THE LABORATORY OF EXPERIMENTAL PHONETICS IN PRAGUE BETWEEN 1919 AND 1939: RESEARCH PRACTICES AND STUDENT INSTRUCTION

Pavel Šturm

Institute of Phonetics, Charles University, Prague, Czech Republic
pavel.sturm@ff.cuni.cz

Abstract: The paper examines Prague's Laboratory of Experimental Phonetics in the 'interwar' period. The research is based on primary resources, most importantly a series of reports of the institute's founder, Josef Chlumský, who documented the activities occurring in the seminar of experimental phonetics that took place each semester at the university, and a cash book logging every new item that came into the possession of the laboratory. The attending students experimented with speech and the various ways it could be examined instrumentally. It is shown that the laboratory was utilized not only for scientific research but also for demonstration and educational purposes. Several important publications emerged under the auspices of the laboratory that employed experimentation and instrumental measurement. It is argued that this period at the Institute of Phonetics can aptly be depicted as a place and time of abundant and fruitful phonetic research with a strong experimentation ethos that was transferred to the students as well.

1 Introduction

The aim of this article is not to present an overview of Czech phonetics between 1919 and 1939. Such contributions have been published elsewhere [1, 2], the former reviewing mainly the initial years at the Laboratory of Experimental Phonetics in Prague and its creation, the latter being more linguistically oriented. Founded in 1919 by JOSEF CHLUMSKÝ (1871–1939), the laboratory quickly gained international reputation as an important centre of phonetic research. Since the publication of [1], new documents have come to light. It has been discovered at the current Institute of Phonetics that Chlumský wrote a lengthy report about the activities at his department for the dean of the faculty each year (see Fig. 1). Chlumský's reports reveal many interesting details about the running of the laboratory. The structure of the reports varied slightly over the years, and the following information was usually contained:

- a list of students
- the curriculum for the year
- a list of those who submitted seminar work, and what it was
- comments on the operation of the laboratory, including the sound archives
- a list of new equipment, books and gramophone records
- visits to the laboratory
- personal changes (if any).

The rest of the article will focus on the following questions: What activities were carried out at the laboratory? (Section 2); Who were the actors involved? (Section 3); Where was the laboratory located? (Section 4). This will bring unique and valuable information on actual student work and instruction in the interwar period. Thus, the very short description in [1] *("The participants learned about and practised various methods, conducted painstaking measurements and were encouraged by Chlumský to carry out independent research. They also received auditory and transcription training.")* can now be substantially expanded, and the modern link between research and student instruction highlighted.

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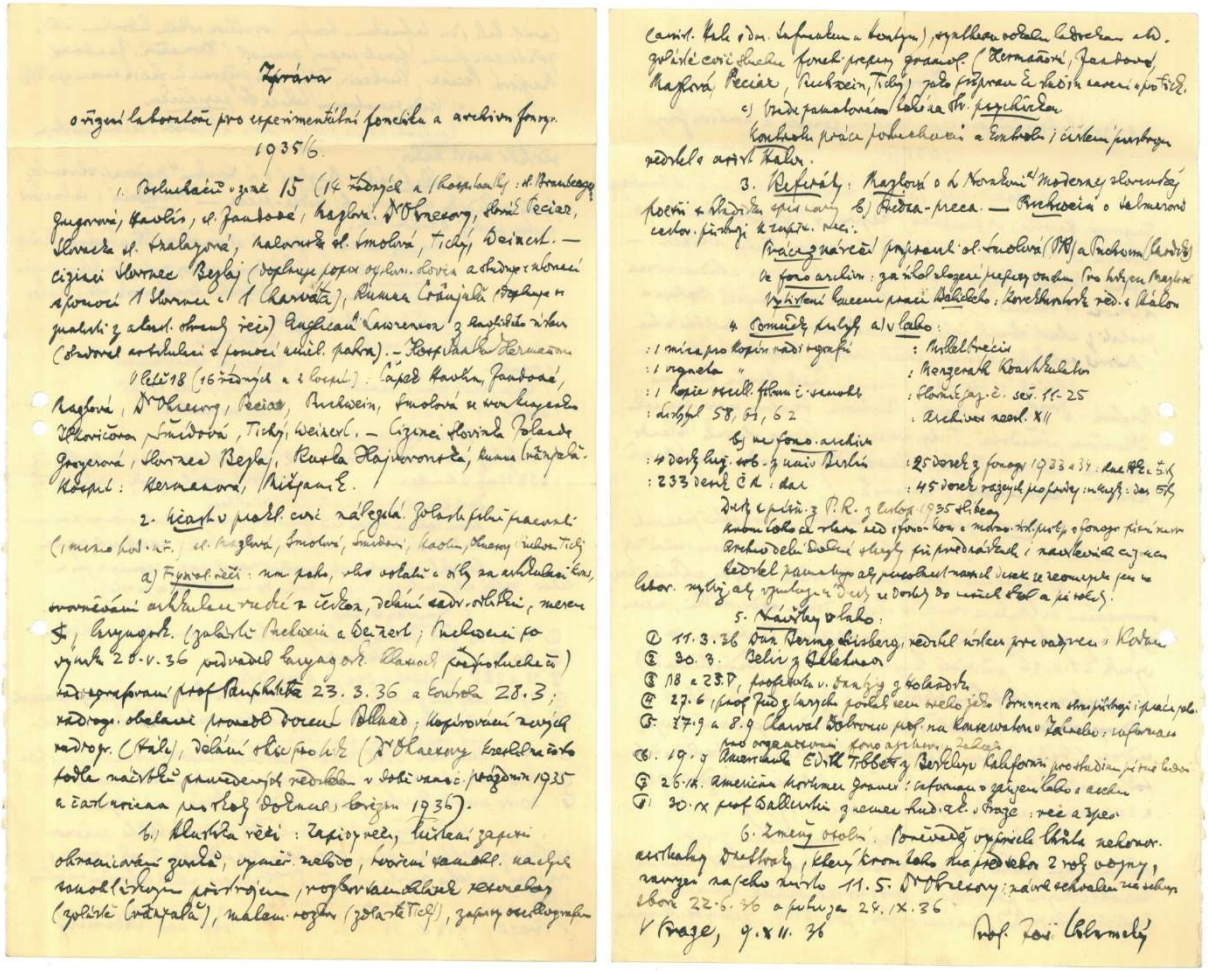

Figure 1. Chlumský's report about the activities of the laboratory for the year 1935/1936.

2 The curriculum at the laboratory

Analysis of Chlumský's reports reveals that the content of the curriculum was remarkably similar throughout the years. Chlumský taught his students the ways of experimentation with speech. That involved a number of instrumental techniques and other approaches to speech analysis. Chlumský classifies the curriculum into three to four parts, which are summarized separately in the reports (cf. Fig. 1, parts designated as "2. a), b), c)" and "3.").

2.1 The "physiological methods"

The most important in Chlumský's view was the introduction to the physiological methods of investigating speech. Being a former pupil and a close friend of Abbé Rousselot, *palatography* featured prominently among the articulatory methods. Students applied paint to the tongue and inspected the hard palate after contact, comparing consonants from different languages (Czech, French, Russian) or tracing the influence of vowels on the place of consonantal contact. It is thus clear (cf. [3]) that the coarticulation phenomenon was known long before Menzerath and Lacerda's pioneering book [4]. In addition, the *artificial palate* was used; students even learned how to create plaster casts of their mouths and how to build the palate. They employed the technique practically in examining their own pronunciation.

The second most important device was the *laryngoscope* and *endoscope* for investigating vocal fold function and the activity of the velum. A variety of sounds was examined, depending on the structure of the student group; for instance, if an American was present, English voiceless [h] was compared to Czech voiced [ɦ]. In any case, states of the glottis were demonstrated during breathing, vowels, [ɦ] and whisper (usually by Bohuslav Hála, see Section 3.2).

In the early twenties, only a few other devices were used and presented to the students, such as *Grandgent's device* for measuring the mandibular angle or *Atkinson's device* for measuring the profile of the tongue during vowel production. A very simple solution was Brücke's approach to determining nasality and nasal airflow: releasing the air against a *burning candle*.

However, as the laboratory inventory grew over the years, new methods were introduced. Breathing patterns were studied with the *spirometer*. Most importantly, *highspeed cinematography* was employed in the late 1920s for capturing the movements of the lips on the one hand and the activity of the vocal folds on the other (in conjunction with laryngoscopy). A specialized collaborator, LUDVÍK HONTY (1903–N/K), assistant at the physics institute and a specialist in scientific cinematography, participated in the recording. In 1930, *stroboscopy* was added to the methods of phonation examination. It was used both for pedagogical purposes and for scientific research. The most famous output of this line of research is Hála's film capturing the movements of the vocal folds by normal, high-speed and stroboscopic cinematography [5, 6]. Lastly, *radiography (X-ray imaging)* of the articulators was possible in Prague already in the 1920s and continued to be employed throughout the 1930s (see Section 3.2). Unlike for teaching, these techniques were used for research by advanced students only.

2.2 The "acoustic methods" ("speech recording")

Chlumský further reports on the "acoustic methods", which he earlier on refers to as "speech recording". The *kymograph* was among the earliest procured devices (1919/20) and was used to great extent for both research and teaching. The students of experimental phonetics were taught how to use the machine and especially how to read and interpret the kymographic drawings. This included the ability to determine boundaries between segments (and thus measure the duration of speech sounds or other units) and the ability to derive the fundamental frequency (F0) contour from the kymograms. Furthermore, the *Lioret machine* was available, which allowed the participants to create visible curves from phonographic and gramophonic records. A *microscope* was necessary to examine the fine curves of the recorded signal. Based on kymographic measures, students demonstrated speech phenomena such as vowel length, geminates, aspiration and voicing, melody and stress (accent). In 1926, a second kymograph was procured to be used by the students on their own – they could borrow it for home.

The material varied; it was collected from the students themselves or from visitors to the laboratory. The focus was on examining dialectal and foreign speech. Occasionally, disordered speech was recorded on the kymograph, e.g., the speech of a woman who lost her larynx but managed to speak anyway, or the speech of epileptic patients. Singing was sometimes recorded and analysed. Any guest at the laboratory, famous or not, usually ended up being recorded.

In the 1930s, increased attention was paid to vowel analysis. *Manometric flames* were used for practical demonstration of sound waves but not for research. Students were also trained in determining the characteristic notes (formants) of vowels using the Prague *tonometre* – a set of precise *tuning forks* [7]. This was a replica of Koenig's tonometre in Rousselot's Parisian laboratory. Tuning forks were used in conjunction with *resonators* (Schäfer's and Rousselot's) to characterize the vowels. An *oscillograph* was available at the physics institute, and thus more precise waveform analyses were possible using sound films. A *Fourier analysis* was sometimes performed manually (mathematically). However, this kind of work was performed only by the most advanced students (see a similar note above).

The equipment was a costly matter. Regular funds from the university would not suffice to procure all these instruments, even the less expensive ones. Therefore, Chlumský received extra funding from the Ministry of Education (equivalents of several thousand French francs a year). All the expenses are logged in the institute's cash book, which would merit further analysis.

2.3 Auditory training ("training the ear")

The physiological and acoustic methods were supplemented with auditory training. This was important to Chlumský, an experimental phonetician, which is documented in expressions such as "Examples of how the sense of hearing is sharpened by laboratory work (e.g., while measuring melody) and of how an untrained sense of hearing can err". In the later years, Chlumský also writes about "psychological aspects" without specifying the details of what he means. What is clear, however, is that the psychological aspects were brought up from time to time during exercises, and regularly during student presentations.

A frequent expression in Chlumský's notes is "training the ear as preparation for the study of dialects". Usually, vowels from different languages and dialects were compared while whispering and then speaking normally. The influence of consonants on the quality of the vowels was also examined (cf. Section 2.1 above). The comparisons depended on the enrolled participants each year and their languages (Czech vs. Slovak/Russian/French/German/Serbian etc.). In addition, dictations by Chlumský in Czech and French served as another means of ear training, often combined with collective phonetic transcription. Chlumský recommends the transcription system of Romance scholars. Alternatively, *phonographic and gramophonic records* (made of shellac and played back at 78 rpm) from the institute's sound archives could be used as source recordings since the 1930s, when the archive was expanded. Individual students sometimes received a whole gramophone record (containing up to a few minutes of dialectal speech, for instance) to be transcribed as seminar work. Although the archive still exists, it has not yet been catalogued and digitized.

It should be noted that it was not only consonants and vowels but also melodic intervals in speech that were practised. Songs were a useful tool for improving the ability to discern intervals in speech. Melody was examined in utterances or lexically in words of tone languages.

2.4 Submission and presentation of seminar work

Finally, Chlumský introduced reading and discussion of recent works in experimental phonetics. Students covered for instance Millet's *Précis d'expérimentation phonétique* and *L'oreille et les sons du langage* [8, 9]. It is not clear whether this was part of the seminars from the start, failing to note it down, or whether Chlumský introduced it in 1925. In any case, students were always required to either prepare and present an essay on an assigned topic, or to hand in a detailed report of their own experiment. Such a report could amount to a dozen of pages with neat, small font and many drawings. Figure 2 displays two pages from the seminar work written by the future Prague School linguist JOSEF VACHEK (1909–1996), who attended the phonetics laboratory at the onset of his studies in the summer semester of 1928. The text describes his pronunciation of each Czech consonant and vowel based on articulatory measurements gathered at the laboratory (using direct and indirect palatography, lip aperture measurements, Grandgent's device and direct observation).

2.5 Summary

Chlumský's reports offer an unprecedented detail into how students of experimental phonetics were instructed in the 1920s and 1930s and what methods and devices they used in laboratory sessions. On a more general level, it should be noted that there was always a significant presence of comparative phonetics. On the one hand, different *languages* were compared 1) auditorily, 2) articulatorily (using palatography), and 3) acoustically (using the kymograph). In the same vein, different *dialects* were compared. The dialects were usually those of the participants, who came from different parts of Czechoslovakia. The most salient features of the dialects – those differing most from Standard Czech used by educated people in some contexts – were targeted. However, dialects of foreign languages were also compared.

Most importantly, articulation/acoustics was complemented with auditory analysis, noting for instance the relationship between a shift in the place of articulation of a given sound (e.g., [k]) in a given language/dialect and the corresponding auditory impressions. This speaks against the simplistic view that experimental phoneticians cared only about the instruments (a view represented in the Czech context for instance by ANTONÍN FRINTA (1884–1975) [10, 11]). It can be argued that they were in fact *auditory* phoneticians who extended their perceptual analyses with *instrumental data* to support their claims. Both components were important aspects of phonetic training at the laboratory in the interwar period.

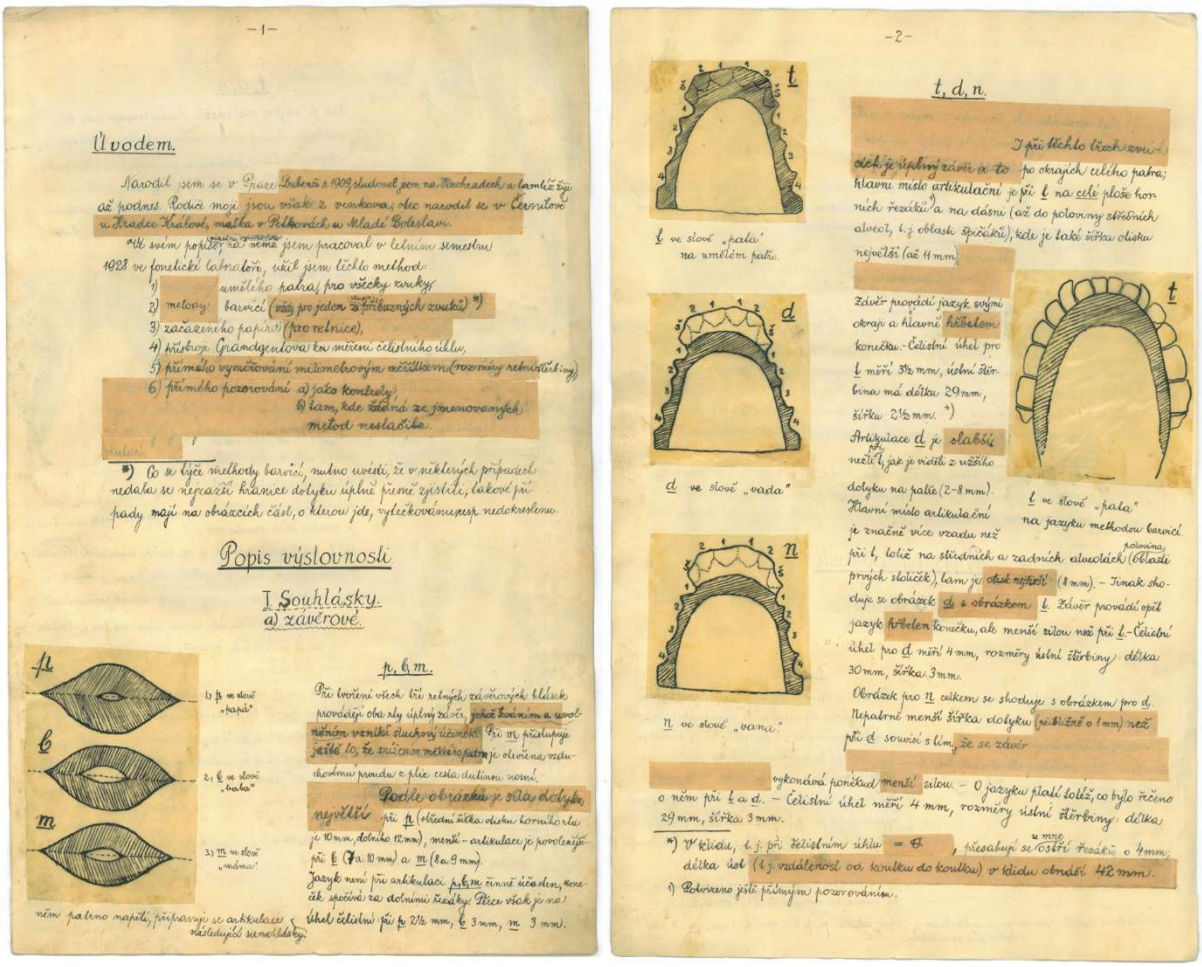

Figure 2. The first two out of 12 pages from the seminar work by Josef Vachek (summer term 1927/28).

3 Participants at the laboratory work

3.1 The students

The laboratory sessions were attended by a variety of people. In addition to philology students at Charles University, they often comprised people from medical fields, people from the musical conservatory, or people sent by important linguists to gain experimental knowledge. Typically, between 10 to 20 students signed up for the course per semester (mean of 14.6; see Fig. 3 for a breakdown). The first drop in Figure 3 seems to be related to Chlumský finishing his life work [12], whereas the second (1933/34) is explained as due to "the director's illness" in the report. Although the majority of participants were Czechs, foreigners comprised a considerable proportion each year (for instance from Russia, the Ukraine, Poland, Yugoslavia, Bulgaria, France, Italy). Among these, BRANKO MILETIĆ (1897–1983) was the most important attendee. He spent several years at the laboratory (1923/24, 1924/25, 1929/30, plus a few shorter

visits), focusing on two topics: Serbian melody [13] and Serbian articulation, including radiography [14]. He later founded an institute for experimental phonetics in Belgrade.

The curriculum prescribed two hours of laboratory work a week (on Wednesday) in addition to several lectures. However, a considerable number of students attended the laboratory outside of the classes as well. The laboratory was open between 2 pm and 6 pm each afternoon, but on Wednesday and Saturday somewhat earlier (7 am – 12 am). Some of the students attended the laboratory daily, for which Chlumský praises them greatly. Such students usually worked on their own research, which typically resulted in publication (especially regarding the highly motivated guest participants). For instance, articles were written about the melody of epileptics mentioned above [15]; the Danish stød [16]; or some aspects of Polish phonetics [17]. Often, student essays were turned into published reviews of the books in question.

According to a separate, continuously updated list of students at the laboratory, 306 people received at least one semester of training in experimental phonetics between 1915 and 1939. Most students attended for one or two semesters, but some signed up over and over. It was not unusual to attend the laboratory for several years.

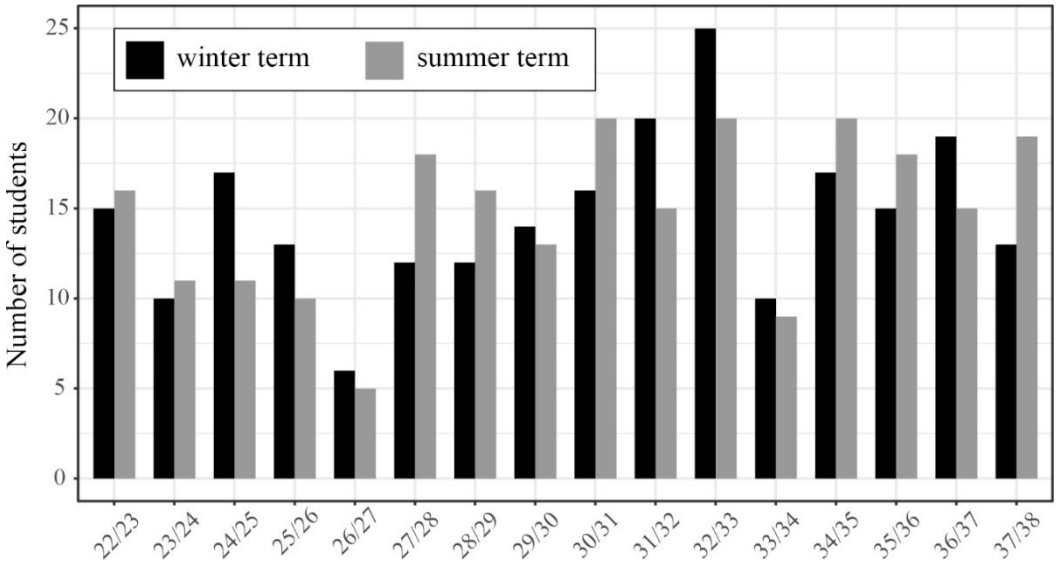

Figure 3. Numbers of students between the years 1922/23 and 1937/38.

3.2 The teachers

Apart from the students, Chlumský and his assistant Hála were present; they taught the students and conducted their own research. BOHUSLAV HÁLA (1894–1970) prepared his dissertation about Slovak pronunciation between 1922 and 1926 [18]. In the meantime, he also used X-ray imaging for Czech sounds' articulation, in collaboration with BOHUMÍR POLLAND (1891–1967), a radiologist at one of the university hospitals. The resulting book [19] was an important work in the Czech context, as it has never been replaced. Virtually all we know about Czech midsagittal pronunciation nowadays is derived from this work.

Hála's work on cinematography of the vocal folds was already mentioned in Section 2.1 (see [1, 6] for more details). In 1929, Chlumský assigned Hála a new topic: the acoustics of Czech vowels. The research extended over several years in the 1930s. Hála employed not only auditory analysis, but also instrumental methods setting up experiments with resonators, tuning forks or oscillators, and computing vowel spectra from the waveform by means of manual Fourier analysis. It is astonishing that his formant values are quite accurate in comparison with today's data. The publication was unfortunately delayed until 1941 by the outbreak of the Second World War [20].

JOSEF CHLUMSKÝ (1871–1939) has authored two prominent publications. In the Czech context, he is best known for the book *Czech Quantity, Melody and Accent* [12]. The work offers several important findings, some of them as verifications of previous auditory impressions of Czech, some entirely original. The research reflects all the methodological aspects discussed above. It is based both on auditory analysis and on instrumental measurements. Conversational speech is compared to laboratory speech. The material was carefully collected, analysed, reanalysed, and then interpreted. A number of studies preceded this seminal publication, including another book which was methodological in nature [21]. It was in these preliminary, preparatory experiments that Chlumský honed his expertise.

Later on, Chlumský conducted radiography of French vowels. The first set of radiograms was created at the end of 1932 based on a native French speaker residing in Prague, with the help of Polland again. The X-ray images had to be checked for errors (such as motion blur or incorrect phase of articulation) and turned into hand-drawn outlines, which were eventually published in the French work *Précis de grammaire historique de la langue française* [22]. Figure 4 shows the first of 17 drawings, along with the acknowledgment of the creators.

Fig. 2. **— Mouvements du voile du palais.**
L'*a nasal* de *pente*. Le voile du palais est *abaissé*.

(1) Ces clichés ont été établis sous la direction de M. Chulmský, professeur de phonétique expérimentale à l'Université de Prague. Les dessins ont été exécutés par M. Straka sur des radiographies du Dr Polland, maître de conférences pour la radiologie à la Faculté de Médecine de Prague. M. Bochet, né à Paris en 1903, d'une vieille famille parisienne, professeur d'histoire au Collège français de Prague, a accepté très aimablement de servir de sujet : c'est son articulation qui est reproduite dans tous les clichés.

Figure 4. One of Chlumský's drawings in the French work *Précis de grammaire historique de la langue française* [22: 7]. The caption includes acknowledgment of the creators (Chlumský, Straka, Polland) and the French subject (Bochet).

Inclusion in such a prestigious publication sparked great interest in Chlumský's radiographies. Therefore, Chlumský focused on this type of work between 1932 and 1937. Radiography of another French speaker, visiting professor Albert Pauphilet, was done repeatedly (on at least 13 occasions). What a number of harmful expositions! As a result, a book with 145 radiographies of French vowels was published in Czech in 1938 under the title *Radiography of French Vowels and Semi-Vowels* with an extended French resumé to great scientific acclaim [23].

In addition to Chlumský and Hála, three more former students became unpaid assistants at the laboratory. JIŘÍ/GEORGES STRAKA (1910–1993) was a promising force but moved to France. KAREL OHNESORG (1906–1976) remained faithful to the institute but moved to a different university after the war. VĚRA MAZLOVÁ (1913–1950) was a second assistant, responsible especially for the sound archive. However, she died prematurely after the war.

No matter how long they stayed at the laboratory, the duties of these assistants (including Hála) included first and foremost assistance during the laboratory sessions: providing demonstrations for students, checking their work along with Chlumský. Moreover, they helped Chlumský with his own research by doing processing and post-processing work – especially drawing kymographic and melodic diagrams or finishing the radiographic outlines. This is acknowledged not only in the reports to the dean but also in the publications themselves.

3.3 Guests at the laboratory

The reports also include information on Czechoslovak and foreign guests that visited the laboratory, for a day or two, for a week, several weeks, or repeatedly over the years. Table 1 lists the most important guests chronologically. They came from a variety of countries (France featured most prominently) and were of different backgrounds. Typically, people from language departments, sound archives or medical fields arrived; there were dialectologists, ethnographers, even singers. This description extends to Czechoslovaks as well. Many former pupils visited the laboratory afterwards to conduct some work. Chlumský usually recorded the speech of any foreigners. A visit of a different sort took place in 1922/23, when 60 teachers of the deaf-and-dumb arrived, for whom Chlumský had lectured about the use of experimental phonetics in their field at a clinic. Clearly, the Laboratory of Experimental Phonetics was a busy place.

Table 1. A selection of guests at the laboratory.

Name	Country	Years	Description in the report
Brunot, Ferdinand	Paris, France	1922/23	founder of the phonetics institute at the Sorbonne; the occasion was made use of to record his French pronunciation
Pankevič, Ivan	Užhorod, Ukraine	1922/23; 27/28	former pupil; a dialectologist; made acquainted with tools for studying dialects
Kaiser, Louise	Amsterdam, Netherlands	1923/24	to get acquainted with our work
Ayer, Charles C.	Boulder, USA	1924/25; 26/27	professor
Ward, Ida	London, UK	1926/27	assistant at the phonetics laboratory in London led by Prof. Rodrick
Miletić, Branko	Belgrave, Yugoslavia	1927/28; 28/29; 33/34	former pupil; to complete his roentgenographic work; consultations regarding the equipment and work at the newly founded exp. phonetics lab in Belgrade
Pernot, Hubert	Paris, France	1928/29	director of the phonetics institute at the Parisian university
Vendryès, Joseph	Paris, France	1928/29; 30/31	from the Parisian university; was interested in the endoscopy of the vocal folds and in the Academy sound archives
Chiba, Tsutomu	Tokyo, Japan	1930/31	the director recorded his speech on the kymograph and phonograph for studying Japanese accent, showed him our sound archives

Dłuska, Maria	Krakow, Poland	1930/31	assistant at the Slavic seminar at Krakow: reported on her journey abroad
Tarneaud, Jean	Paris, France	1932/33	director of the laryngological association in Paris; was interested in the phonetic instruments suitable for medical treatments
Dieth, Eugen	Zürich, Switzerland	1933/34	interested in all the equipment and the procedures; his university asked for help in the setting up of a phonetics laboratory in Zürich
Matha, Louise	Paris, France	1934/35	a surgeon's spouse; singer and director of a singing school in Paris, who uses experimental phonetics knowledge in singing
Brunner, Rudolf	Zürich, Switzerland	1936/37	assistant in the phonographic archive, used the laboratory for a week

4 From a room to a wing

When the Laboratory of Experimental Phonetics was founded in 1919, it had only one room at its disposal at the Institute of Physics. The phonetics lectures took place at various university buildings, but the laboratory itself (including Chlumský, all equipment and students) had to fit in the single room for several years.[1] Each report complaints about this issue, expressing a need for a proper workplace. This was increasingly urgent as new equipment arrived. Since 1926, there were hopes of moving to a new building of the Faculty of Arts. Chlumský participated in dozens of preparatory meetings and subsequent checks of the rooms and furnishing. In 1931, the laboratory was finally relocated to a whole wing comprising five rooms on the ground floor (Fig. 5). The current Institute of Phonetics still resides there.

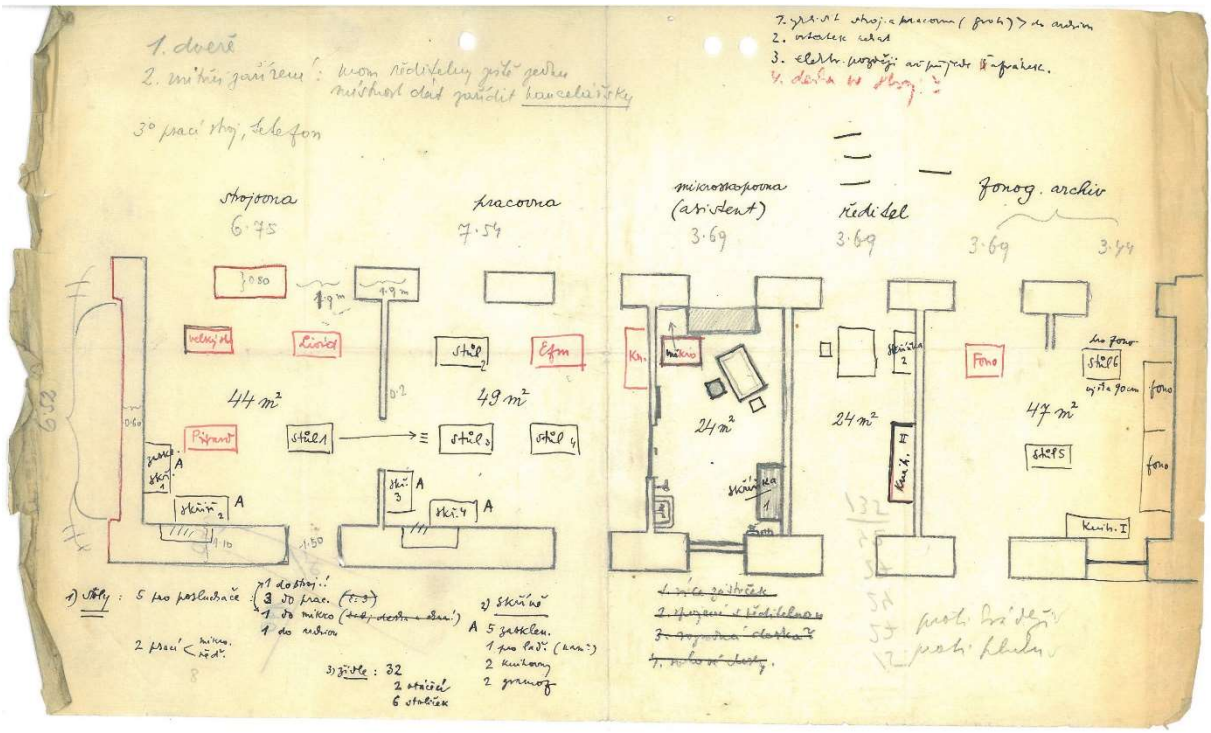

Figure 5. A plan of the phonetics laboratory at the new faculty building. Rooms from left to right: machinery room, workroom, microscopy room (assistant's room), director's room, phonographic archive.

[1] The Institute of Physics was part of the Faculty of Arts in 1919 but the natural sciences were separated from the faculty in 1920 (including physics). The phonetics laboratory continued to be located at the new science faculty despite its affiliation to the Faculty of Arts. This did not seem to cause problems or generate resistance from the professors at the arts faculty.

5 Conclusions

The laboratory was utilized for scientific research, as could be expected, but also for demonstration and educational purposes. This includes both students and guests from various fields. The use and usefulness of the methods was demonstrated while allowing students to have practical experience with examining speech. Moreover, Chlumský always encouraged students to conduct research of their own, in addition to the compulsory class work. As a result, several publications emerged under the auspices of the laboratory – written by both teachers and students – that employed experimentation and instrumental measurement. The interwar period at the laboratory can thus aptly be depicted as a place and time of abundant and fruitful phonetic research. Importantly, the Prague phoneticians strived to transfer such experimentation ethos to their students and disciples in various ways. The Prague laboratory continued to gain international renown and became a phonetics centre, like Rousselot's Parisian laboratory; this time, mostly (but not only) Middle and Eastern European students and interns arrived. At least two phonetic centres – in Belgrade and Zürich – were founded thanks to Chlumský's assistance.

6 Acknowledgments

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