THE PERSPECTIVES OF SCIENTIFIC RESEARCH SEEN BY GRIGORE C. MOISIL FORTY YEARS AGO

EUFROSINA OTLĂCAN*

Motto: *"There are people whose contribution to the progress of mankind is so great that their biography is put into the shade, the life is hidden away by the work".*

(Gr. C. Moisil at the W. Sierpinski's death)

Abstract. The creation, the personality and the entire activity of the Romanian mathematician Grigore C. Moisil (1906–1973) are illustrative of the idea of universality in science and cultural integration. Moisil obtained his degree in mathematics at the University of Bucharest and became a PhD in 1929, with the thesis "The analytic mechanics of continuous systems." The three years of courses at the polytechnic school did not finalize with an engineer diploma, they only meant an opening towards the understanding of technical problems. The scientific area of Moisil's work covered, among other domains, the functional analysis applied to the mechanics of continuous media, to differential geometry or to the study of second order equations with partial derivatives. One of the most original parts of Moisil's creation is his work in mathematical logic. Within this frame Moisil developed his algebraic theory of switching circuits. By his theory of "shaded reasoning", G. C. Moisil is considered, besides L. Zadeh, one of the creators of the fuzzy mathematics. Apart from his scientific and teaching activities, Moisil was a highly concerned journalist, present in many newspapers and on television broadcasts.

Keywords: Grigore C. Moisil, mathematical creation, mathematical analysis, mathematical logic, differential geometry, physics, mechanics.

1. BIOGRAPHICAL DATA

The *History of the mathematics in Romania* (Andonie, 1966**)** in its pages dedicated to Gr. C. Moisil, describes the personality of this mathematician as being „the man of a great spiritual delight".

Grigore C. Moisil was born on 10 January 1906 in the Romanian Danubian port Tulcea. Both his parents worked in education, the father, Constantin Moisil teaching history in high school (later he became academician), the mother, Elena Moisil, being a schoolmaster, "a teacher for children between 7 and 11 years", as Grigore C. Moisil said (V. Moisil, 1998). His mother was successful in making her boy not be afraid of mathematics, she has taught him counting before writing or reading. After he attended the elementary and secondary school in Vaslui and

* University professor, Doctor in Mathematics; Romanian Committee for History and Philosophy of Science and Technology, CRIFST, Romanian Academy.

Bucharest, Moisil was admitted to the Faculty of sciences, section of mathematics, from the University of Bucharest in 1923 and became its graduate in 1927.

In parallel with his courses in mathematics, Moisil attended and passed exams at the Polytechnic of Bucharest, but never finished the engineering studies. "Between being an engineer or a mathematician, I have chosen to remain a mathematician… this meant a very serious sacrifice because at that time the university professors, the associated professors, were very poorly paid", he said.

The mathematical researches captivated him completely and so, at the age of 23, on 4 June 1929, Moisil defended with distinction his doctoral thesis in mathematics at the University of Bucharest. Soon after that, Moisil went to Paris where he stayed until 1931. Coming back to Bucharest, he remained here only to pass his "docenta" in mathematics at the University, on 1 July 1931. Moisil's study travels continued with Rome (1931 – 1932) and then Paris, where he has had a grant.

Moisil began his teaching activity on 1 November 1932, as an associate professor at the University of Iași. On 1 November 1936 Moisil became a full professor and remained in Iași till on 30 December 1941, when he was called to Bucharest, at the Faculty of Sciences of the University, to give courses of superior analysis and mathematical logic.

Between 1946 and 1948 Moisil interrupted his activity to the university and represented Romania at Ankara, as an ambassador. But even on this position, Moisil gave a series of conferences with mathematical subjects: "I wrote in a summer an important study that had consequences when I returned to country. Then I wrote a volume of mathematical logic", told Moisil in an interview in 1970 (V. Moisil, 1998, p. 33).

Back the country, Gr. C. Moisil taught a course of geometrical applications of mathematical analysis (1948–1949) at the University of Bucharest, then he was head of the department of mathematical analysis at the Institute of Geology and Mining Techniques of Bucharest (1948–1951), and taught theory of elasticity, and also as a head of department at the Faculty of Mathematics and Physics (1949–1955) in the University of Bucharest. In the same faculty Moisil was head of the department of algebra (1955–1965) and from 1965 head of computers department. From 1965 he moved his courses of mathematics at the Faculty of Law and Philosophy. In his activity of teaching, Gr. C. Moisil gave a diversity of courses, beginning with the first course of modern algebra in Romania between the years 1932 and 1942, then the courses of differential and integral calculus, geometrical applications of algebra, mathematical logic, theory of elasticity, computer programming, and ending with algebraic theory of automatic mechanisms.

Grigore C. Moisil was a member of the Romanian Academy since 1948, head of the section at the Institute of Mathematics, president of the Mathematical Society, and founded the Calculus Center at the University of Bucharest in 1962. In 1963 Gr. C. Moisil was State Prize Laureate. Abroad Moisil was a member of the Academy of Sciences from Bologna (from 1964), of the Institute of Philosophy

from Paris and member of the executive committee of the International Federation for Automatic Control –I.F.A.C. (1965), member of the Society of Mathematics of France, President of the Latin Express Mathematicians (1965–1969), member of the Academy of Sciences from Poland (1967), member of the Academy of Sciences from Messina, Italy (1968), Doctor Honoris Causa of the Academy of Sciences from Bratislava, Slovakia (1969), Metodiu and Kiril Award for scientific merits (1970). In 1971 Gr. C. Moisil was elected vice-president of the International Union of History and Philosophy of Sciences, in 1972 he became a member by correspondence of the Royal Society of Sciences from Liège, Belgium, and in 1973 member of the Association of Symbolic Logic from Oslo, Norway.

Moisil's courses and conferences took place in many university cities. We will enumerate here the years and places of some of these conferences: 1931 at Poitiers (France), 1932 at Tchernautzy (Cernăuți) (today in Ukraine), 1947 at Istambul (Turkey), 1955 at Warshawa, Wroclaw, Poznan and Torun (Poland), 1957 at Bologna, Milano, Napoli, Rome, Bari (Italy) and he returning to Italy in 1959 in order to deliver lectures in Rome, Varena and Milano on the algebraic theory of mechanisms. In 1960 Moisil's conferences took place in France (Paris, Poitiers, Grenoble), in Bulgaria at the Academy of Sciences from Sofia and in Italy (Palermo, Messina, Bologna). Then he has given a series of conferences in Poland (1962), Japan, Russia and Hungary in 1964. Moisil participated with papers in about 20 congresses and international conferences of mathematics.

Although Moisil lived in a "cold" period of international relations, the outstanding brilliance of his mind assured him the presence in impressive world institutions. Thus, Moisil was a member of the Editorial Staff of the *Journal de Mathématiques* from Paris, of *Automatisme* from Brussels, of the *International Computing Center Bulletin* from Rome.

In 1973 Grigore C. Moisil gave his last lessons at Montreal and New York and died in Ottawa, Canada, on 21 May, being 67 years of age.

During his life, Moisil wrote more than 300 papers and 20 books of mathematics, in the domains of mathematical analysis, mathematical logic, modern algebra, probabilities, statistics, applied mathematics in mechanics, electricity, algebraic theory of switching circuits, mathematical linguistic and also a lot of articles with implications in the economic life, and other fields of enlarged interest. Since 1969 he had a weekly collaboration at the review "The Economic Life" and since 1970 the column "Science and humanism" at the review "The Contemporary" in Bucharest.

2. ABOUT MOISIL'S MATHEMATICAL CREATION

Grigore C. Moisil approached successfully all the domains of pure or applied mathematics. His multi-valence for sciences manifested very early. Still as a student, between 1925 and 1926, Moisil published 13 papers in the *Bulletin of the*

Society of Students in Mathematics, in *Gazeta matematică* and in *The Mathematical Review of Timişoara*.

When Moisil was 23, he had already defended his doctoral thesis in front of a commission formed by Gheorghe Ţiţeica as president, Dimitrie Pompeiu and Anton Davidoglu, members. His thesis had as subject the analytical mechanics of continuous systems, and was published in 1929 by Gauthier-Villard in Paris, under the title « *La mécanique analytique des systèmes continues* ». Moisil applied the method of functional analysis to the systems with infinite degrees of liberty.

To illustrate the diversity of the domains in which Moisil proved great scientific creation, we quote a few titles of his conferences or papers: « *Sur la théorie des groupes infinis* » (Paris, 1929), « *Sur une classe de systèmes d'équations aux derivées partielles de la physique mathématique* » (Bucharest, 1931), « *Sur la structure mathématique des lois de la physique* » (Poitiers, France, 1931), "*The global character of laws of physics*" (in Romanian, Cernăuți, 1932), « *Sur l'intégration des matrices* » (Paris, 1932), « *Recherches sur l'algèbre de la logique. Hommage à M. Vito Volterra pour son 75-ème anniversaire* » (Iași, Romania, 1936), « *La structure mathématique de la logique* » (Bucharest, 1937), « *Sur la théorie classique de la modalité des jugements* » (Bucharest, 1938), « *Recherches sur les logiques non-chrysippiennes* » (Iași, Romania, 1940), « *Recherches sur la théorie des chaînes* » (Iași, 1941), « *Hydrodynamique plane des liquides visqueux* » (Paris, 1946), "On the decomposition of seismic waves into waves of condensation and waves of shearing" (in Romanian, Bucharest, 1950), "About the invariants of Vequa's systems" (in Romanian, Bucharest, 1954, 1955), « *Sur la théorie algèbrique des mécanismes automatiques* » (Dresda, Germany, 1955), « *Sur l'application des imaginaries de Galois à la synthèse des schémas à relais polarizes* » (Bulgaria, 1956), « *Sur l'application des logiques à trois valeurs à l'étude des schémas à contacts et relais* » (Paris, 1956), "*Teoria algebrica dei mecanismi automatici*" (Bari, Italy, 1958), « *La logique à cinq valeurs et ses applications à l'étude des circuits à fonctionnement électrique* » (Liblice, Cehia, 1959), « *Sur les functions monogènes au sens de Féodorov* » (Bulgaria, 1959), "An algebraic theory of the actual operation of relay switching circuits" (Bucharest, 1964, IFAC Symposium).

Analyzing Moisil's research, the following domains call upon our attention:

– **Functional analysis and its different applications**, especially in the analytical mechanics of continuous systems, Moisil being the first in the world that had this idea. But he used functional analysis in other domains also, such as the theory of groups which have one infinity number of parameters, the differential geometry and the mechanics of wave fields. Moisil found applications of the concept introduced by Vito Volterra whom Jaques Hadamard called "functional" in 1910. In his book "Theory of functionals" (London, 1930, pp. 182–183) Volterra mentions succinctly Moisil's functional analysis researches. Relating to the theory of infinite groups, Moisil extended their structure and Sophus Lie's theorems. Moisil's works of functional differential geometry realize the extension of Riemann's geometry of an

infinity dimensional space to the movement of continuous systems. In the undulating mechanics of wave fields Moisil proved the correspondence between a wave field and a geodesic line in a functional Riemannian variety.

– **Mathematical analysis** appears in Moisil's researches by the equations with partial derivatives, with the formula of reciprocity, the reduction of the elasticity equations, the extension of Pompeiu's monogenity of the quaternions, monogenity in Feodotov's sense. Examples of works belonging to this domain:

– *Sur les formes de Phaff à une infinite de variables*, (1930)

– *Sur l'équation* $\Delta u = 0$, (1930)

– *Sur les systèmes de M. Dirac du type elliptique*, (1930)

– *Sur les functions conjuguées de Volterra*, (1931)

– **Mathematical logic** was one of the most original parts of Moisil's creation. The researches in this domain led the mathematician to very interesting philosophical considerations about mathematics, and also to a rich activity concerning the algebraic theory of switching circuits. He was the author of 30 papers, 24 of them published between 1936 and 1943, with theoretical subject about logic and 62 papers (until 1965) which deal with the applications of the algebra and logic to the automatic mechanisms. In the works of logic, Moisil opposes a pan-mathematization to the pan-logism, his conviction being that mathematics is a science of structure, while the formal logic is a descriptive one, its principles being simple conventions in Poincaré sense. So, the mathematical thought is an irreducible form of activity of human spirit. Moisil studied the calculus of predicates in the logic with three values as a particular case of the calculus of predicates in the logic with n values. More details about the Moisil's many-valued logics will be given in a next paragraph.

We selected only a few titles of works of logic written in various periods of his life:

Among the works with theoretical results concerning the science of logic we mention:

– *La statistique et la logique du concept*, (1937)

– *Recherches sur les logiques non-chrysippiennes*, (1940)

– *Sur les idéaux des algèbres lukasiewicziennes trivalentes*, (1960)

– *Sur les logiques de Lukasiewicz à un nombre fini de valeurs*, (1964).

Among the works related to the application of mathematical logic to automates we mention:

– *Teoria algebrică a funcţionării schemelor cu contacte şi relee în mai mulţi timpi*, (1955)

– *Sur la théorie algébrique des mécanismes automatiques de certains circuits électriques*, (1957)

– *Sur l'application des logiques à trois valeurs à l'étude des schémas à contacts et relais*, (1956)

– *Les logiques à plusieurs valeurs et l'automatique*, (1961)

Algebra: in this domain Moisil has both works of scientific research and university courses. Among the papers, we choose some significant titles:

– *Remarques sur quelques types d'Algèbres non associatives*, (1934)

– *Sur les anneaux de caractéristiques 2 ou 3 et leurs applications*, (1941)

– *Sur la representation des groupes abéliens infinis de torsion*, (1941).

Fundamental books for the university mathematical education, published in Romanian, are:

– "*Course of superior algebra*" (Iași, 1935)

– "*Inele şi Ideale"* (Rings and ideals) (Bucharest, 1954).

Moisil's works of algebra and logic are naturally followed by those of the theory of finite automata (mechanisms). After a long series of articles and scientific papers, in 1959 Moisil published, in Romanian, "*Teoria algebrică a mecanismelor automate*" (The algebraic theory of automatic mechanisms) and for this book he received the State Award. The book was translated into Russian in 1963, into Czech in 1964, in English, under the title *Algebraic Theory of Switching Circuits,* in 1969. In French the book was also translated under the title *Théorie structurelle des automates finis* (Gauthier-Villard, Paris, 1967). Arnauld Kaufmann wrote in 1993 that this book contains extensions and previsions which are of the day still. In the preface of the Romanian edition (1959) Moisil wrote: "In Romania, since 1953, several mathematicians and engineers have formed a group who deals with these problems". And later, in 1969, in the English edition: "The aim of the present volume is in the main to show the contributions brought by the author and his co-workers up to August, 1st 1957". Modestly, Moisil wrote: "Fortunately, the gaps left by my technical insufficiency were filled up by the contribution of several engineers who attend a free course on the algebraic theory of switching circuits".

– **Differential geometry** is also a domain where Moisil achieved important results with his study relating the geodesics and minimum surfaces. Moisil demonstrated that in a singular Riemann's space the geodesics are represented by a differential system with m equations of second order and n-m equations of first order and second degree. Now this theorem is known as "*Moisil's theorem*" (Andonie, 1966, p. 405). As illustrations we consider the following titles:

– *Remarques sur les trajectories orthogonales d'une famille de surfaces*, (1930)

– *Sur les variétés totalement géodésiques d'un espace de Riemann*, (1931)

– *Sur les géodésiques des espaces de Riemann singuliers*, (1941).

– **Mathematical linguistics**: Moisil dealt with logical models of the language and with automatic translation from one language into another. Example: the papers "Problems risen by the automatic translation. The conjugation of verbs in Romanian" (1971) or « *Quantité et structure en linguistique mathématique* » (1960).

– **Physics, mechanics:** In this domain it is sufficient to remember Moisil's conferences: « *Sur la structure mathématique des lois de la physique* » (Poitiers, 1931),

"Global character of physics lows" (Cernăuți, 1932), and all his works which apply the functional analysis to the mechanics of waves.

– **Shaded reasoning**: One of the greatest Moisil's ideas that led to fuzzy reasoning and fuzzy theory. The French mathematician Arnauld Kaufmann, Prize "Grigore Moisil" of the Romanian Academy in 1995, considers that Grigore Moisil, together with Lotfi Zadeh, are the creators of fuzzy mathematics. Among the works treating this subject, we mention his last conference entitled « *Ensembles flous et logiques à plusieurs valeurs* ».

3. MOISIL'S MATHEMATICAL CREATION AS IT IS SEEN TODAY

The Romanian academicians S. Marcus (*Academica*, Mars 1996) and H.N. Teodorescu (Teodorescu, 1993) wrote about this aspect of the scientific inheritance of Grigore C. Moisil. We find several coordinates in the writings of the two authors regarding the impact which Moisil's creations had in the development of science in Romania and in the world. Before going into any detail, let us mention these coordinates: 1) the development of computers sciences and the extension of their use; 2) trans-disciplinary itinerary within and outside mathematics; 3) the isomorphism as a Key-concept of Moisil's thinking; 4) non-classical logics, a piece of great resistance in Moisil's work, with long distance effects; 5) the capacity to choose the structural nature of mathematics and extend this to other scientific domains, including human sciences.

We give several details about the contents of these coordinates.

1) Moisil was a true *fighter for the introduction of computers in the scientific life* in Romania. As recognition of his quality of pioneer in the domain of the knowledge and use of computers, of his remarkable contributions at the beginning of informatics, I.E.E. Computer Society of Baltimore, Maryland, USA, conferred him the "Computer Pioneer Award" in 1997 (V. Moisil, 1998, p. 213).

Moisil created the Computer Center of the University of Bucharest in 1962. This Center became the meeting place of scientists, engineers, writers, musicians, painters, critics, philosophers. Moisil was convinced that the development of informatics stimulates a radical modification of mentalities. In Moisil's thought this ought to be the development of algorithmic thinking and cognitive models and not only the learning of operation means. Academician Radu Voinea (*Academica*, Mars 1996, p. 3) quotes Moisil: "It is not so important if we import computers or we produce them in the country. It is important to train specialists who work with computers, because, as it is known, the automatic machines do not work themselves".

Gr. C. Moisil followed closely the construction of the first Romanian computer at the Institute of Atomic Physics in Bucharest, by engineer Victor Toma, and in 1955, presented at Berlin the logical project of CIFA-1. S. Marcus writes that for Moisil data processing training was the main target of Romania in this

domain in the seventies, of as many people as possible, especially young ones. "The letter sent (by Moisil) to the dean of the Faculty of Mathematics at the beginning of 1973, relating to the re-organization imposed by the development of computers imposes, is a spiritual testament" (*Academica*, Mars 1966, p.11).

2) About the *trans-disciplinary itinerary* outside mathematics, we will speak in the 4th part of this paper. Concerning the transgression practice of the branches within the mathematical sciences, we know that Moisil began in this manner his scientific life, his doctoral thesis being the application of the functional analysis to the mechanics of continuous media. The list of the over 300 works on topics of logic, modern algebra, differential equations, functional analysis, differential geometry, topology, probabilities, mechanics, electricity, automata, linguistic, theory of graphs, all these are the proof of his own multi-disciplinarity. But Moisil wanted to convey this spirit to the young generation. S. Marcus says about Moisil: "He is attracted by the articulations of some heterogeneous domains" and tells how, in 1955, at the conference of differential geometry, Moisil makes the proposal to the young generation to bring in the differential geometry the rigor of the theory of the real variable functions which constitutes the correct form of mathematical thinking" (*Academica*, Mars 1966, p.11).

3) S. Marcus argues that the *isomorphism*, understood as structural analogies between different theories, is a key-concept of the Moisilian thinking, and brings as an example the idea of chain; "it is identified in probabilities (Markov, Onicescu, Mihoc), mechanics (ergodic processes), equations with partial derivatives (Hadamard about the Huyghens principle), ordered sets and lattices (Birkhoff), logics (the concatenated character of the processes of deduction) and the graphs theory (in a moment when this was just crystallizing itself), in order to rise it (the idea) then to the philosophical significance of concept" (*Academica*, Mars 1966, p. 11).

4) About Moisil's works in the domain of no-classical logics and their echo in the world of science we must begin with the fact that Moisil realized for Lukasiewicz's logics what Boole had realized for the classical logic, namely their algebraic model, nowadays called the model of *Lukasiewicz-Moisil Algebras.* This is just the title of the monography published in Amsterdam by North Hollands Publishing House, in 1991, having as authors V. Borcescu, A. Filipoiu, G. Georgescu, S. Rudeanu. P. Pagliani in his paper entitled "*Towards a logic of rough sets systems*" (presented at the 3rd International Workshop on Rough Sets and Soft Computing, 1994) expresses his conviction that Moisil's point of view leads to a better understanding of the qualitative approach of vagueness. P. Pagliani refers to the notion of the "indiscernability" introduced by Z. Pawlak in the 80's as *rough sets*, in contrast with the quantitative approach of L. Zadeh's *fuzzy sets.* S. Marcus underlines that in his conferences on the logic of shaded reasoning (Urbino, 1972) Moisil maintains from the structure of vague sets both the imprecise aspects and the shaded ones.

The importance of Moisil's concept of s*haded reasoning* is emphasizes by the French mathematician A. Kaufmann in 1991: « *On peut affirmer qu'à la genèse de la théorie des ensembles et des structures floues se trouvent deux écoles mathématiques – l'école américaine formée autour de Zadeh et l'école roumaine formée autour de Moisil* ». Kaufmann said that Moisil was not only a mathematician, but also an engineer, endowed with a great talent, a physicist and a philosopher, and that Moisil's book « *Théorie structurelle des automates finis* » (Paris, 1967) contains extensions and previsions which are still up to date.

Many young researchers from abroad came to study with Moisil. Among them the following should be mentioned: Ivo Rosenberg from Brno, Ilon. Berczi from Szeged, A. Ghiliza from Novi-Sad, J. Chinal from Paris, D. Ponasse from Lyon, G. Vidal from Lille. Michel Dénouette, engineer from Paris, stayed 7 months in Romania to learn about the theory of automatic mechanisms. A group of researchers from the University of Bahia Blanc (Argentina) continued Moisil's researches. Professor Antonio Monteiro from this university wrote on May 15, 1975: « *nous sommes tous ici des disciples du Professeur Moisil, dont l'oeuvre est l'objet de notre plus profonde admiration* ». C. Cignoli, from the same university, entitled his doctoral thesis: *Moisil Algebras.*

But the impact of the Lukasiewicz-Moisil algebras is not only a way that leads to fuzzy theory. They play a prominent part in the mathematical morphology, a new and important domain of artificial intelligence, whose object is the mathematical modelling of the analysis of images. C. Rouse shows why mathematical morphology needs complete lattices and M. Jalobeanu proves that the Lukasiewicz – Moisil algebras are sufficient in the mathematical morphology, Hayting's algebras not being necessary (*Academica*, Mars 1966, p.11) Moisil's many-valued logics is now reclaimed by the *expert systems*. A letter written on 23 November 1989 by professor W. Ostasiewicz towards professor H.N. Teodorescu from Iași, contained the following text: "I think it would be very interesting for all to know something more about the syllogistics within the framework of multi-valued logic developed by Moisil just in 1938! This subject is now very popular among experts of expert systems, but I am afraid that no more of them know the pioneers of *inference engine*".

The important monograph *The algebraic theory of switching circuits* (Pergamon Press, 1969) followed to a long series of studies belonging to Moisil and his collaborators, this series being opened in 1953 by Moisil's book *Lecţii asupra teoriei algebrice a mecanismelor automate* ("Lectures on the algebraic theory of automat mechanisms") delivered at the ICET (Electro-Technical Research Institute). *Théorie structurelle des automates finis* was published in Paris (Gauthier-Villard, 1967) and in 1971 the Romanian Academy published a collective volume entitled *Logique – Automatique – Informatique*.

5) The fifth coordinate, i.e. Moisil's capacity to consider structural mathematics as an instrument of human sciences, will be the input for the next part of our paper.

4. MATHEMATICIAN GR. C. MOISIL AND THE WORLD OUT OF MATHEMATICS

Moisil had a strong belief that the "fundamental change which appeared in pure mathematics in the first half of our century was the passing from the mathematics of quantity to the mathematics of structure" (*Tribuna*, Cluj, 1971: V. Moisil, 1998, p. 102). So, he opened new ways in mathematical research, and also in the whole scientific research, by the introduction of the mathematical thinking in other sciences and in certain domains of arts. He thought of future and in particularly of the future of science, about which he said: "The Present is only the loading of Future with Past Potentialities". He added (V. Moisil, 1998, p. 194): "Science is not good today if yesterday it didn't think of tomorrow". Again Moisil said: "The spirit of modern mathematics is based on mathematical logic, mathematical linguistics, the study of formal systems and on abstract algebra" (interview, 1970, V. Moisil, 1998, p. 38). About logic, he said: "Logic today is not only an opportunity for philosophy, but an important instrument which people must learn to use." (V. Moisil, 1998, p. 79).

Especially after 1959 Moisil became interested in humanities, such as history, archeology, music, graphic arts, medicine, law. He became the core of various work groups. Professor Moisil spared no effort to popularize mathematics; he talked to pupils in secondary schools, gave conferences and interviews, wrote articles in newspapers and magazines, appeared in radio broadcast and TV-shows. So Moisil became "a charismatic figure of Romanian science and, paradoxically, a TV-star". (V. Moisil, 1998, p. 213).

The penetration of mathematics in human sciences follows two channels: one channel is based on capacity of structural mathematics to create models; the other channel is characterized by the necessity to introduce computers to be used by experts in various sciences. Moisil names additional domains where mathematics is used, besides physics and engineering. Moisil himself brought important contributions to these scientific branches. The following domains are only some few examples: economy, biology, medicine and pharmacy, archeology, linguistics.

Moisil considered the degree in which mathematics penetrated in the sciences of his time and referred to the future, analyzing every situation:

The problems of economy which found mathematical solutions are well determined under the titled of "Mathematical economy", with its chapter of transports, programming (linear, pseudo-linear, Boolean, dynamical), theory of stocks. Moisil said in 1971, in his conference at Lincei, in Italy, that the trend in mathematical economy is characterized by: « *…la creation d'une nouvelle branch de l'économie mathématique, la programmation pseudo-booléenne, qui résout les problèmes économique dont les inconues ne sont pas des nombres, mais des decisions: oui ou non. Elle diffère de la théorie de la décision qui est fondée sur la probabilité de la réussite* ».

Mathematical biology will become a well and unitary constituted science, but untill now only problems of neuro-cybernetics are formulated. Algebraic theory of finite automata could be applied to the neural circuits. "Cybernetics will be the meeting place of biology and mathematics".

In medicine and pharmacy the methods of probabilities and statistics conducted to a lot of conclusions about diseases, diagnosis, treatment, Mendel's genetics. Computers will help the medical activities increasingly.

In archeology some mathematical methods are already used.

In mathematical linguistics the theory already has been structural, therefore pre-mathematical (Moisil, 1970, [3], p. 48). The future of linguists and historians need the theory of classifications. Mathematical methods will be used to recognize the style in literature and art and also the authorship of a work of art.

A mathematical psychology, that is at the same time a cybernetic pedagogy, will benefit from the mathematical theory of learning and from the automata to realize self-learning.

But not only humanities gain by use of mathematics, mathematics itself derives advantages from culture. Moisil said in 1968: "…mathematics is a science whose concepts are too breakable, too dry, too precisely limited. The disciplines of life and society, of human thinking, are fluid disciplines, with some flexibility, with concepts that are not clearly defined, but which are able to include things less strictly delimited than a mathematical definition does it".

This manner of understanding the world of shades between *yes* and *no*, where there are so many *perhaps*, "a certain essential lack of precision, ineffably linked to humanism", led Moisil to his shaded logic (*floue logique*, *logica nuanţată*).

H.N. Teodorescu (Teodorescu, 1993) found three periods in the development by Moisil of his concept of shaded logic: 1) till 1945, when he had a semantic search for the "third truth value", in parallel with mathematical development; 2) 1956–1965, when Moisil applies the many-valued logic to the diagrams (schemes) with automata, relays, transistors; now he finds a technical sense to the intermediary values of truth; 3) after 1965, at the same time with the publishing of Zadeh's works, Moisil found a common linguistic sense, but it is his own sense, for the intermediary values of truth, namely the sense of *shaded* (*nuanţat* in Romanian, *nuancé* in French).

Moisil considered that media should be engaged in the scientific life, and said: "It is an incontestable fact that the television plays a part in establishing the contact between the men of science and the rest of the population".

The Romanian philosopher Constantin Noica wrote in May 1977 (V. Moisil, 2002, p. 364): "We need someone like him who, with his priorities, should contribute essentially to the introduction of novelties of our century into our scientific and humanistic culture, and to increase the number of novelties with his share. We needed someone to show us the extraordinary assault taken by mathematics on the culture of our days, reminding us, as he did, that "whenever limits of mathematical knowledge were indicated, they were surpassed".

In 2007, Romanian Academy Publishing House released the homage book "*Grigore C. Moisil şi continuatorii săi – Grigore C. Moisil and his followers*", volume coordinated by Afrodita Iorgulescu, Solomon Marcus, Sergiu Rudeanu, Dragoş Vaida.

We shall finish this paper about a great scientist with his words, written in January 1973, four months before he died: "I do not make confidences; you understand that a scientist who cannot sense the poetry, the novel, generally the literature, the essay and other arts, will give you the impression he is a crippled person" (V. Moisil, 1998, p. 129).

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