José María Lanz y Zaldívar (1764–1839)

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Abstract The Mexican José María Lanz y Zaldívar was one of the authors, together with the Spaniard Agustín de Betancourt, of the first book about industrial kinematics, dealing with mechanisms classification in a systematic fashion. The book, written in French, was published first in Paris in 1908 and later was translated to English and German. Furthermore, at the end of the eighteenth and the first part of the nineteenth centuries, apparently Lanz y Zaldívar played an important role in developing modern engineering in Europe.

Biographical Notes

The mathematician, mechanical and hydraulic engineer Lanz y (and) Zaldívar was born in Campeche, México in 1764. He pursued studies at the *Instituto Campechano* and sometime after he was instructor at the same institution. Successively, he moved to Spain where he studied naval engineering, and obtained the position of Cadiz' Alférez (similar to Lieutenant) of the Marine Guards. He was at the service of the Royal Fleet of Spain with the above-mentioned official rank. From 1782, Lanz, with the degree of ship's lieutenant was in service in the military *fragata* San Fernando at La Habana's offshore. By the end of 1782 he was moved to the fragata Santa Lucía. The latter used to make trips from la Habana (Cuba) to Veracruz (Mexico) as was registered in the so-called *hoja de servicios* (sheet of services) shown in Fig. 1. Then, he was sent to Yucatán by Colonel Borja to work on the *henequen* (hemp) and the *jarcia* (ropes) being fabricated with this fiber. Indeed, in 1783 Lanz was living in Yucatán, where he studied the possibility of using *henequen* to fabricate naval *aparejos* and wrote

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D. Joseph Maxia Lanz
natural de Campeche
de Estado Soltero

Empleos.	Dias	Mes	Año	Tiempo q. sirvió cada uno de los Años	Meses	Dias	Empleos.
Guardia-Marina	13	Oct.e	1781	1.	2.	7.	De Guardia Marina.
Alferez de fragata.	21	Dic.e	1782	3.	3.	3.	De Alf.z de Fragata
Alferez de Navio.	25	Feb.o	1786	1.	1.	2.	De Alferez de Nav.a
Ten.te de fragata....	28	Feb.o	1787	3.	10.	2.	De Ten.te de frag.a
Teniente de Navio.	1.o	Oct.e	1791	2.	11.	10	De Ten.te de Navio.
Total del tiempo que sirvió hasta 11. de Feb.o de 1794, q.e por R.l orden de la misma ha. se le dió de baja.				12	3	21	

Extracto de sus Servicios

Estuvo embarcado quatro años, dos meses, y doce dias, y navegó en Amexica, y Europa. Sobre el Navio S.n Fernando se halló en el Combate de la Esquadra combinada contra la Inglesa, en Octubre de 82. A principios del año de 83 fué destinado á la fragata Santa Lucia, destinada á llevar la noticia de la paz á la Havana, y Vera Cruz: fué comisionado por el Brigadier, y Comandante General D. Francisco de Borja á ir á Campeche á tomar conocimiento del cultivo, abono y metodo conque en aquella Provincia se

Fig. 1 Lanz's sheet of services (Archivo de la Marina de Guerra de Viso del Marqués)

a report on this task. (This report was published in the *Registro Yucateco*, although, according to Justo Sierra O'Reilly, it was thought that the real author was Policarpo Antonio Echánove y Arzubia. However, Joaquín Lanz Trueba in the brochure *Estudios sobre el henequén*, published in Campeche in 1926, showed that Lanz y Zaldívar was the first to write about this plant.) On the 1st of January of 1784, Lanz returned to La Habana, where for some time he was in service on the *fragata* Santa Dorotea.

Lanz returned to Madrid in 1789 to participate, under Mendoza's (Lanz' advisor) direction, in a trip through France, England, Germany, Sweden, Poland and Russia to collect data, designs and documentation. After the trip through Europe, and back in Spain, he became director of a clock factory.

Because of his outstanding scientific activity, he obtained a scholarship for studying in Paris where he had met Monge and Betancourt by the end of 1789. Lanz y Zaldívar got married in Paris where he decided to stay with his wife. However, from 1802 to 1805 he lived in Madrid and taught at the *Escuela de Caminos y Canales* (School of Roads and Channels). Actually, Lanz lived in Spain in an intensive epoch of intellectual renovation fostered by the egregious figure of Carlos III and his successor Carlos IV.

In 1808, together with Agustín Betancourt, he published the book *Essai sur la composition des machines* in Paris (Lanz and Betancourt, 1808). This is a basic book about industrial kinematics. By the end of the eighteenth and the first part of the nineteenth centuries, Lanz played an important role in developing modern engineering in Europe.

He was expelled from Paris because of his ideological links with the French revolution. Nevertheless, it seems inaccurate that he was receiving Napoleon I's orders, as pointed out by Antonio Rumeu de Armas (1983) in his book, but was actually working on the orders of Napoleon's brother Jose I Bonaparte, King of Spain. Because of that, he went back to Spain and took second-level political positions in the administration. (Rumeu's book has seven chapters, three appendices, and reproduces among other illustrations, the first page of Lanz's service sheet, the cover of the first edition of *Essai sur la composition des machines*, and two of Lanz's letters. One letter is addressed to the Conde Fernán de Núñez and the other one is addressed to the Principe de la Paz, dated 1793 and 1796, respectively.) In 1832, the Board of the *Real Conservatorio de Artes* proposed to the Treasury Minister that Lanz y Zaldívar be appointed (the equivalent of) Full Professor. Lanz y Zaldívar died in Paris in 1839.

According to Rumeu's book, Antonio Gutiérrez, a student of Lanz y Zaldívar, described him, at the age of 67, as kind and good with a reddish face, gross, and short. As a recognition of him after his death, in 1848 a portrait was ordered for Antonio García (Vicuña 1888), and supposedly was exhibited at the *Real Conservatorio de Artes*. So far, unfortunately, the author did not found the portrait.

Essai sur la Composition des Machines

Introduction

Modern activity relating to mechanism design can be considered as starting with the foundation of the *École Polytechnique* in Paris in 1784. This can be also considered the beginning of the Theory of Machines and Mechanisms (TMM), that greatly evolved from the nineteenth century to a topic of modern engineering that today we call Machine and Mechanism Science (MMS). The founding fathers of TMM can be considered to be those who established the *École Polytechnique* and particularly the first teachers of the disciplines that have contributed to the formation of modern industrial engineering. Among those first teachers, also investigators, one can recognize Gaspard Monge, Lazare Carnot, Luis Lagrange, Jean Pierre Nicolas Hachette, Louis Poinsot, Paul Réné Binet, Claude Louis Marie Henri Navier, Dominique François Jean Arago, Jacques Philippe Marie Binet, Jean Victor Poncelet, Jean Marie Constant Duhamel, Félix Savary, Alexix Thérèse Petit, Gaspard Gustave Coriolis, Michel Chasles. Some of them were also *École* students, and later they became professors of mechanics and/or machines at the *École*.

In particular, however, one can recognize in Gaspard Monge (1746–1818) the first teacher of TMM, since he first planned specific classes on mechanism analysis and design at the beginning of the *École Polytechnique*. Monge proposed these classes as the final application of his program on Descriptive Geometry. But only in 1806 the Council of the *École* did approve the teaching for 10 h of mechanism analysis. Meanwhile, Monge had investigated mechanisms by informing other teachers on this topic. His successor was Jean Pierre Nicolas Hachette (1769–1834), who was in fact the teacher who gave the first classes on mechanisms (Hachette 1811) and continued his teaching activities for a long time.

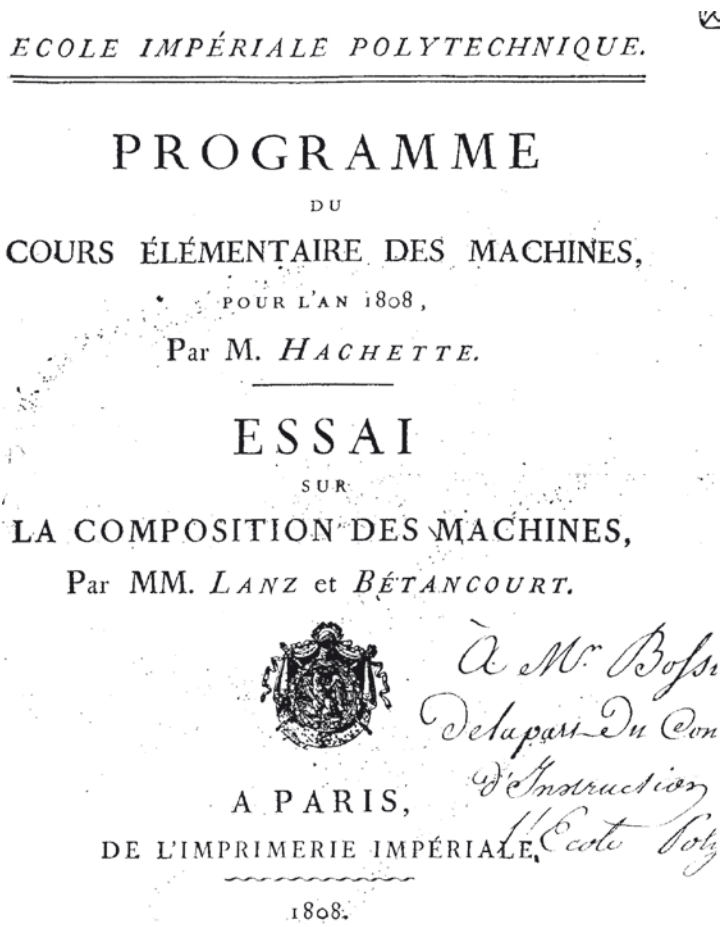
Among those students who attended the first classes on mechanisms which were conducted under the supervision of Monge, one can recognize José María Lanz y Zaldívar and Agustín de Betancourt. Their personalities and activities can be considered very significant and illustrative of early modern industrial engineers, not only for the brilliant academic and technical contributions, but even for the intense engineering activity, and with a wide radius of action. However, Lanz and Betancourt are yet not fully considered in the history of modern TMM, since they are not cited or at the most, mentioned with little information (García-Diego 1985; Rubio and Cuadrado 2000; López-Cajún and Ceccarelli 2005; Ceccarelli et al. 2006).

In this section, details of contributions and activities by Lanz are reported and discussed with the aim of stressing not only the historical significance, but also the pioneering activities in modern engineering. Particular attention has been addressed to the revision of the *Essai sur la composition des machines* that was first published at Paris in 1808, as the text of the early teachings on mechanisms, and in the form that was inspired by Monge, but given by Hachette (1811).

The *Essai sur la composition des machines* was written as related to an Elementary Course on Machines as an application of classes of Descriptive

Geometry given at the *École Polytechnique*. The course was planned in 1795, but only Hachette started it in 1806.

The first draft of the *Essai* was reorganized by Lanz in the years 1805–1807. Lanz and Betancourt reviewed the *Essai* together during the 4 months of coincidence in Paris and submitted it to the *École Polytechnique* in the second semester of 1808. At the same time, Hachette began a course on the Elements of Machines, and he prepared a program of lessons and tables to classify elementary machines. Thus, since Monge and Hachette had knowledge of the book prepared by Lanz and Betancourt, they proposed its publication within the framework of the *École Polytechnique*. Hachette reviewed the manuscript with the idea of adapting it for the above-mentioned program and the *Essai* was published in 1808, and included Hachette's program as shown in Fig. 2. In this first edition, the table of classification


ECOLE IMPÉRIALE POLYTECHNIQUE.

PROGRAMME

DU

COURS ÉLÉMENTAIRE DES MACHINES,

POUR L'AN 1808,

Par M. HACHETTE.

ESSAI

SUR

LA COMPOSITION DES MACHINES,

Par MM. LANZ et BÉTANCOURT.

A PARIS,

DE L'IMPRIMERIE IMPÉRIALE.

1808.

Fig. 2 Title page of the Essai sur la composition des machines

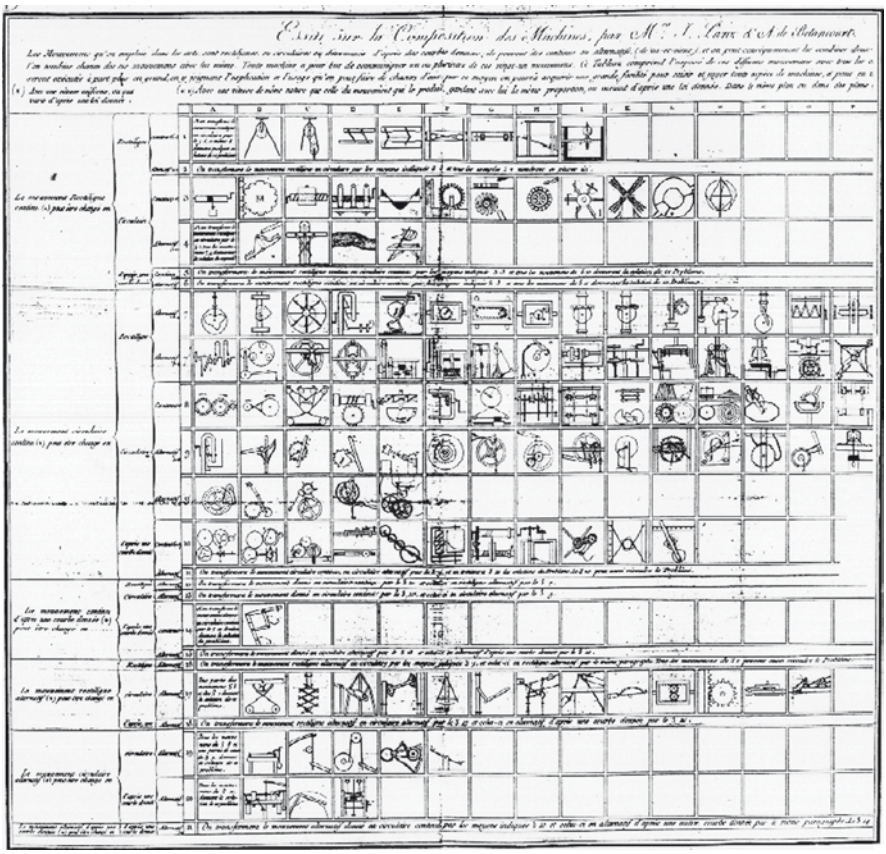


Fig. 3 The table for mechanism classification by Lanz and Betancourt

of Hachette appears at the beginning together with one more complete table by Lanz and Betancourt (Fig. 3).

The content of the book is based on a comprehensive classification of mechanisms that were obtained from considering circular and straight-line motions both for input and output links in continued or alternative modes. Thus, ten classes of mechanisms were identified, as shown in the Table of Fig. 4 and in Fig. 5 by using basically existing well-known mechanism designs and referencing to several technical sources of that time.

The classes of mechanisms are combinations of circular and straight-line input-output motions taking into consideration continuous or alternating motions that could have had practical applications at that time, but still of current interest. Indeed, the treatment of the mechanism that is identified in the table of the classification is described and discussed in detail both for general and for specific purposes. This was done by means of a modern kinematic approach and addressing attention to motion properties and mechanism behavior.

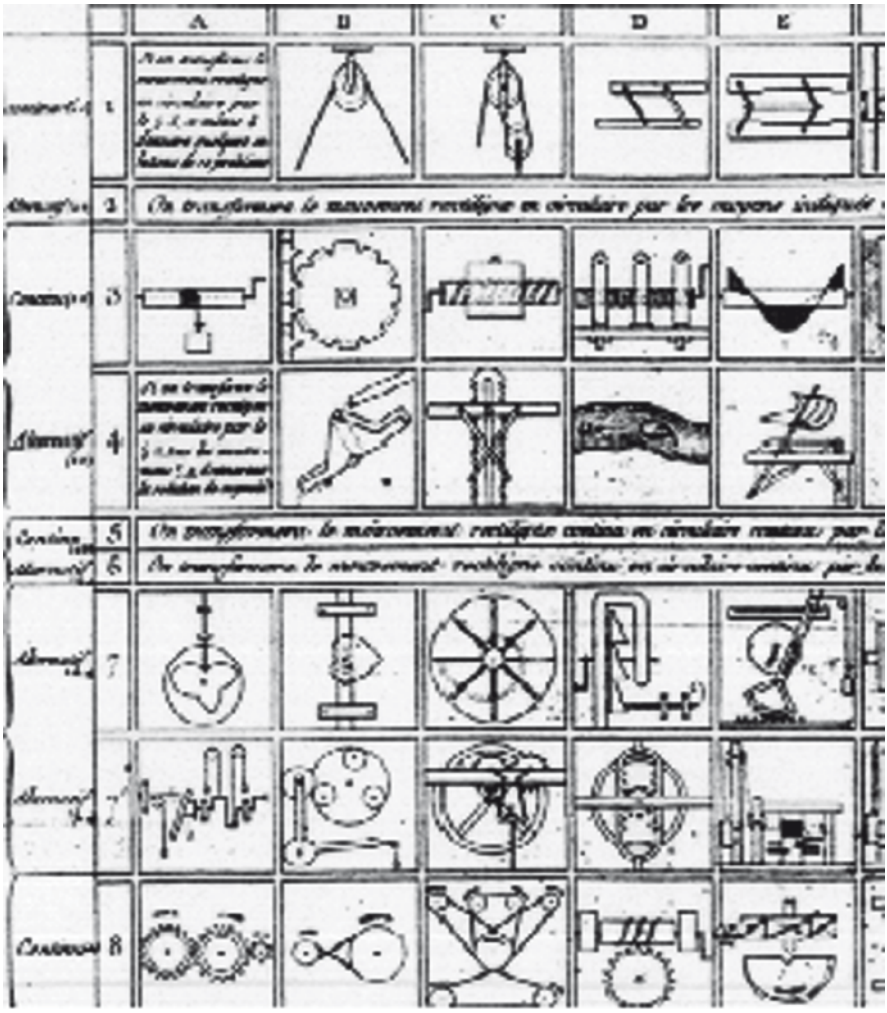


Fig. 4 A section of the table of mechanism classifications

Considerations are also deduced for design purposes. Examples from the *Essai*, which are explained on pages 114–115 and 109–110, respectively, are illustrated in Figs. 5 and 6. In particular, an analysis of the Watt linkage for straight-line guidance is shown in Fig. 5. This was done by using several configurations of the mechanism to emphasize the efficiency of it. The mechanisms shown in Figs. 5 and 6 were analyzed from a practical viewpoint, also showing alternative solutions.

The work in the *Essai* can be considered as a synthesis of the personal experiences of Lanz and Betancourt after maturation within the framework of the rigorous formation at the *École Polytechnique* under the supervision of Monge and Hachette.

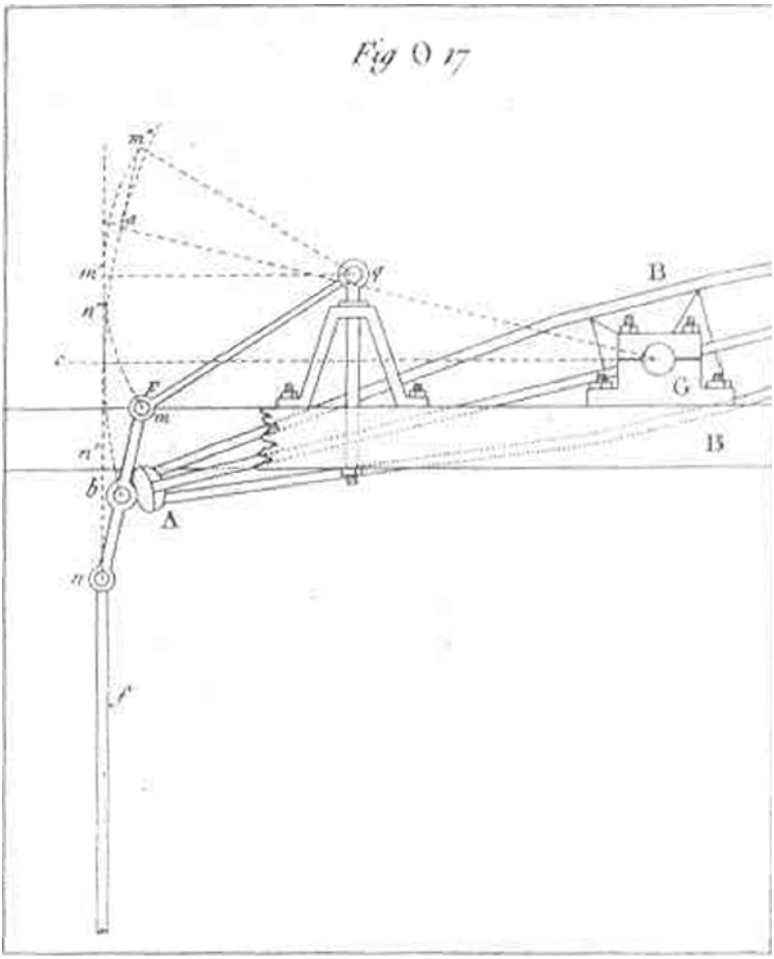


Fig. 5 Example of the Essai: the Watt four-bar linkage

The systematic approach was a successful attempt to treat, with a unique framework the great variety of mechanisms that were designed and used at that time, including an effort for the conception of additional mechanisms. The early kinematic analysis is used in the *Essai* to study and identify basic properties of mechanisms, from a general abstract viewpoint, in order to free the mechanism designs for specific purposes, as used in the previous *Theatrum Machinarum*.

In the *Essai*, in addition to the machine collections, are included the then-existing bibliography, inventors and scope of use of the machines. Indeed, at the end of the eighteenth century, there was already a need for a modern collection of used mechanisms with detailed technical analysis. These were produced much more in depth than in the past handbooks like the *Theatrum Machinarum*, mainly in France, as illustrated by first patents or by new collections like, for example, in the *Enciclopedie*.

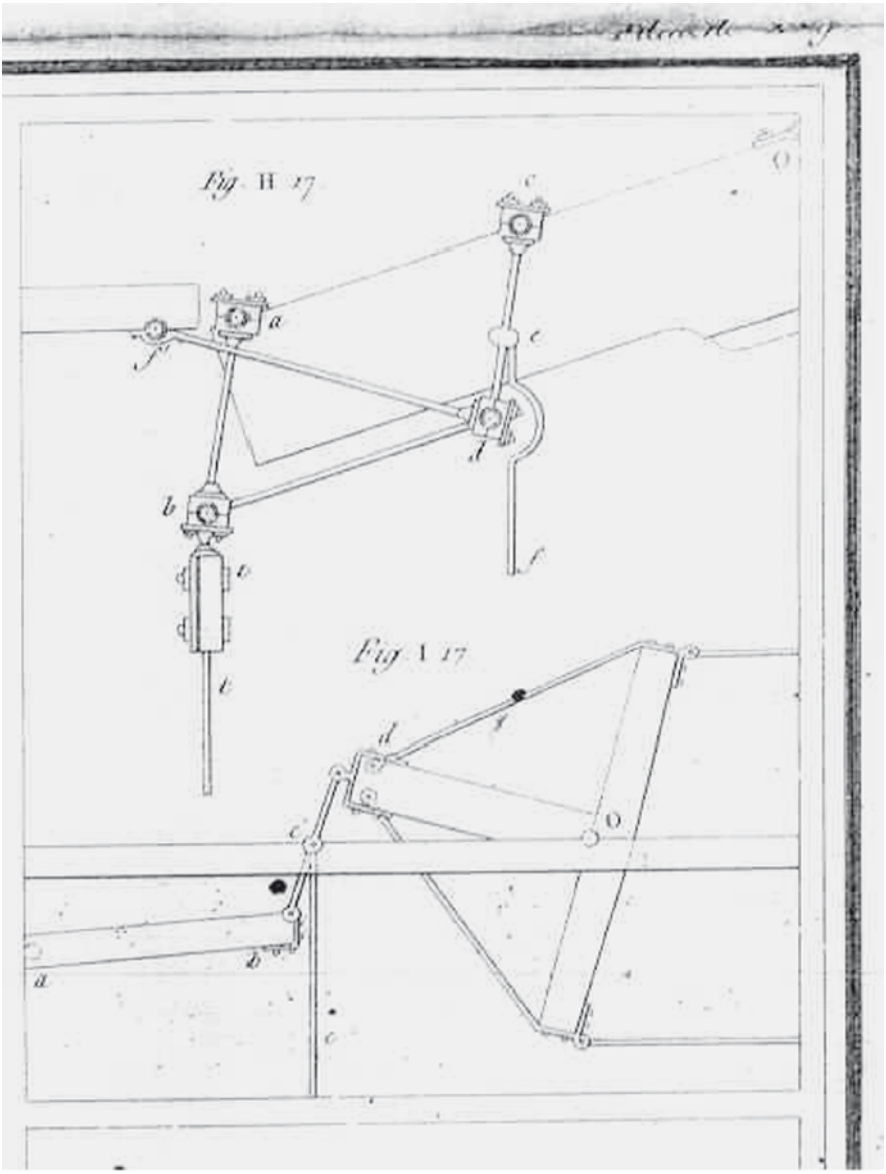


Fig. 6 Example of analysis of linkage mechanisms in the Essai: a study of different practical solutions

On the Circulation of the *ESSAI*

There are three editions in French from the *Essai*. The first one was published in 1808, and it includes the *Programme du cours Élémentaire des Machines pour l'an 1808* by Hachette. The second one was published in 1819 without the text of Hachette, and the third one was published in 1840. There are also two editions in English with the title "Analytical essay on the construction of machines". The first edition was published by R. Ackerman in 1820 and the second one was published in 1822 as included in the "Essays on practical mechanics" by Thomas Fenwick. There is also a German edition, published in 1829, and titled "Versuch über Zusammensetzung der Maschinen" von Lanz und Betancourt.

Modern Interpretation of Main Contributions

The *Essai* was used throughout the whole nineteenth century as a fundamental technical treatise for both research and professional activity and it inspired the work and research of many kinematicians in the nineteenth century, mainly with the aim of improving and/or completing the mechanism classification with the evolution and enlargement of Mechanism Design and Technology.

The modern content of the text can be recognized in an exhaustive classification of the existing mechanisms and in a synthetic description of each mechanism, even with formulation whose purpose was the design. This approach has been very successful for a long time. In fact, the *Essai* has been republished and translated in several languages. It has also inspired other milestone works in TMM, which have been used by practicing engineers throughout the whole nineteenth century.

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References

Ceccarelli M, Cuadrado JI (1997) Sobre el Essai sur la Composition des Machines por Jose Maria de Lanz y Augustin de Betancourt en 1808, 3° Congreso Iberoamericano de Ingeniería Mecánica, CD Proceedings, La Habana

Ceccarelli M, Erogova O, Cuadrado-Iglesias JI, López-Cajún C (2006) V. Pavlov, "Agustin Betancourt: an early modern scientist and engineer in TMM", ASME Paper No. DETC2006-99198

García-Diego JA (1985) En busca de Betancourt y Lanz. Editorial Castalia, Madrid

Hachette JNP (1811) Traitè elementaire des machines, Paris

Lanz JM, Betancourt A (1808) Essai sur la composition des machines, Paris

López-Cajún C, Ceccarelli M (2005) Facts on MMS by Lanz and Betancourt. Proceedings of the Third International Workshop on HMMS, Moscow, Russia, pp 64–69

Rubio FJ, Cuadrado JI (2000) Development of 'Course of Machines' at the Ecole Polytechnique from its origin to the middle of the XIX-th century. In: Ceccarelli M (ed) Proceedings of

HMM2000, International Symposium on History of Machines and Mechanisms. Kluwer, Dordrecht
Rumeu de Armas A (1983) El científico mexicano, José María Lanz, fundador de la cinemática industrial, Madrid
Vicuña G (1888) Lanz y Betancourt: Bosquejo bibliográfico, Madrid