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**BETWEEN PLATO AND WIENER.  
PHILOSOPHICAL CYBERNETICS  
IN THE 17<sup>th</sup> CENTURY**

The knowledge concerning steering and control has been gathered since the dawn of humanity. Its contemporary name is derived from the Greek expression κυβερνητική τέχνη which means the art of steersmanship. Plato introduced it to philosophy, nevertheless the one-word term ‘cybernetics’ was coined more than two thousands years later by Ampère,<sup>1</sup> who restricted its scope to a mere subfield of political science.<sup>2</sup> Of course, the field of cybernetics is much broader, embracing all steering processes, and its principal aim is to identify general principles of steering and control. As it is well known, scientific cybernetic research begun only in the second part of the 19<sup>th</sup> century, not in the context of political science but in the framework of physiology, psychology and engineering.<sup>3</sup> Most of the main concepts of modern cybernetics emerged in the 1920–1930s due to the development of theories of computing, games, information, and pursuit. The threshold of conceptual ‘critical mass’ was exceeded in the 1940s in France, Germany, and the USA. The birth of cybernetics is often dated to the seminal publication by Wiener (1948).<sup>4</sup> In a sense cybernetics fell victim of its

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<sup>1</sup> André-Marie Ampère *Essai sur la philosophie des sciences ou Exposition analytique d'une classification naturelle de toutes les connaissances humaines*, pt. 2, Bachelier, Paris 1843, p. 140–143. In the same year ‘cybernetics’ appeared in Polish, in a treatise by Bronisław Trentowski *Stosunek filozofii do cybernetyki, czyli sztuki rządzenia narodem. Rzecz treści politycznej* [The relation of philosophy to cybernetics, or the art of governing a nation: a political piece], J. K. Żupański, Poznań 1843.

<sup>2</sup> Cybernetics was classified as a science of the 3<sup>rd</sup> degree, as a part of politics sensu stricto, the latter was a part of politics in general.

<sup>3</sup> Three notable names in this period: Claude Bernard (1813–1878), Eduard Pflüger (1829–1910), Felix Lincke (1840–1917). For history of cybernetics in the 19<sup>th</sup> century see e.g. Volker Henn “Materialien zur Vorgeschichte der Kybernetik”, *Studium Generale*, vol. 22 (1969), no. 2, p. 164–190.

<sup>4</sup> Norbert Wiener *Cybernetics: or Control and Communication in the Animal and the Machine*, John Wiley and Sons, New York 1948.

initial success. The rapid development eventually led to fragmentation, so the most active former branches of the cybernetic movement are now being considered as separate fields, as in the case of Artificial Intelligence. Our considerations are based on the “classical cybernetics” between 1940s and 1970s.

It can be easily guessed that a slow gestation spanning over more than two thousand years had several causes. Not only advanced formal methods were needed, and even the emergence of individual scientific and engineering disciplines on which cybernetics had been founded was not enough. Philosophical underpinnings were also needed. In this respect, the 17<sup>th</sup> century was the formative period. We do not claim that all philosophical ideas pertaining to cybernetics emerged in early modernity. Rather, some existing concepts were expressed in modern terms and included in a broader intellectual framework. We shall list the basic assumptions of cybernetics with brief explanations. Then we shall briefly review the contribution of 17<sup>th</sup>-century philosophers to the development of these assumptions.

1. **Systemism.** Reality is to be apprehended in a systemic way. Cybernetics focuses on the structure instead of the matter.
  - 1.a. Sometimes systemism is reduced to generalised behaviourism, i.e. the directive ‘black boxes should not be looked into’. The latter is rather commonsensical.<sup>5</sup>
2. **Analogisation of systems.** There are classes composed of systems which are isomorphic with regard to steering/control relations. An example is the class of autonomous systems (see Item 6. below).

The term ‘isomorphic’ means a kind of similarity, namely ‘sameness’ with regard to cybernetically relevant features.<sup>6</sup>
3. **Energetic and material nature of interactions** (‘energy & matter principle’). All interactions, including the steering/control interactions, are of energetic and/or material nature. Informational interactions are singled out on the basis of negligent ratio between energy-matter ‘expenditure’ of cause and the respective ‘gain’ of effect.

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<sup>5</sup> See e.g. W. Ross Ashby *An Introduction to Cybernetics*, Chapman and Hall, London 1956, item 16/7.

<sup>6</sup> The problem of detecting relevant isomorphisms is also encountered in the general systems theory, see remarks by von Bertalanffy: *General Systems Theory: Foundations, Development, Applications*, G. Braziller, New York 1973, pp. 33–34, 80–86. The following saying is attributed to Stefan Banach: “A mathematician is one who sees analogies between theorems; a better mathematician is one who can see analogies between proofs, and the best mathematician can find analogies between theories. The ultimate mathematician would see analogies between analogies.” In the case of cybernetics one must indeed see analogies between theories.

It is not a *definition* of information. There are several *types* of such definitions, moreover no definition embraces all important intuitions of information, whether commonsensical or scientific.<sup>7</sup>

4. Purposiveness and intentionality. The steering process is aimed at a purpose anticipated by the steering system ('the helmsman knows where he is going').

5. Cybernetic hierarchy of systems. There is a ranking of systems according to their (self-)steering capacities.

No such ranking was ever agreed by cyberneticians.<sup>8</sup> Cybernetic rankings are sometimes mistaken with hierarchies of systems in terms of their 'complexity'.<sup>9</sup>

6. Identification of autonomous systems. In the hierarchy of systems there is a class of systems capable of self-steering and self-control in their own interest (autonomous,<sup>10</sup> self-governing, purposeful<sup>11</sup>). 'Own interest' means maintenance of existence and steering capacities.

6.a. The principle is often limited to the principle of homeostasis: some systems (homeostats) are capable of maintaining the quality of their inner environment, as survival demands that all parameters of the systems stay in a specific, 'normal' range.

7. Characterisation of systems. There are features of systems incapable of being changed by steering or control without disturbing the identity of a given system (or even destroying it). Such features can be termed cybernetic 'characters' or 'natures'.

The term 'rigid steering parameters' is also used<sup>12</sup> – rigidity meaning *independence* of external influences and not *invariability*. If the character of a system changes, it does so spontaneously (e.g. when the system is ageing). Of course, real-life systems display both rigid and flexible features.

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<sup>7</sup> Alfréd Rényi emphasised a historical correlation between the kinds of energy and kinds of information discovered one after another; "Some fundamental questions of information theory", (in:) *Selected Papers of Alfred Rényi*, vol. 2, 1956–1961, Akadémiai Kiadó, Budapest 1976, p. 526.

<sup>8</sup> The most important ones were proposed by de Latil and Mazur. Pierre De Latil: 'degrees of automatism' and 'hierarchy of effectors'; see *Thinking by Machine: A Study of Cybernetics*, transl. Y. M. Golla, Houghton Mifflin, London 1956, pp. 40, 318. Marian Mazur: 'hierarchy of systems according to admissible steering processes'; see *Cybernetyczna teoria układów samodzielnych* [A cybernetic theory of autonomous systems], PWN, Warsaw 1966, pp. 50–57.

<sup>9</sup> Compare the widespread Boulding's typology; Kenneth E. Boulding 'General Systems Theory: The Skeleton of Science', *Management Science*, vol. 2, no. 3 (Apr. 1956), p. 202–205. Boulding was followed e.g. by Ludwig von Bertalanffy (*General Systems Theory*, pp. 28–29).

<sup>10</sup> Mazur's term.

<sup>11</sup> Ackoff's and Emery's term.

<sup>12</sup> Marian Mazur: *Cybernetyka i charakter*, p. 271–272; see also *Cybernetyczna teoria układów samodzielnych*, part IV.

8. Characters are empirical (principle of motivation). A character of a system can be inferred from its actions caused by various stimuli.  
From the black-box perspective (Item 1. above) a character is nothing more than a function transforming the set of stimuli (inputs) into a set of possible reactions.
9. The feedback principle. Feedback is the principal type of steering/control interaction.
10. The principle of requisite variety. If a system is to control another one, it must display greater (or at least the same) variety. In other words, the former should have an ‘advantage of possibilities’ as compared with the latter.  
Variety is understood as the range of possible (qualitative or quantitative) behaviour or the number of possible states. The principle was formulated by Ashby<sup>13</sup> in 1950s.
11. Probabilism. Neither information needed for steering is known with absolute certainty nor reaching the goal is sure.
12. The evolutionary principle.

Cybernetics employs two main versions of evolutionism: *Darwinian* (selection of the fittest) and *Lamarckian* (inheritance of acquired traits).

There are also three main (and not yet achieved) goals of cybernetics:

1. A general theory of information and steering systems.
2. Optimisation of steering in existing autonomous systems, including an applicable and rational theory of society.
3. Construction of artificial autonomous systems i.e. systems having both ‘intelligence’ and capacity of reproduction.

Systemism, as we have said, neglects the matter emphasising the structure instead. The early modern preoccupation with the problem of substance seems very far removed from ignoring what the ‘world stuff’ would be. However, the Leibnizian hierarchical universe of synchronised monads is quite close to the systemic worldview. Certainly the monads themselves despite their declared simplicity are systems of a kind. Early modern thinkers realised analogies between steering processes in different classes of systems, mainly between mechanical, organic, and social ones. In Hobbes we find an elaborate tripartite analogy of this kind (mechanism-human body-state).<sup>14</sup> Nevertheless, such analogies remained stereotypical for a long time, serving merely as illustrations. A real breakdown happened when systemic analogies

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<sup>13</sup> William Ross Ashby *An Introduction to Cybernetics*, Items 11/6.–11/13.

<sup>14</sup> See ‘Introduction’ to *Leviathan*.

began to be used as a basis for new scientific theorems and this demanded not only analogies but also isomorphisms.

The introduction of the ‘energy & matter principle’ was necessarily postponed to the much later discovery of general principles of conservation of energy and matter. Again, Leibniz was the first to recognise a particular kind of physical energy, namely the kinetic one (*vis viva*) and to notice its conservation.<sup>15</sup> The purposiveness and intentionality principle is very old and could be traced back to the primitive patterns of thinking. Cybernetic hierarchies of systems were certainly predated by ideas of Great Chain of Being. The long history of the notion of autonomous system cannot be treated here. The principle of homeostasis was formulated by Claude Bernard as the principle of fixity of the internal environment (*la fixité du milieu intérieur*).<sup>16</sup> The very word was introduced by Walter Cannon, and aptly termed ‘wisdom of the body’.<sup>17</sup> The intuition is much older, dating back at least to Aristotle<sup>18</sup> in political science, and to the humoral doctrines in medicine. Among economists we find Dudley North (1641–1691) with the concept of economy as a mechanism tending towards equilibrium. Descartes is credited with, however implicit, observation of regulation in the human body<sup>19</sup> which in turn would be the first hint at the feedback principle.

The idea of characterisation of systems has ancient roots, nevertheless it was not until Schopenhauer that philosophy produced an idea of human character compatible with modern cybernetic ideas.<sup>20</sup> Similarly, the principle of requisite variety stems from the old metaphysical principle that a cause is always more perfect than its effect. Historians of mathematics

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<sup>15</sup> See e.g. René Dugas *A History of Mechanics*, tr. J. R. Maddox, Routledge & Kegan Paul, London 1957, pp. 219–221. As it is known from the history of physics, kinetic energy and momentum were initially viewed as competing candidates for the fundamental quantitative notion of mechanics.

<sup>16</sup> Bernard describes three types of life: hidden (*vie latente*), oscillatory (*vie oscillante*), and constant or free (*vie constante ou libre*). He wrote concerning the latter: “*La fixité du milieu intérieur est la condition de la vie libre, indépendante: le mécanisme qui la permet est celui qui assure dans le milieu intérieur le maintien de toutes les conditions nécessaires à la vie des éléments.*” – *Leçons sur les phénomènes de la vie communs aux animaux et aux végétaux*, vol. 1., J.-B. Baillièrre et fils, Paris 1878, p. 113.

<sup>17</sup> Walter Bradford Cannon *The Wisdom of the Body*, W. W. Norton & Company, New York 1932.

<sup>18</sup> *Polit.* 1310a.

<sup>19</sup> Description of extraocular muscles in *L’Homme*, see *Oeuvres de Descartes*, ed. Adam & Tannery, vol. 11, pp. 135–136 and fig. 4.

<sup>20</sup> An interesting account of three ideas of human character in English philosophy: Jamie C. Kassler *Inner Music: Hobbes, Hooke, and North on Internal Character*, Athlone, London 1995.

generally acknowledge that the 17<sup>th</sup> century saw the birth of both probability theory and modern probabilism.<sup>21</sup> Mathematical probability found important application in the domain of games, eventually giving rise to game theory.

The very phrase “game theory” needs a bit of explanation. It has two meanings, one possible and another actual. In the first sense it would cover any mathematical study of games, of course including probabilistic analysis. The latter was rapidly developing in 17<sup>th</sup> and 18<sup>th</sup> centuries, quite advanced problems like the gambler’s ruin being studied for several cases. However, the contemporary usage of the term in question corresponds to a specific understanding of “game” itself. Game is seen as an encounter of at least two agents with differing interests, and the main point is to identify and analyse their strategies. It can be also said that a game is a system influenced by at least two “helmsmen” (players) having possibly contradictory aims.<sup>22</sup> A full-fledged theory of games was developed only in 20<sup>th</sup> century (Steinhaus, von Neumann, Morgenstern), not without earlier predecessors.<sup>23</sup>

The Pascal’s wager<sup>24</sup> is regarded as a milestone in the development of probabilistic argumentation in philosophy. The French thinker was not the first to use that kind of argument for godly life, anyway he is often granted the priority in applying probabilistic ideas to theology, perhaps because the historical context of “new probabilism”, and “new reasonableness”,<sup>25</sup> not to mention the fact that the very formulation of the wager seems tailored for game theoretical analysis. Despite dubious validity of the original conclusion drawn by its author, and obvious problems with mathematical interpretation of infinite gain and loss appearing in the wager, it was the starting point of something we would label “theological cybernetics”,<sup>26</sup> preceding

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<sup>21</sup> See e.g. Ian Hacking *The Emergence of Probability*, Cambridge University Press, Cambridge 1975.

<sup>22</sup> We modified a definition from: Maria Kempisty (ed.) *Mały słownik cybernetyczny* [Little cybernetic dictionary], Wiedza Powszechna, Warsaw 1973; entry “Gra” [Game].

<sup>23</sup> As far as we know, the first modern strategic analysis of a game was carried out in 1713, in the correspondence between Pierre Rémond de Montmort and certain Monsieur de Waldegrave; David Bellhouse “The Problem of Waldegrave”, *Electronic Journal for History of Probability and Statistics*, vol. 3, no. 2 (Dec. 2007).

<sup>24</sup> *Pensées*, 451 (Chevalier’s number). On the wager, see e.g. Ian Hacking *The Emergence of Probability*, chap. 8.

<sup>25</sup> We borrowed terms used by Lorraine Datson to describe early modern recipes for being “both rational *and* less than certain in matters of contemplation, as well as action”; see “Probability and evidence”, (in:) Daniel Garber (ed.), *The Cambridge History of Seventeenth-Century Philosophy*, Cambridge University Press, Cambridge 1998, p. 1108.

<sup>26</sup> Both idea of providence and the doctrine of deism can be included in its pedigree.

contemporary attempts to explore mathematical aspects of encounter between humans and divine entities.<sup>27</sup>

The 17<sup>th</sup> century produced mostly criticisms of ancient evolutionary doctrines.<sup>28</sup> Isolated transformist ideas which emerged at that time<sup>29</sup> certainly do not contradict the claim that only in the next century evolutionism began to gain an upper hand. Even Hobbes, who certainly knew about ancient concepts of Empedocles, was disinterested in them.<sup>30</sup>

Cybernetics needs appropriate formalisation, including suitable mathematical tools. Two names immediately come to mind in this context—again Hobbes and Leibniz. The former equated reasoning with calculation<sup>31</sup>, the latter invented binary system and envisaged a general science (*mathesis universalis*), employing a formalised universal language founded on a one-to-one symbolisation of simple ideas (*characteristica universalis*). Wiener explicitly mentioned<sup>32</sup> a related Leibnizian concept, *calculus ratiocinator* or *calculus univeralis*, being a deductive system embedded in the universal language.

As for goals of cybernetics, the early modern period saw first constructions of computing machines (Wilhelm Schickard, Pascal, Leibniz). These primitive manually operated mechanisms were a far cry from modern computing automata. Contemporary historians locate them at the beginning of the enterprise of mechanisation of mathematical reasoning. It should be emphasised that neither computing mechanisms, neither Artificial Intelligence are the same as autonomous systems. We already noticed that AI (like Ar-

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<sup>27</sup> Steven J. Brams *Superior Beings: If They Exist, How Would We Know? Game-Theoretic Implications of Omniscience, Omnipotence, Immortality, and Incomprehensibility*, wyd. 2., Springer, Nowy Jork 2007. Brams makes explicit references to Pascal, especially in chap. 2. For a shorter account of his approach see: “Belief in a Superior Being: A Game-Theoretic Analysis”, (in:) Charles L. Harper Jr. (ed.) *Spiritual Information: 100 Perspectives on Science and Religion. Essays in Honor of Sir John Templeton’s 90th Birthday*, Templeton Foundation Press, Philadelphia–London 2005, pp. 242–249.

<sup>28</sup> See Matthew Goodrum “Atomism, Atheism, and the Spontaneous Generation of Human Beings: The Debate over a Natural Origin of the First Humans in Seventeenth-Century Britain”, *Journal of the History of Ideas*, vol. 63, no. 2 (Apr. 2002), pp. 207–224.

<sup>29</sup> There is a controversy concerning Leibniz in this respect, given various interpretations of *Protogaea*; see Lloyd Strickland *Leibniz Reinterpreted*, Continuum, London 2006, pp. 125–131.

<sup>30</sup> See *De Homine*, I.1. [*Latin Works*, vol. 2, pp. 1–2].

<sup>31</sup> Again incidentally: *De Corpore*, I.1.2; *Leviathan* I.5 [*English Works*, vol. 1, p. 3; vol. 3, pp. 29–30]. No wonder that Bocheński called it “*jeu d’esprit* of a dilettante” (I. M. Bocheński *A History of Formal Logic*, tr. Ivo Thomas, Chelsea, New York 1970, p. 274).

<sup>32</sup> Norbert Wiener *Cybernetics*, p. 12.

tificial Life) detached itself from the classical cybernetics-and the project of artificial autonomous system needs both AI and AL.

Nothing in the main assumptions of cybernetics implies mechanicism. Generally speaking, a mere analogisation of a mechanism with an organism allow both mechanistic understanding of the organism and organismic treatment of the mechanism. The principle of analogisation does not exclude the possibility that there is a favoured element of a given analogy, i.e. one regarded as more important, central, or simply better known. Cybernetics is mechanistic, and not organismic (and of course not socio-centric). First, a considerable part of its methods are taken from physics which remains mechanical until now, despite the changes of underlying mechanics. Second, mechanicism represented by cybernetics is directly linked with early modern version of this ideology. It has historically developed along two main, often intertwining, lines: explanatory mechanicism and mechanomorphism.<sup>33</sup> The first is essentially epistemological, focusing on physicalist and reductionist explanations. The latter is founded on more or less explicit ontological claims that entities commonly regarded as non-mechanisms (especially living beings) *are* machines. Of course neither Cartesian, nor cybernetic mechanicism excludes methodological self-consciousness and awareness that mechanistic understanding is to some degree conventional. An example can be found in the opening of Descartes' *L'Homme* ("Ces hommes seront composez, comme nous, d'une Ame & d'un Corps..."). Another well-known passage contains the claim "that, were there such machines exactly resembling in organs and outward form an ape or any other irrational animal, we could have no means of knowing that they were in any respect of a different nature from these animals".<sup>34</sup> Descartes of course stopped short of asserting the same possibility in the case of humans. And Wiener wrote in the same respect: "if we could build a machine whose mechanical structure duplicated human physiology, then we could have a machine whose intellectual capacities would duplicate those of human beings."<sup>35</sup>

It should be finally noticed that the early modern philosophy supplied also a powerful argument against both materialisation and mechanisation

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<sup>33</sup> A term rarely used in English, however capturing the essence of the 'ontological' mechanicism. See e.g. Adam Synowiecki "Mechanicyzm" [Mechanicism], (in:) Zdzisław Cackowski et al. (ed.) *Filozofia a nauka. Zarys encyklopedyczny* [Philosophy and science. An encyclopedic outline], Ossolineum, Wrocław 1987, p. 351.

<sup>34</sup> *Discourse on the Method*, V; John Veitch's translation.

<sup>35</sup> Norbert Wiener *The Human Use of Human Beings: Cybernetics and Society*, Houghton and Mifflin, Boston, 1950, p. 57.

of mind, the Leibniz's mill:<sup>36</sup> if "there were a machine, so constructed as to think, feel, and have perception", then a wanderer inside it would "find only parts which work one upon another, and never anything by which to explain a perception".<sup>37</sup> Today we can regard it as targeted both against Descartes and Wiener.

#### S U M M A R Y

Philosophical assumptions of cybernetics are listed and briefly explained. Principal contributions of early modern philosophers to their development are described. It is claimed that 17<sup>th</sup> century was the formative period of philosophical cybernetics.

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<sup>36</sup> Leibniz *Monadology*, § 17.

<sup>37</sup> *Ibid.*, Robert Latta's translation.

