Nicolae Manolescu (1907–1993)

Theodor Ionescu

Abstract Nicolae Manolescu is the founder of the Romanian school of Mechanism and Machine Science (MMS) and one of the IFToMM founders.Through his extensive scientific activity, he approached numerous MMS topics but, above all, he carried out studies on the numerical, structural and kinematic analysis and synthesis of the plane kinematic chains and of various degrees of mobility mechanisms, as well as on the kinetostatic and dynamic analysis of mechanisms. Throughout his entire activity he promoted MMS at national level and essentially contributed to the worldwide recognition of the Romanian school of MMS.

Biographical Notes

Nicolae Manolescu was born on 11 April 1907 in Adjudul Vechi, a small town in the eastern part of Romania as the second son of Ion Manolescu, a railway employee, and Ecaterina, housewife.

He began primary school in 1913 in his home town and continued his education in Focsani, a town with a rich cultural tradition. After leaving the secondary school in 1926, he entered the Polytechnic School in Timisoara at which, in 1931, he took a graduate degree in electromechanical engineering.

Completing military service in 1932, he began his engineering career at the Braila town Municipal Works and, after a time, he moved to the CFR (Romanian State Railways) where he held several technical and managerial positions between 1932 and 1956.

Although he had worked as an assistant lecturer during his last year at Timisoara Polytechnic School and delivered lectures at the Military College, the year 1949 marked the beginning of his long-standing, complex university career.

T. Ionescu (✉)
CFR – Romanian State Passenger Railways, Bd, Dinicu Golescu 38, 010873, Bucuresti, Romania
e-mail: theodor.ionescu@cfr.ro

M. Ceccarelli (ed.), *Distinguished Figures in Mechanism and Machine Science: Their Contributions and Legacies, Part 2*, History of Mechanism and Machine Science 7,
DOI 10.1007/978-90-481-2346-9_7,

Between 1949 and 1959, he was an academic at the Railways Technical Institute of Bucharest and at the Oil and Gas Institute of Bucharest (1950–1958). Combining research with teaching, Nicolae Manolescu climbed the academic ladder through hard work, professional competence and complete dedication.

In 1956, he joined the Polytechnic Institute of Bucharest. His rich technical and scientific culture enabled him to also offer courses in the domains of Strength of Materials, Machine Parts, Dynamics of Railway Vehicles, Thermotechnics, Mechanics, Mathematics.

Professor Manolescu got his Ph.D. degree in MMS in 1969 with a comprehensive work "Contributions to the Numerical, Structural and Kinematic Synthesis of Assur Groups, of Kinematic Chains, of Mechanisms and of Articulated Plane Motor-Mechanisms". In recognition of his overwhelming activity, he was conferred in 1971, with the scientific title of "Doctor Docent" in the field of Mechanism and Machine Science.

Endowed with a prodigious memory and a remarkable working power, he fully engaged himself in guiding younger colleagues and subordinates, conducting research and doctoral theses, contributing to national and international technical journals, lecturing at world famous technical universities, organizing and taking part in symposia, conferences and congresses. He also held the Chair of Mechanism and Machine Theory between 1962 and 1972 and was the Dean of the Transportation Faculty of the Bucharest Polytechnics between 1958 and 1972. He also acted as a technical adviser to the Ministry of Transportation.

As a consulting professor, he continued to carry out academic teaching, doing research and managing the Romanian branch of IFToMM from 1972 until his death in 1993.

Figure 1 presents Professor Nicolae Manolescu addressing the audience at his 80 years anniversary in 1987.

Nicolae Manolescu crowned his lifetime's scientific and technical activity by his election in 1991 as a corresponding member of the Romanian Academy.

A great promoter of MMS in Romania and in the world, he was one of the IFToMM founders and an active member of the IFToMM Technical Committee for Linkages and Cams and of the IFToMM Permanent Commission for Standardization of Terminology. He was the founder of the Romanian branch of IFToMM, e.g. the Romanian Association for the Theory of Mechanisms and Machines (ARoTMM) and held its chair for a long period. It was he who initiated the "SYROM" International Symposium on Theory and Practice of Mechanisms, within IFToMM, which has taken place in Romania every 4 years since 1973, bringing together world MMS personalities and promoting their activities and works.

The results of his studies and research can be found in many courses, academic books and treatises on MMS, in more than 150 articles in technical journals, and more than 120 papers at national and international conferences and congresses.

In his private life, Professor Manolescu had a great tragedy, loosing his first wife and his two children, in the Second World War bombardments in 1944.

He died on 10 October 1993 as a tragic consequence of a car accident.

Fig. 1 Nicolae Manolescu in 1987, addressing the audience at his 80 years anniversary (Author's photo archive)

List of Main Works

Here are some of his main works:

- Books/Courses/Treatises (in Romanian): "Theory of Mechanisms and Machines", 1955; "Theory of Mechanisms and Machines. Kinetostatics and Dynamics", 1958; "Collection of Problems in Mechanism and Machine Theory ", 1963; "Collection of Problems in Mechanism and Machine Theory", 1968; "Theory of Mechanisms and Machines", 1972.
- Doctoral thesis (in Romanian): "Contributions to the numerical, structural and kinematic synthesis of Assur Groups, of kinematic chains, of mechanisms and of articulated plane motor-mechanisms", 1969.
- Papers/articles (in Romanian) : "On the mechanisms made up of different family kinematic chains", 1961 ; "Structural synthesis of plane articulated kinematic chains with 10 elements, 13 kinematic pairs, and degree of freedom L = 4", 1969.
- Papers/articles (in English or French): "Sur la détermination du degree de mobilité des mecanismes", 1963; "Une methode unitaire pour la formation des chaines cinematiques et des mecanismes plans articules avec differents degrés de liberté et mobilité", 1964; "Systematisation et classification des mécanismes – moteurs plans articules, a deux degrés de mobilite '*total*', (M = 2) et '*partial*', (M = 2)", 1965; "The methods of formation of Assur groups function of the number of loops (Zg) and of the rank of links (J)", 1966; "Structural

synthesis of plane kinematic chains with multiple joints and five degrees of freedom $L_3 = 5$ '*total*', $L_3 = 5$ '*partial*' and $L_3 = 5$ '*fractional*'", 1967; "Structural and kinematic synthesis of plane driving-mechanisms with multiple joints and two degrees of mobility: '*Total*' $M_3 = 2$ and '*Partial*' $M_3 = 2$", 1968; "For a united point of view in the study of the structural analysis of kinematic chains and mechanisms", 1968; "Criteria of forming the plane jointed mechanisms with multiple joints and simple links with e = 11 links and $M_3 = 2$ degrees of mobility '*partial*', '*partial-total*' and '*fractional*'", 1971; "La détermination des variants indépendante des fermes Baranov avec e = 9 élements en utilisant la méthode de graphisation inverse", 1971; "The method of determination of the number of structural kinematic variants of KCsj by joints simplifying", 1971; "A method based on Baranov trusses and using graph theory to find all the planar jointed kinematic chains and mechanisms", 1973; "La comparaison des chaines cinématiques et des mécanismes au point de vue structural a l'aide de la théorie des graphes", 1975; "The unitary method of structural synthesis of all the planar jointed Kinematic chains (KCmjsl)", 1979; "A unified method for the formation of all planar jointed kinematic chains and Baranov trusses", 1979; "La formation des fermes Baranov avec $L_3 = 0$ et 1 a l'aide de la méthode unitaire elaboree pour les chaines cinématiques plans articulees", 1981; "The history of the original methods used in the synthesis of the planar kinematic chains with different degrees of freedom (liberty)", 1988; "L'état actuel du nombre des variants nonisomorphes des chaines cinematiques plans avec articulations multiples et éléments simples (CCpames) et e = 12, $C_5 = 16$ et $L_3 = 4$ degres de liberte", 1989; "Sur la synthese structurale des chaines cinématiques plans avec articulations multiples, $L_3 = 6$ degrés de liberte et e = 8 et 10 elements simples (CCpames)", 1989; "The planar initial jointed kinematic chain", 1993; "L'histoire de l'optimisation de la synthèse des chaines cinématiques plans articulés avec differentes degrés de liberté", 1993.

Review of Main Works

Looking back at the life and work of Manolescu, we have to notice his vast scientific and pedagogical activity concerning mechanisms and machines and, at the same time, his total commitment to engineering. His studies and research were essential for understanding and solving many difficult problems related to the practice of mechanisms and machines in industry and transportation.

As it would be unrealistic and practically impossible to present his lifetime activity within these few pages, we are going to give a concise selection of his most interesting scientific topics.

Concerning the mobility degree of mechanisms, Manolescu extended the original Ozol formula to

$$M_f = \sum_{m=f+1}^{5} (6-m)\,c_m - (6-f)Z, \tag{1}$$

where Z is the number of independent cycles of the mechanism, c_m the number of kinematic pairs of class m, $f = (6 - b)$ – family of the space in which a free element has b degrees of freedom, M the degree of mobility of the mechanism of family f.

Manolescu also established methods for determining the family f of a mechanism by exploring the joining conditions of the kinematic elements and/or by identifying the Assur groups making up the mechanism, thus facilitating the Dobrovolski formula application:

$$M_f = (6-f)n - \sum_{m=f+1}^{5} (m-f)\,c_m \tag{2}$$

where n is the number of kinematic elements.

Figure 2, from Manolescu et al. (1972), presents, for exemplification, the structural scheme of a steam locomotive's distribution mechanism with 14 links and 20 kinematic pairs and, in conformity with relation 2, a degree of mobility $M = 2$. This is also obvious when considering the Assur groups composing this mechanism: dyads (2, 3), (4, 5), (12, 13) and a double triad (6, 7, 8, 9, 10, 11) and the remaining two driving elements : links 1 and 14.

Manolescu considered the problem of structural and numerical synthesis of the plane kinematic chains with simple elements and simple and multiple joints and of the derived mechanisms, as well, which are fundamental for the study of mechanisms structure, kinematics and kinetostatics. Consequently, his studies and research in this domain were developed throughout his entire life, the prominent results and gains being discussed in many papers and communications.

The purpose was to elaborate an optimized methodology for the structural synthesis of planar-jointed kinematic chains (PJKC), capable of delivering all kinematic chains which were able, in their turn, to generate all existing plane mechanisms. A lot of scientists strived to achieve this objective, among whom were Crossley, Kurt Hain, Woo, Kiper, Schian, Mruthyuniaya, Hwang, Rao, but Manolescu played the major role in elaborating it.

These configurations, being of greatest interest from the theoretical point of view, unfortunately may not be found, in their integrality, to be viable and applicable in the real practice of machines and mechanisms.

In his research, Manolescu introduced new concepts and definitions, such as motor mechanism (MM) – a mechanism with a driving element; initial mechanism (IM) – a mechanism made up of fixed and driving elements; Assur group (AG) – a subsystem in the componence of a mechanism, characterized by a degree of mobility $M = 0$; degree of mobility "*total*" – when the movements of all driven elements depend simultaneously on the movements of all driving elements; degree of mobility "*partial*" – when the movements of the driven elements do not depend simultaneously on the movements of the driving elements; degree of mobility "*fractional*" – when

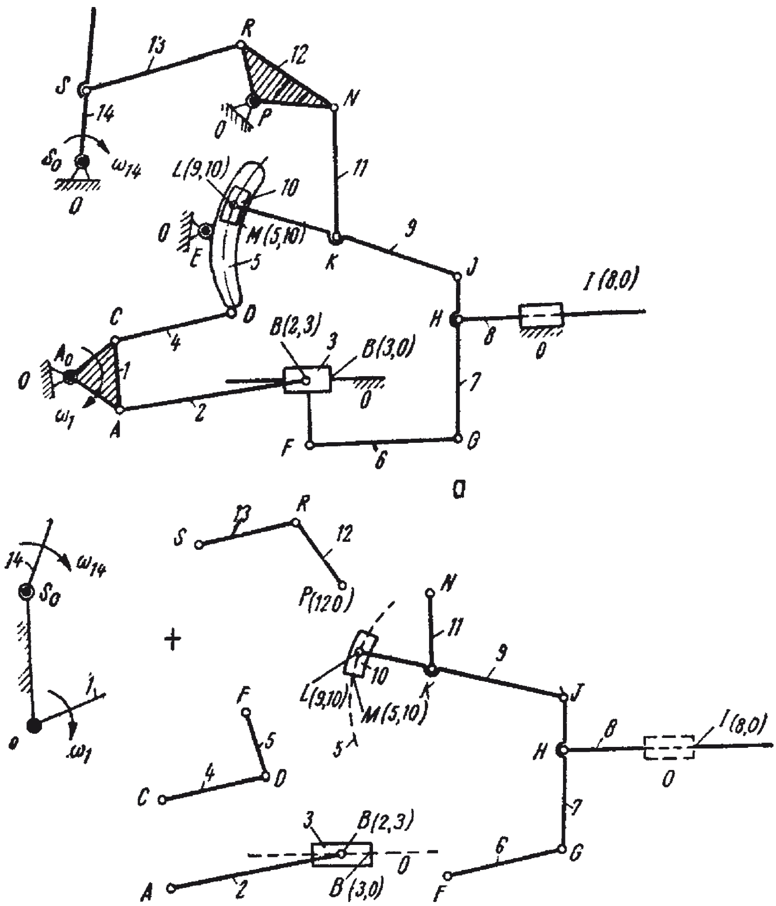


Fig. 2 The steam locomotive distribution mechanism (Manolescu et al. 1972)

there are some driven elements whose movements do not depend on the movements of all driving elements; Baranov truss (BT) – a closed (overconstrained) kinematic chain, which by loosing an element give birth to a corresponding Assur group; graphisizing operation(G) – transforming a structural scheme of a kinematic chain into a graph; inverse graphisizing operation (G) – transforming a graph into a structural scheme of a kinematic chain; joints simplification (JS)- transforming a multiple kinematic pair into several simple kinematic pairs; amplification with *dyads* (AD) – connecting Assur groups of the "*dyad*" type to a kinematic chain.

Figure 3, Manolescu (1964), shows the generation of planar-jointed kinematic chains, using Assur groups and leading to mechanisms with a degree of mobility *"total"* (a), *"partial"* (b) and *"fractional"* (c). These aspects were taken into consideration by many researchers such as Cebisev, Gruebler, Kraus, Crossley and Kurt Hain, who initially proposed the terms *" total"* and *"partial"*.

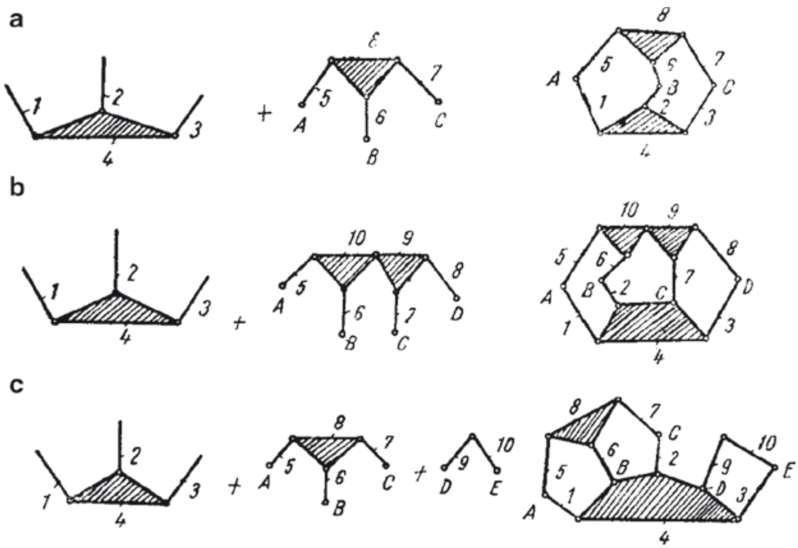


Fig. 3 Generation of planar jointed kinematic chains with a degree of freedom "total", "partial" and "fractional" (Manolescu 1964)

All these concepts of Manolescu are widely used now by the MMS Romanian school and also by many other scientists and researchers in the MMS field.

Over time, Prof. Manolescu developed and experimented several methodologies for the structural and numerical synthesis of kinematic chains and mechanisms. He used them comparatively on sample cases, even combining them and, eventually, arriving at his own conclusions upon their particularities and advantages/disadvantages. He was permanently struggling to improve them, with the declared intention of discovering all the (possible) existing configurations of planar jointed kinematic chains.

A first methodology is based on Assur groups. The plane kinematic chains of a given degree of freedom are obtained by successively amplifying an initial chain (of the same degree of freedom) with Assur groups, until the achievement of the considered number of kinematic elements and kinematic pairs. Finally, the solutions are selected from pre-established criteria and only the distinctly nonisomorphic configurations are retained.

With regard to mechanisms, Fig. 4. in Manolescu, Environment and Planning (1979), presents Manolescu's vision of the two methodologies used for the formation of planar driving mechanisms (PDM) : the methodology based on Assur groups – dyad, triad, tetrad (columns 1–3) and the classical methodology (Reuleax 1876), by defining the fixed link of a planar-jointed kinematic chain and then the driving link (columns 5, 4, 3).

A second methodology developed by Prof. Manolescu is derived from Baranov trusses amplified by nonassuric groups. This was used mostly as a comparative and verifying methodology and gave way to a third and more elaborated methodology,

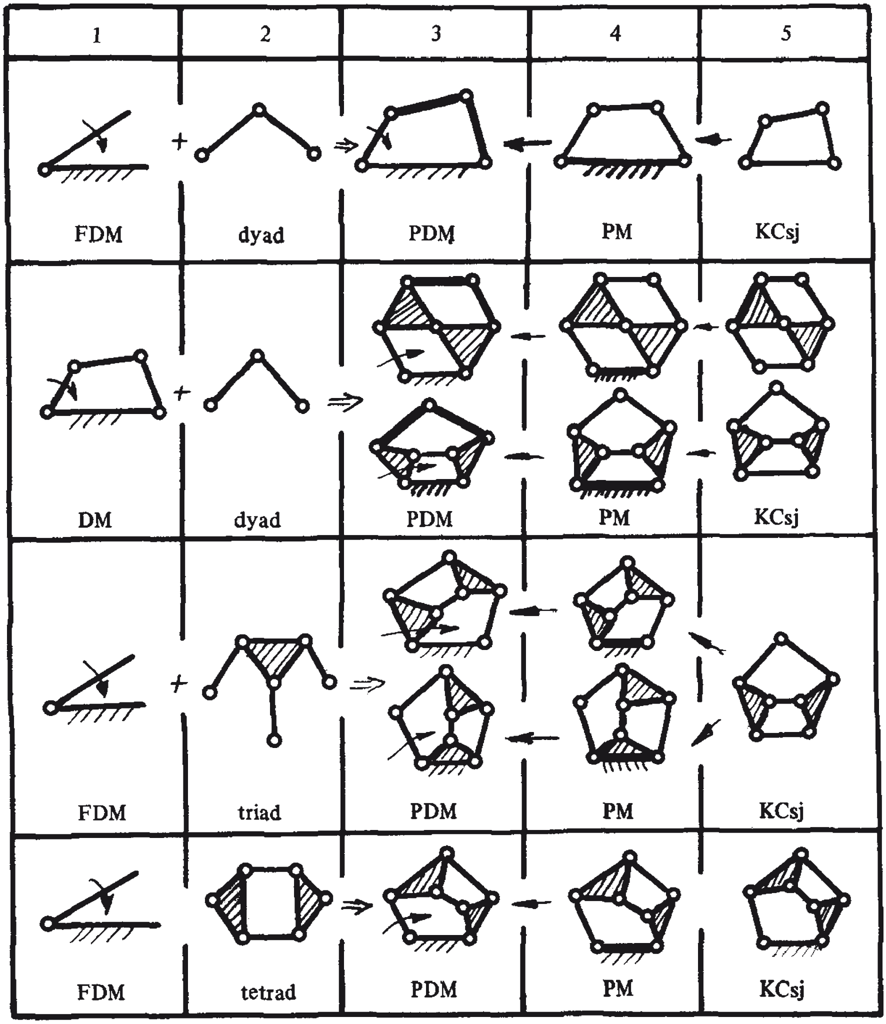


Fig. 4 Two methods of formation of planar-driving mechanisms (Manolescu, Environment and Planning B 1979)

based on graph theory. The graph theory takes into consideration the associated graph of a planar jointed kinematic chain (PJKC). This associated graph has knots corresponding to the kinematic chain elements and, simultaneously, the lines corresponding to the kinematic pairs.

An example for obtaining "Stephenson" and "Watt" planar-jointed kinematic chains from a Baranov truss with five elements by the successive operations of graphisizing (G) and joints simplification (JS), is shown in Fig. 5, by Grecu (2007).

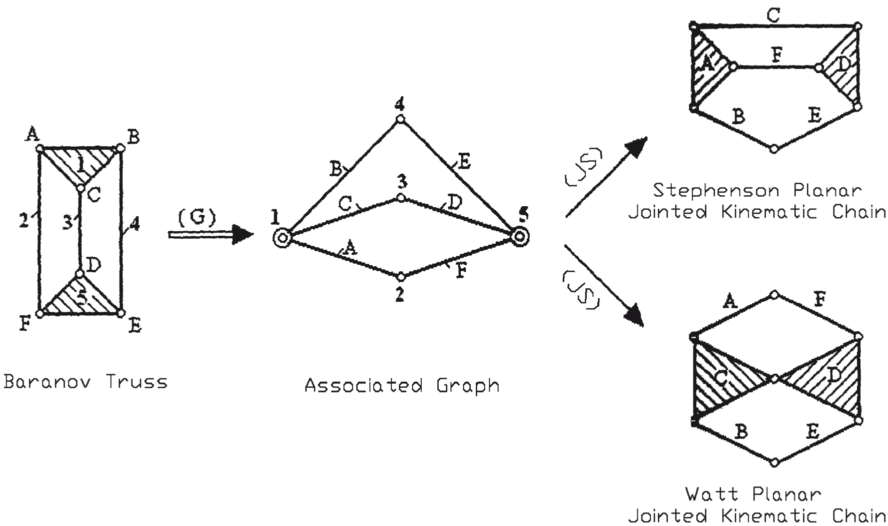


Fig. 5 Generation of “Stephenson” and “Watt” planar jointed kinematic chains from the Baranov truss by (G) + (JS) operations (Grecu 2007)

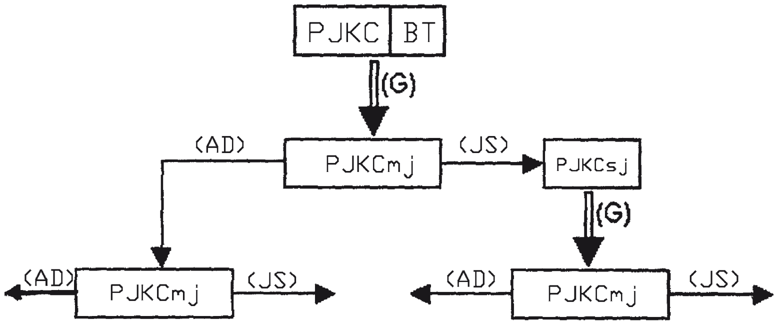


Fig. 6 The basic algorithm of Manolescu’s structural synthesis Methodology (**a**) Manolescu et al. (1972); (**b**) Grecu (2007)

By noticing that the associated graph of a planar-jointed kinematic chain (or Baranov truss) can itself be considered a planar-jointed kinematic chain with multiple joints (PJKCmj) (see Fig. 5.), Manolescu delivered his ultimate structural synthesis methodology based on the combination and multiple use of operations of graphisizing (G), joint simplification (JS) and amplification with *dyads* (AD). The basic algorithm of this methodology is presented in Fig. 6. by Manolescu et al. (1972) and by Grecu (2007).

Starting from a planar-jointed kinematic chain (PJKC) or Baranov truss (BT), by the graphisizing operation one comes to its associated graph, which in its turn can be considered a planar jointed kinematic chain with multiple joints (PJKCmj). By applying the operation of joints simplification (JS), we come to another planar-jointed kinematic chain with simple joints (PJKCsj), of the same degree of freedom; or, by applying the operation of amplification with *dyads* (AD), we come to another different planar-jointed kinematic chain with multiple joints (PJKCmj) with more elements but with the same degree of freedom.

The process can be continued by repeatedly applying, in an arborescent manner, these operations of graphisizing (G), joints simplification (JS), amplification with *dyads* (AD), thus getting several new solutions of planar-jointed kinematic chains with even more elements.

By this methodology, Manolescu was able to verify the computer-aided solutions obtained by researchers in India and Taiwan and to achieve his goal of discovering all the existing configurations. The methodology can be also extended to the study of kinematic chains with superior kinematic pairs, cams, cylindrical gears, etc.

In his last studies, Manolescu introduced the concepts of "planar initial jointed kinematic chain" (PIJKC) and "planar initial jointed kinematic chain with simple links" (PIJKCsl).

The following tables are relevant for these concepts and express some of Manolescu's last published achievements.

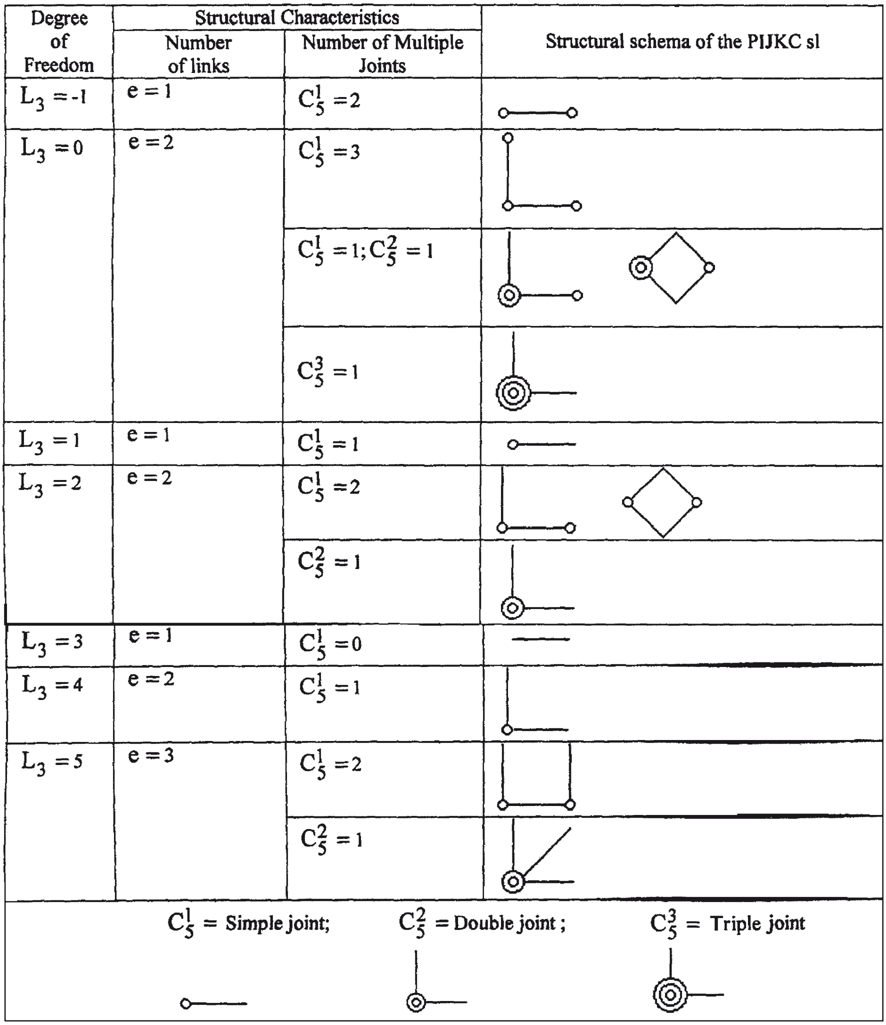
Figure 7, from Manolescu (1993) and also Grecu (2007) presents the nonisomorph variants of planar initial jointed kinematic chain with simple links-PIJKCsl.

In Figure 8, of Manolescu (1993), are shown the generation of planar-jointed kinematic chains with simple links, multiple joints and degree of freedom $L = 4$.

In Figure 9, of Manolescu (1993), the generation of planar-jointed kinematic chains with simple links, multiple joints and degree of freedom $L = 5$ is explained.

Figure 10, of Manolescu (1993), shows the generation of planar-jointed kinematic chains with simple links, multiple joints and degree of freedom $L = 6$.

Professor Nicolae Manolescu definitely left his mark upon the Romanian school of mechanisms and machines. His studies and findings are fundamental to the further development of MMS in Romania and abroad. For hundreds of polytechnics graduates, he will be remembered as a great teacher, an innovative, sympathetic and creative one. His life and dedicated work are, above all, an inspiration for all of us who knew him and have read his works. Figure 11 shows Professor Nicolae Manolescu with some of his pupils and collaborators at his 1992 anniversary at Bucharest Polytechnic Insituitute.



Degree of Freedom	Structural Characteristics: Number of links	Structural Characteristics: Number of Multiple Joints	Structural schema of the PIJKC sl
$L_3 = -1$	$e = 1$	$C_5^1 = 2$	
$L_3 = 0$	$e = 2$	$C_5^1 = 3$	
		$C_5^1 = 1; C_5^2 = 1$	
		$C_5^3 = 1$	
$L_3 = 1$	$e = 1$	$C_5^1 = 1$	
$L_3 = 2$	$e = 2$	$C_5^1 = 2$	
		$C_5^2 = 1$	
$L_3 = 3$	$e = 1$	$C_5^1 = 0$	
$L_3 = 4$	$e = 2$	$C_5^1 = 1$	
$L_3 = 5$	$e = 3$	$C_5^1 = 2$	
		$C_5^2 = 1$	

C_5^1 = Simple joint; C_5^2 = Double joint; C_5^3 = Triple joint

Fig. 7 The nonisomorph variants of planar initial jointed kinematic chain with simple links (**a**) Manolescu (1993); (**b**) Grecu (2007)

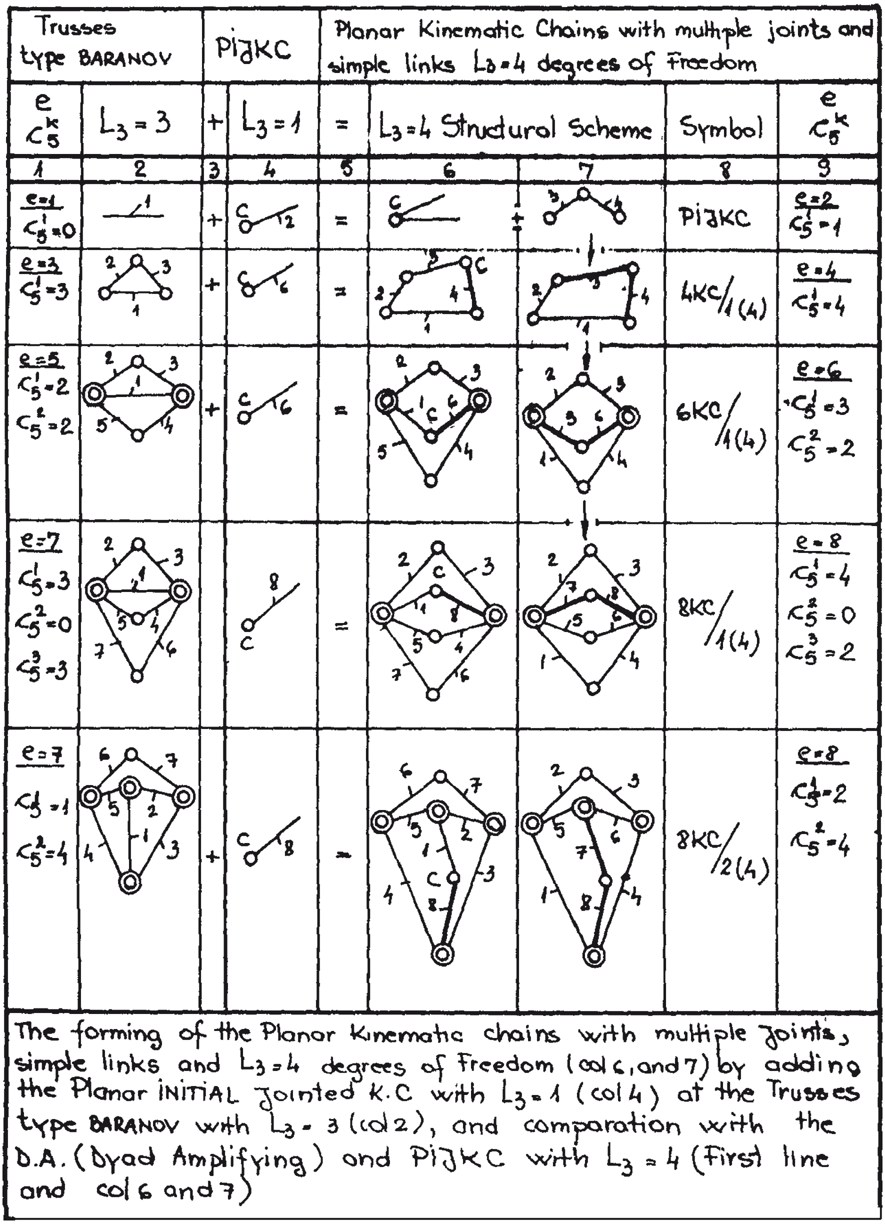


Fig. 8 The generation of planar jointed kinematic chains with simple links, multiple joints and degree of freedom L = 4 (Manolescu 1993)

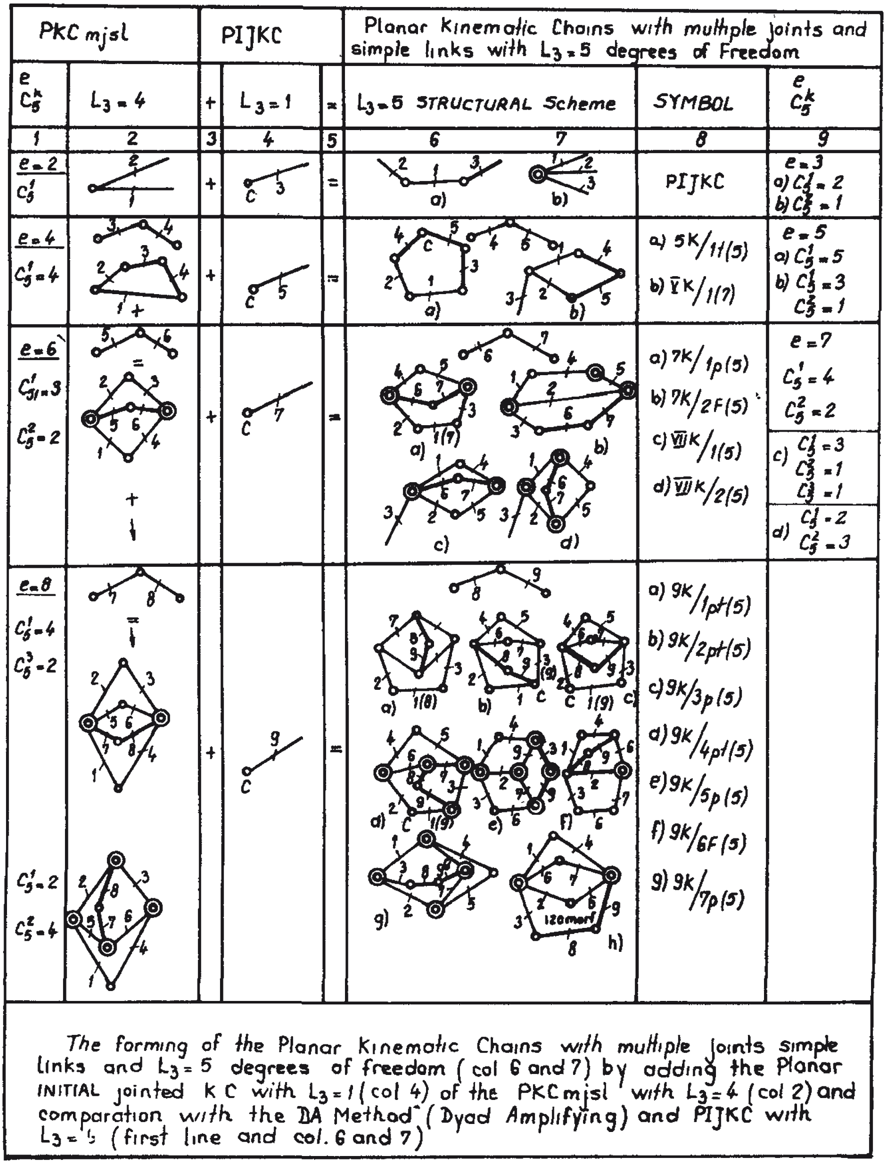


Fig. 9 The generation of planar jointed kinematic chains with simple links, multiple joints and degree of freedom L = 5 (Manolescu 1993)

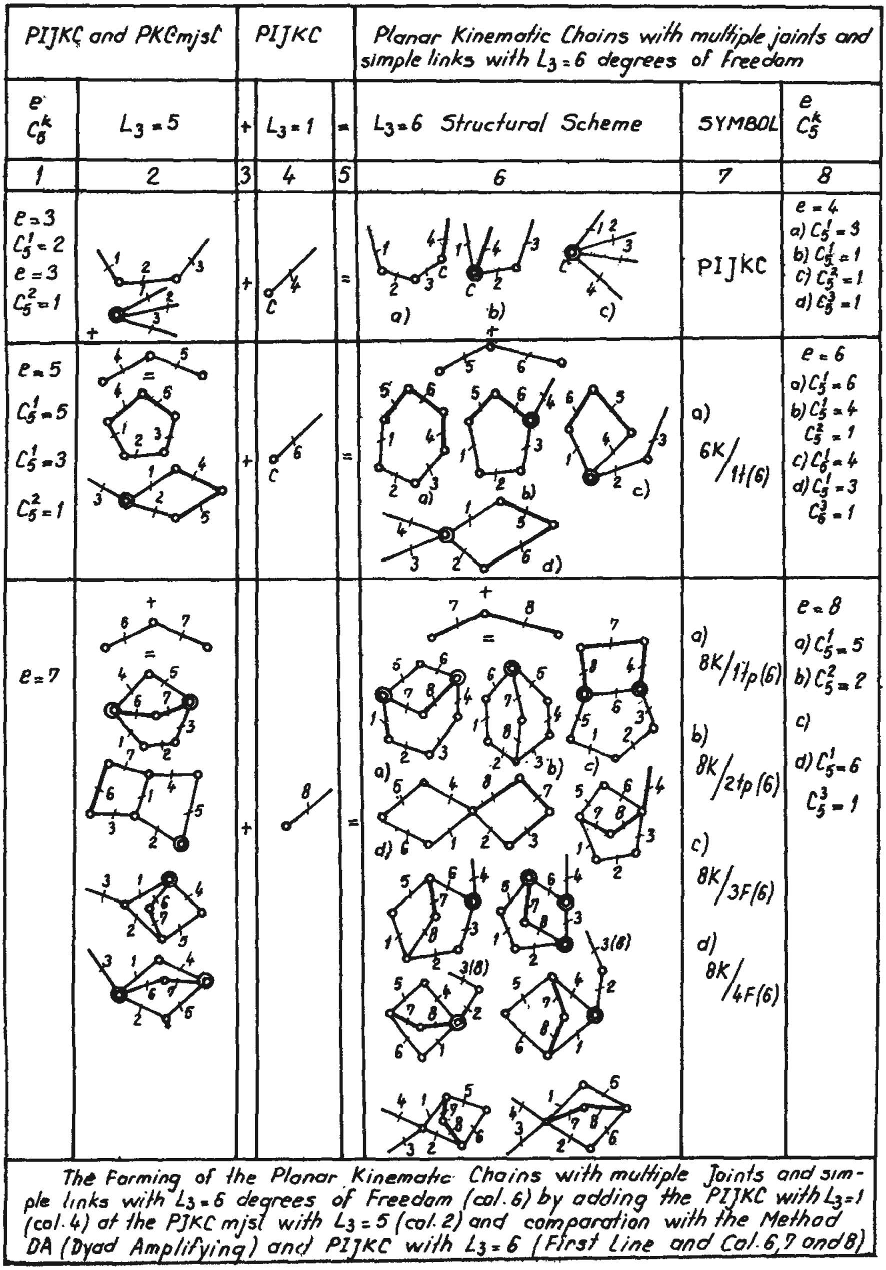


Fig. 10 The generation of planar jointed kinematic chains with simple links, multiple joints and degree of freedom L = 6 (Manolescu 1993)

Fig. 11 Nicolae Manolescu at his 1992 anniversary at Bucharest Polytechnic Institute, chair of Mechanisms and Machines (flanked, from left to right, by S. Cononovici, A. Lascu, F. Duditza and R. Bogdan, T. Ionescu, P. Alexandru, B. Grecu, F. Nitzu, I. Tempea) (Author's photo archive)

References

Manolescu N (1955–1956) Theory of mechanisms and machines, vol 1–4. Litografia I.C.F., Bucuresti (in Romanian)

Manolescu N, Maros D (1958) Theory of mechanisms and machines. Kinetostatics and dynamics. Editura Tehnica, Bucuresti (in Romanian)

Manolescu N et al (1963) Collection of problems in mechanisms and machines theory, vol 1. Editura Didactica si Pedagogica, Bucuresti (in Romanian)

Manolescu N et al (1968) Collection of problems in mechanisms and machines theory, vol 2. Editura Didactica si Pedagogica, Bucuresti (in Romanian)

Manolescu N, Kovacs F, Oranescu A (1972) Theory of mechanisms and machines. Editura Didactica si Pedagogica, Bucuresti (in Romanian)

Manolescu N (1961) On the mechanisms made up of kinematic chains of different families. Studii si Cercetari de Mecanica Aplicata, XII, nr. 3. Bucuresti, pp 589–615 (in Romanian)

Manolescu N, Manafu V (1963) Sur la détermination du degré de mobilité des mécanismes. Buletin Institut Politehnic Bucuresti, XXV, nr. 5, Bucuresti, pp 45–66

Manolescu N (1964) Une Methode Unitaire pour la Formation des Chaines Cinématiques et des Mécanismes Plans Articules avec differentes Degrés de Liberté et Mobilité. Revue Roumaine Science et Technique, serie de Mecanique Appliquee, IX, 6, Bucuresti, pp 1263–1300

Manolescu N (1965) Sistematisation et Classification des Mecanismes-Moteurs Plan Articules a deux Degrés de Mobilite "total" ($M_3 = 2$), et "partial" ($M_3 = 2$). Revue Roumaine Science et Technique, Serie de Mecanique Appliquee, X, 4, Bucuresti, pp 999–1042

Manolescu N, Antonescu P, Erceanu I (1966) The methods of formation of Assur Groups function of the number of loops (Zg) and of the rank of links (J). Buletin Institut Politehnic Bucuresti, XXVIII, nr. 3, Bucuresti, pp 59–83

Manolescu N, Tempea I (1967) Structural synthesis of plane kinematic chains with multiple joints and five degrees of freedom $L_3 = 5$ "total", $L_3 = 5$ "partial" and $L_3 = 5$ "fractional". Revue Roumaine Science et Technique, Serie de Mecanique Appliquee, XII, 5, Bucuresti

Manolescu N (1968) Structural and kinematic synthesis of plane driving mechanisms with multiple joints and two degrees of mobility: “total” $M_3 = 2$ and “partial” $M_3 = 2$. Revue Roumaine Science et Technique, Serie de Mecanique Appliquee, XIII, 1, Bucuresti

Manolescu N (1968b) For a united point of view in the study of the structural analysis of kinematic chains and mechanisms. J Mech 3(3):149–169

Manolescu N (1969) Contributions to the numerical and structural synthesis of Assur groups, of kinematic chains, of mechanisms and plane jointed motor mechanisms. Doctoral dissertation, Institutut Politehnic Bucuresti (in Romanian)

Manolescu N, Tempea I (1969) Structural synthesis of plane jointed kinematic chains with e = 10 Elements, c5 = 13 Joints and Degree of Freedom $L_3 = 4$. Buletin Institut Politehnic Bucuresti, XXXI, nr. 4, Bucuresti (in Romanian)

Manolescu N (1971) Criteria of forming the plane jointed mechanisms with multiple joints and simple links, with e = 11 Links and $M_3 = 2$ Degrees of Mobility “partial”, “partial-total ” and “fractional”. Proceedings of the 3rd World Congress on TMM, vol D, paper D-11, Kupari-Dubrovnik, pp 161–176

Manolescu N, Ardeleanu T (1971) La Détermination des Variantes Indépendentes des Fermes Baranov avec e = 9 Eléments en utilisant la Méthode de Graphisation Inverse. Proceedings of the 3rd World Congress on TMM, vol D, paper D-12, Kupari-Dubrovnik, pp 177–188

Manolescu N, Tempea I (1971) The method of the determination of the number of structural kinematic variants of KCsj by joints simplifying. Proceedings of the 3rd World Congress on TMM, vol C, paper C-12, Kupari-Dubrovnik, pp 145–162

Manolescu N (1973) A method based on Baranov Trusses and using graph theory to find all the planar jointed kinematic chains and mechanisms. Mech Mach Theory 8(8):3–22

Manolescu N, Dranga M (1975) La Comparaison des Chaines Cinématiques et des Mécanismes au point de vue Structurel a l’aide de la Théorie des Graphes. Buletin Institut Politehnic Bucuresti, XXXVII, nr.1, Bucuresti, pp 41–46

Manolescu N (1979) The unitary method of structural synthesis of all the planar jointed kinematic chains (KCmjsl). Proceedings of the 5th World Congress on TMM, vol I, Montreal, pp 514–518

Manolescu N (1979) A unified method for the formation of all planar jointed kinematic chains and baranov trusses. Environ Plann B (London) 6:447–454

Manolescu N, Martineac A (1981) La Formation des Fermes Baranov avec $L_3 = 0$ et 1 a l’aide de la Méthode Unitaire élaboreée pour les Chaines Cinématiques Planes Articulées. Proceedings of the 3rd International Symposium on Theory and Practice of Mechanisms, SYROM ‘81, paper 15, Bucharest, pp 137–158

Manolescu N (1988) The history of the original methods used in the synthesis of the planar kinematic chains with different degrees of freedom (liberty). Proceedings of the Conference on Mechanism Construction, Liberec, pp 145–154

Manolescu N (1989) L’etat actuel du Nombre des Variantes Nonisomorphes des Chaines Cinématiques Planes avec Articulations multiples et Eléments simples (CCpames) et e = 12, c5 = 16 et $L_3 = 4$ Degrés de Liberté. Proceedings of the 5th International Symposium on Theory and Practice of Mechanisms, SYROM ‘ 89, vol I, Bucharest, 1989, pp 531–548

Manolescu N (1989) Sur la Synthese Structurale des Chaines Cinematiques Planes avec Articulations Multiples, $L_3 = 6$ Degres de Liberte et e = 8 et 10 Elements Simples (CCpames). Proceedings of the 5th International Symposium on Theory and Practice of Mechanisms, SYROM ’89,vol IV, Bucharest, pp 113–123

Manolescu N (1989) The planar initial jointed kinematic chain. Proceedings of the 5th International Symposium on Theory and Practice of Mechanisms, SYROM ‘ 89, vol I/2, Bucharest, pp 549–556

Manolescu N (1993) L’histoire de l’optimisation de la Synthèse des Chaines Cinématiques Planes Articulées avec differentes Degrés de Liberté. Proceedings of the 6th International Symposium on Theory and Practice of Mechanisms, SYROM ‘93, vol 1, paper 22, Bucharest, pp 169–192

Crossley F (1965) The permutation of kinematic chains of eight members or less from the graph theoretic viewpoint. In: Developments in theoretical and applied mechanics, vol 2. Pergamons, Oxford, pp 467–486

Dijksman EA (1975) Kempes (focal) linkages generalized, particularly in connection with Hart's second straight-line mechanism. Mech Mach Theory 10(3):445–460

Grecu B (2007) Structural synthesis of mechanisms – main objective of scientific papers of Prof. N. Manolescu, Homage paper on the occasion of N. Manolescu 100th birth anniversary, Polytechnic Institute of Bucharest, April 2007 (in Romanian)

Reuleaux F (1976) The kinematics of machinery: outlines of a theory of machines. Translated and edited by A.B.W. Kennedy. Macmillan, London

Mruthyuniaya T (1979) Structural synthesis by transformation of binary chains. Mech Mach Theory 14:221–231

Kojevnikov C (1979) Osnovnaia Structurnovo Sinteza Mehanizmov. Naukova Dumka, Kiev (in Russian)

Kiper G, Schian D (1975) Die 12 gliedrigen Grublerschen kinematischen Ketten, VDI-Z, No. 6, Maerz (II), pp 283–288 (in German)

Dijksman EA, Timmermans EA (1994) Look-out for prime-chains with a prescribed number of mobility degrees of freedom. Mech Mach Theory 29(5):653–672

Mruthyuniaya T, Raghayan M (1984) Computer aided analysis of the structure of kinematic chains. Mech Mach Theory 19(3):357–368

Mruthyuniaya T (1984) A computerized methodology for structural synthesis of kinematic chains. Part II. Application to several fully or partially known cases. Mech Mach Theory (Pergamon Press) 19(6):497–505

Mruthyuniaya T (1984) A computerized methodology for structural synthesis of kinematic chains. Part III: Application to the new case of 10 link, three freedom chaises. Mech Mach Theory (Pergamon Press) 19(6):507–530

Wen Miin Hwang, Yii Wen Hwang (1992) Computer aided structural synthesis of planar kinematic chains with simple joints. Mech Mach Theory (Pergamon Press) 27(2):189–199

Rao AC, Rao CN (1993) Loop based pseudo-hamming values, testing isomorphism and rating kinematic chains. Part I; Inversions, prefered frames and actuators. Part II. Mech Mach 28(1):113–143

Gogu G (2005) Mobility of mechanisms: a critical review. Mech Mach 40:1068–1097

Baranov G (1948) Klassificatia Stroenie, Kinematica i Kinetostatica ploskih Mehanizmov s Parami pervovo Roda, Trudi seminara po TMM, AN SSSR, T.V, vol 20 (in Russian)