

# LASER-BEAM TECHNOLOGY IN DIACHRONIC PHONETIC RESEARCH AND ETHNOLINGUISTIC FIELD WORK

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## ABSTRACT

In recent years, laser beam technology has been used to reproduce the sound from wax phonograph cylinders and other old recordings. These methods have been used for the reconstruction of speech of the aboriginal population on Sakhalin which has been recorded in the beginning of this century. In this way, very useful data on earlier stages of languages and dialects have become available for linguists and anthropologists.

## 1. USE OF THE PHONOGRAPH

The principle of the original phonograph is simple: a metal horn focuses the energy of the sound waves onto a thin diaphragm, which supports a small needle in its centre. When the diaphragm vibrates in response to the energy of the focused sound waves, the needle, too, vibrates as it is drawn across the revolving surface of a wax cylinder. The needle cuts a groove consisting of microscopic gouges in the soft cylinder surface. In this way, a recording of the pattern of sound waves is made. To play back the recording, the needle is replaced over the gouges made during the registration. The attached diaphragm vibrates and creates sound waves duplicating those which had originally been recorded.

From the early use of the phonograph until the coming of portable disc-recording equipment, the phonograph was the only means of recording phonetic data. In the late 1880s, ethnographers were intrigued by the possibilities of applying the new cylinder phonograph for field work. It was used for the first time around 1890 for the study of American Indian speech and in the beginning of this century Ainu data were recorded on the island of Sakhalin, north of Japan.

## 2. WAX CYLINDERS AND THE PROJECTS FOR THEIR RESTORATION

Old recordings on wax cylinders are still being kept in many places. It would be of great interest to regain the sound material they contain, and to improve its quality by using modern digital techniques of registration and signal enhancement.

The events which have led to the project on the retrieval of sounds from wax cylinders started in Poland with the discovery of a number of phonographic wax cylinders. They contain linguistic, musical and ethnographic material, primarily on the Ainu people of Sakhalin. The recordings were made at the beginning of this century by the Polish anthropologist Piłsudski [1].

The Institute of Linguistics of Poznań University (Poland), Hokkaido University (Japan) and the Institute of Linguistics of Groningen University started a common project to analyse material obtained from the phonograms and other old recordings and to set up ethnolinguistic field work. The goals of this collaboration are the following:

- a. Application of acoustic, electronic and optical engineering techniques to the retrieval of information on phonographic wax cylinders and other old recordings;
- b. The interpretation of the phonetic and linguistic contents of the recordings, and the study of the languages of Sakhalin at the beginning of this century;
- c. Phonetics and ethno-musicological analysis of the recorded speech and songs; comparison with present day material.
- d. The organisation of field work expeditions to the Minority Peoples of the North in the USSR.

## 3. THE REPRODUCTION SYSTEM

Using the original Edison-type phonograph for the reconstruction of the sound material involves a risk of damaging the wax cylinders. This method cannot be applied to broken cylinders which have been repaired. Thus a non-destructive, non-contacting method has been developed on the basis of laser-optics technology.

A Gaussian beam emerging from the single-mode He-Ne laser with a wavelength of  $0,633 \mu\text{m}$  is focused by an objective lens. The wax cylinder, which is translated during rotation, is illuminated by a diverging Gaussian beam of which

the spot diameter on the cylinder can be adjusted to the width of the grooves. The detecting plane for the reflected beam is set perpendicular to the optical axis. The wax cylinder is rotated, whereas the intersection position of the reflected ray on the detecting plane moves in time on this plane. The time variation of the position is detected by a position-sensitive device and it corresponds to the acoustic signal. The signal stored can be deduced from the detected variation of the reflected beam.

The properties of the sounds reproduced in this way depend on the width of the illuminating laser beam, since its finite size breaks down the principles of geometric optics on which the method is based. Further, there is the obstructive noise in the sound, caused by using a coherent laser beam for illumination, and there is the tracking error resulting from improper contact with the grooves. These problems have been investigated experimentally by Asakura et al. [2], who found that the most suitable beam width for the laser-beam should have a spot diameter between 80 and  $100 \mu\text{m}$ . In this way, the sounds reproduced can be heard naturally and without obstacles. Since the laser-beam reflection method is non-contacting and non-destructive, it is a powerful tool for retrieving sounds from old wax cylinders without damaging them.

## 4. SIGNAL ENHANCEMENT

The data are stored on new optical/digital sound carriers and in order to improve the quality of the sound obtained, special techniques have been developed. The sound reproduced from old recordings is usually of poor quality. This may be caused by the original recording

techniques (e.g. resonances in the horn), by the damage of the cylinders which has occurred over the years (clicks at burst positions) and by the techniques of reconstruction. In order to improve the sound quality, several methods have been developed which can also be applied to speech enhancement in general. In Japan, various programs have been developed and applied for this purpose [3]. In the case of the Ainu tapes, the result of the processed sounds was not always satisfactory: in several cases, the listeners preferred the original unprocessed sounds, even if there was noise on the tape. This was due to the fact that after processing the noise level is reduced, but certain bad-quality-features are still there and become more prominent. The recorded and processed Ainu data are stored at the Research Institute of Applied Electricity, Hokkaido University (Japan).

#### 5. RESULTS OF THE WAX CYLINDER RESTORATION PROJECTS

The Japanese project has provided the possibility to study the Ainu language from Sakhalin as it was spoken at the beginning of this century. Originally, the Ainu people lived in the Northern part of Japan, on Sakhalin and the Kurile Islands; at present their language is only spoken on Hokkaido. Old Ainu people were consulted when the material from the Pilsudski wax roles was played to them. In some cases, they recognized their Ainu dialect and the voices from the past.

In this way, the last stages of a dying language have been safely recorded. The material can be studied by linguists and ethnologists in order to obtain information on

the Ainu people. The wax cylinders and their contents can thus be considered to be part of a very important cultural heritage, because they contain valuable sound data of speech and songs of the Ainu people that were lost long ago.

#### 6. THE ETHNOLINGUISTIC FIELD WORK ON SAKHALIN.

In July and August 1990, the University of Hokkaido has organized an international field-work expedition to Sakhalin in order to study the language situation of the original population on that island and the way this has been influenced by Japanese and Russian.

The idea was to look for the Ainu population and to investigate the status of the other small minority groups, in particular Nivkh (Gilyak), Uilta (Orok) and related Tungusic peoples, who were the first inhabitants of Sakhalin. Unfortunately, during our expedition no more Ainu people could be found, and the only person who represented the Ainu language and culture from Sakhalin was probably the old informant we met on Hokkaido.

The original population of Sakhalin consisted of some Paleo-Siberian and Tungusic peoples, in particular the Nivkh and Orok in the North and Centre, and the Ainu in the South. Their numbers were rather small, and during the colonisation process by the Russians from the North and by the Japanese from the South, they were soon numerically dominated by these stronger nationalities. Due to their isolated life as hunters and fishermen, they were able to keep their native language and culture for a long time, but since the beginning of this century the assimilation process has gradually become stronger.

The dramatic events of 1945, culminating in the Soviet occupation of the whole island, had enormous consequences for the ethnographic and linguistic situation on the island: practically all Japanese inhabitants and together with them many of the aboriginals, left Sakhalin for Japan. New immigrants came from all parts of the Soviet Union and at present, more than 100 nationalities are living on the island. Several of them still cultivate their own language.

During the expedition to Sakhalin, a great deal of material on the Minority Peoples of the North was collected: about 80 hours of audio, 30 hours of video and numerous photographs and written documents. Part of the recordings consists of interviews with representatives of the minorities of Sakhalin. These interviews can be considered as 'case studies' of the language situation for particular minorities. Most of the material is related to the Nivkh population.

The life of the Nivkh and other Minority Peoples of the North has changed considerably under the influence of Russification. They have become a small minority on Sakhalin, scattered over the island and surrounded by Russians and other immigrants who take part in Russian culture.

During our field work expedition on Sakhalin, most of the subjects for our project were elderly people with a strong motivation to use their language. Practically all young people we met no longer had an active knowledge of the language, and they only communicated in Russian.

It can be concluded that on Sakhalin a process of assimilation is taking place, which may result in the complete disappearance of these small languages and cultures.

This process of "language death" may, however, slow down, if these minority cultures are receiving more attention. Further field work should be conducted in order to facilitate the conservation of data on the languages and cultures of these Peoples of the North and other minority groups.

The data collected about these aboriginals (Nivkh, Orok and others) are now analysed and a description is given. The availability of these data will enable a comparison with the historical recordings.

#### 6. REFERENCES

- [1] ASAKURA, T. et al. (ed.) (1986), *Proceedings of the International Symposium on B.Pilsudski's Phonographic Records and the Ainu Culture*. Hokkaido University, Sapporo, 1985.
- [2] ASAKURA, T. et al. (1986), "Reproduction of the Sound from old Wax Phonographic Cylinders using the Laser-Beam Reflection Method". *Applied Optics*, 25, 597.
- [3] DE GRAAF, T. (1989), "Reconstruction, Signal Enhancement and Storage of Sound Material in Japan". *Proceedings of the 2nd Int. Conference on Japanese Information in Science, Technology and Commerce*. Berlin, pp. 367-374.