

ACOUSTICS AT THE GDAŃSK TECHNICAL UNIVERSITY

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History of the development of acoustics at the Gdańsk Technical University within the past half-century is briefly outlined. A contribution of the Gdańsk acousticians to the development of acoustics on the country-wide scale is characterized. A decisive influence of Professor Malecki's achievements on the growth of the Gdańsk acoustical milieu is demonstrated.

1. Introduction

Several months ago, on the occasion of the forty years jubilee of the Electronics Faculty at the Gdańsk Technical University an attempt was undertaken to collect data concerning the history of the Faculty, and of the entire Technical University. A jubilee book has been edited on that occasion [5], which contained, among others, many detailed information on the development in acoustics. It is the aim of this article to select those data, and to present them as an entity, together with necessary explanations and appropriate comments.

Starting a historical essay on the development of acoustics one can not refrain from recurring to its most ancient foundations. It is worth mentioning that, although acoustical problems were already treated abundantly by famous philosophers of the antiquity, Pythagoreas, Aristotle, Euclide, or by its engineers such as Vitruvius, and by many others, the name of acoustics appeared but in the seventeenth century, coined probably by Kircher, in his treaty "Fonurgia". Later on, acoustics developed, as a section of physics, especially fast in the eighteenth and nineteenth century, thanks to contributions of a pleiad of renown scientists, from Durerney and Chladni through Young, Fresnel, Fourier, Poisson and Laplace, to Corti, Helmholtz and Strutt-Rayleigh [2].

At the threshold of the twentieth century, electrical and electronic methods applied to acoustics caused an accelerated progress of that interdisciplinary domain. Gradually, electroacoustics, room acoustics, hydroacoustics, aeroacoustics, geoacoustics, audiology, psychoacoustics, sonochemistry, noise control, ultrasonics, molecular acoustics, bioacoustics, sound engineering, musical acoustics, speech recognition and synthesis, sound reinforcement and many other branches of acoustics developed into almost independent disciplines.

A landslide development in the area of acoustic applications has begun with the advent of computer technology. Sound studio techniques applied to broadcasting, film and television, and other media are omnipresent factors influencing everybody's life now. Voice controlled systems and especially voice-operated, speaker-identifying computers will soon become a crucial step in a further revolutionary progress of human civilization.

In spite of such brilliant achievements in the field of applications, the role of acoustics among university disciplines is underestimated. Acoustics has not reached, so far, a faculty level at any university. Laboratories, chairs, or even institutes of acoustics are components of various faculties, either of mechanics, or electronics, or physics, etc. Thus, didactic programs for acoustical studies can not be rationally conceived, being rather a compromise between discrepant directions of teaching. Due to that situation, students graduated in acoustics are too narrowly educated within the fundamental of acoustics. The situation can improve only when acoustics at universities develops into independent faculties.

Creating faculties of acoustics requires, first of all, a formation of their adequate scientific and didactic staff. Before this is achieved, it is worth observing such a development on the example of the Gdańsk Technical University. The knowledge of the history of a development helps in its further progress.

2. Early rudiments

The history of the Gdańsk Technical University began in the year 1904, when it was opened under the name of Technische Hochschule Danzig [4]. Searching for rudiments of acoustics in Gdańsk should concern the periods preceding the first, and the second World War. Helas, documents from those periods were lost during destructions in 1945. However, some data were recovered.

It is namely known that in the year 1908/09, a new organized Chair of Light Technics and Telecommunication conducted laboratories on telecommunication measurements, which had to include some acoustic measurements. Laboratory equipment was founded by the renown enterprise Siemens & Halske. Other facilities were built in the period between the two wars.

In 1945, immediately after the cease of hostilities in Gdańsk, a Polish crew restoring to order the University buildings found an acoustic laboratory in an almost undamaged state. An anechoic chamber in the Building of Electrotechnics was equipped, among others, to particle velocity measurements by the Rayleigh disc

method. That laboratory provided a rudimental base of the Chair of Applied Electrotechnics and Acoustics, then organized under the leadership of Professor Ignacy Malecki, at the Electrical Faculty. The Chair started research and teaching in the domain of acoustics, concentrated mainly on problems in architectural acoustics and in hydroacoustics. A former laboratory of the German navy, left in the harbour of Gdynia, was employed for the latter group of problems [3].

3. First achievements

One of the two earliest Ph. doctor's dissertations acquired at the Electrical Faculty, in 1950, concerned hydroacoustics problems. The doctor's degree has been obtained by dr Z. Góra-Zubalewicz, whose promotor was Professor MALECKI [5].

Starting from 1946, lectures on Electroacoustics were given by Prof. Malecki to students of the third year, at the sections of teletechnics and radiotechnics. The lectures continued till 1951, when Professor Malecki was transferred to Warsaw [5]. Earlier, however, he wrote a series of Polish original textbooks on acoustics, very important for scientific and didactic purposes in a recently organized university.

The first book, entitled "Mechanism of the sound propagation in rooms", was edited in 1949 by a publishing house A. Krawczyński, in Gdańsk, and sponsored by a Gdansk students' editing commission "Bratnia Pomoc" [1]. The book was an enlarged version of the second dissertation (habilitation), written by Prof. Malecki during the war period, in the years of the heaviest Nazi terror in Poland. Scientific activities in that period, as it is said in the book foreword, became fighting tools for the liberation of the country. The text was preceded by a review of late Professor M. Wolfke, the eminent Polish physicist, who highly appreciated the value of the book, emphasizing its role as the first Polish scientific publication on room acoustics.

4. A pause

Professor Malecki's transfer to Warsaw caused a pause in acoustical activities at the Gdańsk Technical University. However, the pause was not absolute. Professor Malecki acted as promotor or reviewer of dissertations in the domain of acoustics. Acoustical problems entered in research works and didactic programs of various chairs at the Faculty of Electronics (earlier Faculty of Communication). Among others, the Chairs of Radionavigation, of Radiocommunication, of Fundamentals of Telecommunication, and partly others, applied to the studies of acoustical problems. Some studies connected to acoustics were also pursued at the Mechanical Faculties. Those activities prepared a necessary basis, first of all, a qualified staff of academic teachers ready to start again a full scale scientific progress in the domain of acoustics.

5. Continuation of achievements

During a reorganization of the Electronics Faculty, in 1969, a department was created, destined exclusively to acoustical research and teaching. Organized by Professor Zenon Jagodziński, under the name of Hydroacoustics and Electrophony Department, it comprised two separate Laboratories: Hydroacoustic one and Electrophonic one. Later on, in 1982, the Laboratories developed into independent Departments under the names of Hydroacoustics, and of Sound Engineering. Both Departments underwent a fast, continuous process of development, becoming a strong scientific centre, which helped in research and education in other institutions.

The development process may be characterized, on one hand, by a number of graduations obtained in acoustics at the both mentioned departments. The total number exceeded five hundreds MSc and BSc degrees. On the other hand, the professional level of the graduates is highly assessed by institutions where they work, many of them working abroad at very advanced positions.

A number of dissertations in acoustics obtained at the Electronics Faculty TUG is also an attribute to the achievements of the Gdańsk acousticians. The total number of 26 promotions, among them 19 titles of doctor of science and 7 of habilitated doctor of science, including those obtained at other universities by this Faculty scientists, were awarded so far [5].

Recently, after a reorganization of the Faculty, a new unit has been created, namely the Chair of Acoustics, which includes the Departments of Sound Engineering and of Hydroacoustics, as well as some specified laboratories.

6. Acoustics at other Faculties of the Technical University

Besides of the Electronics Faculty, acoustics problems were practised at some other faculties of the Technical University, in cooperation with acousticians-lecturers from Electronics: e.g. at Architecture, where lectures on Architectural Acoustics and Environmental Acoustics were given, or at Mechanics, where research cooperation in acoustic measurements techniques were maintained, or Shipbuilding, where underwater acoustics problem were of common interest. Series of lectures on environmental acoustical problems were also given to all students within a general education course.

7. Acoustics at other Gdańsk educational institutions

Acoustics at the Electronics Faculty also influenced the developments of activities outside the Technical University. Both acoustical Departments cooperated and helped actively in the creation of the Environmental Laboratory of Acoustics, organized at the Gdańsk University. At the Gdansk Academy of Music, a Laboratory of Musical Acoustics was created, as well as courses on Technology of Experimental Music were introduced there, thanks to the participation of the TU Sound Engineering Department.

A long term scientific and didactic cooperation was established between the Department of Hydroacoustics and the Naval Academy in Gdynia. Several other departments of the Faculty, as well as of the former Shipbuilding Faculty, actually Oceanotechnics Institute, participated in that cooperation.

Cooperation with local industry plants, as well as with those all over the country, concerning acoustical problems was also developed. Especially worth mentioning was a close cooperation with the Polish Committee on Radio and Television, which comprised not only didactic, but also scientific and productional aims.

The cooperation started in the fifties, when an educational formation of the Polish Radio technical staff in Northern Poland was entrusted to acousticians of the TUG Electronics Faculty, under the supervision of M. Sankiewicz. More than hundred of proficiency certificates and titles of technicians have been conferred during that period of theoretical and practical training. Further cooperation developed into common scientific and production activities. A commonly organized stereophonic sound studio at the Electronics Building produced numerous sound recordings for broadcasting through Gdańsk Radio and TV transmitters, as well as for the central program emitted from Warsaw. Those activities became an excellent basis for professional formation of students, graduating in Sound Engineering, and gained a durable popularity of this direction of teaching among Faculty candidates.

8. Gdańsk share in national and international acoustical cooperation

Scientific and, especially, didactic achievements are generally difficult to be valued or appreciated. However, they may be estimated on the ground of presentations made by authors before a competent audience, such as usually gathers at the meetings of scientific societies. Therefore, contributions to society activities may be, to some extent, treated as a criterion of achievement quality on a larger than local scale.

In the sixties, Gdańsk acousticians joined the Polish Acoustical Society, governed then by the Poznań centre, with Professor Helena Ryffert as Society President. In 1981, however, Professor Zenon Jagodziński, then head of the TUG acousticians, was elected the PAS President. His successor, Professor Antoni Śliwiński, the actual PAS President is from Gdańsk University too. The Gdańsk Branch of the PAS organized in the seventies and eighties several country-wide Open Seminar on Acoustics, with the participation of acousticians from abroad. The Gdańsk seminars outnumbered other ones relative to the number of papers and participants.

In the meantime, other specialized symposia were organized by the Gdańsk PAS Branch, first of all, Symposium on Hydroacoustics, held yearly since 1984, and Symposium on Sound Engineering, held biannually since 1985.

An important world-wide acoustical event, and an outstanding success of the Gdańsk acousticians from both the University and the Technical University, was the organization of an international conference entitled "Prospects in Modern Acoustics — Education and Development" held at Jastrzębia Góra near Gdańsk, in 1987. The concept of this conference and its affirmation by the International Commission on

Acoustics, as well as by the International Union of Pure and Applied Physics, was again due to Professor Malecki, while Professor Śliwiński acted as President of the Organizing Committee [6].

Gdańsk acousticians participated more and more frequently in conferences and congresses organized abroad. Besides, they went to training periods or to visiting-professor contracts to several foreign universities or scientific centres, e.g. to France, Great Britain, Germany, Greece, Denmark, United States of America, Canada, etc., being revisited by their foreign partners. The Gdańsk acousticians are members of several foreign acoustical societies, e.g. Société Française d'Acoustique, Acoustic Society of America, Audio Engineering Society, Hellenic Acoustical Society, Deutsche Arbeitsgemeinschaft für Akustik, etc. Experience gained from all the above mentioned activities permitted to undertake a new important initiative.

In 1991, Gdańsk acousticians have been authorized by the Governing Bodies of the Audio Engineering Society to create a new regional section of the AES. Then, the Polish AES Section was founded in Gdansk, which was become the Board site of the new scientific society in Poland. Actually the Polish AES Section, under the chairmanship of M. Sankiewicz, has already about one hundred members, which actively participate in society actions.

9. Concluding remarks

A short essay on the development of acoustics in the Gdańsk Technical University does not permit all achievements, to be properly characterized and presented with an appropriate balance. Their value might be comparatively estimated if faced with the achievements of other scientific centres in Poland, or, moreover, to those abroad. Such estimation would need enlarged studies, which actually are beyond possibilities of the present authors.

However, in order to deliver another information, more appropriate for comparisons, a total number of publications written by the acousticians of the Technical University of Gdańsk has been evaluated, basing on recently published data [5]. This number amounts to 931 publications, including co-authors' items, written by 51 acousticians. At any rate, it seems to be an important contribution to the developments of acoustics in Poland.

A final conclusion occurs irresistibly. The achievements done by Professor Malecki during the period of his activity in Gdańsk, turned out to be fruitful, despite the period of a supposed pause. Thus, the Gdańsk Technical University has become an important scientific centre for Acoustics, especially for Hydroacoustics and for Sound Engineering, i.e. exactly those two acoustical domains initiated then by Professor Malecki.

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CATEGORICAL PERCEPTION IN ABSOLUTE PITCH

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Three music students, possessing of absolute pitch, participated in an experiment of categorical identification of two adjacent musical pitch categories A_4 and B_4 . Next, they also participated in the experiment in which their ability to differentiate between two tone pulses separated by frequency level distance of 25 cents was tested. When ABX procedure was used with the tone-pulse length reduced to 20 msec and the interstimulus interval extended to 10 sec, the between-category discrimination in two subjects markedly exceeded the within-category discrimination, which signalled the existence of categorical perception.

1. Introduction

The words "absolute pitch" (AP) mean the ability of some musically trained people to recognize musical tones of a desired pitch (passive AP) or both to recognize and produce them (active AP) without being given any tone of reference (BACHEN [1], RAKOWSKI and MORAWSKA-BUNGELER [15]). Most people, also including professional musicians, do not possess this ability, which possibly can be developed only in early childhood (WARD [16]). Instead, they can practice and develop the ability to recognize and to produce a number of frequency-ratio categories called musical intervals. The ability to deal with musical intervals and their sequences (melodies) is called "relative pitch" (RP).

The phenomenon of absolute pitch can be described as the existence in the long-term memory of a set of 12 standards and corresponding "chromas" or categories. These standards, which are imprinted in the long-term memory with considerable accuracy, serve in the formation of those categories as salient points along the frequency-ratio continuum (MORAWSKA-BUNGELER and RAKOWSKI [12]). The chroma categories are nearly a semitone wide and in "good quality" AP possessors have sharp, well-defined boundaries.

The shapes of chroma-category boundaries are very similar to those obtained in experiments concerning the perception of synthetic speech sounds. In course of such experiments performed at Haskins Laboratories, LIBERMAN et al. [7] found and