EQUIPMENT

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Until now, we have never reported in our Proceedings about the equipment available in our institute.
That is, because the topic is not really interesting; of interest is what is done with the equipment.
This time, we will make an exception, because during the past few years a lot of time and money was spent on equipment. That was necessary because most of the equipment dated back to 1965 when our institute was newly fitted out. Therefore, the instrumentation was somewhat obsolete.
The following overview is restricted to some essentials, and doesn't pretend to be complete.

1. MECHANICAL WORKSHOP.

In 1965, a fully equipped mechanical workshop was installed in our institute. Although the amount of work decreased somewhat as years went by, because of the fact that electronic or computerized tackling of problems became more and more simple, we still think that it is important to have an appropriate fitted out mechanical workshop (see e.g., the work on vowel models).

2. ELECTRONIC WORKSHOP.

The equipment of the electronic workshop has been renewed almost completely during the last few years. The wide application of digital techniques of greater complexity and the pertaining integrated circuits led on the one hand to the need for much faster measuring instruments and on the other hand to a more sophisticated manner of construction of our tailor-made electronic devices.

3. EQUIPMENT FOR ACOUSTIC MEASUREMENT, REGISTRATION AND ANALYSIS.

We have at our disposal a small an-echoic room and a complete set of Brüel & Kjaer measurement and registration equipment.

Although the equipment still operates with vacuum tubes, we don't think this is a reason for replacing it. The specifications of the newer types are of course better, but not spectacularly so. However, we have met two real problems:

- for measurements at low sound pressure levels the B & K condensor microphones are inadequate,
- we have felt the need for a very small ideal sound source for measuring purposes.

(Apparently, manufacturers of equipment for acoustic measurements have a predilection for overdoses of noise rather than for the low intensity speech sound.)
To solve the first problem, we purchased Sennheiser MKH 105 T condensor microphones, which have a much lower impedance, and therefore a much higher signal-to-noise ratio.
As to the second problem, we intend to construct a 'ionophone' as described by Fransson and Jansson [Fransson and Jansson, 1975].

In addition to the equipment mentioned above, for analysis applications we have a 'wave analyzer' with mechanically coupled chart recorder (General Radio, types 1900 A and 1521-BQ1 respectively), with which amplitude-frequency graphs can be made. Furthermore, this device offers the possibility of carrying out measurements in a noisy environment ('tracking filter mode').

Recently we got at our disposal a Hewlett Packard 4520 A FFT signal analysing system, which is applicable to a number of purposes:

a. various standard type analysing procedures can be performed, producing outputs very quickly on a CRT screen. In addition to the graph, complete annotation of scales and variables is displayed. Many time-consuming acoustic measurements which were formerly performed with the aid of the B & K equipment, can be carried out with the HP-analyzer. This greatly reduces the analysis time;
b. with the aid of the HP-analyzer certain measurements can be realized (particularly on hardware vowel models) which up to now were not possible or at least with great difficulty. These possibilities are part-

ly due to the fact that the HP analyzer can process two signals simultaneously so that measurements such as cross-correlation and tranfer function can be performed;

c. measurement outputs as well as measurement parameters can be stored on magnetic tape cartridges, thus saving final or intermediate results without the necessity for plotting the outputs on paper. Additionally, every user can recall his (or her) measurements at any moment without the need of readjustment of all measuring parameters. Outputs which must be stored permanently can be plotted on paper, included complete annotation, by making use of the HP plotter coupled with the analyzer;

d. unlike the other analysis equipment mentioned above, the HP analyzer is able to deal with single event signals, because the signal to be analyzed is stored in memory.

Last but not least, we have a permanently interconnected measurement system specifically designed for the analysis of speech segments, particularly taped material. This system consists mainly of a segment selection device [Wempe, 1976] with oscilloscope and a segment spectrograph [Wempe, 1979].

4. COMPUTER FACILITIES.

In 1975, we regarded our IBM 1130 computer system as being obsolete. In close cooperation with the Phonetic Institute of the Catholic University in Nijmegen we scanned the minicomputer market looking for a new system.

At that moment we knew that there was a growing demand for computer facilities in the Faculty of Arts, but that there were no facilities at all except our IBM system. It was decided then to investigate whether it would be possible to purchase one single minicomputer system, which was to be connected to the CDC Cyber of SARA (the common computer centre of our university, the Free University and the Mathematical Centre), for the whole faculty. Clearly, special attention had to be paid to I/O facilities, e.g. our own demands for fast A/D and D/A conversion, but also the possibility of printing special characters.

In fine, this development has led to the birth of the 'Computer Department of the Faculty of Arts', which is housed in our institute. The Computer Department does meet the needs of many people in our faculty, and the computer is used for a variety of applications in research in linguistics, literature, music science, history, and, of course, phonetics ['De computer in de Letteren', 1981]. The growth has been enormous during the last few years: the computer system has been expanded already twice since the installation in 1976.

The computer installed is a Data General Eclipse S/200, working under the RDOS operating system plus the time sharing system TSS of Polymorphic Computer Systems, Inc. The Eclipse has a very fast hardware floating point processor, 256 kb of MOS-memory, a 192 Mb and a 10 Mb disk unit, and a 9 track 800 bpi mag-tape unit. On-line there are 5 terminals: 1 Tektronix 4025, 2 Beehive DM-1 S and 2 Beehive Super Bee. A 428 l/m 96 ASCII line printer as well as a Versatec D 1200-A electrostatic printer/plotter, especially meant for printing special characters, is present.

Interesting for speech processing are the graphics (which are, in addition to the Tektronix and the Versatec: a Calcomp 565 drum plotter, and a storage oscilloscope operating with an interface of our own design), and the facilities for direct analog and digital I/O. For the latter, Data General uses a separate chassis, the DGDAC 4300, in which 16 different modules (A/D, D/A, TTL-in, TTL-out, multiplexers, etc.) can be placed. The DGDAC is regarded by the computer as one device; the DGDAC's controller directs the data transfer to or from the correct module within the DGDAC.

In our present configuration there are two DGDAC's. One DGDAC, containing the TTL inputs and outputs, is directly connected to the I/O bus of the Eclipse. The other one, containing the A/D convertor with 16 channel mux and the D/A convertors (4 on one board), is connected to the Eclipse via a small I/O processor, the DCU-50. The DCU is in fact a Nova processor with 1 kw fast local memory. The DCU can address 32 kw of memory, from which the lowest 1 k is its own memory, the remaining 31 k being shared with the memory of the Eclipse. This set-up gives the possibility to leave the interrupt handling and the data transfer to and from the D/A and A/D convertors to the DCU, thus greatly relieving the Eclipse.

We designed and built ourselves programmable clock signal generators, gain amplifiers and anti-aliasing filters, and control logic for tape recorders.

Unfortunately, Data General's software for controlling the DGDAC, SAM (sensor access manager), is not appropriate for fast applications, and doesn't support the combination DCU-DGDAC. For the development of system oriented software we got great help from drs. L. Boves from the Phonetic Institute of the Catholic University in Nijmegen. At application level we use the Interactive Laboratory System (ILS), a package of programs for speech analysis and synthesis, based mainly on lineair prediction, developed at the Speech Communication Research Lab., Inc., Santa Barbara. Our own application programs are as far as possible based on the file structures used in ILS.

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