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CONTRIBUTION OF PROF. I. MALECKI TO THE POLISH SCHOOL OF ACOUSTICS

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A detailed study of the history of the Polish acoustics does not exist. The easiest way to present such a history might consist in describing the activity of separate teams, gathered around several leading personalities. The following publication is an attempt to present the scientific contribution to Polish acoustics of Professor Ignacy Malecki himself and of the teams which were co-operating with him.

The first Polish research on acoustics was started in the middle of the thirties. During the war period, lectures on acoustics were given at the underground Warsaw Technical University. When the country was being rebuilt after the war, solutions of the problems of acoustics of the reconstructed halls, as well as proper solutions for the noise control in the building industry were required. The scientific research at the Warsaw Technical University, and at the Building Research Institute has started. The Electro-acoustical Chair was founded at the Warsaw Technical Unversity. Later on the Institute of Fundamental Technological Research of the Polish Academy of Science was established, where research on acoustics, aimed mainly at the ultrasonic testing, the improvement of noise measurements, and the acoustics of speech, were conducted. Theoretical studies on the electro-mechano-acoustical analogies and the coupled electro-acoustical fields were carried out. Heterogeneous media, especially ceramics, were tested theoretically and experimentally. An interest in hypersounds and in the quantum representation of the acoustical phenomena was growing. The diffraction field and the transport of the vibrations through the ear channel have been described using the quantum method. Focal point hase been shiflet from the measurement of the acoustic waves velocity and their attenuation to the investigation of the active phenomenon, i.e. the acoustic emission was performed, and different fields of its application were developed. The acoustic emission during the brittle fracture and during chemical reactions were also studied. Scientific cooperation with other countries and the teaching activity associated with the research undertaken were conducted.

1. The pre-war period

The first research and technical work on acoustics in Poland date from 1935–36. At that time, a few centres, which dealt with those problems, were set up. These were: the Institute of Physics of the Poznań University, (M. Kwiek), the Research

Department of the State Tele- and Radioengineering, Warsaw (Z. Żyszkowski), the State Institute of Telecommunication (T. Korn, W. Pajewski). The institution which was mostly interested in the development of acoustics in Poland was, however, the "Polish Radio", therefore the foundation of the Technical Division of the Polish Radio Research Department in 1936 was the fact of a great importance. Engineer Ignacy Malecki (born 18th of November 1912) was appointed the head of this division; in that time he had already some experience in the field of acoustics, since in 1935 he had started his doctor's thesis, promoted by a famous acoustician Prof. Edwin Mayer, at the Heinrich Hertz Institut in Berlin. The thesis was dealing with generation of ultrasounds of very high frequency, as it was regarded in these times (200 kHz), by a tourmaline crystal. The political course of events interrupted his work at the Institute, so that I. Malecki came back home and took up the above-mentioned post.

At those times, the Polish Radio used almost exclusively foreign electro-acoustical equipment, mainly German and American. Design of the broadcasting equipment in Poland was therefore not needed, but the improvement of the sound quality in broadcasting studios by their suitable shaping, and proper selection and arrangement of microphones were of main interest. I. Malecki was acquainted with the broadcasting technique in certain European broadcasting stations, so he could undertake the task in a competent way, which consisted in designing the acoustic system for the Polish Radio Center. The Center was to be founded in the very down-town area of Warsaw. The design of the Center was completed before the war, and the work on foundations of its main building started in the spring in 1939. The design contained many pioneering (in those times) solutions concerning, among others, the technological process of recording, and the wide range regulation of the reverberation time of the studios.

2. The Second World War (1939–1944)

The outbreak of the Second World War cancelled these plans. Vicissitudes of Polish acousticians during the war were different. Some of them left the country, others, as M. Kwiek, earned his living by repairing church organs. I. Malecki stayed in Warsaw. As he cooperated with the Warsaw Technical University before the war, he took part in organizing of the underground activity of this college. For him, it was a possibility to do some teaching, though in a limited range, on acoustics. He lectured on the architectonic acoustics at the Achitecture Faculty of the underground Technical University. Using professional literature smuggled from abroad, he continued theoretical studies related with his previous experimental research, which had been undertaken during his work for the Polish Radio. Working often with the risk of his life, he completed his doctor's thesis, which he defended at the underground University in 1941, and in 1943 he presented his habilitation thesis (needed for the position of an associate professor), and he received the "veniam legendi" (the right to lecture at the universities). Both theses referred to the architectural acoustics; they were entitled: '*The Physics of Porous Materials*' [1], in which he dealt with the mechanism of attenuation of sonic waves by capillary structures, and *Propagation of Acoustic Waves*

in Halls. In the latter thesis he developed the theory of acoustic field in case of an uneven distribution of sound absorbing materials on the walls of a room, and he applied a statistical approach to transient states in a bounded space. I. Malecki came there independently to the same conclusions which may be found in the results of the research of L. Cremer and R.H. Bolt, which were undertaken at the same time.

3. The 1945–1953 period

Remnants of the laboratories of the Warsaw Technical University were destroyed during the Warsaw Uprising in 1944. Some of the few scientists, who survived the war and did not leave the country, started to rebuild the universities and research laboratories. The acoustical institution at the Technical University of Poznań (M. Kwiek) and the laboratories of the State Institute of Telecommunication (J. Kacprowski, W. Pajewski) associated with acoustics were restored. The laboratories were not totally destroyed, since the battles of the Warsaw Uprising did not reach the Institute area. Departments of electro-acoustics (Z. Żyszkowski) and otolaryngology were created in Wrocław from the very foundations.

Since no experimental basis for a scientific work existed then in Warsaw, and the work on reactivation of the Warsaw Technical University proceeded slowly, Dr. I. Malecki decided to leave for Gdańsk. The activity of Prof. Malecki in Gdańsk was characterized in the paper of M. Sankiewicz and G. Budzyński [2]. Prof. Malecki headed a group of people who had never dealt with acoustics before. There were: J. Góra, the first postgraduate student of Prof. Malecki, and J. Wojciechowicz, an excellent designer. This group undertook ambitious tasks, which were urgently needed for rebuilding the destroyed country; acoustic designs of the reconstructed and new auditoria, and reproduction of the hydroacoustic equipment used by the German Kriegsmarine.

At the same time education of young engineering staff began. In 1946, at the age of thirty-four, Dr. I. Malecki was nominated a full professor by the president of Poland. In 1950 Prof. Malecki returned to his mother college — the Warsaw Technical University, where he took over the Chair of Electro-acoustics of the Telecommunication Faculty. During a few years he held responsible posts at the University — as the dean of the faculty, and then as the vice-chancellor for scientific affairs. At the same time, he took an active part in the organization of the Polish Academy of Sciences.

The Chair of Electro-acoustics, which was headed by Prof. Malecki for almost twenty years, educated several generations of acousticians and electro-acousticians in this period, mainly in the fields of movie and broadcasting techniques, room acoustics, and design of electro-acoustical equipment. It was the only institution of this speciality in the Warsaw area. The faculty closely cooperated with the industry and polish broadcasting W. Straszewicz, M. Abramczyk, S. Basiński and W. Lenczewski were the first staff members of the chair.

The field of scientific activity of Prof. Malecki in those days was the resultant of the demands of the country in times of reconstruction and industrialization, and of his own scientific interests. Prof. Malecki continued his work on architectural acoustics, which he had started before the war, and presented its synthesis in a book [3].

His designs concerning restoration of the Polish parliament (Sejm), the National Theater in Warsaw, auditoriums, the movie and broadcasting studios, were accomplished. Dr. W. Straszewicz, who was an assistant professor at the Electro-acoustics Chair at those times, was the closest collaborator of Prof. Malecki. He was the author of the acoustical designs of many prestigious halls, such as the that of the National Philharmonic Hall in Warsaw, the Grand Theatre in Łodź, the Philharmonic Hall in Bydgoszcz.

The large-scale reconstruction of the country required the introduction of modern, industrialized building methods, large-panel constructions. That brought new problems for acoustics — design of prefabricated walls and floors, acoustical insulating level of which might be acceptable by the users. In order to attain it, J. Sadowski organized the Laboratory of Building Acoustics at the Building Research Institute, the scientific adviser of which became Prof. Malecki. Development of the measurement methods [4], examination of acoustical properties of the building materials used in Poland, and proposals concerning novel constructions and materials [5–8] were the results of this cooperation.

A few years later Prof. Malecki came back to these problems and he presented, basing on further experimental results of that laboratory and on his own theoretical studies, the theory of impact noises transmission through plate floors [9, 10]. He presented there the application of the theory of wave propagation in an infinite plate to the problem of wave motion in a rectangular plate with boundary conditions simulating the parameters of real floors, the flexural Lamb waves being taking into account. This work attracted the interest of building specialists of the Easteuropean countries of that time.

From the problems of building noise control Prof. Malecki passed to the acoustics of urban planning systems [11], and in this field he co-operated with J. Sadowski.

Looking for more effective methods of industrial noise control, Prof. Malecki started the research on the theory of spatial absorbers, and performed the measurement of a prototype construction [12–15]; this work was conducted in the Chair of Electro-Acoustics.

The pre-war contacts of Prof. Malecki were continued. Optimizing of acoustical conditions in broadcasting studios was still the principal scientific and engineering problem. A considerable part of his books: *The broadcasting and movie acoustics* [16] and *The technique of sound recording* [17] were devoted to that problem. The books were a compendium of the state of knowledge in this field at those times. Original scientific papers of Prof. Malecki, which were connected with this problem, concerned mainly the criteria of acoustical quality of broadcasting studios [18–21]. Prof. I. Malecki presented these papers at several conferences of the Organisation Internationale de Radiodiffusion [22, 23]. This organization accepted the practical conclusions following from those publications.

Apart from the applied research, Prof. Malecki was also interested in the fundamental research, serving as a theoretical basis of different fields of aocustics. In the period discussed, the beginning of the fifties, the foundations of modern acoustics were created [24, 25]; a revision of the classical system of Kelvin's electro-mechano-acoustical analogies became necessary. Firestone formulated an "improved" system, which concerned the lumped constants scheme. Prof. Malecki in several publications [26–31] presented extensions of both the analogy systems to continuous and isotropic media, and also to the transmission lines. An essential aspect of the study consists in treating the acoustic impedance as a wave quantity [32], and in application of the mathematical methods used in telecommunication to the problem of propagation of elastic waves in rods [33]. In his later studies Prof. Malecki frequently used to return to different methods of application of the electro-mechano-acoustical analogies. Many years later he summed up his research in a book form [34] and he kept on dealing with these problems, in cooperation with Dr R. Uklejewski [35].

4. The 1953–1969 period

Let us return to Prof. Malecki's personal history. Working still as a head of the Electro-Acoustics Chair of the Warsaw Technical University, he found a new and a wider field for his activity in the Polish Academy of Sciences (PAN). He became its corresponding member in 1953, and its full member in 1957. In October 1953 the presidium of the Polish Academy of Sciences nominated him for the post of a director of the recently created Institute of Fundamental Technological Research of the Academy. It was (and is) an interdisciplinary institute, and became the largest institute of the Academy a few years later; its most important departements were: mechanics of continuous media, automatics, electronics, and acoustics. Work in the field of acoustics was conducted in the Department for Vibration Research, which was headed by Prof. Malecki, independently of his post of the Director General of the whole Institute. He spent nine years at this post, until he left for the Presidium of the Polish Academy of Sciences in 1962. He acted as a scientific Deputy Secretary of the Academy for more than two tenures.

The Department for Vibration Research was dealing mainly with the ultrasonic methods, what caused a change in the subject matter of Prof. Malecki's scientific research. A team of young, talented acousticians worked in this institution. All of them are professors now. They were, among others,: Prof. J. Wehr, who greatly contributed to the development of measurement methods of the velocity and attenuation of ultrasonic waves [36, 37], and unfortunately died tragically in 1977; Prof. L. Filipczyński, the designer of the first Polish ultrasonic flaw detectors [38], who developed the theory of ultrasonic waves diffraction at obstacles [39] and the electro-acoustic transducers theory. Further on his scientific way, he was most successful in the field of medical ultrasonic diagnostics. The work of the team he headed [40] brought him an international approval. Recently he was elected a member of New York Academy of Sciences. The book written by him, together with Prof. J. Wehr and Prof. Z. Pawłowski [41], was a compendium of knowledge of Polish

materials engineers during many years. Prof. Z. PAWŁOWSKI had a great share here as a mechanician and a materials scientist. He also published a series of papers in the field of materials testing methods [42, 43].

Prof. J. KACPROWSKI, the oldest member of this group headed by Prof. Malecki, started his activity in the team creating the foundations of the theory of electro-mechano-acoustic transducers [44]: then he developed the methods of acoustical measurement of noise, e.g. [45], and finally he concentrated on the problems of speech analysis and synthesis, e.g. [46], where he was an unquestionable authority.

In the discussed team, the problems of elimination of noises and vibrations were represented mainly by Prof. S. CZARNECKI. His achievements included the development of the theory of sound control by resonators [47] and screens [48]. He was, together with Prof. Malecki, an initiator of many research and engineering projects, which were undertaken by the team. Unfortunately, he died untimely in his most creative years.

Prof. J. RANACHOWSKI was one of the first co-workers of Prof. Malecki in the Department for Vibration Research, and then in the Institute, where he also acted as the deputy director for many years. Prof. Ranachowski organized a team dealing in a comprehensive way with acoustic properties of brittle materials, especially of ceramics. Starting with his doctor's thesis [145], he developed a theory, based on experimental verification, of dependence of the ultrasonic wave velocity and attenuation on the structure and strength of ceramic materials [49–51, 151]. A very high measurement precision was obtained and new general rules were discovered. Results of the research found numerous applications, mainly to testing the high-tension insulators [148, 149].

The problem of reconstruction and development of the Polish mining industry, which was urgent in 1950–1955, was an impulse for Prof. Malecki to undertake, together with Prof. W. Kołtoński, the laboratory and *in situ* investigation on application of ultrasound as a tool for prospection of geological strata [52–55]. The managerial duties did not allow Prof. Malecki to continue the *in situ* work, which were then taken over by Prof. KOŁTOŃSKI [56] together with Dr. A. JAROSZEWSKA [57]. Prof. Malecki dealt mainly with directing the ultrasonic engineering development in the institute and in the whole country. A series of his synthetical papers [58–68] date from this period. They were of a great significance for the development of the Polish acoustics, since they pointed at the research problems which had not been solved yet, suggested priorities, and presented the industrial and social importance of acoustics.

The research on the acoustic properties of ceramics, conducted by the author of this publication, also undertaking the problems of prospecting of geological strata, and next the general aspects of ultrasonic non-destructive testing, directed attention of Prof. Malecki to the theory of propagation of ultrasonic waves in heterogeneous media. The theory has not been entirely developed till now. He focussed his interest mainly on the "granular" media, as they are vastly represented in modern technology [69–75]. The idea was based on treating the heterogeneities which appear in a material, e.g. spherical pores in technical porcelain, as a system of spatial sources, which radiate a wave of disturbance. A single obstacle impedance was also considered

[76]. The theory of granular media was verified experimentally and improved theoretically [77] by Prof. J. Ranachowski who used an example of porous ceramic materials [78]. In addition to electrical porcelain, sintered copper materials were tested, which also exhibit porosity, subject to theoretical determination [147].

In the period of his work in the management of the Polish Academy of Sciences in 1962–1969, Prof. I. Malecki was unable to conduct experimental work; however, he kept on working theoretically and, first of all, he completed his monumental monograph — about 700 pages — which was published in Polish in 1964 [79], and then, in an improved and supplemented version, edited in English by Pergamon Press (Oxford) in 1969 [80]. For Polish acousticians it was a basic university handbook and a valuable aid for research work. Unfortunately, both editions are not available nowadays.

In that time the scientific interests of Prof. Malecki were directed to higher frequencies of acoustic waves, in the range of hundreds of megahertz [81, 82].

A transducer utilizing the coupling of the mechano-acoustic field with the electro-magnetic field seemed to be the most promising source of high frequency elastic waves. In theoretical studies, it led to a more general problem of coupled fields theory. Prof. Malecki cooperated here closely with Prof. S. Kaliski, who was a leading specialist in this field at those times. The problem was based on computing the influence of electric or magnetic field on the attenuation and velocity of propagation of the Rayleigh wave in a boundary layer between the media. The wave velocity dispersion effect appears particularly distinct when one of the media is an ideal conductor.

The statement that a feedback appears at a coupling of an electron beam propagating across the boundary surface of two media with an acoustic wave, was of importance for further theoretical research and applications. A negative attenuation of acoustic wave appears when specified conditions concerning the media and the electron beam are fulfilled, so an electronic amplifier appears [83]. Laboratory tests of such amplifiers were conducted by Prof. Kaliski.

The theory of coupled fields was the subject of Prof. Malecki's plenary lecture at the 5th Congress of the International Commission on Acoustics (ICA) in Liége in 1965 [84]. The lecture was given a very good reception by the congress participants.

Attention has been also paid to the necessity of evaluation of nonlinear effects during propagation of acoustic waves. The contribution of Prof. Malecki to this problem was presented in a few papers [85–88], where he drew attention to the significance of the third harmonic in distortion measurement.

5. The 1969–1983 period

The next logical step in Prof. Malecki's scientific interests was transition to the research on the phenomena in the gigahertz band (hypersounds). These are mainly theoretical studies, as they were done in the period when Prof. Malecki was holding important managerial positions — in 1969–1972 he was the director of the

Departement of Science Policy of UNESCO in Paris; after he return home he once again took over the post of the Director of the Institute of Fundamental Technological Research.

Prof. Malecki was fascinated by the question of passage from methods of classical acoustic to the quantum acoustics; he dedicated nearly ten years of his scientific activity to the problem. He published two monographs [89], [90] on this topic, which included original theoretical solutions. He also published a series of articles [91 – 99].

Prof. I. Malecki's theoretical work on quantum acoustics deals with two slightly different questions: (1) improvement of the quantum acoustic methods for description of systems in which the quantum structure of acoustic field is not approximable by the methods of classical acoustics (it refers mainly to hypersounds); (2) utilization of the quantum method as a convenient tool for analysis of the acoustic field of lower frequencies (including audio-acoustical problems).

In the first scope, the most important results of the research, obtained partially in cooperation with Dr. M.M. Dobrzański [92, 94, 95, 100], included: (a) calculation of phonon scattering by reversion of obstacle spins [94]; (b) application of the Airy equation to the description of boundary conditions in quantum closed system [91, 93]; (c) determination of the range of applications of the Hamilton-Jacobi equation for the boundary conditions [95]; (d) description of interaction of phonons with exitons [99].

Co-operation with Dr. M.M. Dobrzyński lead to results of a large significance. Prof. I. Malecki proposed a formulation of an acoustic wave as a stream of quasi-phonons, which correspond to moving oscillators with distinguished wave numbers [91, 96, 103]. The usefulness of such a presentation was demonstrated on an example of calculation of acoustical scattering around an elastic obstacle in a liquid medium [92].

A new idea was the application of the quantum acoustics method to the description of transmission of sound signals in the internal ear. It has been suggested that the quantum approach is useful for presentation of discontinuous processes occurring during excitation of the hearing organ near the auditory threshold [102, 104, 107, 108]. The auditory canal was presented as a chain of quasi-quantic wave oscillators. The limiting value of the sound intensity incident at the eardrum, at which the application of quantum methods is necessary, has been defined.

The research in the field of quantum acoustics, which has been initiated by Prof. I. Malecki, is developed theoretically and experimentally by his close collaborators. The quantum phenomena are most easily observed in hypersonic frequencies, so the design of resonant and thermal sources of hypersounds by M. Aleksiejuk have been the starting-point. He worked in a team with W. Larecki [105] and S. Piekarski [110], who were dealing with the theory of quantum acoustic fields.

Nowadays, experimental and theoretical studies are going in the direction of testing the acoustical properties of high-temperature superconductors [111] and generation of hypersounds by superconductor junctions [111].

With reference to his earlier works, Prof. Malecki dealt also with developing the electro-mechanical analogies for quantum systems [93, 97].

6. The period from 1983

After his retirement, Prof. Malecki has not reduced his scientific activity; on the contrary, having more time for himself, he could resume the experimental research. Prof. Malecki is still employed in the Institute of Fundamental Technological Research, where he closely cooperates with the team of Prof. J. Ranachowski. This activity resulted in a few synthetical studies [113–118, 119], and in several invited lectures at the 6th Congress of the Federation of Acoustical Societies of Europe (in Zurich in July 1992) [120], and at the 14th Congress of the International Commission for Acoustics (ICA) in Beijing, China, in September 1992 [121].

Prof. Ranachowski's team has undertaken a comprehensive research of the acoustic emission (AE) phenomenon and its application. A modern method of AE measurement has been elaborated. The AE analyzers which have been produced on the basis of the method are widely used by Polish scientific institutions. The research has also allowed to determine, more accurately than before, the dependence of the AE activity on the brittle fracture process, what has opened new possibilities for evaluation by the AE method the strength, "time of life" and fatigue processes of materials [125, 126]. Presently, an investigation of the correlation of the AE activity with electric effects is carried out.

Prof. RANACHOWSKI's team dealt also with the photo-acoustic method of materials evaluation in collaboration with Prof. I. Malecki [151, 152].

The closest collaborators of Prof. Malecki are: Dr. J. RZESZOTARSKA, who deals with the acoustical emission phenomena in chemical reactions; she has studied a specific acoustic emission effects which occur during the oscillatory reactions [122]; and Dr. Z. RANACHOWSKI, the designer of the analyzer of the acoustic emission effects, who deals with electronic processing of these signals, particularly with application to concrete [123]. He has started to deal, together with Dr. M. MEISSNER and under guidance of Prof. Malecki, with the simulated sources of acoustic emission. The subject of their work [124] consists in designing of the simulated sources and propagation of the signals emitted by them.

The research on the influence of thermo-mechanical processes on the acoustic emission (AE) activity, which was undertaken by the team of Prof. Ranachowski, has been utilized for a comparative study [127] of AE activity during temperature changes in different materials and processes. It enabled the observation of some regularities, based mainly on the asymmetry of the AE activity during heating and cooling of the material. Dr. WITOS, co-operating with Prof. I. Malecki, dealt with the evaluation of utility of the descriptors of AE signals [128]. The research on the AE includes also the theoretical study of Prof. I. Malecki on the determination of the frequency and the amplitude distributions of the AE signals depending on the degree of spatial distribution and correlation of the sources [129].

Recapitulation of previous achievements has been presented in the comparative analysis of the AE applications [130].

7. Organizing activity in Poland

Shortly after the end of the war, Prof. Malecki tried to gather the remaining Polish acousticians and to attract young engineers and scientists to the work on acoustics. At the same time, being aware of the weakness of the Polish acoustic community in those days, he invited several leading foreign acousticians to conferences, organized by him. During the period 1953–1966 six such conferences took place, organized by the Institute of Fundamental Technological Research. The first three conferences [131–133] were of particular importance due to their pioneering character. They took place in turn at Krynica (1953), at Międzyzdroje (1956), and again at Krynica (1958). They were devoted to ultrasounds and to electro-acoustical transducers. The other conferences, dealing with different sections of acoustics, took place in Warsaw. These conferences were of a great importance for the stimulation of research on acoustics in Poland. They had also a definite international extent, because Prof. Malecki, thanks to his wide personal contacts, managed to assure the participation of prominent acousticians from the countries of Western Europe and from the Soviet Union. During the cold war period it was one of very few opportunities to meet for the two groups of scientists of the same speciality, who hardly knew anything about each other. Advantages of such meetings were evident and fully appreciated by the participants of those meetings.

Scientific cooperation with France was particularly successful. Prof. Malecki and Prof. Pimonow (CNET Paris) were co-chairmen of the Polish–French Colloque sur Ultrasons [134–136]. These events took place every two years, alternately in Jabłonna near Warsaw and in Paris, in the years 1978, 1980, 1982, 1984 and 1987. It was a rare example of a systematic co-operation of friendly scientists from both the countries.

The greatest international meeting of acousticians in Poland was the 2nd Congress of the Federation of Acoustical Societies of Europe (FASE), which took place in Warsaw in 1978 [137]. It was the initial period of the activity of this organization — the first congress took place in Paris in 1975. Prof. I. Malecki was the president of the congress. Prof. S. Czarnecki was the president of the Organizing Committee and the leading debate animator. For the first time so many foreign acousticians (about 350 persons took part in the Congress) could acquaint with the Polish achievements in the field.

The conferences were good opportunities for casual meetings; a systematic co-operation of the whole community was also necessary. Apart from the Polish Acoustical Society, which was founded in 1961 by Prof. M. Kwiek (who died in a tragic accident a few years later), there was a necessity of organizing an official representation of the Polish acoustics, and publishing a journal dedicated to acoustics. Prof. Malecki has been devoted to this idea during his whole life: integration of the Polish acoustic community, collaboration, and presentation of achievements independently of the specialities of individual acousticians. Prof. Malecki took up this initiative and, after many efforts, he succeeded in putting into effect the resolution of the Presidium of the Polish Academy of Science, establishing the Committee for Acoustics of the Academy in 1964. Prof. Malecki was appointed the first chairman of this Committee and was

being relected to this post for the two next terms until 1969, when he left for Paris. The committee played an important role in presenting the Polish achievements in acoustics to the authorities, to the society, and to other countries. Prof. L. Filipczyński has been the chairman of the Committee since 1970, while Prof. I. Malecki was elected the Honorary Chairman of the Committee.

The quarterly Archiwum Akustyki, which began to appear in 1966, (originally edited by Prof. S. Czarnecki), is being published in English as Archives of Acoustics since 1969 Prof. J. Lewandowski is now editor-in-chief. Prof. I. Malecki was the Chairman of the Editorial Board for many years.

Great importance of co-ordination of the scientific research in the field of acoustics [153, 154] by means of the governmental projects should be also mentioned. These projects contributed, to a great extent, to the animation and thematical integration of the research in Poland.

8. The international co-operation

Prof. I. Malecki is known among scientists of many countries not only as an acoustician but also as one of the initiators of a new scientific field — the science of science. It has strengthened his position on the international ground and, thanks to that, he was elected a vice-president of the International Council of Scientific Unions (ICSU) in 1962, and he held this post until 1966. ICSU is the governing body of sixteen international unions in the field of exact and natural sciences, among others the International Union of Pure and Applied Physics (IUPAP). The International Commission for Acoustics (ICA) is the member of this union. Appreciating the achievements of Prof. I. Malecki in the international field, and his personal output in acoustics, IUPAP designated him to the post of the ICA chairman in 1966 and repeated this election in 1969. He was the president of two ICA world congresses in Tokyo in 1968, and in Budapest in 1971, where he delivered the opening lectures [138] [139] [140], and presented the development of the world acoustics and its future trends. The ICA members from Poland were later Prof. L. Filipczyński (1974–80) and Prof. A. Śliwiński (1981–89).

The development of acoustics in Europe made it necessary to organize international congresses and symposia not only world wide but also on a regional scale. This is why several prominent acousticians (J. Frenkiel, W. Furrer, H. Zwicker, I. Malecki) initiated the Steering Committee of the Federation of Acoustical Societies of Europe (FASE). The formal foundation of the organization took place at its first congress in Paris in 1975. Since then Prof. I. Malecki has actively taken part in the FASE activities. In 1979 he was elected to the post of the vice-president of FASE. After his term in the office was over, the participants of the FASE meeting in Goettingen elected him a Honorary Member and a life-member of the FASE Scientific Board.

Prof. Malecki is also in a frequent contact with acoustical societies of many countries. He has been elected to a Honorary Member of: the Acoustical Society of Poland, the Acoustical Society of Spain, the Ultrasonic Society of India, the Latin

American Acoustical Society. He is a fellow of the American Acoustical Society. He is a Doctor Honoris Causa of the Technical University of Budapest and of the Academy of Mining and Metallurgy of Cracow.

The appointment of Prof. Malecki to the chairman of the structured session on the Acoustic Emission (AE) at the 14th ICA Congress in Beijing in 1992 [141] was a mark of appreciation for Prof. Malecki's latest scientific works in the field of AE.

9. Education of acousticians

As mentioned above, Prof. Malecki started to lecture at the Warsaw Technical University during the war period. Then, as he was the head of the Electro-Acoustics Chair for twenty years, he had a vast influence on the creation of study programmes in the field of acoustics at this university. Lecturing on fundamental acoustics, architectural acoustics, movie and broadcasting acoustics and ultrasonic engineering, he educated many generations of Polish acousticians. He promoted dozens of dissertations. His lectures on basic acoustics for the first years of study at the Telecommunication Faculty of the Warsaw Technical University contributed to popularization of acoustics among future engineering of other specialities; Prof. Malecki presented his remarks concerning the problems of acoustical education in publications [142, 143].

The integration of the acoustical community and, as a result, creation of the Polish school of acoustics, seems to be the most valuable achievement of Prof. Malecki. The enclosed list of twenty-four doctor's theses, which were promoted by Prof. Malecki, shows the weight of this school. Twelve of Prof. Malecki's postgraduate students are professors nowadays.

The book: *Problems and methods of modern acoustics* [144], which was published on the occasion of Prof. Malecki's 75th birthday, shows the output wealth of the school created by him.

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