Rubbercon '81

THE INTERNATIONAL RUBBER CONFERENCE

8-12 June 1981

Volume II

Theme and objectives

The science of technology and its profitable and practical application to the rubber industry will be the theme of RUBBERCON 1981. Changing applications of polymers, and the innovations that will result from processing the wide range of natural and synthetic polymers, urethanes and thermoplastic elastomers available will be reviewed. As rubber is a multi-discipline industry, the conference will aim to bring together chemists, physicists, engineers, designers and technologists. It will try to build bridges between these experts, to cross-fertilize their ideas and to break down inter-disciplinary and international barriers.

CONFERENCE CHAIRMAN

J M Buist

CONFERENCE COMMITTEE

P Hill
G F Morton
A J Smith
A G Thomas
D M Turner
M J Whelan
R E Whittaker

CONFERENCE SECRETARY

R H Craven

The Plastics and Rubber Institute
11 Hobart Place
London, England, SW1W OHL

Telephone: 01 245 9555

Cables: Plarubinst London-SW1

Telex: 912881 Plarubinst

ISBN 0-903107-32-5

THE INTERNATIONAL RUBBER CONFERENCE 1981

Volume II

CONTENTS

F7 Withdrawn

F8 REP injection moulding press and micropressor
R S H Farrer

SESSION 7G - REINFORCEMENT

G1 Filler choices in the rubber industry - the incumbents and some new candidates
E M Dannenberg

G2 A new non-black reinforcing filler for rubber
D G Jeffs

G3 New silica filler for rubber compounds
L Gonzalez Hernandez, L Ibarra Rueda, C Chamorro Anton, A Rodriguez Diaz

G4 The effect of cure system modifications on the performance of silica containing tread compounds
K M Davies and R Lionnet

G5 The influence of treated carbon blacks on the capillary viscoelastic and vulcanizate properties of rubber
W A Brown and A C Patel

G6 Properties of thermoplastic rubbers based upon polyolefin blends
D C Blackley, Y F Kam and K S Lee

G7 A review of short-fibre-rubber composites
T Eccersley

CONTRIBUTORS' BIOGRAPHICAL NOTES

Mr K Yokose graduated in industrial chemistry course of the faculty of engineering from Kyoto University in 1941. He joined Sumitomo Electric Industries Ltd in 1942, and was engaged in the business of research and development. Appointed Director, Technical Manager of Sumitomo 3M Company in 1960. Appointed Director of Sumitomo Electric Industries, Ltd in 1969. Transferred to Sumitomo Rubber Industries, Ltd and appointed Managing Director of the same in 1974. Appointed President of the same in 1980.

Dr W Coppens obtained a PhD in Chemistry at the State University of Gent (Belgium) in 1971. Meanwhile he joined the Research Centre of the N V Bekaert in 1980. Since then he is project manager of different projects in the Research Centre, one of which concerns the adhesion of steel cord to rubber.

Dr T R Manley, DSc, C Chem, FRSC, APRI, C Eng, MIEE, was educated at St Joseph's College, Dumfries and the University of Glasgow. After industrial experience with Geigy, ICI, Reyrolles and Formica he joined Newcastle Polytechnic in 1962. He gave the first paper on DTA of polymers in the UK in 1960 and pioneered the application of far infra red spectroscopy to polymers. At present he is visiting Professor in the University of Gezira.

Mr F W Hampson M Phil, C Chem, FRSC, FPRI, MBIM, MIIM, Society of Chemical Industry Prize Winner 1972 was educated at Rutherford College of Technology and Newcastle Polytechnic, and is Divisional Technical Administrator for the Dunlop Company Gateshead factories. As a practising industrialist since leaving school he has been responsible for the successful management of research, development, process and production departments in four Dunlop Divisions, as well as having national and regional responsibilities with the Manpower Services Commission, RPPITB, TEC and PRI for the Education and Training of young people entering industry.

Mr K G Ashness graduated from UEA with an Honours degree in Chemistry in 1975 and with an MSc in Chemical Spectroscopy in 1978. He subsequently undertook a CASE studentship for research in Environmental Chemistry at both RAPRA and Loughborough University, and will graduate in July 1981. In January 1981 he took up employment with Hazelton Laboratories in Harrogate, North Yorkshire.

Dr G Lawson graduated with an Honours degree in Chemistry from the University of Kent at Canterbury in 1968. He obtained a PhD from the same Institute in 1972 for research studies in Instrumental Mass Spectrometry. This work was continued until 1975 when he joined RAPRA to work in the Environmental Centre. As Project Manager within the Environmental Services Group he is currently responsible for the provision of many analytical services to the polymer industry.

Dr B G Willoughby graduated with an Honours degree in Chemistry from UMIST in 1966. He carried out research in that Institute until 1972 and obtained a PhD in 1971 for his researches into fluoropolymers. Before leaving UMIST he completed a two-year fellowship on polymer reactions and joined RAPRA to work in associated fields. In 1976 he was promoted to Principal Chemist, having responsibilities in projects management and as a Divisional Consultant on polymer and analytical chemistry.

Dr P S Johnson graduated with an Honours degree in Chemistry in 1959 and D.Phil in 1962 from Oxford University. In 1976 he received a masters degree in Business Science from Waterloo University, Ontario, Canada. He joined Shell Chemical Company in 1962. In 1967 he transferred to Polysar Limited in Sarnia, Ontario. His current position is Advisor on Processing Technology in the Technical Development Department.

Mr P K Freakley joined the Michelin Tyre Company in 1963 as a mechanical engineering apprentice and obtained a Higher National Certificate while with the company, later taking a post as quality/process control engineer. He then obtained a Grad. PRI at the National College of Rubber Technology and spent one year with Woodville Polymer Engineering Company, prior to taking up his present post as lecturer in the Institute of Polymer Technology, at Loughborough University of Technology, in 1973.

Dr A Van Meerbeerk obtained a PhD in chemistry from Louvain University (Belgium) in 1973. He joined Glaverbel in 1973, transferring to Monsanto in 1975 where he worked in research and development department. Since 1977, he joined the Marketing Technical Service of Monsanto as a rubber technologist.

Mr J R Davies obtained the Royal Institute of Chemistry Graduateship in 1958 and was elected to ARIC in 1960. He has wide industrial experience in Textile industries (1950-1956); Atomic Energy Authority (1956-1962) and Natural Rubber Research (NRPRA) (1962-1968). He joined Monsanto in 1968 and transferred to Monsanto Europe in Belgium in 1972 and was responsible for customer technical service to Eastern Europe. In 1980 he was appointed Group Leader, Industrial Rubber Products, Marketing Technical Service responsible for Europe/Africa. He has published 20 scientific papers and was elected to the fellowship of the Royal Society of Chemistry in November 1980.

Dr M A Wheelans graduated with an Honours degree in chemistry from the Northern Polytechnic, London University in 1953 and obtained a PhD in 1956. He obtained ANCRT and AIRI qualifications in 1957 while studying polymer science and technology at the National College of Rubber Technology. He joined the Malaysian Rubber Producers' Research Association in 1957 where he is now a principal scientist/technologist. He was awarded a Fellowship (FIRI) in 1974.

Mr H Ellwood has worked for Farrel Bridge for many years in the design and development of mill room equipment. The inventor of the MVX, he is the holder of over 15 patents on mill room and associated equipment. His present position is Manager - New Products at Farrel Bridge.

Dr E M Dannenberg received the Bachelor of Science and Master of Science degrees in Chemical Engineering from the Massachusetts Institute of Technology. He was awarded the degree of Docteur es Sciences Physiques by the Universite de Mulhouse, France. Most of his professional career was with the Cabot Corporation, USA, where he held the positions of Vice President of Research and Development, Scientific Director, and Corporate Research Fellow. He is presently a private consultant specializing in raw materials for the rubber industry. Dr Dannenberg is past Chairman of the Rubber Division, American Chemical Society, a Fellow of the PRI, and the US representative on the International Rubber Conference Committee.

Dr D G Jeffs graduated in chemistry at Kingston Polytechnic in 1967, while working for Van Leer (UK) Ltd. He joined English China Clays in 1968 and was engaged in studies on the surface chemistry of clays until 1975. He then transferred to the Paint and Polymer Division of ECC International, where he has led a research group investigating the use of mineral fillers in paint, rubber and plastics.

Mr L Gonzalez Hernandez graduated in chemistry from La Laguna (Tenerife) University in 1963 and obtained the doctor degree with honours in Madrid University in 1968. He joined the "Instituto de Plasticos y Caucho" IPC, (CSIC) in 1969, and was promoted to Senior Scientist in 1971.

Dr L Ibarra Rueda graduated in Chemistry from Madrid University in 1967, and obtained the doctor degree with honours from the same University in 1972. He joined the IPC in 1974.

Mrs C Chamorro Anton graduated as a Chemical Engineer in 1970. She joined the IPC in 1976.

Mr A Rodriguez Diaz graduated in chemistry from Madrid University in 1976. He joined COMSIP AUTOMACION, SA in 1977. Since 1979 a Research Fellow at IPC.

Dr W A Brown graduated with a PhD degree in Inorganic Chemistry from the University of Texas in 1961. He worked for the Aluminium Company of America and the Shell Chemical Company before joining the Carbon Black Division of Ashland Chemical in 1968. He is presently the Manager of Carbon Black Research at the Ashland Chemical Research Laboratory in Columbus, Ohio.

Dr A C Patel graduated with a PhD degree in Geology from the University of London. He joined Ashland's Carbon Black Research Laboratory in 1969 and is presently a Principal Research Chemist at Ashland's Rubber Products Technical Service Laboratory in Akron, Ohio.

Dr D C Blackley graduated with an honours degree in chemistry from the University of London in 1950. He obtained his PhD from the University of Birmingham in 1953 for work on the kinetics and mechanism of free-radical copolymerisation. He served as a Scientific Officer in the Royal Naval Scientific Service from 1953 to 1957. In 1957 he joined the National College of Rubber Technology as lecturer in Latex Technology. He is currently Reader in Polymer Science and Technology at the National College.

Dr Y F Yam graduated with a first-class honours CNAA degree in polymer science and technology from the National College of Rubber Technology in 1976. He obtained his CNAA PhD in 1979 for work on thermoplastic rubbers carried out at the National College. He is currently working as a Research Fellow at the National College on a project sponsored by the Polymer Engineering Directorate.

Mr K S Lee obtained his ANCRT and APRI (AIRI) from the National College of Rubber Technology in 1958. He joined the British Bata Company in 1958, and transferred to Du Pont UK Ltd in 1961. He joined the teaching staff of the National College of Rubber Technology in 1963, where he is currently Senior Lecturer in Rubber Technology.

TYRE MANUFACTURE IN JAPAN

K.YOKOSE*

During the last ten years the Japanese tyre industry has maintained a steady growth. Raw rubber consumption has increased from 369,000 tons to 704,000 tons. Total industry employees increased from 33,000 to 37,000. Productivity improved from 39 to 19 manhours per ton of product. Heavy oil consumption decreased from 0.8 to 0.4 kilo-litres per raw rubber ton. Quality has improved and product development accelerated.

How has this been achieved?

1) Management strategy concentrates on long term growth rather than short term profit.

2) High capital investment in research, modernisation, productivity and energy saving.

3) Cost reduction through quality improvement and productivity and better use of resources.

4) Personnel motivation.

There is only one trade union operating in any one company. Management and employees agree that improved company performance results in a better life for the individual. The consciousness of belonging to the company comes from a "permanent employment" system without any lay off. The seniority system is still common but pay and promotion are strongly related to performance.

Every employee is trained in quality consciousness. This has resulted in voluntary Quality Circles emerging on the shop floor with the dynamic encouragement of management. SRI had 125 registered quality groups in 1970 rising to 394 in 1980.

Suggestions schemes are given much attention with inter section competition and active follow up. SRI staff made 1,000 suggestions in 1970 and 353,000 in 1980.

There are close relationships and understanding between all levels of employees. Belief in the Company and active participation towards a common prosperity are our greatest assets.

The Japanese people are not "workaholics". They are not so different from other nationalities. The encouragement and drive and mutual trust must come from management.

(A full set of text is separately prepared.)

*Sumitomo Rubber Industries, Ltd., Kobe, Japan

TYRE MANUFACTURE IN JAPAN

K.Yokose*

During the last ten years the Japanese tyre industry has maintained a steady growth. Raw rubber consumption has increased from 370,000 tons (1970) to 800,000 tons (1980). Productivity improved twice and unit oil consumption was halved. Quality has improved and product development accelerated. The paper explains the fundamental management concepts which lie behind this progress.

JAPANESE TYRE INDUSTRY, THE PAST AND THE PRESENT

In a guest room of Sumitomo Rubber Industries in Kobe, there is an old balloon tyre kept in a glass case. This is a historical tyre made in 1913 as the first automobile tyre in Japan by Dunlop Rubber Co.(Far East)Ltd., the original predecessor of S.R.I.

Since that cradle age, the Japanese tyre industry grew gradually, and in 1941 when World War II broke out, total claimed production capacity was 16,000 raw rubber tons. However, as the factories were so seriously damaged during wartime and also as raw material supply was extremely scarce, production output in 1946 was only 3,300 tons.

There was a big technology gap left between Western countries and Japan, and in order to absorb the advanced technology all of the six tyre manufacturers introduced technical aid from U.S.A. and U.K. during the 1950s. Synthetic rubbers, new types of carbon blacks and rubber chemicals, high tenacity rayon and then nylon cords, cord treating machines, modern machines for mixing, component preparation, cover building and curing were introduced during the decade. That was really the induction period prior to the subsequent growth of the Japanese tyre industry.

1960 to 1973 was the period of high economic growth and motorisation in Japan. Road conditions were very much improved, inland transportation was shifted from rail to road, and car ownership became no longer a dream of the people. (Table 1)

*President, Sumitomo Rubber Industries Ltd., Japan

TABLE 1 - Development of motorisation in Japan

	1961	1973	1979
No. of vehicles registered	1,963,555	24,999,281	36,231,013
No. of vehicles per 1000 population	21	231	312
Road pavement (%)	39.9	92.7	93.9 (1977)
Mileage of expressway (km)	-	1,453	2,428

As well as the automobile industry, the tyre industry made rapid progress including the development of radial tyres during this period, and from the material side, much benefit was gained from the expanding Japanese petrochemical industry, as 70% of the raw material for tyres is made from oil.

However, the oil crisis which broke out in late 1973 gave the most serious impact to Japan which is importing almost all its resources from abroad. Like other industries, the tyre industry made strenuous efforts to survive as mentioned later. They rode across the second storm blown in 1978 and at the moment it appears that they have achieved good success.

This is the history of the Japanese tyre industry grown with a close correlation with the automobile industry (Figure 1) and the current status is as shown in Table 2. Quantitywise Japan is the second largest tyre producing country consuming 750,000 tons of new rubber in 1979 next to the giant U.S.A. who consumed about 2,000,000 tons in 1978. Total industry employment was 37,000 in 1979.

TABLE 2 - New rubber consumption in tyre industries in 1979

	(1,000 ton)	
U.S.A.	1,968	(1978)
Japan	750	
France	338	
Germany	287	
U.K.	187	
Italy	183	

(Ref IRSG Rubber Statistical Bulletin Vol 35, No.4 January 1981)

Sales are divided nearly equally into 3 sectors of the market, i.e. domestic replacement, OE market and export, and the trend has not changed very much during the last several years as seen in Fugure 2.

BACKGROUND OF THE PROGRESS

Characteristics of Japanese industries

Japan is a country which lacks natural resources and the only practical way for some 116 million people to enjoy cultural lives is to import raw material and to process it into valuable products for export. You may see it well in Table 3, indicating how much we depend on imported resources and even food as compared with other industrial nations.

TABLE 3 - Dependence of major resources on importation in 1978

	Japan	U.S.A.	U.K.	Germany	France	
	%	%	%	%	%	
Total energy	92.4	21.9	21.2	56.9	81.4	Remarks
Coal	75.2	△ 7.9	△ 0.1	△ 9.8	51.3	△ denotes export.
Oil	99.8	37.7	45.6	95.0	97.7	
Natural gas	82.6	4.5	7.8	62.3	70.6	
Iron ore	98.4	30.4	78.7	96.4	39.6	
Wheat	93.8	△ 229.5	30.4	8.8	△ 37.9	
Timber	66.4	2.7	73.8	16.8	10.2	

(Ref White Paper, International Trade and Industry (1981)

It is the fate of Japan. The management philosophy in industry is based on this recognition, and managerial actions come from it. But the aim of management is achievable only through people, therefore, the most efficient way is to motivate them so that everyone contributes actively to the growth of the company rather in the manner of 'bottom-up' when the 'top-down' management strategies are prosecuted by them. To that end, good communication between employees and management is vitally important.

Social and cultural circumstances in Japan are very favourable for realising this thought, but the important thing is how to reflect them practically and efficiently in company management and to give people a life worth living.

Socail welfare is supported by both governmental and private sectors, but in Japan the weight is still higher in the private sector than in Western countries and management responsibility for the employees is all the more important in Japan.

Investment on a long term basis

Investment on a long term basis is important anywhere and anytime, but it is never easy for the management to operate always in this way, as they must build a strategy often under very difficult financial circumstances and future uncertainties. They are responsible for both employees and shareholders, and then necessary funds must be available.

However, the relative strengths of many industries today, both nationally and internationally, clearly reflect the degree of positive investment made with a long term view. The management of Japanese industry attached great importance to this. Their strategy was concentrated on long term growth rather than short term profit, and high capital was invested in research, modernisation, productivity and energy saving. As a result, for example, capital equipment ratio, i.e. tangible fixed asset/regular employee ratio is higher and the plant age is less in Japan than in other industrial nations, both of which are supporting high productivities in Japan.(Figure 3 and Table 4 on page E1-13)

Figures in these charts are for all manufacturing industries, but this feature is probably more or less the same in the tyre industry, too. As I said before, 1960 - 1973 was the era of high economic growth and motorisation in Japan, and the tyre industry, too, expanded remarkably. However, the profit earned by us was a different matter for many years. But the foundation of the current Japanese tyre industry was made during this period. Since the 1973 oil crisis, investment with long term view has become more important in order to survive under a slowly growing world economy with particular emphasis on research and development and improvement in efficiences.

Long term investment is also important in human resources, about which I will talk later.

Technical developments

One of the responsibilities of technical management is to decide how and when it should commence important developments with limited resources. From this standpoint, I would speak about the history of radial tyre developments in Japan.

In July 1963, the first stretch of the Nagoya to Kobe expressway was opened. It was the dawn of the motorway age in Japan, now extended over 2,800 kms. It urged the development of radial tyres for future road transportation, but these tyres were unknown outside the tyre industry.

In 1965, car radials were commercialised in Japan. At that time the Japanese tyre industry started to expand the production capacity of car radials, although the financial situation was very difficult for most of the tyre campanies. Market reaction was rather cool at first, but in several years the radial became popular in the replacement market and was then adopted by car makers starting from the fitment to their cars for export. On the whole, the shift from the crossply to the radial was rather gradual in Japan as seen in Figure 4a. Progress of radialisation in the U.S.A., however, was much different. From the late 1960s, the belted bias tyre was popularised especially in their OE market. However, the situation changed dramatically in a short period and the proportion of radials increased to 65% in OE and 27% in the replacement markets there in 1975 as seen in Figure 4b. If such a rapid change had happened in Japan, the Japanese tyre industry would have suffered very much, as the OE sector in the car tyre market was much higher in Japan than in the U.S.A.

During the 1970s, under pressure from the OE makers, the performance of car radials was refined to improve steering maneuverability, comfort and noise, essential factors in the vehicle/tyre system. The prime concern in recent years has been the reduction in rolling resistance and tyre weight to improve fuel consumption of cars and we are challenging more and more rigorous requirements from car makers on these aspects.

The development of truck/bus radials was more difficult than that of car radials as the machinery required is completely different from that required for making crossply tyres. It is said that some tyre manufacturers in Japan had started their development work in the mid 1950s, but it was only around 1967/1968 when commercial production was commenced on a small scale, and it took still further time before quantity production started of truck/bus radials. Since then radialisation has progressed steadily to a production level of 38% in 1980, and the products have been much diversified for various uses in domestic and overseas markets.

Although truck/bus radials were originally developed for normal load highway use, service condition for truck tyres is traditionally arduous in Japan, in particular on local roads, and it was necessary to develop more robust radials. Fitment of radials has increased considerably since the oil crisis owing to the significant contribution to fuel saving, but better tread life and retreadability are more and more strongly demanded by cost conscious customers, and OE makers are requesting us to further improve rolling resistance and to reduce tyre weight to the minimum.

All these developments in product improvement and diversification were progressed under very keen competition in the market, and behind the progress there were tremendous efforts in research and development and production technology over a very long period of time. Financial support for these activities, as expressed in the R & D expenditure/sales turnover is about 2 - 4% in the Japanese tyre industry, which seems to be higher in other nations.

Another important characteristic which supported the technological developments was total commitment to the consumer in the mind of everyone in the company, about which I will talk next.

Quality

It was remarkable and fortunate for Japanese industry that from early postwar days the various management sciences and methodologies were given close attention by foresighted executives, among which quality control has been most influential.

It was introduced into Japan at first as statistical quality control which was developed in the U.S.A. for industrial application, although the theoretical development of statistics itself owed much to the pioneering studies in Britain as remembered in the works of R.A.Fisher (1924) and E.S. Pearson (1933), which were then formulated to BS 600 in 1935.

In the early stages, in Japan, statistical quality control was mainly of interest to the technical engineers as a useful method in their analytical works, and it took years until the concept permeated to the workplace that quality is to be built in during the manufacturing process and that it can be accomplished by a proper application of statistical quality control.

From the beginning of the 1960s, the concept was further expanded in a way that quality is to be built in during design and processing, eventually towards the concept of total quality control (TQC), which covers every activity of the company from market survey, product development, quality assurance and after-service of the products.

Methodology development from SQC to TQC was going faster in some American leading companies, but there was a significant difference in the manner of execution between the U.S.A. and Japan. In Western nations, QC or reliability activities were performed by the experts, while in Japan, it was emphasised that the same is to be achieved through the participation of everyone.

To implement TQC by this approach, it is necessary for everyone from top management to the workers to be unbiasedly and repeatedly trained and educated to make themselves adaptable to change, and it is particulary important for the management.

A good example of the participation of everyone may be seen in so-called QC Circles, which became a nationwide movement in Japan from the mid 1960s.

The QC Circle is a small group to voluntarily perform quality control activities within the workshop to which they belong and is a part of the companywide quality control activities.

QC Circle movement has become more and more active in recent years, accelerated especially after the oil crisis, and for instance, at Sumitomo Rubber Industries, the registered number of groups increased from 125 in 1970 to 394 in 1980, and the participation ratio against the total number of workers is now more than 130% as many people belong to more than one Circle.

It is not a sort of mental movement but a scientific approach by applying a primary statistical method and technique for identifying and solving the quality problems in the workshop, and is usually headed by properly trained chargehands who take the initiative in their small groups. The principal motive of the movement is that they should not supply the customer with inferior quality and the downstream shops are the customers of the upstream shops. Therefore, the main subjects of the movement are to reduce defective products, to improve the process capability and efficiencies, but it also covers improvement in environment and safety.

The material contribution of QC Circle movement was significant as eventually assessed by cost reduction obtained by higher efficiencies through improved quality, but equally or more important might be hidden contribution as workers developed an intense consciousness of quality and cost, and an actual sense of participating positively to the improvement and development of the company through their voluntary workshop activities. People find their happiness in achieving improvements by displaying their wisdom and being recognised for it, and wish to challenge new targets defined by themselves. It gives them a life worth living as a human, and we do not think it is proper to expect them merely to perform their assigned tasks.

However, as I told you before, QC Circle activity is a part of an integral companywide quality control, and uniform and reliable products can be made only by a quality link starting from market survey and ending at after-services, and the close information feedback established among the respective stages.

Good quality is the prerequisite for good sales. At the same time, from many years experience,it is our strong belief that the best way for reducing cost is through better quality, about which I will reiterate later.

Cost reduction

The oil crisis in late 1973 was literally an oil shock to Japan, and it warned us of the end of the economic growth we enjoyed previously. Like in other nations, sales fell and wages and material cost rose remarkably, but Japan revealed itself to be most sensitive to oil as compared with other nations. (Table 5)

TABLE 5 - Producers cost sensitivities by 10% price increase of imported oil

	All industries	Rubber industry
	%	%
Japan	0.45	0.39
U.K.	0.23	0.11
Germany	0.19	0.05
U.S.A.	0.06	0.01

(Ref White Paper Labour (1980))

The tyre industry, as well as other industries, made utmost efforts to improve its constitution, and in 1976 the industry was restored to the level of 1973, increasing shipments to export market and also to OE makers who were exporting more than 40% of their outputs. However, behind the restoring growth, the effort of the tyre industry itself in improving its efficiency was also significant. (Figure 5 and Figure 6)

What actions have we taken to improve the efficiency?

Although we requested our people to save every penny of unnecessary expense, investment was continued in research and development, plant improvement and modernisation and also computerisation. Each company developed its own production control system to minimise the inventory of finished goods and in-process products and to improve the flexibility suitable for many kind, small lot production.

All led to the improvement in productivity and efficiency, however, here I would mention our basic thought behind the productivity improvement. As briefly referred to in the previous section, it is our belief that the best way for improving efficiency and reducing cost is through better quality control, because it can eliminate the defective product, which is really a waste of material, man power, machine output and energy. Good quality does not mean surplus quality. It involves uniform and consistent quality.

An example may be seen relating to the weight reduction of tyres requested by OE makers in connection with their efforts to improve the fuel consumption of their cars. It is possible to design a light tyre without performance penalty, but it requires higher accuracies in component preparation, assembling and curing, therefore, process capability must be improved at all stages, and in turn, a higher process capability enables us to reduce product weight further. It produces a big material saving even though it may be somewhat offset by the use of better grade materials, besides, it will give us a bonus in energy cost saving. Assuming a factory producing 10,000 covers a day, an average tyre weight reduction by 100 grams could save about 800 - 1,200 kwh electricity a day. It means that annual electricity cost can be reduced by £11,000 - 17,000. This is a very approximate calculation, however, it is important that manufacturing cost can be reduced by improving quality resulting in higher productivity and more efficient utilisation of resources.

It is people who accomplish those objectives along the management strategy, therefore, it is necessary to have good relations established between people, motivate and organise them to attack the clearly defined targets collectively.

<u>Labour - management relation</u>

<u>Labour unions</u>

Labour-management relations are generally good in the Japanese industries. However, it is not a traditional one, and in the early postway days, many enterprises including the leading car manufacturers experienced serious labour disputes and strikes. The tyre industry was no exception, and it appeared the unions were against improvements in productivity.

However, from many lessons experienced over the years by themselves and also from other industries, both management and union learnt a lot, and the spirit of mutual understanding and cooperation has grown up gradually over a long period. Behind the improved labour-management relations, we can not ignore the characteristics of the union and the system of employment in Japan.

Unions in Japan are organised at the company level, i.e. company unions, therefore union leaders have to take into account the financial situation of the company in relation to union activities. It also makes communication easier between labour and management compared with the case of job-based trade unions. Employment in Japan particulary at big companies, is so-called lifetime employment under which the happiness of the employees can never be independent from the prosperity of the company to which they belong. Individuals are naturally sensitive to the performance of the company which reflects their own contribution, while management is responsible for long term stable growth to assure the people better living. In other words, management and employees have the sense of 'we are in the same boat' and it is rather unusual for crew members to move from one boat to another.

When freshmen are employed, graduated from schools, they are given orientation and discipline as social and company members, and they are subjected to training and education by scheduled courses throughout their company lives. On the other hand, all of them are union members until promoted to management and many people have experience of active union involvement. In fact, there are many executives who used to be union leaders.