

The History of Acoustics in Breslau/Wrocław before and after 1945: A Bridge over Time

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ABSTRACT

The paper presents the history of research and the most important people active in the field of acoustics in Breslau before 1945 and in Wrocław after this date. The first important acoustician to lecture in Breslau and here died in 1827 was Ernst Chladni. Organized research in acoustics originated at the end of the 19th century by Otto Lummer at the University of Breslau. His successor was Professor Clemens Schaefer. In 1910, the TH Breslau was founded, and research in acoustics was also conducted here. The leading figure was Erich Waetzmann. He dealt with room acoustics and electroacoustics. Professor Kurt Schuster was a pioneer in the measurements of acoustic impedance. The book “Ultrasound” by Prof. Ludwig Bergmann remains important to this day. After 1945, the research was concentrated at the Wrocław University of Technology. The pioneer of this research was Professor Zbigniew Żyszkowski, who dealt with electroacoustics and telephonometry. His students were: Wojciech Majewski, specialist in speech and Janusz Renowski - psychoacoustician. The professors in next generation are Andrzej Dobrucki, who currently heads the Chair of Acoustics and Tadeusz Gudra, active in ultrasound. The youngest professor, from the further generation is Krzysztof Opieliński.

Keywords: History, Acoustics, Breslau/Wrocław

1. Introduction – a short history of universities in Breslau/Wrocław

Wrocław is a big university city in south-western Poland. It was known as Breslau before 1945. In this paper the name Breslau is used for history before 1945 and Wrocław after this date. In over a thousand years of its history, the city belonged to different countries. At the beginning of 18th century the city belonged to Austrian Empire. The University of Breslau has been founded by Austrian Emperor Leopold I and Order of the Jesuits in 1702 (1). The University, under name of Leopoldina had only two faculties: Philosophy and Theology. In years 1740 – 1763 – after Silesian wars between Austria and Prussia Breslau was joined to Prussia. The university has lost its catholic character. In 1811 the University of Breslau has been joined with University Viadrina in Frankfurt/Oder. It had 5 faculties: Catholic Theology, Protestant Theology, Law, Medicine and Philosophy. Such disciplines, as mathematics, physics, chemistry etc. functioned in the form of seminars at the Faculty of Philosophy. In 1867 – the Physical Cabinet has been founded under directory of prof. dr. Oscar Emil Meyer. In 1900 begins the modern history of physics at the University of Breslau. In this year the Institute of Physics was established. First Directory of the Institute was prof. Meyer to 1904, then prof. Otto Lummer. In 1910 the Technical University in Breslau has been established (Königliche Technische Hochschule zu Breslau). The Inauguration has been done by Emperor of Germany – Wilhelm II. He

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received the first title of Doctor Honoris Causa. The University initially had 3 faculties: Machine Engineering and Electrotechnics; Chemistry and Metallurgy; General. Between 1918 – 1945 the name was Technical University (Technische Hochschule Breslau). The TH Breslau had 4 faculties: General, Faculty of Civil Engineering, Faculty of Machine Engineering and Electrotechnics, Faculty of Material Management. Physics (and acoustics) was placed at the General Faculty (1). In January 1945 the University and Technical University were closed and evacuated to Post-war Germany. After the war, the staff of both Universities worked in various German Universities, i. e. Aachen, Braunschweig, Berlin, Gießen, Jena, Köln.

In May 1945 the new chapter in history has been opened. At that time, there was a capitulation of Festung Breslau, and the city was joined to Poland as Wrocław. The joined University and Polytechnics in Wrocław has been founded on 24th August 1945 by the Decree of Polish Government—. The rector was prof. Stanisław Kulczyński from University of Lwów (today Ukraine). In 1951, the University and the Polytechnic were separated. Currently, the Polytechnic is named Wrocław University of Science and Technology. The University consists of 16 faculties, among others the Faculty of Electronics, which includes the Department of Acoustics and Multimedia (2).

2. The beginnings of acoustics in Breslau - Ernst Chladni

A visit in Breslau in 1827 of famous scientist Ernst Chladni can be considered as beginning of acoustics in this city. Ernst Chladni (Figure 1) was born in 1756 in Wittenberg. He studied law and philosophy at Universities in Wittenberg and Leipzig, and he received an PhD degree in 1782. His scientific activity included vibration of structures, construction of musical instruments, meteoritics (3).



Figure 1 - Ernst Chladni



Figure 2 – Title page of Chladni’s book “The Acoustics”

He is the discoverer of the so-called figures of Chladni that are formed on the vibrating plate as nodal lines. Chladni is the author of the first modern handbook in acoustics, published in Leipzig in 1802 (Figure 2). Ernst Chladni earned his living by traveling around Europe and giving lectures. He met Napoleon Bonaparte. The Emperor was very interested in Chladni’s research, and he gave him a large amount 6000 francs for research, and he funded the prize for the mathematical description of phenomena associated with the sound figures. This prize won French mathematician Sophie Germain in 2016. The complete mathematic description of vibration of plates gave Kirchhoff after 1850. In February 1827 Chladni came to lecture in Breslau and died here on April 4, 1827. He was buried in the cemetery near the city center (3). Unfortunately, this cemetery has been destroyed during the defense of the Festung Breslau in 1945 and it does not exist nowadays. On April 18, 2008, a memorial plaque dedicated to E. Chladni was unveiled at the Mineralogical Museum of the University of Wrocław (Figure 3). The plaque was funded by the Polish Acoustical Society and the Polish Meteorite Society.



Figure 3 – The Chladni’s memorial plaque in Wrocław (*with the kind permission of the Mineralogical Museum of the University of Wrocław*)

3. The history of acoustics in Breslau in 20-th century before 1945

The beginning of systematic research in the field of acoustics in Breslau should be combined with the establishment in 1900 of the Institute of Physics at the University of Breslau and its second director, Otto Lummer. Otto Lummer (Figure 4) was born in Gera in 1860. He studied Physics and Mathematics in Tübingen and Berlin. He received the Ph.D. degree in 1884 for the dissertation „About a new interference phenomenon on a plane-parallel glass plate and a method to check the plane parallelism of such glaziers”. He was the constructor of the optical interferometer known as the "Lummer rings" as well as the photometer. Otto Lummer obtained the D.Sc. degree (habilitation) in 1901, and he became the full professor and director of the Institute of Physics in Breslau in 1904. Twice, in years 1910-1911 he was a candidate to Nobel Prize. Although the main scientific activity of Otto Lummer was optics, he was also active in the field of acoustics. He has a contribution to room acoustics and theory of shockwaves (bang) produced by the quickly moving sound sources. Otto Lummer was the initiator of the creation in Breslau the radio station „Schlesische Funkstunde” and he was the first chairman of its supervisory board (1924). He was also the Editor of the journal „Schlesische Funkstunde” (Figure 5), where he published papers in the field of acoustics (1).



Figure 4 - Otto Lummer



Figure 5 - The papers by Otto Lummer in the field of acoustics

After the establishment of TU Breslau in 1910, Otto Lummer was a member of the General Faculty. Otto Lummer died in Breslau in 1925. His successor as the director of the Institute of Physics at the University of Breslau was Clemens Schaefer. Clemens Schaefer was born in Remscheid (Westphalia) in 1878. He studied physics at universities in Bonn and Berlin. He received Ph.D. degree in 1900 by Emil Warburg in Berlin and habilitation in 1903 at University in Breslau. Between 1920 and 1926 he was professor and director of the Institute of Experimental Physics at University of Marburg (Hesse). In years 1926 – 1945 he was full professor and director of the Institute of Physics at University of Breslau. After 1945 he was the professor of physics at University in Köln. Clemens Schaefer died in Köln in 1968. Clemens Schaefer was active in various areas in physics. In acoustics he has contribution in the fields: ultrasonic waves in crystals, creation of combination tones (objective in strings and membranes and subjective – the extension of Helmholtz theory) and the acoustic radiation pressure.

Professors practicing acoustics at TH Breslau were, among others, Erich Waetzmann (Figure 6), Ludwig Bergmann i Kurt Schuster (1). Erich Waetzmann was born in Weissensee (heute Chycina), Provinz Posen (Poznań) in 1882. He studied mathematics and physics in Berlin, Marburg and Breslau. In 1904 he received the Ph.D.at University of Breslau by Otto Lummer and in 1907 he received habilitation at University of Breslau. From 1917 he worked in TH Breslau, from 1920 as Professor of Physics. From 1926 he was full professor and director of the Institute of Physics at TH Breslau and honorary professor of Institute of Physics at University of Breslau. In 1930 – 1932 Erich Waetzmann was the Rector of TH Breslau. Erich Waetzmann died in Berlin in 1938.



Figure 6 - Erich Waetzmann

Main scientific interest of Erich Waetzmann was acoustics. The subject of his habilitation thesis was resonant theory of hearing, originally proposed by Helmholtz. Waetzmann and Schuster developed the theory of reverberation in rooms (1929). The equation known as Eyring equation has been published by Waetzmann and Schuster a few months earlier than by Eyring. Waetzmann was the constructor of different acoustical devices e.g. audiometer, geophone, acoustical monitoring devices, acoustic filters. The successor of Professor Waetzmann as the director of the Institute of Physics was Professor Ludwig Bergmann. Ludwig Bergmann was born in Wetzlar (Hesse) in 1898. He was educated in mathematics and physics at University of Gießen, where he received the PhD degree in 1921. He received habilitation at the University of Marburg. From 1927 he worked at the University of Breslau where he cooperated with Prof. Clemens Schaefer. In years 1939 - 1945 he became full professor and director of the Institute of Physics at TH Breslau, after death of Erich Waetzmann. From 1940 Ludwig Bergmann was also honorary professor of physics at University of Breslau, and from 1949 – honorary Professor at University of Gießen. Ludwig Bergmann died in 1959 in Heidelberg. The main work of Ludwig Bergmann is the handbook „Ultrasound and its Application in the Science and Technology”, 1-st edition VDI-Verlag, Berlin 1937. This book had many editions and it is still a „bible” in ultrasound. Kurt Schuster (Figure 7) was born in Frankfurt am Main in 1903. In years 1922 – 1927 he studied physics at TH Breslau and University of Breslau.



Figure 7 - Kurt Schuster

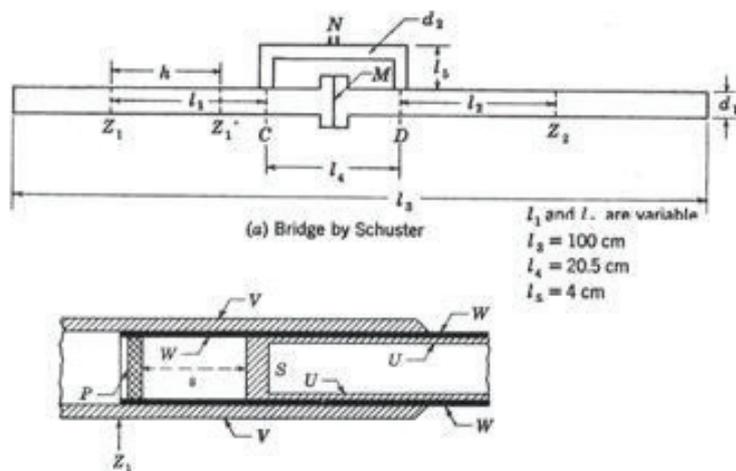


Figure 8 - Schuster's bridge and acoustic impedance pattern

Kurt Schuster received the doctoral degree by Erich Waetzmann in 1927. Title of dissertation was „Coupling vibrations of continuous subsystems”. He obtained the habilitation in 1936 at TH Breslau. The subject of his habilitation was measuring of acoustical impedance by comparison. Kurt Schuster constructed an impedance bridge and acoustical impedance pattern (Figure 8). In years 1943 – 1943 he was professor at the TH Breslau. From 1949 he was professor at University of Jena. Kurt Schuster died in Jena in 1995.

Other important acousticians who studied or worked in Breslau were: Erwin Meyer (1899 - 1972), who studied with Otto Lummer in years 1918 - 1924, after the World War II Director of the Third Physics Institute (Vibration Physics) at the University of Göttingen; Lothar Keibs (1908 -1979) – pupil of E. Waetzman, from him he received the Ph.D. degree in 1936 for dissertation about measuring of eardrum impedance, after 1945 in Berlin. University of Music in Berlin, German radio and TV station and Hans Joachim von Braunmühl (1900 – 1980) – inventor of the double membrane electrostatic microphone with a shared backplate (together with Walter Weber), author of the handbook „Introduction to practical acoustics” Hirzel Verlag, Leipzig 1936, after 1945 technical director of the German radio station(1).

4. The history of acoustics in Wrocław after 1945

The organizer of the scientific life in the field of physics in Wrocław in 1945 was professor Stanisław Loria (1883-1958). Professor Loria visited Breslau as young Ph.D. in years 1907-1909 and he co-operated with Otto Lummer. At that time, he also met Professor Clemens Schaefer. He was also a friend of Max Born, later Nobel Prize winner. In years 1945 - 1947 he was the vice-rector of the

joined University of Wrocław and Polytechnics of Wrocław (4). In 1945, he took over the assets of the Institute of Physics at the hands of Prof. Clemens Schaefer and organized the Department of Experimental Physics. This fact was noted independently in the memories of both Professor Loria and Professor Schaefer and it can be considered a bridge (or rather a footbridge) between two historical eras (1,4). Professor Loria was active in optics and radioactivity and he did not deal with acoustics. The reactivation of acoustics in Wrocław relates to the name of professor Zbigniew Żyszkowski (2) (Figure 9).



Figure 9 - Zbigniew Żyszkowski

Zbigniew Żyszkowski was born in Warsaw in 1910. He completed his education in 1934 at Warsaw University of Technology, receiving the degree of MSc. Eng. in Electricity. In years 1934 – 1939 he worked as engineer in Polish Tele- and Radiotechnical Company where he designed electroacoustic transducers. During World War II he was in England, where he served for British Army as engineer of radar devices. In 1947 Żyszkowski came back to Poland and began the work at Wrocław Polytechnics (now Wrocław University of Science and Technology). In 1954 he received the title of professor and he became a post of chairman of the Department of Wired Telecommunications. In years 1952-54 and 1960 – 68 he was the Dean of Faculty of Telecommunications and between 1958-59 – the Vice-Rector of the Polytechnics. In 1968 he was the initiator of the Institute of Telecommunications and Acoustics and served as its 1-st director (1968- 1980). Within the Institute he was also the chairman of Department of Electroacoustics. Zbigniew Żyszkowski died in 1989 in Wrocław. His scientific interests concerned electroacoustics and telecommunications. Zbigniew Żyszkowski is the author of 10 books. Most important is „Foundation of Electroacoustics”. It has 3 editions in 1953, 1966 and 1983. The successive editions were re-arranged and expanded. Other his book in acoustics is „Acoustical measurements” (1987). Prof. Żyszkowski promoted 12 doctors and is the creator of Wrocław electroacoustics school.

In 1985 two acoustical departments have been organized in the Institute of Telecommunications and Acoustics: The Department of Acoustics and the Department of Analysis and Signal Processing in Acoustics. The heads of these departments were prof. Janusz Renowski and prof. Wojciech Majewski (2).

Janusz Renowski (Figure 10), was born in 1933 in Parczew (near Lublin). He received PhD degree in 1964 by Zbigniew Żyszkowski. In years 1964 – 65 he worked in Institute of Physics in Marseille (France) and 1979 – 1984 he was the professor at the University in Oran (Algeria). He was head of the Department of Acoustics in years 1985 - 1998, to retire. The scientific interest of Janusz Renowski is psychological acoustics, particularly subjective evaluation of sound quality. He is author of 4 books and promoted 8 doctors.

Wojciech Majewski (Figure 11), born in 1931, received PhD in 1964 by Zbigniew Żyszkowski. In years 1966 - 68 and in 1973 he stayed at the scholarship in Communication Sciences Laboratory at Florida University, Gainesville and in year 1979 - at the 2-months scholarship at Michigan University in East Lansing. In years 1969 – 1981 he served as vice-director in Institute of Telecommunications and

Acoustics, and in 1981-84 – director of the Institute. In 1993-96 he was the vice-rector of the Wrocław University of Technology. Between 1985 – 2002 Wojciech Majewski was the head of the Department of Analysis and Signal Processing in Acoustics. In 1993 he obtained the title of full professor. Since 2002 prof. Majewski is retired. Scientific specialization of Wojciech Majewski is speech communication. He is author of more than 100 publications, including 4 books (as co-author). In 1979 Wojciech Majewski was a member of expert group in phonoscopic analysis connected with kidnapping and murder of Aldo Moro – the Prime Minister of Italy. Professor W. Majewski promoted 10 PhD's. In his department worked professor Czesław Basztura, who died in 2000.

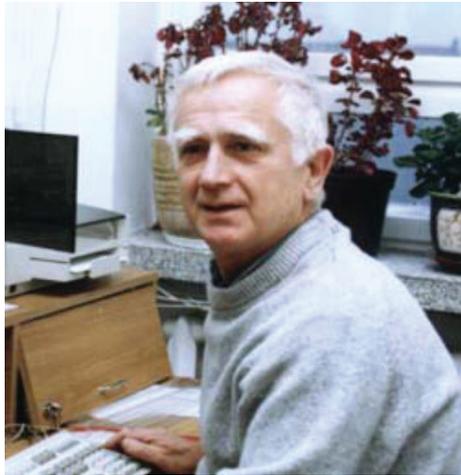


Figure 10 - Janusz Renowski



Figure 11 - Wojciech Majewski

In 1998, after Janusz Renowski retirement, the Head of the Department of Acoustics became Andrzej Dobrucki (Figure 12). In 2007 the Department of Acoustics and Department of Analysis and Signal Processing in Acoustics have merged, and now is one Chair of Acoustics and Multimedia. Andrzej Dobrucki was born in Rawicz (a city between Wrocław and Poznań) in 1949. He received PhD degree in 1977 by Wojciech Majewski, and habilitation in 1993. In 2007 he obtained the title of full professor. In 1988 A. Dobrucki stayed at the scholarship in Kiev Institute of Technology (Soviet Union, now Ukraine). In years 2003 – 2016 he visited the University Paris-Est Creteil one week every year with lectures about hearing aids. In 2009 had 1-month visit at University du Maine in Le Mans (France). Andrzej Dobrucki scientific interests are electroacoustics and technical acoustics, particularly, construction, modeling and measurement of electroacoustic transducers. He is the author more than 200 publications, including 6 patents and 4 books. The most important is „Electroacoustic transducers” published in 2007 by WNT Warsaw (Figure 13). Prof. A. Dobrucki promoted 17 PhD's. Since 2014 he serves as the President of the Polish Acoustical Society.



Figure 12 - Andrzej Dobrucki

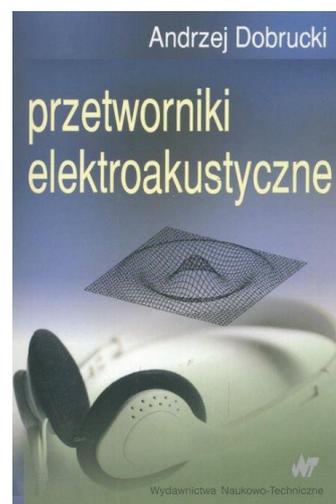


Figure 13 - Cover of the Dobrucki's book "Electroacoustical transducers"

In the department of Acoustics and Multimedia work two professors - specialists in ultrasound: Tadeusz Gudra and Krzysztof Opieliński. Tadeusz Gudra (Figure 14) born in 1946, received the PhD degree in 1981 by Zbigniew Żyszkowski and habilitation in 2007. Since 2015 he is full professor, and since 2018 he is retired. Tadeusz Gudra is the author more than 200 publications including 22 patents and 3 books. Most important book is „Properties and application of ultrasonic transducers working in gases”, Publishing House of Wrocław University of Technology 2005.



Figure 14 - Tadeusz Gudra



Figure 15 - Krzysztof Opieliński

Krzysztof Opieliński (Figure 15) was born in 1965 in Września (near Poznań). He received PhD degree in 1998 by Andrzej Dobrucki and habilitation in 2012. Since 2015 he is associate professor. K. Opieliński is the author of 190 publications, incl. 5 patents and two books: „Application of ultrasound waves to characterizing and imaging of internal structure of biological media”, Publishing House of Wrocław University of Science and Technology, 2011 and „Ultrasound in tissues”, Academic Publishing House EXIT, Warszawa, 2018. Since 2014 Krzysztof Opieliński is the General Secretary of the Polish Acoustical Society.

5. Conclusion

The first important acoustician in Breslau was Ernst Chladni in 19th century. Systematic research and education in the field of acoustics in Breslau began at the beginning of the 20th century. Two main centers of acoustics existed to 1945: The Institute of Physics at University of Breslau and Institute of Physics at the TH Breslau. The acoustics was cultivated mainly as the branch of physics. After 1945 main research and education in acoustics exist at Wrocław University of Science and Technology, at the Faculty of Electronics. It is cultivated mainly as the branch of technology. There is continuity of acoustical tradition in Breslau/Wrocław before and after 1945.

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