET) does not even try to mimic actual living systems its optimality implications are much stronger than the descriptively inclined homeostatic system theories in biology dare to state.

Interestingly enough it is mainly the strong set of assumptions on the information of economic agents in GET that is crucial for the strong results: Because it is *assumed* that all information is available, costlessly produced and acquired, human evolution as a process of knowledge acquisition cannot be brought into the picture at all! Evidently the outstanding inapplicability of GET has motivated some of its scholars to develop less stringent versions, so-called computable general equilibrium approaches (CGE), where the set of assumptions is softened. The modern terminology thus discusses the question of homeostasis in social systems as the opposition between equilibrium and disequilibrium approaches. The latter sometimes are associated with *evolutionary economic theory* - an approach that incorporates disequilibrium and the emergence of new combinations in a dynamic framework (Hanappi, 1994). It is this field of economic theorizing that probably would have interested Norbert Wiener most, since it is in evolutionary economics, where empirical observation drives model building - and not vice versa.

In modern terminology, formal systems now usually are investigated in three steps: existence of equilibrium, uniqueness of equilibrium and (dynamic) stability of equilibrium. While most GET researchers still hold that systems worth investigating must meet all three criteria, their opponents insist that in real life divergent processes play an important role in stimulating the emergence of new phenomena - and this characteristic property of social systems should be studied formally too. Homeostatic systems meet the existence and the stability criterion, not necessarily the uniqueness criterion - hence the weaker optimality purport. Furthermore the new concept of structural stability might be interpreted as another possibility to formalize sudden jumps between kinds of homeostatic systems.

So while Wiener had the correct intuition, time had not come to provide him with the appropriate tools of advanced social sciences, in particular of game theory, to allow him to graft his vision of social cybernetics forcefully on a methodologically sound economic approach. All he could do in 1948 was to criticize the forerunners of GET, and that was what he did.

The theory of strategic games and simulation approaches indeed opened up a Pandora's box for model builders. As any modern textbook proves, (Bierman and Fernandez, 1998) or (Osborne M., Rubinstein A., 1994), the new formal tools with their ability to model learning behavior are open to be used for the issue the theorist wants to transport. While in the forties the example of mathematics for theoretical physics still lead many scholars to the view that there is *one* mathematics which basically is isomorph to the structure of matter and somehow must be isomorph to the structure of living systems, nowadays these illusions have vanished. Mathematics is just an extreme type of language, open to be used for the issue a theorist wants to formulate. And if there are too many difficulties, then mathematics is extended.

The qualitative innovation of von Neumann's game theory proved to be the idea that social agents should be modeled as model-building, strategic entities with constraint information acquisition and information production capacities. Of course, this potential existed only in nucleus in the book of 1943. Exploiting this potential analytically, and filling in simulation wherever problems become untractable, has proved to be a forceful way to reformulate the dynamics of political economy. Power structures and control designs reappear again, the

shallow illusions of omnipresent, equilibrating markets, or more precisely of *their results*, are diverted to the background.

Power and Control

When investigating information and language Wiener already pointed out that the control of the means of communication is the most effective and most important issue. Thus in large societies (in which direct contact of all members is not possible) it is crucial who has control over the means - such as '*the press, both as it concerns books and as it concerns newspapers, the radio, the telephone system, the telegraph, ...*' (Wiener, 1948, p.161) - or in more contemporary terms: the mass media. These aspects of power and control become even more important in the era of the so-called information society. As the concept 'information society' suggests, the processing of information has become so easy - in terms of cost, speed and capacity - that information processing really dominates our lives. In the industrialized world there are PCs in almost every household and internet connection is heavily pushed by powerful pressure groups. As a consequence these new types of information processing devices are omnipresent in work, education and leisure time. The information services distributed by the mentioned technologies are available 24 hours every day - the permanent offers of these information channels perpetuate their continually increasing use and importance.

Mass media in the immediate post-war period used to be uni-directional, television being the the best example. There was one centralized sender and a mass of receivers with no technical possibility of quick feedback. Already in this setting - the one which Wiener must have had in mind - centrally developed role models were distributed most efficiently to implant 'correct' behavior in the privately entertained models of information consumers. With the introduction of home computers and network technologies bi-directional communication is conquering mass communication. Does this new type of intercommunication undermine the evident dangers of ideological manipulation by powerful entities owning the centre of information distribution - the abyss envisaged by Norbert Wiener?

As we developed in greater detail in (Egger E., Hanappi H., 1994) and (Hanappi H., Hanappi-Egger E., 1997), this is not the case - it can even be argued that the possibility of bi-directional communication can amplify ideological streamlining. The latter development will necessarily evolve if the technical devices induce the communicating agents to use a language that itself, as a kind of perverted universal grammar in the sense of Chomsky (Chomsky, 1957), transports ideological content. Since this language has to be actively learned it becomes part of the consciousness of the agent, part of the ego, it is not only a passively received and stored role model. While grammar thus is endangered, semantics often is transported in the disguise of images and icons. Psychologically optimized pictures and animations - the leading edge coming from professional advertising - provide subconscious rules of behavior. Add the plethora of different fields of action that the average citizen has to manage in ever shorter time and it becomes only too 'natural' that his increasing confusion, his decreasing semantic capacity, is replaced by the syntax and semantics of those controlling the intercommunication channels. Norbert Wiener's Leviathan in action.

Who are the big players in today's strategic games of information? With the tremendous drive towards oligopolies observed in the last decade the handful of mass media moguls and capital groups dominating global information production become easier to identify every day. A similar trend can be found for political entities: The three large continental organizations of North America (USA), Asia (Japan) and Europe (European Union) known as the triade, have replaced the complicated system of nation states. Technical, political and economic aspects of strategic competition cannot be disentangled anymore. And finally, there are some silent, *potential* players: households and people in the third world.

Control of the existing power structure still is distributed over a number of players - it is a dynamic, strategic game. Though there is a trend towards a diminishing number of players and despite the endogenously produced problems like mass unemployment, this constellation seems to be able to perpetuate its relative stability at least in the next decade. Contrary to Wiener's claim, there seems to be some kind of relative homeostasis - but not the one moving towards the democratic world community that has been so many peoples goal since the French enlightenment.

Conclusion

From the point of view of contemporary modeling approaches in the social sciences cybernetics at first sight looks like a superfluous, old-fashioned spleen of people like Norbert Wiener. Indeed, there has been a lot of scientific refinements since the days when the concept was in fashion. But as we tried to show, Norbert Wiener's vision in the concluding chapter of his path-breaking book is characterized by a deep understanding of social processes and an extraordinary feeling for the theoretical tools necessary to model them.

Perhaps the most compelling justification of the cybernetic approach, though it comes with a different brand name, is the current boom of artificial life and autonomous agents approaches, e.g. (Langton, 1995), (Holland, 1995) and (Epstein and Axtell, 1996). For many of the researchers involved Herbert Simon's concept of bounded rationality was an important stimulus (Simon, 1982). All of these models are more or less complicated feedback models working usually on different levels of perception - interaction between micro- and macrolevels is made explicit. These ideas proved to be so attractive that even leading researchers of competing paradigms sometimes step out to give them a try (Sargent, 1993). Others praise feedback models without even mentioning cybernetics, not to speak of Wiener (Kendrick, 1988). But this would not scare the latter.

It remains a rather remarkable fact, that not only his vision of the dynamics of the coming information society proved to be - dangerously - correct, also his methodological proposition of the construction of cybernetic systems is currently experiencing an (undercover) renaissance. And this is exactly what Norbert Wiener would have pleased.

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