

## EARLY EXPERIMENTAL PHONETICS IN GERMANY – HISTORIC TRACES IN THE COLLECTION OF THE TU DRESDEN

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### ABSTRACT

At the beginning of the last century, the growing interest in foreign cultures and languages led to a rapid development in experimental phonetics. In Germany, Rousselot's scholar Panconcelli-Calzia introduced experimental phonetics as a scientific discipline in Hamburg, as did Gutzmann and Wethlo in Berlin. A number of historic instruments which remind us of these times are preserved at Dresden University now. This paper gives a short overview of the development of experimental phonetics in Hamburg and Berlin and the history of the phonetic collection in Dresden. In the main part, some projects concerning selected objects of the collection are summarized.

**Keywords:** Experimental phonetics; Wethlo's cushion pipe; pitch measurement; mechanical voices.

### ZUSAMMENFASSUNG

Das gewachsene Interesse an fremden Kulturen und Sprachen führte zu Beginn des vorigen Jahrhunderts zu einem Aufschwung der Experimentalphonetik. In Deutschland führte der Rousselot-Schüler Panconcelli-Calzia die Experimentalphonetik als Wissenschaft in Hamburg ein, wie es durch Gutzmann und Wethlo in Berlin erfolgte. Eine Anzahl historischer Geräte, die an diese Zeiten erinnern, befinden sich heute in der TU Dresden. Dieser Beitrag gibt eine kurze Übersicht über die Entwicklung der Experimentalphonetik in Hamburg und Berlin und die historische Sammlung in Dresden. Einige Vorhaben zur Erschließung ausgewählter Objekte aus der Sammlung werden behandelt.

### 1. INTRODUCTION

The foundation of a phonetic laboratory at the Colonial Institute in Hamburg as well as the foundation of the Phonographic Commission in Berlin were the most important steps for the development of phonetics in Germany in the last century. The historic acoustic-phonetic collection of the TU Dresden preserves objects which are very well suited to illustrate this development.

### 2. PHONETICS IN HAMBURG

The Humanities Faculty of the Hamburg University goes back mainly to the Hamburg Colonial Institute, which was opened in 1908. It included a number of chairs working with foreign languages. There, a phonetics laboratory was founded in 1910 as a part of the Department of African Languages, developing later into a separate institute of the Hamburg University, which was founded in 1919.



**Figure 1:** G. Panconcelli-Calzia recording the throat sound and the lip activity using a kymograph.

From 1910 to 1949, the Phonetics Laboratory or Institute, resp., was directed by Giulio Panconcelli-Calzia (1878–1966, [1], Figure 1) who was a scholar of the Abbé Rousselot. He was an ingenious researcher who built the institute into a place of international scientific importance. He founded the journal *VOX*, which served as an international platform for experimental phonetics. It is notable that the First International Congress of Experimental Phonetics took place in Hamburg as early as 1914.

A detailed description of the history of the institute is given in [2]. In the 1990s, the educationals branch of the institute was transferred to another department. The remaining part, which focused to general phonetics, was closed down at the end of the winter term 2006/07 due to the re-structuring of Hamburg University.

### 3. PHONETICS IN BERLIN

At the Berlin University, phonetics was established as an institution out of two disciplines: linguistics and medicine. The linguistic root is formed by the Phonographic Commission, founded in 1915, which started up to record the voices of speakers representing foreign peoples on wax cylinders or records. This institution developed in several steps into an Institute of Sound Research at the Berlin University. In 1951, the institute was renamed Institute of Phonetics.

The second root of phonetics at the Berlin University is represented by Hermann Gutzmann sen. (1865-1922), who worked as a voice and speech pathologist. Gutzmann, who made Speech Therapy part of the University's curriculum, collected all the new instruments and research devices that had been used since 1900 by the emerging discipline of experimental phonetics. It was on Gutzmann's initiative that the first Phonetics Laboratory was founded in Berlin. In 1926, the Phonetics Laboratory became an independent institution under the direction of Franz Wethlo (1866–1960). Wethlo received the teaching assignment for Experimental Phonetics in 1926, which gave him the opportunity to extend the laboratory and to purchase new equipment. He developed numerous pieces of apparatus. After the re-opening of Berlin University in 1947, the Phonetics Laboratory became part of the Institute for Special Education in 1950, which had just been founded.

More details and a description of how the two roots came together can be found in [3] and [4]. After the re-structuring following the German reunification in 1990, phonetics was organized under the roof of the School of Rehabilitation Sciences. As a result of the higher education reform at the three Berlin universities, enrolment for the course of study 'Science of Speech/specialisation Voice and Speech Therapy' was stopped by decree in the autumn semester 1993. This led to the closing down of the subject area Phonetics in Berlin at the end of the year 1996.

## 4. THE HISTORIC COLLECTION AT THE TU DRESDEN

### 4.1. Speech acoustics in Dresden

Information Technology at the TU Dresden goes back to Heinrich Barkhausen (1881–1956), the "father of the electron valve", who taught from 1911 to 1953. Speech research in a narrower sense started with the development of a vocoder in the 1950s. Walter Tscheschner (1927–2004) performed his extensive investigations on the speech signal using components of the vocoder.



**Figure 2:** A view into the collection.

In 1969, a scientific unit for Communication and Measurement was founded in Dresden. It is the main root of the present Institute of Acoustics and Speech Communication. W. Tscheschner was appointed Professor of Speech Communication and started with research in speech synthesis and recognition, which today continues.

### 4.2. The parts of the collection

The historic acoustic-phonetic collection of the TU Dresden consists of three parts:

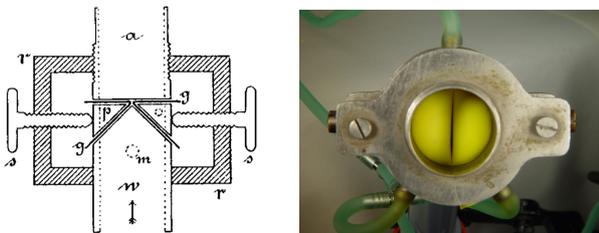
- Objects that illustrate the development of acoustics and speech technology at the TU Dresden [5]. The most interesting devices are speech synthesizers of various technologies.
- Objects illustrating the development of experimental phonetics from 1900 until the introduction of the computer. The items of this part were collected by D. Mehnert from different phonetics laboratories and rehabilitation units throughout Germany. All objects are shown in a web presentation [6].
- Objects which were formerly collected at the Phonetics Institute of Hamburg University. This important collection, which is described in [7], was transferred to Dresden in 2005 in accordance with a contract between the two departments due to the closing of the Hamburg institute.

As a consequence, the collection preserves not only exhibits from the history of its own institute. It also looks after the material estate of the most important phonetics institutes in Germany, which were closed after 97 years of existence in the case of Hamburg and after 80 years in the case of Berlin. The collection is displayed in two rooms (Figure 2) where it can be viewed by interested visitors.

## 5. SELECTED PROJECTS

### 5.1. Wethlo's cushion pipes

A first project dealt with the reconstruction of historical larynx models. In 1898, Ewald had proposed an improvement of the existing larynx models (which used simple membranes as models of the vocal cords) by replacing the membranes with air-pressurized cushions. Wethlo investigated this more natural construction very detailed from 1913 onwards [8]. The model which forms a milestone in the development of voicing theories is known as "Wethlo's Polsterpfeife" (cushion pipe, Figure 3). The Dresden collection includes a number of these objects in different sizes. Some of them are originals from Wethlo's estate.



**Figure 3:** Wethlo's cushion pipe. Left: Cross section from the original publication [8]. Right: Top view of the large cushion pipe with inserted cushions.

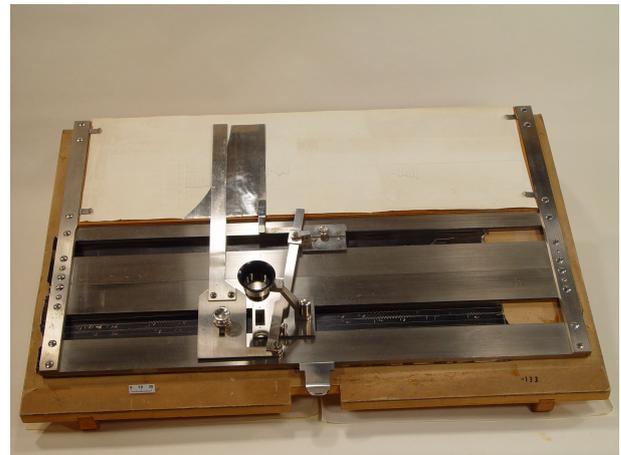
In a series of experiments [9] we investigated

- which material was best suited for a working reconstruction of the cushions,
- which air pressures (subglottal and in the cushions) is required for proper voicing with the pipes of large, medium, or small size, resp.,
- which sound quality can be produced by this kind of modelling.

### 5.2. History of pitch measurement

Pitch measurement has always played an important role in phonetics. There were different methods for recording speech signals, but the application of a kymograph was the predominant one (Figure 1). After recording the speech signal, it had to be measured to produce a curve showing the pitch vs. time. The whole procedure of converting kymographic waveforms into pitch contours comprised a number of steps which had to be performed with the highest accuracy. Because this was a very time-consuming process, a number of aids were proposed which were in use until the 1950s. We demonstrated different methods by means of original equipment from the Dresden collection at an exhibition in 2006 [10]<sup>1</sup>.

The Stockholm scientist E. A. Meyer constructed a mechanical aid for pitch extraction without loss



**Figure 4:** Improved version of the pitch contour measuring apparatus.

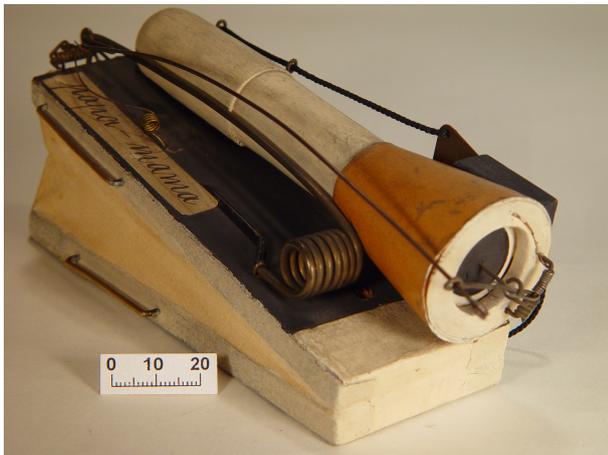
of accuracy. The device is estimated to save 80 % of the analysis time. Following the first experience with Meyer's apparatus in phonetic laboratories, an improved model was developed by Schneider [11] (Figure 4). Its mechanical parts were more robust, and some accessories like a magnifying glass, paper rolls for continuous work, and a so-called length-comparator were added. The measurement was possible with an accuracy of 1/100 mm.

Wethlo aimed to simplify the exact but complicated procedures. He developed a quick procedure which he called 'simplified phonetic pitch measurement' [12]. The devices which he invented for this procedure are shown in the Dresden collection now.

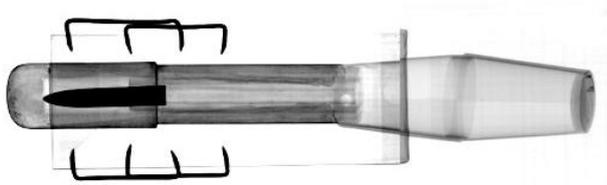
### 5.3. Mechanical voices from Kessel and Hölbe

In the year 1899, the notable otologist Johannes Kessel (1839–1907) presented a number of small mechanical voices like that in Figure 5 at a scientific meeting in Munich ([13], [14]). He demonstrated devices for simple sounds (5 vowels, *r*, *au*) but also for short words (*Papa/Mama*, *Emma*, *Hurrah*). Kessel aimed to use them to teach people who have a high degree of deafness. He recognized, however, that the quality of the synthetic voice was still insufficient for this purpose. Later, the original devices came to the Hamburg laboratory [15, p. 48], where a second set of mechanical voices was bought from the manufacturer in 1917.

The mechanical voices are interesting as early mechanical speech synthesizers. Therefore we started a project to explore the genesis of this technology [16]. It is known that Hugo Hölbe from Sonneberg was the manufacturer of the voices. Sonneberg is a town in Thuringia and was known as the world capital of toys in former times. We learned that "Stimmenmacher" (voice manufacturer) was a



**Figure 5:** The mechanical voice for *Papa/Mama*.



**Figure 6:** X-ray photograph of the mechanical voice for the vowel *o*.

separate profession in the production of puppets and cuddly toys. Hugo Hölbe (1844–1931) is noted as a voice manufacturer in the local address books from 1887 to 1911. His estate includes approx. 60 voice mechanisms which are preserved in the well-known "Deutsches Spielzeugmuseum (German Toy Museum) Sonneberg" [17] now. Among them, the prototypes of the voices which were used by Kessel can be identified. They date back to the year 1870 according to the files of the museum.

Generally, the voices consist of a pair of bellows and a reed pipe with a dedicated shape. It will be interesting to compare these mechanical voices with the state of the art of the acoustical modelling of vowels in that times. The shapes of the "articulation tracts" were analyzed by X-ray techniques as a first step (cf. Figure 6).

## 6. ACKNOWLEDGEMENTS

Many colleagues supported the activities with the historic collection. The authors thank all helpers, especially Dr. Janina Schuldt (Hamburg) and Sonja Gürtler (Sonneberg) for valuable hints and Dr. Rolf Dietzel (Dresden) for taking the photographs of all objects for the web presentation.

## 7. REFERENCES

- [1] Köster, J.: Giulio Panconcelli-Calzia. *The Phonetician*, CL-61, 1992, 3–10.
- [2] Neppert, J.; Pétursson, M.: Death of a Phonetic Institute: The Phonetic Institute of the University of Hamburg. Submitted to *The Phonetician*, No. 93.
- [3] Mehnert, D.: Phonetics at the Berlin University - a Survey. Submitted to *The Phonetician*, No. 92.
- [4] Mehnert, D.: *Phonetik an der Berliner Universität - ein Rückblick auf ihre Geschichte und auf Forschungsarbeiten der letzten Jahre. Studentexte zur Sprachkommunikation, vol. 35.* Dresden: Universitätsverl. 2005, 33–54.
- [5] Hoffmann, R.: *Sprachsynthese an der TU Dresden: Wurzeln und Entwicklung. Studentexte zur Sprachkommunikation, vol. 35.* Dresden: Universitätsverl. 2005, 55–77.
- [6] [www.ias.et.tu-dresden.de/sprache](http://www.ias.et.tu-dresden.de/sprache)
- [7] Grieger, W.: *Führer durch die Schausammlung, Phonetisches Institut.* Hamburg: Christians 1989.
- [8] Wethlo, F.: *Versuche mit Polsterpfeifen. Passow-Schaefers Beiträge für die gesamte Physiologie* 6(1913) 3, 268–280.
- [9] Hoffmann, R.; Mehnert, D.; Dietzel, R.; Kordon, U.: *Acoustic experiments with Wethlo's larynx model. International Workshop to the Memory of Wolfgang von Kempelen, Budapest, March 11–13, 2004. Grazer Linguistische Studien* 62 (2004), 51–60.
- [10] Mehnert, D.; Hoffmann, R.: *Measuring Pitch with Historic Phonetic Devices. 3rd International Conference Speech Prosody, Dresden. May 2–5, 2006.* Dresden: TUDpress 2006, 927–931.
- [11] Schneider, C.: *Beschreibung eines konstruktiv veränderten und erweiterten Messapparates und eines neuen Tonhöhen spitzen-Markierapparates. VOX* 1913, H. 4, 193–201.
- [12] Wethlo, F.: *Vereinfachte phonetische Tonhöhenmessung. Zeitschrift für Phonetik* 4 (1950), H. 1–2.
- [13] Denker, A.: *Bericht über die Versammlung deutscher Ohrenärzte und Taubstummenlehrer zu München. Archiv für Ohrenheilkunde* 47, Nr. 3, Nov. 1899, 198–208.
- [14] Kessel, J.: *Demonstration von Apparaten zur Erzeugung künstlicher Laute. Verhandlungen der Versammlung Deutscher Ohrenärzte und Taubstummenlehrer in München, am 16. Sept. 1899.* Berlin: Staude 1900, 28–29.
- [15] Panconcelli-Calzia, G.: *Quellenatlas zur Geschichte der Phonetik.* Hamburg: Hansischer Gildenverlag 1940.
- [16] Hoffmann, R.; Mehnert, D.: *Die Kesselschen Stimm-Mechaniken in der historischen akustisch-phonetischen Sammlung der TU Dresden. DAGA, Stuttgart, March 19–22, 2007.*
- [17] [www.spielzeugmuseum-sonneberg.de](http://www.spielzeugmuseum-sonneberg.de)

<sup>1</sup> This exhibition will also be presented at the ICPhS 2007.