Jan Oderfeld (1908–2010)

Teresa Zielinska

Abstract Jan Oderfeld contributed greatly to the field of machines and mechanism science, especially with his achievements in the development of aircraft jet engines, classification of machines and mechanisms, and introduction of optimization methods in mechanical design. He promoted engineering study and was one of the founding fathers of the IFToMM—the International Federation for Promotion of Mechanism and Machine Science. He was the innovator of significant improvements in complex machinery, as well as an excellent teacher to many generations of mechanical engineers. By developing and improving jet engines, he significantly contributed to the progress of aeronautical engineering.

1 Biographical Notes

Jan Oderfeld (Fig. 1) was born in an average-sized town in Poland, Częstochowa, on February 19, 1908. In 1924, he completed his secondary education, and in 1930, he graduated from the Warsaw University of Technology, Faculty of Mechanical Engineering.

Early in his studies, he showed an interest in solving industrial problems; afterwards, he got a job in the well-known machine-production plant "Pioneer" in Warsaw, Poland. After concluding his military service, he created a team of engineers who undertook the very challenging task of constructing a turbine jet engine. In 1931, they managed to construct two prototypes of the engine, both of which underwent successful tests (Bernardzikiewicz et al. 1933) (Fig. 2).

A brief look at the history of jet engines helps to shed light on the pioneering achievements of Jan Oderfeld.

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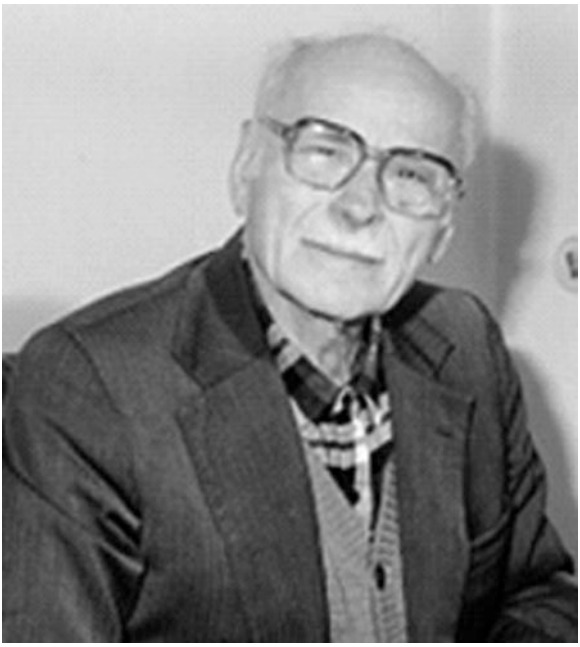

Fig. 1 Professor Jan Oderfeld (1908–2010)

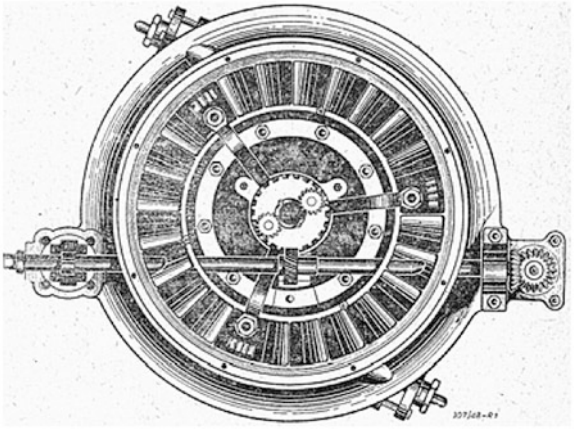

Fig. 2 First Polish jet engine developed by Jan Oderfeld and co-workers. Copy of drawing extracted from his paper

The first patent for a gas turbine used to power an aircraft was filed in 1921 by Maxime Guillaume (France). In 1930, in England, Frank Whittle submitted a patent for a two-stage axial compressor feeding a single-sided centrifugal compressor (granted in 1932). Whittle's first working engine appeared in April 1937. In 1935, Hans von Ohain, being unaware of the English designs, started work on a similar design in Germany, and his first centrifugal engine was successfully launched by September 1937. As can be seen from the two prototypes they

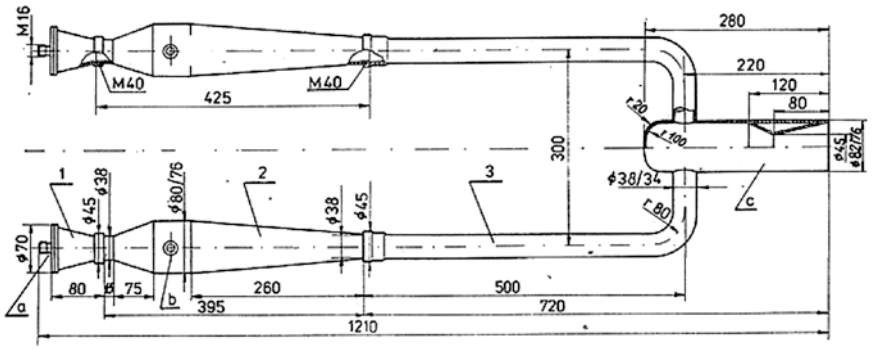

Fig. 3 Pulsejet engine (1933)—design drawing from Jan Oderfeld's publication

managed to deliver in the period of one year, 1931 (Foa 1960), Jan Oderfeld's team took the leading position in the global race for a good jet engine.

Development of pulsating combustion began around the 17th century. Christiaan Huygens, a well-known mathematician, designed a pulsating engine powered by gun powder (Foa 1960). In a pulsejet engine, air is admitted through movable vanes that are closed by the pressure resulting from each intermittent explosion of the fuel in the combustion chamber, thus causing a pulsating thrust. At the beginning of the 20th century, the Esnault-Peltrie push-pull combustion engine was patented. This engine used pulsed combustion to drive a turbine, and from this turbine, work was to be extracted. In 1909, Gorges Marconnet designed the first valveless pulsejet.

In 1932, on the premises of the Experimental Workshop of the Public Engineering Production Plant "Ursus" near Warsaw, Oderfeld's team constructed a pulsejet engine applicable for unmanned aerial vehicles (Fig. 3). Unfortunately, the pioneering work of the young Polish engineer came to a stop in 1933 due to a lack of funds. A model of that jet engine can be seen at the Museum of Technology in Warsaw.

From 1932 to the beginning of World War II, Jan Oderfeld worked in the Engine Production Plant "Skoda" P. Z. L. in Warsaw, first as a production engineer, and then, from 1936, as the head of the design team (Fig. 4). He contributed actively to the design and supervised the testing of the Foka (Seal) aircraft piston engine, which was applied to the Wilk (Wolf) aircraft in 1938.

Together with his team, he constructed a gas turbine for the aircraft piston engine Cirrus (Oderfeld 1937a, b) (Fig. 5). The turbine passed its tests successfully in 1938. From 1937 to 1939, he was also engaged in individual engineering activity, converting a carburetor aircraft engine into an injection one, which in those days was a novel invention.

In 1937, he started teaching by delivering lectures on aircraft engines at the Air-Force Officers' Cadet School in Warsaw (Oderfeld 1938a, b). During World War II, roughly seventy of his former students fought in the Battle of Britain, many of whom were killed.

Fig. 4 Jan Oderfeld's identity card, issued by the engine production plant

During the war, Jan Oderfeld worked in Skierniewice (a small town near Warsaw), running a cooperative machine-workshop called Rolnik (Farmer) (Fig. 6). Under his efficient supervision, a small repair shop with a small number of workers developed into a large production plant manufacturing agricultural machinery.

Immediately after the war, in the academic year 1945/1946, engineer Jan Oderfeld began to work for the Engineering High School. Holding the position of a temporary professor, he lectured on engineering mechanics, aircraft engine design, and statistical quality inspection methods. At the same time, he took a position at the Polish Committee for Standardisation (PKN), where he contributed to the restoration and completion of the standardisation activities. He initiated statistical quality inspection, which led to its successful implementation in both the industry and the army. In the PKN, at first, he was the Head of the Standards Editing Department, and finally, in 1948, he was appointed to the position of General Executive Officer, holding this post until 1951. The research which he conducted in co-operation with Professor Hugo Steinhaus, a famous mathematician, was of crucial importance for standardisation and production inspection.

Oderfeld pursued his activities in many different fields, cooperating with a variety of scientific and industrial centres. In 1949, he joined the Warsaw University of Technology, where at first he took the position of a temporary professor. In 1955, he was nominated to be an associate professor, and in 1961, he became a full professor. Between the years 1949 and 1955, he headed the Division for

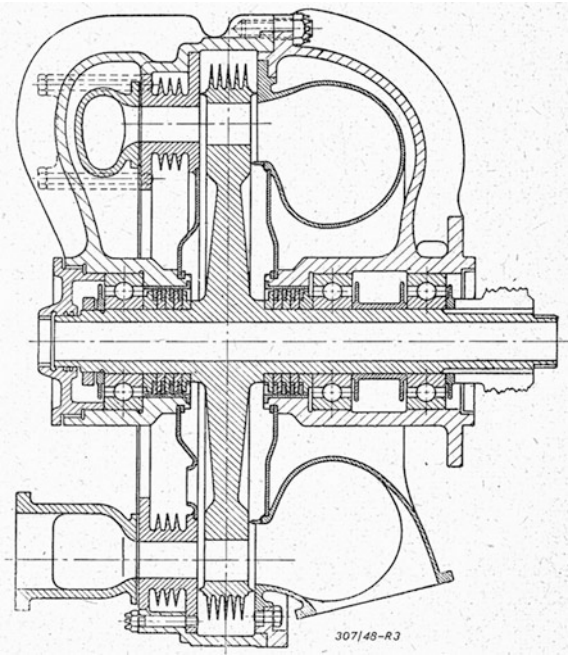

Fig. 5 Gas turbine for an aircraft engine—design drawing from Jan Oderfeld's publication

Fig. 6 Rolnik (farmer machine-workshop) where Jan Oderfeld worked during World War II

Fig. 7 Jan Oderfeld receiving his Doctor Honoris Causa diploma from the rector of Warsaw University of Technology—February 2008

Aircraft Engines, and from 1955 until his retirement in 1978, he headed the Division for Theory of Machines and Mechanisms (at present: the Division for Theory of Machines and Robots at the Faculty of Power and Aeronautical Engineering, WUT). This was the first university level educational unit addressing the theory of machines and mechanisms, which was a step towards the creation of the IFToMM. Soon after founding the Division, Oderfeld initiated a teaching course on the Theory of Machines and Mechanisms (TMM) and published the first textbooks on this subject in Poland. During the years 1964–1966, he served as a Dean at the Faculty of Power and Aeronautical Engineering of the Warsaw University of Technology. It was the result of his recommendation that the teaching programs at all mechanical faculties at WUT were modified in order to include fundamentals of control engineering, dynamical metrology and fundamentals of experiment planning. He also promoted numerical methods in both teaching and research. In February of 2008, at the age of 100, the Warsaw University of Technology conferred upon Professor Jan Oderfeld the title of Doctor Honoris Causa (Honorary Doctor) (Fig. 7). This very prestigious recognition is reserved for persons with truly exceptional achievements.

Jan Oderfeld passed away in Warsaw on March 17, 2010.

2 List of Main Works

1. Que peut-on attendr du turbocompreseur (J. Oderfeld, J. Sachs). Les Ailes 1937, Dec., 7–8.
2. Book: Aircraft Engines—Cooling Systems 1938 (111 pages, in Polish)
3. Book: Aircraft Engines—Cam Systems 1938 (240 pages, in Polish)
4. On the Dual Aspect of Sampling. Colloquim Mathematicum 1950, 2, 89–97
5. On Mechanism Classification, Archives of Machines Building, IV 1957, 367–374 (in Polish)
6. Book: Outlines of Machines and Mechanisms Theory, PWN 1959 (200 pages, in Polish)
7. Book: Introduction to Mechanical Machines Theory, WNT 1962a (300 pages, in Polish)
8. On Optimum Synthesis of Machines. General Lecture, IVth World Congress on the Theory of Machines and Mechanisms, Newcastle, 1975.

3 Review of Main Works on Mechanism Design

Among many papers published by Jan Oderfeld, it is worthwhile to note those on the so-called principle of duality, which created a basis for his Ph.D. Thesis on *Statistical set of products classified according to the alternative.* In 1951, this thesis was successfully defended at the Wrocław University of Technology (his supervisor was Professor Hugo Steinhaus). This work initiated his significant contribution to standardization, which is very important for the proper design and exploitation of machines and mechanism systems.

In cooperation with Professor Zdzisław Rytel, Oderfeld developed the Classification Frame for Standards, later replaced with the International Classification for Standards (ICS). During the years 1951–1974, he focused his activities on mathematics applied to machine engineering. He led the Group of Statistical Quality Inspection at the Mathematical Institute (now, the Industrial Application Department at the Institute of Mathematics of the Polish Academy of Sciences). His research covered a broad scope of mathematical methods applied to machine-building, rubber and military industries, as well as to medicine, biology and pharmacology. Moreover, from 1951 to 1954, he delivered lectures on statistical quality inspection at the Central School of Planning and Statistics (presently known as the Warsaw School of Economics).

Beginning with his first paper published in 1933, Oderfeld announced over 200 works in a broad scope of fields (over forty of them were published after his retirement), including 15 books and textbooks. His magnificent scientific achievements were supported by deep expert knowledge gained through practice. In general, his activities can be divided into three areas spaced through time with overlapping periods.

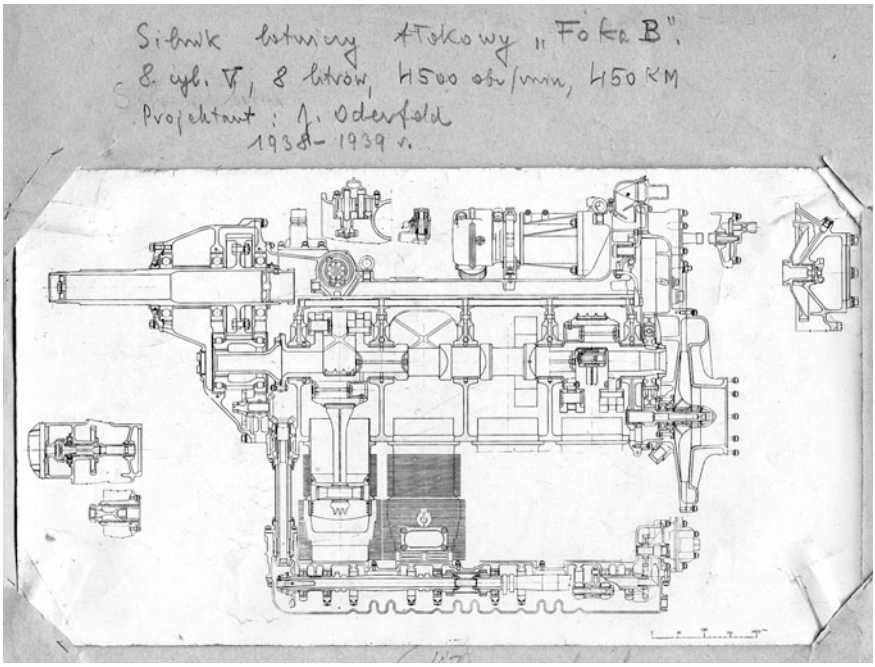

Fig. 8 Eight-cylinder aircraft piston engine Foka (*Seal*)—design drawing by Jan Oderfeld

The first period lasted over 30 years and covered the field of **aircraft engines** (Oderfeld 1937a, b, 1938a, b). The Professor was among those who constructed the first Polish jet engines (Fig. 8). He also dealt with piston engines. After World War II, he co-operated with the well-known Polish aircraft engine designer Wiktor Narkiewicz, dealing with gear system design (including cams) and optimal balance of crankshafts. He also investigated the combustion engines applied to Polish aircraft.

The second period of activity, which also lasted over 30 years, was devoted to **applied mathematics,** mainly in the fields of standardisation and quality inspection (Oderfeld 1950, 1954a, b). Oderfeld struggled for standardisation of units. He always emphasised that, from the engineering point of view, mathematics cannot be limited to the relations between dimensionless numbers. Oderfeld was far-sighted, and thus, long before the International Classification for Standards (ISO) was introduced, he encouraged his co-workers to use [kg], [m], and [s] units. Between the years 1946 and 1960, he defended this point of view against some local opponents, also indulging in international activities devoted to ISO development, which supported the world-wide implementation of an SI system of units.

In the third period, lasting over 50 years, the Professor dealt with the **theory of machines and mechanisms**, in its broad meaning, including metrology, control engineering, robotics and biomechanics. This was always the main focus of his activities. The research that he conducted on engine balancing and timing gear

design starting in the pre-war period should be mentioned here. Later on, Oderfeld used this experience to develop the theory of machines and mechanisms, focusing on mechanism classification, kinematical analysis and development of design solutions for increasing the precision of mechanisms (Oderfeld 1957, 1959, 1962a, b, 1987). He analysed dynamical similarities, developed fundamentals of experimental testing in mechanics and contributed to optimisation methods for the purpose of machine design. His first works in this area appeared in 1954 and were devoted to economic factors that must be considered during machine design analysis (Oderfeld 1954a, b). Later on, Professor Oderfeld established his research school in this field, focusing on application of linear and non-linear programming methods for optimal design of machines and mechanisms (Oderfeld 1954a, b, 1962c) (Fig. 9). Many algorithms and methods which he developed were included in the design practice of complex machines and mechanisms, e.g., the optimisation methods employed in the design process of many well-known Polish jib cranes (Oderfeld 1975, 1976).

Together with Wiktor Narkiewicz, he patented an original design for magnetic drum memory. This should be mentioned as one of his most significant achievements. The design was implemented on a large scale. Subsequently, those memories were used in standard computers produced in Eastern Europe for many years.

4 On the Recognition and Circulation of Works

During his long professional career, Jan Oderfeld was involved in intense activities for different national and international scientific and technical organisations; he was a member of the Committee of Machine Design of the Polish Academy of Sciences, worked for groups and committees of the Polish Federation of Engineering Associations, and engaged in activities for the International Standard Organisation, as well as being a member of the Warsaw Scientific Society.

In 1969, while serving as the President of the Polish Committee for Theory of Machines and Mechanisms, he chaired the organising and scientific committee of the 2nd World Congress on Theory of Machines and Mechanisms in Zakopane, Poland. During the Congress, representatives of 16 countries **founded the International Federation for the Theory of Machines and Mechanisms (IFToMM)** (at present: the International Federation for the Promotion of Mechanism and Machine Science) (Fig. 10). Oderfeld was one of the founding fathers of this organisation, along with the following well-known scientists and researchers:

Academician Ivan Artobolevski (the former USSR)
Prof. Erskine F. R. Crossley (the USA)
Prof. Michael S. Konstantinov (Bulgaria)
Dr. Werner Thomas (the former FRG)
Prof. B. M. Belgaumkar
Prof. Kenneth H. Hunt (Australia)

general lecture

J. ODERFELD

SEPTEMBER 8-13 1975

Fourth World Congress ON THE THEORY OF MACHINES AND MECHANISMS

NEWCASTLE UPON TYNE · ENGLAND

ON OPTIMUM SYNTHESIS OF MACHINES

J. ODERFELD
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SYNOPSIS In Sections 1 and 2 basic notions are introduced and relations between optimum synthesis and design explained. In Section 3 it is shown that the main problems in optimum synthesis are related to the following points: kind of information requested, kind of information available, number of objective functions, form of the objective function and of the constraints. Section 4 is a short review of the recent research in synthesis of machines.

Fig. 9 Title page of 4th World Congress on the theory of machines and mechanisms with the general lecture by Jan Oderfeld

Prof. J. Oderfeld (Poland)
Prof. Jack Phillips (Australia)
Prof. George Rusanov (Bulgaria)
Prof. Wolfgang Rössner (the former DDR)
Prof. Zènò Terplàn (Hungary)
Prof. Jammi S. Rao (India)
Prof.Giovanni Bianchi (Italy)
Prof. Adam Morecki (Poland)
Nicolae I. Manolescu (Romania)

Fig. 10 Photograph taken during the announcement of the IFToMM foundation act (*1* Ivan Ivanovich Artobolevski, *2* Adam Morecki, *5* Nicolae I. Manolescu, *6* Erskine F. Crossley, *7* Giovanni Bianchi, *8* Aron E.Kobrinskii, *9* Werner Thomas, *10* Jan Oderfeld)

Leonard Maunder (the UK)
Douglas Muster (the USA)
Ilic Branisky (the former Yugoslavia).

Oderfeld actively supported the development of the IFToMM and was one of its Executive Council members from the years 1969–1975. The Professor was a tutor for many Polish scientists who have performed numerous prestigious duties within authorities, committees and working groups of the Federation. The Polish School of TMM, established by Oderfeld, is highly appreciated. Up until his death, the Professor maintained a close co-operation with both the Polish Committee of TMM (being its Honorary President) and with the IFToMM. He followed IFToMM achievements and anniversaries, and being in good health, he participated in many IFToMM-supported events, even in his old age (Fig. 11).

In 1953, Jan Oderfeld was among those who established the Journal entitled "Applicationes Mathematicae". From the years 1954–1991, he was a member of the Editorial Board of the scientific journal "Archives of Machine Design". Among his accomplishments is his over thirty years of activity within the framework of the ongoing series of Technical Knowledge Contests for secondary school pupils, very popular in Poland. He was one of the founders and organisers of those contests.

Fig. 11 Jan Oderfeld (in the *middle*) attending the 16th CISM-IFToMM symposium on robot design, dynamics, and control 2006

5 Modern Interpretation of Main Contributions

Jan Oderfeld's achievements in the fields of science and education, as well as his organizational activities, have brought him many national and international awards. Among other honors, it must be emphasised that, during the 9th International Congress of the IFToMM in Milan 1995, the ranks of Honorary Member of the Federation and Honorary Member of the Editorial Board of the Journal of Mechanism and Machine Theory affliated with IFToMM were conferred upon him.

The recognition of Jan Oderfeld's contribution cannot be separated from the history of the IFToMM. Nowadays, the IFToMM is widely and well-recognised within 47 member countries. Many successful conferences have been initiated by IFToMM members. In 1969, the IFToMM was established with a mission to initiate and facilitate international collaboration between Eastern and Western countries, and it currently focuses on the support and enhancement of international collaboration and the exchange of research results in the field of Theory of Machines and Mechanisms.

The following three statements constitute the motto which Jan Oderfeld always emphasized and recommended:

- theory cannot be separated from engineering practice; they both should be combined, forming proper engineering art,
- each experimental result needs its error estimation,
- no detail should be neglected by a good engineer.

The above constitutes the best summary of his views and concludes his contributions to high quality engineering.

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References

Bernadzikiewicz W, Sachs J, Oderfeld J (1933) Problems of reactive aircraft engine. Automobile Tech 5:124–128 (in Polish)
Foa JV (1960) Elements of flight propulsion. Wiley, New York
Oderfeld J (1937a) Methods of temperature control in turbine compressor. Technical newses of aircraft engineering. J Assoc Pol Aeronaut Eng 3:212–215 (in Polish)
Oderfeld J, Sachs J (1937b) Que peut-on attendre du turbocompresseur. Les Ailes 863:7–8
Oderfeld J (1938a) Aircraft engines—cooling systems. (111 pp, in Polish)
Oderfeld J (1938b) Aircraft engines—cam systems. (240 pp, in Polish)
Oderfeld J (1950) On the dual aspect of sampling. Colloqium Mathematicum 2:89–97
Oderfeld J (1954a) Statsitical quality control. PWN (156 pp, in Polish)
Oderfeld J (1954b) Machines strenght and economical savings. Arch Mach Build I:33–65 (in Polish)
Oderfeld J (1957) On mechanism classification. Arch Mach Build IV:367–374 (in Polish)
Oderfeld J (1959) Outlines of machines and mechanisms theory. PWN (200 pp, in Polish)
Oderfeld J (1962a) Introduction to mechanical machines theory. WNT (300 pp, in Polish)
Oderfeld J (1962b) An algorithm for finalizing instantaneous centres. Arch Mach Build, IX:177–188
Oderfeld J (1962c) Programing in machines construction. Arch Mach Build, IX:455–486 (in Polish)
Oderfeld J (1975) On optimum synthesis of machines. General lecture, IVth world congress on the theory of machines and mechanisms, Newcastle
Oderfeld J (1976) Computer aided design of a family of self-propelled cranes. In: Proceedings of symposium C.A.D, Milan, pp 375–381
Oderfeld J, Morecki A (1987) Theory of machines and mechanisms. PWN (360 pp, in Polish)