

ELECTRON MICROSCOPE UNIT

ANNUAL REPORT

1997

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

HIGHLIGHTS OF 1997

DEVOLUTION OF FINANCIAL RESPONSIBILITY

The Electron Microscope Unit is an interfaculty Unit serving primarily the faculties of Engineering, Science and Medicine. Issues regarding the position of the Unit in the devolved structure, the mechanism for budgetary allocation to the Unit, lines of reporting and lines of feedback regarding requested budgetary allocations remain unresolved. In particular it is still not clear how the revenues necessary to sustain the Electron Microscope Unit will be raised. The need to put in place an extensive cost recovery mechanism was deferred in order to allow further discussion during 1998.

IMAGING CENTRE

Considerable use was made of the image digitization facilities by both microscopists and non microscopists. A dye-sublimation printer capable of producing photographic quality output was added to the centre and software for image processing and analysis was installed. A total of fifty people who were not users of the microscopy facilities made use of the imaging centre in 1997 thus expanding the range of people making use of the resources offered by the Unit. Siting the imaging centre in the Unit gives users access to expertise in digital imaging that is not otherwise available.

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), Associate Professor R.D. Knutsen (Materials Engineering), Mr D.A. Gerneke (EM Unit), Mr R.S. Rickard (Geological Sciences) and Mrs H. Ilsley (Anatomical Pathology). In addition Associate Professor R.B. Tait (Mechanical Engineering) has been co-opted onto the Committee.

A Meeting of the Electron Microscope Steering Committee was held on 23 September 1997.

USE OF THE UNIT

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

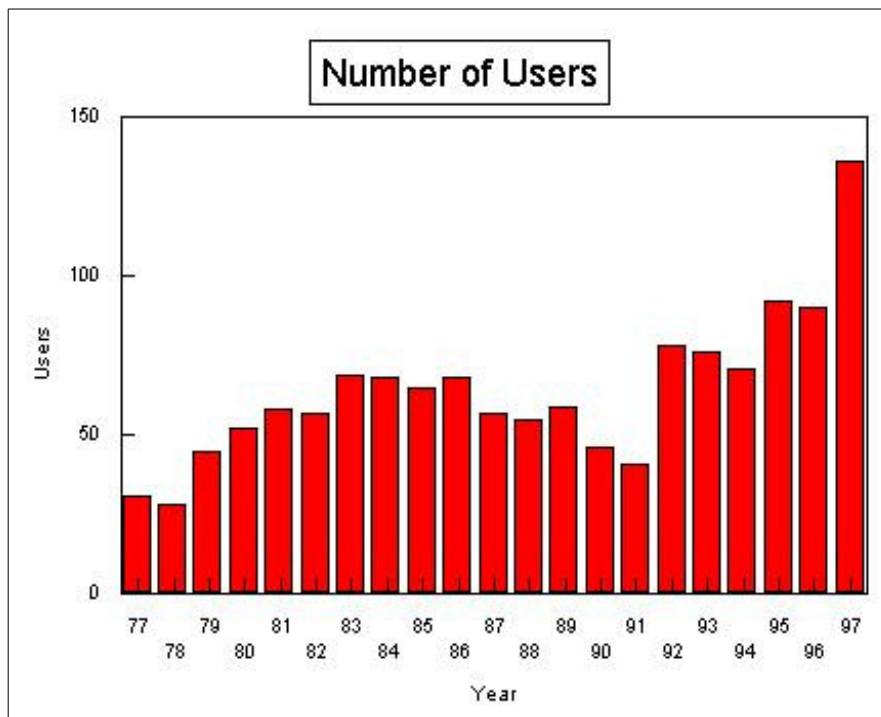


Figure 1: Number of users of microscopy facilities per year since 1977.

One hundred and thirty six people made use of the microscopy services of the Electron Microscope Unit in 1997. In addition a further 50 users utilized services other than those related to microscopy.

The names and departments of the users are listed in Table 7.

Figure 1 shows that the total number of electron microscope users has increased dramatically. However figure two shows that the total electron microscope time used has remained roughly constant. This is because an increasing number of users make a single use of the electron microscope facilities as a minor component of their studies. These students depend on EM staff to assist them in all stages of their microscopy and they do not master the technology. However there continue to be a number of students utilizing EM as a major component of their studies, these students are mainly from the departments of Materials Engineering, Botany and Medicine. It can be seen from figure 3 that students from these departments utilize just over half the total microscope time used.

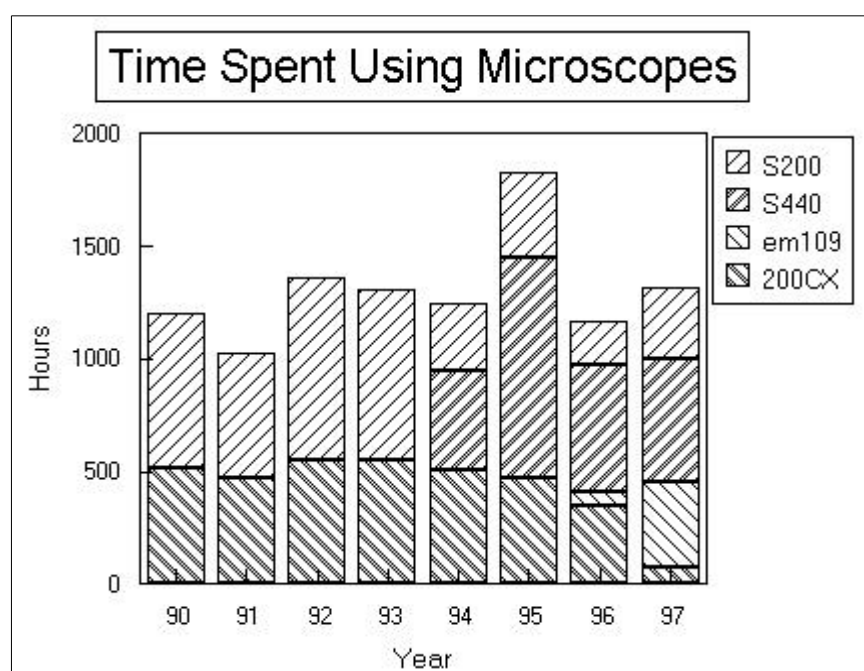


Figure 2: Time spent using the Unit's microscopes since 1991.

Total time spent using the Unit's microscopes was 1316 hours in 1997.

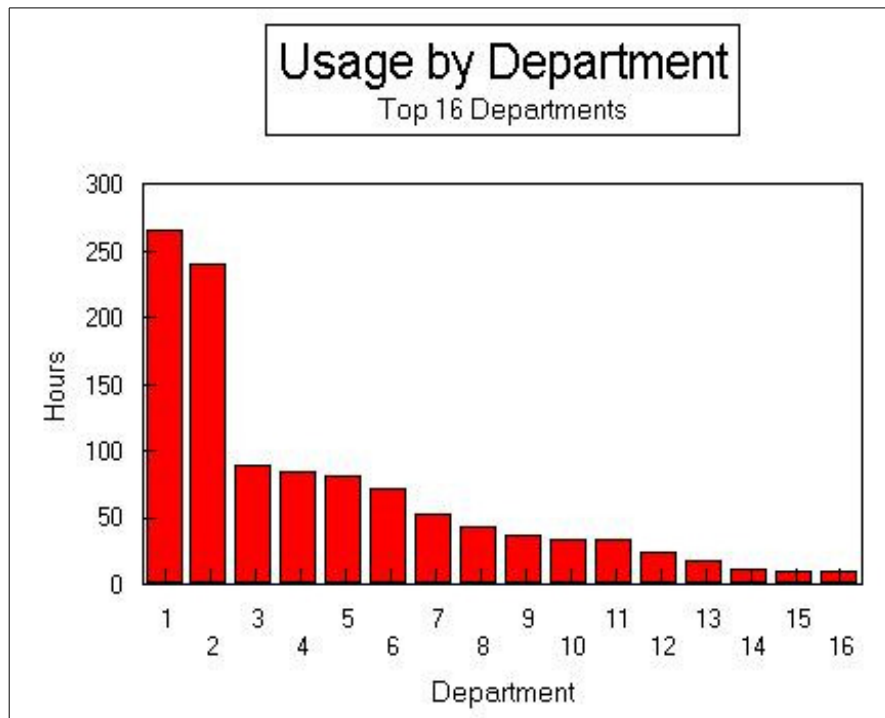


Figure 3: Microscope usage by department.

The key is as follows:

1	Materials Engineering	9	Mathematics
2	Botany	10	Zoology
3	Liver Research	11	Biochemistry
4	EMU	12	Microbiology
5	Geological Sciences	13	Medical Microbiology
6	Stellenbosch University	14	Cardiothoracic Surgery
7	Chemical Engineering	15	Chemistry
8	UWC	16	Mechanical Engineering

ELECTRON MICROSCOPES AND ASSOCIATED EQUIPMENT

LEO STEREOSCAN S440

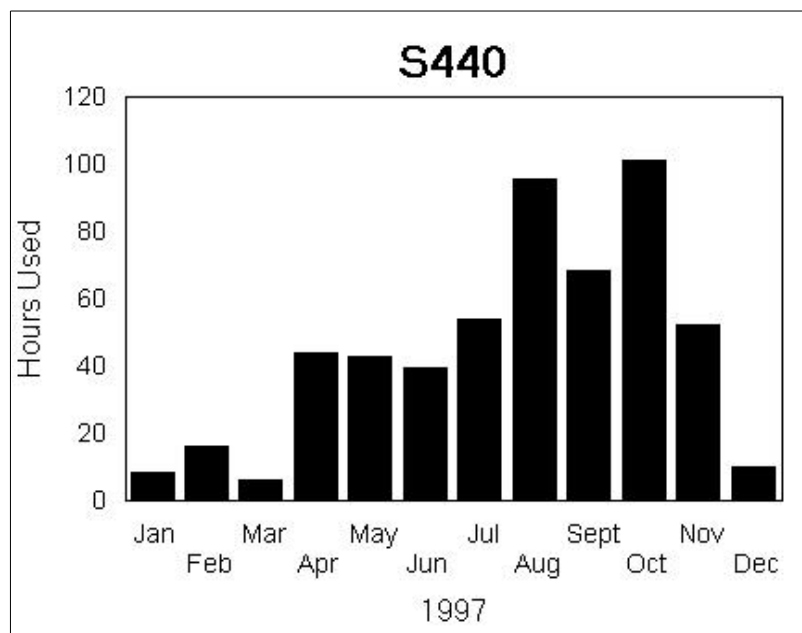


Figure 4: Use of the Leica S440 SEM

The S440 was used for a total of 540.5 hours which is similar to the usage for 1996. The rotary pump was overhauled. The demand for this instrument by outside users, notably students and staff from UWC and Stellenbosch remains high. The low utilization in January, February and March is atypical.

CAMBRIDGE S200 SEM AND KEVEX 7000 ANALYSIS SYSTEM

The S200 was used in total for 317.5 hours. The instrument worked reliably for most of the year even though it requires on-going maintenance. The only major incident was the failure of a power supply the replacement of which cost R6401.30. The failure occurred while Mr Duncan was in Cambridge and the repair was effected by an external contractor.

The Kevex system was not used in 1997 and is currently not operational.

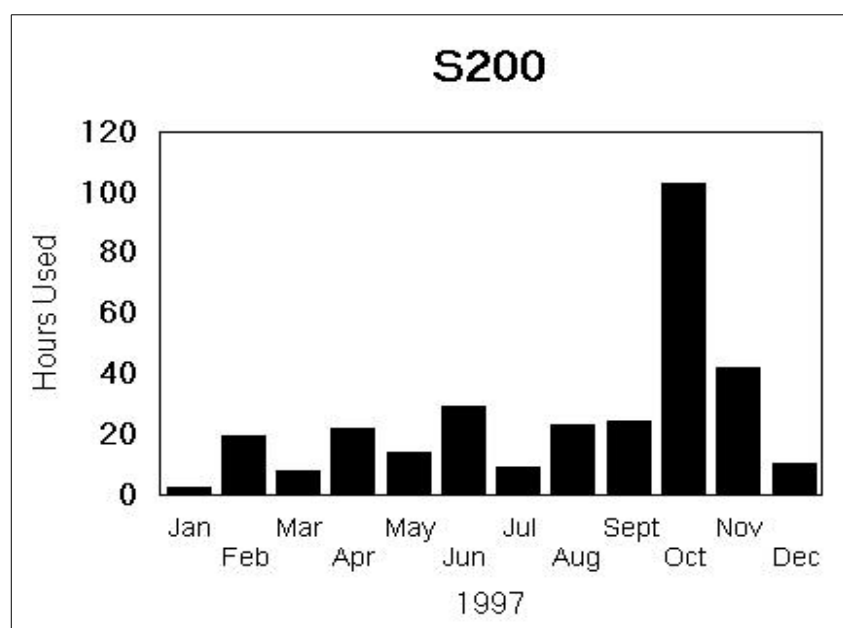


Figure 5: Use of the Cambridge S200 SEM

JEOL 200CX TEM

Use of the 200CX TEM again fell during the year to 78.5 hours.

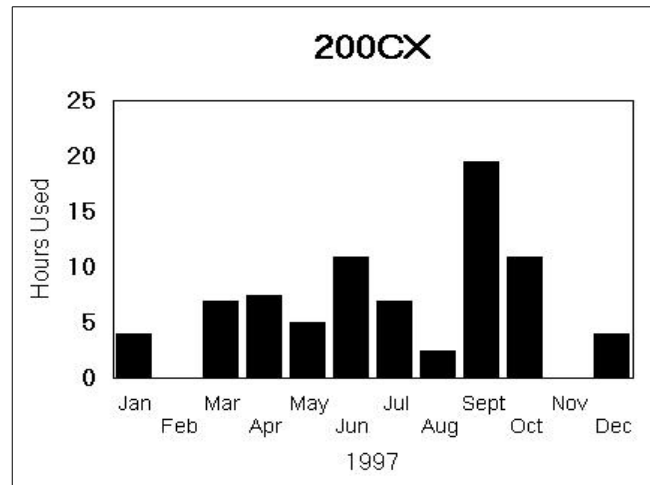


Figure 6: Use of the Jeol 200CX TEM

The instrument was taken out of service in February and part of March so that an attempt could be made to identify the cause of the instability which has been rendering the microscope increasingly less usable over the last few years. The instrument was thoroughly cleaned and serviced. The damaged rubber cone insulator was replaced and the pneumatic system was repaired. Inspection of the high voltage insulators revealed some deposits (due to high voltage tracking) which we were advised by the manufacturer not to remove. After reassembly the problems remained. The manufacturer identified two possible causes: damage to the insulators or instability in the high voltage power supply. If the insulators were damaged repair would entail the replacement of the entire electron gun at a cost of substantially more than R100,000 as the insulators are no longer manufactured. This course of action would need to be carefully evaluated considering the age of the microscope and the fact that it lacks important modern facilities. Some time was spent analysing the high voltage power supply and attempting to identify the cause of the instabilities. However no progress was made in remedying the fault.

Towards the end of the year the director investigated the possibility of acquiring a second hand EM in order to give the users of the Unit access to the resources they needed until funds became available to replace the 200CX. Ultimately the opportunity was lost and the director now believes that replacement of the JEOL 200CX with a comparable new instrument is an urgent priority.

The cost in 1998 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

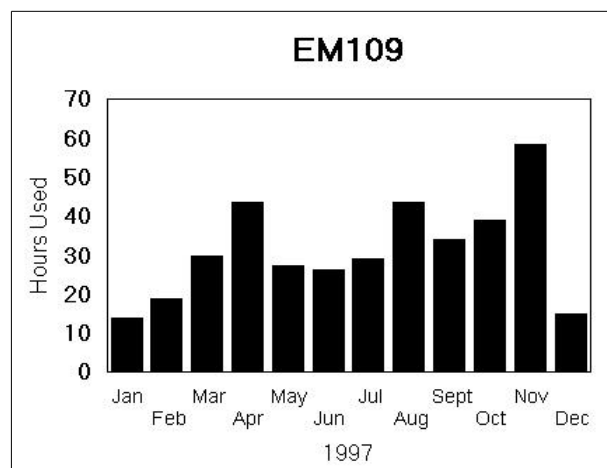


Figure 7: Use of the Zeiss EM109 TEM

The EM109 was the mainstay of the TEM service offered by the Unit in 1997 and it was used for a total of 379.5 hours. It is well suited to routine biological use and it can be used by students in their introduction to microscopy. Nine new users from the departments of Botany, Microbiology (UCT and UWC), Biochemistry, Anatomy and Cell Biology and Medicine were trained to use it. The instrument required only routine maintenance during 1997 including a rotary pump which was overhauled.

OTHER EQUIPMENT

ULTRAMICROTOME

Use of the ultramicrotome increased to 376.5 hours. Eight new users were trained. Cryo-microtomy and the localization of cell components using antibody labelling are the bread and butter of modern cell biology. This instrument is of fundamental importance to researchers from most departments in the Biological Sciences.

TEACHING

USER COURSES

The five day intensive course aimed at honours and post graduate students, "Introduction to Microscopy for Biologists", was held twice and attended by a total of 10 people, including 1 from UWC.

1/4/1997-7/4/1997	6 Honours students from Chemical Engineering, Biochemistry, Botany and Microbiology UWC
22/5/97-28/5/97	3 Masters students and a lecturer from Sports Science

INDIVIDUAL TRAINING

Three new users were trained to operate the 200CX, two were trained to operate the S440, five to operate the S200, seven to operate the EM109 and eight to operate the ultramicrotome.

SCHOOL VISITS

A group of fifteen pupils from Norman Henshilwood visited the Unit for a lecture and demonstration on 28 January, fourteen pupils from Herzlia on 11 February and a group of 24 pupils from Bishops visited on the 11 and 19 March.

STUDENT PRACTICALS

A TEM practical session was held for 7 Microbiology honours students on 23/8/97 and for 14 Botany honours students on 8 and 10/4/97

RESEARCH ACTIVITY

Research was generally carried out in collaboration with other departments and laboratories.

Two PhD students have for some time been registered under the supervision of the director. Mr Reavis left South Africa for the United States at the beginning of 1997. Subsequent correspondence with him indicates that he is unlikely to complete his degree. Mr Jaffer is continuing with his work although progress is slow.

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.

Studies on otoliths

M.E. Waldron and D.A. Gerneke

Banding in otoliths from mackerel (*Trachurus trachurus*) are used to determine the age of the fish. The bands are laid down daily but details of their formation are not fully understood. Studies of the bands by cathodoluminescence and other imaging have been undertaken in order to gain some understanding of this.

Development of a STEM detector

D.A. Gerneke, D. Bolton

Investigations into the improvement in the design of transmitted electron detectors over those supplied by commercial manufacturers are being undertaken. Prototype detectors have been constructed.

The Ageing of Abalone

D.A. Gerneke, G. Hawkes and R. Day (University of Melbourne, Australia)

Imaging using secondary and backscattered electrons and cathodoluminescence of manganese labelled Abalone shells was carried out for the purpose of age validation.

PUBLICATIONS

Publications, for 1997, that resulted from research in which the EM Unit staff have been directly involved are listed:-

Conference Proceedings

Gehring, M., Rybicki, E.P., Burgers, W., Jaffer, M.A. and Williamson, A-L. 1997. Expression of HPV16L1 Protein in tobacco. Biotech SA: 2nd Biotech Conference

Published Conference Proceedings

Chinn, I.L., Gerneke, D.A. and Gurney, J.J. 1997. Sulphide inclusions in diamonds. Communication. Electron Microsc. Soc. South Afr. **27**: 48

Hawkes, G., Day, R., Gerneke, D. and Bettioli, A. 1997. High-resolution microstructure analysis of cathodoluminescent bands within the shell of Black-lip Abalone. Proceedings of the Third International Abalone Symposium, Monterey, California. 34.

Kirsch, R., Jaffer, M.A., Woodburne, V.E., Kirsch, R.E. and Shephard, E.G. 1997. The uptake of fibrinogen by polymorphonuclear neutrophils. Communication. Electron Microsc. Soc. South Afr. **27**: 96

Nelwamondo, A., Jaffer, M.A., Sewell, B.T. and Dakora, F.D. (1997) Effects of silicon supply on N₂ fixation in symbiotic cowpea (*Vigna unguiculata* L. WALP). Communication. Electron

Microsc. Soc. South Afr. **27**: 73

Sherwin, H.W., Driouich, A., Vire, M., Jaffer, M.A. and Farrant, J. 1997. Cell wall architecture of hydrated and dry leaves of the resurrection plant *Craterostigma wilmsii* ENGL. Communication. Electron Microsc. Soc. South Afr. **27**: 70

Westall, F., Gobbi, P., Gerneke, D. and Mazzotti, G. 1997. Ultrastructure in the carbonate globules of Martian meteorite ALH84001. Proceedings of the Fifth Trieste Conference on Chemical Evolution and the Origins of Life. Trieste. 1-6.

Publications of a Popular Nature

Sewell, B.T. and Delpierre, G.R. 1997. Electronic Science Tutor (Computer Programme for Revising High School Physical Science) GRD Training Corporation.

Published Papers

Nicolls, F.C., de Jager, G. & Sewell, B.T. 1997. Use of a general imaging model to achieve predictive autofocus in the scanning electron microscope. Ultramicroscopy **69**: 25-37

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. A great deal of the work done by users is published only as conference proceedings, such work is not reflected here.

Bessarabov D.G., Sanderson R.D., Popkov Y.M., Valuev V.V., Timashev S.F., 1997, New possibilities of electroinduced membrane gas and vapour separation, Ind.Eng.Chem.Res., **36**, 2487-248

M'Kombe C.M, Dry, M.E, O'Connor C.T. ,1997. Influence of preparation variables on the dispersion of platinum on zeolite KL. Zeolites **19**, 175-179.

Ridgway, T.M., Stewart, B.A., Branch, G.M. & Hodgson, A.N. 1997. Morphological and genetic differentiation of *Patella granularis* (Gastropoda: Patellidae): recognition of two sibling species along the coast of southern Africa. J. Zool., Lond.

Röger, H.P., Möller, K.P., O'Connor, C.T. 1997, The Transformation of 1,2,4-trimethylbenzene: A probe reaction to monitor external surface modifications of ZSM-5, Microporous Materials **8**, 151-157.

Sewell, G.S., O'Connor, C.T., van Steen, E., 1997, The Amination of Ethanol using Cobalt catalysts: Effect of support and Activation Procedure. J.Catal. **167**, 513-521

Valuev, V.V., Timashev, S.F., Bessarabov, D.G., Sanderson, R.D., 1997, Use of electrically induced facilitated-carrier transport in cation-exchange membranes for olefin/paraffin separations, in: "Progress in Membrane Science and Technology", Eds.: A.J.B. Kemperman, G.H. Koops, Euromembrane pp 169-171, University of Twente, Dinkeldruk, Oldenzaal, The Netherlands, 1997

Zilla, P., Zhang, Y., Human, P., Koen W. and von Oppell U. , 1997. Improved ultrastructural preservation of bioprosthetic tissue. Cardio Vascular Research **6**

Zilla, P., Weissenstein, C., Bracher, M., Zhang, Y., Koen, W., Human, P. and von Oppell, U., 1997. High glutaraldehyde concentrations reduce rather than increase the calcification of aortic wall tissue. Cardio Vascular Research **6**.

FINANCE

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

OTHER MATTERS

STAFF DEVELOPMENT

Mr Dane Gerneke attended a two week course in X-ray spectrometry presented by Prof James Willis at UCT during February 1997. Mr James Duncan attended a two week course in Scanning Electron Microscope Maintenance held in Cambridge England. Mr Mohamed Jaffer attended a one week course in Digital Imaging presented by Mr Andrew Yarwood of JEOL, UK held at Rhodes University from 30 June to 3 July. Mrs M Waldron attended a Health and Safety Course and a Prism course. And Mr W. Williams attended a Windows course.

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 1997 were Anglo American, Constantia Potters, Envig, S.A. Nylon Spinners, Patterson and Cook Consulting Engineers, Special Products, Swartklip Products and Visicare. Use by students and staff from the Universities of Stellenbosch and the Western Cape increased. Mr Miidzo Hove from The University of Zimbabwe used the S440 for his doctoral research at his own expense.

SPUTTER COATER

Mr Duncan designed and built a timing mechanism for the sputter coater which will enable sputtering conditions to be preset. This will increase the versatility of the coater, particularly for heat sensitive samples.

VISITORS TO THE UNIT

Dr Frances Westall, University of Bologna, Italy made use of the SEM facilities for some four weeks in order to examine rocks, including the Mars meteorite, for traces of the remains of living organisms. She attracted some media attention which included being filmed using the S440 by the BBC for a documentary on the origin of the earth due to be broadcast in July 1998.

OPTICAL MICROSCOPY COURSE

A course on optical microscopy conducted by Mr P. Robinson of the University of Staffordshire was held in the Unit from to as part of the MSSA'97 pre-conference activities. The course which was sponsored by Wirsam Scientific Instruments was attended by 22 people.

MICROSCOPY SOCIETY OF SOUTHERN AFRICA CONFERENCE 1997

An exhibit advertising the services of the Unit was constructed by Mr D. Gerneke and Mrs M. Waldron and displayed throughout the meeting. Members of the Unit presented five papers and posters at the conference. Dr Kirsch and Mr Jaffer won a prize for the best student presentation.

CLEANING THE UNIT

The situation with regard to the cleanliness of the Unit further deteriorated during 1997 and it proved impossible for a satisfactory arrangement for cleaning to be made. Mr Basil Mohamed continued to empty the dustbins.

SUMMARY

1997 unfortunately saw the collapse of the Unit's ability to reliably offer a number of TEM services

which are important to materials scientists. This has been predicted for a number of years. The availability of the EM 109 enabled most biological TEM users to proceed unimpeded.

Services in Scanning Electron Microscopy were substantially enhanced with the availability of two reliable instruments for the first time in several years.

The Imaging Centre continues to be a popular service which is used by both microscopists and other members of the University.

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

31 March 1998

TABLE 1

Services Offered by the Unit during 1997

Service	Comment
Access to 200CX TEM	Service curtailed. Used by 14 staff and students.
Access to S440 SEM	Heavily used by 69 users
Access to S200 SEM	Well used by 37 users
Access to the EM109 TEM	Well used by 36 users
Training on 200CX	Three users were trained
Training on S440 SEM	Two new users were trained
Training on S200	Five new users were trained
Training on the EM109 TEM	Used in courses. Seven users individually trained
Access to Ultracut S Ultramicrotome	Well used
Training on Ultracut S	Eight 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	Used
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	Well used.
"Introduction to EM for Biologists"	This course was held twice.

Access to specimen polisher	Used
Access to high vacuum coating plant and accessories	Adequately used
Store of EM consumables	Used by all our users
Access to prep lab	Used
Collection of books and journals on microscopy	Well used
Access to Joyce Loeb 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
Dye sublimation printer	Used

TABLE 2

Equipment Expenditure

Equipment	Source of Funds	Cost
Portable Oscilloscope	UEC	R 19 351.50
Gauge head and meter	UEC	R 13 463.40
Dye Sublimation Printer	Contribution from UEC	R 9 480.00
	Contribution from ITEC	R 29 286.00
	Contribution from URC	R15 000.00
	Contribution from EMU	R 12 095.23
	TOTAL	R 98 676.13

TABLE 3

External Services: Fund 001258

Opening Balance of Funds	R 6 542.00
Income	
Transfers	R 8 000.00
Materials and Consumables	R 8 496.43
TOTAL	R 16 496.43

Expenditure

Computer Software	R 1 310.66
Equipment Registered Assets	R 762.41
Operating Expenses	R 27.38
Staff Benefits	R 6.25
Telephone Calls/Rentals	R 1 766.08

Temporary Salary	R 2 500.00
Staff Training	R 700.00
Subsistence and Travel	R 387.92
TOTAL	R 7460.70

Closing Balance 1997 R 15 577.73

TABLE 4

Departmental Grant: Fund 000516

Opening Balance of Funds R 0.00

Income

Annual Grant	R 44 344.93
Transfers	R 1 000.00
TOTAL	R 45 344.93

Expenditure

Cleaning Materials	R 590.80
Computer Expenses	R 5 189.45
Gas - General	R 8 447.33
Equipment Non Cap	R 75.40
Laundry	R 225.49
Maintenance Department Charges	R 3 739.70
Operating Expenses	R 8 654.23
Petty Cash Floats	R 695.56
Printing / Photocopy	R 1 039.45
Postage , Telephones and Fax	R 10 315.93
Repairs and Maintenance General	R 2 998.25
Stationery	R 2 373.34
Staff Training	R 100.00
Hire of Equipment	R 900.00
TOTAL	R 45 344.93

Closing Balance 1997 R 0.00

TABLE 5

Consumables Store: Fund 000933

Opening Balance of Funds R 29 091.00

Income

Internal Recoveries	R 32 981.50
TOTAL	R 32 981.50

Expenditure

Computer Consumables	R 3 627.54
Materials and Consumables	R 13 499.16
Photographs	R 5 183.00
Repair and Maintenance	R 7 745.00
Sundry expenses	R 159.29
TOTAL	R 30 213.99
Closing Balance of Funds 1997	R 31 858.51

TABLE 6

Maintenance: Fund 000995

Opening Balance of Funds	R 20 070.00
Income	
Internal Recoveries	R 45 577.36
Transfer	R 5 833.59
TOTAL	R 51 410.95
Expenditure	
Computer Software	R 11 100.40
Conference Expenses	R 627.96
Operating Expenses	R 8 833.16
Postage	R 1 266.43
Repair and Maintenance	R 6 970.17
Rentals	R 1 616.50
Equipment (Registered Assets)	R 1 148.75
Printing and Photocopying	R 198.75
Travel	R 4 460.00
Utilities	R 444.01
TOTAL	R 36 666.13
Closing Balance of Funds 1996	R 34 814.82

TABLE 7

Users of the Unit

This table may be obtained on request from the Unit

It contains the names of the 185 users of the unit during 1997 and their affiliations