

Sixty - Eighth
Annual Report
2005



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Tun Abdul Razak Research Centre

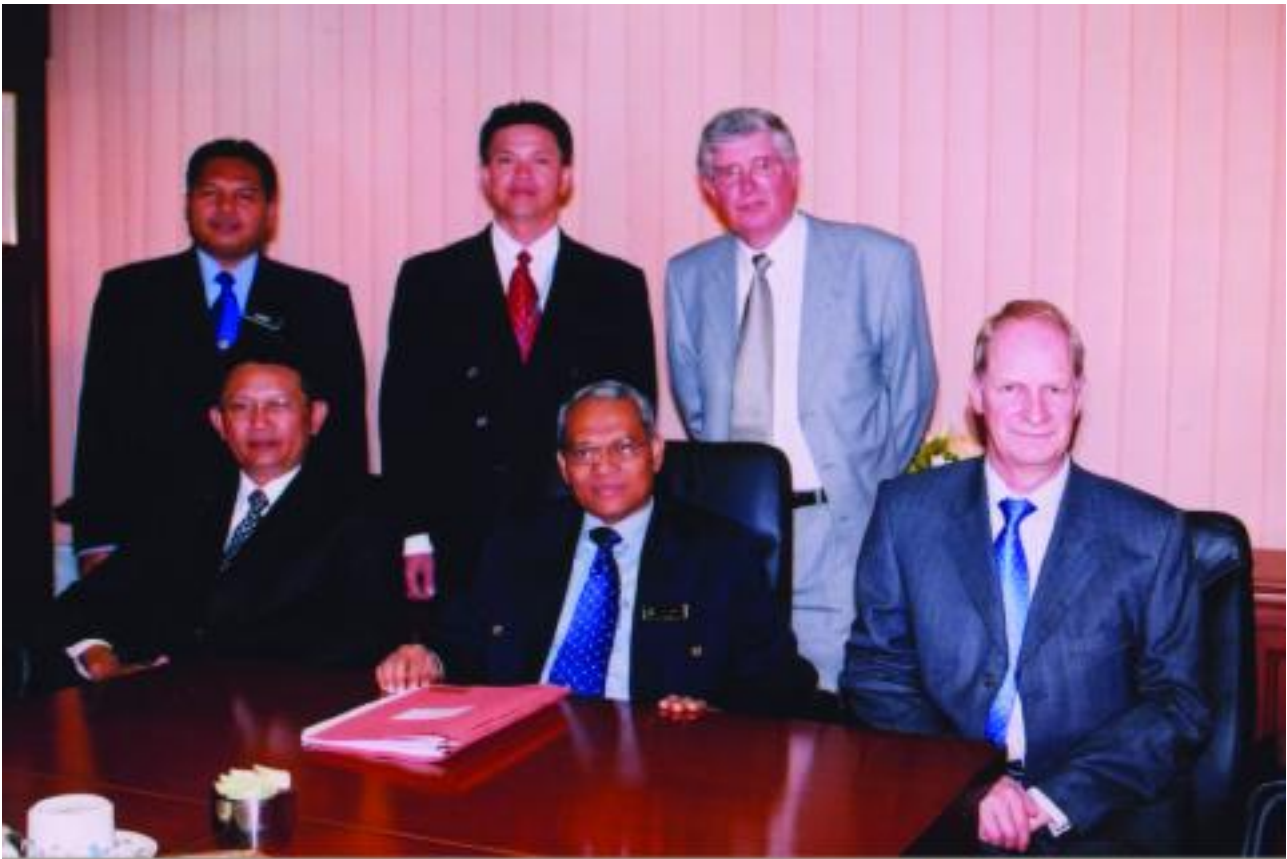
A research and promotion centre of the Malaysian Rubber Board

Company registration number: 336256

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The Board

Back row (from left to right):

*Mr Ak Nan a/l Eh Took, Mr Oon Kim Hung,
Dr Arthur Roger Williams*

Front row (from left to right):

Mr Salleh Subari, Datuk Abdul Hamid Sawal, Dr Andrew J. Tinker



Mr Mohd Jaaffar Ahmad



The Board

Chairman

*Datuk Abdul Hamid Sawal, PJN, DPMT, DSDK, KMN, SDK, BEcons (Hons) (Malaya), MBA (USA) (Retired 31.12.2005)
Director General of Malaysian Rubber Board, ex-officio*

*Dato' Dr Kamarul Baharain Basir, DPMP, JSM, BSc (Hons), PhD (Appointed 1.1.2006)
Director General of Malaysian Rubber Board, ex-officio*

Vice-Chairman

*Dr Sidek Dulngali, JSM, BSc (Hons), PhD (Retired 29.3.2005)
London Representative, Malaysian Rubber Board, ex-officio*

*Mr Salleh Subari, BSc (Hons), ANCRT (Appointed 29.3.2005)
London Representative, Malaysian Rubber Board, ex-officio*

Other Members

*Mr Oon Kim Hung, BSc (Hons)
Oon Corporation Resources (M) Sdn Bhd
Appointed by the Minister of Primary Industries, Malaysia*

*Dr Arthur Roger Williams, PhD, DSC (Appointed 1.1.2005)
Appointed by the Minister of Primary Industries, Malaysia*

*Mr Mohd Jaaffar Ahmad BSc, MBA (Appointed 1.1.2005)
Regional Manager, Malaysian Palm Oil Board*

*Mr Ak Nan a/I Eh Took (Alternate to Mr Mohd Jaaffar Ahmad, Appointed 1.1.2005)
Ministry of Plantation Industries & Commodities, Malaysia*

*Dr Andrew J. Tinker, JSM, PhD
Director of Research, ex-officio*

Deputy Company Secretary

Dr Elias bin Awang, PhD

Accounts Supervisor

Zaila Bakar, CAT

Registered Office and Laboratories

*Tun Abdul Razak Research Centre,
Brickendonbury, Hertford, SG13 8NL
United Kingdom*

Solicitors

Stephenson Harwood

Auditors

Wagstaffs Chartered Accountants

Bankers

*Bank Bumiputra Malaysia Berhad
Barclays Bank PLC*

(as at 31st December 2005)

Senior Staff

(as at 31st December 2005)

Industry Development & Promotion Division

Division Head

Salleh Subari BSc, ANCRT *

* Seconded from the MRB

Market Intelligence & Promotion Unit

Unit Head

K. Lawson MSc, MBA, MCLIP
Principal Scientist

Senior Scientist

R. Newell BSc
G.M. Reader BSc

Scientists

D. Cawthra BA
S.T. Mahyudin BA
N. Tyler BSc

Industrial Support Unit

Unit Head

B.W. Evans PhD
Principal Scientist

Senior Scientists

G.E. Bennett MPRI
M.S.D. Fernando PhD, DIC, MChemE

Scientist

G.T. Spiller BSc

Deputy Company Secretary

Elias Awang PhD

Administration

M.P. Harris
Assistant Company Secretary

Zaila Bakar CAT
Accounts Supervisor

D.M. Newton BSc
Computer Network Administrator

Site Services

S. Ballard
Site Manager

Quality Assurance Officer/ Health & Safety Officer

F.J. Winfield MSc
Principal Scientist

Rubber Consultants

I.R. Gelling KMN, PhD
Administrator

Director of Research

A.J. Tinker JSM, PhD

Engineering Products & Design Division

Division Head

K.N.G. Fuller PhD, MInstP
Senior Principal Scientist

Engineering Design Unit

Unit Head

A.H. Muhr PhD, CPhys, CEng, MIMMM
Principal Scientist

Principal Scientist

H.R. Ahmadi MSc

Higher Scientists

J. Gough PhD

J.G.R. Kingston PhD, GradIMMM

Scientist

J.K. Picken MSci

Product Evaluation & Testing Unit

Unit Head

P.S. Brown MA
Principal Scientist

Senior Scientist

C.D. Forge MSc

Materials Research & Development Division

Division Head

S. Cook PhD
Senior Principal Scientist

Consultant

I.R. Gelling KMN, PhD

Advanced Materials & Product Development Unit

Unit Head

A.V. Chapman PhD
Principal Scientist

Senior Scientists

T.R. Johnson DPhil, FRSC

I.J. Stephens FIMechIE

Higher Scientists

J. Patel BSc, CEng

T.J. Pond MSc

Scientist

D. J. Lowe BSc

Materials Characterisation Unit

Unit Head

I.S. Stephens BSc
Principal Scientist

Senior Scientists

R.C. Crafts MSc, CChem, MRSC

R.T. Davis PhD

P.C. Guban BSc

M.J. Perkins PhD (Deputy Unit Head)

Higher Scientists

P.E. Swinyard BSc, CChem, MRSC



Dato' Dr Kamarul Baharain Basir
Chairman, Tun Abdul Razak Research Centre

Chairman's Foreword

The global requirement for polymers continued to grow in 2005, with strong consumer demand especially from China's growing automotive market. While natural rubber prices continued to surge during the year, the synthetic alternatives have also become more expensive as a result of rising oil prices. This has brought about an increase in natural rubber's share in the global market for elastomers.

The higher costs of raw materials have made it necessary for manufacturers to adopt changes in their operations in order to remain competitive. Coupled with the strong ringgit, which was unpegged from the US Dollar in July 2005, it is even more important that manufacturers focus on producing high-tech, and high value-added products. In this context, TARRC's pioneering R&D work in rubber science and technology has been further strengthened and geared to specifically assist manufacturers to design, develop and manufacture these types of products.

Significant progress has been made in the application of Finite Element Analysis (FEA). The ability to model the dynamic behaviour of products enhances the design capability and the ability to predict the service life of products is also of importance to customers and designers. TARRC is currently able to provide this service to the industry.

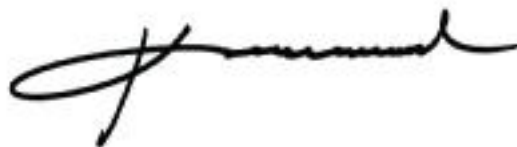
TARRC will continue to provide direct technical support to Malaysian manufacturers towards improving productivity and efficiency in their factories. It is encouraging to note that more and more companies are taking advantage of these backup services provided by the MRB system.

TARRC continued to play an important role in the promotion and marketing of business opportunities within the Malaysian rubber industry. In 2005, TARRC in collaboration with Malaysian Rubber Export Promotion Council (MREPC), organised a major marketing event: a Rubber Economic and Technical Mission to France, Italy and Germany led by the Malaysian Minister of Plantation Industries and Commodities, YB Datuk Peter Chin Fah Kui. This type of high profile event is a very effective way to promote the excellent investment opportunities available in the Malaysian rubber industry.

In the current climate of high raw material costs and demand for improved quality, customers are seeking improvements in raw materials. Speciality rubbers from Malaysia continue to be promoted worldwide and considerable interest was generated during 2005 from multinational companies. There are now several companies evaluating Deproteinised Natural Rubber (DPNR) and Epoxidised Natural Rubber (ENR), two of the speciality rubbers developed by the MRB, for use in their products. This technical promotion will continue in future years to develop new markets for these versatile raw materials.

The latex protein allergy issues in Europe continued to be closely monitored during the year. These issues have a bearing on Malaysia's export of gloves, catheters and thread, products which earned the country RM6.16 billion in 2005. It is important that distributors, purchasers and users of latex products are informed about safety, use and best practice. It is pleasing to note that the four glove seminars held, together with the MREPC, in London, Edinburgh, Paris and Milan in 2005 attracted a large audience that was made aware of how Malaysia's manufacturers have taken strong measures to produce excellent quality, low protein gloves.

I would like to thank TARRC's former Chairman Datuk Abdul Hamid Sawal, who has guided the Research Centre through the settling years of its major reorganisation of the scientific staff to its present structure. This enabled TARRC's research programme to expand and focus on the needs of the rubber products manufacturing sector. Market-oriented downstream R&D is now firmly the priority of TARRC's scientists, engineers and technologists, who continue to remain at the forefront of scientific excellence and push forward to develop new materials and products. It is pleasing to note that there has been much progress in several fields such as the development of the novel devices 'cushion isolators' for floor seismic isolation, and the investigation of rubber nanocomposite materials.



Dato' Dr Kamarul Baharain Basir

Report of the Board

The Board is pleased to submit this its sixty-eighth Annual Report and the Audited Accounts of the Research Centre for the year ended 31st December 2005.

The Board

Datuk Abdul Hamid Sawal retired as a Member and Chairman of the TARRC Board on 31st December 2005 after six years in office. Dato' Dr Kamarul Baharain Basir was appointed Director General of the Malaysian Rubber Board (MRB) by the Minister of Plantation Industries and Commodities, Malaysia on 1st January 2006 and became a Member and Chairman of the TARRC Board (ex-officio). Dr Sidek Dulngali as London Representative of the MRB, remained a Member and Vice-Chairman (ex-officio) until his resignation on 29th March 2005 after two and a half years. The Board was pleased to record its gratitude and appreciation for Datuk Hamid's and Dr Sidek's services rendered to the Research Centre. Mr Salleh Subari was appointed London Representative of the MRB and a Member and Vice-Chairman (ex-officio) of the Board on 29th March 2005. Dr Andrew Tinker, as Director of Research, remains a Member (ex-officio). Mr Oon Kim Hung was appointed to the Board by the Minister of Primary Industries on 1st January 2004, and remains a Member. Dr Arthur Roger Williams, Mr Mohd Jaaffar Ahmad and Mr Ak Nan a/l Eh Took (alternate member) were appointed to the Board by the Minister of Plantation Industries and Commodities on 1st January 2005.

The Board met three times during 2005 to transact business.

The Members of the Board as at 31st December 2005 are listed on page 3.

General Meeting

The sixty-eighth Annual General Meeting of TARRC was held on 30th August 2005.

Legal Status

The Tun Abdul Razak Research Centre (TARRC) is an organisation and research centre of the Malaysian Rubber Board (MRB), the body corporate established by statute in Malaysia for purposes of overseeing the development of the rubber industry with research and development as the core activity. Incorporated in England since 1938, TARRC is a Company Limited by Guarantee and not having a share capital, the word 'Limited' being omitted by Licence of the Department of Trade and Industry. TARRC by reason of the definition in Section 1(1) of the Companies Act 1980 and the bringing into force of Part 1 of that Act became a Private Company on 22nd December 1980.

Principal Activities

The principal activities of TARRC are scientific research into rubber, technological developments in the compounding, processing, and the improvement of tyre performance and service lifetime of rubber products as a whole. It also publishes and distributes scientific and technical literature on rubber for, in particular, the promotion of Malaysian rubber products and Malaysian rubber. Foreign Direct Investment (FDI) opportunities and manufacturing activities in the Malaysian rubber industry are also promoted and encouraged by participation in international meetings, seminars and exhibitions. TARRC activities are geared towards expanding markets for Malaysian rubber products.

The Board adopted the Report 'The Continuing Role of the Tun Abdul Razak Research Centre' following its submission to the Honourable Minister of Primary Industries, Malaysia, in 1999. The Report clearly sets out the core activities of TARRC as specialised R&D focusing particularly on its prevailing expertise in rubber in engineering applications and advanced materials, transfer of technology, commercialisation of R&D outcomes, promotion of products, training for personnel both from the Malaysian Rubber Board and the industry in Malaysia and consultancy services. Clear targets are set for income generation.

In keeping with this policy, the Board charged the Director and Staff to continue to enhance income through exploitation of TARRC's scientific resources and expertise and commercialisation of its R&D findings to increase its degree of self-financing. The Board was pleased that in 2005 TARRC was involved in three contracts, one financed by the European Union and two funded from the Waste & Resources Action Programme.

The Board was particularly pleased that Datuk Peter Chin, Hon. Minister of Plantation Industries and Commodities, was able to visit TARRC during the year.

TARRC plays an ever increasingly important role as Malaysia industrialises. Although technical support for Malaysian rubber continues, the Centre's much more important role now is to assist Malaysian rubber product manufacturers by factory visits, transfer of technology, enhancing their product development capabilities and compounding and processing know-how. TARRC answered 88 recorded technical enquiries in support of the Malaysian rubber industry, 49 of these coming from Malaysian companies seeking advice and assistance on compounding, product manufacture and specifications. TARRC has also continued to work closely with other Malaysian organisations, particularly the Malaysian Rubber Export Promotion Council, the Malaysian External Trade Development Corporation and the Malaysian Industrial Development Authority, to promote the Malaysian-manufactured rubber products and the rubber industry as a whole.

The Board was pleased with TARRC's involvement in the Economic and Technical Mission to France, Italy and Germany led by Datuk Peter Chin. The Board was encouraged by the favourable response from European delegates and Malaysian Mission members to the organisation of the activities comprising the Mission; details of this major event are described in the Director's Report on page 20.

The Board was also pleased with the progress made over the past year in many of the technical R&D projects run by TARRC to assist and support the Malaysian industry. Details of work performed and significant achievements over the year, including developments in the areas of engineering design and new materials, are reviewed in the Director's Report on pages 20-29.

The Board was pleased to note the considerable increase for the third year running in income and profitability achieved by Rubber Consultants.

Senior Staff as at 31st December 2005

During the year three appointments were made, three officers resigned and two retired. The total senior staff strength on 31st December 2005 was 40, including four employed on contract.

Supporting Staff as at 31st December 2005

During the year eight appointments were made, five members resigned, three retired and Ms Linda Whybrew, Administrative Assistant, died. Her death is recorded with deep regret. The total number of supporting staff on 31st December 2005 was 43, including three employed on contract.

The Board records its thanks to all employees for their work in 2005.

Publications

A list of the staff lectures and the scientific and technological papers published in 2005 follows the Report of the Director of Research on page 30.

Finance

The Income and Expenditure Account and the Balance Sheet as at 31st December 2005, together with Explanatory Notes and the Auditor's Report, are presented on pages 10 to 19. In the opinion of the Board, the current market value of TARRC's freehold properties is in excess of the net book value shown in the Balance Sheet.

Auditors

During the year, Wagstaffs Chartered Accountants were appointed auditors to the company and in accordance with Section 385 of the Companies Act 1985 a resolution proposing their reappointment will be put at the forthcoming Annual General Meeting.

**For and on behalf of the Board
Salleh Subari
21 July 2006**

Annual Financial Statements

for the year ended 31st December 2005

Directors' responsibilities

The directors are responsible for preparing the financial statements in accordance with applicable law and United Kingdom Generally Accepted Accounting Practice.

Company law requires the directors to prepare financial statements for each financial year which give a true and fair view of the state of the affairs of the company and of the profit or loss of the company for that year. In preparing these the directors are required to:

- select suitable accounting policies and apply them consistently;
- make judgements and estimates that are reasonable and prudent;
- prepare the financial statements on the going concern basis unless it is inappropriate to presume that the company will continue in business.

The directors are responsible for keeping proper accounting records which disclose with reasonable accuracy at any time the financial position of the company and to enable them to ensure that the financial statements comply with the Companies Act 1985. They are also responsible for safeguarding the assets of the company and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

The directors of a company must, in determining how amounts are presented within items in the profit and loss account and balance sheet, have regard to the substance of the reported transaction or arrangement, in accordance with generally accepted accounting principles and practice.

Independent auditors' report to the members of the Tun Abdul Razak Research Centre

We have audited the financial statements of Tun Abdul Razak Research Centre for the year ended 31st December 2005 which comprise the income and expenditure account, the balance sheet, the cash flow statement, the statement of total recognised gains and losses and the related notes. These financial statements have been prepared under the historical cost convention and the accounting policies set out therein.

This report is made solely to the company's shareholders, as a body, in accordance with Section 235 of the Companies Act 1985. Our audit work has been undertaken so that we might state to the company's shareholders those matters we are required to state to them in an auditors' report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to anyone other than the company and the company's shareholders as a body, for our audit work, for this report, or for the opinions we have formed.

Respective responsibilities of directors and auditors

As described in the statement of directors' responsibilities the company's directors are responsible for the preparation of the financial statements in accordance with applicable law and United Kingdom Accounting Standards (United Kingdom Generally Accepted Accounting Practice).

Our responsibility is to audit the financial statements in accordance with relevant legal and regulatory requirements and International Standards on Auditing (UK and Ireland).

We report to you our opinion as to whether the financial statements give a true and fair view and are properly prepared in accordance with the Companies Act 1985. We also report to you if, in our opinion, the directors' report is not consistent with the financial statements, if the company has not kept proper accounting records, if we have not received all the information and explanations we require for our audit, or if information specified by law regarding directors' remuneration and transactions with the company is not disclosed.

We read the directors' report and consider the implications for our report if we become aware of any apparent misstatements within it.

Basis of audit opinion

We conducted our audit in accordance with International Standards on Auditing (UK and Ireland) issued by the Auditing Practices Board. An audit includes examination, on a test basis, of evidence relevant to the amounts and disclosures in the financial statements. It also includes an assessment of the significant estimates and judgements made by the directors in the preparation of the financial statements, and of whether the accounting policies are appropriate to the company's circumstances, consistently applied and adequately disclosed.

We planned and performed our audit so as to obtain all the information and explanations which we considered necessary in order to provide us with sufficient evidence to give reasonable assurance that the financial statements are free from material misstatement, whether caused by fraud or other irregularity or error. In forming our opinion we also evaluated the overall adequacy of the presentation of information in the financial statements.

Opinion

In our opinion the financial statements give a true and fair view, in accordance with United Kingdom Generally Accepted Accounting Practice, of the state of the company's affairs as at 31 December 2005 and of its profit for the year then ended and have been properly prepared in accordance with the Companies Act 1985.

Wagstaffs
Chartered Accountants and Registered Auditors
Richmond House, Walkern Road, Stevenage, Hertfordshire, SG1 3QP

Income & Expenditure Account

for the year ended 31st December 2005

	Notes	2005 £	As restated 2004 £
Income	2	6,396,651	4,147,397
Cost of sales		(2,436,336)	(2,416,541)
Gross surplus		<u>3,960,315</u>	<u>1,730,856</u>
Distribution costs		(4,371)	(3,093)
Administrative expenses		(1,540,201)	(1,509,139)
Other operating income		98,265	84,255
Operating surplus	3	<u>2,514,008</u>	<u>302,879</u>
Other interest receivable and similar income	4	21,334	15,305
Interest payable and similar charges	5	(93,000)	(96,000)
Surplus on ordinary activities before taxation		<u>2,442,342</u>	<u>222,184</u>
Tax on profit on ordinary activities		-	-
Surplus on ordinary activities after taxation		<u>2,442,342</u>	<u>222,184</u>
Retained surplus for the year	12	<u>2,442,342</u>	<u>222,184</u>
Statement of total recognised gains and losses			
Surplus on ordinary activities after taxation		2,442,342	222,184
Actuarial loss in respect of defined benefit pension scheme		(1,628,000)	(75,000)
Total recognised gains relating to the year		814,342	147,184
Prior year adjustment - FRS 17		(2,215,000)	(2,376,000)
Total recognised gains/losses since last annual report		<u>(1,400,658)</u>	<u>(2,228,816)</u>

Balance Sheet

as at 31st December 2005

	Notes	2005		As restated 2004	
		£	£	£	£
Fixed Assets					
Tangible assets	8		1,458,375		1,550,512
Current assets					
Stocks	9	1,715		1,715	
Debtors	10				
falling due after more than one year		2,155,766		240,598	
falling due within one year		662,570		339,581	
Cash at bank and in hand		<u>1,712,389</u>		<u>1,468,899</u>	
		4,532,440		2,050,793	
Creditors: amounts falling due within one year	11	<u>(544,978)</u>		<u>(403,810)</u>	
Net current assets			<u>3,987,462</u>		<u>1,646,983</u>
Net assets excluding pension asset			5,445,837		3,197,495

Balance Sheet Continued

Pension liability	14	(3,649,000)	(2,215,000)
Net assets		<u>1,796,837</u>	<u>982,495</u>
Reserves			
Profit and loss account	12	1,191,048	384,517
Other reserves	12	605,789	597,978
Members' funds	13	<u>1,796,837</u>	<u>982,495</u>

These financial statements were approved by the Board on 21st July 2006 and signed on its behalf by:

Mr Salleh Subari
Director

Dr Andrew Tinker
Director

Cash Flow Statement for the year ended 31st December 2005

	Notes	2005 £	As restated 2004 £
Reconciliation of operating surplus to net cash inflow from operating activities			
Operating surplus		2,514,008	302,879
Depreciation		115,978	108,775
(Increase) in stocks		-	(3)
(Increase) in debtors		(2,238,157)	78,766
Increase in creditors		141,168	(263,589)
Provision for service cost of defined benefit pension scheme		281,498	316,000
Defined benefit pension scheme contributions paid		(568,498)	648,000
Net cash inflow from operating activities		<u>245,997</u>	<u>(105,172)</u>
Cash flow statement			
Net cash inflow from operating activities		245,997	(105,172)
Returns on investments and servicing of finance	20	21,334	15,305
Capital expenditure	20	(23,841)	(110,836)
Increase in cash in the year		<u>243,490</u>	<u>(200,703)</u>
Reconciliation of net cash flow to movement in net debt (Note 21)			
Increase in cash in the year		243,490	(200,703)
Net debt at 1st January 2005		1,468,899	1,669,602
Net funds at 31st December 2005		<u>1,712,389</u>	<u>1,468,899</u>

Notes to the Financial Statements for the year ended 31st December 2005

1. Accounting policies

Accounting convention

Changes in accounting policy

In preparing the financial statements for the current year, the company has adopted the following Financial Reporting Standards:

FRS 17 'Retirement Benefits'

Notes to the Financial Statement Continued

The company has adopted FRS 17 'Retirement Benefits' disclosure and presentation in these financial statements. The adoption of this standard represents a change in accounting policy and the comparative figures have been restated accordingly.

The effect of the change in accounting policy to adopt FRS 17 was to increase staff costs by £281,000 (2004: 316,000) and to reduce other finance income by £93,000 (2004: £96,000). The result of the above was to decrease profit by £374,000 (2004: £412,000) and to decrease the total recognised gains and losses by £1,628,000 (2004: £75,000).

Income

Income represents the total invoice value of sales made during the year, excluding value added tax, trade discounts and all other taxes.

Tangible fixed assets and depreciation

Depreciation is provided at rates calculated to write off the cost less residual value of each asset over its expected useful life, as follows:

Freehold land	-	Not depreciated
Freehold buildings	-	2% straight line
Leasehold properties	-	Straight line over the life of the lease
Plant and machinery	-	20% straight line
Fixtures, fittings and equipment	-	20% straight line
Motor vehicles	-	25% straight line

Stock

Stock is valued at the lower of cost and net realisable value.

Pensions and other post-retirement benefits

Defined contribution scheme

The pension costs charged in the financial statements represent the contribution payable by the company during the year.

Defined benefit scheme

The company operates a defined benefit pension scheme for employees. The assets of the scheme are held separately from those of the company.

Pension scheme liabilities are measured on an actuarial basis using a projected unit method and are discounted to their present value using a discount rate of 5% per annum.

Pension scheme assets are valued at market value at the balance sheet date.

The pension scheme deficit is recognised in full on the balance sheet.

Deferred taxation

Deferred tax is recognised in respect of all timing differences that have originated but not reversed at the balance sheet date where transactions or events have occurred at that date that will result in an obligation to pay more, or a right to pay less or to receive more, tax, with the following exceptions:

Provision is made for tax on gains arising from the revaluation (and similar fair value adjustments) of fixed assets, and gains on disposal of fixed assets that have been rolled over into replacement assets, only to the extent that, at the balance sheet date, there is a binding agreement to dispose of the assets concerned. However, no provision is made where, on the basis of all available evidence at the balance sheet date, it is more likely than not that the taxable gain will be rolled over into replacement assets and charged to tax only where the replacement assets are sold;

Provision is made for deferred tax that would arise on remittance of the retained earnings of overseas subsidiaries, associates and joint ventures only to the extent that, at the balance sheet date, dividends have been accrued as receivable;

Notes to the Financial Statement Continued

Deferred tax assets are recognised only to the extent that the directors consider that it is more likely than not that there will be suitable taxable profits from which the future reversal of the underlying timing differences can be deducted.

Deferred tax is measured on an undiscounted basis at the tax rates that are expected to apply in the periods in which timing differences reverse, based on tax rates and laws enacted or substantively enacted at the balance sheet date.

Foreign currencies

Monetary assets and liabilities denominated in foreign currencies are translated into sterling at the rates of exchange prevailing at the accounting date. Transactions in foreign currencies are recorded at the date of the transactions. All differences are taken to the Profit and Loss account.

2. Income	2005 £	As restated 2004 £
Class of business		
Rubber Consultants	971,876	899,487
Contributions from MRB	5,273,203	3,097,597
Research and other contracts	151,572	150,313
	<u>6,396,651</u>	<u>4,147,397</u>
Geographical market		
UK	829,792	776,605
Europe	267,109	234,474
Rest of the world	5,299,750	3,136,318
	<u>6,396,651</u>	<u>4,147,397</u>
3. Operating surplus	2005 £	As restated 2004 £
Operating surplus is stated after charging:		
Equity settled share-based payments	66,572	26,533
Depreciation and other amounts written off tangible assets	118,878	108,775
Auditors' remuneration	10,750	10,750
and after crediting:		
Profit on disposal of tangible fixed assets	2,900	-
Net foreign exchange gain	(14,015)	(13,276)
	<u>21,185</u>	<u>24,032</u>
4. Interest receivable and similar income	2005 £	2004 £
Bank interest	21,334	15,305
	<u>21,334</u>	<u>15,305</u>
5. Interest payable and similar charges	2005 £	As restated 2004 £
Net finance cost in respect of defined benefit pension scheme	93,000	96,000
	<u>93,000</u>	<u>96,000</u>
6. Employees	2005 Number	2004 Number
Number of employees		
The average monthly numbers of employees (including the directors) during the year were:		
Technical and administration	83	86
	<u>83</u>	<u>86</u>
Employment costs	2005 £	As restated 2004 £
Wages and salaries	2,117,292	2,116,230
Social security costs	171,138	170,868
Pension costs-other operating charge	303,887	329,932
Staff costs-operating charges	2,592,317	2,617,030
	<u>2,592,317</u>	<u>2,617,030</u>

Notes to the Financial Statement Continued

6.1. Directors' emoluments	2005 £	2004 £
Remuneration and other emoluments	<u>61,532</u>	<u>64,322</u>
	Number	Number
Number of directors to whom retirement benefits are accruing under a defined benefit scheme	<u>1</u>	<u>1</u>

7. Taxation

The Department of Trade and Industry has approved the Company as a research association for the purpose of Income and Corporation Taxes in accordance with the Corporation Taxes Act 1988 and the Capital Allowances Act 1990. The company is therefore exempt from Income and Corporation taxation in this regard.

8. Tangible fixed assets	Land and buildings freehold	Long leasehold property	Plant and machinery	Fixtures, fittings and equipment	Total
	£	£	£	£	£
Cost					
At 1st January 2005	2,264,592	243,586	3,639,968	266,533	6,414,679
Additions	-	-	26,740	-	26,740
Disposals	-	-	(56,989)	-	(56,989)
At 31st December 2005	<u>2,264,592</u>	<u>243,586</u>	<u>3,609,719</u>	<u>266,533</u>	<u>6,384,430</u>
Depreciation					
At 1st January 2005	1,057,561	90,382	3,449,691	266,533	4,864,167
On disposals	-	-	(56,990)	-	(56,990)
Charge for the year	43,272	4,871	70,735	-	118,878
At 31st December 2005	<u>1,100,833</u>	<u>95,253</u>	<u>3,463,436</u>	<u>266,533</u>	<u>4,926,055</u>
Net book values					
At 31st December 2005	<u>1,163,759</u>	<u>148,333</u>	<u>146,283</u>	-	<u>1,458,375</u>
At 31st December 2004	<u>1,207,031</u>	<u>153,204</u>	<u>190,277</u>	-	<u>1,550,512</u>

9. Stocks	2005 £	2004 £
Finished goods and goods for resale	<u>1,715</u>	<u>1,715</u>

10. Debtors	2005 £	2004 £
Trade debtors	222,803	252,316
Amount owed by connected companies	317,926	294,644
Other debtors	38,304	33,219
Prepayments and accrued income	<u>2,239,303</u>	-
	<u>2,818,336</u>	<u>580,179</u>

Included within debtors are staff loans to the sum of £17,018 (2004: £21,053) representing amounts due from employees in respect of housing loans. The full balance at the year end is considered to be due after more than one year.

Also included within other debtors is £2,239,303 representing a contribution from the Malaysian Rubber Board in order to assist with funding the company's defined pension scheme deficit. The contribution will be payable over 10 years with the first instalment anticipated in 2006. Of the total contribution, £1,963,113 is receivable over a period in excess of one year.

Included within amounts due by connected companies is £302,103 due from Elgem Technology, of which £175,635 is repayable after more than one year.

Notes to the Financial Statement Continued

Amounts falling due after more than one year and included in debtors are:

Amounts owed by connected companies	175,635	219,545
Other debtors	17,018	21,053
Prepayments and accrued income	1,963,113	-
	<u>2,155,766</u>	<u>240,598</u>

11. Creditors: amounts falling due within one year	2005	2004
	£	£
Trade creditors	38,093	62,088
Other taxes and social security costs	65,394	56,894
Other creditors	27,704	31,955
Accruals and deferred income	413,787	252,873
	<u>544,978</u>	<u>403,810</u>

	Profit and loss account	Special reserve	Total
	£	£	£
12. Equity reserves			
At 31st December 2004 as previously stated	2,599,517		2,599,517
Prior year adjustment - FRS 17	(2,215,000)		(2,215,000)
At 1st January 2005 (restated)	384,517	597,978	982,495
Retained surplus for the year	2,442,342		2,442,342
Actuarial loss in respect of defined benefit scheme	1,628,000		
Other movements	(7,811)	7,811	-
At 31st December 2005	<u>1,191,048</u>	<u>605,789</u>	<u>3,424,837</u>

	2005	As restated 2004
	£	£
13. Reconciliation of movements in shareholders' funds		
Surplus/(deficit) for the year	2,442,342	222,184
Actuarial loss in respect of defined benefit scheme	(1,628,000)	(75,000)
	814,342	147,184
Opening shareholders' funds	3,197,495	3,211,311
Prior year adjustment	(2,215,000)	(2,376,000)
Opening members' funds (restated)	982,495	835,311
Closing members' funds	<u>1,796,837</u>	<u>982,495</u>

14. Pension and other post-retirement benefits

The company operates a pension scheme providing benefits based on final pensionable pay. The assets of the scheme are held separately from those of the company, being invested with insurance companies.

Pension contributions are determined by a qualified actuary on the basis of triennial valuations using the projected unit method. A full actuarial valuation was carried out at 1st January 2003 and updated at 31st December 2005. The main assumptions used by the actuary were:

Tun Abdul Razak Research Centre Pension and Assurance Scheme

	2005	2004	2003
	%	%	%
Rate of increase in salaries	3.5	3.5	3.5
Rate of increase in pensions payment	2.5	2.5	2.5
Discount rate	5.0	5.5	5.5
Inflation assumption	<u>2.5</u>	<u>2.5</u>	<u>2.5</u>

Notes to the Financial Statement Continued

The principal liabilities in the scheme were:

The fair value of the scheme assets and the expected rate of return, the present value of the scheme liabilities and the resulting Deficit are:

Tun Abdul Razak Research Centre Pension and Assurance Scheme

	Long term rate of return expected at Value at 31/12/05		Long term rate of return expected at Value at 31/12/04		Long term rate of return expected at Value at 31/12/03	
	%	£'000	%	£'000	%	£'000
Equities	7.8	4,452	6.5	3,574	6.5	3,481
Bonds	5.0	1,717	4.5	1,230	4.5	566
Other	4.5	309	3.8	240	3.8	304
Total market value of assets		6,478		5,044		4,351
Present value of scheme liabilities		(10,127)		(7,259)		(6,727)
Surplus/(deficit) in the scheme		(3,649)		(2,215)		(2,376)
Net pension liability		(3,649)		(2,215)		(2,376)

Analysis of the amount charged to operating surplus

Tun Abdul Razak Research Centre Pension and Assurance Scheme

	2005 £'000	2004 £'000
Current service cost	281	316
Past service cost	-	-
Total operating charge	281	316

Analysis of the amount charged to other finance income

Tun Abdul Razak Research Centre Pension and Assurance Scheme

	2005 £'000	2004 £'000
Expected return on pension scheme assets	310	278
Interest on pension scheme liabilities	(403)	(374)
Total income	(93)	(96)

Analysis of amount recognised in Statement of total recognised gains and losses

Tun Abdul Razak Research Centre Pension and Assurance Scheme

	2005 £'000	2004 £'000
Actual return less expected return on pension scheme assets	686	(75)
Experience gains/(losses) arising on the scheme liabilities	(526)	-
Gain/(loss) arising from changes in assumptions underlying the present value of the scheme liabilities	(1,788)	-
Actual gain/(loss)	(1,628)	(75)

History of experience gains and losses

Tun Abdul Razak Research Centre Pension and Assurance Scheme

	2005	2004	2003	2002	2001
Difference between the expected and actual return on scheme assets: amount (£)	686	(75)	416	-	-
percentage of scheme assets	11%	(1)%	10%	-	-
Experience gains and losses on scheme liabilities: amount (£)	(526)	-	5	-	-
percentage of the present value of the scheme liabilities	5%	-	-	-	-

Notes to the Financial Statement Continued

	2005	2004	2003	2002	2001
Total amount recognised in Statement of total recognised gains and losses: amount (£)	(1,628)	(75)	421	-	-
percentage of the present value of the scheme liabilities	16%	(1)%	6%	-	-

An analysis of the movements in the surplus/deficit during the year are shown below: Tun Abdul Razak Research Centre Pension and Assurance Scheme

	2005 £'000	2004 £'000
Deficit brought forward	(2,215)	(2,376)
Total operating charge	(281)	(316)
Total finance income	(93)	(96)
Actuarial gain/(loss)	(1,628)	(75)
Contributions	568	648
Deficit carried forward	<u>(3,649)</u>	<u>(2,215)</u>

The pension contribution in the year in total amounted to £568,000 and amounts to 26% of pensionable earnings together with an additional contribution of £290,000.

In order to eliminate the deficit in the scheme, the MRB has pledged additional contributions of £290,000 per annum above the 26% of pensionable salaries currently paid by the scheme members.

Defined contribution scheme

The company operates a defined contribution pension scheme in respect of the senior employees. The scheme and its assets are held by independent managers. The pension charge represents contributions due from the company and amounted to £22,389 (2004 - £13,932).

15. Financial commitments

At 31st December 2005 the company had annual commitments under non-cancellable operating leases as follows:

	Other 2005 £	Other 2004 £
Expiry date:		
Within one year	-	595
Between one and five years	<u>8,343</u>	<u>8,343</u>
	<u>8,343</u>	<u>8,938</u>

16. Capital commitments

Details of capital commitments at the accounting date are as follows:

	2005 £	2004 £
Contracted for but not provided in the financial statements	<u>-</u>	<u>23,253</u>

17. Related party transactions

During the year the company charged the Office of London Representative of the Malaysian Rubber Board a sum of £29,025 (2004: £24,000) in respect of administration services.

At the Balance Sheet date an amount of £15,823 (2004: £2,156) was owed by the Office of London Representative of the Malaysian Rubber Board. Both the company and the Office of London

Notes to the Financial Statement Continued

Representative are owed by the Malaysian Rubber Board.

The company charged £9,700 (2004: £9,300) to the Office of London Representative of Malaysian Rubber Board for use of the office and services supplied.

During the year the company charged a sum of £88,701 (2004: £75,273) to Elgem Technology Ltd for scientific and research consultancy, and the provision of services.

At the Balance Sheet date Elgem Technology Ltd owed this company a sum of £302,103 (2004: £292,488).

Tun Abdul Razak Research Centre, Elgem Technology and the Malaysian Rubber Board Office of London Representative are all controlled by the Malaysian Rubber Board.

18. Company limited by guarantee

The Tun Abdul Razak Research Centre (TARRC) is an organisation and research centre of the Malaysian Rubber Board, the body corporate established by statute in Malaysia for purposes of overseeing the development of the rubber industry with research and development as the core activity.

Incorporated in England since 1938, TARRC is a Company Limited by Guarantee and not having share capital, the word Limited being omitted by Licence of The Department of Trade and Industry. TARRC by reason of the definition in Section 1 (1) of the Companies Act 1980 and the bringing into force of Part 1 of the Act became a Private Company on 22nd December 1980.

The liability of each member is limited to £1.

19. Controlling interest

The company is controlled by the Malaysian Rubber Board, which is a statutory Authority of the Government of Malaysia.

20. Gross cash flows

	2005	2004
	£	£
Returns on investments and servicing of finance		
Interest received	21,334	15,305
Capital expenditure		
Payments to acquire tangible assets	(26,740)	(110,836)
Receipts from sales of tangible assets	2,899	-
	<u>(23,841)</u>	<u>(110,836)</u>

21. Analysis of charges in net funds

	Opening balance	Cash flows	Closing balance
	£	£	£
Cash at bank and in hand	1,468,899	243,490	1,712,389
Net funds	<u>1,468,899</u>	<u>243,490</u>	<u>1,712,389</u>

Director's Report

Visitors to Brickendonbury

In March 2005, we were delighted to welcome the Honourable Minister of Plantation Industries and Commodities, YB Datuk Peter Chin Fah Kui to our laboratories at Brickendonbury. This was the Minister's first visit to the Research Centre, and he was given an in-depth briefing on the activities of the laboratory, including a presentation by the Chairman of TARRC, Datuk Abdul Hamid Sawal.

Promotion of the Malaysian rubber industry

Seminars and conferences

The visit of the Hon. Minister to TARRC was in conjunction with a seminar in London entitled 'Selecting the right gloves: glove selection for healthcare and personal protective equipment'. The seminar, jointly organised by the Malaysian Rubber Export Promotion Council (MREPC) and TARRC and assisted by the UK's Association of British Healthcare Industries, focused on how recent experience and best practice can be used to guide policy makers and users in glove selection. Experts from Germany, Finland, Malaysia and the UK examined the scientific evidence on the use of natural rubber latex gloves and latex allergy to address the important issues.

The medical glove industry in Malaysia makes an enormous contribution to the country's export earnings and we believe this type of key event is vital to inform purchasers and users of the high quality products that Malaysian manufacturers are able to produce. We, of course, as part of our research programme continue to assess latex protein concerns in Europe including monitoring market issues relevant to latex products.

Datuk Peter Chin in his keynote address emphasised that for many years Malaysia had been working with its manufacturers and taking steps to address the latex allergy problem and '...had already come up with new and improved processing technologies to produce gloves that are low in protein, low in powder or powder-free. Malaysia is the only country that has taken increasingly stringent measures to prohibit the export of poor quality NR latex gloves with high protein level.'

The seminar was also held in Edinburgh and all together more than 150 delegates, including occupational health professionals, purchasers and users, glove manufacturers and distributors, raw materials suppliers, and academic and scientific experts participated in the discussions on this important topic.

Conclusions from the seminars and discussions demonstrated that evidence from Europe shows that use of good quality, low protein, powder free natural rubber latex gloves, together with monitoring and health surveillance, can prevent new cases of latex protein allergy and keep already sensitised staff in the workplace. We were encouraged that following the seminars, many positive comments were received from participants, mainly praising the informative balanced presentations and discussions.

As well as the two seminars held earlier in the year, TARRC was also involved in the Malaysian Rubber Economic and Technical Mission to France, Italy and Germany led by Datuk Peter Chin.

This major event consisted of three one-day meetings held in September in Paris, Milan and Hamburg, focusing on business opportunities in the Malaysian rubber products manufacturing sector, including latex-dipped products, industrial and general rubber components and finished goods. These events were organised jointly by TARRC and MREPC



The Honourable Minister of Plantation Industries and Commodities, YB Datuk Peter Chin Fah Kui, visited TARRC in March 2005 for the first time. He is pictured (top left) on the balcony of the TARRC administrative mansion building, (top right) during the briefing by TARRC's Director of Research Dr Andrew Tinker, and (middle right) with Mr Salleh Subari, CEO and Vice Chairman of TARRC, Dato' Teo Suat Cheng, CEO, MREPC, Dr Andrew Tinker and Datuk Abdul Hamid Sawal, the Chairman of TARRC, planting a tree to commemorate the visit.

The Ministerial party is pictured in the Brickendonbury grounds. From left to right: Mr Sebastian Ting, Political Secretary to the Minister, Dato' Dr Ong Eng Long, Deputy CEO, MREPC, Mr Salleh Subari, Dato' Teo Suat Cheng, Dr Keith Fuller, TARRC, Datuk Peter Chin Fah Kui, Dr Stuart Cook, TARRC, Datuk Abdul Hamid Sawal, Dr Andrew Tinker and Mr Mohd Aminuddin Hashim, Under Secretary, Ministry.



in collaboration with the Malaysian External Trade Development Corporation (MATRADE) and the Malaysian Industrial Development Authority (MIDA).

TARRC staff worked together with MATRADE, MIDA and the Embassies in each country to invite delegates to the seminars, arrange meetings and factory visits for the Mission members. TARRC was also responsible for the co-ordination of the arrangements during the 10-day event.

Presentations were given by TARRC staff as part of the investment seminar in Paris and Italy highlighting TARRC's role as the investment and outsourcing route to the Malaysian Rubber Industry and Malaysian Rubber Board's (MRB) R&D facilities in Malaysia and the UK which support the industry.



In March 2005, the Honourable Minister of Plantation Industries and Commodities, YB Datuk Peter Chin Fah Kui, presented the keynote address to delegates at the seminar 'Selecting the right gloves: glove selection for healthcare and personal protective equipment'.

At the North European International Rubber Conference in Maastricht, five technical papers were presented by TARRC staff providing an opportunity to promote the work on electrochemical degradation (ECD), low-zinc vulcanisation, nanocomposites and thermoplastic vulcanisates.

With TARRC engineers leading the field in the area of constitutive modelling of elastomeric components, staff are often in demand to participate in conferences and meetings with other researchers to discuss advances in this area. This year was no exception and at the 4th European Conference on Constitutive Models for Rubber held in Stockholm, TARRC experts authored or co-authored four papers given at the conference, presenting three of them.

Exhibitions

Work continued in 2005 in publicising Foreign Direct Investment (FDI) opportunities and manufacturing activities and expanding markets for Malaysian rubber products through attendance at 18 international exhibitions throughout Europe. At two of these events, the Automotive Trade Show and Interplas 2005 (both held at the NEC in Birmingham), TARRC



TARRC continues to promote business opportunities in the Malaysian rubber industry by participating in exhibitions such as Interplas, one of Europe's major rubber and plastics exhibitions held in Birmingham.

shared an exhibition stand with MATRADE. Through these activities, we continue to increase contact with European companies and promising leads are nurtured and monitored.

Promotion of Malaysia's speciality rubbers

TARRC staff continue to play an active role in the promotion and technical support of the speciality rubbers developed by the MRB such as DPNR and ENR. A paper on the use of DPNR for engineering applications was presented at the American Chemical Society Rubber Division Spring Technical Meeting and generated considerable interest from the audience, which included a number of well-known multinational companies. Through these contacts trials of the material will be expanded to include new customers and products. Discussions and analyses of results continued with a significant number of companies worldwide now in the process of evaluating DPNR for use in their products.

Rubber in engineering

Design and manufacturing expertise

TARRC has been at the forefront of establishing engineering design principles for rubber components through its Engineering Design of Natural Rubber (EDNR) bulletin, first published by P.B. Lindley in 1964. Our experienced engineers lead their field in the design and manufacture of rubber components, using their expertise in Finite Element Analysis (FEA) for elastomeric systems. FEA has been a key tool in advancing capability to optimise cure cycles and to design products meeting specifications for mechanical endurance, load deflection behaviour and dynamic properties.

In 2005 a significant advance has been made at TARRC in the ability of FEA to predict real-life performance of rubber components. The dynamic stiffness values of rubber components, such as automotive bushings, in different directions are the key parameters determining how well the components control vibration and noise. The capability to design rubber components with a specified stiffness is very important to manufacturers. The current capability of commercial FEA software to calculate dynamic stiffnesses is very poor and a viscoelastic 'overlay' model that uses existing FEA materials models in parallel has been explored to give more realistic simulations. It has proved to be very promising for simulating uniaxial behaviour of a filled NR vulcanisate and its applicability to multiaxial deformations, which are more typical of service conditions, has now been assessed. It has been shown that the model does work reasonably well in the specific multiaxial deformations investigated, suggesting it will have good general applicability within FEA, not only for engineering components but also for other applications such as rolling tyres. It should also be capable of predicting energy dissipation during deformation histories, if used together with an appropriate subroutine, and this would lead to a capability of simulating heat build-up.

The prediction of the service life of components under cyclic fatigue loading involves the calculation of the energy available for the growth of a crack from a pre-existing flaw. The calculation would be simplified if it can be assumed that the result depends only on the local stress around the flaw and that this stress is uniform. Finite element analysis of two examples has confirmed these assumptions for components which do not have extreme local stresses. The energy for crack growth may then be estimated without the need to consider the presence of flaws in the FEA of the component.

This puts the prediction of service life under fatigue conditions on a much sounder footing. Another important outcome of the work is an appreciation of the significant effect of hydrostatic pressure on the energy for crack growth, and this explains why over-compression of bushes during swaging can enhance fatigue life.

Priority, as always, is given to tailoring TARRC's programmes for research and transfer of technology to best support the Malaysian industry. Visits to some Malaysian manufacturers in 2005 revealed strong interest in design software, such as the bush design spreadsheet developed in the last year. The software is currently being expanded to ensure that it covers

all common types of bush products, with a view to making it available to industry in the near future.

Hydromounts consisting of two fluid chambers within an elastomeric mount are now commonly used as engine mounts, and Malaysian manufacturers are supplying such mounts to the automotive industry. In order to achieve full design capability it is necessary to be able to model the dynamic behaviour of hydromounts under various service conditions. In 2004 a spreadsheet-based model was programmed at TARRC for predicting the main features of the dynamic response of hydromounts. In 2005 work was carried out to modify the linear theoretical model to account for the non-linear effect of the resistance to the flow of the liquid through the channel connecting the two chambers. Effort was then directed towards producing a model in the time domain to incorporate more non-linear effects that cannot be modelled in terms of frequency dependence as they exhibit a sudden change in properties with amplitude of excitation. The modified model predicts the effects of non-linearities such as the resistance to the flow of the liquid through the inertia track and the vacuum phenomenon created when the direction of the load is reversed. The reliability of the time-domain non-linear model was confirmed by a direct comparison with the linear, frequency-domain model. A good agreement was observed. This model can also be used to predict the response of hydromounts to transient excitations and the capability to do this reliably within multi-body simulation software is a key requirement for shortening the development time for a new model of car.

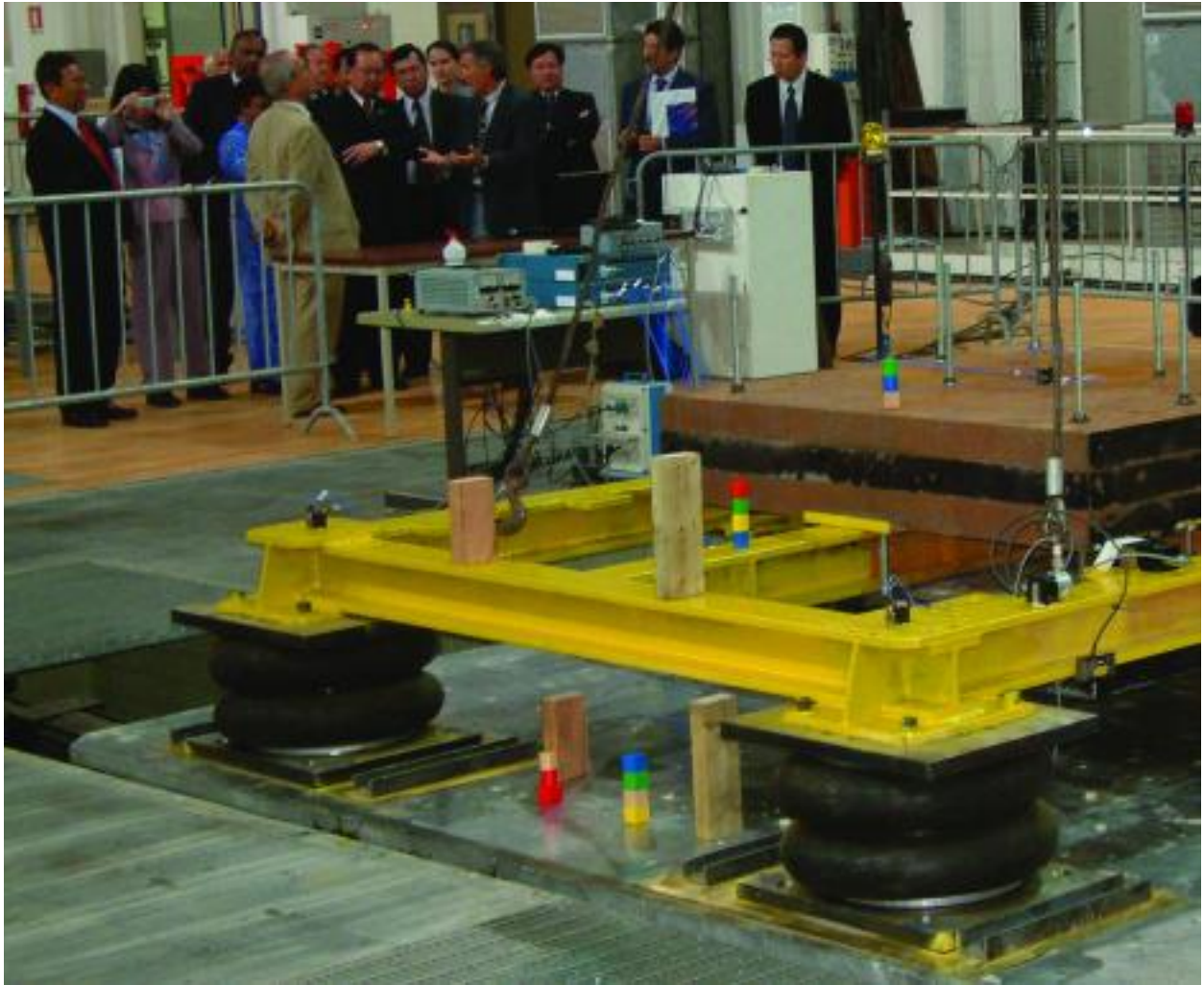
Base isolation systems

During the Mission in September, the Minister of Plantation Industries and Commodities, YB Datuk Peter Chin Fah Kui, visited ENEA's Casaccia Research Centre in Rome, Italy, and was able to witness shaking table tests carried out to evaluate a novel device developed for floor seismic isolation, and possibly suitable for seismic protection of individual dwellings. These tests are part of our work on the technical promotion of base isolation, and the initial analysis of the tests showed that the devices - known as cushion isolators - performed very well. The isolator was also tested under a constant load to check how much the vertical deflection increases over a prolonged period. For the isolator to support a structure safely the decrease of the deflection with time must be small. The results indicated the deflection would increase by a small amount, only by 50 percent of the initial deflections over the first 20 years; the increase would be much smaller over the following 20 years. The tests confirmed that the isolator could safely support the weight of a structure over at least 50 years. After completion of the full assessment of the test data, optimization of the design from the point of view of compactness and fabrication will be considered.

The manufacture in Malaysia of the 17 elastomeric laminate bearings to support a base-isolated demonstration building in Algeria was completed by the end of the year. The project leader from TARRC visited Malaysia to witness the prototype testing of the bearings which passed the specification requirements. The project leader also visited Algeria several times in 2005; during the first visit three papers were presented at an earthquake conference in Chlef where there was considerable interest shown in base isolation. The main purpose of the second visit was to discuss the installation of the base isolation system with the contractor. During both visits steps were taken to organise a Working Group who will consider developing a building code for base-isolated buildings in Algeria. These steps included a visit to the Ministry of Housing. The process of drafting and approving a new code would take one to two years; without it every project would need special approval.

Technical support for the Malaysian rubber products industry

TARRC's project on productivity and efficiency of rubber component manufacturing continued to make progress with 15 factories visited during the year to address the concepts of 'lean manufacturing'. As with the visits made previously, TARRC technologists were able to make immediate improvements with, for instance reductions in scrap and waste. It is encouraging that TARRC has been informed that news of the success of this project has spread through



At ENEA's Casaccia Research Centre in Rome, Datuk Peter Chin witnessed the successful shaking table tests carried out to evaluate cushion isolators developed for floor seismic isolation.

the industry in Malaysia and companies are beginning to ask for working visits to their manufacturing facilities.

Some of the visits in 2005 coincided with a seminar held in Kuala Lumpur 'Enhancing technical competitiveness through R&D, productivity and quality improvements'. Several TARRC officers presented papers at this seminar to the Malaysian industry and feedback from the delegates was very good.

In 2004 the Head of the Materials Research and Development Division achieved 'black-belt' status after the completion of Six Sigma training. The fundamentals of Six Sigma involve process improvement with the aim of eliminating process defects and process variation. Training TARRC staff to 'yellow-belt' status also began in 2004 and in 2005 the training was extended to more officers at the Research Centre. Three TARRC officers also led two one-day Six Sigma Yellow Belt training sessions at Rubber Technology Centre, Sungai Buloh; combined with the concept of 'lean manufacturing' these ideas can be passed to the Malaysian industry to allow them to compete more competitively in the global marketplace.

Electrochemical degradation (ECD)

Procedures have been developed at TARRC for testing the susceptibility of automotive coolant hose towards ECD, which is the most common cause of failure. Both technical advice and ECD testing facilities are available for Malaysian automotive coolant hose manufacturers

looking to meet ECD resistance requirements of their customers. Some insight into the possible mechanism of ECD has been gleaned using the TEM network visualisation technique developed at TARRC, by which it has been possible to discern regions of failure at the rubber-black interface resulting from low level currents induced in service.

Development of new materials

NRTPV development

Recent market trends indicate that TPE materials will have captured about 20 percent of the thermoset rubber market by 2006, TPE producers continue to seek to improve their range of products by addressing performance characteristics such as UV and environmental resistance and recovery. NRTPV development at TARRC aims to provide alternative TPV materials based on natural rubber and polypropylene for applications with service temperature requirements up to 135°C. The applications for NRTPV are expected to be particularly appropriate for automotive sealing profiles.

The potential of NRTPV for use in sealing applications has been demonstrated in compression stress relaxation testing using test jigs designed at TARRC. Compression stress relaxation measurements are favoured by sealing component manufacturers as they give data that more representative of real service conditions than simple set measurements. A significantly improved performance for a 53 Shore A NRTPV compound, as compared with a commercially available TPV based on EPDM of similar hardness, has been observed in ongoing tests over two months at 40°C.

At the same time, advances in the production process have led to a substantial increase in throughput. This has been achieved without any detrimental effect on the performance of NRTPV; indeed, processability has been enhanced.

Nanocomposite materials

A project began in 2004 to investigate the properties of rubber nanocomposites containing organoclays. The term 'nanocomposite' describes a two-phase material where one of the phases has at least one dimension in the nanometer range. The market for these materials continues to grow, especially in the automotive industry, as more market sectors are discovered where nanocomposites can replace traditional materials. Whereas most nanocomposites are based on plastics, TARRC scientists continue to make progress in mapping the benefits, and hence potential applications, of using nanoclay fillers in rubbers.

TARRC's work on nanocomposites containing low levels of montmorillonite (MMT) nanoclays as the only filler has already indicated the potential for improvements in durability. One property expected to be greatly enhanced by nanoclays is resistance to permeation, but substantial effects were not seen in these nanocomposites. The work was extended to NR compounds containing carbon black in addition to the nanoclay; such compounds are likely to be used in practice rather than compounds only containing nanoclay as the filler. These dual filler compounds show significant reduction in air permeability due to the nanoclay, despite the orientation of the nanoclay in the test specimen not being well-aligned across the flow path of the air. In practical use, the compound would be processed to ensure appropriate alignment of the individual nanoclay platelets to minimise permeability of the product.

The reduction in scorch safety associated with the use of MMT organoclay fillers has been shown to be due to the ammonium salts used as modifying agents; these activate the vulcanisation process.

Other work on rubber nanocomposites involved the use of sepiolite organoclays instead of those based on MMT. In contrast to the flat sheets of MMT, sepiolite consists of long rod-like structures. Whilst it is therefore unlikely to produce the increase in barrier properties anticipated of MMT nanocomposites, sepiolite is expected to produce materials with useful

tensile or dynamic properties that vary depending on the orientation of the clay particles. These properties could prove beneficial in a variety of 'smart' applications. Although the work is at an early stage, one positive observation is that, although modified with the same ammonium salts as MMT, sepiolite organoclays do not reduce scorch safety to the same extent.



Testing gloves for holes using the condom electronic leak tester developed at TARRC is far more efficient in terms of time and manpower than the water leak test in the glove Standard. This equipment could be readily adapted to perform the rapid screening of gloves for holes.

The tester is permitted by the ISO Standard for rapid screening for holes in condoms. This leak tester is more sensitive than the water leak test, so all condoms failing the electronic test must be checked by the water leak test; only those failing the water leak test are said to have holes. NR latex gloves from a number of sources, including Malaysia were tested using the electronic leak tester and all passed the EN455 Standard at the quoted quality level of 1.5%. All of the gloves failing the electrical test passed the water leak test of the glove Standard. Testing by the electronic leak tester was far more efficient in terms of time and manpower than the test in the Standard and it is suggested that this equipment could be readily adapted to perform the rapid screening of gloves for holes.

Physical testing services

The demand for physical testing carried out by the Product Evaluation and Testing Unit remained high in 2005, both for Consultancy work and 'in-house'. To keep up with clients' requirements, new equipment installed in 2005 included multi-cell ovens that have been extensively used to support the NRTPV programme.

This year a project was commenced in collaboration with the MREPC using the condom electronic leak tester to screen latex gloves. Currently, the definitive pinhole test for gloves and condoms is the water leak test, which is labour intensive and time consuming. The electronic leak

Contract research

We were pleased to secure two contracts in 2005 under the WRAP Programme (the Waste & Resources Action Programme). WRAP is a major UK government funded programme established in 2001 to promote resource efficiency. Its particular focus is on creating stable and efficient markets for recycled materials and products and removing the barriers to waste minimisation, re-use and recycling.

The first project is designed to demonstrate that reclaimed rubber crumb can be used in high specification compounds such as tyre treads. The specially treated rubber crumb, produced by the lead partner, will be mixed into tyre tread masterbatch and then hot-cure retreaded tyres will be built from the resultant compound. The mixing is scheduled to commence early in 2006. Commercial vehicle tyre service trials are part of the research programme and are expected to last between six and nine months, with measurements of tread wear taken on a monthly basis. Another partner will perform similar work on OTR tyres.

The second project funded by WRAP titled 'Recycling of Tyre Rubber into New Rubber Products through Efficient De-Vulcanisation', was commenced towards the end of 2005. The aim of this project is to develop improved chemical systems for efficiently breaking the sulphur crosslinks (de-vulcanisation) of waste tyre rubber, leaving unbroken the original polymer chains, and thus providing recyclate with similar properties to the original polymer that can be used at high levels in high-value new rubber products.

The EU-funded Project 'Reduced Zinc in Rubber products for an Enhanced Environment', which commenced in 2001 with TARRC as a joint lead partner and co-ordinator, was completed early in 2005 and the results are being disseminated. The impression gathered from both the EC and the collaborating partners was that it had been a very successful project. The wide-ranging studies have established that the zinc oxide content in sulphur-vulcanised compounds of different rubbers (including NR, emulsion SBR, EPDM and NBR) can be reduced typically by about 50% without any detrimental effect on properties. In the case of solution SBR, and its blends with BR used in tyre compounds, much larger reductions down to very low zinc oxide levels were attained. The crosslinking chemistry in the high-vinyl solution SBR used in tyre tread compounds was shown to be quite different from that found in NR. Truck tyres with low-zinc NR treads and passenger tyres with very low-zinc SBR/BR treads were manufactured and tested, both on rolling drum test equipment and on the road; their performance matched or even surpassed that of reference tyres. To investigate the release of zinc to the environment resulting from tyre wear, leaching experiments were carried out using tyre tread powder buffed from the manufactured tyres. These indicated that zinc would be readily leached in acid soils, but only very slowly in alkaline soils.



Rubber Consultants continues to generate a major part of its income from analysis, particularly for the pharmaceutical industry. A new capillary column is fitted to a GC-MS prior to analysing pharmaceutical samples.

capabilities include headspace GC-NPD testing for acrylonitrile monomer, and headspace GC-FID for detection of volatile organics.

In 2004, Rubber Consultants' engineers supported the successful bid of a Malaysian company for the supply of high-damping rubber-to-metal bonded bearings for two liquefied natural gas tanks in China. In 2005, a contract was awarded to supply rubber bearings for a third tank at the same facility and the manufacturer again required technical assistance from Rubber Consultants. The three tanks together have required the manufacture of over 1000 bearings.

Rubber Consultants

Analysis, particularly for the pharmaceutical industry, again performed strongly in 2005, contributing to another good year overall with turnover up eight percent. In order to fulfil the needs of the pharmaceutical industry, a range of quality procedures have been developed, with the assistance of outside consultants, to meet the requirements of these clients and FDA/MHRA regulations in respect of working to GMP (Good Manufacturing Practice). Two new laboratories are being readied for use in 2006. These laboratories will be newly designed and dedicated areas for the GC-MS and GC-FID facilities for cGMP leachables testing. The GC-MS equipment has the latest inert source detectors, and other

Dr Andrew Tinker
Director of Research



Towards the end of the year, representatives from the Academy of Sciences, Malaysia, the Ministry of Education and six prize-winning Malaysian students visited the Research Centre. The group was on a study visit to London, part of a grand prize for the winners of the DUMEX National Science Quiz and Science Project 2005 held annually in Malaysia for primary school students. The six Science Quiz and Science Project winners were given an introductory talk on rubber and then a tour of the laboratories including various demonstrations in Engineering, Microscopy and the Mill Room.



For many years TARRC, through its consultancy unit, Rubber Consultants, has promoted the use of the facilities at Brickendonbury as a conference centre. Many local businesses have used the conference rooms for their events, seminars or meetings over the years. With the completion of the renovation of the Mansion in autumn, Rubber Consultants is again in a position to promote the Brickendonbury Conference Centre, now with upgraded presentation facilities in the Blue Room. Dr Stuart Cook, Head of the Materials Research and Development Division is pictured in the Blue Room talking to the prize-winning Malaysian students.

Scientific Papers

H.R. Ahmadi, J.G.R. Kingston and A.H. Muhr

Modelling dynamic properties of filled rubber in uniaxial and biaxial stress configurations.

ECCMR 2005, KTH, Stockholm, Sweden, 27-29 June, in Constitutive Models for Rubber IV, ed. P.E. Austrell & L. Kari, publ. Balkema, Taylor & Francis Group, London. pp299-304.

Publication 1728

H.R. Ahmadi, J.G.R. Kingston, A.H. Muhr, D. Besdo and J. Ihlemann (Institute of Mechanics, University of Hannover, Germany)

Transient response of inelastic materials to changes of amplitude.

ECCMR 2005, KTH, Stockholm, Sweden, 27-29 June, in Constitutive Models for Rubber IV, ed. P.E. Austrell & L. Kari, publ. Balkema, Taylor & Francis Group, London. pp305-311.

Publication 1729

A.H. Ahmadi, J.G.R. Kingston and A.H. Muhr

Dynamic properties of filled rubber - experimental data and FE simulated results.

Paper #48, Fall 168th Technical Meeting of the Rubber Division, American Chemical Society, Pittsburgh, PA, USA, 1-3 November.

Publication 1730

H.R. Ahmadi, Keith Fuller, Matej Fischinger, Tatjana (Institute of Structural Engineering, Earthquake Engineering and Construction, Ljubljana, Slovenia)

A smart elastomeric isolator.

9th World Seminar on Seismic Isolation, Energy Dissipation and Active Vibration Control of Structures, Kobe, Japan, 13-16 June.

Publication 1731

A.V. Chapman

Reducing zinc in rubber compounds.

Proc. International Rubber Conference 2005, MECC, Maastricht, The Netherlands, 7-9 June.

Publication 1732

A.V. Chapman

The role of zinc in the vulcanisation of different rubbers.

Elastomers 2005, Warsaw, Poland, 20-21 October.

Publication 1733

A.V. Chapman and T.R. Johnson

The role of zinc in the vulcanisation of styrene-butadiene rubbers.

Proc. International Rubber Conference 2005, MECC, Maastricht, The Netherlands 7-9 June.

Publication 1734

S. Cook, T.R. Johnson and D. Lowe

Properties of clay/rubber nanocomposites.

Proc. International Rubber Conference 2005, MECC, Maastricht, The Netherlands 7-9 June.

Publication 1735

S. Cook, J. Patel and A.J. Tinker

Recovery and fatigue properties of NRTPV.

Proc. International Rubber Conference 2005, MECC, Maastricht, The Netherlands 7-9 June.

Publication 1736

S. Cook, J. Patel and A.J. Tinker

Natural rubber based TPVs for improved performance.

Proc. TPE 2005 Conference, Berlin, Germany, 14-15 September.

Publication 1737

M.S.D. Fernando, C.D. Forge, G.T. Spiller and J. L. Clark

An evaluation of deproteinised natural rubber for engineering applications.

Spring 167th Technical Meeting of the Rubber Division, American Chemical Society, Hyatt Regency San Antonio Texas, USA, 16-18 May.

Publication 1738

K.N.G. Fuller and Fumihiko Yazaki, et al

Elastomeric isolators for seismic protection of bridges and buildings: requirements specified in new ISO Standard

International Rubber Conference, Yokohama, Japan, 24-28 October.

Publication 1739

K.N.G. Fuller, Alberto Dusi (Numeria Srl, Cremona, Italy) and Kamarudin Ab-Malek (Malaysian Rubber Board)

Base isolation for the protection of structures and their contents.

Proc. 'Séminaire 50ème anniversaire du séisme du 9/9/54 et 25ème anniversaire du séisme d'El asnam', Chlef, Algeria, 11-12 September.

Publication 1740

K.N.G. Fuller, Marco Mezzi (University of Perugia, Italy) and Alberto Dusi (Numeria Srl, Cremona, Italy)

Comparison of International Codes on Seismic Isolation.

Proc. 'Séminaire 50ème anniversaire du séisme du 9/9/54 et 25ème anniversaire du séisme d'El asnam', Chlef, Algeria, 11-12 September.

Publication 1741

K.N.G. Fuller, Alberto Dusi (Numeria Srl, Cremona, Italy) and H. Azzouz (CTC-Chlef, Algeria)

The first application of base-isolation in Algeria.

Proc. 'Séminaire 50ème anniversaire du séisme du 9/9/54 et 25ème anniversaire du séisme d'El asnam', Chlef, Algeria, 11-12 September.

Publication 1742

J. Gough and A.H. Muhr

Initiation of failure of rubber close to bondlines.

Proc. International Rubber Conference 2005, MECC, Maastricht, The Netherlands 7-9 June.

Publication 1743

J. Gough and A.H. Muhr

Energy release rates for small cracks in rubber components.

ECCMR 2005, KTH, Stockholm, Sweden, 27-29 June, in Constitutive Models for Rubber IV, ed. P.E. Austrell & L. Kari, publ. Balkema, Taylor & Francis Group, London. pp51-57.

Publication 1744

J.G.R. Kingston, A.H. Muhr, W.V. Mars (Cooper Tire & Rubber Company, Findlay, Ohio, USA), S. Martin (Premier Automotive Group, Warwickshire, UK) and K.W. Wong (Jebco, Malaysia)

Fatigue life analysis of an exhaust mount.
ECCMR 2005, KTH, Stockholm, Sweden, 27-29 June, in Constitutive Models for Rubber IV, ed. P.E. Austrell & L. Kari, publ. Balkema, Taylor & Francis Group, London. pp23-29.

Publication 1745

A.H. Muhr

Modeling the stress-strain behavior of rubber.
Rubber Chemistry and Technology, Vol 78, No. 3, 391-425.

Publication 1746

Faridah H.A.H., A.J. Tinker and Farid A.S.
Dependence of Tg of NBR vulcanisates on plasticiser level and crosslink density.
J. Rubb. Res., 8, 131 (2005).

Publication 1747

A.J. Tinker

Emerging technologies driving the rubber industry.

Proc. Rubber Planters' Conference 2005, Kuala Lumpur, Malaysia, November 2005, published by the MRB.

Publication 1748

Staff Lectures

All of the lectures listed, with the exception of those marked with an asterisk (*) have been or will be published. Speakers are listed first, unless otherwise indicated.

H.R. Ahmadi

Dynamic performance analysis of conventional and hydroelastic engine mounts.

Enhancing Technical Competitiveness through R&D, Productivity and Quality Improvements Seminar, Sheraton Imperial, Kuala Lumpur, 18 April.*

H.R. Ahmadi, J.G.R. Kingston and A.H. Muhr
Modelling dynamic properties of filled rubber in uniaxial and biaxial stress configurations.

ECCMR 2005, KTH, Stockholm, Sweden, 27-29 June.

H.R. Ahmadi, J.G.R. Kingson, A.H. Muhr (speaker), D. Besdo and J. Ihlemann (Institute of Mechanics, University of Hannover, Germany)
Transient response of inelastic materials to changes of amplitude.

ECCMR 2005, KTH, Stockholm, Sweden, 27-29 June.

H.R. Ahmadi, J.G.R. Kingston (speaker) and A.H. Muhr

Dynamic properties of filled rubber - experimental data and FE simulated results.

Fall 168th Technical Meeting of the Rubber Division, American Chemical Society, Pittsburgh, PA, USA, 1-3 November.

H.R. Ahmadi, Keith Fuller (speaker), Matej Fischinger, Tatjana (Institute of Structural Engineering, Earthquake Engineering and Construction, Ljubljana, Slovenia)

A smart elastomeric isolator.

9th World Seminar on Seismic Isolation, Energy Dissipation and Active Vibration Control of Structures, Kobe, Japan, 13-16 June.

G.E. Bennett

Statistical Process Control - an overview.

Enhancing Technical Competitiveness through R&D, Productivity and Quality Improvements Seminar, Sheraton Imperial, Kuala Lumpur, 18 April.*

G.E. Bennett

A guide to process improvements using Statistical Process Control (an aid to establishing a Lean Manufacturing Programme in the rubber industry.

PRI of Malaysia - Klang Section, Sungai Buloh, Malaysia, September/October.

P.S. Brown and S. Cook

Fast curing tread compounds.

Enhancing Technical Competitiveness through R&D, Productivity and Quality Improvements. Seminar, Sheraton Imperial, Kuala Lumpur, 18 April.*

A.V. Chapman

Reducing zinc in rubber compounds.

DIK 'Further education' Seminar 'Vulcanisation und Verfahren', DIK, Hannover, Germany, 5 October.*

A.V. Chapman

Reducing zinc in rubber compounds.

International Rubber Conference 2005, MECC, Maastricht, The Netherlands, 7-9 June.

A.V. Chapman

The role of zinc in the vulcanisation of different rubbers.

Elastomers 2005, Warsaw, Poland, 20-21 October.

Staff Lectures Cont.

A.V. Chapman and T.R. Johnson

The role of zinc in the vulcanisation of styrene-butadiene rubbers.

International Rubber Conference 2005, MECC, Maastricht, The Netherlands 7-9 June.

S. Cook

Electrochemical degradation of coolant hose.

Enhancing Technical Competitiveness through R&D, Productivity and Quality Improvements Seminar, Sheraton Imperial, Kuala Lumpur, 18 April.*

S. Cook

Nanocomposites.

Enhancing Technical Competitiveness through R&D, Productivity and Quality Improvements Seminar, Sheraton Imperial, Kuala Lumpur, 18 April.*

S. Cook, T.R. Johnson and D. Lowe

Properties of clay/rubber nanocomposites.

International Rubber Conference 2005, MECC, Maastricht, The Netherlands 7-9 June.

S. Cook, J. Patel and A.J. Tinker

Recovery and fatigue properties of NRTPV.

International Rubber Conference 2005, MECC, Maastricht, The Netherlands 7-9 June.

S. Cook, J. Patel and A.J. Tinker

Natural rubber based TPVs for improved performance.

TPE 2005 Conference, Berlin, Germany, 14-15 September.

B.W. Evans

Your investment and outsourcing route to the Malaysian rubber industry.

Business opportunities in Malaysia Seminar, Malaysian Rubber Economic and Technical Mission to France, Italy and Germany, September.*

B.W. Evans

Lean Manufacturing - what we need to work on.

Enhancing Technical Competitiveness through R&D, Productivity and Quality Improvements Seminar, Sheraton Imperial, Kuala Lumpur, 18 April.*

M.S.D. Fernando, C.D. Forge, G.T. Spiller and J. L. Clark

An evaluation of deproteinsed natural rubber for engineering applications.

Spring 167th Technical Meeting of the Rubber Division, American Chemical Society, Hyatt Regency San Antonio Texas, USA, 16-18 May.

J. Gough

Analysis and fatigue prediction of rubber components.

Enhancing Technical Competitiveness through R&D, Productivity and Quality Improvements Seminar, Sheraton Imperial, Kuala Lumpur, 18 April.*

J. Gough

Use of Finite Element Analysis in Rubber Engineering.

Universiti Sains Malaysia, Penang, 12 October.*

J. Gough

Modelling of cure of large rubber mouldings.

Abaqus Users' Meeting, Crown Princess Hotel, Kuala Lumpur, 15 November.*

J. Gough and A.H. Muhr (speaker)

Initiation of failure of rubber close to bondlines.

International Rubber Conference 2005, MECC, Maastricht, The Netherlands 7-9 June.

J. Gough and A.H. Muhr (speaker)

Energy release rates for small cracks in rubber components.

ECCMR 2005, KTH, Stockholm, Sweden, 27-29 June.

A.D. Roberts, A.V. Chapman and N. Mari

Leaching studies on tyres and buffings: literature and experiments.

ETRA Conference 2005, DIK, Brussels, Belgium, 2-5 March.*

A.J. Tinker

TPEs - What They Are And How They Work.

Manchester Polymer Group, 7 February.*

A.J. Tinker

Technical support for the Malaysian rubber industry.

Business opportunities in Malaysia Seminar, Malaysian Rubber Economic and Technical Mission to France, Italy and Germany, September.*

A.J. Tinker

Emerging technologies driving the rubber industry.

Rubber Planters' Conference 2005, Kuala Lumpur, Malaysia, November.