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SCIENTIFIC AND ENGINEERING PROBLEMS FACING POLISH ACOUSTICIANS FIFTY YEARS AGO

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1. Introduction

After the II World War's of awful destruction of the whole country, material goods, and its population, but in the same time the common will of the nation to rebuild the ruins, to develope the home industry and to assure acceptable conditions for every-day life created the unique historical chance to undertake the huge engineering and technological tasks. The polish acousticians played a modest nevertheless significant role in the solution of the problems related with the realization of these tasks.

Polish acoustics has the tradition of the research activities since the beginning of the thirties, mainly in the field of the architectural and physiological acoustics.

During the occupation time the polish acoustics suffered the hard loss a number of acousticians did not survived or emigrated abroad, however some theoretical research was pursued. An important fact for the future was that the lectures related with acoustics and electroacoustics were continued at the electrotechnique and architecture faculties of the underground Warsaw Technical University.

In spite of everything, just after the war several young acousticians supported by the students of the newly founded or old universities were able to participate in the national efforts of rebuilding the ruins. First off all they continued to carry on the intensive efforts required of acoustics concerning the definite solutions of the key engineerings problems to be taken into account by engineers, planners, economists and the local and central authorities.

To fulfill this role of the advisers the home scientific research in the field of acoustics had to be initiated and developed, as the essential basis for the adequate treatment of the engineering problems, all the more that the west-european and american experiences e.g. in building acoustics were not fully applicable for the specific local conditions.

Four engineering problems closely related with acoustics were of crucial importance for the rebuilding of the country fifty years ago:

1) town planning,
2) dwelling houses construction,
3) public halls design,
4) noise control in industry.

2. Town planning

The cooperation of acousticians with the region and cities planners and architects was mostly related with the following objects:

1. On the global country scale — the location of newly founded large industrial centers, the foundation of new or drastic changes of the existing cities sizes and importance, the conception of the basic infrastructure principally the planning of the high-ways.

2. Inside the cities — the mutual situations of the noisy objects like the industrial plants, of heavy traffic routes and the places where relative silence is required like hospitals or universities. The protection of quiet areas e.g. parks for citizens to relax.

3. The architectural plan of the living quarters including the fixing of distances between houses and the number of its stores, the localization of streets and places of public interest.

From the point of view of acoustics, town planning is mainly related to the research of the out-doors sound waves propagation. The studies taught soon after the war included the following themes:

1) the attenuation and deflection of sound wave propagation over ground caused by strips of vegetation and screens,

2) the calculation of minimal admissible distance from the sound source as function of the source parameters and the acceptable noise level,

3) the dependence of large distance sound wave propagation from wind direction,

4) the first stage of the systematic measurements of the "acoustic atmosphere" of large cities (Warsaw) and the preparation of the "acoustic maps" of noisy streets.

To formulate the advise concerning town planning it was necessary to dispose the reference point namely, admissible noise level this general question will be discussed at the end of this paper.

The chance to influence the planners decisions depended on the scope of the projects.

It was not at all possible at global level, from the acoustical point of view, because localization of large industrial centers near the great cities like Cracow and Warsaw had an entirely political character and the directions of the principal high-ways had defined by the strategic military reasons. The position of acousticians by the detail town planning e.g. as concern the situation of the hospitals, the universities and the industrial plants of local interests was more favourable. In several cases the close cooperation of the architect and the acoustician was attached first of all in Warsaw and as its outcome the acoustic requirements were complied e.g. for the design of houses stores, number and orientation to the streets.

3. Dwelling houses construction

In consequence of the lack and vital need of flats throughout the whole country cheap and efficient technologies of house building were necessary.

The elaboration and realization of new technologies was the priority task of the civil engineers and the entire building industry. The prefabricated elements production was generally recognized as significantly advance as compared to the traditional brick construction. Later on the thermal low pressure steam technology of concrete production was typical, but after the war the prefabricated elements were first of all used for ceilings as the light hollow blocks. The brick walls were built as thin as possible. Naturally the sound insulation between flats was very poor and complaints from the inhabitants about bad acoustic conditions were common.

In theory the technical solution was very simple, by the application of flotting ceilings or floors and by the construction of thicker walls. However, such proposals were unrealistic from an economic point of view.

The polish acousticians underthought the research to find a possibly cheap and effective way to increase the insulation of the prefabricated elements to air-born sound and impact noise.

Several original theoretical works was done on the vibrations of the plates with different types of perforation and boundary conditions. The fulfillment of block hollows by the sound absorptive material, the vibration damping between the plates and the new construction of ceiling blocks were experimentally investigated.

The efforts of the acousticians to ameliorate noise insulation in dwelling houses gave in general only restricted results, nevertheless in a number of flats, the additional means for noise abatement were applied partly from private founds.

4. Design and construction of halls

During the II World War the majority of theaters, concert halls and cinemas were destroyed. In Warsaw after the uprising in 1944 all the buildings of public interest were completely in ruin.

Just a few months after the end of the war Warsaw was again confirmed as the capital and the restoration of the places important for national culture was generally approved as a priority.

The design of large halls like theaters, concert halls and broadcasting studios the advise and cooperation of the acousticians was indispensable. It was not accidental, that the acoustics of halls or more general architectural acoustics had in this time rather favourable conditions for development.

Part of the research in this field was the continuation and the experimental verification of previous theoretical works.

The scientific research was divided into two main issues

1) the analysis of sound field distribution in an enclosure,

2) the condition for the optimal subjective perception of music and speech.

As usual the three methods of sound field analysis: geometrical, statistical and waves propagation were applied.

In the range of the geometrical method the polish research concerned:

— The interaction of several waves fronts generated by the given spatial distribution of the "virtual" point sound sources.

— The graphical three dimensions sound rays presentation.

— The application of three dimensional light beams models. This last method appeared very efficient for the design of the reflective surfaces in the ceilings of the large halls.

The research in the field of the statistical method were interesting

— The calculation of the sound field inhomogeneities due to the distribution of the sound absorptive area.

— The correction of the usual reverberation time formula by taking into account the difference of absorption capability due to the local sound field intensity.

The wave method improvement was at this time one of the leading subjects of interests in several research units in Europe and the USA and of discussion at the acoustical international meetings.

Polish acousticians participated in these discussions contributing some remarks upon the more precised definitions of notions of clearness, the spatial diffusity, and limit distance.

Another field of research were the properties of sound absorptive materials. The following items were subjects of studies:

— The influence of material porosity degree and structure.

— The calculation of the materials input impedance in the function of the plane wave incidence angle.

— The designs of the bulk absorptive devices having the absorption coefficient larger than one.

For the design of the theaters, concert halls or auditoria the subjective quality of music and speech perception is a decisive factor of appraisal. The polish acousticians were fully conscious of this requirement and the psychoacoustics was one of the field of research.

Already before the war some works related to the subjective feeling of the reverberation time were done. After the war in the time of fast reconstruction of a large number of halls the well known criteria of the optimal reverberation time (e.g. Knudsen) were applied. Nevertheless some own research were undertaken, for instance it was necessary to elaborate the specific method for estimation of the intelligibility of polish speech. In research initiated in the frame of the International Broadcasting Organization (OIR) had as the aim the method for the comparative evaluation of the subjective quality of the broadcasting studies.

The measurements of the reverberation time and the estimation by the large teams of listeners the subjective acoustic quality of the newly built or reconstructed theaters and concert halls also had general value. The comparition of these data with the parameters of the halls internationally recognized as the best was interesting from the scientifical point of view. From my own experience and the relations of my friends it is underlining

the close and friendly cooperation of the architects and acousticians. The reconstruction of the large halls of great importance for the national culture should be recognized as a joint creative achievement of the architect and acoustician for this reason I would like to mention the names of Prof. M. KWIEK (Warsaw Great Theater) and dr W. STRASZEWICZ (Warsaw National Philharmonie and Great Theater in Łódź) sadly both deceased.

5. Noise control in industry

Noise control in industry is an important part of the general problem of labor protection. In principle the assurance of saver conditions of work was one of the key watchwords of the government. However, the necessity of the continuous industrial noise control were rather disregarded. Only the spread of professional diseases (deafness) caused by the long-period of work in noisy conditions has been taken into account by decision-makers.

Nevertheless acousticians tried to act in the two directions: reduction of noise and vibrations at the source and the decrease of average noise level in industrial plants. The first task was related mainly with some proposals of changes of details of machineries, the technological processes or transportation means. For instance the changes of the types of the transmission gears or other design of the transportation pipes for high pressure gas or chemical liquids were elaborated. Some research works were initiated concerning the vibration of moving parts of machines and the generation and reduction of flow-induced noise.

However, the acousticians had few occasions for direct cooperation with design institutions. The proposals for the means of noise and vibrations were often rejected, because its overcomed the obligatory rigid rules and methods of the construction of the industrial equipment and systems.

The position concerning the average noise level control in large production halls was more favourable. Some proposals concerning the placement of sound absorptive materials inside the halls, the elimination of reflecting area on the hall ceilings and the screening of very noisy machines were accepted by the managements of the several (however not numerous) industrial plants. The research related with the properties of sound absorptive materials and sound propagation in the enclosures were useful also for these projects.

6. General problems

To attain the ambitions aims of the polish acoustics fifty years ago some preconditions were indispensable.

To execute or even to formulate the requirements related with noise control, the value of admissible noise level should be defined for several most important cases, namely for trafic noise, out-door of buildings noise, noise inside houses and at the working places. The research into this matter was carried on only in the very restrain range, chiefly directed to the support of some complains e.g. related with the loss of hearing or unpleasant living conditions. For general purposes the ISO standards and experiences of well known

laboratories were admitted as references. However for efficient activity legal confirmation of this requirements was necessary. For this reasons already few years after the war the Polish State Committee for Standards accepted several polish standards for admissible noise levels. Unfortunately the law or by-law on noise abatement at the parlamentary or governmental level was not considered in these years.

Another important condition for the success of acoustics was the capability of acoustic measurements. Here the significant contribution gave the industry connected with the electroacoustic devices production and the universities and research institutes which elaborated the prototypes of the polish sound level-meter.

It is also necessary to stress the role of the international cooperation for the young polish acoustical community. The political situation at this time was of course unfavorable for the official East-West scientific agreements. However, some scientific contacts with the West of Europe based partly on previous personal links were retained. The most important acoustical journals were available, also the participation of polish acousticians in international scientific meetings gradually increased for instance since the second ICA (International Commission onAcoustics) congress in 1953 (Stuttgart) polish acoustians were represented at these congresses and even in the ICA board. To be quite objective it is necessary to underline the significant role of the close cooperation with the acoustical organizations mostly the committees on acoustics of the Academies of Sciences of the countries of the parts communistic blocks.

Finally it is worth stateing that at this time after all the prime duties of the polish acousticians was the teaching of students and the cooperation with engineers, architects, physicians and last but not least with the decision-makers at different levels. We were obliged to accept this priority in spite of pure cognitive scientific research.

In consequence the major part of publications were addressed to the home specialists and practitioners, edited in polish as the books or the papers in professional journals. Of course, the contents of these publications are now obviously out-of-date. But in spite of all this was the significant attainments of the polish acoustical community and it seems just to indicate as references the books publish in polish a few years after the war, a few later editions which include some valuable information about the past are also indicated.

This paper was a different character than the scientific papers usually published in this journal. However, it seems that the position of the polish acoustics interests as being part of world history of the development of acoustics as scientific discipline and as a modest participant in changes in social and cultural conditions after wartime disasters.

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