RESEARCH UNIT FOR EXPERIMENTAL PHONOLOGY

UNIVERSITY OF STELLENBOSCH (RUEPUS)

ANNUAL REPORT: 1995 / 1996

1 BACKGROUND

This progress report covers activities of the **second year** of the first four-year cycle of the Unit, i.e. activities that have taken place in the financial year ending **March 1996**. It will be presented in the prescribed format for annual progress reports as specified by the CSD.

1.1 Mission and vision

The **mission** of RUEPUS may best be described as

- Fostering knowledge on the nature of the human speech communication act, and
- Promoting inter- and intra-cultural communication in South Africa through the study of those aspects of the speech communication process that may lead[1] to the development of
    - Computer-based speech systems for applications in education, business & industry etc.,
    - Diagnostic and remedial tools for application in the field of speech and hearing pathology in the indigenous languages of Southern Africa.

It is **envisioned** that studies emanating from RUEPUS will be of **scientific relevance** for

- **Linguistic theory** in general as these studies will assess the viability of an integrated approach towards phonetics and phonology in explaining problematic speech phenomena,
- **Language studies in Southern Africa** in particular as these studies will present data of a quantitative nature to augment impressionistically based studies,
- **Applications in human-machine communication systems** as acoustic and perceptual speech data become available as spin-offs for use in text-to-speech systems and automatic speech recognition systems applied to the languages spoken in Southern Africa,
- **Speech pathological and remedial purposes**, in as far as experimental data may be utilised clinically.

1.2 Long term goals

Following from above, two types of long-term goals were set for the Unit:

- **Basic academic goals**: i.e. contributing through basic research to a theory of human communication by reassessing the respective roles of phonetics and phonology vis-à-vis one another within an idealised grammar, and
- **Applicational goals**: i.e. contributing through the above-mentioned research to the development (mainly indirectly) of human-machine communication systems and/or applications in the neglected area of speech pathology with respect to the African languages.

Implicit to setting these goals is the assumption that researchers will be trained in a field that is both linguistic and technological in nature and which has up to now attracted very little attention from local linguists. This situation is in sharp contrast to that found in other parts of the world where speech science as a discipline and experimental phonetics as well as laboratory phonology have all been well developed.[2]

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[1] In the original mission statement (see 1994/5 Progress Report, p.3) the actual development of such systems were foreseen, due to various factors this statement of intent had to be modified.

[2] See for instance, Bloothooft, G, Hazan, V, Huber, D, & Llisterri (eds.) 1995. *European Studies in Phonetics and Speech Communication*, Utrecht: OTS Publications.

Based on the experience of the first two years, and in view of seemingly changing priorities with regard to basic and applied research in South Africa as well as a growing emphasis on research capacity building, it is becoming evident that the specific long-term goals of this Unit may need to be adapted. Please see Sections 4.2.5 and 4.3 for further discussion in this regard.

2 PROGRESS REPORT

2.1 Achievement of goals

Generally speaking it may be stated that the specific goals set for the second year have been achieved as will be explicated in more detail in the appropriate sections below

2.2 Projects

2.2.1 Orientation

Responding to suggestions made by the Advisory Committee of RUEPUS on 19 May 1995 that

a) The core project, "Laboratory phonology: Theoretical foundations and applications", be looked at in a more realistic way. A sharper focus should be placed on combining theory and praxis, and
b) Research projects done under the auspices of the Department of African Languages be separated from the work done in RUEPUS,..."

A number of specific aims and activities were redefined in order to obtain a more sharpened focus. The proposed core project (Project 1) remains unaltered, while two other projects (Projects 2&3)[3] and their sub-projects are integrated and more explicitly directed towards the main aim of the research programme at large.

In essence, therefore, the original **research programme** entitled

Experimental Phonology:
Explaining phonological and phonetic phenomena in selected languages of Southern Africa,

is advanced by the following **core project**:

Laboratory Phonology: Theoretical foundations and applications.

Three components may be distinguished in this project:

i. A **critical assessment** of "Laboratory Phonology" as a school of thought (i.e. exploring the nature of the so-called phonetics - phonology interface), its **theoretical foundations,** and the **methods** employed to present appropriate explanations for phonetic and phonological phenomena in general.

ii. The **development (and/or application) of specific techniques and methods** to facilitate experimental investigations into diverse speech phenomena.

iii. **Applications** related to problematic phonetic and phonological phenomena prevalent in the main languages spoken in Southern Africa.

[3] It was mentioned in the 1995 meeting of the Advisory Committee that the originally proposed Project 4 (EPG-analyses) might not be feasible due to high costs involved for apparatus.

Three questions stand to be answered in all applications:

a) Can this particular phenomenon be best explained in terms of phonological or phonetic theories?
b) What type of experimental techniques and methods would be best suited for a specific investigation?
c) What does this explanation reveal about the nature of the human speech communication act?

2.2.2 Implementation

i. Assessment of theoretical foundations and methods

The first component is addressed through continuous literature surveys and interpretative analyses of research results obtained by other researchers operating within this paradigm. It is the aim to trace the nature of these developments in order to assess the significance of these results in general for applications in particular.

In practice this translates to the compilation of a **bibliographical database** with cross-references to problematic phenomena, methods employed and results obtained. This information is drawn from

- Formal publications such as the **Papers in Laboratory Phonology** series,
- Other scientific publications addressing the phonetics-phonology interface debate.

ii. The development (and/or application) of specific experimental techniques and methods

Depending on the nature of the problem various experimental techniques and methods are investigated, developed and applied in order to gain insight into the problem at hand. At this point in time the following experimental techniques/methods have been employed in different sub-projects (details to be reported on in the appropriate sections):

- **Smoothed Pseudo-Wigner Distribution analysis**:
  This technique, which has been developed for signal analysis in general, represents excellent time/frequency resolutions combining the type of results traditionally obtained separately by broad and narrow band spectrograms. An adapted version of this technique was developed by a colleague in Stuttgart and applied in the analysis of speech. This technique was then applied in the analysis of clicks (cf. Project 2) with significant results.

- **Electromagnetic Articulography (EMA):**
  The use of EMA is one of the latest developments in the field of articulatory-acoustic research and is partly the result of the fact that the use of X-rays in speech research has been prohibited in many countries in the world. This technique was applied in the analysis of clicks (cf. Project 2) with interesting, though restricted results.

- **Acoustic-articulatory modelling:**
  A first approximation of a locally developed computer programme modelling acoustic space on the basis of the acoustic signal has been implemented [4], however, it has become clear that a number of technical and computational problems still need to be overcome when using this method.

[4] Cf. Prinsloo, GJ. 1993. *Dynamic vocal tract features for the recognition of co articulated vowels*. PhD, University of Stellenbosch.

- **Speech synthesis:**
  Experimentation with the High Level Synthesis Programme (HLSYN) of MIT/Sensimetrics has shown that this system may be used to good effect in studies on tone production and perception.

- **Computer based utility tools for research:**
  Due to the fact that large corpora of speech data are to be administered in various ways, a number of utilities were produced to assist researchers in their tasks:

  - Perceptual test analyser: used to prepare stimuli for perceptual testing
  - Computer based phonetic transcriber (automatic & manual)

  While it is possible to embark on limited development of utilities etc., it has become extremely important for the Unit to keep close ties with the Institut für Maschinelle Sprachverarbeitung (IMS) at the University of Stuttgart, Germany, where the development of tools for speech research has a high priority.

iii. Language specific applications

The third component comprises **language specific applications** in which problematic phonological and phonetic phenomena prevalent in languages spoken in Southern Africa are investigated. The aims of these investigations are

(i) To present credible explanations at phonetic and/or phonological levels, and
(ii) To contribute to insight into the nature of the human speech communication act with specific focus on the phonetics-phonology interface.

Viewing language as biologically based behaviour,[5] explanations for sound structures and sound changes are sought on the one hand, in terms of constraints on human articulatory and perceptual mechanisms, while, on the other hand, assessments are made of the appropriateness of phonological explanations for the same phenomenon.

The **choice of specific topics** is based on either

(i) Long standing problems within specific languages which have not been adequately resolved phonetically or phonologically, or
(ii) On problems of special linguistic or communicative interest.

Current research projects relate to three types of phenomena:[6]

- Tonal phenomena
- Segmental phenomena
- Interference phenomena.

The following **sub-projects** are currently being conducted. Each project will be discussed cursorily with an indication of the progress that has been made and the manner in which research results have been disseminated. A summary of the publications referred to will be presented in 2.3.

[5] Cf. Lindblom, Kohler, Ohala in Bloothooft, G, Hazan, V, Huber, D, & Llisterri (eds.) 1995. *European Studies in Phonetics and Speech Communication*, Utrecht: OTS Publications

[6] After rephrasing Projects 2 & 3.

2.2.3 Current and completed projects

2.2.3.1 Project 1 - Explaining problematic tonal phenomena

This project is concerned with the nature of tonal perception in the African languages, its impressionistic description, and its implications for phonological theories, and comprises the following sub-projects.

Sub-project 1 A

Lexical disambiguation in Xhosa and Zulu

JC Roux, Joey Haasbroek, A Radebe, M Dlali & Bongiwe Shongwe

The assumption that segmental tone is the only disambiguating factor in a tone language such as Xhosa or Zulu is challenged. The implications for an auto segmental theory of tone in which tonal values are assigned to segmental units are assessed.

The experimental phase comprises acoustic analyses, the creation of synthetic stimuli (mainly produced by HLSYN and ASL) and the administration of various types of perception tests with mother tongue speakers/listeners of the languages.

The **hypothesis** entertained here is that non-contextual lexical disambiguation does not take place in terms of segmentally based feature values (e.g. a tone associated to a specific vowel/syllable) but rather in terms of the perception of complex spectral changes across segmental boundaries.

This is an **ongoing project** with estimated completion in **December 1997.**

Sub-project 1 B

The production and perception of statement and question intonation in Xhosa

JC Roux, Jackie Jones & N Saule

DLitt candidate: Mrs Jackie Jones of UNISA

Impressionistic descriptions of the phonetic qualities of statement and question sentences (inter alia, echo-questions) in Xhosa show a wide range of variation. An existing auto segmental phonological analysis of the phenomenon adopts one specific phonetic view to the exclusion of others. Mother tongue listeners address the correctness and generality of impressionistic descriptions in this study with a shift towards and emphasis on the perception of these sentence types.

This study makes extensive use of speech editing in the time domain as well as synthesis and re-synthesis of speech signals. To the best of our knowledge this is the first full-fledged perceptual study in Xhosa at this level.

The working **hypothesis** here is that a number of variable but predictable strategies are employed by the mother tongue speaker to encode statement and question

sentences in this language and that the listener adapts to these strategies when decoding a signal.

This is an **ongoing project** with estimated completion in **March 1998**

2.2.3.2 Project 2 - Explaining problematic segmental phenomena

Sub-project 2 A

The phonetics and phonology of click articulations in Nguni

JC Roux & G Dogil

Despite excellent work that has been done in this field[7] there are still a number of unresolved issues in the phonetic description of click articulations, and many sound changes involving clicks are not yet adequately understood. This study therefore investigates

i. The appropriateness of different techniques to describe the phonetic attributes of click sounds (this includes electro-magnetic articulographic techniques, limited electro-palatographic techniques, Wigner distribution analyses etc.),
ii. The role of physical constraints in explaining phonological processes involving clicks.

This project is being done with the close co-operation of two German colleagues at the Institute for Computational Linguistics (IMS), Stuttgart (i.e. Prof. G Dogil and Dr W Wokurek). The application of Wigner distribution analysis, which allows for real fine-grain investigation into the nature of the acoustic signal, has revealed data, which contradicts the well-held position that the so-called "noisy" clicks are "affricated". All indications are that the dental click [|] is preaffricated and the lateral click [||] is only fricated if not also pre-affricated. Very interesting results also emerged regarding nasal and voiced clicks.

Research is now directed towards the un-encoded nature of clicks and the implications it holds for general theories of phonetics. An article entitled **The nature of un-encoded speech: Clicks in Xhosa** is currently being prepared for the *Journal of Phonetics* by Dogil & Roux.

This is an **ongoing study** with estimated completion in **March 1998**.

Sub-project 2 B

Homorganic nasal assimilation in Xhosa.

Bulelwa Ntlabezo & JC Roux

MA candidate: Ms B Ntlabezo (Rhodes University)

[7] Cf. Ladefoged, P & Traill, A. 1994. Clicks and their accompaniments. *Journal of Phonetics* 22, 33-64.

Classical distinctive feature theory within a linear as well as non-linear approach is not in a position to account for the above-mentioned phenomenon as far as labio-dental assimilations are concerned. In Nguni it is furthermore suggested that this process is morphologically conditioned, which results in the process being blocked in certain circumstances. This view, however, is challenged and it is **hypothesised** that the process may be explained purely in phonetic terms.

This project is currently nearing completion. Detailed acoustic analyses have shown a relationship between the nature of the vowel preceding a nasal and a following fricative. Different arguments (physiological and others) are presented to explain why lip-based vowels block homorganic nasal assimilation in /VNfV/ (or /VNvV/) sequences and why vowels with extreme lip spreading do not.

The estimated date of completion for this sub-project is **December 1996.**

Sub-project 2 C

The phonetics and phonology of demonstratives in Xhosa.

Thandi Maxela & JC Roux

MA candidate: Ms T Maxela (Port Elizabeth)

In this study phonetic aspects of demonstratives were investigated, more specifically whether a sequence of vowels, as in certain demonstratives such as /laa/, /abaa/, /ezaa/ etc., should be treated phonetically as a lengthened vowel or as a sequence of two sounds with a juncture. The influence of surface structures on the formulation of phonological rules in pre-generative, generative and non-linear phonological models were explored. The adoption of a CV-model of phonology proved to be the best way to describe the processes involved in the formulation of Xhosa demonstratives.

This sub-project was **completed in March 1996**.

2.2.3.3 Project 3 - Explaining problematic interference phenomena

In view of the multi-lingual composition of the South African society topics involving interference phenomena are included as various types of interferences (as well as physical disorders) may lead to a breakdown in communication. This project aims at presenting explanations for interference phenomena, and if possible, suggests ways and means to remedy the particular situation.

Sub-project 3 A

Aspects of phonetic and phonological interference in Xhosa speech communication.

PW Lewis, JC Roux, G Dogil & J Flege

DLitt study: PW Lewis (Cape Town Teachers' Training College)

In the process of inter-cultural communication speakers of English and Afrikaans, when attempting to speak Xhosa very often do not produce Xhosa speech sounds in a way that is easily perceived and comprehended. Seen from another angle, mother tongue speakers of Xhosa very often find it difficult to comprehend what an Afrikaans or English speaker of Xhosa is trying to convey due to incomplete coding of the speech signal by the speaker. This study in essence focuses on the intelligibility of Xhosa speech produced by Afrikaans or English speakers of Xhosa. It comprises various types of rating tests, intelligibility tests and acoustic analyses. All in all a total of 38 000 tokens will have been analysed in this study.

Prof. Jim Flege of the University of Alabama and expert in this field is consultant to this project whilst Prof. Dogil acts as co-promoter.

Proposed date of completion: **December 1997**

Sub-project 3 B

The perception of English vowels by Nguni and English listeners as spoken by each group.

Robyn Glaser, JC Roux & S Tuomi

BSc (Logopaedics) study (University of Cape Town): Ms Robyn Glaser

In everyday contact, especially through the media, situations arise in which communication may break down between speakers of English and of one of the Nguni languages. Within the South African context it is often assumed that spoken "Black English" is difficult to perceive and to understand by whites. This assumption was tested on a very limited scale at perceptual level. In the same vein, the perception of "White English" by whites and blacks respectively, were also tested. The results suggested that bad production leads to bad perception regardless of the mother tongue of the listener.

This project was **completed** in **February 1995.**

Sub-project 3 C

Phonetic and phonological aspects of Tswana-Afrikaans.

DP Wissing & JC Roux

Tswana speakers of Afrikaans exhibit an extreme amount of regressive voicing assimilation in /C (#) C/ combinations. This phenomenon attributes to the typical "black Afrikaans" accent, which is often heard, and which may lead to breakdown in communication. This is peculiar as Tswana has a typical /CVCV/ syllable structure in which it is unlikely that the first consonant will be retrogressively influenced by the second consonant.

It was **hypothesised** that a specific relationship may exist between negative voice onset time (-VOT) and regressive assimilation of voice and that this may be the reason for the existence of this phenomenon. This hypothesis was eventually confirmed.

The project was **completed in December 1995,** although some publications are still to follow.

Sub-project 3 D

Phonetic and phonological interference in the English of speakers of Tswana and Afrikaans.

AJ van Rooy & DP Wissing

MA study: Mr AJ van Rooy (Potchefstroom University)

The relationship between the phonetic and phonological aspects of final consonant devoicing in the English pronunciation of mother tongue speakers of Afrikaans and Tswana was investigated. An extensive acoustic study was made and the results were interpreted in terms of a new phonological model conceptually integrating phonetics and phonology (i.e. the so-called Integrated Representational System IRS of Clements & Herz).[8] It was indicated that this model was far more effective to explain the devoicing phenomenon than the any linear generative model.

This project, which was **completed in December 1995**, paved the way for a new project involving the description of distinctive features of Zulu.

Sub-project 3 E

Phonetic and phonological interference in the production of Zulu clicks by Sotho speakers.

AM Radebe & JC Roux

MA study: Mr AM Radebe

This study focuses on the production of clicks by Sotho mother tongue speakers of Zulu. It has been documented that erroneous production or substitution of clicks may lead to a breakdown in communication in such situations. This study seeks to determine the nature of these interferences and to explain it in terms of phonetic and /or phonological theories.

This estimated conclusion of this study is **December 1997**.

Sub-project 3 F

Preferred syllable structures in Nguni and Sotho

JC Roux, PW Lewis & J Louw

[8] Clements, GN & S Herz. 1994. *Phonetics in Grammar: An Integrated Representational System for Phonology and Acoustic Phonetics*. Unpublished manuscript.

It is well known that syllable structures may play a role in cross-linguistic interference. In the process of lexical borrowing the Xhosa language seems to prefer certain combination of segments within syllables, which may differ from the original or expected forms. It is **hypothesised** that this is due to a preference for certain combinations within a specific syllable structure on the basis articulatory ease and perceptual stability. This experiment aims at quantifying the segmental composition of syllables by means of computer analyses and then to relate these results to acoustic articulatory modelling in testing the above-mentioned hypothesis. This data will be viewed cross-linguistically in view of similar data found in literature.

This is an **ongoing study**; expected date of completion December 1997

2.2.4 New research projects

The interesting results obtained by Van Rooy (Sub-project 3D) have prompted an investigation into the implementation of the IRS-system in explaining phenomena related to especially the laryngeal node in Zulu. This study, entitled "Laryngeal features in Zulu: an IRS approach" will be undertaken by Ms Shamila Naidoo of the Department of Zulu at the University of Natal (Durban). It will slot in as Sub-project 3 G and will aim at providing phonetic as well as phonological evidence for the behaviour of ejectives, aspirates and implosives in phonological processes.

Expected date of completion is **December 1998**.

SUMMARY OF PROJECTS

PROJECT	TITLE	COMPLETED	EST COMPLETION
1 A	Lexical disambiguation in Xhosa and Zulu		December 1997
1 B	Production and perception of statement and question intonation in Xhosa		December 1998 (DLitt) - (Stell)
2 A	The phonetics and phonology of click articulations in Nguni		March 1998
2 B	Homorganic nasal assimilation in Xhosa		December 1996 (MA) - (Stell)
2 C	The phonetics and phonology of demonstratives in Xhosa	March 1996 MA cl (Stell)	
3 A	Interference in Xhosa speech communication		December 1997 (DLitt) - (Stell)
3 B	The perception of English vowels by Nguni an English listeners.	December 1995 BSc Log (UCT)	
3 C	Phonetic and Phonological aspects of Tswana-Afrikaans.	December 1995	
3 D	Interference in the English of speakers of Tswana and Afrikaans	December 1995 MA cl (Potch)	

3 E	Interference in the production of Zulu clicks by Sotho speakers		December 1997 (MA) - (Stell)
3 F	Preferred syllable structures in Nguni and Sotho		March 1998
3 G	Laryngeal features in Zulu: An IRS approach		December 1998 (DLitt) - (Stell)

Number of Master's studies students: Completed: 2 + 1
Current: 2

1995 Maxela, T. *The phonetics and phonology of Xhosa demonstratives: A non-linear approach*. MA cum laude, University of Stellenbosch. pp 221.

1995 Van Rooy, AJ. *Fonologiese en fonetiese aspekte van slotkonsonantontstemming in die Engels van Afrikaans- en Tswanasprekendes*. MA cum laude, University of Potchefstroom. pp 142.

1995 Glaser, R *An investigation into the effects of Nguni first language interference on the identification of English vowels by English and Nguni listeners*. Dissertation BSc Logopaedics, University of Cape Town.

Number of Doctoral studies students: Completed: 0
Current: 3

2.3 Publications

2.3.1 Articles published in subsidised journals

Reported in 1995

1995[9] Roux, JC.
Prosodic data and phonological analyses in Zulu and Xhosa. *South African Journal of African Languages*, 15.1: 19-28

1995 Roux, JC.
On the perception and production of tone in Xhosa. *South African Journal of African Languages*, 15.4: 196-204

New

1996 Lewis PW & JC Roux
A phonological Process analysis of the acquisition and loss of clicks in Xhosa. *South African Journal of African Languages*, 16.1: 1-9

In Press Ntlabezo, BN & Roux, JC.
Phonetic motivation for phonological processes: Labiodental assimilations in Xhosa. **Accepted** for publication in the *South African Journal of Linguistics (Special edition on Phonetics and Phonology)*. October 1996.

In Press Van Rooy, AJ.
Degrees of neutralization during syllable final devoicing: Evidence from second language phonetics. **Accepted** for publication to the South *African Journal of Linguistics*

( ) Roux, JC.

[9] This article was awarded the VIA AFRIKA PUBLISHERS / AFRICAN LANGUAGE ASSOCIATION OF SOUTHERN AFRICA prize for the best publication in African linguistics in 1995 in July 1996.

Xhosa: A tone or pitch accent language? **Accepted** for publication in *South African Journal of African Languages* in 1996. (**Temporarily withdrawn** by author pending new experimental results.)

( ) Roux, JC.
On the prosodics of declarative and question sentences in Xhosa. **Accepted** for publication in *South African Journal for African Language* in 1996. (**Temporarily withdrawn** by author pending new experimental results.)

2.3.2 Articles in conference proceedings

1995 Scharf, G, Hertrich, I, Roux, JC & Dogil, G.
An articulatory description of clicks by means of electromagnetic articulography. *Proceedings of the 13th International Congress of Phonetic Sciences, ICPhS 95*, Stockholm, Sweden. Vol 1: 378-379

1995 Roux, JC, Dogil, G & Wokurek, W.
Click articulations in Xhosa: New perspectives through Wigner distribution analysis. *Proceedings of the 13th International Congress of Phonetic Sciences, ICPhS 95,* Stockholm, Sweden. Vol. 1: 502-505

1995 Wissing, DP & Roux, JC.
The interrelationship between VOT and voice assimilation. *Proceedings of the 13th International Congress of Phonetic Sciences, ICPhS 95*, Stockholm, Sweden. Vol. 1: 50-53

1996 Wissing DP & Roux, JC.
Voice assimilation in (Tswana) Afrikaans: A phonetic solution for a phonological problem. *SA Linguistics 1995*, Ed EF Kotzé, University of Port Elizabeth Publication Series B23, 262-268.

1996 Van Rooy, AJ.
Word-final devoicing by Tswana and Afrikaans speakers of English: Second language interference or universal tendency? *SA Linguistics 1995*, Ed EF Kotzé, University of Port Elizabeth Publication Series B23, 214-227.

In Press Roux, JC.
Aspects of tonal perception in Nguni. *Proceedings of the First World Congress of African Linguistics 1994*, (Ed RK Herbert) Kwaluseni, Swaziland.

2.3.3 Papers delivered at conferences

International

1995 JC Roux.
A perceptual approach to the study of tone. Laboratory workshop conducted as part of a two-day workshop at the *8th International Biennial Conference of the African Language Association of Southern Africa (ALASA 95),* University of Stellenbosch, Stellenbosch

1995 Scharf, G, Hertrich, I, Roux, JC & Dogil, G.
An articulatory description of clicks by means of electromagnetic articulography. Poster session conducted by Roux & Scharf at the *13th International Congress of Phonetic Sciences, ICPhS 95*, Stockholm, Sweden.

1995 Roux, JC, Dogil, G & Wokurek, W.
Click articulations in Xhosa: New perspectives through Wigner distribution analysis. Paper presented by Roux at the *13th International Congress of Phonetic Sciences, ICPhS 95,* Stockholm, Sweden.

1995 Wissing, DP & Roux, JC.
The interrelationship between VOT and voice assimilation. Paper read by Wissing at the *13th International Congress of Phonetic Sciences, ICPhS 95*, Stockholm, Sweden.

National

1995 Wissing, DP & Roux, JC.
Voice assimilation in (Tswana) Afrikaans: A phonetic solution for a phonological problem. Paper read by Wissing at the *31st Annual Congress of the Linguistic Society of Southern Africa (LSSA),* University of Port Elizabeth.

1995 Van Rooy, AJ.
Word-final devoicing by Tswana and Afrikaans speakers of English: Second language interference or universal tendency? Paper read at the *31st Annual Congress of the Linguistic Society of Southern Africa (LSSA),* University of Port Elizabeth.

1996 Roux, JC
Laboratory notes on click articulations in Xhosa. Paper read at the *Regional Conference of the African Language Association of Southern Africa*, Bellville. University of the Western Cape.

2.4 Staff activities

2.4.1 Visits abroad

Profs. DP Wissing and JC Roux attended the **13th International Conference of Phonetic Sciences**, which took place in Stockholm, Sweden from 13 - 19 August, 1995. This conference takes place once every four years and was attended by approximately 1200 participants. This was a well-organised and very stimulating meeting where 42 different countries were represented and 598 papers were read. Wissing and Roux were involved in three presentations. As had been the case with the previous conference in Aix-en Provence in 1991, the absence of participants from Africa was quite striking. Apart from the two South Africans there were no other participants from the rest of Africa. This is indeed a sad state of affairs as the richness of languages in Africa has extremely much to offer for scientific research. At this point in time African scholars present very little input to the development of speech science in general. African scholars should be encouraged to attend these conferences. The next conference takes place in 1999 in Berkeley, California.

Prior to attending the above-mentioned conference, Wissing and Roux took part in a 5-day course on speech synthesis in Mariefried, Sweden. This course took place from 7 - 11 August 1995 and was presented by Dr Ken Stevens of MIT and Dr John Local of the University of York. Attention was focused on high-level synthesis (HLSyn), a method developed by Dr Stevens and colleagues. This method has the well-known Klatt-synthesiser as basis though with an interface reducing the number of parameters used to synthesise speech by rule to ten. This intensive course was attended by 16 participants and was excellently presented. The use of HLSyn has simplified the manner in which speech stimuli can be prepared for perception tests.

Mr Philip Lewis, part-time researcher spent two months (January and February, 1996) with Prof. JE Flege of the University of Binghamton in the USA in preparation for his work on Sub-project 3A. This was indeed a very fruitful visit and Prof. Flege expressed his interest to get involved in more projects on African languages.

2.4.2 Activities in respect of professional associations

Prof. Roux acted as conference organiser for the **8th Biennial International Conference of the African Language Association of Southern Africa (ALASA 95)** in Stellenbosch from 4-7 July 1995. The staff of RUEPUS were all actively involved in the presentation of a two-day workshop on phonology and phonetics. This workshop was mainly presented in the phonetics laboratory and was attended by 19 persons. Profs.

Chuck Kisseberth and Farida Cassimjee (University of Illinois), JSM Khumalo (Wits) and Dr J Claughton (Rhodes) all played an active part in this workshop, which received favourable response.

2.5 Visitors received

Prof. Greg Dogil, Chair of the Institut of Computational Linguistics (IMS) at the University of Stuttgart was the guest of RUEPUS for the period 1 January - 31 March 1996. His visit was very successful and he made a significant contribution to the activities of the Unit. The following activities in which he played a major role need to be mentioned:

- In depth academic discussions with staff of the following institutions
  - University of Stellenbosch: RUEPUS; Departments of African Languages and General Linguistics.
  - University of Cape Town: Departments of Logopaedics, General Linguistics
- Workshops on Experimental Phonetics and Speech Technology at
  - University of Potchefstroom on 21 February, 1996
  - UNISA on 22 February 1996. (This workshop was well attended by staff and students from UNISA, the University of Pretoria and Vista.)
- Development work in speech pathological applications including
  - The development of differential diagnosis procedure for aphasia and it severity implementing the Token Test adapted for Xhosa and Swati (with Patricia Mavimbela of UCT),
  - The development of a short differential diagnosis procedure for dysarthria and speech apraxia for Xhosa and Swati (with Patricia Mavimbela of UCT).
- Joint preparation of conference papers for the following conferences

i. Annual National Conference of ALASA.
Rand Afrikaans University, Johannesburg. July, 1996:
Roux, JC & Dogil, G.
Noisy, nasal and voiced clicks in Nguni: Some experimental observations.
(Paper already read)

ii. International Congress of Clinical Phonetics and Linguistics.
München, Germany. September, 1996:
Dogil, G, Mavimbela, P, Tuomi, S & Roux JC.
Apraxia of speech: evidence for the un-encodedness of clicks.
(Paper accepted for presentation.)

iii. 8th International Phonology Meeting.
Vienna, Austria. 1-3 November 1996.
Dogil, G & Roux, JC.
Syllables and un-encoded speech.
(Paper accepted.)

iv. 6th Australian International Conference on Speech Science and Technology
Adelaide, Australia. 3-6 December 1996.
Roux, JC & Dogil, G.
Un-encoded Speech: Clicks and their accompaniments in Xhosa.
(Abstract presented.)

Prof. Dogil is a prolific researcher with wide academic contacts. He has expressed the wish to continue co-operating with the Unit and has already made enquiries in Germany for possible assistance from the Deutsche Forschungsgemeinschaft (DFG) to enable junior researchers from RUEPUS to visit his laboratories for further training.

2.6 Conferences and symposia presented

Please see the discussions above in 2.3 and 2.5.

2.7 Implementation of research

Research results were disseminated at various national and international conferences as indicated above as well as through the presentation of three workshops. While the type of research emanating from the Unit may to a very large degree be regarded as basic in nature, it does provide spin-offs as indicated in the previous report. These spin-offs entail the development of two systems:

(i) COMPHON (Computerised Phonetics)

This multi-media educational computer programme is directed towards the theoretical study of phonetics in general, but more importantly, also to the practical enhancement/remedy of pronunciation. Apart from its application in language specific studies, it may also serve as a tool to remedy various forms of speech interference.

Due to a lack of funds and staff this project could not be assigned a special priority in the past year, and no real progress may be reported. It is, however, hoped that the situation may change with respect to the co-operation with the Language Laboratory Centre, which could lead to an effective continuation of the project.

(ii) TEXT TO SPEECH SYSTEM (Version 1: Xhosa)

These types of systems are currently in development worldwide and have a large range of applications ranging from office automation, through a variety of educational applications to reading machines for the handicapped. Apart from the progress reported in 1994/5 no real priority was assigned to this project due to a lack of funds and trained staff.

3 INFRASTRUCTURE

3.1 Staff

The following persons were appointed for the periods specified:

Researchers at Stellenbosch:

Ms Bongiwe Shongwe (BA Hons, HTD)	1/2/1995 - 31/12/1995
Mr Moeti Radebe (BA Hons)	1/2/1996 -
Ms Joey Haasbroek (BA, enrolled MA)	1/2/1995 -
Mr Jan Louw (M Eng)	1/4/1995 -

Researchers at Potchefstroom:

Ms H Raubenheimer (MA)	1/2/1995 -
Mr AJ van Rooy (MA)	1/2/1995 -

Although they are only explicitly listed in one or two sub-projects, Ms Haasbroek and Mr Louw are involved in most of the projects as far as it may concern aspects of the conceptualisation and/or implementation of these projects. Please see further discussion in 4.3.

3.2 Resources

Although both laboratories (one in Potchefstroom and one in Stellenbosch) have access to technical support services of the respective departments of Information Technology, it was also necessary to make use of the services of the Institute for Electronics at the University of Stellenbosch to assist in setting up certain configurations and programs.

3.3 Equipment

In order to run applicable programmes, one 486 Personal Computer was acquired in 1995. DATAFUSION SYSTEMS also made available one 486 PC to ease the pressure on the two existing workstations. There are, however, specific problems regarding the upgrading of equipment. Please see 4.3 in this regard.

4 PLANNING FOR NEXT YEAR

4.1 Ongoing projects

In order to contribute to the main project **Laboratory Phonology: Theoretical foundations and applications**, all sub-projects as specified in 2.2 will be continued. Specific attention will be paid to Sub-project 2A (Click articulations) in which some interesting progress has been made.

4.2 New projects

4.2.1 Proposed Sub-project 2 D

Strengthening processes in Sotho and Nguni (Roux, Olivier & Radebe)

A preceding nasal seems to have severe influences on the segmental composition of the following consonant in /NCV/ clusters in the Sotho and Nguni languages. In some instances it may even have conflicting end results, cf. Xhosa /n + ph/ > */mph/ > /mp'/, Sotho /n + f/ > /mph/. These sound changes have traditionally been described amongst other as a strengthening process, or as nasal strengthening. Accounting for all these changes in a homogeneous way in terms of a phonological feature analysis proves to be problematic in various ways. This study will focus on articulatory and perceptual constraints playing a role in these sound changes.

4.2.2 The development of acoustic databases: SASPEECH

Research in the field of phonetics has by and large been taking a turn towards the implementation of large annotated articulatory and/or acoustic databases (cf. Bloothooft et al, 1995: 18-42). The development of these types of databases together with computer based tools to extract relevant information from these databases and to perform various types of analyses on the data have become a priority in most phonetic laboratories. Gathering good quality data on speech in the African languages has always proven to be problematic, specifically also with projects of RUEPUS.

In order to address this problem a joint initiative of the Department of African Languages at the University of Stellenbosch, the Institute for Computational Linguistics at the University of Stuttgart, Germany and RUEPUS is contemplated. This project entitled **SASPEECH** (South African Speech) (cf. **Appendix C** for an executive summary) is an initiative setting up and maintaining an annotated acoustic speech database of the eleven official languages spoken in South Africa as well as of pathological speech in a format suitable for rapid computer access and for low cost distribution to users in various fields of application. In a certain sense it will pose to fill a gap left by the abolishment of the South African Speech Archive, which functioned under the auspices of the HSRC for some years.

Funding for this project will be sought from the private sector.

4.2.3 RUEPUS as collaborator in FRD project on speech technology

RUEPUS was approached to become part of a project entitled **The development of spoken language science and technology for application in Southern Africa, which** is sponsored by the Foundation for Research Development (FRD). This project is directed by Prof. Elizabeth Botha of the Department of Electrical and Electronic Engineering at the University of Pretoria and draws on the co-operation of Profs. C Brink at the Laboratory for Formal Aspects of Computer Science (FACCSLAB) (University of Cape Town), G Oosthuizen at the Department of Computer Science (University of Pretoria) & E Barnard of the Oregon Graduate Institute in the United States. The aim of this project is to develop a variety of speech-enabled devices (from telephones to bank teller machines to computer programs for instruction) operating in the indigenous languages of this country. The initial role of RUEPUS will be to assist in the establishment of an acoustic database for Xhosa. It will be beneficial to participate in this project as the Unit will not only have access to new technologies and programmes, but also to the data collected.

4.2.4 WWW Home page

The publication of a newsletter appearing twice a year was surmised in the previous annual report. Due to various practical reasons, and to newly available technology it was decided rather to opt for a home page on the World Wide Web in order to reach a wider public. The activities of RUEPUS may now be found at the following location on the Internet:

http://www.sun.ac.za/local/academic/nefus/nefwww.html

Responses have already been received from as far as Japan, France and Argentina.

4.2.5 Capacity building

In pursuing the academic aims set for RUEPUS whilst simultaneously making a contribution to research capacity building especially with regard to the training of post-graduate students from previously disadvantaged backgrounds, is indeed a very taxing enterprise. On the one hand high quality scientific results are expected in a relatively short space of time, whilst on the other hand people have to be trained in an interdisciplinary field which has in the past received very little attention whatsoever, and for which very little appropriate undergraduate courses exist in this country. It was indicated in 1.2 that this situation is in sharp contrast to that in other countries outside of Africa.

It is to be understood that the type of research, which is being done at the Unit, is symbiotic in nature and comprises a technological component as well as a linguistic one. For the Unit to function effectively, it is necessary to do research and developmental work on the technical side so as to provide the conceptual framework and experimental tools for linguistic applications. Seen from the opposite angle, as soon as a problem of linguistic nature is identified for which no acceptable phonological explanation may be available, ways and means are sought to explain it in the physical domain. This then leads to questions such as *"Which types of acoustic analyses are necessary? Which types of perceptual tests should be administered given the existence of different theories of human perception? Which types of stimuli should be applicable and how should they be created - through speech signal editing, speech synthesis from scratch or through resynthesis? Which types of computer programmes will be needed to handle large quantities of data effectively?"* etc. These tasks are currently excellently performed by Mr

Louw and Ms Haasbroek (cf. 3.1) working in close co-operation with the persons responsible for the various projects contributing effectively to the research process.

Turning to research **capacity building in general** in this field: we need to make provision for at least two types of researchers, i.e. for those with a **linguistic background** as well as for those with an **engineering and/or computer science background** in the hope to stimulate the development of a field which will be of the utmost importance in the next century where, amongst other developments, human-machine interaction through natural speech will be at the order of the day.

Focusing on **capacity building of researchers with a linguistic background**: undergraduate students in African languages by and large have little or no training in experimental phonetics even up to Honours-level. These students need specific training as well as hands-on experience in experimentation to enter into this field with success. An MA-programme of the Department of African Languages at the University of Stellenbosch is currently the only one in the country explicitly directed towards this goal. Although 12 students are currently enrolled for this course (representing languages such as Zulu, Xhosa, Sesotho, Venda and Tsonga) as well as three Doctoral students, not all of them have gained ample experience yet to be included in RUEPUS projects bearing in mind the strict academic aims which obviously need to be met in research output. This is the reason why relatively few researchers of previously disadvantaged communities are involved in current projects. At the heart of this problem is the fact that undergraduate and even post graduate syllabi in African languages of most universities traditionally do not focus on anything else than impressionistic descriptive phonetics, hence no real interest is generated for experimental work. The process of bringing language students of all backgrounds into this research domain indeed remains a challenge.

The recent announcement[10] of a possibility for Research Units to apply to the CDS for **additional funds for research capacity building** is very much welcomed, especially in view of some informal negotiations between RUEPUS and the Department of African Languages at the University of Venda. Following two presentations at recently held conferences, the Director was informally approached by a senior staff member of the above mentioned department to assist in setting up limited research facilities and in training members of staff in the use of these facilities. Furthermore, to assist in redesigning syllabi for phonetics and phonology to make it more applicable for current needs. A submission to this effect will be made to the CSD before the deadline on 31 August 1996. Should this application succeed and the necessary funds could be obtained from the authorities at the University of Venda, this action could significantly contribute towards research capacity building.

Whilst actions are contemplated to promote capacity building within the linguistic domain, it is equally important to do the same with respect to researchers with **an engineering/computer science background**. Although it may be argued that this type of capacity building should be the responsibility of the FRD, the development of the field of Speech Science and Speech Technology is truly interdisciplinary in nature and should be approached in an integrated fashion. **The Director would appreciate advice from the Advisory Board in this regard**. It may be mentioned that specific joint projects with the Department of Electric and Electronic Engineering at the University are being planned in this regard over and above the project mentioned in 4.2.3 above.

4.3 Specific needs that should be addressed

In order to meet the challenges of high quality academic research it is absolutely necessary to have high quality staff and high quality equipment. From the proposed budget

[10] Cf. correspondence of Dr Rose Morris dated July 8, 1996.

(Appendix B) it will be seen that RUEPUS is experiencing difficulties to provide for both staff and equipment with a total budget of **R104 000 per annum** (R80 000 from CSD and R24 000 from the University of Stellenbosch). To maintain the current (1996) salaries of **staff** (research assistants and ad hoc workers) an amount of **R91 246** will be needed. In terms of current regulations as specified by the CSD, the maximum amount payable to a researcher is R24 200, bringing the CSD portion to R72 180. The additional amount of R19 066 needed to cover these salaries will be forthcoming from the contribution of the University. This effectively leaves an amount of **R12 754** for running costs, national and international travel, and the upgrading and/or replacement of equipment. Disregarding for the moment the necessity for the upgrading of equipment, it is foreseen that RUEPUS will not be able to keep the services of the current two researchers beyond the life of the first four-year cycle (if so long). This will obviously have a severe impact on its activities.

In addressing this problem it may be argued that RUEPUS should also seek other sponsors as well. The problem, however, is that very few organisations (be it governmental or not) are interested in financing basic research and research capacity building *per se.* Sponsors are normally interested in the delivery of products of the one kind or the other. Speech research fortunately implies a vast array of applications in a technologically driven society, for which potential sponsorships could be available. The situation in which RUEPUS finds itself could possibly be alleviated to some extent should the focus of its activities be adapted towards the long term "applicational goals" (cf. 1.2, page 2) and that these goals be more actively pursued. In real terms this will mean a sharper focus on

"(...) The study of those aspects of the speech communication process that may lead to the development of

- *Computer based speech systems for applications in education, business and industry, etc.*
- *Diagnostic and remedial tools for application in the field of speech and hearing pathology in the indigenous languages of Southern Africa."* (p. 1)

If this is to be agreed upon, it will have the following effects:

- It will create more realistic possibilities for sponsorships from institutions for whom it will be beneficial in the long run to invest in research and eventual development of speech based systems which may be used for automatic information retrieval, education and training etc. in a language spoken in Southern Africa.
- It will reposition RUEPUS favourably to pursue aims of "innovative interdisciplinary research and development" as proposed by the latest *Green Paper on Science and Technology.* This will be extremely important not only for possible future funding, but also for adapting to anticipated new measurement tools for the assessment of research (cf. *Green Paper*, p 90).
- It will open new possibilities to involve engineering and computer science students to get actively involved in interdisciplinary work with students in linguistics, even more specifically, with students of African linguistics. (Cf. the projects already anticipated in 4.2.2 and 4.2.3).
- It will make a definite contribution towards the development of the African languages *per se* within the South African context.[11]

[11] The draft reports of the **Language Plan Task Group** (LANTAG) of Government were discussed at a national conference in Pretoria on 29 June 1996. From these reports and ensuing discussions it became quite clear that at official level, no provision whatsoever is being made for the Speech and Language Technology development in SA. This is ironic, especially in view of specific recommendations of the comprehensive **LEXINET** programme, which was undertaken by the HSRC in 1988 under the supervision of Dr Rose Morris. The African languages need to be developed in the technological domain, if not, they will remain marginalized in use in the financial, public and educational sectors.

The basic point to be made here is that basic and applied linguistic research and research capacity building in a particular component of linguistics alone is not the type of activity that will attract vast sums of money from sponsors. In step with changing needs in the country a related shift in focus could alter the financial situation of the Unit. If not, it is difficult to see how it would be possible to sustain the activities of RUEPUS for another cycle especially if the upgrading of equipment is also considered.

The Advisory Board's views on this issue will be appreciated.

4.4 Staff

The personal circumstances of the main co-worker to RUEPUS, Prof**. Daan Wissing**, has changed considerably over the last year. He has become the director of a similar research unit at the University of Potchefstroom known as the **Research Unit for Phonetics and Phonology** (Navorsingseenheid vir Fonetiek en Fonologie). This Unit is funded by the University of Potchefstroom. Due to this development it was agreed that his formal co-operation with RUEPUS be severed, although the two Units will continue to co-operate as far as possible.

It is suggested here that the close contact that has developed between RUEPUS and the Institute for Computational Linguistics at the University of Stuttgart (IMS)[12] be maintained and strengthened, as this co-operation is very beneficial for both parties. On the one hand, RUEPUS obtains access to the latest developments in technology, and on the other hand, IMS has access to a vast variety of African languages for descriptive and developmental purposes. It is suggested in the budget that an amount be made available annually to facilitate ongoing contact between members of the two laboratories.

4.5 Future goals

4.5.1 Research Fellow

During the 13th International Conference of Phonetic Sciences, which took place in Stockholm, Prof. John Ohala (UC at Berkeley and Chairperson of the International Phonetic Association) expressed keen interest in the activities of RUEPUS and accepted an invitation to visit the Unit in 1997. Prof. Ohala may be regarded as one of the foremost proponents of Laboratory Phonology in the world, and it would be an honour for the Unit to accommodate him. The following dates have provisionally been agreed upon 15 - 30 March 1997. Naturally, visits to other centres in South Africa will be included in his itinerary. Application will be made to the University of Stellenbosch and to the CSD to sponsor this visit.

5 BUDGET

5.1 Statement of income and expenditure for the previous financial year (1995/6)

Please see **APPENDIX A**

5.2 Budget for next financial year (1997/8)

Please see **APPENDIX B**

6 GENERAL

I would like to express sincere thanks and appreciation to

[12] The Director spent 4 months in 1994 in Stuttgart, whilst Prof. Dogil (Head of IMS) was the guest of RUEPUS for three months in 1996.

- The **Centre for Science Development** and the **Research Committee of the University of Stellenbosch** for their generous financial support without which nothing reported would have been possible,
- **DATAFUSION SYSTEMS** for their contribution to the hardware of the laboratory,
- The **staff of RUEPUS** for rendering excellent work, very often in extremely pressed circumstances,
- The **members of the Advisory Board** who have displayed their insight and contributed to the direction of RUEPUS.

PROF. JC ROUX **STELLENBOSCH**
DIRECTOR: RUEPUS **7 AUGUST 1996**