RESEARCH UNIT FOR EXPERIMENTAL PHONOLOGY

UNIVERSITY OF STELLENBOSCH (RUEPUS)

ANNUAL REPORT: 1996 / 1997

1 BACKGROUND

This progress report covers activities of the **third year** of the first four-year cycle of the Unit, i.e. activities that have taken place in the financial year ending **March 1997**. 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 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 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.

Following a discussion reported in the minutes of the Advisory Committee of 7 August 1996 (Section 5 Future focus of RUEPUS, p2) it has become necessary to change the focus of RUEPUS for the next cycle should approval for continuation of the Unit be granted)

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.[1]

[1] For sub-project references, please see 1995/6 Annual Report.

2.2 Completed projects

2.2.1 Homorganic nasal assimilation in Xhosa.

Sub-project 2B
Ms Bulelwa Ntlabezo (Rhodes University) & JC Roux

This project demonstrated that 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 often suggested that this process is morphologically conditioned, which results in the process being blocked in certain circumstances. This view, however, was challenged and it was hypothesised that the process might be explained purely in phonetic terms.

Detailed analyses have shown the quality of the preceding vowel may influence the following nasal in the articulatory movement towards a following fricative. Different arguments referring to physiological evidence were 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. An explanation for the presence of intrusive stops (i.e. /m+f/ > [✪φf]) was presented in terms of the Source-Filter Theory of speech production.

Dissemination of results:

(i) One article in an accredited journal: SA Journal of Linguistics: Roux & Ntlabezo (1996)
(ii) One presentation at an international conference in Leipzig, Germany: Roux (1997)[2]

2.2.2 Phonetic and phonological aspects of Tswana-Afrikaans/ Speech interference

Sub-project 3C
DP Wissing & co-workers, 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 were still to follow. (Prof Wissing and co-workers were involved in RUEPUS projects in 1994/95).

Dissemination of results:

(i) Four articles in accredited journals: Wissing & Zonneveld (1996); Wissing & Coetzee (1996), Van Rooy & Wissing (1996), Nortjé & Wissing (1996).
(ii) One presentation at a national conference of the Linguistic Society of South Africa: Wissing (1996)
(iii) One article in conference proceedings: Wissing & Roux (1996)

[2] This presentation falls beyond the scope of this report, i.e. it took place after 31 March 1997.

2.3 Current projects

2.3.1 Lexical disambiguation in Xhosa and Zulu

Sub-project 1A
JC Roux, Joey Haasbroek, A Radebe

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 **ongoing project** with an estimated completion date in **December 1997** has been adversely affected by the resignation of Ms Haasbroek in November 1996 (Please see section 4.3 on staff situation)

Dissemination of results:

(i) One presentation at national conference of ALASA: Jones & Roux (1996)

2.3.2 The production and perception of statement and question intonation in Xhosa

Sub-project 1B
Ms Jackie Jones DLitt candidate & JC Roux

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 resynthesis 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. One section of the research, i.e. acoustic analyses has been completed and perceptual stimuli are currently being prepared for the application of perceptual tests with mother tongue listeners of Xhosa. This is an **ongoing project** with estimated completion in **March 1998**

Dissemination of results:

(i) One presentation at national conference of ALASA, Johannesburg: Jones (1996)
(ii) One presentation at regional workshop of ALASA, Pretoria: Jones (1996)
(iii) One chapter in an academic Festschrift: Jones & Roux (in press)

2.3.3 The phonetics and phonology of click articulations in Nguni

Sub-project 2A
JC Roux & G Dogil

Despite excellent work that has been done in this field 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 analyses, 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. Further results obtained by electropalatographic (EPG) procedures reveal that lateral occlusions may take place prior to velar occlusions in the production of clicks. This finding presents a challenge towards the use of digraphs containing a velar stop as first part of the phonetic representation of clicks, e.g. as [k|] or [ŋ͡|]. Mismatches between the articulation and perception of voiced clicks have been established as well as the implications thereof for phonetic transcriptions.

Research is now directed towards the unencoded nature of clicks and the implications it holds for general theories of phonetics. This is an **ongoing study** without any estimated date of completion due to the complexity of the topic. A member of the Institute for Computational Linguistics (IMS) at the University of Stuttgart (Dr Michael Jessen) has applied to the Alexander von Humboldt Stiftung for a post-doctoral grant (Feodor Lynen Stipendium) to join the current team in South Africa on this project.

Dissemination of results:

(i) Six different presentations at six international conferences in, respectively, Vienna (Dogil, 1996), Budapest (Roux, 1996), München (Dogil, 1996), Adelaide (Roux, 1996), Paris (Roux, 1997) & Leipzig (Roux, 1997)[3]
(ii) Two different presentations at two national and regional conferences in South Africa: (Roux, 1996a, 1996b).
(iii) Three publications as proceedings of international conferences: Dogil et al (1996), Dogil & Roux (1996), Dogil & Roux (i.p.)
(iv) One publication in an accredited journal: Roux & Lewis (1996)

2.3.4 Aspects of phonetic and phonological interference in Xhosa speech communication.

Sub-project 3 A
PW Lewis, JC Roux, G Dogil & J Flege

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

[3] This presentation falls beyond the scope of this report, i.e. it took place after 31 March 1997

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 to this DLlitt study of PW Lewis. The project as a whole is nearing completion; the thesis will be submitted for examination in **December 1997.**

Dissemination of results:

None thus far, however, two publications are currently being prepared on grounds of this study.

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

Sub-project 3E
AM Radebe & JC Roux

This MA 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.

Unfortunately progress is rather slow on this project due to personal problems encountered by Mr Radebe. New estimated conclusion of this study is **December 1998**.

Dissemination of results:

None thus far.

2.3.6 Preferred syllable structures in Nguni and Sotho

Sub-project 3F
JC Roux, PW Lewis & J Louw

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. The data will be viewed cross-linguistically in view of similar data found in literature.

Although some of the results related to preferred syllable structures in Nguni have already been disseminated in publications and conference presentations, the project has grown in stature due to new co-operation with the Bible Society of South Africa. It has been agreed in principle that RUEPUS will have access to all electronic versions of the Bible in the African languages spoken in Southern Africa. This will naturally expand the database on which phonotactic searches are made dramatically, and for the first time real cross-

language comparisons will be possible, as the same text will be used as a source. Apart from the linguistic value of this investigation, valuable information on the phonotactic structures of these languages will become available for use by Bible translators. This is an **ongoing study**; expected date of completion **December 1999**.

Dissemination of results:

(i) One presentation at an international conference: Vienna (Roux, 1996)
(ii) One publication as proceedings of an international conference: Roux & Lewis

2.3.7 Strengthening processes in Sotho and Nguni

Sub-project 2D
I. Olivier & JC Roux

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 MA study will focus on articulatory and perceptual constraints playing a role in these sound changes.

Dissemination of results:

None thus far as this is a new project.

2.3.8 Speech Technology Applications

JC Roux, E Botha, J Haasbroek, J Louw & P Swart

In the 1995/6 Annual report it was mentioned that RUEPUS had been 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 programme 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 educational instruction as well as literacy programmes) operating in the indigenous languages of this country.

This informal co-operation led to two sub-projects conducted by RUEPUS:

An acoustic speech database of Xhosa lexical items
JC Roux, L Botha, J Haasbroek & L de Wet

An annotated acoustic database of 2 000 lexical items spoken by 50 speakers of Xhosa (i.e. 10 000 tokens) was developed during 1996. This may be regarded as a first experiment in the quest to set up larger speech databases of normal running speech in Xhosa and eventually in other African languages. The database is currently used to train neural networks functioning in the development of an automatic speech recognition system for Xhosa. This project is nearing completion and shed some light on the correct procedures to compile an acoustic database of this kind.

(Please see section on future activities, which will clarify the involvement in this project.)

Modelling the intonation of imperatives in a Xhosa text-to-speech system
P Swart, L Botha, JC Roux

Research into the development of a text-to-speech system for Xhosa which commenced during the first year of the existence of RUEPUS, but which had to be abandoned due to a lack of funds, was revived through the Foundation for Research Development (FRD) grant to Prof Liesbeth Botha. A milestone was achieved when the FRD (Natural and Engineering Sciences) agreed to sponsor a MA student in African languages (Ms Pippa Swart) to proceed with this interdisciplinary study. This is indeed in line with some of the ideals expressed in the *White Paper on Science and Technology*. This project is making good progress.

Dissemination of results:

These two sub-projects compelled the Director to attend and participate in two unscheduled international conferences in, respectively, Pietermaritzburg and Pretoria to promote the cause for speech technology applications and development in the African languages: Roux (1996a, 1996b).

2.4 Publications and conference presentations stemming from co-operation in RUEPUS projects

2.4.1 Publications in accredited journals

1996: Roux, JC & Ntlabezo, BN: Phonetic motivation for phonological processes: Labio-dental assimilations in Xhosa. **South African Journal of Linguistics**, 31:139-151.

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

1996: **Wissing, DP & Zonneveld, W**. Final devoicing as a robust phenomenon in second language acquisition: Tswana, English and Afrikaans. **South African Journal of Linguistics**, Supplement 33, pp 4-55.

1996: **Wissing, DP & Coetzee, AW**. Die stemlose eksplosief van Afrikaans: `n eerste verkenning. **South African Journal of Linguistics**, Supplement 33, pp 1-19.

1996: Van Rooy, AJ & Wissing, DP. Degrees of neutralisation during syllable-final devoicing: evidence from second language phonetics. . **South African Journal of Linguistics**, Supplement 33, pp 77-98.

1996: Nortjé, Sylvia & Wissing, DP. Accepting accent: attitude of high school pupils towards language varieties. . **South African Journal of Linguistics**, Supplement 33, pp 139-162

2.4.2 Publications in national and international conference proceedings

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. (Reported in 1996)

1996: Dogil, G, Mayer, J, Mavimbela, P, Roux, JC & Tuomi, S. Speech coding and apraxia of speech: Evidence from Xhosa in **Clinical Phonetics and Linguistics**.

Proceedings of the 5th Annual International Conference of the ICPLA, (eds W Ziegler & K Deger) München, Germany.

1996: Dogil, G & Roux, JC. Notes on unencoded speech: Clicks and their accompaniments in Xhosa**. Proceedings of the Sixth Australian International Conference on Speech Science and Technology, SST-96**. (Ed P McCormack & A Russel), 55-60.

I.p: Dogil, G & Roux, JC. Syllables and unencoded speech: Clicks and their accompaniments in Xhosa**. PHONOLOGICA 96** (ed J Rennison), University of Vienna**.**

I.p.: Roux, JC & Lewis, PW. Preferred syllable structures in Xhosa. **PHONOLOGICA 96** (ed J Rennison), University of Vienna.

2.4.3 Chapters in books

i.p. Jones, J & Roux JC. Queclaratives in Xhosa revisited. In **Festchrift for Prof JA Louw**, (ed Prof R Finlayson)

2.4.4 Papers read at international conferences

(Name of presenter underscored)

1996 G Dogil & JC Roux. Syllables and unencoded speech: Clicks and their accompaniments in Xhosa**. The 8th International Phonology Meeting,** University of Vienna, Vienna.

1996 JC Roux. Noisy clicks in Nguni**. One-day Workshop on Phonetics and Phonology,** Hungarian Academy of Science, Budapest, Invited opening paper. (Organiser: Prof M Gosy)

1996 JC Roux & G Dogil. Notes on unencoded speech: Clicks and their accompaniments in Xhosa **The 6th International Conference on Speech Science and Technology,** Adelaide, Australia.

1996: **G Dogil, J Mayer, P Mavimbela, S Tuomi & JC Roux**. Speech coding and apraxia of speech: Evidence from Xhosa. **The 5th International Conference of Clinical Phonetics and Linguistics**, München, Germany

1996: JC Roux, PW Lewis & J Louw. Preferred syllable structures in Xhosa. **8th International Phonology Meeting, University of Vienna, Vienna.**

1996a JC Roux. Human-machine communication in a developing country**. International symposium on culture, communication and development,** HSRC & UNESCO, Pretoria

1996b JC Roux. Developing speech-based communication systems in the indigenous languages of South Africa. **The Third International Conference of the Third World Science, Technology and Development Forum**. University of Natal, Pietermaritzburg.

1997 JC Roux. Phonetic explanations for phonological phenomena: Labiodental assimilations in Xhosa. **2nd World Congress of African Linguists (WOCAL 2)**, Leipzig, Germany.

1997 JC Roux. On the phonetic representation of clicks: Some experimental phonetic considerations**. 16th International Congress of Linguists, Paris, France.**

2.4.5 Papers read at national conferences

1996: Jones, J & Roux JC. Queclaratives in Xhosa. **National Conference of ALASA**, Rand Afrikaans University, Johannesburg.

1996: Jones, J & Roux JC. Demonstration of resynthesis techniques and perceptual testing strategies. **Regional Workshop of ALASA**, at UNISA, Pretoria.

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

1996: **JC Roux.** Noisy, nasal and voiced clicks in Nguni: Some experimental observations. **Annual National Conference of ALASA.** Rand Afrikaans University, Johannesburg.

2.5 Staff activities

2.5.1 Visits abroad

The Director was invited to take up a position of Visiting Professor at the Institute for Computational Linguistics (IMS) at the University of Stuttgart, Germany for the whole of November 1996. During this period extensive attention was paid to the project "The phonetics and phonology of click articulations" in which Prof Dogil is an active research partner. This also lead to the presentation of a joint paper at the 8th International Phonology Meeting in Vienna as well as the finalization and presentation of another in December 1996 in Australia at the 6th International Conference on Speech Science and Technology. Whilst in Europe an invitation was extended to the Director to read an opening paper at an international workshop on phonetics organised by the Hungarian Academy of Science in Budapest. The focus at this workshop was primarily on methodological aspects of phonetic research. This was a very enriching experience and good contacts were made with Hungarian phoneticians.

In December 1996 the Director attended a two-day workshop on Speech Databases as part of the 6th International Conference on Speech Science and Technology in Adelaide, Australia. The workshop focused on the use of the so-called EMU system, which appears to be a good option for devising annotated speech databases for the languages of Southern Africa.

The visit to Europe was totally sponsored by the IMS, whilst the conference attendance in Australia was in accordance with the accepted budget of RUEPUS. In both cases valuable academic contacts were made.

2.6 Visitors received

2.6.1 Prof Tore Janson

(University of Gøteburg, Sweden)

Prof Janson is a well-known phonologist and historical linguist. He paid a two-day visit to RUEPUS in October 1996 on his request. He has published quite extensively on cross-linguistic phonotactics and took the opportunity to engage in discussions on the phonotactics of the Sotho and Nguni languages, which incidentally is a current project of RUEPUS. These discussions proved to be very beneficial for the project as a whole.

2.6.2 Prof Ryohei Kagaya & Prof Seiji Niimi

Institute for the Study of Languages and Cultures of Asia and Africa (ILCAA), Tokyo University of Foreign Studies

Research Institute of Logopedics and Phoniatrics, Faculty of Medicine, University of Tokyo.

RUEPUS was approached by the above-mentioned researchers to participate in a Japanese project entitled **Laryngeal adjustments and depressor consonants in Xhosa and Zulu**. This study comprises a fibre optic and electromyographic study of the thyroarytenoid

and cricothyriod muscles. The Director was personally involved in this project by supplying sets of test material (i.e. phonologically balanced word lists) and assisting in the actual data acquisition process, which took place on 17 & 18 September 1996 in a suitably equipped room at the Tygerberg Hospital. Staff of the Department of Ear, Nose and Throat assisted in this process obtaining unique data on the production of various sound types (including clicks) in Xhosa. The researchers brought their own equipment to South Africa and their input proved to be very stimulating from both a linguistic as well as a speech physiological perspective.

Some of the results have been made available to RUEPUS and it has been agreed that a joint publication is to follow, hopefully within the next year.

(The Director has been acquainted with Prof Kagaya since 1983 and RUEPUS and ILCAA have been exchanging publications since 1995.)

2.6.3 Prof John Ohala

Department of Linguistics, University of California, Berkeley.

RUEPUS invited Prof Ohala, the current president of the International Phonetic Association as a Foreign Research Fellow in accordance with the CSD sponsorship programme. Appendix C represents a full report on Prof Ohala`s activities. It may be pointed out that he and the Director participated in two colloquia at, respectively, Stellenbosch and at the University of Venda in Thohoyandou. Prof Ohala also presented a public lecture at UNISA on the same topic.

This was an extremely successful visit and the researchers at RUEPUS gained enormously from Prof Ohala`s input. Exciting new research contacts have been established between the universities of Stellenbosch, Venda and Berkeley with this visit. The CSD is to be thanked and applauded for sponsoring this visit.

2.7 Conferences and symposia presented

2.7.1 Colloquia

During the visit of Prof Ohala two colloquia were presented on the topic "The Phonetics of Phonology". The first of these colloquia took place at the University of Stellenbosch on 19 March 1997 and comprised two presentations, one by Ohala ("The phonetics of phonology") and one by Roux ("Phonetic explanations for phonological phenomena in Afrikaans and in African languages.") followed by a round table discussion. This meeting was attended by 21 post-graduate students and staff from all three regional universities.

This colloquium was repeated on 27 March 1997 at the University of Venda at Thohoyandou and was attended by approximately 18 persons. Following the Research Capacity Building programme between RUEPUS and the University of Venda (see 2.8 below) this meeting coincided with the presentation of a speech workstation to the University of Venda and as such created new interest in the field of phonetics and phonology at this university.

RUEPUS was instrumental in organising a public lecture by Prof Ohala at UNISA on 25 March 1997. This meeting was extremely well attended (approximately 30 persons) from the universities of South Africa, Pretoria, Potchefstroom, Vista and the Witwatersrand.

2.8 Research Capacity Building (RCB) Programmes

2.8.1 University of Venda (1996/7)

The CSD sponsored a Phonetics/Phonology RCB initiative between RUEPUS and the University of Venda with the following aims:

(i) To establish a basic phonetics laboratory in the form of an applicable computer based speech workstation;
(ii) To train researchers in experimental methods and techniques of speech research in order to conduct studies in speech production and perception;
(iii) To engage in joint research projects between the two institutions.

Initially three staff members of, respectively, the departments of Venda, Tsonga and Northern Sotho were to be trained, however, through the appreciated support of the Gencor Development Trust, three additional staff members were put in a position to take part in the programme, whilst Gencor also provided the speech workstation and applicable software. The following members of staff were eventually trained during a two week session at RUEPUS: Mr NC Netshisaulu (Venda), Ms MG Lamola (N Sotho), Mr MT Babane (Tsonga), Mr M Phalannwa (English), Mr J Rodriques (Afrikaans) & Ms LM Masehela (Linguistics). Training included working with the latest speech processing computer package, **KAY Multispeech.** This training was followed by a colloquium at the University of Venda (with Prof Ohala) and a one-day work session with the group on the new workstation. This workstation, which is accommodated in an appropriate room in the library of the University of Venda, was officially accepted by the Dean of the Faculty of Arts who in turn expressed his thanks towards the CSD, Gencor and RUEPUS.

Three short-term tasks have been assigned to the researchers to afford them a chance to get to grips with the system on their own. The idea is to monitor the execution of these tasks and then to embark on larger projects as soon as they have proved their abilities both methodologically and technically.

Special request to the CSD:

In view of the fact that

(i) The untimely resignation of two assistants of RUEPUS (see section 3.1) who were to assist at Venda, inter alia, lead to a surplus of R10 016,00, and that
(ii) Necessary follow up and monitoring need to be done to ensure that the researchers are fully in command of the use of the system,

It is hereby requested that the surplus funds be kept available to allow for the necessary final guidance and monitoring as expressed in (ii).

2.8.2 University of Transkei (1997/8)

A similar RCB-programme, this time with the University of Transkei, has been approved by the CSD for implementation in 1997/8. The University of Transkei has also made some funds available for the acquisition of the computer hardware and software. Dr Mbulelo Jokeweni will be the contact person in the Department of African Languages at UNITRA. Final arrangements for implementation of the programme, which will be completed in March 1998, are currently in progress.

2.9 Implementation of research

Research results were disseminated through nine papers at international and four at national/regional conferences. The type of research emanating from the Unit may to a very large degree be regarded as theoretical in nature with no directly measurable implementational value.

It was reported in the **1995/6 Annual Report** that (due to a lack of funds and trained staff) little attention had been given to the following two projects of applicational nature. Fortunately, the indirect funding obtained from the FRD has resulted in the revival of the development of a Xhosa text-to-speech system through the MA study of Ms Pippa Swart.

2.9.1 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

2.9.2 TEXT TO SPEECH SYSTEM (Version 1: Xhosa)

These types of systems are currently in development world wide and have a large range of applications ranging from office automation, through a variety of educational applications to reading and speaking machines for the handicapped. Apart from the progress reported in the 1994/5 Annual Report, no real priority had been assigned to this project due to a lack of funds and trained staff. This situation, however, has now taken a positive turn with the indirect FRD funding enabling Ms Pippa Swart to continue with one aspect of this development.

3 INFRASTRUCTURE

3.1 Staff

The following persons were appointed for the periods specified:

Mr Moeti Radebe (BA Hons)	1/2/1996 - 31/7/1996
Ms Joey Haasbroek (MA)	1/2/1995 - 31/12/1996
Mr Jan Louw (M Eng)	1/4/1995 - 30/11/1996
Ms Pippa Swart (BA Hons)	1/1/1997 –

Ms Haasbroek and Mr Louw resigned on financial grounds. Please see 4.3.

3.2 Resources

As in the past RUEPUS made 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

Due to the fact that the University made a research position available to RUEPUS as its annual contribution to the Unit, it was not possible to acquire new equipment for the laboratory. A separate application to the Research Committee, however, resulted in some funds being made available (R5 000) for the acquisition of a CD-ROM writer for data backup purposes. Upon request the University decided in 1997 to revert to previous arrangements in providing funds to the Unit rather than the equivalent of a research position. This enabled the Unit, *inter alia*, to obtain a laptop computer, which has become extremely necessary for fieldwork purposes.

4 PLANNING FOR NEXT YEAR (1998/9 - YEAR 1 OF CYCLE 2)

4.1 Background

Since its inception RUEPUS pursued two aims, which are clearly reflected in its mission:

(i) Fostering knowledge of the human speech communication act, and
(ii) Promoting inter- and intra-cultural communication in South Africa through 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 & industry etc.,
- Diagnostic and remedial tools for application in the field of speech and hearing pathology in the indigenous languages of Southern Africa."

In order to achieve the first aim a number of projects were initiated within a core project entitled "Laboratory phonology: Theoretical foundations and applications." In all of these projects the interaction between phonetics and phonology was assessed in view of the international debate on the so-called phonetics-phonology interface. Phonological claims were tested in the phonetic domain, and this in turn lead, *inter alia*, to the implementation of various types of experimental techniques, e.g. Wigner Distribution Analysis, and Electromagnetic Articulography (EMA). These projects by and large underscored the view that phonological analyses based solely on impressionistic phonetic observations very often lack credibility and do not present real insight into the phenomenon at hand. They furthermore emphasised the point that the relationship between phonetics and phonology is much more intricate than that classically advocated by contemporary phonological models.

It was implicitly understood that working towards the second aim would be coincidental as the prime focus in the first cycle had been on theoretical linguistic issues, and that "spin-offs" of experimental analyses could in principle provide material towards achieving this second (applicational) aim.

A number of factors have contributed to the view that, for the second cycle of its existence (if granted) RUEPUS should refocus its research on **applicational issues** such as those proposed in the second mission statement above. The following reasons may be presented to motivate this shift in focus:

(i) It is probably true to say that no institution in the world is seriously involved in the development of African languages for applications in the field of language and speech technology. This has become abundantly clear in presentations and discussions of the Director at least four international conferences in Africa and in Europe during the last year. This point was accentuated even more at a final round table discussion of the 2nd World Congress of African Linguistics which took place in Leipzig in August 1997 which had as theme: "African languages in the 3rd Millennium." During this discussion not a single word was even raised on African languages and its role in current and future language and speech technology applications. This is extremely ironic in view of what is actually taking place worldwide[4] where language specific speech systems are developed for an extremely wide range of applications in for instance business and industry, and in education. There are a number of current initiatives within RUEPUS which links up quite well with this topic and which may be expanded on in an imaginative way.

[4] Cf. Bloothooft, G, Hazan, V, Huber, D & Llisteri, J (eds) 1995 *European Studies in Phonetics and Speech Communication*. Utrecht: OTS Publications.

This could lead to the creation of a unique resource centre for the actual development of language and speech technology applications.

(ii) Such a change in focus 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. In this sense it would alleviate the funding crisis, which lead to the loss of two highly competent researchers in 1996.

(iii) A new focus will reposition RUEPUS favourably to pursue aims of "innovative interdisciplinary research and development" as proposed by the W*hite 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.

(iv) It will open new possibilities to involve engineering and computer science students involved in interdisciplinary work with students in linguistics, even more specifically, with students of African linguistics. This situation has already been reached by the granting of an FRD bursary to a student in African languages working on a speech technological topic.

(v) It will make a definite and major contribution towards the development of the African languages *per se* within the South African context.[5]

This change in focus will not mean a total departure from theoretical linguistic research as one of the four main projects will still focus on pure linguistic issues. The other three main projects will, however, have a speech technology bias.

4.2 Programmes and projects

The following three main programmes are planned

Programme 1: The phonetics phonology interface

This programme will continue the type of research which dominated the first cycle, however, on a much more limited scale. The current international project "The phonetics and Phonology of click articulations in Nguni" will be continued and augmented by the project "The phonetics and phonology of non-pulmonic articulations in African languages." which will primarily be driven by Dr Michael Jessen (IMS, Stuttgart working at RUEPUS) through the sponsorship of the Alexander von Humboldt Stiftung. (Remark: RUEPUS will have to make some financial contribution to this project if an application for a post-doctoral fellowship at the University of Stellenbosch is not successful.

Researchers: Roux, Dogil & Jessen.

Smaller ad hoc projects at Masters' level on theoretical linguistic topics in African languages may also be accommodated under this programme. (Roux and students at MA level.)

Programme 2: Speech resource development in African Languages

Project 2.1 The phonotactic structures of the African languages

[5] 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 final reports it became quite clear that at official level, no provision whatsoever is being made for the Speech and Language Technology development in SA. This again is very is ironic, especially in view of specific recommendations of the comprehensive **LEXINET** programme which was undertaken by the HSRC in 1988. 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.

This project will constitute an expansion of the current project *Preferred syllable structures in Nguni and Sotho* and will include studies on Venda, Tsonga, and Ndebele. The reason for this expansion is that new software has been developed during 1996/7 by Mr Jan Louw which allows for very sophisticated phonotactic analyses, and which will improve the credibility of current results. Secondly, negotiations with the Bible Society of South Africa have resulted in the acquisition of large corpora of computer readable data, which will allow for much more representative results.

Researchers: JC Roux, Ms Alta Jones, NC Netshisaulu (UniVen), Ms Mary Masehela (UniVen), M Jokweni (Unitra), M Mmbi

Project 2.2 Acoustic speech databases of normal and pathological speech in African languages

This project is a revised version of that presented to the Advisory Committee in the 1995/6 Report.
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 D** 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.

Should this project materialize as contemplated, it will not only turn RUEPUS into the most prominent speech resource centre in the country, but will also generate research and development opportunities for at least eight to ten mother tongue speakers of the languages spoken in this country.

The main funding for this project will be sought from the private and public sectors. A special proposal in this regard will be made to the Pan South African Language Board (PANSALB).

Programme 3: Human-machine interaction through African languages

This programme makes provision for independent or co-operative projects related to speech technology applications. At this point the following project is envisaged:

Project 3.1 Developing a model for the development of Text-to-Speech (TTS) Systems in the African languages.

Current research (see 2.3.8) has shown that in the development of TTS systems for tone languages a number of factors play a role not normally associated with the development of TTS systems at large. One of the most crucial issues concerns the modelling of intonation

in such a system. Two of the current projects, i.e. J Jones: *The production and perception of statement and question intonation in Xhosa* (2.3.2) and P Swart *Modelling the intonation of imperatives in a Xhosa TTS system* (2.3.8) will need to be expanded on for this purpose.

Researchers: Roux, Swart, J Jones, M Jokweni.

4.3 Specific needs that should be addressed

In the 1995/6 Report to the Advisory Committee, mention was made of problems regarding the salaries of two highly qualified and competent researchers (Ms J Haasbroek MA, and J Louw M Eng cum laude). Two of the members of the Advisory Committee then indicated that they would be willing to augment the budget on a Rand to Rand basis should the University make more funds available to RUEPUS. Negotiations were then initiated with top management of the University, however, before any final decision had been reached, both staff members resigned and took up more profitable positions in the private sector. Mr Louw, however, is still available as consultant in an ad hoc capacity. The negotiations with the University were then terminated due the fact that, even if additional funds had been forthcoming, it would have been to little avail as RUEPUS had lost expertise at a very crucial point in time. This loss will probably be reflected in the research output of 1997/8.

It is hoped that, with a change in focus, RUEPUS will be in a far better position to negotiate for research and development funds in the private and public sectors.

4.4 Staff

In 1996/7 the once formal ties with Prof. Daan Wissing, were severed as explained in the previous Report. Prof Wissing and his team, however, still contributed directly and indirectly to the publication output of RUEPUS as is indicated in 2.4.

The contact of RUEPUS with staff of the Institute for Computational Linguistics at the University of Stuttgart (IMS) was 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. As indicated above, one of the staff members of IMS, dr. Michael Jessen is applying for a postdoctoral appointment at RUEPUS.

Although there are currently very few contracted black staff members at RUEPUS, it must be pointed out that (as explained in the 1995/6 Report) this type of interdisciplinary training takes time. The first RCB programme, however, has created a situation where at least six black staff members have been trained of which at least three will become co-workers in the 1998/9 projects. This number will be increased dramatically after the second RCB-programme at UNITRA and even more so should the SASPEECH project be implemented.

5 BUDGET

5.1 Statement of income and expenditure for the previous financial year (1996/7)

Please see **APPENDIX A**

5.2 Budget for next financial year (1998/9)

Please see **APPENDIX B**

6 GENERAL

I would like to express my sincere thanks and appreciation to

The Centre for Science Development and the Research Committee of the University of Stellenbosch for their generous financial support to the activities of this Unit

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DATAFUSION SYSTEMS for the use of computer hardware in the laboratory,

The **staff and students of RUEPUS** for their dedication and high quality work,

The **members of the Advisory Board** for their support and well meant comments.

PROF. JC ROUX **STELLENBOSCH**
DIRECTOR: RUEPUS **4 SEPTEMBER 1997**