ELECTRON MICROSCOPE UNIT
ANNUAL REPORT
1996

Director	**B.T. Sewell**
Principal Technical Officer	**D.A. Gerneke**
Chief Technical Officer (Part Time)	**J. Duncan**
Senior Technical Officer	**M.A. Jaffer**
Technical Officer	**M. Waldron**
Photographic Assistant	**W. Williams**

April 1997

TERMS OF REFERENCE

The Electron Microscope Unit is an Inter-faculty facility. The following terms of reference were approved by Senate (PC 11/87) and confirmed by GPC (1/2/88).

"The prime objective of the EM Unit is the provision of a dedicated service to the University's research and teaching community."

"The Unit should aim at a high level of maintenance of the instruments, with a minimum of down-time".

"The Unit should ensure the provision of an adequate basic teaching in electron microscopy for users".

The Senate (PC 11/87) also approved the establishment of an E M Unit Steering Committee.

HIGHLIGHTS OF 1996

STAFF

Mrs M.E. Waldron joined the Unit as a Technical Officer on 1 March 1996. Her primary role is the management of all of the Unit's logistics, including use of SAP/R3. She also helps users with sample preparation and operates the scanning microscopes. She has maintained an interest in research on fish ageing and continues to collaborate with her former associates at the Sea Fisheries Research Institute.

IMAGING CENTRE

Electron microscopic imaging has become increasingly digital. As a consequence of this the Unit has gained considerable expertise in the generation, processing, manipulation, analysis and storage of digital images. This expertise is being tapped by users outside of our traditional user community of electron microscopists. In order to serve the needs of this extended group of users the Unit has established an imaging centre with facilities for scanning, manipulating, analysing, archiving and printing digital images. There are also facilities for the digitization of video images and for the production of digital videos. The scanning facilities are built around a Nikon LS4500 scanner which was purchased with funds provided by ITEC and UEC. Software includes Photoshop, Premiere and Visilog. A number of other resources including computers, a CD-recorder and slidemaker have been consolidated into the centre from other locations in the EM Unit, creating a central facility which is fully resourced. The facilities for digital video were gained from funds earmarked for the production of multimedia educational materials and were housed in the Unit for a variety of reasons including their physical security. A powerful computer running Microsoft Windows NT server was installed to act as a fileserver to facilitate the storage and distribution of image data to users via the network. This machine supplements the existing VAX based networking giving users access to nearly 4Gb of networked storage for short term use.

The centre still lacks facilities for high quality printing but efforts are currently being made to select appropriate equipment using the funds allocated.

The centre was launched in September with an intramural conference on digital imaging attended by about 50 people from thirteen departments.

SURVEY OF ELECTRON MICROSCOPE NEEDS

A letter requesting information about future perceived EM needs was circulated to all heads of department in the faculties of Science, Engineering and Medicine as well as to other established users of the Unit.

The following emerged from the survey:

- There is widespread satisfaction with the EM Service as it currently exists.
- The departments that currently have "in house" microscopes are extremely resistant to any moves towards centralization.

- There was no perceived need for any transmission electron microscope facilities that are currently not available. There is a need for the existing capabilities to be maintained.
- Rather surprisingly - and contrary to a postulate expressed in the letter - the need for enhanced SEM facilities was expressed. The capability requested is low vacuum SEM (LV-SEM). This technique has had a major impact on the electron microscopy of non conducting specimens, including hydrated biological specimens and was at the time not available at any location in South Africa.
- An issue that surfaced several times was the need for the Unit to be structured to take in work for users. This differs from the currently preferred method of operation in which users learn to operate the instruments under instruction from Unit staff.

  Since the survey the technician running the EM service at Red Cross Hospital, on whom many users depended has resigned. This will impinge on the plans expressed by several HOD's and requires the EM situation in the Medical School to be re-evaluated.

  The maintenance of TEM services at their present levels around the current ageing instruments may be costly and may not be cost effective. In spite of the results of the survey the Unit is aware of two unfulfilled TEM needs: x-ray analysis and cryo-microscopy. Modification of our current instruments to meet these needs is not reasonable considering their age and design.

MEETINGS OF THE ELECTRON MICROSCOPE STEERING COMMITTEE

The Electron Microscope Steering Committee is a technical subcommittee of the Equipment Committee chaired by the dean of the Faculty of Science, Professor V.C. Moran. It comprises the director of the Unit, five members of academic staff and three members of technical staff. The current members are Associate Professor B.T. Sewell (EM Unit), Associate Professor H.P. Linder (Botany), Professor J.J. Gurney (Geological Sciences), Professor B.B. Rawdon (Anatomy and Cell Biology), Professor J.A. Thomson (Microbiology), Dr R.D. Knutsen (Materials Engineering), Mr D.A. Gerneke (EM Unit) and Mr R.S. Rickard (Geological Sciences). In addition Associate Professor R.B. Tait (Mechanical Engineering) has been co-opted onto the Committee. Mr M. Emms was elected to represent technical officers using electron microscopes at Medical School subsequent to the resignation of Mr P.D.G. Richards. He has since resigned leaving a vacancy on the committee.

Meetings of the Electron Microscope Steering Committee were held on 21 May 1996 and 9 December 1996.

USE OF THE UNIT

Services provided by the Unit during 1996 are listed in Table 1.

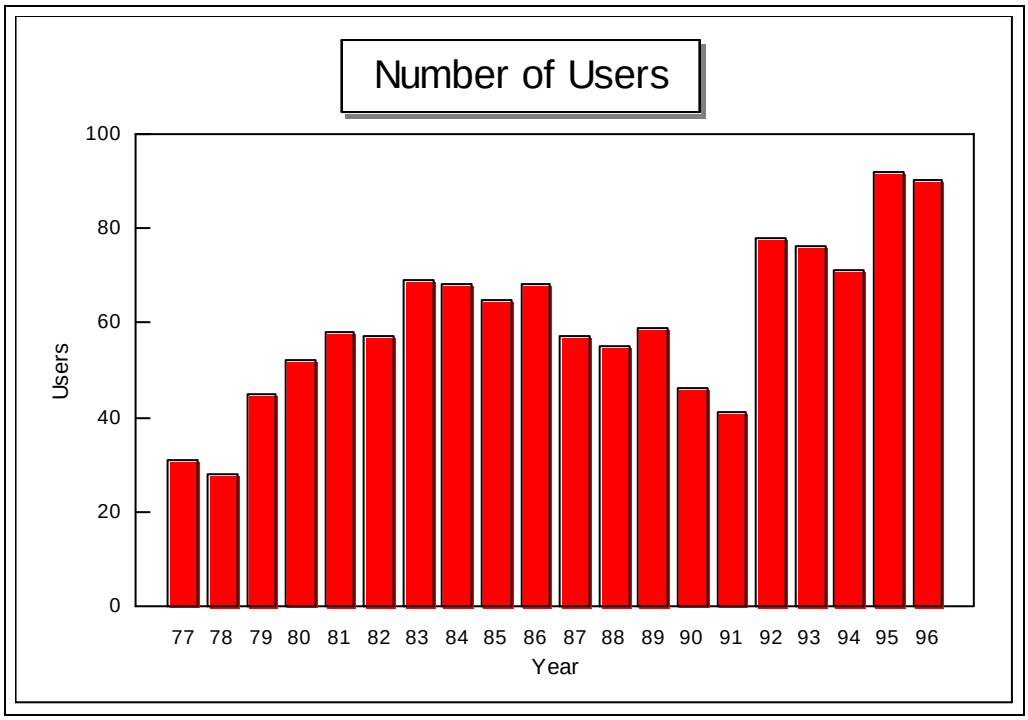

Figure1: Number of users per year since 1977.

Ninety people made use of the microscopy services of the Electron Microscope Unit in 1996. In addition a further 38 users utilized services other than those related to microscopy.
The names and departments of the users are listed in Table 7.

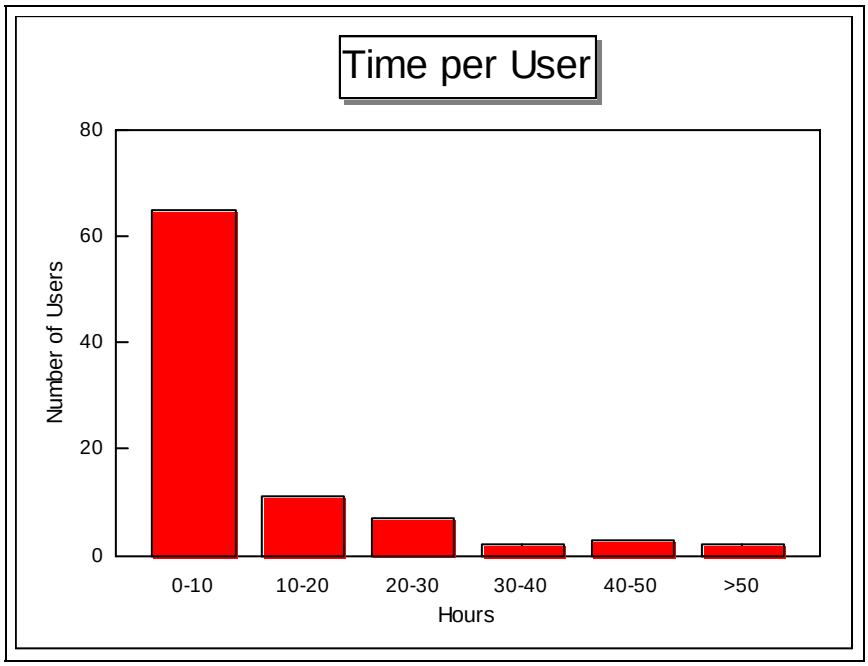

Figure 2: Usage pattern. The graph shows the time users spent viewing samples, either alone or assisted on any one of the electron microscopes**.**

The usage pattern, which has not changed from previous years, shows that the largest number of users made use of the Unit facilities for a comparatively short time. There is very little point in investing time in training these people and therefore they make considerable demands on the Unit staff. This graph illustrates the continued high demand for a samples in-results out pattern of usage.

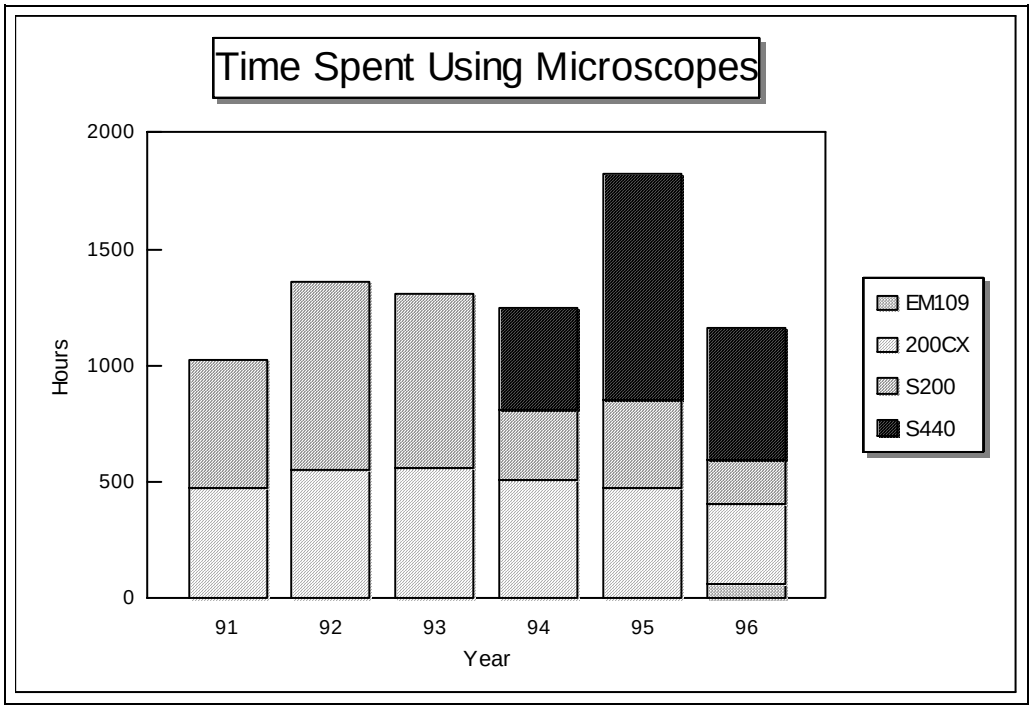

Figure 3: Time spent using the Unit's microscopes since 1991.

Total time spent using the Unit's microscopes was 1164 hours in 1996. Nearly half of this time (568 hours) was spent using the S440.

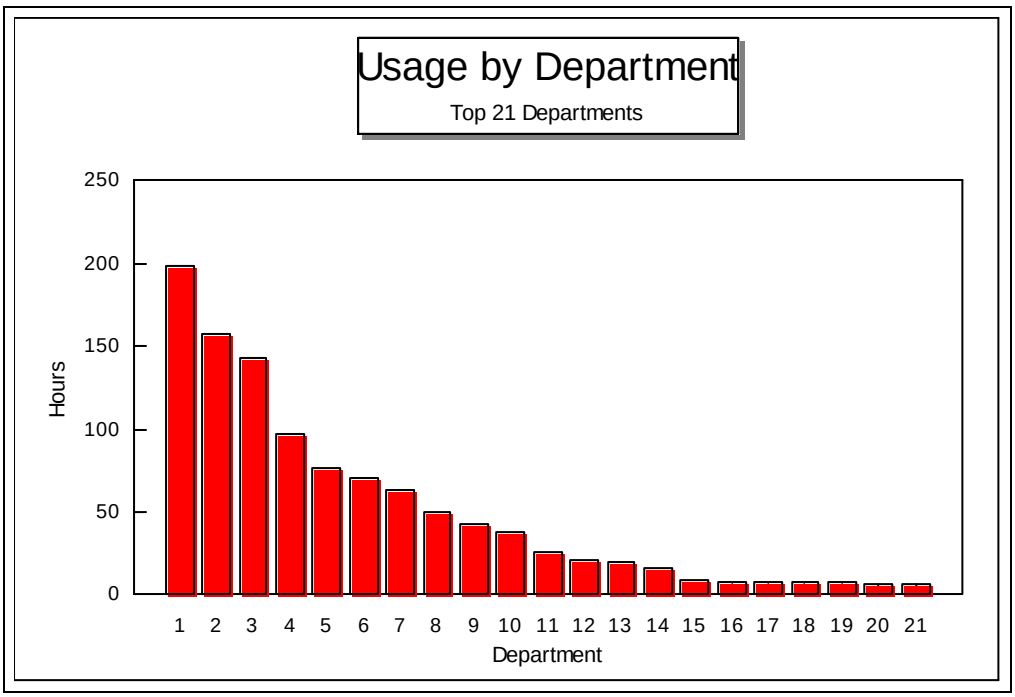

Figure 4: Microscope usage by department.
The key is as follows:

1	Materials Engineering	8	Chemistry	15	Physics
2	Botany	9	Stellenbosch University	16	UWC
3	EMU - User training	10	Mechanical Engineering	17	Cardiothoracic Surgery
4	Chemical Engineering	11	Liver Researh	18	Energy Research Institute
5	Microbiology	12	Univ Botswana	19	Halliburton
6	Geological Sciences	13	Univ Witwtersrand	20	NAC
7	Zoology	14	Biochemistry	21	Dentistry UWC

TEACHING

USER COURSES

A SEM training course was held from 13/5/1996 to 17/5/1996, 3 new SEM users were trained.

The four or five day intensive course aimed at honours and post graduate students, "Introduction to Microscopy for Biologists", was held four times and attended by a total of 26 students, including 3 from UWC and one staff member.

12/2/1996-19/2/1996	4 honours students from Anatomy and Cell Biology and 2 M.Sc. students and a technician from Botany
15/4/1996-19/4/1996	7 Biochemistry honours students
23/4/1996-29/4/1996	3 UWC Microbiology honours students and a Botany M.Sc. student
23/4/1996-29/4/1996	10 Microbiology honours students

INDIVIDUAL TRAINING

Eight new users were trained to operate the 200CX, three were trained to operate the S440, seven to operate the EM109 and ten to operate the microtome.

SCHOOL VISITS

A group of fourteen pupils from Herzlia visited the Unit for a lecture and demonstration on 26 February.

LECTURES

Mr Jaffer delivered three lectures and a practical on "Virus Structure and Electron Microscopy" as a component of Microbiology 303S from 12-16 August.

ELECTRON MICROSCOPES AND ASSOCIATED EQUIPMENT

LEICA STEREOSCAN S440

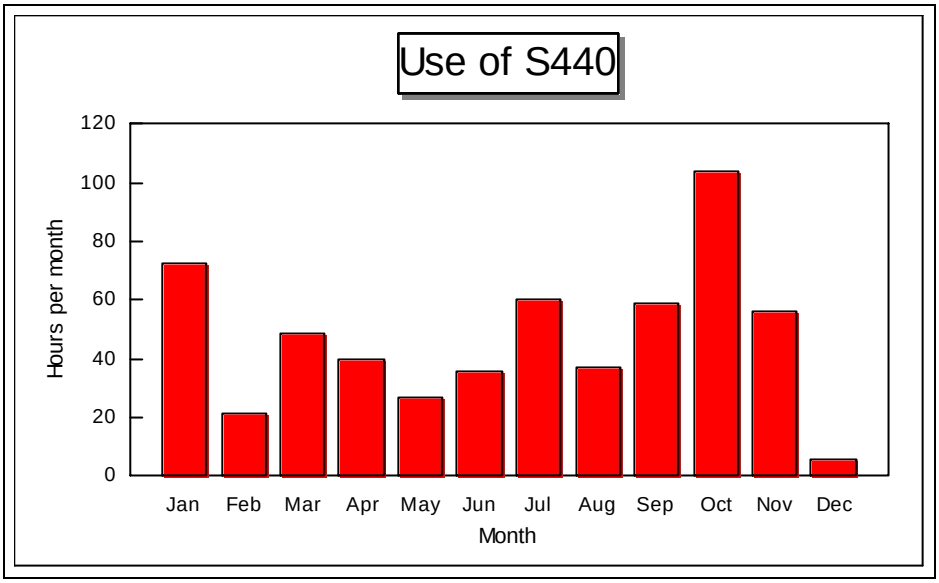

Figure 7: Use of the Leica S440 SEM

The S440 was used for a total of 568 hours. The decrease from 1995 was due to the completion of work by one student in the department of Materials Engineering. Sixty users made use of the instrument and use was made of all of its facilities. Thirty-seven users were from UCT, the remainder coming from other Universities including two outside South Africa, associated institutions and private companies.
The electron optics board failed in June and was replaced under LEO's board replacement scheme at a cost of R13 609.61. The downtime resulting from this breakdown was 104 hours.
The Kevex energy dispersive x-ray analysis system is the most heavily used accessory on the system. The control of the system was improved by installing a separate computer to run the Kevex software, thus separating it from the main microscope control computer. The Kevex software was updated at a cost of R17 467.18, shared equally by the maintenance budgets of ITS and the Unit.

CAMBRIDGE S200 SEM AND KEVEX 7000 ANALYSIS SYSTEM

The S200 was used in total for 189 hours which is again well below its former rate. In spite of the rebuilding and repair that took place in 1994 and 1995 the instrument continued to display occasional faults which manifested themselves as lines on the photographs. A concerted attempt was made to trace the remaining faults and a large part of Mr Duncan's time was devoted to servicing this instrument. In total the instrument was removed from service for some 192 hours. For most of the year users were allowed to use the instrument with the caution that the results would be imperfect. By October all the circuit boards related to the imaging path had been cleaned, inspected, repaired as necessary and had their connectors replaced with gold ones and all faults that were manifesting themselves as lines had been corrected. The repair has amounted to a thorough reconditioning of the instrument and it is hoped that it will function to specification for some time. In addition the vacuum pump bearings failed but this was fortunately detected before major damage was done and the need for an expensive repair was averted.
The Kevex system was not used in 1996. The possibility of transferring it to the 200CX TEM was investigated but this was found to be impractical.

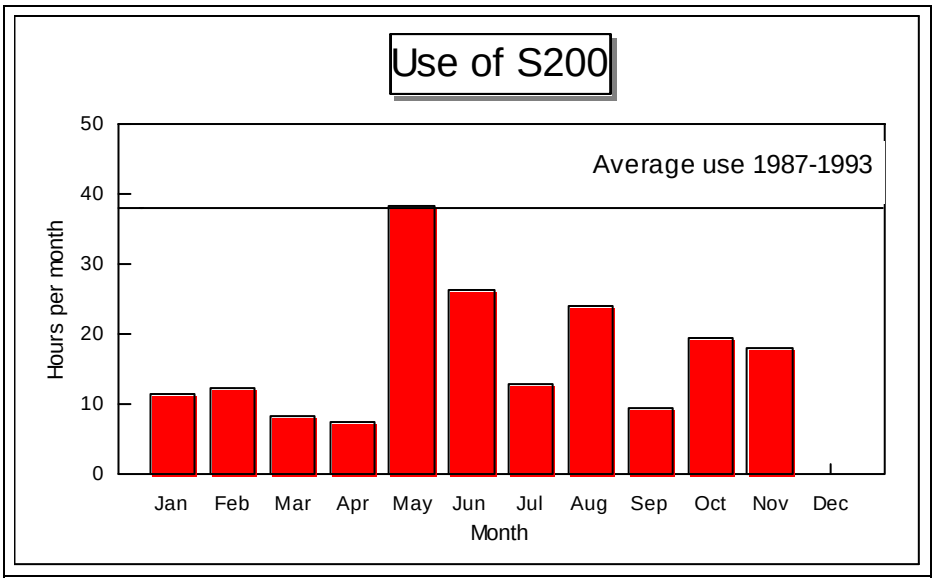

Figure 5: Use of the Cambridge S200 SEM

JEOL 200CX TEM

Use of the 200CX TEM again fell during the year to 344.5 hours. This is entirely due to the termination of projects originating in the department of Microbiology. However the total number of users increased from 25 in 1995 to 27 in 1996.

This instrument has had problems relating to the stability of the high voltage circuitry which resulted in flickering of the beam and drift from focus. Although we have known about these problems for some time it has been possible to work around them and they have not been addressed. Ultimately a 200kV discharge occurred damaging a silicon rubber insulator which had to be replaced at a cost of R8829.30. Only 60 hours downtime resulted from this incident as the microscope was brought to an operational state without confronting the underlying problems - a task which would have rendered the microscope unusable for a considerable period of time.

The primary users of the instrument (Materials Engineering) were consulted regarding setting aside time on the instrument to address the problems and it was agreed that this would commence at the beginning of 1997.

The AstroCam 4100 CCD camera which was initially delivered in 1995 and which was returned to the manufacturer for modification because it did not meet specification was returned to us and reinstalled on the microscope. A number of deficiencies had still not been corrected but these were ultimately fixed by ourselves with the co-operation of the manufacturer. Ultimately the camera did work to specification. In retrospect the purchase of this camera has been a sobering experience and has highlighted the risks associated with buying into technology at the forefront.

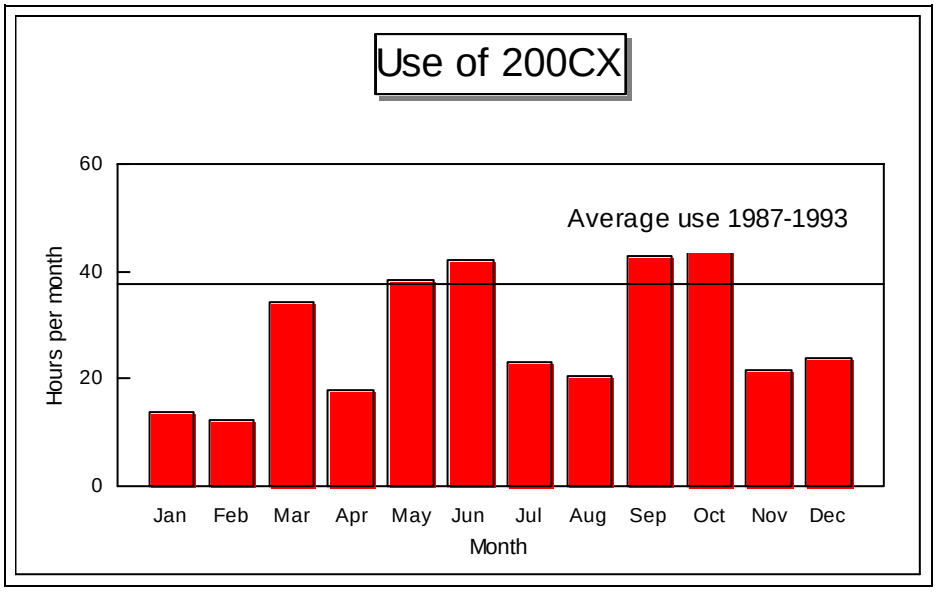

Figure 6: Use of the Jeol 200CX TEM

Urgent attention must be given to planning the replacement of the JEOL 200CX. The instrument is in its eighteenth year of service. No similar instruments of this age remain in use in the area served by JEOL UK and service support and spares will become increasingly difficult to obtain. The only other 200CX in South Africa, at Iscor, was replaced in 1996.

It is anticipated that our instrument will become increasingly unreliable in future. The instrument also lacks a number of capabilities expected of a modern, top flight, research instrument and thus the range of TEM experiments that can be done at UCT is limited. Although enhanced capability seems to be unimportant to the current group of researchers at UCT, lack of modern facilities will impinge on the range of research possible and must have an effect during the expected fifteen year lifetime of the instrument.

At present there are no plans to replace either of the other two research calibre microscopes in the Western Cape (at UWC and the MRC) and thus it is not reasonable to anticipate that UCT users will easily be able to make use of equipment elsewhere.

The cost in 1997 of purchasing a new instrument which maintains the capability of the 200CX is approximately R3.5m and an instrument with enhanced capability may cost as much as R5.0m

ZEISS EM109 TEM

The EM109 was brought into service from the beginning of 1996. Users who can exploit its capabilities were encouraged to use it in preference to the 200CX and seven researchers were trained to use it. As the machine is simple to use and robust, all students taking the “Introduction to Microscopy for Biologists” used the instrument themselves during the course. Apart from course use the instrument was used for 62.5 hours for research.

OTHER EQUIPMENT

MICROTOME

Use of the microtome increased to 328 hours. Ten new users were trained. Several projects utilising the cryo-sectioning capabilities of the instrument were commenced. One of these, originating in the Liver Research Unit, is showing considerable promise.

FINANCE

Details of the Unit's accounts are presented in Tables 2, 3, 4, 5 and 6.

RESEARCH ACTIVITY

Research was generally carried out in collaboration with other departments and laboratories.
The Director devoted time to the three research projects described below and to the supervision of two PhD students (Mr Jaffer and Mr Reavis) and one MSc student (Mr Nicolls). Mr Nicolls graduated in July.

Electron Tomographic studies of the chromatin fibre:
B.T. Sewell and M.A. Jaffer.
Chromatin in the cell nucleus is compacted through a series of folding events. The first of these foldings is the formation of nucleosomes. This is well understood. The nucleosomes are then formed into fibres which have a diameter of about 30 nm. The structure of the fibres remains unknown. Electron tomography is a method which could lead to the structure determination of the fibre at the level of resolution necessary for understanding of its folding.

Computer analysis of gel electrophoretograms:
B.T. Sewell, S.C. Reavis (Provincial Laboratory for Tissue Immunology).
This project involves the development of a computer system for the analysis of gel electrophoretograms. Although many of the algorithms are of general application the primary objective is the development of a system for the automatic analysis of the tandem repeat VNTR DNA polymorphism for paternity testing.

Autofocus Algorithms in the Scanning Electron Microscope
B.T. Sewell, G de Jager and F.C. Nicolls (Department of Electrical Engineering)
Accurate and rapid automatic focusing of the scanning electron microscope would simplify the operation of the microscope for novice users and enable an experienced user to achieve more. The only published work in the area makes use of a large number of scans of the same area and chooses the one which has the best focus. The goal of this project is to design and implement an algorithm which will be able to predict focus from a small number of scans. The project is being undertaken as part of our partnership agreement with Leica, Cambridge

Studies on otoliths
M.E. Waldron and D.A. Gerneke
Banding in otoliths from mackerel *(Trachurus trachurus)* can be used to determine the age of the fish. The bands are laid down daily but details of their origin are not fully understood. Cathodoluminescence and other imaging studies of the bands have been undertaken in order to gain some understanding of this.

PUBLICATIONS

Publications, for 1996, that resulted from research in which the EM Unit staff have been directly involved are listed:-

Conference Proceedings

Gerneke, D.A. & Waldron, M.E. 1996. Application of Cathodoluminescence to Horse Mackerel (Trachurus trachurus) Otoliths. Combined ACEM-14, IUMAS-1, MAS-9 conference, Sydney Australia :53.

Sewell, B.T., Wittridge, N.J., Gerneke, D.A. & Knutsen, R.D. 1996. Microtexture of Polycrystalline Metals by Electron Backscattered Diffraction Pattern Analysis, 33rd Annual Convention of the S.A. Chemical Institute, Cape Town.

Published Conference Proceedings

Gerneke, D.A. & Sewell, B.T. 1996. Optimization of the performance of a transmitted electron detector in the SEM. Proceedings of the Microscopy Society of Southern Africa **26**:4.

Nicolls, F.C., de Jager, G. & Sewell, B.T. 1996. A Predictive Autofocus Algorithm for SEM. Proceedings of the Microscopy Society of Southern Africa **26**:5.

Waldron, M.E. 1996. Age validation of the South African sardine, Sardinops sagax, using daily growth increments. Benguela Dynamics Symposium, University of Cape Town, South Africa :75.

Waldron, M.E. and Gerneke, D.A. 1996. Microstructure of fish otoliths using SE1, BS and CL detectors. Proceedings of the Microscopy Society of Southern Africa **26**:123.

Theses Passed for Higher Degrees (Masters and Doctoral)

Nicolls, F.C. 1996. The development of a predictive autofocus algorithm using a general image formation model :1-115. Masters thesis: University of Cape Town.

Publications of a Popular Nature

Sewell, B.T. 1996. Learning Science - The Future is here!, Archimedes 38:34-35

Published Papers

Waldron, M.E. and Gerneke, D.A. (1996) “Comparison of two scanning electron microscope techniques for examining daily growth increments on fish otoliths”, Journal of Fish Biology, **50**(2),450-454.

Publications by Users of the Unit

The following list includes those papers given to the Unit by users. It is unfortunately not a complete list of published work that has been conducted in the Unit.

Frimmel, H.E., Klotzli, U.S. and Siegfried, P.R. (1996), “New Pb-Pb single zircon age constraints on the timing of Neoproterzoic glaciation and continental break-up in Namibia.” Journal of geology, **104**,459-469.

Nash, R.J., Dry, M.E. and O’Connor, C.T. (1996), “Aromatization of 1-Hexene and 1-Octene by Gallium/H-ZSM-5.” Applied Catalysis A General **134**,285-297.

O’Donovan, A.W. and O’Connor, C.T. The use of cyclohexanol, dehydration, isobutane, cracking and 2,6-DPIN synthesis over dealuminated mordenite to probe acidity. In “Progress in zeolites and porous materials” H. Choun, S.-K Ihm and Y.S. Uh (eds), Stud. Surf. Sci. Catal. 105b Elsevier, Amsterdam 1996. p 949-956.

O’Donovan, A.W., O’Connor, C.T. and Koch K.R. (1996) “Effect of acid and steam treatment of Na- and H-Mordenite on their structural, acidic and catalytic properties.” Microporous Materials **5**,185-202.

Sewell, G.S., Van Steene, E. and O’Connor, C.T. (1996) “Use of TPR/TPO for characterization of supported colbalt catalysts.” Catalysis letters **37**,255-260.

Sherwin, H.W. and Farrant, J.M. (1996) “Differences in rehydration of three desiccation tolerant angiosperm species.” Anals of Botany, **78**,703-110.

Van Niekerk, M.J., Fletcher, J.C.Q. and O'Connor, C.T. (1996) “Effect of catalyst modification on the conversion of methanol to light olefins over SAPO-34.” Applied Catalysis A General **138**,135-145.

Van Steen, E., Schnobel, M and O'Connor, C.T. Selective partial oxidation of α-olefins over iron antimony oxide. In "Heterogenous hydrocarbon oxidation." B.K. Warren and S.T. Oyama (eds) ACS symposium series 683, American Chemical Society, Washington DC 1996. p292-300

Webber, R.W., Fletcher, J.C.Q, Moller, K.P. and O'Connor C.T. (1996), "The characterization and elimination of the external acidity of ZSM-5. Microporous Materials **7**,15-25.

Wittridge, N.J. and Knutsen, R.D. (1996) "Recovery and recrystillisation characterisation in ferritic stainless steel using electron channeling contrast." Materials Characterisation **37**,31-37.

OTHER MATTERS

STAFF DEVELOPMENT

Mrs Waldron attended a course on optical microscopy presented by Mr P. Robinson. Mr Gerneke attended a course on cryo-SEM presented by Dr P. Echlin. Both courses were held under the auspices of the Microscopy Society of Southern Africa.

SERVICE TO INDUSTRIAL AND OTHER EXTERNAL USERS

The Unit offers its facilities on an ad hoc basis to external users. Clients exploiting these services during 1995 were Membratek, S.A. Nylon Spinners, Patterson and Cook Consulting Engineers, Scientific Services, Ultra High Pressure, Special Products, Halliburton and Atlantis Diesel Engines.

FUNDING REPAIRS

The cost of repairs and maintenance in 1996 was high. Most of the cost was carried by the maintenance fund built up by the users over the past three years through the charging of a usage fee. A contribution of R15 000 was made by the Departmental Grants committee by releasing the maintenance provision that had been allocated to the Unit.

CLEANING THE UNIT

The arrangements for cleaning the Unit have never been totally satisfactory and considerable correspondence on the matter has been entered into over the years. In 1996 Mr Basil Mohamed who had been assigned to do the job for 1.5 hours per day became too ill to do the job properly and was assigned to light duty. The current arrangement is that a temporary cleaner comes for three days per month and cleans as required. In this way major cleaning work is being done but lack of continuity is a problem.

VISIT TO AUSTRALIA BY MR GERNEKE

Mr Gerneke was in Australia from 29/1/96 to 18/2/96. He attended the joint conference of the Australian Electron Microscopy Society and the International Union of Microanalytical Societies (IUMAS) and a satellite workshop on cathodoluminescence. He presented a paper at the conference and was invited to present a lecture at Melbourne University. The Zoology department at Melbourne University consulted him in order to get their cathodoluminescent system working and teach them to use it. After his return a number of specimens have been sent to him from Melbourne for examination of their cathodoluminescence.

VISITORS TO THE UNIT

Professor John McKenzie, co-ordinator of the Centre for Electron Microscopy at the University of North Carolina spent a day in the Unit and presented a lecture on "Digital Printing of Electron Micrographs". Dr Pat Echlin, Director of the Multi-Imaging Centre, Department of Plant Sciences, Cambridge University visited the Unit for a morning and consulted with users from the Department of Botany on cryo-techniques.

SUMMARY

1996 saw an expansion of the services offered by the Unit through the establishment of the Imaging Centre and the EM109. Services in scanning electron microscopy and x-ray analysis continued to be well used. 1996 was also the year in which it became necessary to confront the issue of the continuation of first rank services in transmission electron microscopy. This issue gave rise to considerable introspection on the part of the Unit. The way forward is certainly not clear at the present time but it is hoped that some issues will be resolved during 1997.

I wish to express my sincere thanks for all the support the Unit has received from Prof. V C Moran, as the Chairman of the Electron Microscope Steering Committee, and the committee members who played an active role in the continued functioning of the Unit.

Prepared by: Associate Professor B.T. Sewell
Director
14 April 1997

TABLE 1

Services Offered by the Unit during 1996

Service	Comment
Access to 200CX TEM	Used by 27 staff and students.
Access to S440 SEM	Heavily used by 60 users
Access to S200 SEM	Not as well used as in previous years. Major reconditioing was undertaken.
Access to the EM109 TEM	Used
Training on 200CX	Eight users were trained in 1996
Training on S440 SEM	Three new users were trained in 1996
Training on S200	One course was held for three new users.
Training on the EM109 TEM	Used in courses. Seven users individually trained
Access to Ultracut S Ultramicrotome	Well used
Training on Ultracut S	Ten new users were trained
Sectioning of blocks supplied by the user	Well used
Embedding of biological specimens	Well used
Sputter Coating of specimens supplied by user	Very popular service
Critical point drying of specimens supplied by the user	Very popular service
Access to darkroom facilities	Well used by a small number of users. Many potential users would rather have their darkroom work done for them.
Printing of EM films	Service used to capacity
Preparation of slides of electron micrographs for lecture purposes	Used
Access to optical microscopy facilities	Used
Access to Image Analysis (GENIAS)	Used. Used for teaching image analysis.
Access to Image Processing and Analysis (Visilog)	Used.
Element analysis by EDS	There is considerable demand for this service on the new Kevex Sigma system.
"Introduction to EM for Biologists"	This course was held four times.
Access to specimen polisher	Used very infrequently in 1996
Access to high vacuum coating plant and accessories	Adequately used
Store of EM consumables	Used by all our users
Access to prep lab	Used for the final stages of preparation only.
Collection of books and journals on microscopy	The books are well used during our courses.
Access to microdensitometry facilities	Not used
Vacuum Leak Detection	Used by the Physics department
Production of CD ROMS	Over 100 were produced
Digitization of transparent media on LS4500	Well used
Production of slides from digital images	Used
Digitization of video tape	Used
Production of digital videos	Used

TABLE 2

Equipment Expenditure

Funded by the Equipment Committee	
Contribution to establishment of Imaging Centre	R 39 691.00
TOTAL	R 39 691.00
Funded by ITEC	
Contribution to establishment of Imaging Centre	R 22 191.00
Contribution to computer for X-ray analysis	R 8 000.00
TOTAL	R 30 191.00

TABLE 3

External Services Entity

Opening Balance of Funds	R 19 870.46
Income	
Miscellaneous	R 3 399.14
Materials and Consumables	R 2 952.00
Hire of Equipment	R 1 505.00
TOTAL	R 7 856.14
Expenditure	
Computer Software	R 1 511.11
Equipment Registered Assets	R 8 256.13
Conference Fees	R 1 060.00
Entertainment	R333.69
Telephone Calls	R 247.19
Telephone Rentals	R 180.09
Transfers	R 9 596.62
TOTAL	R 21 184.83
Closing Balance 1996	R 6 541.77

TABLE 4
Departmental Grant

Opening Balance of Funds	R 4 818.62**Db**
Income	
Annual Grant	R 43 300.00
Transfers	R 8 589.16
Other income	R 959.13
Photographs	R 3 605.15
TOTAL	R 56 453.44
Expenditure	
Ad hoc Grants	R 245.00
Books	R 673.98
Cleaning Materials	R 431.84
Computer Consumables	R 70.68
Computer Supplies	R 718.20
Gas - General	R 9 901.20
Equipment Registered Assets	R 2 899.89
Fax	R 0.75
Films	R 324.85
First Aid	R 15.25
General Expenses	R 696.48
Laundry	R 35.56
Lab Equipment	R 581.14
Maintenance Department Charges	R 1 754.00
Materials and Consumables	R 12 763.78
Minor Equipment	R 215.71
Periodicals	R 275.99
Printing / Photocopy	R 867.77
Postage and Telegrams	R 1 996.99
Refreshments	R 305.86
Repairs and Maintenance General	R 6 108.64
Stationery	R 1 088.31
Subscriptions	R 70.00
Sundry Expenses	R 475.19
Telephone Calls	R 4 161.05
Telephone Rentals	R 3 360.00
Hire of Equipment	R 2 685.75
Transfers	R 2 286.04
TOTAL	R 51 634.82
Closing Balance 1996	R 0.00

TABLE 5

Consumables Store

Opening Balance of Funds	R 9 711.39
Income	
Ad hoc Grant	R 15 245.00
Miscellaneous	R 7 080.45
Other	R 169.03
Internal Recoveries	R 28 362.56
TOTAL	R 20 952.96
Expenditure	
Computer Consumables	R 2 171.96
Course Fees	R 300.00
Films	R 134.40
Materials and Consumables	R 13 268.56
Photographs	R 8 003.53
Repair and Maintenance	R 7 500.00
Sundry expenses	R 159.13
TOTAL	R 31 537.58
Closing Balance of Funds 1996	R 29 090.85

TABLE 6
Maintenance

Opening Balance of Funds	R 17 708.47
Income	
Hire of Equipment	R 20.00
Miscellaneous Income	R 766.66
Internal Recoveries	R 43 151.65
Redistribution of Annual Grant	R 9 089.61
TOTAL	R 54 829.62
Expenditure	
Computer Software	R 15 596.78
Lab Equipment	R 720.00
Postage	R 3 588.00
Repair and Maintenance	R 1 561.00
Sundry Expenses	R 501.20
Rentals	R 2 250.71
Equipment (Registered Assets)	R 22 938.17
Minor Equipment below R100	R542.86
Transfer	R 4 769.10
TOTAL	R 52 467.82
Closing Balance of Funds 1996	R 20 070.27

TABLE 7
Users of the Unit

Anatomy	Kidson, S	Staff
	Omlin, F.	Staff
Archaeology	Jordan, S.	PhD
	Sillen, A.	Staff
Atlantic Diesel Engines	Hunt, J.	Staff
Avian Demography Unit	Navarro, R.	Staff
Biochemistry	Husler, P.	Staff
	Koonjul, P.	PhD
	Moletsi, M.	BSc
Botany	Asary, M.	BSc
	Dace, H.	MSc
	Dakora, F	Staff
	Dlamini, T.	BSc
	Farrant, J.	Staff
	Klak, C.	MSc
	Kruger, L	MSc
	Malan, H	Staff
	Newamonde, M.	MSc
	Sherwin, H.	Staff
Cardiothoracic Surgery	Zhang, Y.	Staff
	Zilla, P	Staff
Centre for Occupational Health		
	Rama, D.	Staff
Chemistry	Hibbert, B.	PhD
	Jappie, D.	PhD
	Koch, K.	Staff
	Nassimbeni, L.	Staff
	Rogers, A.	Staff
	Yu-Shan, W.	BSc
Chemical Engineering	Cohen, B.	PhD
	Galatolo, P.	MSc
	Hurgobin, S.	MSc
	Langenbach, K	BSc
	McDonald, A.	Staff
	May, N.	MSc
	Nash, R.	PhD
	O'Connor,C.	Staff
	Peterson, J.	PhD
	Petrik, L.	Staff
	Scholtz , N.	PhD
	Theron, J.	PhD
	Vasic, S.	Staff
Civil Engineering	Orsmond, W.	MSc
Clinical Immunology Unit	Passmore, J.	PhD
Dentistry (UWC)	Grobler, S.	Staff
	Quick, A.	MSc
	Reid, R.	BSc
Electrical Engineering	Gallagher, G.	BSc
	Greagor, I.	BSc
Energy Research Inst.	Wicking-Baird, M.	Staff
Geological Sciences	Barnard, L.	Staff
	Chetty, D.	MSc
	Doucoure, M.	Staff
	Glendinning, J.	MSc
	Halbich, T.	MSc
	Layon, R.	MSc
	Minter, L.	Staff
	Thompson, S.	BSc
	van Heerden, L	Staff
	Tredoux, M.	Staff

Halliburton	Hill, S.	Staff
Kirstenbosch	Kurzwiel, H.	Staff
Liver Research Centre	Jennings, B.	PhD
	Kirsch, R.	PhD
Materials Engineering	Anderson, S	MSc
	Ball, A	Staff
	Cotton, J.	PhD
	Duckham, A.	MSc
	Feng, Z.	MSc
	Jarvis, E.	BSc
	Knutsen, R.	Staff
	Matheson, I.	MSc
	Mginqi, L.	MSc
	Pugsley, V.	MSc
	Suckling, M.	MSc
	Towle, N.	BSc
	Topic, M.	PhD
	Williams, G.	BSc
	Wittridge, N.	PhD
Mathematics	Bruyns, P.	Staff
Mechanical Engineering	Butler-Smith, P.	MSc
	Tait, R.	Staff
	Smith, M.	BSc
Medical Microbiology	Stannard, L.	Staff
Membratek	Stroewald, H.	Staff
Microbiology	Dominy, C.	PhD
	Fourie, P.	BSc
	Jacobs, C.	MSc
	Martin, D.	MSc
	Nizet, T.	MSc
	Peterson, Y.	MSc
	Quobela, M.	Staff
	Rybiki, E.	BSc
	Smith, A.	PhD
	von Wechmar, B.	Staff
NAC	De Waal. H	Staff
	Meyer, K.	PhD
	Pineda, C.	Staff
	Przybylowicz, W.	Staff
	Przybylowicz, J.	Staff
Physics	Barrett	BSc
	Rudzani, N.	MSc
S.A. Nylon Spinners	Austen, R.	Staff
	Hopton, J.	Staff
	McConnell, H.	Staff
SFRI	Durholtz, D.	PhD
	Lipinski, M.	Staff
Special Products	Pomario, A.	Staff
Surveying	Barry, M.	Staff
	Crone, S	MSc
	Mason, S.	Staff
	Williams, T.	BSc
Tridonic, S.A.	Wileman, J.	Staff
Ultra High Pressure Unit	Dickerson, G.	Staff
University of Botswana	Ekosse, G.	MSc
University of Stellenbosch		
Inst. Polymer Science	Bessarabov, D.	PhD
Chemical Engineering	De Jongh, D.	MSc
	Grobler,	MSc
	Spicer, J.	MSc
	van Zyl, R.	MSc
UWC (Microbiology)	Davidson, S.	Staff
	Fielding, B.	MSc
WITS (Geology)	Longa Tonga, E.	PhD

Zoology	Barnett, M.	PhD
	Bloomer, S.	PhD
	Cooper, M.	BSc
	Nicholson, S	Staff
	Ridgway, T.	Bsc
	Webb, S.	PhD
	Waldron, M.	Staff

Total No: 128