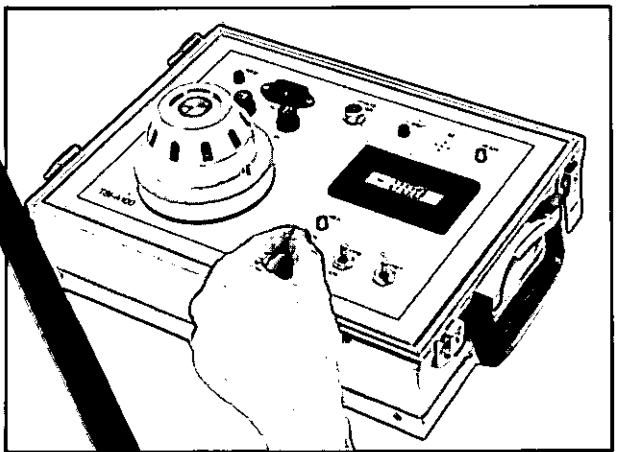
The Journal of The Institute of Hospital Engineering February 1985

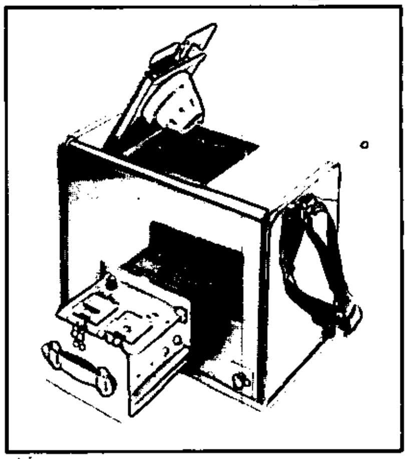
HOSPITAL ENGINEERING

- Maintenance data analysis for ambulances
- Factors in the determination of vehicle replacement policies

Maintenance made easy



▲ *TSI A100 Smoke Detector Test Meter*



▲ *TSA B220 Smoke Sensitivity Test Unit*

◀ *TSE A100 Smoke Pole*

TSI A100 SMOKE DETECTOR TEST METER

Gives service engineers the ability to quickly confirm that the electronic performance of the detector has not changed from original setting. Either ionisation or photoelectric detectors can be tested on this portable unit powered from rechargeable batteries.

TSA B220 SMOKE SENSITIVITY TEST UNIT

Specially designed for fast and efficient testing of smoke detectors and offering the advantage of compactness and portability for versatile use in the field. Compatible with most UK and European smoke detectors.

TSE A100 SMOKE POLE

This universal smoke detector test unit is the result of extensive research and development, aimed at making in situ testing a simple and time saving operation. Light weight telescopic construction for easy adjustment to ceiling height. Integral, simple-to-operate, controls and power supply, plus smoke generation.

Avoid expensive and annoying false alarms, often caused by inadequate testing and maintenance, by using the quick, simple and cost effective Hakuto range of maintenance and testing equipment. Hospitals, hotels, factories, laboratories and all other establishments, where smoke detectors form the first line of fire defence, will improve protection by reliable and regular maintenance. Hakuto equipment makes testing and maintenance of any smoke detectors a simple and time saving process, for both service engineers and in-house maintenance staff.

HAKUTO

EFSEC DIVISION

HAKUTO INTERNATIONAL (UK) LTD.
ELEANOR HOUSE
35 ELEANOR CROSS ROAD
WALTHAM CROSS
HERTFORDSHIRE EN8 7LF.
TEL: 01-367 4633 (2 LINES) LEA VALLEY (0992) 769090 (4 LINES)
TELEX: 299288 HAKUTO G

I am interested in your range of smoke detector maintenance equipment. Please send me further information.

NAME ____________________

ADDRESS ____________________

____

____

____

Hakuto — the wisest choice

HOSPITAL ENGINEERING

The Journal of The Institute of Hospital Engineering

Volume 39 No 2 **February 1985**

Front cover picture: courtesy of the London Ambulance Service

HOSPITAL ENGINEERING is published ten times a year by TGV Publications.

The Annual Subscription is UK: £28.50
Overseas: £35.00 USA: $55 Canada: $67

Director
David B Goad MSIAD MIOP

Editor
Jenny Campbell

Advertisement Manager
Michael Birch IMR International
14 Bath Road Swindon Wilts SN1 4AA
Telephone: (0793) 45311

All correspondence relating to the Journal should be addressed to:
HOSPITAL ENGINEERING
TGV Publications, 41 Earl Street,
Maidstone, Kent ME14 1PF England
Telephone: Maidstone (0622) 678310

UK ISSN 0309-7508

Printed by The Enfield Printing Co,
Enfield, Middlesex

The Institute of Hospital Engineering
20 Landport Terrace
Southsea, Hants PO1 2RG, England
Telephone:
Portsmouth (STD 0705) 823186

President
L G Hadley CEng FIMechE FInstE
FCIBS MConsE FIHospE

Secretary
J E Furness MBE VRD*

Hon Librarian
D L Hall FIHospE MIPlantE
MRSH MBIM LHA
49 Fitzroy Avenue
Harborne
Birmingham B17 8RL
Tel: 021-554 3801, ext 4838 (Office hours)

Talking Point

The author is a member of the Institute's Council and Regional Engineer of the North Western RHA

The art of accuracy (or the importance of being earnest)

W. J. SMITH, BSc(Hons) CEng FIMechE FCIBS FIHospE MBIM

When I was asked to write an article for 'Talking Point', my mind immediately, and naturally, turned to the great issues of the day which affect those engaged in hospital engineering. I thought of Griffiths, of Illingworth, of building failures as seen by the Public Accounts Committee, of project management, of fee competition, of quality assurance, of energy conservation, of the status of engineers in society in general and in the NHS in particular, and, of course, those great euphemisms — cost improvements and manpower targets!.

Which should I write about? Indeed, what more could be written about them? Very little, I suspect, that would help us with our primary task of helping our patients. How could I, as a Regional Engineer for twelve years, and therefore an expert at nothing, add anything useful to the thousands of words of wisdom that have adorned the pages of this and other journals?

My conclusion was inevitable — I could not. And yet, what is the predominant common factor in all these issues? In my mind, there is no doubt. It is the accurate and effective use of our most precious heritage, the English language, to get the message across.

Ask anyone who is not an engineer, what he thinks of engineers. He will probably answer that he does not understand us because we cannot communicate. How can we let this be said of us? Of accountants, yes. Let them stick to their figures. Whoever else could understand those balance sheets, anyway? Of doctors yes. Let them use their psuedo-Latin. After all, the BMA's Handbook of Medical Ethics states that 'a doctor must preserve secrecy on all he knows'. But we must not let engineers be tarred with the same brush. We would not last long in practice if we told our clients and Authorities as little about our diagnoses, our conclusions and our proposals as our G.P.'s tell us, as patients in their surgeries. Our clients will not be content with being told 'try this'. If things are not better, come back in a week!" Imprecise and ineffective communication is not of much more use than that. It must prevent us from being as successful as we could be, in using our skills to deal with those great issues of the day.

Let us look at some of the common problems which beset engineers, and others, in communications. Firstly, the inaccurate use of grammar. Nature — at least my nature — abhors a split infinitive. Yet they seem to have become the rule rather than the exception. So many times we hear people saying different 'to' when only a few moments logical thought will show clearly that something can only be different 'from' something else (and who is better trained than engineers in logical thinking?) And spelling. How many times I have discarded applications for posts of 'Principle' engineers on the grounds that if the applicant can't spell it, then he doesn't deserve to be one. I quote from a recent letter from a Mr. Tingle to the Chartered Mechanical Engineer: 'Six mons ago I cudent even spel ingineer an now I are one!' Then there is the addition of superfluous words as in the example 'In order to'. What is wrong with just 'To'. I even heard once 'In order for to do!' How many times do we read reports that are obscured by jargon, showing that the writer has forgotten to imagine himself in the position of the intended reader?

The continuing use of abysmal standards must make our clients and colleagues wonder: if we cannot even write English, how can we be trusted to practice something as complicated as engineering. I haven't even mentioned faulty punctuation and the growing practice of using nouns as adjectives!

It is not only with our clients, and colleagues of other professions, that clear communications are important. It is amongst ourselves. How many times have ambiguities only been discovered too late? Too often they are found in specifications only after the contract is let and the claims start rolling in. It is so easy to fall into the yawning jaws of ambiguity. Most readers will recall the schoolboy's joke of the man with a wooden leg called Fred. Some may have read the report in a local paper of a fire in a public school. It started that the fire alarm alerted the matron who was in her bed on the third floor, as were the headmaster and six senior boys!

With electricity at 11 k.V and steam at a pressure of 150 pounds per square inch, and electrical applicances attached to patients, we are working with dangerous systems. Clarity of specifications and working instructions are vital. It is of little use of measure in microns and calculate to six significant figures if our messages have less than a 50% chance of being interpreted as we intended. Again almost quoting Mr. Tingle, 'for want of comma, clarity was lost; for want of clarity, safety was lost; for want of safety, a man was lost.' And I fear, the engineering profession too.

The danger has always been with us. It is even more pressing in these days of communication via computers and fashionable or in-words ('hopefully' — ugh!) Oscar Wilde said that nothing that is worth knowing can be taught. I believe in the importance of being earnest about improving our standards of communication. Let us concentrate our efforts on fighting the danger before it is too late. Inspite of Wilde's maxim, perhaps a course on 'English for Engineers' should be established at Falfield. Let them hear from you with a message that is loud and clear.

Institute News

New Year's Honours List

MR JOHN BOLTON

We are delighted to record that Mr. John Bolton, Chief Works Officer and Director General of Works, Department of Health and Social Security, was appointed CB in the recent New Year's Honours List, an honour surely most well deserved. Mr. Bolton was elected an Honorary Fellow of the Institute of Hospital Engineering in March 1969, soon after his appointment as Chief Engineer, DHSS. However, his contributions to Institute affairs had preceded this by some considerable time and in a variety of ways. For instance, he was a visitor, on more than one occasion, to the courses the Institute used to hold at the University of Keele, speaking to the course members and acting as Session Chairman. Mr. Bolton, has so often when his duties and commitments have allowed, attended the Institute's Annual Conference, again acting as Chairman of sessions and, speaking too at the Annual Conference Dinner. Again, he has played a role at certain of the One-day Symposia the Institute stages in London, particularly, when these have been organised in conjunction with the Department. We are delighted, then, at this recognition of Mr. Bolton's contribution to 'hospital engineering and works services' over the years and offer congratulations from the Institute membership.

MR. W. HENDRY

We are most pleased to note that Mr. W. Hendry was appointed MBE in the recent

continued on page 4

41st ANNUAL CONFERENCE
HOTEL MAJESTIC
HARROGATE, MAY 22nd—24th 1985

CONFERENCE PROGRAMME

Wednesday 22nd May

9.00am IHEX '85 Exhibition opens

10.30am OFFICIAL OPENING of 41st Annual Conference and IHEX '85 by BRYAN ASKEW ESQ.
Chairman, Yorkshire Regional Health Authority
Introduced by L. G. HADLEY ESQ CEng, FIMechE, FInstE, FCIBS MConsE, FIHospE, President, The Institute of Hospital Engineering

10.40am ELECTRICAL SERVICES IN HOSPITALS
'15th EDITION — ITS APPLICATION'
Speaker: D. K. MORRELL ESQ CEng, MIEE, MCIBS
North Western Regional Health Authority
'INTEGRATION OF ELECTRICAL SERVICES'
Co-ordination of Electrical Services
Speaker: A. V. WHETHAM ESQ, William Steward & Co Ltd
Approach from the Designer
Speaker: R. M. CUTCLIFFE ESQ CEng, FIMechE, FCIBS, FIHospE. Regional Engineer, West Midlands Regional Health Authority
Chairman: M. N. LOWSLEY ESQ CEng, MIMechE, MCIBS, FIHospE. Regional Engineer, Yorkshire Regional Health Authority

12.45pm Lunch

2.00pm DEVELOPMENTS IN LINEN SERVICES
'MODERN LAUNDRY DESIGN CONSIDERATIONS'
Speaker: W. G. FUELL ESQ CEng, MIMechE. Laundry Engineering Advisor, Department of Health & Social Security
'CONCEPTUAL DESIGN OF INTEGRATED HEAT AND WATER RECOVERY SYSTEMS'
Speaker: R. M. NEALE ESQ BSc, PhD, CEng, MIChemE
Director of Research, Fabric Care Research Association Ltd
'TUNNEL WASHING SYSTEMS'
Speaker: E. A. JACKSON ESQ Head of Applied Technology. Fabric Care Research Association Ltd
Chairman: K. H. DALE ESQ OBE, CEng, MIEE, FIHospE lately Regional Engineer, Yorkshire Regional Health Authority

5.00pm Visit to Exhibition IHEX '85 to include Cheese and Wine Party

7.00pm CIVIC RECEPTION —Royal Baths Assembly Rooms

Thursday 23rd May

8.30am IHEX '85 Exhibition opens

10.00am HSDU, PINDERFIELDS
'PLANNING AND THEORY'
Speaker: W. R. HYSLOP ESQ BArch (Hons), RIBA, ARIAS
Principal Architect, Department of Health and Social Security
'OPERATIONAL MANAGEMENT'
Speaker: J. G. HARDMAN ESQ CEng, MIMechE, FIHospE District Works Officer, Huddersfield Health Authority
Chairman: D.A. HEARH ESQ RIBA. Assistant Regional Architect, Yorkshire Regional Health Authority

12.00pm Lunch

1.00pm VISIT TO HSDU, PINDERFIELDS

4.30pm Leave Pinderfields and return to Hotel Majestic arriving 5.45pm

7.30pm CONFERENCE DINNER DANCE

Friday 24th May

10.30am THE FUTURE FOR THE ENGINEERING PROFESSION
Speaker: PROFESSOR J. C. LEVY OBE, PhD, CEng
Director — Engineering Profession Engineering Council
Chairman: J. G. CLARKE ESQ, Dip. Arch, RIBA
Regional Works Officer, Yorkshire Regional Health Authority

12.00pm CONFERENCE CLOSURE by The President The Institute Of Hospital Engineering

IHEX '85

IHEX '85,to be held at the Hotel Majestic, Harrogate in May this year, will be an unrivalled opportunity for hospital engineers and manufacturers of hospital engineering equipment to get together. Last year saw the launch of the first-ever IHEX. The enthusiasm of both the visitors' and exhibitors' response has led to a greatly extended IHEX '85.

The exhibition, as it was last year, will be held in conjunction with the 41st Annual Conference of the Institute, which is hosted by the Yorkshire Branch. And though special arrangements will be given to encourage visits from all levels of hospital engineering staff employed within the Yorkshire Health Authority and neighbouring areas, there will be hospital engineers from all over Britain attending. Individual invitations will be mailed directly to everyone engaged in hospital engineering throughout the country. And in addition there will be wide general promotion for all those who have an interest.

Delegates to the Conference, however, are specially well placed to see the best of the exhibition. In response to suggestions made last year, IHEX '85 will be even more closely integrated with the Conference this year. All coffeee and tea breaks will be taken within the exhibition, and exhibitors are invited to join delegates for lunch.

Wine 'n cheese

Last year both delegates and exhibitors reported that they had found particularly valuable these informal and friendly get-togethers. This year, in recognition that business and pleasure can mingle successfully visitors are invited to a wine and cheese party on Wednesday 22nd May at 5.30pm.

There is not only a greatly increased number of visitors expected to attend. This year there are many more exhibitors, and the space they have been allocated is generous enough to allow for working exhibits and extensive displays. A large number booked stands at last year's exhibition in Bristol, but many more including several international manufacturers, have shown their enthusiasm by taking space this year.

IHEX '85 will cover the latest developments in all aspects of hospital engineering, including building and construction, hospital equipment technology, communications, computers, manufacturers' supplies etc. It will provide a unique forum for the exchange of information, and ideas, and be a valuable and stimulating experience for everyone who attends in whatever capacity.

See you there!

New Year's Honours List. Mr. Hendry is a member of the Institute of very long standing, having been much involved in the affairs of the Southern Branch over the years. He completed his hospital service as Group Engineer, Knowle Hospital from which post he retired in 1974. He was elected a Companion of the Institute on the 19th November 1974 in recognition of his contribution over the years.

Mr. Hendry has been a Justice of the Peace for a considerable number of years. In addition, he has somehow found time to make numerous other contributions to 'public life' and it is in these last respects, particularly, that he has earned the recognition so due to him.

Certificate of Pre-Vocational Education

A new scheme and qualification for young people, the *Certificate of Pre-Vocational Education* (CPVE), was published in January by the Joint Board for Pre-Vocational Education.

The Certificate of Pre-Vocational Education will be a national qualification of prevocational education for young people aged 16 and above who undertake an approved one year full-time programme of study and related activities.

The CPVE scheme will be available on a full-time basis from Autumn 1985 to students who have completed their compulsory education. Its aim is to help young people to make the transition from school to adulthood by providing them with an individually relevant educational programme.

All students who complete a validated CPVE programme of study will receive a Certificate which recognises their attainments but also embodies national standards. It is believed that employers in particular will welcome this development.

All CPVE programmes will include the opportunity for subsequent progression to continuing education, training and/or work.

Oxford Spring Lectures (formerly 6 Branch meeting)

At the preliminary meeting held at 7 Queen's Square on Saturday, 8th December 1984 it was agreed that the 1985 meeting would be held on Wednesday, 5th June 1985 at the New John Radcliffe Hospital, Oxford.

Elections to Council 1985

These will be held in accordance with the relevant Articles of Association. At the Annual General Meeting to be held on 24th May 1985 the following Members of Council will retire by way of normal rotation (in accordance with Articles 81 and 82).

W. N. BENWICK Nominated Member
K. J. EATWELL General Member
L. R. F. HOUSE Area Member — Southern and South West
R. J. SEAR Area Member — Midlands
H. WAUGH Area Member — Scotland

Of these, only K. J. EATWELL and R. J. SEAR are eligible for re-election in their respective categories but both have indicated that they will not seek re-election. Candidates for Area Members, for the above Areas, and for General Member may be nominated by any Branch or group of five members. Such nominations duly signed and bearing the written assent and a brief history of the nominee, should reach this office by registered post within 14 days of the date of this letter. (Particular attention is drawn to Article 67).

To comply with the relevant Article, actual Ballot Papers will be sent only to paid-up Corporate Members.

List of Council nominees

B. T. ROSE CEng, FIMechE, MInstE, FCIBS, FIHospE, FInstR, MRoSH Consulting Engineer — *Nominated Member.*
Partner, J. Roger Preston and Partners
Member, IHospE Chartered Engineer Assessment Panel
Honorary Auditor, IFHE

C. ASTLEY CEng, MIMechE, MCIBS, FIHospE Regional Engineer — *General Member*
Oxford Regional Health Authority

Change of name

The Partners of Pashler and Partners are pleased to announce that Roy D. Walton, FCIBS., FIHospE., has joined the practice to take up a partnership position from the 1st January 1985. From this date the firm will be under the new name of *'The Pashler Walton Partnership'.*

Watt Committee on Energy reports — Reduced prices

Until April 1st 1985, the Watt Committee offers the following reports at reduced prices. Intending purchasers must send cash with orders, mentioning that they are responding to this special offer.

Report No.	Title	Special Price, £	Normal Price, £
2	Deployment of national resources in the UK, 1975-2025	*5.25*	10.50
3	The rational use of energy	*4.25*	8.50
4	Energy development and land in the United Kingdom	*10.25*	20.50
5	Energy from the biomass	*5.25*	10.50
6	Evaluation of energy use	*7.25*	14.50
7	Towards an energy policy for transport	*10.25*	20.50
8	Energy education requirements and availability	*11.25*	22.50
9	Assessment of energy resources	*9.25*	18.50
10	Factors determining energy costs and an introduction to the influence of electronics	*10.40*	20.80

These prices include postage and packing for addresses in the United Kingdom.

Available from: Watt Committee on Energy, 18 Adam Street, London WC2N 6AH. Tel: 01-930 7637.

FORTHCOMING BRANCH MEETINGS

North East Branch: *Hon Sec: G. Baxter TN Darlington (0325) 460100*
March 12th — Telecommunications Lecture, Hexham

East Anglian Branch: *Hon Sec: J. A. Parker TN Norwich (0603) 611 233*
March 9th — Annual General Meeting, St. Andrews Hospital, Norwich

Southern Branch: *Hon Sec. R. P. Boyce TN Chichester (0243) 781 411*
March 9th — Annual General Meeting preceded by 'World Energy Supplied and Alternative Sources' by Technical Representative of CE&B. St. Leonards Hospital, Nr Ringwood

North West Branch: *Hon Sec. E. A. Hateley TN Manchester (061) 236 9456 ext 266*
March 8th — Annual Dinner Dance, Worsley Court House
March 19th — Annual General Meeting followed by talk on the NW Water Authority.

Midlands Branch: *Hon Sec. W. Turnbull TN Birmingham (021) 378 2211 ext 3590*
February 20th — Hospital Lighting and the CIBS Guide Presented by G. Daniels, Moorlite Electrical Limited, Post Graduate Medical Centre, Queen Elizabeth Hospital.
March 6th — Annual General Meeting and technical presentation by West Midlands Gas, West Midlands Gas HQ, Wharf Lane, Solihull

West of Scoland Branch: *Hon Sec. R. W. Gardner TN Glasgow (041) 204 2755 ext 2710*
March 22nd — Annual Dinner Dance
March 28th — Annual General Meeting, Glasgow Royal Maternity Hospital

East Midlands Branch: *Hon Sec. E. A. Hall TN Nottingham (0602) 475783*
March 6th — Annual General Meeting followed by 'Totem Total Energy System' a presentation by Fiat Energy (UK) Ltd, Committee Room, Balderton Hospital, Near Newark.

Welsh Branch: *Hon Sec. M. J. Back Cardiff (0222) 755944 ext 2562*
March 14th — Boiler House Control and Water Treatment, presented jointly by Messrs Gestra and Houseman Burnham. Location as above
April 24th — AGM and social evening, 7pm, Red Lion Hotel, Pendoylen

Please contact the respective Branch Secretary should you wish to attend any of the above meetings.

Engineering education and training for the 1980's and 1990's

The Engineering Council recently published a policy statement which marks a major step in the development of its policy on engineering qualifications.

'Standards and Routes to Registration' sets out clearly the paths leading to the three qualifications — Chartered Engineer (CEng), Technician Engineer (TEng) and Engineering Technician (EngTech), which The Engineering Council is empowered to grant to those on its register of engineers. At present there are some 300,000 names on the Council's Register.

The policy statement sets improved academic and training standards but recognises that not all individuals follow a standard pattern and that engineering has a crucial role to play in wealth-creation. It seeks to switch the emphasis in training from time-serving to the achievement of standards.

Standards and Routes to Registration — price £8 (including U.K. postage). Available from The Engineering Council, Canberra House, Maltravers Street, London WC2R 3ER.

Energy Management Experience — The Second Energy Management in Buildings Conference

A series of papers in the field of energy utilisation in buildings including studies on energy conservation from the whole spectrum of building types. These will include reports on sophisticated automated techniques and basic procedures with general application. The management and economic aspects of energy saving will also be included.

The Royal Institute of British Architects, London W1. Thursday 9th May and Friday 10th May 1985.

£168.00 + £17.00 VAT, which includes preprints of the papers, morning coffee, lunch and tea on both days. Accommodation is NOT included. Special terms for hotel accommodation have been arranged and BR are providing reduced fares for delegates. Details will be sent to booked delegates. *Enquiries and cheques (payable to CICC Ltd.) to the Conference Secretary (EME), Mrs. E. Howe, CICC Ltd, PO Box 50, Nottingham NG2 7JP. Telephone: Nottingham (0602) 813078.*

Lucas Scholarship Award

Readers are reminded that applications must reach the Institute office by 28th February.

THE INSTITUTE OF HOSPITAL ENGINEERING ONE DAY SYMPOSIUM

ENERGY MANAGEMENT

The Small Hall, Kensington Town Hall, Hornton Street, London W8

Wednesday 13th March 1985

PROGRAMME

10.00 Coffee

10.30 OFFICIAL OPENING by L. G. HADLEY ESQ, CEng, FIMechE, FInstE, FCIBS, MConsE, FIHospE, President, The Institute of Hospital Engineering
CHAIRMAN for the day: DR. J. H. CHESTERS, OBE, FEng, FRS, Chairman, The Watt Committee on Energy.

10.40 THE DHSS/INTER-REGIONAL ROLE
Speaker: B. C. OLIVER ESQ, CEng MIMechE MInstR FIHospE
Superintending Engineer Department of Health & Social Security
ENERGY MANAGEMENT — THE GOVERNMENT ROLE
Speaker: ALAN WILLIAMS ESQ. BSc, CEng, FInstE
Energy Efficiency Office Department of Energy.

11.10 FUNDING AT REGIONAL LEVEL
Speaker: C. ASTLEY ESQ. CEng MIMechE MCIBS FIHospE
Regional Engineer Oxford RHA

11.40 DELETING CONSENSUS MANAGEMENT FROM ENERGY MANAGEMENT
Speakers: R. D. WILSON ESQ, CEng, FIMarE, MCIBS, FIHospE
District Works Officer South Manchester Health Authority
JOHN GILL ESQ, CEng, FIHospE, AMIE
District Engineer South Manchester Health Authority

12.10 OPERATING EXPERIENCES AND FUTURE POTENTIAL OF THE ENERGY MANAGEMENT SYSTEM AT THE JOHN RADCLIFFE HOSPITAL, OXFORD
Speaker: JOHN WINN ESQ, TEng, MIHospE, MIPlantE
Oxfordshire Health Authority

12.45 Lunch

14.15 MONITORING, TARGETING, REPLACEMENT AND CONTROL AT DISTRICT AND UNIT LEVEL
Speaker: MICHAEL SNEDKER ESQ
Member, National Energy Management Advisory Council
Chairman, Devon and Cornwall (SW) Energy Management Group. Fuel Efficiency Officer
Cornwall and Isles of Scilly Health Authority

14.45 ENERGY MANAGEMENT WITHIN MARKS AND SPENCER PLC
Speaker: GEORGE COLMAN ESQ, CEng, MIMechE, MInstR
Marks and Spencer PLC

15.15 TECHNICAL OVERVIEW
Speaker: V. E. SKEGG ESQ, CEng, MIMechE, MIMarE, MCIBS, MInstR

15.45 OPEN FORUM

16.30 Close

TICKET APPLICATIONS

To: The Secretary, The Institute of Hospital Engineering, 20 Landport Terrace, Southsea PO1 2RG.

Please send me .... ticket(s) for the ONE DAY SYMPOSIUM entitled 'Energy Management' to be held on Wednesday 13th March 1985.

I enclose £ .... to cover the cost. Ticket to include morning coffee, lunch and VAT. Member: £40.25 Non Member: £46.

No fees will be returned for cancellations (in writing please) received after midday on Thursday 7th March 1985.

VAT Registration No. 339 3963 20

NAME (in capitals please) ....

ADDRESS ....

....

Position ....

Non Member (please tick) ....

NB. Please note that tickets are available ONLY from The Institute of Hospital Engineering (TN: Portsmouth (0705) 823186).

Maintenance data analysis for ambulances

This Paper was given at the one-day symposium 'Organisation of NHS Transport' on 3rd October 1984. A.M Al-Zuhairi is at the Postgraduate School of Studies in Industrial Technology, University of Bradford. S.T. Peacock who presented the paper at the symposium is Reliability Engineer at Bradford University Research.

A M AL-ZUHAIRI. S T PEACOCK BTech MSC MSaRS

1. Introduction

The Department of Health & Social Security in 1980 commissioned the Postgraduate School of Studies in Industrial Technology at the University of Bradford to study the maintenance of ambulances. An extensive data collection scheme was undertaken in the West Yorkshire region to retrieve the relevant information. Over 80,000 records corresponding to 400 ambulances covering a period from 1974 to 1981 were collected. The data were microfilmed and 16 vehicles from one area were selected, purely randomly, for detailed analysis. The vehicles were mostly Ford Transit, 6-cylinder, 2.5 litre ambulances put into service in 1974/75. The objective of the study was to establish criteria for the level of maintenance and the economic life of vehicles. This paper describes the methodology used and gives the main results of the analysis performed.

2. Data Bank

2.1 Data Collection

Maintenance records from ambulance stations in the West Yorkshire region which were microfilmed comprised the following:

1) Job repair card
2) Costed accident repair card
3) Monthly service card
4) 5,000 mile service card
5) 15,000 mile service card

The legibility and quality of the records were on the whole quite good and provided a good foundation on which subsequent analyses were performed. Furthermore, the data collection exercise itself led to the following comments and suggestions (1):

a) Since repairs are made at both sub-depot and headquarters neither team of mechanics has the complete maintenance history. This can lead to situations arising where it is assumed that the other party has carried out maintenance when in fact neither team of mechanics has undertaken the task. A log book in the ambulance itself could overcome this problem.

b) In West Yorkshire alone the ambulance fleet comprises at least half a dozen different makes and types. This causes problems regarding the stocking of spare parts, both in terms of storage space and in costs. A standardisation on just one or two vehicle types would help to reduce both costs and delays in repairs.

c) Many maintenance staff expressed the opinion that the number of ambulances involved in accidents had recently increased, although there was no statistical evidence at hand to support this view. Possible reasons suggested for this increase are:-

(i) negligence on the part of ambulance crews
(ii) increase in traffice density
(iii) deterioration in road surfaces.

Although (ii) and (iii), factors external to the NHS, will play a part in some accidents, increases in accidents involving 'the jumping of red lights', road junctions and careless reversing, which fall into category (i), are not the problem of maintenance departments. However, they are the problem of other departments in the National Health Service. Data collection and analysis would have to be undertaken in order to substantiate such claims so that the problem could be investigated in greater depth.

d) Many ambulance crews do not carry out simple vehicle repairs (e.g. wheel change, check oil/water, turn on petrol tap). This results in a mechanic often having to travel many miles in order to rectify the problem. Both time and money could be saved if ambulance crews were to carry out these minor maintenance actions.

A summary matrix for the 16 ambulances considered in the analyses is given in Table 1 which shows that all vehicles were brought into service in 1974-75 and that between 4-7 years records were considered for each vehicle.

2.2 Computer Database

The maintenance records contained information regarding flet number, job number, mileage, date, station, work carried out, duration of work carried out, labour costs, parts costs, tyre tread depth and brake efficiency. In order to store the data collected on computer, it was first put into coded form. Thus, codes were formulated for components, sub-components, faults, actions, station and parts costs. A standard coding form was developed and all data were first transferred to these forms. Computer programs developed by the Postgraduate School of Industrial Technology, University of Bradford, for a Hewlett Packard HP9845B desktop computer were then utilised to input this data onto a storage medium (magnetic tape). The programs also facilitated file editing and listing. Additional programs were written allowing preliminary data analysis. These programs facilitated:-

(i) plotting of frequency histograms of individual component usage
(ii) plotting of frequency histograms of grouped component usage
(iii) calculation of repair times and utilisation
(iv) calculation of parts costs as a function of mileage

A detailed description of this database can be found in (2). In work of this kind it is extremely important that a standard format be established for the data. This not only makes data retrieval relatively simple, but also allows systematic analyses to be performed. Future maintenance programs should in the author's opinion, make adequate provision for this. The advent of low-cost micro-computers and expected trends in micro-electronics will make the use of computerised maintenance management schemes more attractive, both from an economic and operational stand-point.

3. Maintenance Models

In reliability maintenance management it is important to distinguish between two models:

(i) When failure occurs, repairs maintenance is carried out. The repair maintenance restores the component or system to a condition identical to that prior to the failure. Thus, maintenance restores the component or system to the *'bad-as-old'* condition.

(ii) When failure occurs repair maintenance restores the component or system to a condition identical to that when first installed. In this case the component or system is restored to the *'good-as-new'* condition.

It will be appreciated that in practice the underlying process of failure and repair will occur somewhere between these two ideal cases. However, in either model, one first needs to establish the underlying probability density function (p.d.f.) or failure.

Now, assuming the failure p.d.f. is known and, for example, that (i) is applicable, one can identify the existence of reliability growth/degradation and use this model for reliability performance predictions. One such model utilises the non-homogenous Poisson process for describing reliability performance (3).

If model (ii) is adopted for describing the failure/repair process, then the results of renewal theory can be applied to the performance of the component or system (see for example (4)). Using these results one can formulate optimum maintenance policies. For example, suppose planned preventive maintenance is scheduled for times T, 2T, 3T... ..., and that the system is returned to the 'good-as-new' condition after each maintenance. If a failure occurs, the system is repaired and returned to the 'good-as-new' condition. Repair times are assumed to be neglibible. If the cost of planned maintenance is C_p and the cost of repair is C_r, then the average cost per unit of time is given by

$$C_T = \frac{C_p + C_r + H(T)}{T}$$

where H(T) is known as the renewal function defined as the expected number of renewals in the time interval (O,T). C_T has a minimum when $(dC_T/dT) = O$

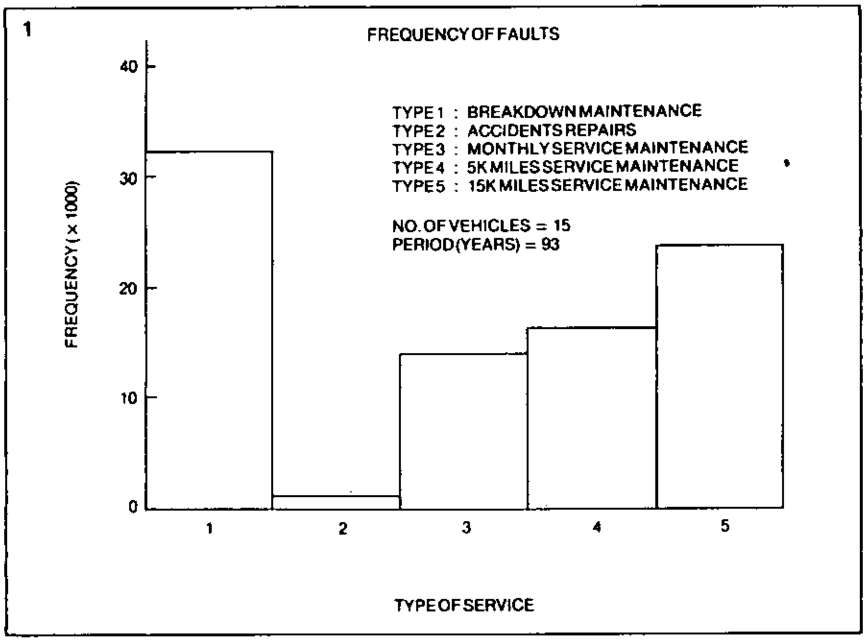


Figure 1 Service frequency

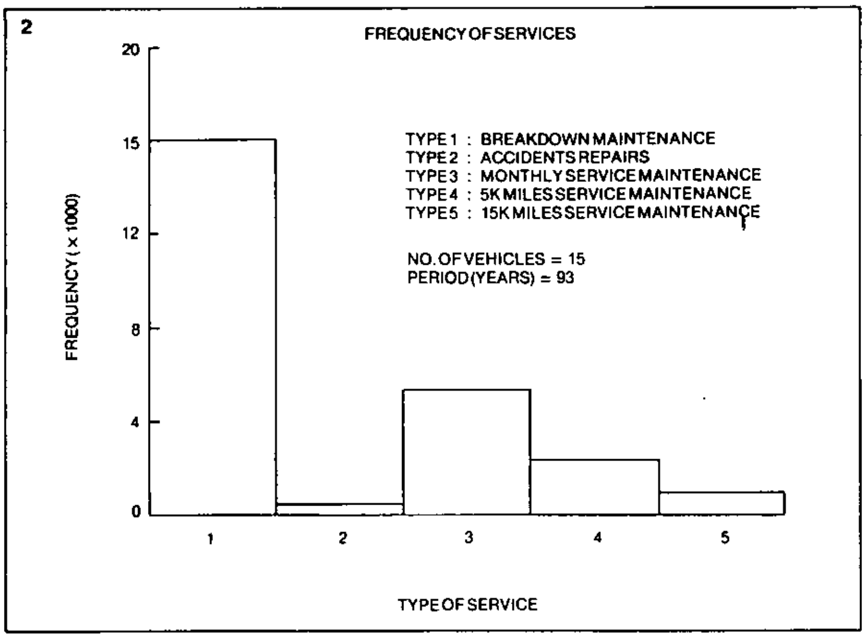


Figure 2 Fault frequency

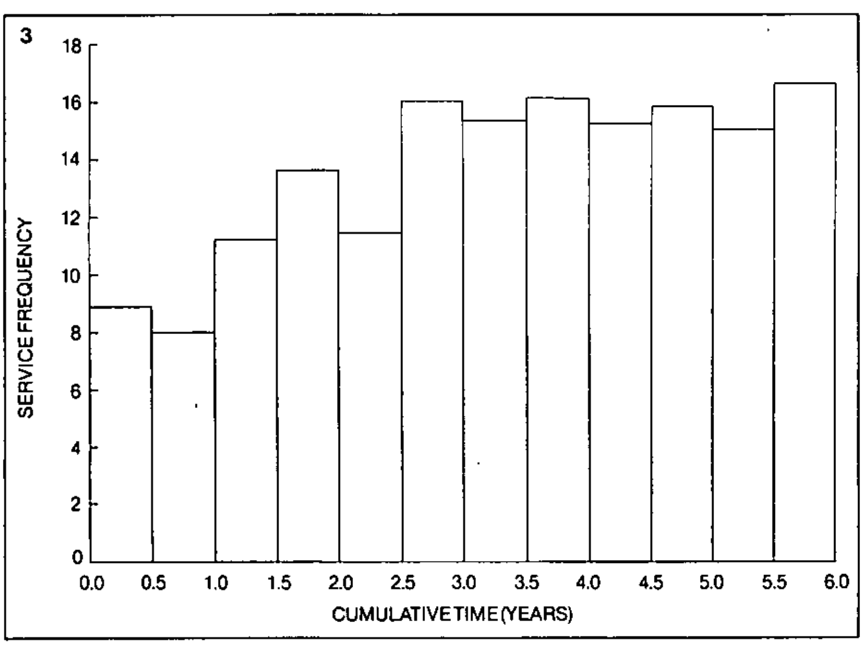


Figure 3 Trend in services with age

i.e. $T_{opt} = \frac{C_p}{C_r\, h(T)} + \frac{H(T)}{h(T)}$

where h(T) is known as the renewal density (h(T) = d H(T)/dT). One can obtain H(T) and h(T) either from tables (5) or using computer programs (6). In order to minimise costs one would schedule planned maintenance to occur at intervals of T_{opt}.

The applicability of such models to ambulances is a topic for further research. If cost-effectiveness is to be achieved then serious consideration should be given to this type of modelling.

4. Analysis of Ambulance Data

4.1 Service/Fault Rate Analysis

A histogram of the frequency of service types 1 to 5, given in 2.1 is shown in Fig. 1. The observed number of faults associated with eah service type is shown in Fig. 2. Table 2 gives the service rate, fault rate and faults per service for each of the service types. It can be seen that:

(i) There is an average one accident (service type 2) per vehicle every two years.

(ii) There are approximately 17 breakdowns (service type 1) per vehicle per year.

(iii) For each unscheduled service there are approximately two faults found.

(iv) Efficiency of planned preventive maintenance is estimated to be (5493/8727 × 100% = 63%, assuming that faults revealed during planned maintenance would ultimately result in breakdown.

4.2 Composite Service Rate Trend

The average number of all services occurring during successive six-monthly intervals is shown in Fig. 3 for the composite case of 16 vehicles. This is obtained by combining all services and suitably normalising by dividing by the number of vehicles. It is evident that generally there is an upward trend up to about three years, after which the service rate remains constant. Since one would expect service types 3-5 to remain fairly constant over the life of the vehicle, this initial upward trend is probably due to increases in service types 1 and 2 (i.e. repairs). The initial service rate is about half the equilibrium value.

4.3 Maintenance Cost Analysis

The average maintenance cost per vehicle for intervals of 20,000 miles is shown in Fig. 4. Material costs are based on 1981 prices and labour cost is calculated at £6 per hour. An increasing trend in total cost is clearly evident, although an increase in labour cost accounts for the largest proportion of this. This would suggest that at some stage it is more cost effective to dispose of the ambulance and replace it than to continue its service. More detailed investigation of this problem is presented later. The average total cost per vehicle for 140,000 miles is £6,615. This comprises £1,495 material costs and £4,670 labour costs. Labour cost, therefore, constitutes overall about 76% of total costs.

4.4 Subsystem Material Cost Analysis

Ten categories of ambulance subsystem are encoded by the database. These are:

1. Engine
2. Cooling System
3. Exhaust System
4. Steering System
5. Clutch and Gears
6. Brakes and Wheels
7. Body
8. Electrical System
9. Accessories
10. Miscellaneous

The material costs for each vehicle associated with each of these subsystems are shown in Table 3. Table 4 gives average percentages for the 16 ambulances. It is evident that subsystems 1, 5 and 6 each contribute about 20% to total material costs and together constitute approximately 60% of total material costs. Additional and more detailed results can be found in (7).

5. Maintenance Expenditure Modelling

The model adopted for maintenance expenditure is the 'Duane' type model (8) given by

$$C(d) = \alpha . d^{\beta} \quad (1)$$

where C(d) = cumulative expenditure (in pounds) up to and including mileage dx1000

α, β = model parameters

In this model

$\beta < 1$ represents decreasing maintenance expenditure rate

$\beta = 1$ represents constant maintenance expenditure rate

$\beta > 1$ represents increasing maintenance expenditure rate

TABLE 1. Data Summary

Vehicle No.	Fleet No.	Vehicle Type	Body Type	Date in Service	Duration of records (years)
1	386	2.51, 6 cylinder	Hanlon	5.2.74	6
2	399	,,	,,	1.3.74	6
3	401	,,	,,	28.2.74	6
4	404	,,	,,	27.2.74	6
5	405	,,	,,	6.3.74	7
6	409	,,	,,	14.3.74	6.5
7	414	,,	,,	18.4.74	6.5
8	418	,,	,,	19.4.74	6
9	422	,,	,,	22.1.75	6
10	438	,,	,,	18.2.75	4.5
11	439	,,	,,	18.2.75	6
12	440	,,	,,	24.2.75	4.5
13	443	31, Dual Purpose 6 cylinder	,,	25.3.75	6
14	455	2.51, 6 cylinder	,,	22.5.75	5.5
15	459	,,	,,	16.6.75	5
16	465	6 cylinder, dual purpose	,,	25.6.75	5.5
		Total			93

TABLE 2. Service/fault rates

Service Type	No. Services	Service Rate (per year)	No. Faults	Fault Rate (per year)	Fault per Service
1	1600	17.2	3234	34.8	2.0
2	47	0.5	88	0.9	1.9
3	527	5.7	1419	15.3	2.7
4	236	2.5	1665	17.9	7.1
5	95	1.0	2409	25.9	25.4
TOTAL	2505	26.9	8815	94.8	3.5

Optimum economic replacement policies arise for situations when $\beta > 1$. For all other situations additional factors will determine when a vehicle should be replaced.

A logarithmic transformation of (1) gives

$$\ln C(d) = \ln \alpha + \beta \ln d \quad (2)$$

A plot of ln C(d) against ln d will give a straight line with intercept ln α and slope β. One can therefore use the method of least squares to obtain estimates of α and β. Table 5 gives a summary of the analyses for individual vehicles and for the composite case of 16 vehicles. A high correlation coefficient is obtained in all cases indicating that the model gives a good fit to the data. Generally, ϱ is greater than unity, indicating that expenditure rate increases with mileage.

Setting d = μr in (l) gives

$$C(r) = \alpha (\mu r) \beta \quad (3)$$

where r = age of vehicle in years

μ (average yearly mileage/1000)

Accordingly, for the composite case of

TABLE 3. Material Cost Analysis for the Subsystems

Vehicle No.	Fleet No.	Material Cost (f)							1981 Prices			
		System Number*										
		1	2	3	4	5	6	7	8	9	10	Total
1	386	494.40	116.29	421.94	31.76	168.03	205.48	72.23	21.34	85.05	44.21	1660.73
2	399	176.88	109.09	117.12	35.93	274.55	243.08	05.78	71.06	16.17	85.02	1214.68
3	401	467.26	80.53	174.28	105.54	260.29	300.17	215.73	70.85	17.88	77.15	1769.68
4	404	250.80	96.37	228.48	123.67	278.49	129.91	157.08	78.93	24.56	58.43	1426.72
5	405	296.08	54.78	96.47	149.71	206.27	134.33	165.76	43.79	17.44	33.97	1198.60
6	409	345.44	91.79	440.29	37.20	307.10	418.12	140.83	79.22	47.65	79.25	1986.88
7	414	312.32	75.13	235.51	40.94	358.86	338.29	104.25	48.96	27.54	85.38	1627.18
8	418	219.94	33.13	125.23	25.20	272.00	335.16	177.03	72.33	15.03	46.24	1321.27
9	422	34.12	30.37	13.34	44.89	165.98	132.40	31.59	42.01	12.15	56.14	562.99**
10	438	268.94	98.91	121.17	60.61	279.27	133.84	191.47	45.42	22.34	77.27	1299.36
11	439	319.07	49.18	0.00	15.82	116.86	102.88	71.20	24.88	13.44	39.69	753.02
12	440	389.76	86.30	11.28	28.34	169.20	580.51	71.57	69.39	19.05	130.32	1555.71
13	443	135.21	66.22	26.66	30.82	214.08	282.87	41.39	55.91	45.99	65.45	964.59
14	455	171.55	70.40	19.26	43.73	265.29	114.13	82.47	27.22	15.38	83.30	892.73
15	459	81.19	79.13	19.86	29.75	331.92	177.13	77.10	16.91	29.59	68.41	910.99
16	465	151.86	110.04	15.30	41.28	225.50	408.66	94.01	25.48	15.46	47.89	1135.49
TOTAL		4114.82	1247.66	2066.19	845.19	3893.69	4036.96	1779.49	793.70	424.72	1078.22	20280.62

* 1: Engine
2: Cooling system
3: Exhaust system
4: Steering system
5: Clutch & gears
6: Brakes & wheels
7: Body
8: Electrical system
9: Accessories
10: Miscellaneous

** Insufficient Data

16 vehicles in which $\mu = 23$, the following model is obtained

$$C(r) = 8.587 \times (23r)^{1.411} \quad (4)$$

6. A Proposed Replacement Model

6.1 Economic Factors Determining Replacement

An increasing trend in maintenance costs with accrued mileage suggests that an optimal replacement age may exist for the ambulances in the study. It is assumed that average annual total cost incorporates:-

(i) the initial cost of the vehicle
(ii) the salvage value of the vehicle
(iii) labour costs of maintenance (including overheads)
(iv) material (spares) costs

Furthermore, it is recognised that any economic model needs to deal with both interest rate and inflation rate. The cost of unavailability is not included, firstly, because the main task of the ambulance fleet is to provide a carrying service for patients, especially in emergencies. Secondly, the West Yorkshire Ambulance Service provides more vehicles than are normally required for routine service duties. Downtime costs, therefore, are assumed not to influence the replacement decision.

As with certain types of aircraft, it is conceivable that fuel consumption of ambulances could increase with age, thereby increasing running costs. On the other hand, Christer and Goodbody (9) suggest that the replacement decision is independent of fuel costs. Since no relevant data was available regarding this topic it is not included in the model.

The salvage value of an ambulance varies little with age. A vehicle is not normally put up for disposal unless it needs a repair costing more than the average annual total cost. Thus, the capital acquisition cost of a vehicle less salvage value is assumed constant (£13,500).

6.2 Economic Replacement Age (ERA)

A generalised mathematical model adopted in this analysis for determing ERA given in (10) is

$$T_a = \frac{(C-S)}{n} + \frac{1}{n}\int_0^n r(t)\,dt \quad (5)$$

where T_a = average annual total cost
C = capital cost
S = salvage value
n = age of vehicle (in years)
$r(t)$ = rate of maintenance expenditure (i.e. maintenance cost in the interval $(t, t + \Delta t)$ is $r(t).dt$

Minimum cost arise when $\delta\, Ta/\delta n = O$ giving $r(n) = Ta$. Thus, the ambulance should be replaced at age (n) when current maintenance cost r(n) is equal to (or just exceeds) the average annual cost T_a.

Assuming that inflation rate and interest rate are 10% and 8% respectively, Table 6 gives the ERA for each vehicle. Inflation and interest rates are taken into account as described in (8). The average replacement age is seen to be 7.75 years at an average annual cost of £4,449 per vehicle. Similar analysis for the composite case of 16 vehicles gives an ERA of 8 years and an average annual cost of £4,521 per vehicle.

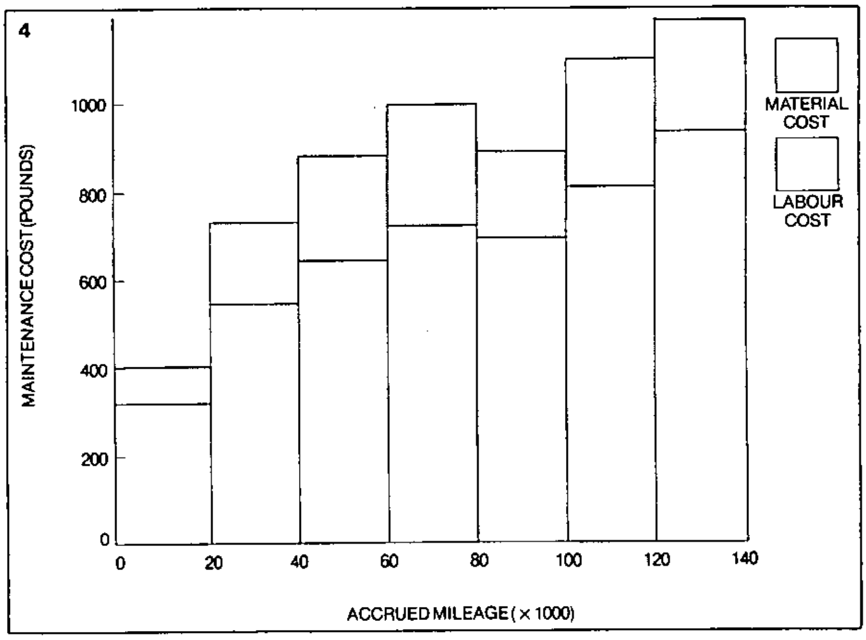


Figure 4 Maintenance cost as a function of mileage

TABLE 4. Percentage Material Costs for the Subsystems

System No.	System	Average percentage of total material cost	
		Weighted	Unweighted
1	Engine	19.75	20.29
2	Cooling system	6.36	6.15
3	Exhaust system	8.50	10.19
4	Steering system	4.36	4.17
5	Clutch & gears	20.49	19.20
6	Brakes & wheels	19.95	19.91
7	Body	8.74	8.77
8	Electrical system	4.03	3.91
9	Accessories	2.12	2.09
10	Miscellaneous	5.70	5.32
TOTAL		100%	100%

TABLE 5. Summary of maintenance expenditure analysis

Cost (1981 prices)	α	β	Correlation Coefficient
Individual vehicles			
Material	0.99-1.86	0.19-8.91	0.932-0.999
Labour	1.13-2.12	0.38-18.55	0.956-0.999
Total	1.07-2.20	0.30-43.33	0.952-0.998
Composite 16 vehicles			
Material	1.493	1.015	0.997
Labour	1.396	7.619	0.999
Total	1.411	8.587	0.999

6.3 Sensitivity Analysis

Each input parameter is varied in order to observe variations in output. This provides a measure of the sensitivity of the model to input variations. In the model, the following parameters are varied both individually and simulatneously:

(i) β parameter (β-1)
(ii) α parameter
(iii) Accumulated mileage per year.

The effect on ERA of simultaneous variations in input parameters for the composite care of 16 vehicles is shown in Table 7.

Provided that the changes in the input parameters for the sensitivity analysis are small, the effect on replacement age and average annual total cost by varying more than one parameter simultaneously can be obtained by linear superposition of the individual results. In order to validate this linearity, further cases were run with different input parameters and the results are shown in Table 8. Linear superposition, with an accuracy of up to 3%, is valid with regard to average annual total cost. However, linear superposition is considerably less accurate with regard to ERA. This arises from two factors. Firstly, ERA is only calculated on an annual basis (i.e. a discrete variable) and secondly, the model is extremely sensitive to the average annual total cost. Thus, linear superposition can be used to estimate average annual total cost, but must be used with caution to calculate ERA.

7. Comparison of Results

The estimated values of α and β are 8.587 and 1.411 respectively. The 95% confidence limits on these parameters can be shown to be ±3% and ±17% respectively. Using these limits one obtains an overall ERA of 7.67 years with a corresponding average annual cost of £4,554. These results are estimated to be correct within one year for ERA and £601 for average annual cost. Comparison with results shown in Table 6 show that the two methods give statistically consistent results.

8. Conclusions

1) Maintenance management schemes utilising a systematic method of recording essential information are necessary. Consideration should be given to the use of computers for maintenance databases which allow relatively easy data retrieval. The advent of low cost micro-computers should make this an attractive proposition from both an economic and operational point of view.

2) The ambulances breakdown on average 17 times per year. Once every two years an accident repair will be necessary.

3) The efficiency of planned preventive maintenance is estimated to be approximately 63%.

4) The average number of breakdown faults is estimated to be 35 per year.

5) Maintenance costs increase with accumulated mileage/age of the vehicle. Overall, labour costs constitute 76% of the total maintenance cost.

TABLE 6. Economic Replacement Age of Ambulances

Vehicle No.	Accumulated mileage/year (× 1000)	α Parameter	β Parameter	Replacement age (years)	AV. Annual total cost (£)
1	19.89	0.682	2.031	5	5031
2	19.88	11.313	1.365	8	4165
3	22.13	16.381	1.256	9	4040
4	26.28	15.786	1.232	9	4138
5	18.81	20.111	1.263	9	4117
6	22.63	3.980	1.586	7	4740
7	21.03	15.706	1.296	9	4265
8	29.38	23.110	1.133	10	4115
9	31.91	43.334	1.068	9	4929
10	21.65	16.476	1.301	8	4512
11	19.84	0.302	2.204	5	4988
12	24.58	8.031	1.383	8	4252
13	17.10	0.413	2.163	5	4655
14	21.64	1.243	1.854	6	4899
15	27.89	10.263	1.287	9	4030
16	23.00	7.288	1.424	8	4306

Average replace age = 7.75 years
Standard deviation of replacement age = 1.653 years
Average annual total cost (16 vehicles) = £4,449
Standard deviation of average annual total cost = £367.7

TABLE 7. Combined Sensitivity Analysis of Replacement Age

% Change	Economic replacement age (years)									Accumulated mileage/ year (× 1000)
$(\beta$-1) \ α	−20%	−15%	−10%	−5%	0%	5%	10%	15%	20%	
−20%	12	11	11	11	11	10	10	10	10	19
−15%	11	10	10	10	10	10	9	9	9	20
−10%	10	10	9	9	9	9	9	8	8	21
− 5%	9	9	9	8	8	8	8	8	8	22
0%	8	8	8	8	8	7	7	7	7	23
5%	8	7	7	7	7	7	7	6	6	24
10%	7	7	7	6	6	6	6	6	6	25
15%	6	6	6	6	6	6	6	5	5	26
20%	6	6	6	5	5	5	5	5	5	27

Inflation rate = 10% Interest rate = 8%

TABLE 8. Validation of Superposition

% change in parameter	(β-1) parameter		α parameter		μ parameter		Superimposed derived values		Simulataneous variation of parameters	
	R	M	R	M	R	M	R	M	R	M
−10%	8	4067	8	4286	8	4197	8	3508	9	3612
− 9%	8	4107	8	4309	8	4228	8	3602	9	3690
− 8%	8	4148	8	4333	8	4260	8	3699	9	3771
− 7%	8	4190	8	4356	8	4292	8	3796	9	3856
− 6%	8	4233	8	4380	8	4325	8	3896	9	3945
− 5%	8	4287	8	4403	8	4357	8	4005	8	4044
− 4%	8	4332	8	4427	8	4389	8	4106	8	4131
− 3%	8	4378	8	4450	8	4422	8	4208	8	4222
− 2%	8	4428	8	4474	8	4455	8	4315	8	4318
− 1%	8	4472	8	4497	8	4488	8	4415	8	4417
0%	8	4521	8	4521	8	4521	8	4521	8	4521
1%	7	4566	7	4543	7	4552	5	4619	7	4618
2%	7	4610	7	4564	7	4582	5	4714	7	4719
3%	7	4656	7	4586	7	4612	5	4812	7	4823
4%	7	4702	7	4607	7	4642	5	4909	7	4932
5%	7	4762	7	4628	7	4673	5	4932	7	5059
6%	7	4810	7	4649	7	4704	5	5121	7	5178
7%	7	4860	7	4670	7	4734	5	5222	6	5292
8%	7	4911	7	4691	7	4765	5	5325	6	5405
9%	7	4963	7	4713	7	4796	5	5430	6	5522
10%	7	5015	7	4734	7	4827	5	5534	6	5645
Unchanged parameters	α = 8.587 μ = 23,000		β = 1.411 μ = 23,000		β = 1.411 α = 8.587					

6) A model of the form $C(d) = \alpha d^{\beta}$ is suitable for describing the trend in maintenance costs.

7) The economic replacement age of the ambulances is of the order of 8 years with an associated average annual cost of £4,500.

8) Linear superposition of costs arising from changes in the three input parameters ($\alpha, \beta - 1$ and μ) is valid with regard to average annual cost to an accuracy of 3% for a total variation of 10% in the input parameters. ERA is most sensitive to changes in value of the β parameter.

9. Acknowledgement

We are grateful to the D.H.S.S. for their support of this research and to the West Yorkshire Ambulance Service who provided the data on which these analyses are based.

10. References

1) Waitt, C.P., **A Preliminary Report on Data Collection for Ambulance Reliability Study within the West Yorkshire Region,** Postgraduate School of Studies in Industrial Technology, University of Bradford, April 1981. Confidential Report

2) Fosse, J., Hamilton, F.I., and Blakeley, A.M., **Data Collation and Preliminary Analysis for Ambulance Reliability within the West Yorkshire Region,** Postgraduate School of Studies in Industrial Technology, University of Bradford, September 1981. Confidential Report.

3) Keller, A.Z., **A generalised Theory of the Non-Homogenous Poisson Process,** presented at 8th Advances in Reliability Technology Symposium, University of Bradford, 25-27 April, 1984, Paper B4/2.

4) Cox, D.R., **Renewal Theory,** Methuen & Co. Ltd., Science Paperbacks, 1962, London.

5) Baxter, L.A. et al, **Renewal Tables: Tables of Functions Arising in Renewal Theory,** Technical Report, University of Southern California, 1981.

6) Giblin, M.T., **Derivation of Renewal Functions using Discretization,** presented at 8th Advances in Reliability Technology Symposium, University of Bradford, 25-27 April, 1984.

7) Kamath, A.R.R. and Al-Zuhairi, A.M., **Tables and Results of Ambulance Project (DHSS) (for discussion),** Postgraduate School of Industrial Technology, August 1982. Confidential Report.

8) Al-Zuhairi, A.M. and Peacock, S.T., **Maintenance Data Analysis for Ambulances within the West Yorkshire Region,** Postgraduate School of Industrial Technology, Report No. UB1T/108, September 1983. Confidential Report.

9) Christer, A.H. and Goodbody, W., **Equipment Replacement in an Unsteady Economy,** J.Opl. Res. Soc., Vol.31, 1980.

10) Kamath, A.R.R. et al **A Study of Ambulance Reliability in a Metropolitan Borough,** presented at the 4th National Reliability Conference, Birmingham, 6-8 July 1983.

The author is now Staff Inspector in the Management Services Branch at the DHSS, Newcastle-on-Tyne Central Office. This paper was presented at the one-day symposium 'Organisation of NHS Transport' on 3rd October 1984.

NHS arrangements for vehicle maintenance

G W WRIGHT

Introduction — background to study

Works Group (OPSI) asked Central Management Services to undertake a study of vehicle maintenance arrangements, including those for ambulances. An earlier CMS report based on a Review of NHS Transport had drawn attention to the fact that a variety of schemes existed for the maintenance of NHS non-ambulance transport and that because of limited facilities and a general lack of control there was a tendency for maintenance to be corrective rather than preventive. There was evidence of a lack of technical expertise available locally to which management could turn for advice and it was generally considered that management had no means of determining whether or not contract maintenance charges with local garages were fair. The report recommended that existing arrangements should be reviewed with the aim of establishing minimum standards of maintenance, determine management accountability for the service and evaluating the cost effectiveness of inhouse maintenance facilities.

There was a lack of information in the Department on current practices concerning the maintenance of NHS vehicles and Works Group considered it essential to obtain detailed information about existing arrangements in order to identify both good and bad practice and thus enable central guidance to be issued.

Terms of reference

The following terms of reference were agreed between CMS and Works Group:-

'To examine the present arrangements for the maintenance of all mechanically propelled NHS vehicles (excluding electric-powered vehicles) in a sample of Health Authorities, to obtain details of the procedures, organisational arrangements and documentation and, if appropriate, make recommendations to improve the efficiency and the cost effectiveness of the service.'

Key areas of the maintenance function

The findings of the study indicated that certain KEY AREAS of the Maintenance Operation contributed most to the effectiveness or otherwise of the system. A combination of these factors to a great or lesser degree influenced the *standard* of maintenance.

The key areas are:

i. Staff having the necessary technical knowledge/experience.
ii. Vehicle records and information systems.
iii. Vehicle replacement procedures.

Key area-1. Staffing Organisation

Two notable features emerged about the organisation of the maintenance function. These were:

i. the range of different grades of those staff with day to day responsibility for vehicle maintenance, and
ii. the apparent absence of staff with either technical expertise or experience in fleet management.

These features were more pronounced in non-ambulance locations and normally the control of transport, including the arrangements for maintenance, was organised at district level and was often fragmented. To some extent this was a reflection of the disparate management structure of the NHS, the legacy of arrangements prior to the 1974 Reorganisation and the lack of attention paid to transport in the NHS.

(Refer to Sheet 1 — 'Operational Arrangements'.)

The most effective organisational arrangements were found where a transport manager with automotive and fleet opeational experience was responsible for all aspects of the transport function, including the budget. The Study Team considered that the absence of transport managers with the necessary technical knowledge and fleet management experience ranks as the most serious deficiency in the maintenance operation. An effective maintenance system is unlikely to remain effective without the experience and knowledge that only a qualified person can offer and a poor maintenance system could certainly benefit from such an appointment. In recommending the appointment of suitably qualified staff for the post of Transport Manager it is accepted that implementation will take time, particularly at those authorities where the present jobholder is not qualified.

It is also recognised that the introduction of a Transport Manager will give rise to additional costs but these will be offset by the savings arising from such an appointment.

The size of some fleets may rule out the viability of such an appointment but some commercial firms retain a transport manager for fleets as small as 25 vehicles. Health authorities should therefore be encouraged to consider such an appointment taking local circumstances into account, including the type of maintenance system in operation and the extent of clerical support available.

It was recognised that ambulance and non-ambulance fleet operators must be allowed access to professional advice. The extent to which this is required will be largely determined by the level of experience and technical knowledge of the staff involved. Under the present arrangements staff would be expected to seek the advice of the Works Department but the study revealed that only rarely was a knowledge of automotive engineering to be found there. In the context that professional advice must be readily available to those who need it we considered DHSS too remote, particularly if help or advice is required quickly to resolve some of the day problems. We considered today that the appointment of a suitably qualified Transport Manager would obviate or at least minimise this problem. However, it has already been recognised that the introduction of experienced transport managers will not be achieved overnight; furthermore, some authorities with small fleets will continue to operate without one and they will not be in a position to enjoy the benfit of easy access to the necessary advice.

We regarded this situation as being undesirable and recommended that a post of Transport Adviser should be introduced at Regional level. His responsibilities would include:

i. Arranging contracts in conjunction with the Regional Supplies Officer and, where appointed, the District Transport Manager.
ii. The jobholder would be responsible for advising on all vehicle purchases.
iii. Although responsibility for maintenance standards would rest at District Level the Regional Transport Adviser would monitor standards of performance.

The major advantages seen in creating a new Regional post are that:

i. Professional advice and technical expertise is readily available to *all* health authorities. This will resolve one of the major deficiencies in many existing maintenance systems.
ii. Maintenance standards will be monitored and improved; and
iii. Purchasing arrangements will be more cost-effective.

In concluding our look at the staffing organisation of the maintenance function it is worth reflecting that in the past vehicle maintenance has suffered from poor decisions taken by staff not properly qualified to give them. This has sometimes resulted in costly and expensive mistakes and it is considered that a valuable opportunity would be missed if the staff best qualified and most closely associated with the maintenance function did not play a part in the formulation of maintenance policy. The report therefore recommends that Transport Manager should be involved in decisions affecting, for example, the choice of maintenance system the operational arrangements for vehicle serving and repair and recruitment of mechanics.

Key area-2. Vehicle records and information systems

The standard of documentation varied from one location to another but this aspect was seen as being the one where most guidance was required.

The demands of the transport function are such that an effective system of control is essential. A prime aim of any control system should be to provide information which is:

- ☐ appropriate
- ☐ accurate
- ☐ timeous
- ☐ easy to access/retrieve, and
- ☐ brief

The general absence, unreliability, inadequacy or superfluity of information relating to vehicles and their performance was a major factor in undermining the effectiveness of some maintenance operations. The level of knowledge relating to vehicle costs, vehicle performance and, in the case of in-house applications, workshop performance was less than satisfactory we hold the view that just as there are dangers in managers relying too heavily on personal subjective evaluations so too are there hazards in operating procedures which do not produce the information required.

The main weaknesses were identified as: *Refer to Sheet 2 — vehicle records — the main weaknesses*

Some locations chose to maintain records of vehicle costs on the regional computer. The position was improved in only a few cases and it was found that computer statements of vehicle costs were not always an accurate reflection of the true position. From time to time some obvious errors appeared on the computer output but seldom was it easy to establish the cause of the error. Resolving the problem invariably meant discussion with either finance or computer staff or sometimes both. Incorrect coding at the input stage was a common fault. Another weakness was that code headings were too broad consequently items of a similar description sometimes appeared under a separate heading. We found that the 'miscellaneous designator' was used too readily especially where it was not immediately apparent under which sub-head expenditure had been incurred. The findings made clear that some locations using the regional computer were, for various reasons, not obtaining full benefit from it.

It is important that vehicle records should be seen as an integral part of an information system. The CMS report contained guidance on the sort of information which we considered would contribute to an effective information system.

The information shown is not intended to be exhaustive and should be viewed as representing no more than a nucleus of the requirements of the maintenance function. The information should be held for each vehicle in the fleet.

(Refer to Sheet 3 — Vehicle Records — The Basic Requirements)

This information would, if used properly, give some measure of the overall effectiveness of fleet performance. Additional information needs, such as 'on-costs' would be required where in-house arrangements were operated. No attempt was made in the report to prescribe a format for collecting or recording this information. The omission was deliberate since this will depend on whether records are maintained clerically or held on computer.

Transport Managers would be responsible for the design of the system and Regional Transport Advisors would be responsible for co-ordinating the introduction of the information systems. By doing it in this way we considered that some measure of uniformity would be achieved throughout the Region in the standards of collecting and recording information. This will hopefully result in an effective data base and reduce the need for subjective decisions and improve policies and planning.

Key area-3. Vehicle replacement

The majority of staff interviewed claimed that replacement of vehicles was based on DHSS guidelines, subject to the availability of funds.

DHSS guidance governing vehicle replacement suggests that ambulances should be replaced at 7 years or 140,000 miles and that light vehicles should have a minimum life of either 55,000 miles or 5½ years. For larger vehicles this is increased to 7 years or 70,000 miles. Most authorities visited prepared a programme each year of vehicles due for replacement. It was not unusual for the purchase programme to be curtailed or even disregarded because money was not available.

There was a general feeling among staff with responsibility for transport that for far too long it had been accorded insufficient priority — 'a Cinderella Service'. It was clear that the transport operation at most of the authorities visited had suffered in some way from a shortage of funds and Transport Managers invariably found themselves having to compromise on the number of vehicles to be replaced. This inevitably resulted in vehicles being operated after their economic life had expired. The shortage of funds meant that some districts were forced to buy used vehicles. This only served to aggravate the problems of vehicle maintenance. The extent to which vehicle replacement complied with DHSS guidelines was illustrated in the CMS Report.

(Refer to Sheet 4 — Vehicle Replacement — DHSS Guidelines)

It was generally accepted by most of the ambulance staff interviewed that ambulances were not a specialist vehicle in maintenance terms. However, there was some feeling that the Department's vehicle replacement guidelines were less favourable to ambulances than comparable vehicles operating in district fleets. This view and other considerations support the need for a review of the present guidelines to confirm whether or not they represent the most economic basis on which to formulate policy.

It has to be recognised, however, that the success of any system of vehicle replacement is heavily influenced by other factors. Records of vehicle running costs and maintenance costs for instance are fundamental to ensuring that vehicles are replaced at the proper time. Success will not be achieved however unless adequate funds are made available and it is vital that managers in the transport field should be concerned with maximising the use of limited resources. It is felt that the recommendation to appoint Transport Managers and Regional Transport Advisors will introduce the right blend of managerial skill and technical expertise to achieve this aim.

The majority of ambulance services in the study sample recognised the advantages in rotating the vehicles in their fleets and this was achieved successfully. However, some health authorities could do more to prolong the active life of some vehicles and the CMS Report contains a recommendation that Transport Managers should be encouraged to exercise discretion when it comes to replacing vehicles and to give consideration to allocating vehicles from high mileage jobs to tasks with lower mileage involved. This could in itself be an economy providing that costs are monitored carefully.

Sheet No.1 OPERATIONAL ARRANGEMENTS

Vehicle maintenance was organised in a number of ways but, normally, responsibiilty was given to either Administration or Works Staff. Sometimes however, the responsibility was divided between two departments. It was found that where such an arrangement existed weaknesses were more likely to arise, notably in areas involving communication, definition of areas of responsibility, and the recording of vehicle records and performance.

The decision to place responsibility with Works Officers was rarely the result of careful planning but often an expedient based on the concept that the only available technical expertise was in the Works Departments. To some extent this was true in that vehicle workshop staff and engineers talked the same language but in practice automotive engineering knowledge was rare in Works Departments.

The December 1970 edition of Management Services (NHS) Guide to Good Practices in Hospital Administration (Section 7, paragraph 10) states, 'Administrative arrangements for maintenance should be the responsibility of the Transport Officer who would be expected to seek technical advice from Group Engineers'. Quite often, however, pressures of work and other priorities prevented Works Staff from being able to devote the necessary time to vehicle maintenance.

Some districts had appointed a transport manager/officer with comprehensive duties including budget responsibility. At others the transport function, including maintenance, was combined with other duties as the task itself was insufficient to warrant a full time post. At District level, too, transport was organised and run by staff without fleet management or technical experience. Small hospital-based fleets were sometimes controlled by a higher clerical officer.

The maintenance function at ambulance locations was generally better organised than non-ambulance locations. One reason for this appreared to be that staff responsible for the day-to-date operation had a greater degree of knowledge and experience in fleet maintenance. Managers at 6 of the 8 ambulance locations visited were experienced in fleet management and were qualified in either motor engineering or the mechanical aspects of vehicle maintenance.

Sheet No.2 VEHICLE RECORDS AND INFORMATION SYSTEMS — THE WEAKNESSES

The absence of information such as vehicle downtime.

Little or no attempt to cost overheads for such things as the cost of buildings, tools, rates etc.

In-house labour costs were often not itemised or related to individual vehicles.

Time and effort were wasted keeping information which was rarely, if ever, used by management. Staff indicated that it was maintained mainly for accountability purposes (eg audit).

Access to information was made difficult because of the way in which it was recorded.

Some records were related to fleets of vehicles and details of individual vehicles were not held.

The additional costs for hire of a replacement vehicle were not always recorded against the vehicle it replaced.

Vehicle records at some locations were fragmented and maintained in such a way that it was difficult to determine whether the cost of bodywork repairs was included in the maintenance costs. Several authorities realised its importance as a high cost area and kept separate records.

Occasionally information recorded for individualk vehicles was not collated on a cumulative basis making it difficult to judge vehicle performance during the year.

Form design was poor at some locations.

Occasionally staff were unaware that some records were being duplicated.

Only rarely were managers able to anticipate events from the information available, mainly because of the fragmented and unco-ordinated approach to record keeping and the time scale in which information became available.

Sheet No.3 VEHICLE RECORDS — THE BASIC REQUIREMENTS

Warranty period — in the case of new vehicles and components.

Identity details (including make, type, model, weight, capacity, date of registration).

Assessment of vehicle performance (for example maintenance costs/running costs/mpg).

Mileage.

Legal requirements — MOT/plating.

Vehicle availability — downtime (time off the road and the reason) hire costs for replacement vehicles.

Vehicle maintenance history record.

Major component changes/spares — replacement frequency.

Tyres — cost and replacement frequency.

Batteries — cost and replacement frequency.

Servicing, repairs, accident damage, vehicle modification — costs to be recorded separately (with a breakdown for labour and parts).

Sheet No.4 VEHICLE REPLACEMENT — DHSS GUIDELINES

Mileage

Ambulance

No of vehicles in sample	No of vehicles exceeding DHSS guidelines (age & mileage)	%
669	107	16

Non-Ambulance

No of vehicles in sample	No of vehicles exceeding DHSS guidelines (age & mileage)	%
852	369	43

Age

Ambulance

No of vehicles in sample	No of vehicles 7 years old and over	%
669	100	14.9

Non-Ambulance

No of vehicles in sample	No of vehicles beyond DHSS guidelines	%
852	291	34.2

Age and Mileage

Ambulance — the total number of vehicles which exceeded DHSS guidelines was 107 (16%).

Non-Ambulance — the total number of vehicles which exceeded DHSS guidelines was 369 (43.3%).

The author is Transport Engineer for the Northern Regional Health Authority, Newcastle-upon-Tyne. This paper was given at the one day symposium 'Organisation of NHS Transport' on 3rd October 1984.

Factors in the determination of vehicle replacement policies

EDWIN HODSON BSc CEng MIMechE MIRTE

1. Introduction

This paper sets out a general replacement policy for vehicles in the NHS and draws on the Author's Ambulance Maintenance experience to illustrate certain calculations.

As soon as a vehicle travels its first mile the deterioration process begins; wear and tear resulting from friction, cyclic stress, mechanical shock, electro-chemical reactions, high temperatures, high pressures etc. all take place. Vehicles are complex and typically an ambulance consists of 20,000 separate components many of which can fail to cause vehicle failure and yet unlike industrial plant the vehicle is mobile and its operation is out of sight, variable and uncertain.

Into this disorder the Transport Engineer has to establish fleet safety, economy and engineering control: the replacement policy is a major consideration in his efforts.

2. The replacement problem

It is transport maintenance experience that however good the routine servicing of vehicles, as vehicles age they deteriorate and more frequent repairs are required to maintain their operating condition: these repairs absorb both increasing costs and downtime and there is a time when vehicles appear to need to be replaced.

Clearly if vehicles are replaced frequently there will be considerable purchasing activity but little requirement for maintenance and downtime will be low: while if vehicles are retained for a greater time then there will be less purchasing activity but maintenance effort will be increased and downtime will be increased as well.

The replacement decision therefore controls how much facility and resource is applied to purchasing, maintenance and downtime in a fleet of vehicles. The replacement policy for a single vehicle or a fleet is therefore a major Planning Indicator in Transport Management and dominates vehicle costs.

Using NHS vehicle fleet information presented by Professor Gage[1] in an earlier paper to this Institute, NHS vehicle replacement expenditure is currently £24M per year while maintenance expenditure is £19M per year.

These considerable expenditures are large enough to justify a review of the NHS vehicle replacement policy. The Rayner scrutinies, currently under investigation give an added thrust to the review.

Current guidelines for vehicle replacement given in the NHS Transport Handbook are:-

(a) For Non-ambulance Transport
55,000 miles of travel or 5½ years of age — whichever occurs first, while the Ambulance Services have adopted:

(b) For ambulance Transport.
140,000 miles of travel or 7 years of age — whichever occurs first.

These two guidelines are called upon to apply to a wide range of NHS vehicles:

	Scrapping Recommendation	Replacement Cost C	Average depreciation
Cars	5½ years/55,000 miles	£ 3,000	£ 545/year
Vans	5½ years/55,000 miles	£ 3,000	£ 545/year
Trucks	5½ years/55,000 miles	£ 7,000	£1,272/year
Buses	5½ years/55,000 miles	£25,000	£4,545/year
Mini Buses	5½ years/55,000 miles	£ 8,000	£1,454/year
Ambulances	7 years/140,000 miles	£16,000	£2,286/year
Sitting Case Vehicles	5½ years/55,000 miles	£12,000	£2,182/year

In practice many other replacement policies have been developed. One recent set of replacement recommendations[2] to Oxford Health Region was:

5-6 years — vehicles up to 15 cwt

7-8 years — vehicles up to 30 cwt

12 years — vehicles with coach built bodywork

The problem with all such guidelines is that no allowance is made for individual vehicle usage, care of operation or the differences between vehicles of the same age and mileage. Even if the Transport Engineer is required to make a final judgement as to the time for a vehicle replacement, based on its condition, he is presented with responsibility without a reference framework in which to take a meaningful decision.

The considerations above therefore raise the following questions:-

2.1 Is there a basis for replacement policy?

2.2 Is it reasonable to replace a Mini car and a Mercedes Benz bus at the same age or mileage?

2.3 Is there a case for purchasing a quality vehicle or should the cheapest of a particular type be purchased?

2.4 Is it reasonable to replace all vehicles of the same type at the same age or mileage, when some are clearly in better condition than others?

This paper sets out to provide a simple working method by which each vehicle can be separately assessed for its optimum replacement time.

3. Solution

The reason for replacing a vehicle is one of economy; as future upkeep costs are expected to rise, there is an optimum time when it is cheaper, in the long run, to replace the vehicle than to keep it. This is called the Economic Life of the vehicle. The Economic Life occurs when the average annual cost of ownership and upkeep of the vehicle is at a minimum.

In a statement of vehicle operating costs only two items are time dependent, depreciation and maintenance. By investigating these two variables we can arrive at the time when their sum is a minimum — which is the optimum replacement time, i.e. other constant vehicle operating costs do not enter the replacement decision.

$$\text{average cost of ownership and upkeep} = \frac{\text{replacement cost}}{\text{(vehicle age)}} + \frac{\text{total vehicle maintenance costs to date}}{\text{(vehicle age)}}$$

This deceptively simple equation generates useful solutions for the Economic Life evaluation when certain assumptions are made:

3.1 That the need for this type of vehicle will continue indefinitely

3.2 That the replacement vehicle will be of the same or similar type and will be used in a similar way to the original vehicle.

3.3 That accumulative costs have been corrected for inflation

3.4 That the second hand market follows a 'Regular'* pattern

3.5 That the unpkeep costs/mile travelled tend to increase linearly, in real terms, as the vehicle ages.

**Note* A 'Regular' market is one where the seller and the buyer both agree the same value to the item for sale so that when a vehicle has reached its Economic Life and it has no further operating value in the Transport Fleet, then that is the share view of the buyer, as well. Thus at the Economic Life the resale value of the vehicle has a residual value only. Economists recommend 10% of the cost, as residual value — unless some better value has been found from market experience.

Symbols used:

- Kn = average annual cost of replacement and upkeep of vehicle up to year n
- C = cost of new vehicle, less residual scrap value
- Sn = re-sale value of the vehicle in year n, less residual scrap value
- n = age, in years
- N = Economic Life
- a = rate of increase in maintenance costs/year — £/year² = $\frac{pxm}{100}$
- p = rate of increase in maintenance cost/mile — pence/mile/year
- m = average miles/year

$$Kn = \frac{C - Sn}{n} + \frac{1}{n}\sum_{n=o}^{n=n}(0 + a + 2a + \quad + na)$$

Sn the re-sale value[3], less the residual value, can be modelled as a function of the remaining useful life (N-n). A realistic function is:

Thus, $Kn = C\left(\frac{N-n}{N}\right)^2$

Thus, $Kn = \frac{C}{n} - \frac{C}{n}\left(\frac{N-n}{N}\right)^2 + \frac{1}{n}\frac{(na-o)n}{2}$

$$Kn = \frac{C}{n} - \frac{C}{n}\left(\frac{N-n}{N}\right)^2 + \frac{na}{2} \qquad \text{———— 1.}$$

A minimum average cost of replacement and maintenance is given at:-

$dKn = o$ when $n = N$, by definition

$$\frac{dKn}{dn} = -\frac{C}{n^2} - \frac{d}{dn}\frac{C}{n}\left(\frac{N-n}{N}\right)^2 - \frac{C}{n}\frac{d}{dn}\left(\frac{N-n}{N}\right)^2 + \frac{a}{2}$$

$$\frac{dKn}{dn} = -\frac{C}{n^2} + \frac{C}{n^2}\left(\frac{N-n}{N}\right)^2 - \frac{C}{n}\left(\frac{2n}{N^2} - \frac{2}{N}\right) + \frac{a}{2}$$

at $\frac{dKn}{dn} = o$ and $n = N$

$$o = -\frac{C}{N^2} + \frac{C}{N^2}\left(\frac{N-N}{N}\right)^2 - \frac{C}{N}\left(\frac{2N}{N^2} - \frac{2}{N}\right) + \frac{a}{2}$$

$$o = -\frac{C}{N^2} + \frac{a}{2}$$

$$N = \sqrt{\frac{2C}{a}} \qquad \text{———— 2.}$$

at $n = N$, equation 1 becomes:-

$$Kn = \frac{C}{N} - \frac{C}{N}\left(\frac{N-N}{N}\right)^2 + \frac{Na}{2}$$

$$K_N = \frac{C}{N} + \frac{Na}{2} \qquad \text{———— 1.1}$$

Equation 2 can be rewritten:

$$N^2 = \frac{2C}{a}$$

$$\text{or } \frac{a}{2} = \frac{C}{N^2}$$

Substitute in equation 1.1

Thus at Economic life N:-

$$K_N = \frac{C}{N} + \frac{NC}{N^2} = \frac{C}{N} + \frac{C}{N} = \frac{2C}{N} \qquad \text{———— 3.}$$

Thus at Economic Life N the sum of all maintenance costs to this time (corrected for inflation) equals the replacement cost C.

We can usefully re-write Equation 2. as:

$$N = \sqrt{\frac{2C}{pm}} \qquad \text{———— 4.}$$

where $a = p \times m$

(annual rise in maintenance costs p pence/mile x average mileage m)

Substitute equation 4 in equation 3.

$$K_N = \sqrt{2Cpm} \qquad \text{———— 5.}$$

4. Exploration of these Equations

Equations 3, 4 and 5 provide us with a new approach to the vehicle replacement decision.

Equation 5. $K_N = \sqrt{2Cpm}$

Equation 4. $N = \sqrt{\frac{2C}{pm}}$

Equation 3. $K_N = \frac{2C}{N}$

4.1 EQUATION 5

The minimum average cost of ownership $K_N = \sqrt{2Cmp}$

This equation clarifies the purchasing decision. Where there is a choice between several vehicles all meeting the Operating Specification — then the products C x p can decide the issue.

C x p = Purchase Cost x rate of increase in maintenance costs and this needs to be a minimum value.

High initial purchase cost can be acceptable if the anticipated value of the rates of increase in maintenance costs is suffiently low so that the product C x p is less than other vehicle choices. On the other hand a cheaper vehicle could tolerate a higher value of p but we shall note later on that the additional downtime associated with high values of p would be a factor against such a choice.

Transport Managers and Supplies Officers can legimately purchase vehicles, other than the cheapest, as long as the selected vehicle has the lowest C x p value. The purchasing decision will require a value of p and will therefore involve a Transport Engineering input. The Transport Engineer must supply a value for p for each of the vehicles under consideration.

Where vehicles have been operated before there should be no difficulty in securing a value for p. However, when new vehicles are under consideration then considerable research will need to be undertaken involving, supplier, manufacturer, fleet operators using that type of vehicle and careful assessment of the life expectancy of each major vehicle section and component of the vehicle.

The Committee investigating the specification of Sitting Case Ambulances has approved 12 vehicles as being suitable for the task. I suggest that the application of the (C x p) test is the method by which the number could be reduced to a more manageable selection.

4.2 EQUATION 4

The Economic Life $N = \sqrt{\frac{2C}{pm}}$

This equation shows us that:

(a) The greater the cost of a vehicle, C, the greater its expected life.

(b) Low vehicle mileage, m, leads to a longer life expectation.

(c) A large rate of increase in maintenance costs, p, gives rise to short Economic Life while low rates of increase gives rise to greater Economic Life.

Two charts of Economic Life with variable miles per year travel and pence/mile/year increasing maintenance costs are set out. In both charts the scales selected and values chosen are relevant to Ambulance Service. In the first chart on page 10 the value of C has been taken as £16,000 — typically the cost of an Ambulance, while in the second chart on page 11 the value of C has been taken as £12,000 — typical of parcel van type Sitting Case vehicles.

Of particular interest is the small number of circumstances where the present replacement recommendation coincides with those resulting from this paper and it is well known that the use of vehicles differ greatly between Ambulance Services. Within the selected scales Economic Lives vary from 12.6 years to 5.8 years.

This paper makes the case for an individual vehicle replacement decision but of course fleet planning is all important. To this end it is convenient to introduce the concept of the average fleet performance as the performance of a fleet of identical vehicles operating at that performance.

The charts link the rate of increase in maintenance costs with the fleet average maintenance cost assuming an equal distribution of vehicle ages in the sample so that the fleet average costs in pence/mile p/m is assumed to be the mid life cost; that is the cost after 3½ years of life — in the present replacement system. The fleet's average annual vehicle mileage is taken as the annual mileage of the fleet of average vehicles.

4.3 EQUATION 3

The minimum average cost of ownership and upkeep at the economic life,

$$K_N = \frac{2C.}{N}$$

but more important, at this time the cost of replacement equals the sum of all maintenance costs (corrected for inflation): so that we can simply identify the Economic Life as the time when the sum of maintenance costs equals the cost of replacement.

A continuous summation of maintenance costs gives the Transport Engineer a simple replacement guide directed by economics and independent of mileage travelled or age of the vehicle in years. Each vehicle presents itself with a proper measure of the time for its disposal.

It should be noted the new WIMS (Works Information Management System) Vehicle Maintenance and Scheduling Programme has the facility to sum all maintenance costs (corrected for inflation) to date. This package is under test by the Northern Regional Health Authority at the present time.

In the chart on page 17 the Accumulative Maintenance Costs are plotted from annual rising maintenance costs, a = p x m, against life years n.

From this simple chart the Transport Engineer can plan the replacement decisions for his fleet of vehicles, vehicle by vehicle. When the sum of all the maintenance costs, over the life of the vehicle, (corrected for inflation) equal the cost of the vehicle then the Economic Life has been achieved and replacement should take place.

Where vehicles are close to the replacement point then all maintenance decisions must be made in reference to the effect on the accumulated cost. Should substantial repairs become necessary and their cost of rectification cause the summation of maintenance cost to reach or exceed the purchase price of a replacement vehicle then that maintenance should be abandoned and the vehicle replaced.

The chart on page 17 or one like it is the 'ready reckoner' the Transport Engineer will use in his monitoring of vehicle maintenance cost performance and from which to decide the optimum time for replacement of a single vehicle. The charts on page 16 are to be used as fleet planning instruments; however, the information

Operation	Fleet maintenance costs	p
Urban Ambulance maintenance costs	13.0 p/m	3.7p/m/year
Mixed operation maintenance costs	10.0 p/m	2.9p/m/year
Rural Ambulance maintenance costs	7.0 p/m	2.0p/m/year

Ambulance replacement policy
Economic life — years — where replacement cost C = £16,000
Economic life $N = \sqrt{\frac{2C}{pm}}$ years

p Maintenance Costs Pence/Mile Increase Per Year	10,000	12,000	14,000	16,000	18,000	20,000	22,000	24,000	Fleet Average Maintenance Costs
4.0	8.9	8.2	7.6	7.1	6.7	6.3	6.0	5.8	
3.8	9.2	8.4	7.8	7.3	6.8	6.5	6.2	5.9	
3.6	9.4	8.6	8.0	7.5	7.0	6.7	6.4	6.1	Fleet Average 13.0 p/m
3.4	9.7	8.9	8.2	7.7	7.2	6.9	6.5	6.3	
3.2	10.0	9.1	8.5	7.9	7.5	7.1	6.7	6.5	
3.0	10.3	9.4	8.7	8.2	7.7	7.3	7.0	6.7	
2.8	10.7	9.8	9.0	8.5	8.0	7.6	7.2	6.9	Fleet Average 10.0 p/m
2.6	11.1	10.1	9.4	8.8	8.3	7.8	7.5	7.2	
2.4	11.5	10.5	9.8	9.1	8.6	8.2	7.8	7.5	
2.2	12.1	11.0	10.4	9.5	9.0	8.5	8.1	7.8	
2.0	12.6	11.5	10.7	10.0	9.4	8.9	8.5	8.2	Fleet Average 7.0 p/m
	10,000	12,000	14,000	16,000	18,000	20,000	22,000	24,000	Miles Per Year ,m

Sitting case vehicles replacement policy
Economic life where replacement cost C = £12,000
Economic life $N = \sqrt{\frac{2C}{pm}}$ years

p Maintenance Costs Pence/Mile Increase Per Year	10,000	12,000	14,000	16,000	18,000	20,000	22,000	24,000
4.0	7.7	7.1	6.6	6.1	5.8	5.5	5.2	5.0
3.8	8.0	7.3	6.8	6.3	5.9	5.6	5.4	5.1
3.6	8.1	7.4	6.9	6.5	6.1	5.8	5.5	5.3
3.4	8.4	7.7	7.1	6.7	6.2	6.0	5.6	5.4
3.2	8.7	7.9	7.4	6.8	6.5	6.1	5.8	5.6
3.0	8.9	8.1	7.5	7.1	6.7	6.3	6.1	5.8
2.8	9.3	8.5	7.8	7.4	6.9	6.6	6.2	6.0
2.6	9.6	8.7	8.1	7.6	7.2	6.8	6.5	6.2
2.4	10.0	9.1	8.5	7.9	7.4	7.1	6.8	6.5
2.2	10.5	9.5	9.0	8.2	7.8	7.4	7.0	6.8
2.0	10.9	10.0	9.3	8.7	8.1	7.7	7.4	7.1
Miles Per Year	10,000	12,000	14,000	16,000	18,000	20,000	22,000	24,000

Accumulative Cost Chart

$$\text{Accumulative Maintenance Costs} = \sum_{n=o}^{n=n} (0 + a + 2a + \dots + na)$$

$$= x\, n \,\frac{(0 + na)}{2} = \frac{n^2 \times a}{2}$$

n Life Years										
13	8,400	16,800	25,200	33,600	42,000	50,400	58,800	67,200	75,600	84,000
12	7,200	14,400	21,600	28,800	36,000	13,200	50,400	57,600	64,800	72,000
11	6,050	12,100	18,150	24,200	30,250	36,300	42,350	48,400	54,450	60,500
10	5,000	10,000	15,000	20,000	25,000	30,000	35,000	40,000	45,000	50,000
9	4,050	8,100	12,150	16,200	20,250	24,300	28,350	32,400	36,450	40,500
8	3,200	6,400	9,600	12,800	16,000	19,200	22,400	25,600	28,800	32,000
7	2,450	4,900	7,350	9,800	11,250	14,700	17,150	19,600	22,050	24,500
6	1,800	3,600	5,400	7,200	9,000	10,800	12,600	14,400	16,200	18,000
5	1,250	2,500	3,750	5,000	6,250	7,500	8,750	10,000	11,250	12,500
4	800	1,600	2,400	3,200	4,000	4,800	5,600	6,400	7,200	8,000
3	450	900	1,350	1,800	2,250	2,700	3,450	3,600	4,000	4,500
2	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
1	50	100	150	200	350	300	350	400	450	500
a£/Yr	£100	£200	£300	£400	£500	£600	£700	£800	£900	£1,000

on them all stems from the same fundamental source and the techniques are interchangeable.

Two small groups of Ambulances and Sitting Case Vehicles were examined to illustrate the points made so far[4].

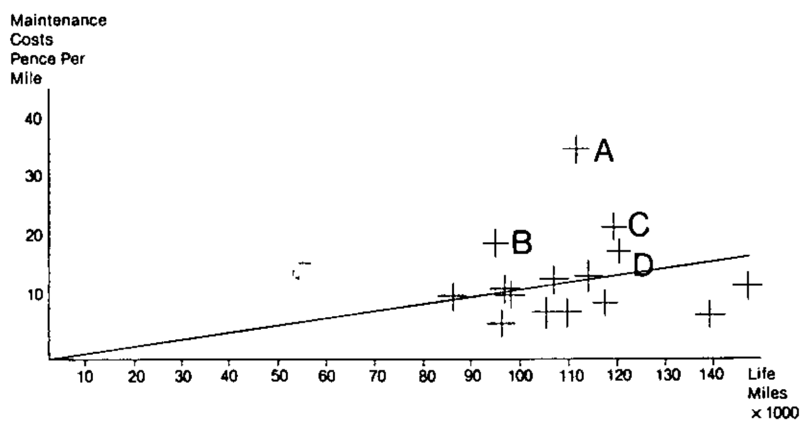
In reference 4 a example of 15 Bedford Ambulances give scattered results but a best fit fleet rising maintenance cost curve p = 1.86 pence/mile/year was obtained. The scatter demonstrates the variability of vehicles and tends to confirm the need to replace vehicles on an individual basis rather than a fleet basis. The p value of 1.86 pence/mile/year is extremely good.

The Economic Life for the group was calculated at 9.63 years or 178,819 miles of travel. The four vehicles A, B, C and D are well above the group line and need investigation from both a mechanical and economic point of view. (See Page 15).

A group of 13 Sitting Case vehicles showed a lesser scatter: although vehicle A needs to be examined. The best fit cost curve P = 5.9 pence/mile/year is very high and leads to a group Economic Life of only 5.7 years and 72,219 miles of travel. (See Page 18).

Bedford Ambulances

Vehicle No.	Mileage to Date	pence/mile — last year maintenance costs	Purchase Date
211	87,174	9.53	1976
212	117,821	8.45	76
213	96,413	18.29	76
214	105,674	7.62	76
215	111,325	35.27	76
216	107,574	11.87	76
217	96,628	10.31	76
218	120,036	17.86	76
219	97,626	5.28	76
220	139,511	7.35	76
221	114,550	12.08	76
222	149,088	10.26	76
223	119,807	20.67	76
224	110,308	7.22	76
225	97,732	9.57	76
Average Annual Mileage m	18,569		



(p = average slope x average mileage per year)

$$P = \frac{11\ p/m}{110{,}000\ \text{miles}} \times 18{,}659 = 1.86 \text{ pence/mile/year}$$

$$N = \sqrt{\frac{2C}{p \times m}} = \sqrt{\frac{32{,}000 \times 100}{1.86 \times 18{,}569}} = 9.63 \text{ years}$$

5. Downtime and Reliability

At this stage the question of increasing downtime and reduced reliability of vehicles needs to be explored for its effect on the replacement decision.

As vehicles age there is a need for increased repair and these repairs take time for completion. This time represents a loss of availability to the Operating Department who will require to use spare vehicles or possibly hired vehicles to maintain service.

The spare vehicles or hired vehicles have an hourly cost and the technique explored here is to evaluate that cost and add it back to the rising maintenance cost curve as a cost correction to the repair downtime. The practical application is considered later in this section.

Transport fleets operate, or hire, spare vehicles to meet the following needs;

Use of Spare Vehicles	Department
1. Spares for Operation Variation	Operation
2. Spares for Routine Servicing	Fleet Maintenance
3. Spares for MOT Testing	Fleet Maintenance
4. Spares for Accident Repairs	Fleet Maintenance
5. Spares for Repairs	Fleet Maintenance

The requirements for spare vehicles 1, 2, 3 and 4 arise whatever the age of the vehicles in the fleet: it is only Item 5 — Repairs, that generates a need for spare vehicles which is related to the reduced availability of the ageing fleet: that part of fleet downtime can be said to have a bearing on the replacement decision.

We must therefore calculate the cost of ownership of the spare vehicles per hour and charge this back to vehicle repairs in a manner proportional to the time taken to carry out the repairs.

The minimum cost of ownership of a spare vehicle is the depreciation cost $\frac{C}{N}$ when N is the economic life. Spare vehicles are required in the critical operating hours when workshops are working to carry out the repairs and therefore the recovery of the cost of ownership of the spare vehicles must take place in this time.

52 weeks @ 39 hours/week = 2028 hours/year

Consider one particular situation taken from the Economic Life Chart for an Ambulance (see page 16):

m = 18,000 miles/year
p = 3.6 p/m/year
N = 7.0 years
C = £16,000

Then $\frac{C}{N} = \frac{£16,000}{7\ Yr} = £2,285/year$

— the average depreciation

Perfect recovery of the spare vehicles would result in an hourly charge of:

$\frac{£2,285}{2,028\ hours} = £1.13/hour$

In the 7th year of the life of the vehicle detailed above maintenance costs are expected to be £4,536.

Typically labour cost/maintenance cost ratio will be 55%/45%; thus time spent on maintenance (£8.50/hr labour rate) is 294 hours.

Within this total is servicing, MOT and accident repair, labour time.

Servicing labour time (for 18,000 miles) is:	40 hours/year
MOT labour time	1 hour/year
Accident labour time	7 hours/year
	48 hours/year

Thus the time spent on repairs is therefore:	294
	−48
	246 hours

The charge for use of the substitute spare vehicle is therefore —

246 hours x £1.13 = £278/year

This cost expressed as a percentage adjustment to the expected repair cost of £4,536 is only 6.1%.

In the maintenance model we have used, the value of p should be increased by 6.1%, to reflect the increasing use of spare vehicles as vehicles age.

The effect on the economic life is:

$$N = \sqrt{\frac{2C}{m\ (p \times 1.061)}} = 97\% \sqrt{\frac{2C}{mp}}$$

Thus this allowance for downtime generates downward adjustement of only 3% to the calculated economic life.

However, we have assumed:

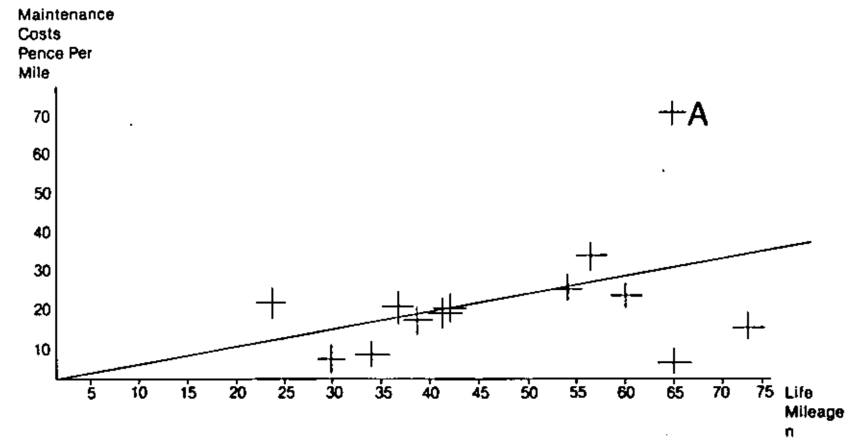
5.1 Perfect 'recovery' of spare vehicles.

5.2 Repairs are completed in the time charged to carry out the repairs.

5.3 Vehicle failures occur at the workshop or in a manner that prevents downtime over and above the workshop time.

Sitting Case Ambulances

Vehicle No.	Mileage to Date	p/m last year for maintenance	Purchase Date
165	65,722	5.53	1977
166	65,915	70.42	1977
167	56,514	34.54	1977
168	60,004	23.77	1977
169	54,641	26.35	1977
170	73,741	14.42	1977
174	38,584	17.50	1979
175	42,336	19.81	1979
176	37,593	20.82	1979
177	43,626	22.52	1979
178	42,174	19.73	1979
179	30,843	6.71	1979
180	34,476	7.09	1979
Average Annual Mileage m	12,670		



$$p = \frac{35\ p/m}{75,000\ miles} \times 12,670 = 5.9\ pence/mile/year$$

$$N = \sqrt{\frac{2C}{p \times m}} = \sqrt{\frac{2 \times 12,000 \times 100}{5.9 \times 12,670}} = 5.7\ years$$

In practice:

	Effect on Basic Downtime
5.1.1 Spare vehicle may be used 80% of the time available	x 1¼
5.2.1 Total time spent in the workshop may be considerably greater than the time required to repair the fault	x 4
5.3.1 Many faults can be detected by thorough inspection at the Routine Service but there will be some road breakdowns that will cause an inflated downtime.	x 2

Under these combined conditions, the downtime is 10 times greater than the theoretical minimum calculated above:-

$$N = \sqrt{\frac{2C}{mp\ (1.61)}} = 79\% \sqrt{\frac{2C}{mp}}$$

ie Downtime may reduce the Economic Life by 21%.

5.4 However, before there should be any reduction of life of vehicles due to maintenance downtime it must be established that:

5.4.1 The operating fleet is fully utilised.

5.4.2 Vehicles of different ages are fully utilised to the full extent of their availabilty.

Analysis of the utlisation of one fleet of Ambulances showed that there was a considerable imbalance in the utilisation of new vehicles and older vehicles. Some of the difference in utilisation is explained by the reduced availability of older vehicles: but only in part. Nearly 40% of the older vehicles travelled less than 5,000 miles per year while none of the newer vehicles travelled less than 5,000 miles a year. (See Page 19).

Clearly there is a gross under-utilisation of the fleet and it may be salutary for all fleet managers to analyse the distribution of fleet usage — certainly before any adjustment to the Economic Life is made on the grounds of downtime.

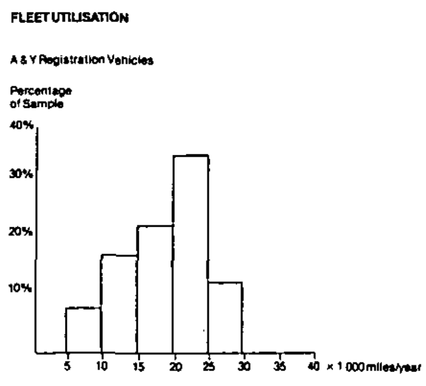
5.4.3 Maintenance systems have been developed to ensure a minimum workshop turnround time.

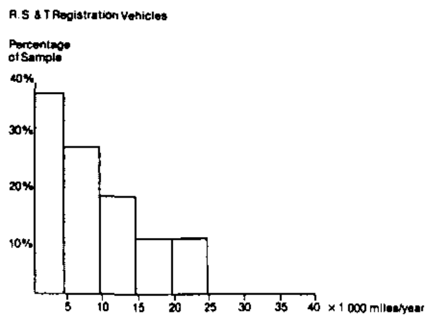
The parameter:

$$\frac{\text{Hours spent repairing vehicle}}{\text{Vehicle total time spent in workshop}}$$

should be closely monitored for all repairs.

5.5 Maintenance systems that call for detailed inspection of vehicles at Servicing, have been adopted in order that faults can be found at the most convenient time and rectified with the minimum effect on downtime.





5.6 Maintenance systems incorporating more frequent inspections as vehicles age, have been adopted — in order to minimise breakdowns or failures in service.

It should be noted that spare vehicle hire has been charged to the vehicle for repairs carried out in the peak operating day time period. If repairs can be carried out 'out of hours', then no downtime charge should accrue to the vehicle — because fewer spare vehicles will be required.

6. Conclusions

6.1 A vehicle replacement policy is now available that reflects the cost, usage of and care given to vehicles. The Economic Life occurs at the time in the vehicle's life when the average cost of ownership and maintenance is a minimum. This time is different for each vehicle in a fleet.

6.2 The Economic Life occurs when the sum of all the maintenance costs equals the replacement costs.

6.3 The increasing downtime associated with the ageing vehicle can have an affect on reducing the Economic Life. Too little effort is made to reduce downtime to as low a figure as possible and measurement of downtime should be undertaken in each fleet of vehicles so that a precise adjustment to Economic Life can be made.

Fleet utilisation needs further examination and Transport Managers need to ensure that older vehicles — while still within their Economic Life — should be used to their full availability before any adjustments are made to the Economic Life calculation.

6.4 The replacement policy proposed here yields significantly different recommendations to those currently in operation; considerable Capital and Revenue cost reductions can therefore be anticipated by its adoption.

7. Recommendations

7.1 Fleet Economic Life should be evaluated by reference to the type of charts illustrated on page 16.

7.2 The replacement time for individual vehicles should be established by the summation of maintenance cost method on page 17. The new WIMS vehicle maintenance system is programmed to do this.

7.3 Downtime due to repair of vehicles should be monitored by Transport Engineers so that the downtime measurement can be applied to the Economic Life calculation.

7.4 Utilisation of vehicles should be analysed and fleets and spare vehicles reduced to more nearly match the full utilisation requirement.

7.5 The concept of the predictable rising cost curve p should recommend itself as a method of precise maintenance budgetting reflecting the age make up of fleets from year to year and their annual mileage expectation.

7.6 Transport Engineers and other Engineers with responsibility for vehicle maintenance, selection and replacement should pursue these replacement policies further.

7.7 The Ambulance Specification Group currently reviewing future Ambulance and Sitting Case design should review these recommendations and incorporate relevant parts into their deliberations. In particular the product of C and p should be used to aid the vehicle selection process.

8. References

8.1 The Financial Aspect of Fleet

Operation by Professor W L Gage, BEng., CEng., MIMechE., AMBIM, MIRTE.
8.2 **'A Study on the Management of Transport Services'**, Management Advisory Services Report, Oxford Health Region, April 1983.
8.3 **'Advances in Vehicle Replacement'**, by Garwyn Phillips of ADVISA Research and Consultancy Services.
8.4 Cleveland Health Authority, Ambulance Division, EMIS Vehicle Usage Report, 8th January 1982.

British Standards Institution

BS 6503 **Specification for handheld blowpipes, mixers and nozzles, using fuel gas oxygen, for gas welding, cutting and related processes** is one of a series of standards applying to gas welding equipment. It specifies materials, construction and performance testing requirements for handheld blowpies used with oxygen and fuel gas for gas welding, cutting and related processes.

BS 6503 does not apply to blowpipes intended for metal scarfing, deseaming, metal spraying or processes involving the entrainment, by the oxyfuel gas stream, of metal powders or powder fluxes. Nor does it apply where air is used in the compressed state or by entrainment as the primary oxidising gas.

Copies of BS 6503 may be obtained from the Sales Department, British Standards Institution, Linford Wood, Milton Keynes MK14 6LE. Price: £16.20.

A revision of British Standard 3683 **Glossary of terms used in non-destructive testing** Part 3 **Radiological flaw detection** gives an update of existing terms and introduces new ones used in the application of radiological flaw detection techniques.

Copies of BS 3683: Part 3 may be obtained from the Sales Department, British Standards Institution, Linford Wood, Milton Keynes MK14 6LE. Price: £16.20.

A revision of PD 6500 **Explanatory supplement of BS 5655 'Lifts and service lifts' Part 1 'Safety rules for the construction and installation of electric lifts' (EN 81: Part 1)** has been prepared by the British Standards Institution to assist users in their understanding and implementation of BS 5655: Part 1. It supersedes the 1981 edition which is now withdrawn.

Those involved in installation of electric lifts will thereby gain an improved appreciation of the basic European standard EN 81: Part 1.

Copies of PD 6500 may be obtained from the Sales Department, British Standards Institution, Linford Wood, Milton Keynes MK14 6LE. Price: £16.20.

Product News

Microprocessor Fire Control System

The heart of the system is the microprocessor control which provides, as standard, full on-site engineering capability for commissioning and maintenance whilst giving the system user all necessary information in a clear and unambiguous way.

At the Central Control a keyboard and LED segment displays are used for commissioning and maintenance functions and provide the following facilities:- 1. Ability to isolate sensor zones. 2. Ability to isolate sounder zones. 3. Ability to automatically test zones with an auto reset facility to enable testing to be carried oiut by one person. 4. In the test mode facilities are provided to differentiate, if required, between a resistance across the line and short circuit.

Further details from: Photain Controls Limited, Unit 18, Hangar 3, The Aerodrome, Ford, Arundel, Sussex BN18 0BE. Tel: (0903) 721531. Telex 87325.

UPS systems combat power supply disruption threat

The enormous proliferation of mini and microcomputers in industry and commerce has raised awareness of the problems of power supply disturbances. In response Power International, has launched two new ranges of compact uninterruptible power supplies (UPS) to provide back-up power in the event of a mains failure caused by human or mechanical interference.

In the power range 125 to 1000VA, four models are available with nominal power ratings of 125, 250, 500 and 1000VA. All the models are for single phase supply and incorporate sealed lead acid cells which can provide up to 10 minutes back-up power.

Further details from: Power International Ltd, 2a Isambard Brunel Road, Portsmouth, Hampshire PO1 2DU. Tel: (0705) 756715.

Infra-red water supply unit

The Infra-red water faucet is a product of applied technology and marks a most significant advance in water supply systems.

The faucet is operated by a low voltage infra-red censor. Placing the hands (or any other object) in range of the censor, activates the flow of water.

Because the flow of water is automatic i.e. no buttons to push or knobs to turn, in fact without any physical contact with the unit, the benefit of its application to hospitals, catering establishments, or in any area where hygiene is important, is obvious.

The faucet provides both hot and cold water, the desired temperature is obtained by adjusting the temperature control, situated on the right hand side of the unit.

A hand operated valve is provided, on the right hand side of the unit, for use in the event of power failure.

In addition to the advantages already mentioned, the faucet is invaluable for disabled people, who find difficulty in operating conventional taps.

Further details from: Kitchener-Clarke, 4 Calverley Bride, Rodley, Leeds LS13 1NQ. Tel: (0532) 571309.

Air-cooled operating theatre lamp

Designed for orthopaedic surgery in Downward Flow Cleanzone Systems, it is aerodynamically styled to produce optimum airflow efficiency.

Turbulence is eliminated, ensuring the vital sterile air flow is neither interrupted or diverted from its pre-determined path which exludes all external airborne contaminants.

The lamps comply with all the latest relevant electrical and performance specifications, control panels and self-contained emergency power units are available if required.

Further details from: Brandon Medical, Leathley Road, Leeds LS10 1BJ. Tel: 0532 457311.

Portable call system

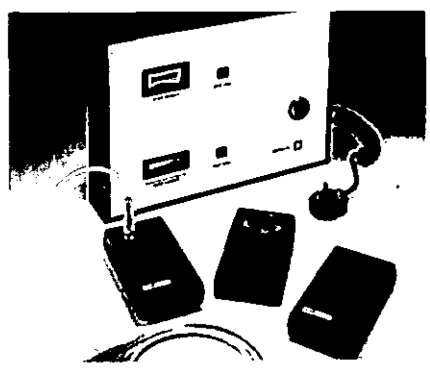
A radio paging system produced by Larkins Security Systems completely eliminates the need for hard wiring in hospitals.

The system is approved by the Department of Trade and Industry. It comprises a portable receiver unit powered from a 13 amp mains supply or internal batteries, and up to 128 hand-held transmitter units, each about the size of a personal stereo tape player.

Pressing a button on the transmitter sounds an alarm on the receiver unit, and the transmitter location appears on a digital display. A memory stacks calls and the alarm sounds until all have been checked through. The alarm can only be turned off at the transmitter.

The advantage of the system is its portability and adaptability. A duty nurse, for example, can go on rounds and carry either the master receiver unit or a mini-receiver, and still be able to receive emergency calls.

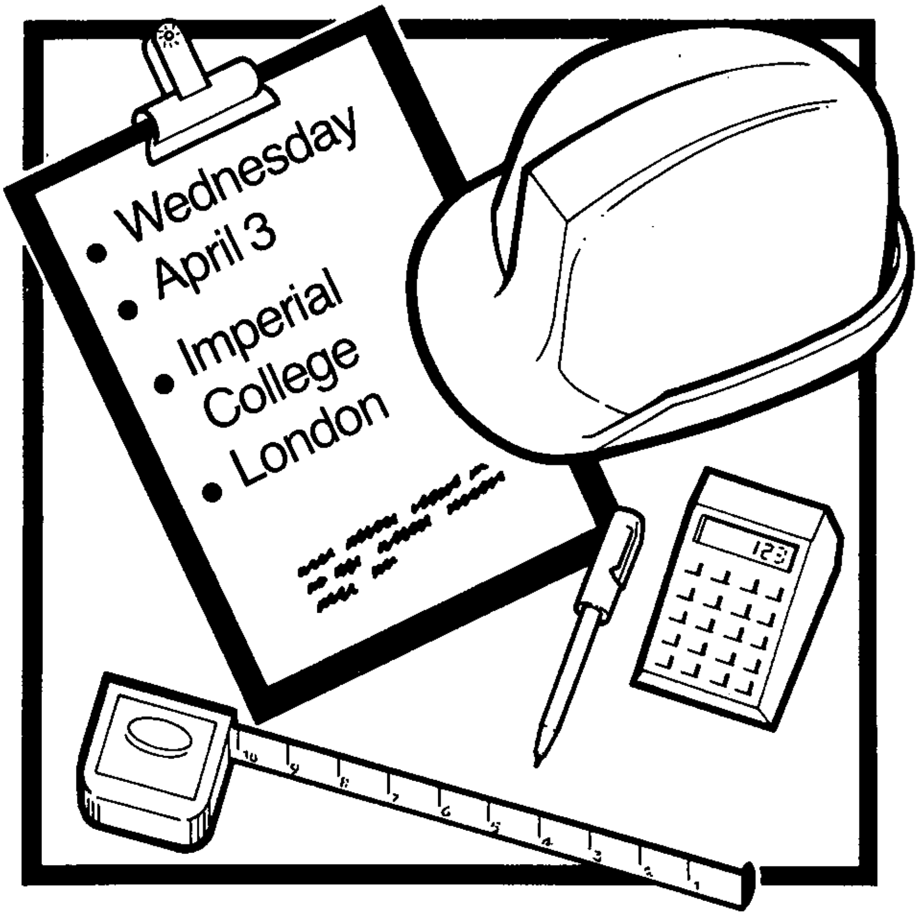
Further details from: Larkins Security Systems Limited, 303 Holdenhurst Road, Bournemouth BH8 8BX, England. Tel: (0202) 38156.



HEALTH & SOCIAL SERVICE JOURNAL

announces a one day conference

'THE WAY FORWARD FOR WORKS'



All works officers and health service managers are awaiting the imminent publication of major NHS reports on the works function.

Health & Social Service Journal is holding a one day conference to examine this central area of activity in the health service.

If you want more information about the conference complete the coupon and send it to:

Alison Blight, HSSJ,
4 Little Essex Street,
London WC2R 3LF.

Tel: 01-836 6633 ex 2430.

Name ______________________

Address ______________________

CLASSIFIED ADVERTISEMENTS

Appointments & Situations Vacant

To place your classified advertisement, please contact Michael Birch on (0793) 45311 or write to him at HOSPITAL ENGINEERING

INSTALLATION ENGINEER, TURNKEY HOSPITAL, SHARJAH, UNITED ARAB EMIRATES

We require, immediately an engineer to manage the installation of all the equipment for the new Sharjah General Hospital, currently being built by a local contractor. The appointee will be based on site for a period of 12 months and provided with all necessary tradesmen and labour to carry out the works.

The contract is a turnkey and everything necessary to provide a working hospital is being supplied. Experience with a broad range of medical equipment an advantage.

We are, however, flexible as to the type of person who would fill this challenging position, irrespective of age and experience, and welcome replies from all who are interested.

Reply A.S.A.P. to: **Manford Associates, Manford House, Church Road, Penn, Buckinghamshire HP10 8LP. telephone 0494 81 6161**

SUBSCRIPTION ORDER FORM

HOSPITAL ENGINEERING

(The journal of the Institute of Hospital Engineering is published ten times a year. In January and July, the Hospital Engineering Newsletter is circulated to Institute Members only).

Please enter my subscription to HOSPITAL ENGINEERING for one year at the following annual subscription rates:

☐ United Kingdom £28.50 ☐ Overseas £35.00 ☐ USA $55.00 ☐ Canada $67

(PLEASE TICK IN BOX AS APPROPRIATE)

My cheque, made out to HOSPITAL ENGINEERING, is enclosed for £............ / $............

Name (BLOCK CAPITALS PLEASE) ____________

Position ____________

Address ____________

____

____

Post Code ____________

Telephone ____________ Date ____________

Signature ____________

Please cut out this order form and post in an envelope to: Subscriptions Dept., HOSPITAL ENGINEERING, TGV Publications, 41 Earl Street, Maidstone, Kent ME14 1PF, England.

hi-tech CLEAN AIR

hi-tech FILTRATION

SALES & MARKETING

1. We are experts in the Air Filtration Industry. Designing, manufacturing and upgrading systems used in factories in the Pharmaceutical, Electronic and Hi-tech Industries. Hospitals, Universities, Public Authorities and many more have a requirement for our services.

2. We manufacture clean rooms, Laminar Flow Work Stations – design, install, service and certify the same.

3. We supply what is rapidly being accepted as the best quality full range of Air Filters available in the U.K. with emphasis on high efficiency and long life. With our own manufacturing facility deliveries are usually immediate.

Our Company has been established 3 years and has now embarked on an extensive expansion programme.

We require a Sales Person to work closely with the Directors in Marketing all three areas with really exciting and long term future prospects for the successful applicant.

Apply in writing please to:—
**P. G. Thompson,
Chairman,
Hi-tech Filtration Ltd.,
Heaton Street,
Standish,
Wigan.
WN6 0DA.**

CLASSIFIED ADVERTISEMENTS
Appointments & Situations Vacant

To place your classified advertisement, please contact Michael Birch on (0793) 45311 or write to him at HOSPITAL ENGINEERING IMR International 14 Bath Road Swindon Wilts SN1 4AA.

RATES: £11 per single column centimetre (minimum depth 3 cm) 4 columns per page. Lineage £3.25 per line (minimum 8 lines) Box number £5.

Unit Works Officer

BASILDON UNIT

Works Officer, Scale 5 – £12,357 - £14,702
(plus £149 per annum Outer London Weighting)

Applications for the above vacancy are invited from suitably qualified candidates of all Works disciplines.

The post is based at Basildon Hospital, a busy acute unit (497 beds) commissioned in 1973, from which works services are also provided to associated Community Units and Ambulance Service premises.

Responsibility is for the operation and maintenance of Building and Engineering services, together with the design and implementation of small works schemes.

Applicants must hold one of the following qualifications (or be an existing NHS Officer with exemption):

i) *Corporate Member of one of the Institutes of* Civil, Mechanical, Electronic & Radio Engineers or the Chartered Institute of Building Services:
ii) A Corporate Member of the Royal Institute of Chartered Surveyors:
iii) *A Registered Architect.*

Further information can be obtained from Mr. R. Pym District Works Officer. Tel: 0268-287611 Ext. 311.

Application form and job description can be obtained from The District Personnel Officer, Basildon Hospital. Tel: 287611 ext. 296.

(Closing date 8th March 1985)

Basildon & Thurrock Health Authority