Legal Cybernetics: An Educational Perspective

Legal Cybernetics: An Educational Perspective

Viktória Ilková*and Adrian Ilka**

**Comenius University in Bratislava, Faculty of Law, Šafárikovo nám. 6, 810 00 Bratislava (e-mails: viktoria.ilkova1991@gmail.com).*
*** Department of Signals and Systems, Chalmers University of Technology, Göteborg SE-412 96, Sweden (e-mail: adrian.ilka@chalmers.se)*

Abstract: Law and control. For the first perception, these concepts may seem different, since the education considers law as a social science and classifies it to the so-called 'human' category, while control (from educational point of view) belongs to technical, 'real' category. However, in fact, if we deeply examine the essential functions of these concepts, we realise that law is control itself, more precisely, a control in a narrower sense. Therefore, let us try to approach the basic theory of law from a technical, control perspective. The main goals of this approach are on the one hand to change the way like students think, broaden their horizons and perceptions, bringing closer the human and the real sides as well. This way, students would gain an insight into the basics of the other discipline, discover the parallels between these concepts and learn to think more broadly. On the other hand, by using this approach, we can solve the main problems of the current legal regulation. This article deals with how to apply the outlined approach to education, indicating the possible practical application methods and future benefits.

Keywords: Law, control theory, system, regulation, cybernetics, correlation, education, study course.

1. INTRODUCTION

Nowadays, automatic control is more advanced than legal regulation. It is developing more rapidly, is effective, optimal, and may guarantee the system stability. The main idea of legal regulation is not bad, but there are many obstacles which can be solved with extensive delay or cannot be solved at all, such as frequent law changes, busyness of the courts and the authorities, delays in proceedings, lack of resources, corruption, economic crisis, poor legal public awareness, etc. The feedback is too delayed, which results in late and questionable correction. For this reason, the legal certainty is also decreasing. The legislation is not effective and cannot guarantees the expected results in acceptable quality.

In this context, the question arises whether the above mentioned problems can be solved. In our opinion the answer is yes, notably with the help of the automatic control theory. Since the legal regulation is basically a specific subset of regulation in a general sense, one can examine the general elements and aspects of the legal system and legal regulation in order to find parallels and correlations with the control theory. It is necessary to draw parallels and find synergies between the general elements of both legal and control systems. All that have to be done, is to analyze the most important definitions and terms of these systems and their subsystems, examine the interactions between them, make comparisons and find the appropriate pairs. Thereby, the legal system's elements would be translated into technical language. This allows creating control-based models. It means that it is possible to model the legal system with each its subsystems, defining its inputs, outputs and possible disturbances as well. If the model is obtained, the system behaviour can be influenced by several model-based control techniques. Using the most appropriate control technique, it is possible to reach stable and optimal system behaviour.

Realisation of this idea is challenging and time-consuming. It requires professionals who are familiar with both disciplines. However, there is a lack of them, probably due to educational dissimilarity of human and real study fields. Therefore, it is necessary to qualify such engineers and lawyers who are trained specifically for above mentioned purpose. First of all, an establishment of a general control theory course for law students is needed. It can also be considered as an optional (not compulsory) course, within which the students would get an insight into the basics of the control theory, learn to recognise the common elements of both legal and control systems, obtain technical and logical mindset and a different perspective for research. Technical universities should also create a course for their own students, which could help them learn the basics of the legal system and its regulation, get to know the legal system's specificities and the conditions required for optimal system behaviour.

The courses would be ensured by experts from the other discipline, i.e. professors or associate professors from the other university. Due to this, a scientific cooperation would form between the representatives of legal and technical studies. Later, the conditions to establish a joint research team would enhance, whose members would come from those who successfully completed the above mentioned

courses. This article serves as a basic idea, a starting point for innovative education and gives some motivation for its realisation.

The rest of the paper is organised in five sections. Introduction is followed by a theoretical background in Section 2, where the key notions are introduced from both legal and control theory side, and some preliminaries are given. The concept of legal cybernetics is described in Section 3, which is followed by some educational ideas in Section 4. Concluding remarks close the paper in Section 5.

2. THEORETICAL BACKGROUND

In order to understand correlations between law and the theory of automatic control, it is necessary to define at least the fundamental concepts of both disciplines.

2.1 Introduction to the general legal theory

Law is a social, legislative and regulatory system that is created or recognised by the state to achieve certain social objectives and to promote and protect certain general societal interests. It is a logically organised system of legal norms that are enforceable by state power (Prusák, 2001).

Based on the mentioned definitions, one can define legal norm as a universally binding rule of human behaviour, which is constituted or recognised by the state in a legally pre-determined form. The state power supervises the observance of legal norms through law-enforcement (Ottová, 2010).

Law has a specific character: normativity. It means that it regulates human behaviour by conferring rights and imposing duties or prohibitions of certain conduct. It provides normative reasons for action. These normative obligations, prohibitions and permissions are the main contents of the legal norms and are expressed in so-called disposition of the legal norm (Ottová, 2010).

A legal norm consists of three parts: the hypothesis, which sets forth the conditions under which a person should be guided by the given legal norm; the disposition, which indicates the rights and duties of the participants in relations arising under the circumstances envisioned in the hypothesis; and the sanction, which defines the consequences for persons who violate the prescriptions of a particular norm. (Prusák, 2001) It is a trichotomy of the legal norm that can be mathematically formulated (by logical operations) as follows: $A \rightarrow B \wedge \neg B \rightarrow C$, where A is the hypothesis, B is the disposition and C is the sanction. This kind of formulation of any legal norm facilitates solution of certain legal cases using automated control theories.

The most significant characteristic of law – from the perspective of the automatic control – is that it is a system. A system, which involves legal norms, legal relationships and several other elements that are in logical interaction with each other. According to the most general definition, a system is a set of entities, which are related to each other. However, these relations are in motion. The law itself is also a practical, real system, which is – as the social relations contained therein – in perpetual motion of change. Consequently, it can be considered as a dynamic system (Varga, 1979).

Thus, law is a real, dynamic system, which each element is in mutual dependence with others. The legal system is not given once and for all; it is not a done, finished system, but a continuum that is in a state of constant change. Due to the legislation process, the legal system is constantly enriched by newer and newer structures of legal norms. It results that on the one hand, the system becomes expanded by new legal norms, other structures of legal norms become modified, and on the other hand, some legal norms lose their quality and legal force (Schubert, 2014).

2.2 System and control theory – cybernetics

Cybernetics is a scientific field that investigates regulatory systems, their structures, constraints, and possibilities. It is an interdisciplinary study of the structure of regulatory systems. The essential goal of cybernetics is to understand and define the functions and processes of systems that have goals and that participate in circular, causal chains that move from action to sensing to comparison with desired goal, and again to action. Cybernetics is applicable when a system being analyzed incorporates a closed signaling loop; that is, where action by the system generates some change in its environment and that change is reflected in that system in some manner (feedback) that triggers a system change, originally referred to as a "circular causal" relationship (Wiener, 1950).

One of the most significant representatives, who used the term cybernetics, is Norbert Wiener. According to his definition, cybernetics is the art of governing (Wiener, 1948). This term is derived from the Greek word “kubernetes”, which means steersman. What is common between these concepts? The steersman disposes of multiple tools to influence the boat's direction. In order to achieve the target, the steersman intervenes in the ship's direction, choosing the most appropriate tool. His choice depends on the occurred environmental factors (wind, waves), which are variables. As it is obvious from the above mentioned explication, the cybernetic model assumes that there is a need to reduce effects, which distract from achieving the target. This process is characterised as a negative feedback.

Studies in cybernetics provide a means for examining the design and function of any system, including social systems such as business management and organisational learning, including for the purpose of making them more efficient and effective.

Cybernetics is closely related to control theory (Åström and Murray, 2012) and systems theory (Bertalanffy, 1968). Control theory is an interdisciplinary branch of engineering and mathematics that deals with influencing the behaviour of dynamical systems, which can be done by open-loop as well as by closed-loop control.

Open-loop control is useful for well-defined systems where the relationship between input and the resultant state can be modelled by a mathematical formula. A closed-loop controller uses feedback to control states or outputs of a dynamical system. In some systems, closed-loop and open-loop control are used simultaneously. In such systems, the open-loop control is termed feedforward and serves to further improve reference tracking performance. A typical control structure is shown in Fig. 1, where $y(t)$ is the system output, $\tilde{y}(t)$ is the measured output, $d(t)$ is the measurable disturbance, $w(t)$ is the reference signal, $e(t)$ is the control error, $u_{ff}(t)$ and $u_{fb}(t)$ are the feedforward and the feedback part of the control input, and $u(t)$ is the control input, respectively.

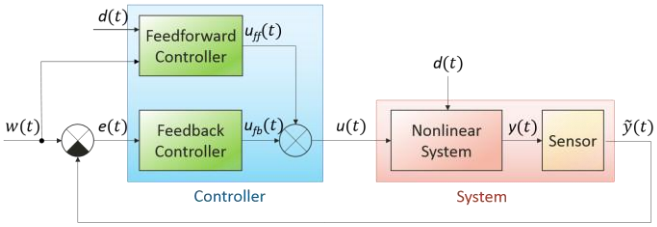

Fig. 1. Control structure with feedforward and feedback controller.

3. THE CONCEPT OF LEGAL CYBERNETICS

Since cybernetics has a transdisciplinary character, it is relevant to the study of several systems, such as mechanical, physical, biological, cognitive, and social systems, including law as well. As it has been mentioned above, the law itself is a system. Because the legal system is very complex – it has a mass of elements, subsystems, connections and interactions that are continually changing – in some cases it can be considered as a stochastic large scale system.

The idea of using cybernetic methods in the law is not new. Considerations on possible use of cybernetic methods even in the social sciences are almost contemporaneous with the widespread distribution of the term cybernetics in the middle of the 20th century (Wiener, 1950).

The researchers realised that the application of cybernetic methods within the legal field could effectively help to overcome the former information crisis. In this regard, significant research has been conducted in the USA (Black, 1984), the former Soviet Union (Kudryavtsev, 1968) and West Germany (Bossel et al., 1976), later in Poland (Wroblewski, 1972) and the former Czechoslovakia (Knapp, 1963), too. This work resulted in a creation of new scientific discipline, as a kind of synthesis of cybernetics, mathematics and jurisprudence: the legal cybernetics.

In the second part of the 20th century, a Hungarian lawyer-mathematician married couple – with their prominent research – further developed the idea of legal cybernetics. The main aim of their work was to create an appropriate scientific background for the use of cybernetic methods in jurisdiction – application of law by court (Bárdos and Bárdos, 1974). They have done several experiments on mathematical modelling of legal norms and on establishing some general schemes for solution of various legal cases as well (Bárdos and Bárdos, 1975a, 1975c, 1978, 1981; Bárdos et al., 1979). For instance, in one of their journal articles titled Experiment for Analysing Legal Cases by means of Mathematical Methods, they dealt with the determination of childcare allowance using learning algorithms (Bárdos and Bárdos, 1975b).

Since the law can be considered as a stochastic, large scale system, one can obtain an effective and optimal legal regulation by using optimal control theory on each system levels. Cybernetic methods are perfectly applicable in the following legal areas:

- Legislative process (law making), using controller design techniques (Paraschiv, 2012).
- Jurisdiction (application of the law by courts) – the main goal is to help the decision-making in various legal cases. The most appropriate cybernetic method in this regard seems to be the fuzzy logics (Dompere, 2014).
- Public administration and regional governance, where one can use mainly cybernetic methods implemented in economics and management (Popek, 2007).
- Cybernetic methods can also facilitate the legal professional's work by creating an effective computer system, which should provide an opportunity to search between acts and judicial decisions not only by key words, but by logical connections as well.

In order to successfully implement cybernetic methods in above mentioned areas, it is necessary to obtain adequate models for such systems. As an illustration, let us examine the general model of the decision-making process:

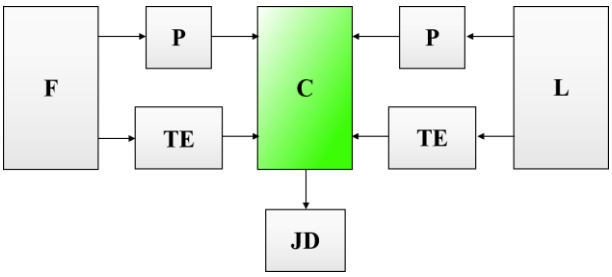

Fig. 2. General Wroblewsky's information model of the decision-making process (Wroblewsky, 1972).

Legend:
F – facts of the case with all circumstances;
C – court;
L – law, system of legal norms, case-law;
P – parties;
TE – general legal theory, judge's evaluation;
JD – judicial decision.

The judicial decision is based on all the circumstances of the case and on the relevant legal norms, which are in force.

A judge can obtain this information from two sources: a) from the parties' expressions and the evidences provided by them, b) through his or her "direct" cognitive actions.

The decision is a result of a so-called transformation (in cybernetic sense), which is carried out in a so-called black box (a court, in this case). The transformation process is determined by the judge's knowledge of the general legal theory, legal principles, as well as by his or her own internal value system. These factors are depending on the actual socio-economic situation.

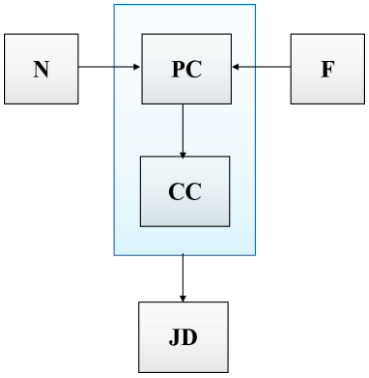

Fig. 2. The logical structure of the transformation process.

Legend:

N – relevant legal norms in force, with a specified content;
F – facts and circumstances of the given case;
PC – determination of possible legal consequences of the facts, according to the relevant legal norms;
CC – selection of concrete legal consequences of the facts;
JD – judicial decision about concrete legal consequences of the given case.

The judge's main role is to identify: a) which legal norms are relevant to the given case, b) what is the specific content of these relevant legal norms (in relation to the given case) and c) what are the legal consequences of the case. Within the judge's thinking process, these interrelated elements do not separate out from each other. This process contains logical operations on such information, which are obtained through the "TE-filter".

Based on the foregoing, the transformation process can be characterised as a determination of all the possible legal consequences based on the known relevant facts and circumstances of the given case (according the relevant legal norms) and a selection of concrete consequence(s) (that are needed to be applied in relation with the concrete circumstances).

4. SOME EDUCATIONAL IDEAS

In spite of the fact that legal cybernetics has been a research problem for decades, considerable practical progress has not been made in this area. This is mainly due to the lack of comprehensive education in this interdisciplinary field. However, the scientific community needs such researchers who are aware of both disciplines at a high level.

For this reason, we suggest a creation of study courses in both technical and legal studies, in order to qualify lawyers who have some cybernetic knowledge as well as engineers who are familiar with legal theory. This provides an excellent background for cooperation of professionals and research institutions from both disciplines.

In parallel with the spread of the study courses, a cooperating research project should begin in the field of legal cybernetics. The absolvents of the course should join to the research that would allow real, practical use of cybernetic methods in some legal areas, making them quicker, effective and optimal.

4.1 Cybernetics for lawyers

The main goal of the proposed study course is to acquaint law students with the main issues of cybernetics, control and system theory, identification, modelling and controller design approaches. The students would learn about how to model legal norms for cybernetic purposes, which kind of legal issues can be solved by cybernetic methods and what methods are the most appropriate to do so.

The purpose of this course should be to introduce the concept of dynamic systems, and to demonstrate its application to legal system. Yet another key concept is feedback and in particular the assessment of the stability of such a system. The course would teach theory and techniques for the design of both output and state feedback controllers. Feed-forward control would be addressed as well.

Possible learning outcome should be:

- Basic system theory (definitions, main objectives, history, systems, legal context),
- Determination of systems and structures (inputs, outputs, disturbances), open- and close loop systems,
- Describe and explain the most important properties of linear dynamical systems.
- Become familiar with the concept of the state-space terminology
- Understand model descriptions for linear time-invariant multivariable systems. Analyse these types of systems from the point of view controllability, observability and stability.

After completing the course, the students would be able to define the legal norm in a way that enables to be modelled for cybernetics purposes. They will be aware of the fact that the implementation of cybernetic methods to the law will not replace their jobs, but make it more easier and effective.

4.2 Legal Theory for Engineers

The principal objective of this study course should be to gain an insight into the legal theory. Students of cybernetics would learn – among others – about the following topics:

- the main purposes of law – definition of law and their objectives, history;

- fields of law – such as civil, criminal, constitutional, administrative, labour, company, financial law, etc;
- distinction between private and public law;
- legal system – continental and anglo-american legal system, their main principles;
- legal sources – legislative acts and their hierarchy;
- legal norms – especially the trichotomy of legal norms and their modelling based on logical operations;
- legal logics;
- basics of legal relationships and contractual law.

They would become aware of several legal processes, such as legislation, jurisdiction, application and interpretation of law, law enforcement, public administration and governance.

The students could compare the legal way of thinking with the cybernetic mindset and then they could recognise the interactions between law and cybernetics. After completing the course, the students would be able to conduct research in cooperation with lawyers in field of legal cybernetics. They could professionally react in case of legal interpretation and apply the controller design techniques in accordance with the requirements of law.

5. CONCLUSIONS

"Education is the most powerful weapon which one can use to change the world." /Nelson Mandela/

The main goal of this article is to introduce a scientific interdisciplinary field, legal cybernetics and to draw attention for importance of education within this area. Of course, the ideas presented in this paper, need to be studied in more detail. By this article, we would like to highlight that an adoption of legal thinking in cybernetics and cybernetic mindset in law means an advance in control education. It can facilitate the communication between lawyers and engineers, supporting their cooperation in research within legal cybernetics in order to solve the current legal problems and make the word a better place to live.

ACKNOWLEDGEMENT

This work has been sponsored by Chalmers Area of Advance Transportation, by Vinnova under the FFI project MultiMEC and by Vinnova under FFI project VCloud II.

REFERENCES

Åström, K.J. and Murray, R.M. (2012). *Feedback Systems: An Introduction for Scientists and Engineers*. Princeton University Press.

Bárdos, P. and Bárdos C. (1974). Some Principle Problems of Cybernetic Methods for Solving Legal Problems. *Jogtudományi Közlöny Budapest*, 29(5), in Hungarian, 239-245.

Bárdos, P. and Bárdos C. (1975a). Legal and Cybernetic Analysis of Legal Problems by means of Cybernetic Methods. *Jogtudományi Közlöny Budapest*, 30(1), in Hungarian, 22-30.

Bárdos, P. and Bárdos C. (1975b) Experiment for Analysing Legal Cases by means of Matematical Methods. Determination of Childcare Allowance by Learning Algorithmus. *Jogtudományi Közlöny Budapest*, 30(6), in Hungarian, 319-328.

Bárdos, P. and Bárdos C. (1975c). Application of Decision Tables for Analysing Legal Problems. *Ügyvitel és Szervezés az Államigazgatásban, Budapest* 1975(2), in Hungarian.

Bárdos, P. and Bárdos C. (1978). The Structure of Thinking in Solving Legal Problems. *Jogtudományi Közlöny Budapest*, 33(2), in Hungarian, 63-82.

Bárdos, P. and Bárdos C. (1981). Interdependances between Law and Logics. *Jogtudományi Közlöny Budapest*, 36(10), 875-875.

Bárdos, P., Bárdos C. and Gulyás, O. (1979). Principal Basis of Cybernetic Methods Applied for Solving Legal Problems. *Jogtudományi Közlöny Budapest*, 34(4), in Hungarian, 259-263.

Bertalanffy, L. von. (1968). *General System Theory: Foundations, Development, Applications*, Revised ed. New York, NY, USA: Braziller.

Black, D. (1984). *Toward a General Theory of Social Control*. Fundamentals. Studies on law and social control, Fundamentals Volume 1, Elsevier Inc, Academic Press, Florida.

Bossel, H., Klaczko, S. and Müller, N. (1976). *Systems Theory in the Social Sciences: Stochastic and Control Systems Pattern Recognition Fuzzy Analysis Simulation Behavioral Models*, Interdisziplinäre Systemforschung. Birkhäuser.

Dompere, K.K. (2014). *Social Goal-Objective Formation, Democracy and National Interest, Theory of Political Economy Under Fuzzy Rationality*. Studies in Systems, Decision and Control, Volume 4, Springer International Publishing, Switzerland

Popek, E. (2007). *Innovation interpretations, methods and the European Administrative Space.* Doctoral thesis, Eötvös Loránd Tudományegyetem, Hungary.

Knapp, V. (1963). *About the possibility of using cybernetic methods in law.* Praha, Nakladatelství Československé akademie věd. In Czech.

Kudryavtsev, V.N. (1968). *Problems of Cybernetics and the Law*. In: Law and Computer Technology, pp. 321-348, Moscow.

Ottová, E. (2010). *Theory of Law.* 3. revised ed., Bratislava, Heuréka, 189 p.

Paraschiv, C.S. (2012). A Perspective on Cybernetics Law, *International Conference on Education and Creativity for a Knowledge Based Society – LAW 2012*, Titu Maiorescu University, pp. 200-208.

Prusák, J. (2001). *Theory of Law*. 2. revised ed. Bratislava, Vydavateľské oddelenie PF UK, 188 p.

Schubert, F. A. (2014). *Introduction to Law and Legal Systems.* 11th Edition. Wadsworth Publishing, 640 p.

Varga, Cs. (1979) The Law and its System. In: *Jogtudományi Közlöny*, Budapest, 34(5), 245-254.

Wiener, N. (1948). *Cybernetics: Or Control and Communication in the Animal and the Machine*. Paris, (Hermann & Cie) & Camb. Mass., MIT Press

Wiener, N. (1950). *The Human Use of Human Beings: Cybernetics and Society*. Houghton Mifflin.

Wroblewski, J. (1972). *Computers as an aid to the judicial process*, Systema.