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Expert Group Meeting on Future Trends in and
Competition between Natural and Synthetic Rubber
Vienna, Austria, 27-30 March 1972

FUTURE TRENDS IN AND COMPETITION BETWEEN NATURAL AND SYNTHETIC RUBBER[1]

(Study)

by

C.W. Robinson & Co., Inc.
New York USA

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id.72-120

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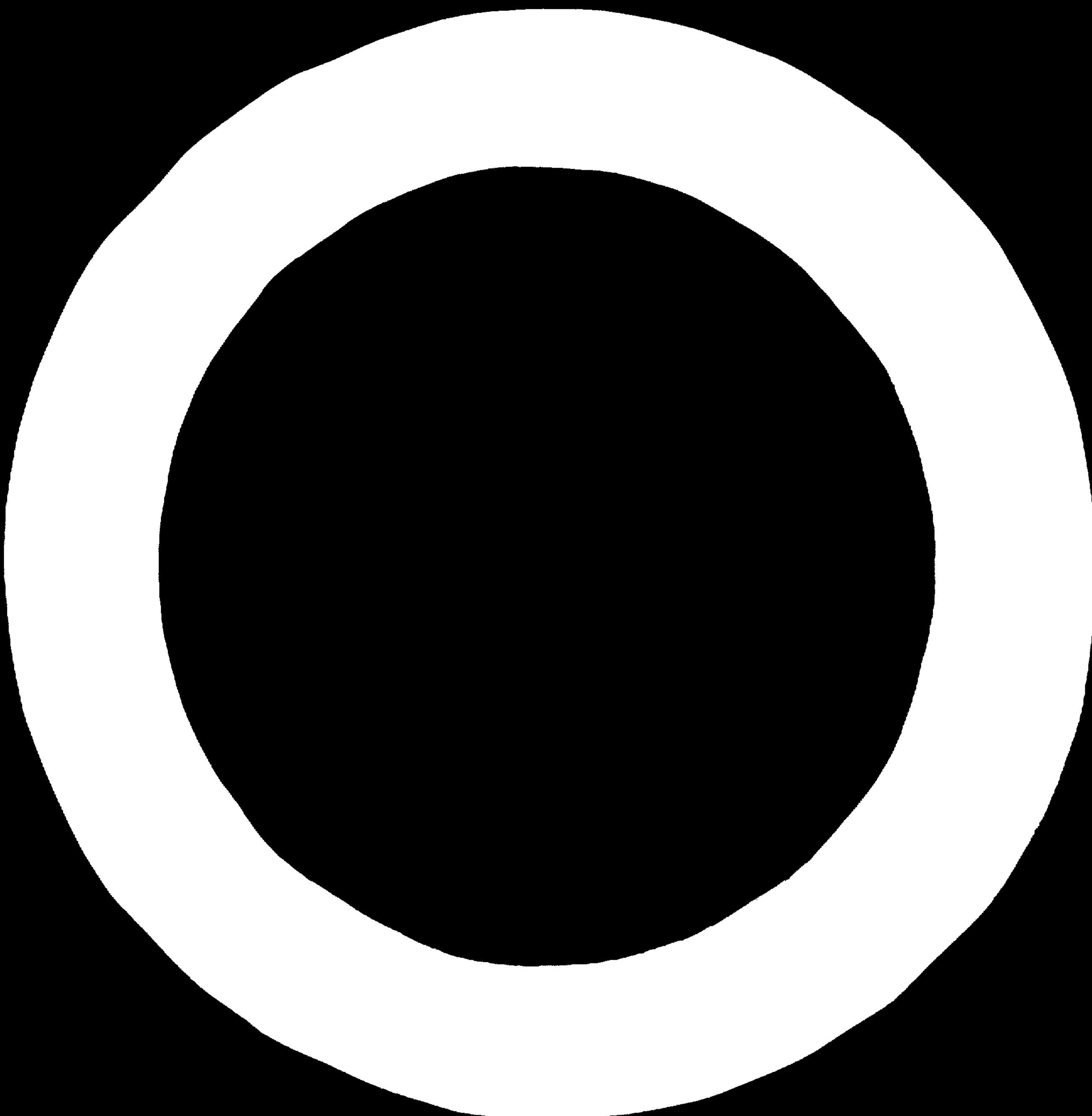

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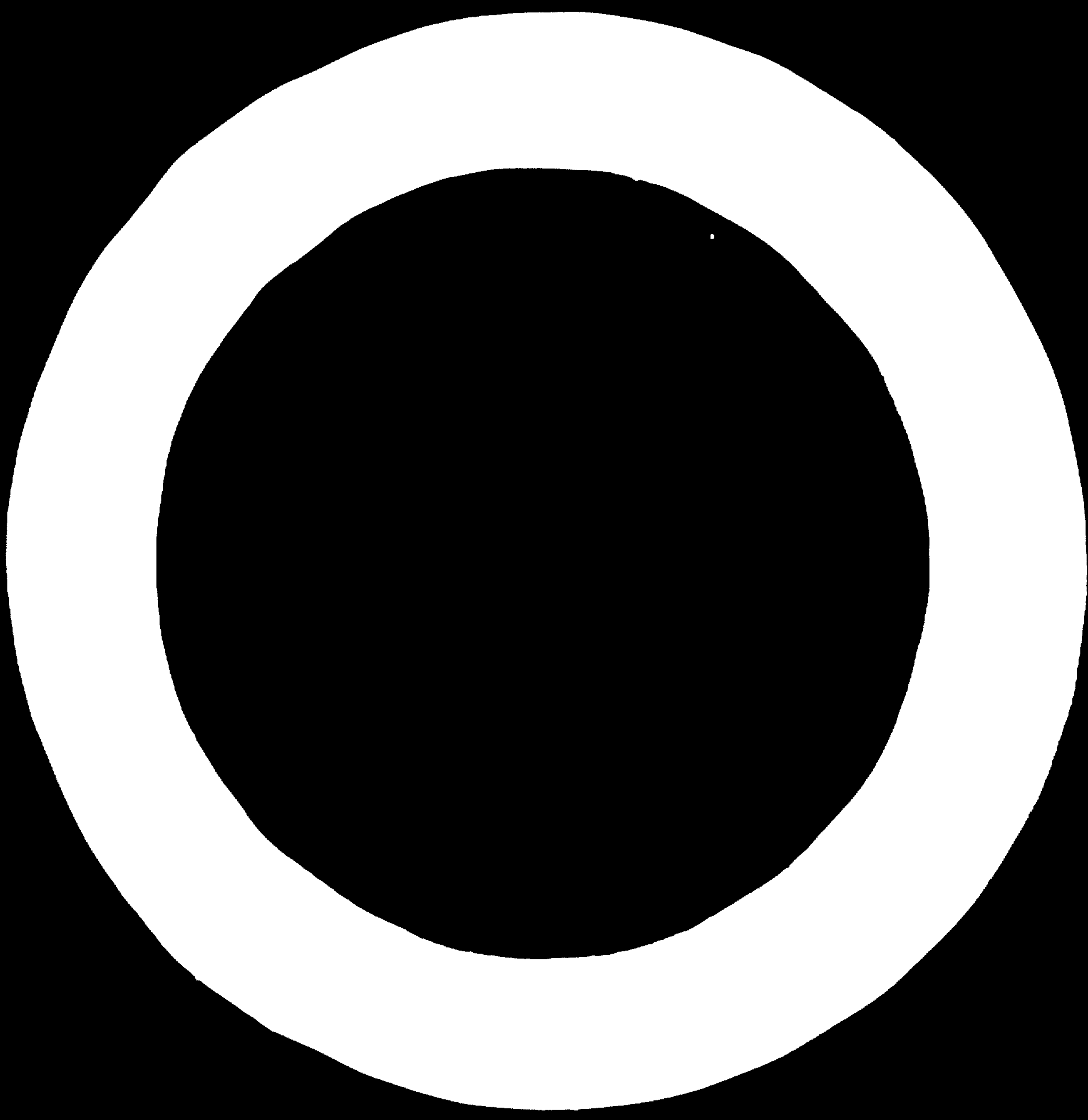

APPENDIX

PREFACE

This report presents a compilation of available data on trends in the rubber industry and its two major segments, natural and synthetic rubber, and projects volumes and prices which may be expected in the decade 1970 - 1980.

The report touches briefly on the history of natural rubber and of synthetic rubber, and summarizes the technological aspects of the various rubbers of significance to the purpose of this report.

The activities of research and development organizations devoted to natural rubber, and the steps being taken to upgrade, standardize, and extend the uses of natural rubber are summarized and the impact of these developments considered in the ten year projections.

Imports of manufactured rubber goods into the developing countries and its existing rubber processing industries in those countries are tabulated.

Conclusions are presented regarding the probable future volume and price trends of natural and synthetic rubbers, and related basic information is included for use by UNIDO and other United Nations agencies with respect to actions that may be

PREFACE - 2

taken in behalf of the natural rubber producing countries of the world.

In order to provide the greatest practical breakdown of information in the various exhibits and tables it was necessary in some cases to use different sources of information for separate exhibits. For example, the figures of "Demand" in Exhibits 8 and 9 represent "new supply of rubber into consuming countries" for both natural and synthetic rubber, whereas the breakdown of "Consumption by Major Sectors" in Exhibits 8A and 9A represent "consumption". As a result, country totals are approximately the same but not identical.

Especial thanks are due to the Executive Office of the International Institute of Synthetic Rubber Producers, the Corporate Planning Office of UNIROYAL, Inc., and their staffs for making available much valuable information from their files, and for their helpful suggestions regarding the report.

INTRODUCTION

Natural Rubber

Rubber has been known since at least the 11th century, and rubber latex has been used for practical purposes, such as waterproofing of clothing, since the 17th century. During the 18th century the French engineer Fresneau made extensive studies of the rubber tree, and it is to him that we owe the first suggestions for the use of dry rubber.

By the middle of the 19th century, following the discoveries of mastication by Hancock, and vulcanization by Charles Goodyear, the number and variety of applications for rubber began to multiply. Although first invented in 1845, what is now the rubber tire was not put to practical use in bicycle tires until Dunlop reinvented the device in 1888.

Until approximately 1900, all rubber was "wild rubber". Consumption rose from 30 tons in 1825 to 2670 tons in 1860, and with the discovery of vulcanization it increased to 8,000 tons in 1870, and to 50,000 tons in 1900.

Starting in 1896 the British began the development of plantations in Ceylon, Singapore, Malaya, and Borneo, starting from seeds of the trees grown from seeds and seedlings of the Hevea tree which had been brought from Brazil by Henry Wickham in 1876.

Production of wild rubber continued to increase up to a high point of 80,000 tons in 1910, after which it has slowly decreased. At that time, more than 10,000 tons per year were coming from plantations, and from then on world production of rubber soared as shown in table A.

TABLE A

World Consumption of Rubber

1900 - 1940

Tons

1900	53,000
1910	103,000
1920	303,000
1925	563,000
1930	723,000
1935	955,000
1940	1,128,000

Development of Synthetic Elastomers

Production of a synthetic substitute for rubber had occupied research workers for many years. In 1913 a "methyl rubber" was developed in Germany. The Allied Blockade of Germany during World War I cut off Germany's supply of natural rubber, and several hundred tons of methyl rubber were made to help out the situation. It was not very good, and was dropped as soon as natural rubber was again available.

Research continued after the war, and several types of Buna rubber were commercialized on a small scale in Germany in 1936. Around 1930 Thiokol and Neoprene had been commercialized in the United States.

With the advent of the Second World War and occupation by Japan of South East Asia, where most of the rubber plantations had been established, the United States was faced with creating rapidly an industry capable of providing a high tonnage of rubber. The product chosen for this crash program was a styrene-butadiene copolymer, originally known as Buna-S in Germany, which was named GR-S in the United States, and is now referred to as SBR. Production reached 4,000 tons in 1942, and rose to 700,000 tons in 1944. When natural rubber again became available, production of SBR was reduced to a rate of 400,000 tons in 1948, and 300,000 tons in 1949.

Production of natural rubber, which had been 1,500,000 tons in 1940, dropped to below 250,000 tons per year in 1945; but by 1948, the 1,500,000 tons production rate had again been achieved and it rose to over 2,000,000 tons in 1959. Even this quantity was insufficient to meet the demand for rubber, which had reached some 3,750,000 tons by this time.

In 1959 at least 80% of all synthetic rubber was of the SBR type, but Neoprene, butyl, nitrile and polybutadiene rubbers were in use. The most significant development of the 1960's has been commercial production of the so-called stereo rubbers, polybutadiene, polyisoprene and ethylene-propylene.* These rubbers were made possible by learning how to control

*Technically ethylene rubber is not a stereo rubber, but is a solution polymerized rubber as are polybutadiene and polyisoprene.

the growth of polymers in a regular fashion such as is achieved by nature in the biosynthesis of natural rubber. One of the stereo rubbers, polyisoprene, is almost a complete duplicate of natural rubber.

Stero rubbers have been the fastest growing group of products among all the rubbers, world* production having increased from 33,000 tons in 1961 to 862,000 tons in 1969.

*Excluding China and Eastern Europe

Since approximately one-half of the natural rubber is produced by smallholders, this explains the large amount of this type of rubber on the market.

Properties of Natural Rubber

Natural rubber, as it appears on the market, contains small amounts of nonrubber substances in addition to rubber hydrocarbon. These materials, in spite of their low concentration relative to that of rubber hydrocarbon, have a profound effect on the vulcanization of the hydrocarbon and the physical properties of the resulting vulcanizate. Since all of these materials may be presumed to have originated in the latex serum, it is to be expected that the method of preparation of the rubber will influence their amount and final condition. In addition, the latex from which the rubber is obtained may vary because of seasonal, climatological, soil, hereditary, and other biological conditions, with the result that the nonrubber portion of rubber has a variable composition.

To obtain uniformity in natural rubber compounds from the standpoint of day-to-day factory processing, it is necessary for the rubber manufacturer to test and blend the rubber he uses on the basis of its physical properties and rate of cure. If this is not done, serious difficulties both in factory processing and in nonuniform products will be encountered.

Types of Natural Rubber Available - RMA Specifications

Natural plantation rubber has been classified by the Rubber Manufacturers Association (RMA), representing factory consumers in the U.S.A., as to types and grades. The type refers to the kind of preparation given to the rubber. The grade refers to arbitrary subdivisions or classifications in a given type based on the quality. Quality is determined by visual examination and depends on color, cleanliness (freedom from dirt, bark, and other foreign materials), freedom from blemishes, and general uniformity. Definite grading standards have been established for 9 types of plantation rubber. Other grades of rubber which appear on the market are not bought or sold on a standard contract but are considered on the basis of representative samples from the lot under consideration.

The standard types and grades are:

Ribbed Smoked Sheets

Nothing but ribbed smoked sheets of rubber can be used in making these grades; cuttings, block, or frothy sheets, or other scrap, air-dried sheets or smooth sheets not permissible.

No. IX RSS: Superior Quality Ribbed Smoked Sheets

No. 2 RSS: Good Fair Average Quality Ribbed Smoked Sheets

No. 3 RSS: Fair Average Quality Ribbed Smoked Sheets

No. 4 RSS: Low Fair Average Quality Ribbed Smoked Sheets

No. 5 RSS: Inferior Fair Average Quality Ribbed Smoked Sheets

Thick Pale Crepes

These grades must be produced from the fresh coagula of natural liquid latex under conditions where all processes are carefully and uniformly controlled. The rubber is creped out in thickness corresponding to the type sample.

No. IX: Superior Quality Thick Pale Crepe

No. 1 : Standard Quality Thick Pale Crepe

No. 2 : Good Fair Average Quality Thick Palish Crepe

No. 3 : Fair Average Quality Thick Off-Color Palish Crepe

Thin Pale Crepes

These grades must be produced from the fresh coagula of natural liquid latex under conditions where all processes are carefully and uniformly controlled. The rubber is creped out to produce crepe in thickness corresponding to the type sample.

No. 1: Standard Quality Thin Pale Crepe

No. 2: Good Fair Average Quality Thin Palish Crepe

No. 3: Fair Average Quality Thin Off-Color Palish Crepe

Estate Brown Thick Crepes

These grades are made from lump and other high-grade rubber scrap generated on rubber estates. Tree bark scrap, if used, must be precleaned to separate the rubber from the bark. Power wash mills are to be used in milling these grades into a form of crepe of thickness corresponding to the type sample. Use of earth scrap, smoked scrap, and wet slab is not permissible in the preparation of Estate Brown Thick Crepe.

No. IX: Clean Thick Light Brown Crepe

No. 2X: Clean Thick Brown Crepe

No. 3X: Brown to Dark Brown Thick Crepe

Estate Brown Thin Crepes

These grades are made from lump and other high-grade rubber scrap generated on rubber estates. Tree bark scrap, if used, must be precleaned to separate the rubber from the bark. Power wash mills are to be used in milling these grades into a form of crepe of thickness corresponding to the type sample. Use of each scrap, smoked scrap, and wet slab is not permissible in the preparation of Estate Brown Thin Crepes.

No. 1X: Clean Thin Light Brown Crepe

No. 2X: Clean Thin Brown Crepe

No. 3X: Brown to Dark Brown Thin Crepe

Thick Blanket Crepes (Ambers)

These grades are manufactured on power wash mills from wet slab, unsmoked sheets, lump, and other high-grade scrap generated on estates or small holdings. Tree bark crepes, if used, must be precleaned to separate the rubber from the bark. Earth scrap is not permissible in these grades. The rubber is creped out to produce crepe corresponding in thickness to the type sample. These grades were formerly described as Remilled Thick Brown Crepes.

No. 2: Clear Thick Blanket Crepe (Amber)

No. 3: Clean Thick Blanket Crepe (Amber)

No. 4: Clean Thick Blanket Crepe (Amber)

Thin Brown Crepes

These grades are manufactured on power wash mills from wet slab, unsmoked sheet, lump, and other high-grade scrap generated on estates or small holdings. Tree bark scrap, if used, must be precleaned to separate the rubber from the bark. Earth scrap and smoked scrap are not permissible in these grades. The rubber is creped out to produce crepe corresponding in thickness to the type sample. These grades were formerly described as Remilled Thin Brown Crepes.

No. 1: Clean Thin Superior Light Brown Crepe

No. 2: Clean Thin Light Brown Crepe

No. 3: Clean Thin Brown Crepe

No. 4: Thin Brown to Dark Brown Specky Crepe

Flat Bark Crepe

This material is produced on power wash mills out of all types of scrap rubber, including earth scrap.

Standard Flat Bark Crepe

Hard Flat Bark Crepe

Pure Smoked Blanket Crepes

Standard Quality Pure Clean Smoked Blanket Crepe. This grade is made by milling on power wash mills smoked rubber derived exclusively from Ribbed Smoked Sheets (including blocked sheets), or Ribbed Smoked Sheet Cuttings. No other type of rubber shall be used, and no nonrubber material shall be added. Rubber of this type is clean, firm, tough, and retains an easily detectable smoked sheet odor.

Technically Classified Rubber

Technically classified, or T.C., rubber is natural rubber which is tested by the producer and marked on the bale to indicate, in addition to its regular market grade, whether it is slow, medium, or fast curing. These marks are colored circles:

1. A red circle indicates slow curing, low modulus less than 427 psi. for No. 1 RSS (in ACS-1 test recipe, cured 40 minutes at 260° F).

2. A yellow circle indicates medium curing, medium modulus between 427 and 711 psi. for No. 1 RSS (in ACS-1 test recipe, cured 40 minutes at 260° F).

3. A blue circle indicates fast curing, high modulus greater than 711 psi. for No. 1 RSS (in ACS-1 test recipe, cured 40 minutes at 260° F).

T. C. rubber can be ordered in the ordinary way through the regular trade channels in the New York and other world markets. The basis of sale is the RMA grade.

Best Uses for Natural Rubber

Prior to the advent of synthetic rubber, natural rubber was used for all rubber purposes. Since synthetic rubber became available, some of the uses of natural rubber have been lost to synthetics, either because synthetic does a better job, or because they are lower in price, or for both reasons.

The rubber products for which natural rubber is preferred are those where these properties are necessary:

High Resilience

Low Hysteresis

Low Heat Buildup

A study in 1954, based on U.S. statistics for the years when it was necessary to use as little natural rubber as possible, found that these uses represented about 27% of total general purpose rubber usage (not including latex). The products for which natural rubber is preferred include heavy duty tires for trucks, buses and airplanes, and certain types of mechanical goods and drug sundries.

Concurrently, products for which general purpose synthetic rubber is preferred to natural rubber include passenger car tire treads, retreading materials, mechanical goods such as

Characteristics and Uses of Rubber

The properties which make any rubber useful are:

Elasticity
Flexibility
Strength
Toughness
Impermeability to water and air
Resistance to cutting, tearing and abrasion
Inertness to the deteriorating effects of the atmosphere and many chemicals

The processing characteristics which make rubber highly valuable as a primary raw material are:

Ease of blending with powders and oils used in compounding
Plasticity of the compounded stock
It is thermoplastic until cured
Building "tack" of uncured rubber, which makes relatively simple the fabrication of a composite article from many separate pieces.
Ease of curing by vulcanization

Prior to the advent of synthetic rubber, natural rubber was used for all rubber purposes. Considerable research had been done on the synthesis of rubber beginning in 1860, but efforts to make possible production of synthetic rubbers on an industrial scale, were encouraged in 1910 because the rapidly increasing demand caused by the commercial development of the motor car was not being met by the small volume of imported rubber, as the plantations were then only in their early stages, although, as mentioned above, the Germans did develop a "methyl rubber" which was later abandoned.

Subsequently, prior to World War II, efforts were expended on producing synthetic rubbers with use characteristics superior to those of natural rubber, e.g. "Neoprene", with its resistance to weathering and attack by heat, oils and a great number of chemicals; and nitrile rubber, which exhibits a high degree of resistance to attack by oils, both at normal and elevated temperatures. Following World War II came the polyacrylate rubbers with their excellent resistance to sunlight, ozone, and sulphur-bearing oils at high temperatures; butyl rubber with its impermeability to air, which made it the "inner tube rubber"; Hypalon (sulfonated polyethylene) with its complete resistance to ozone, weather resistance, heat resistance, color stability, and a high order of resistance to oxidizing chemicals such as nitric acid, sulfuric acid, etc.

Today, nearly every rubber product can be satisfactorily manufactured with synthetic rubber as a partial or total replacement for natural rubber. There are, in fact, no applications where natural rubber must necessarily be used for technical reasons- but there are some products which can only be made satisfactorily with one of the "specialty rubbers" such as Neoprene, nitrile, Hypalon, etc.

Relative Advantages of Natural and Synthetic Rubbers

The forced use of SBR rubbers during World War II, especially in tires (which for more than three decades have represented by far the major use of rubber), demonstrated the wholly practical value of this rubber for passenger car tires. The fact that SBR can be "extended" up to as much as 27% oil content in oil masterbatches, with corresponding reduction in price per pound, makes this synthetic even more attractive to the tire manufacturer. Furthermore, the processing of synthetic tread stocks requires roughly 33% less milling time because the plasticising step for natural rubber is eliminated.

Thus the use of natural rubber in passenger car tire treads has probably been lost forever, except for a thin layer of natural rubber cement which must be applied to the surface of the coated fabric of the tire to overcome the major defect of most synthetic rubber stocks - lack of "green tack" - and obtain satisfactory green adhesion in assembling the tire.

On the other hand, natural rubber has certain qualities much superior to SBR. These are high resilience, low hysteresis, and low heat build-up. In heavy duty tires for airplanes, trucks and buses, these qualities are of paramount importance, and in this field natural rubber continues to hold a major position. Even here, however, the superior abrasion resistance of SBR carbon black stocks, and their outstandingly superior resistance to tread cracking, have led to their incorporation with natural rubber in the treads of these tires. Furthermore, use of synthetic rubber in carcasses of larger truck tires is being studied.

The SBR rubbers have also taken over the field of industrial products and mechanical goods to a large extent. Because these polymers are synthetic, fabricators can deliberately introduce variables to achieve desired end product properties. Furthermore, various formulations of the synthetic rubbers are available "off the shelf" from a number of private producers. For example, there are no less than 18 distinct Neoprenes, and 3 Hypalons available, each with specific end use or processing characteristics.

Industrial product and mechanical goods applications where natural rubber has advantages over the synthetics are largely limited to dipped goods (gloves, apparel and balloons) where better tear resistance qualities have enabled natural latex to retain a substantial share of the market; thread, where the natural latex product wears and washes better than that made with competing materials; and adhesives, where natural latex is preferred 2 to 1 in the United States.

EXHIBIT 2 - 1

INTERNATIONAL ORGANIZATIONS INTERESTED IN NATURAL AND SYNTHETIC RUBBER DEVELOPMENT AND TRADE

NORTH AMERICA

UNITED STATES

International Institute of Synthetic Rubber Producers
45 Rockefeller Plaza
New York, New York 10020
Managing Director: Ralph Lamberson

International Synthetic Rubber Safety Association
Cahirman: Edwin E. Atteberry
Sinclair Petrochemicals, Inc.
Lyondell Plant, P. O. Box 777
Channelview, Texas 77530

Natural Rubber Bureau
15 Atterbury Boulevard
Hudson, Ohio 44236
President S. T. Semegen
Director, Public Relations:
S. R. Dubrowin
1108 16th Street, N. W.
Washington, D. C. 20036

EUROPE

ENGLAND

Institution of the Rubber Industry
4 Kensington Palace Gardens
London W.8
Director: L. R. Mernagh

International Rubber Research and Development Board
19 Buckingham Street
Adelphi, London W.C. 2
Secretary: George Martin

Rubber Growers' Association
Plantation House
1015 Mincing Lane
London, E. C. 3
Chief Executive Officer: W.G.G. Kellett
Secretary : M. D. Eyles

Rubber Industry Standards Committee
2 Park Street
London, W. 1

Rubber Secretariat, Int'l. Organization for Standardization
2 Park Street
London, W. 1

Secretariat of the Int'l. Rubber Study Group
Brettenham House
5-6 Lancaster Place
London, W. C. 2
Secretary: P. F. Adams

FRANCE

Union des Planteurs de Caoutchouc
3 Square Petrarque
Paris 16
Secretary General: R. Fabre

AFRICA

SOUTH AFRICA

Institution of the Rubber Industry - South African Section
Transvaal Branch: P. O. Box 131, Alberton
Natal Branch: P. O. Box 2013, Durban
Eastern Province Branch: P. O. Box 862, Port Elizabeth

EXHIBIT 2 - 3

ASIA

INDIA

Institution of the Rubber Industry - Indian Section
Leslie House, 19 Chowringhie
Calcutta 13

MALAYSIA

Malayan Rubber Fund Board
Natural Rubber Building
P. O. Box 508
Kuala Lumpur
Controller of Rubber Research & Chairman of the Board:
Dr. L. Bateman

EXHIBIT 3 - 1

PUBLICATIONS RELATED TO NATURAL AND SYNTHETIC RUBBER

NORTH AMERICA

UNITED STATES

Adhesives Age
101 West 31st Street
New York, New York 10001

Chemical & Rubber Industry Report
Business and Defense Services Administration
U. S. Department of Commerce
Washington, D. C. 20025

Fabricoater - Haartz-Mason, Inc.
Watertown, Massachusetts

Journal of Applied Polymer Science
605 Third Avenue
New York, New York 10017

Journal of Polymer Science
605 Third Avenue
New York, New York 10017

Natural Rubber News
Natural Rubber Bureau
1108 Sixteenth Street, N.W.
Washington, D. C. 20036

Proceedings of the International Institute for Synthetic Rubber Producers
45 Rockefeller Plaza
New York, New York 10020

Rubber Age
101 West 31st Street
New York, New York 10001

Rubber Chemistry and Technology
Box 123
University of Akron
Akron, Ohio 44304

Rubber Digest and Newsletter
P. O. Box 4265
Atlanta, Georgia

Rubber Formulary
2811 Adeline Street
Oakland, California 94608

Rubber Red Book
(Directory of the American and Canadian Rubber Industries)
101 West 31st Street
New York, New York 10001

Rubber World
630 Third Avenue
New York, New York 10017

MEXICO

Hule Mexicano y Plasticos, Filomeno Mata 13-11
Mexico, D.F.

EUROPE

ENGLAND

International Rubber Digest (of the Rubber Study Group)
Brettenham House
5-6 Lancaster Place
Strand, London, W.C.

Plastics and Rubber Weekly
Davis House, 69/77 High Street
Croydon, Surrey

Journal of the Institution of the Rubber Industry
4 Kensington Palace Gardens
London, W. 8

Proceedings of the Institution of the Rubber Industry
4 Kensington Palace Gardens
London, W. 8

Polymer Age
25 Lloyd Baker Street
London, W.C. 1

EXHIBIT 3 - 3

Plastics Rubbers Textiles
25 Lloyd Baker Street
London, W. C. 1

Transactions of the Institution of the Rubber Industry
4 Kensington Palace Gardens
London, W. 8

Rubber Abstracts, Rubber and Plastics Research Association of Great Britain
Shawbury, Shrewsbury, Shropshire

Rubber and Plastics Age
25 Lloyd Baker Street
London, W. C. 2

Rubber Developments
19 Buckingham Street
Adelphi, London, W.C. 2

Rubber Journal
Davis House, 69/77 High Street
Croydon, Surrey

Rubber Statistical Bulletin
Brettenham House
5-6 Lancaster Place
Strand, London, W. C. 2

Rubber Statistical News (of the Rubber Study Group)
Brettenham House
5-6 Lancaster Place
Strand, London, W. C. 2

Rubber Trends
27 St. James Place
London, S. W. 1

Soviet Rubber Technology
c/o Maclaren & Sons
Davis House
69/77 High Street
Croydon, Surrey

EXHIBIT 3 - 4

FRANCE

Plastiques Modernes et Elastomers
40 Rue du Colisee
Paris

Revue Generale du Caoutchouc et des Plastiques
42 Rue Scheffer
Paris 16

GERMANY

Kautschuk und Gummi-Kunststoffe
Eichborndamm 141-167
1 Berlin 52

Kolloid Zeitchrift
Holzhofalle 35
Darmstadt

Kunststoffe
Kolbergerstrasse 22
Munich 27

Plaste und Kautschuk
27 Karl-Heine-Strasse
Leipzig W. 7031

ITALY

L'Industria della Gomma
Via Cesare Battisti 21
Milano 237

SPAIN

Boletin Instituto Espanol del Caucho
Londres 94 bis
Barcelona

SOVIET UNION

Kauchuk i Rezina (Soviet Rubber Technology) Moscow
English translation available in United States from
Palmer Publishing Co., Inc.
101 West 31st Street
New York, New York 10001

EXHIBIT 3 - 5

ASIA AND OCEANIA

AUSTRALIA

Australian Plastics and Rubber Journal
28 Chippen Street
Chippemdale, Sydney

CEYLON

Planter's Chronicle
Colombo

Quarterly Journal of the Rubber Research Institute of Ceylon
Agalawatta

INDIA

Indian Rubber Bulletin
57-B Free School Street
Calcutta, 16

Planters Chronicle
United Planters Assn. of Southern India
Glenview, Coonoor

Planters Journal and Agriculturalist
13 Ezra Mansions
Calcutta 1

Rubber and Plastics Age
Manu Mansion
16 Old Custom House, Road
Bombay 1

Rubber and Plastics Digest
640, Double Story
New Rajinder Nagar
New Delhi 5

In carpet backing, including high density flowed-on foam, scrim lamination, and separate under-carpet cushions, natural latex is maintaining a 41% position in the United States. In overall latex use, natural rubber has maintained a 28 - 30% position for the last few years in both the U.S. and U.K.

Steps to Broaden Natural Rubber's Acceptability

Quality

One of natural rubber's deficiencies is its greater susceptibility to oxidation in comparison with many of the synthetics. Numerous additives have been used to help offset the breakdown which oxygen causes, but all of them eventually leach out of the product during service.

Recently the Natural Rubber Producers' Research Association has developed a technique for adding to the rubber mix an organonitrogen additive which is converted during vulcanization to a new type of anti-oxidant that actually becomes part of the rubber molecule - permanently "locked in", and impossible to wash out.

Among the many benefits to natural rubber possible through this new anti-oxidant are extended life for car tires, more durable carpet backings, and latex thread that can be dry cleaned.

Rubber products are no different from all other products manufactured in the more developed countries, where emphasis is placed on continual improvement of the product and economy in manufacture. These requirements are automatically reflected in demands by the manufacturer for better quality and more rigid adherence to performance specifications in raw materials.

One reason for the great growth in use of synthetic rubbers, entirely aside from the fact that the quantities of natural rubber available were insufficient to meet the total demand, is that the synthetics are made by rigidly controlled processes which result in uniform qualities and performance characteristics, both of which can be varied to meet custom requirements of the trade. Furthermore, any shipments which do not meet specifications can readily be replaced from producers' local stocks, or if necessary from another supplier.

Marketing

Historically natural rubber has been sold by types and grades, type referring to the kind of preparation, and grade (quality) being a determination only by visual examination based on established criteria for color, cleanliness (freedom from dirt, bark, and other foreign materials), freedom from blemishes, and general uniformity.

Up until 1965, when Malaysia established a technical grading and presentation scheme, designated the Standard Malaysian Rubber (SMR) scheme, and developed new processing methods to allow natural rubber to be processed in block form, there were no technical specifications for natural rubber. Since the introduction of SMR grades, technological research at

The Rubber Research Institute of Malaya has developed rubbers offering constant viscosity, low viscosity, superior processing properties, and oil extension, as well as various special purpose rubbers.

Obviously these developments and standards will be of little value unless all rubber shipped conforms to its labeled specifications. To guarantee the integrity of the SMR grading scheme technical control over processing and labeling is exercised by RRIM under the overall supervision of the Malayan Rubber Export Board.

Since 1965, shipments of technically specified natural rubber from Malaysia have been as shown in Table B.

TABLE B

Shipments of Natural Rubber from Malaysia

1965-1970

	Total Rubber	SMR Rubber	
	Tons	Tons	%
1965	919,200	699	.1
1966	965,500	8,573	.9
1967	990,300	23,576	2.4
1968	1,114,300	81,497	7.3
1969	1,292,000	138,715	10.7
1970	1,586,000	224,281	14.1

In 1969 Indonesia, presently the second largest natural rubber producer, took steps to emulate Malaysia in producing technically specified rubbers, designated SIR, identical to the SMR grades. It was expected that Indonesia would ship about 150,000 tons in 1970, and it is considered not impossible that Indonesia may be able in the near future to supply more technically specified rubber than Malaysia.

Uniform Presentation

In 1970 the Association of Natural Rubber Producing Countries (ANRPC) was founded by Ceylon, Indonesia, Malaysia, Singapore, Thailand, and Vietnam. (These countries account for more than 85% of world production). The association is open to all natural rubber producing countries, and the ultimate aim of the organization is to have central regional markets for all rubber produced by member countries. Other countries which have already shown interest are Cambodia, India, Ivory Coast, Liberia, and Nigeria.

Acceptance of the technically specified rubbers by consuming industries has been enthusiastic, and in October 1970 the

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

LATIN AMERICA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Venezuela							
Tires:	Valencia	C.A. Goodyear de Venezuela	Tires & tubes for all types of vehicles	1956	1500	na	
	Valencia	Firestone Inter-america Co.	Tires & tubes	1954	1300	400	
	Valencia	U. S. Rubber International de Venezuela C.H.	Tires, tubes, hose, molded products, canvas footwear	1955	1100	na	
	Caracas	C.A. Nacional Manufacturera de Cauchos y Neumaticos (General)	Tires & tubes, matting, hose, rubberized fabric, etc.	1941	1600	500	
Non-tires:	Caracas	11 plants including 1 retreader	Miscellaneous Products			na	
	Other Places	6 plants including 1 retreader	Miscellaneous Products			na	

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

SOUTH & SOUTHEAST ASIA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Cambodia							
Tires:	Takhman	Societe Nacional	Tires & tubes		500	na	
Non-tires:	Phnom-Penh	24 plants including 2 retreaders	Miscellaneous Products			na	
	Other Places	5 plants	Miscellaneous Products				
Ceylon							
Tires:	Kelaniya	Ceylon Tire Company	Tires & tubes		1000	na	
Non-tires:	Colombo	8 plants including 2 retreaders	Miscellaneous Products			2300	
India							
Tires:	Bombay	CEAT Tyres of India, Ltd.	Tires & tubes	1961	1600	1045	
	Bombay	Firestone Tire & Rubber Co. of India, Pvt. Ltd.	Tires & tubes, fan belts	1950	2300	1900	
	Calcutta	Inchek Tyres, Ltd.	Tires & tubes		700	600	
	Calcutta	Dunlop India, Ltd.	Tires & tubes, belting, hose, repair materials, foam, adhesives	1936	3500	8400	
	Madras	Dunlop India, Ltd.	Tires & tubes	1958	900		

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

SOUTH & SOUTHEAST ASIA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
	Madras	Madras Rubber Factory, Ltd.	Tires, industrial gloves, foam, soles, heels, molded goods, etc.	1962	2500	na	(5)
	Kerala	Premier Tyres, Ltd.	Tires & tubes	1961	1100	1000	
	New Delhi	Goodyear India, Ltd.	Tires & tubes, belting, adhesives, cement	1961	1200	800	
Non-tires:	Bombay	162 plants including 1 retreader	Miscellaneous Products			na	
	Calcutta	173 plants including 2 retreaders	Miscellaneous Products			na	
	Delhi	141 plants including 3 retreaders	Miscellaneous Products			na	
	Jullundur City	72 plants	Miscellaneous Products mostly footwear			na	
	Kerala	46 plants including 1 retreaders	Miscellaneous Products				
	Madras	35 plants including 3 retreaders	Miscellaneous Products			na	
	Other Places	210 plants including 4 retreaders	Miscellaneous Products			na	

(5) Licensed to Build New Truck Tire Plant for 800 Tires per Day

SOUTH & SOUTHEAST ASIA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Indonesia							
Tires:	Bogor	Goodyear	Tires & Tubes		1200	na	(6)
	Djaharta	Intirub (Public Sector)	Tires & tubes		600	na	
	Palemburg	Indorub (Public Sector)	Tires & tubes	due 1972	225	na	
Non-tires:	Djaharta	39 plants including 8 retreaders	Miscellaneous Products			na	
	Java	177 palnts including 47 retreaders	Miscellaneous Products			na	
	Sumatra	44 plants including 17 retreaders	Miscellaneous Products			na	
Korea							
Tires:	Kuangjoo	Sam Yang Tire Industrial Company	Tires & tubes		600	na	
	Pusan	Hung Ah Tire Co., Ltd.	Tires for trucks and other vehicles		1200	na	
	Seoul	Dong Shim Chemical Products Co., Ltd.	Tires & tubes, footwear, hose		1000	na	
	Seoul	Han Kook Tire Mfg. Co., Ltd.	Tires & tubes of all types		1000	na	

(6) $13 Million Expansion Underway

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

SOUTH & SOUTHEAST ASIA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Non-tires:	Pusan	13 plants	Miscellaneous Products			na	
	Seoul	7 plants	Miscellaneous Products			na	
Hong Kong							
Non-tires:	Hongkong	119 plants	Miscellaneous Products			na	
Malaysia							
Tires:	Kuala Lumpur	Dunlop Malayan Industries, Ltd.	Tires & tubes	1963	2800	na	
	Kuala Lumpur	Goodyear	Tires & tubes	due 1973	na	na	(7)
	Klang	Fung Keong Rubber Mfg., Ltd.	Tires & tubes for cars, trucks, footwear, sheeting, hose, mechanical goods		na	1400	
Non-tires:	Kuala Lumpur & vicinity	16 plants (plus 32 retreaders)	Miscellaneous Products			na	
	Other Places	26 plants (plus 144 retreaders	Miscellaneous Products			na	
Singapore							
Tires:	Singapore	Bridgeton Singapore Co. (Pte) Ltd.	Tires & tubes for cars, trucks, buses and cycles, & misc. products	1965	1400	na	(8)
Non-tires:	Singapore	33 plants (plus 29 retreaders)	Miscellaneous Products			na	

(7) Plans Announced for $40 Million Plant
(8) $10 Million Expansion Underway in 1969

SOUTH & SOUTHEAST ASIA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Philippines							
Tires:	Manila	Firestone Tire & Rubber Co. of the Philippines	Tires & tubes for cars, trucks & earthmoving equipment	1957	600	355	
	Manila	B.F. Goodrich Philippines, Inc.	Tires, tubes, soling, heels, battery cases, rubber rolls, etc.	1956	750	628	
	Manila	Goodyear Tire & Rubber Co. of the Philippines, Ltd.	Tires, tubes for all types of vehicles	1956	650	na	
Non-tires:	All Places	15 plants including 1 retreader	Miscellaneous Products			na	
Taiwan							
Tires:	Nan Kang	Nan Kang Rubber Co.	Tires & tubes		300	na	
	Taipei	Yi Tang Rubber Works, Ltd.	Tires & Tubes		350	na	
Non-tires:	Taipei	Formosa Rubber Corp.	Foam, rubberized cloth, boats, water tanks, rubber lining & industrial rubber products		500		
	Taipei	16 plants	Miscellaneous Products		na		
	Other Places	13 plants	Miscellaneous Products		na		

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

SOUTH & SOUTHEAST ASIA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Thailand							
Tires:	**Bangkok**	**Thai Bridgestone, Ltd.**	**Tires & tubes**	**1969**	**1000**	**na**	
	Bangkok	**Firestone Tyre & Rubber Co., Ltd. (Thailand)**	**Tires & tubes for cars, trucks, tractors, farm implements and motorcycles**	**1964**	**1100**	**225**	
	Bangkok	**Goodyear (Thailand) Ltd.**	**Tires & tubes**	**1969**	**1050**	**na**	
	Bangkok	**Uniroyal Tyre Co.**	**Truck tires & tubes**		**200**	**na**	
Non-tires:	**Bangkok**	**6 plants including 1 retreader**	**Miscellaneous Products**			**na**	
South Vietnam							
Non-tires:	**Cholon**	**19 plants including 2 retreaders**	**Miscellaneous Products**			**na**	
	Saigon	**12 plants including 4 retreaders**	**Miscellaneous Products**			**na**	

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

MIDDLE EAST ASIA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Iran							
Tires:	Ghazvin	Dunlop	Tires & tubes	due 1971	na	na	(9)
	Tehran	General Tire & Rubber Co. of Iran	Auto and tractor tires & tubes	1967	1000	na	
		B. F. Goodrich Iran S.A.	Tires & tubes	1961	1000	499	
Non-tires:	Tehran	18 plants including 2 retreaders	Miscellaneous Products			na	
Iraq							
Non-tires:	Bagdad	7 plants including 2 retreaders	Miscellaneous Products			na	
Israel							
Tires:	Hadera	Alliance Tire & Rubber Co. Ltd.	Tires & tubes for all vehicles, automotive & industrial V-belts	1950	2000	750	
	Tel Aviv	Samson Tire & Rubber Co., Ltd. (formerly General)	Tires & tubes for cars, trucks, agriculture implements & motorcycles	1952	1000	500	
Non-tires:	All Places	22 plants	Miscellaneous Products			2000	
Jordon							
Non-tires:	Amman	6 plants including 2 retreaders	Miscellaneous Products			na	

(9) Dunlop and a Minority Partner in New $14 Million Tire Plant

Rubber Trade Association of New York (RTA) unanimously approved an International Contract for trading technically specified rubbers between producers and the rubber trade. The RTA will select testing laboratories in the United States acceptable to the International Contracts Committee representing the Malaysian Rubber Exchange, the Rubber Association of Singapore, the Rubber Trade Association of New York, and the Rubber Trade Association of London.

In June 1971 the International Rubber Research and Development Board (IRRDB) was scheduled to meet in Ceylon to discuss "Technical Specifications and New Developments in Processing Methods in Consumer Countries". It is the opinion of member organizations of IRRDB that a Standard Natural Rubber (SNR) set of specifications will result from the foregoing moves by the natural rubber producing countries.

Production

Production of technically specified rubber is not difficult for estates, but for smallholders central processing mills will be necessary.

In Malaysia in 1970, 20 new processing factories had come into being, and 12 more were under construction. For the smallholders (who produce about 50% of Malaysian rubber) the Malayan Rubber Developments Sendirian Berhad (MRD) - a non-profit company under the Malayan Rubber Fund Board, organized to bring smallholders the benefits of estate processing - was operating 4 central factories, 4 more were on the drawing boards, and many more were under consideration.

In December 1970, the Malaysian Rubber Development Corporation Berhad was formed as a private commercial venture dedicated to setting up factories that will enable smallholders to produce rubber for processing into SMR. Funding is provided by the Federal Government, Malayan Rubber Fund Board, State Governments, and commercial institutions.

In Indonesia, where over 70% of the rubber is produced by smallholders, the Indonesian government has contracted for 12 plants to produce technically specified natural rubber, and 5 additional plants will be built for private interests.

Guatemala has ordered a crumb rubber processing plant* with capacity of 200 tons/month; a similar plant has been ordered for Nigeria; and a 100 tons/month plant has been ordered for Ceylon.

There appears to be no question but that, under proper technical supervision and control, quality requirements, within the range of natural rubber's inherent and research-modified characteristics, can be and are being fulfilled by producers.

* In a crumb rubber plant raw latex is mixed with acid to produce a coagulum which is then passed through a series of rollers which first squeeze out the water in the latex and subsequently chop up or "crumble" the resulting sheet of rubber, so that the rubber comes off the end of the machine in small particles or "crumbs". The crumb is dropped into forms which hold 75 pounds of crumb which is then compressed into 75 pound blocks.

PAST AND FUTURE TRENDS

Natural and Synthetic Rubbers

The uses and trends in consumption of natural and synthetic rubbers are so intermingled that in this section we discuss the rubber industry as a whole as well as in its separate parts.

Statisitcs of past performance for both natural and synthetic rubber will be found in the Appendix in Exhibits 4, 5, 5A, 6, 7, 8, 8A, 9, and 9A.

Production and Demand

Natural Rubber

Actual production of Natural Rubber for the years 1960 to 1970 is shown in Exhibit 4. It will be seen that world production increased about 45% during the decade, while that of Malaysia increased more than 60%. The greatest progress was in India where production increased 260% from 25,000 metric tons in 1960 to 90,000 metric tons in 1970, thus making it the fifth largest producer, having passed Viet nam, Cambodia, Nigeria and Liberia.

Exhibits 6 and Chart 6A show the production of natural rubber by principal grades, i.e. sheets, crepe and latex, as well as the new standard graded rubber (principally Standard Malaysian Rubber). Exhibit 6 also shows the average prices for each year at which the principal types of natural rubber have sold over the decade of the 60's. Because the price of natural rubber has fluctuated widely, each year's high and low prices for RSS#3 are also shown. Chart 6B shows the high, low, and average price for RSS#3, which is representative of the price trend for all natural rubbers. While production of natural rubber has increased 45% over the decade, prices have fallen from a high of $1,041 per metric ton in 1960 to a low of $375 in 1970 -- a drop of 64%.

The recently established Standard Malaysian Rubber has gained acceptance rapidly, and production has made considerable headway. This subject is discussed in more detail in later sections of this report.

Synthetic Rubber

Production of Synthetic Rubber is shown in Exhibit 5. A breakdown by type is available only for the United States and Canada*. Exhibit 5A shows Synthetic Rubber Plant

*See Exhibit 7 for World Total estimates by type of rubber.

capacities by type of rubber for each country and by regions of the world. Exhibit 5B shows the total Synthetic Rubber capacity for each company in each country.

Of particular significance is the fact that while capacity in North America increased only 75% from 1960 to 1971, and there is a planned increase in capacity of less than 6% to 1975, Western Europe has increased its capacity by over 500% from 1960 to 1971, and has scheduled an additional 42% to 1975.

Not only has Japan increased its capacity from almost nothing in 1960 to 942,000 metric tons in 1971, with an increase of one third scheduled for 1975, but the number of companies involved has increased from two to twenty-five -- almost as many as there are in the United States -- although their current individual capacities are generally smaller. However, according to present plans, by 1975 Japanese Synthetic Rubber Co. will be the largest synthetic rubber company in the world, surpassing Goodyear by 12%.

Estimated capacity of the Centrally Planned Countries has increased 80% during the decade of the 60's and is scheduled for a further increase of almost 80% again by 1975. More than half of this increase is in the U.S.S.R.

Exhibit 7A and 7B show the production of synthetic rubber by principal types for the years 1960 to 1970 as well as published prices for four of the general purpose rubbers. It should be noted that, whereas the prices of natural rubber quoted in Exhibit 6 are actual transaction prices on the Rubber Exchange, the prices of synthetic rubber are strictly published prices for single deliveries in ten ton lots. Practically all sales of synthetic rubber are in larger quantities and are made at negotiated prices. Furthermore, large quantities of captive synthetic rubber are handled as intra-company transactions at internally determined transfer prices.

Reference to the table of prices will show wide discrepancies between U.S., French and U.K. prices, and also that U.S.

prices for S-Type rubber and for polybutadiene have remained constant throughout the period*. It is likely that the French and U.K. prices are more realistic than the U.S. prices quoted.

Of particular interest in Exhibit 7 is the rapid growth of the stereo-regular group of rubbers, in which we have included not only polyisoprene, and polybutadiene, but also ethylene-propylene polymers which are also solution type rubbers. This group of rubbers, which have characteristics much closer to those of natural rubber than styrene butadiene, and one of which, polyisoprene, nearly duplicates natural rubber, have shown remarkable growth, starting from nothing in 1959, and surpassing in volume all the specialty rubbers as a group by 1967.

Projections into the Future

In order to make a reasonable projection of natural and synthetic rubber consumption, it is necessary to look at the total use of rubber without distinguishing between the two. There are many different performance requirements for

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*except for polybutadiene in 1963.

rubber products, but in the last analysis most of them can be, and under extreme circumstances are satisfied in reasonable degree by either natural or synthetic rubber.

Past Trends

The growth of world rubber consumption over the last three quarters of a century (see Table C and Chart C) has been phenomenal, with a growth rate of 11.1% from 1902 to 1925, followed by a 5.5% rate of growth from 1925 to 1941 and 6.8% from 1947 to 1970.

United States

From 1915 to 1949, with the exception of only four years (1932, 1937, 1938 and 1942), the United States consumed more than half of the total rubber supply. The average compound growth rate in U.S. consumption from 1907 to 1925 was 15.6%, which included a six year period from 1913 to 1919 when the growth rate was almost 27% a year.

Subsequent to 1925 the U.S. growth rate dropped to an average compound annual rate of 4.15% from 1925 to 1970. Within that

TABLE C

CONSUMPTION OF ALL RUBBER

1900 - 1970

(000 Metric Tons)

	U.S.A.	Rest of World	Total
1900	21	31	52
1901	23	29	52
1902	22	28	50
1903	24	33	57
1904	26	39	65
1905	27	43	70
1906	29	46	75
1907	29	48	77
1908	33	42	75
1909	40	50	90
1910	43	59	102
1911	42	60	102
1912	57	65	122
1913	53	79	132
1914	63	59	122
1915	100	62	162
1916	119	68	187
1917	150	75	225
1918	162	75	237
1919	218	99	317
1920	209	93	302
1921	180	102	282
1922	307	103	410
1923	324	128	452
1924	334	138	472
1925	394	168	562
1926	372	180	552
1927	379	226	605
1928	444	251	695
1929	475	342	817
1930	382	340	722
1931	361	331	692
1932	342	360	702
1933	419	418	837
1934	470	465	935
1935	500	455	955

TABLE C (continued)

	U.S.A.	Rest of World*	Total*
1936	584	478	1062
1937	552	555	1107
1938	444	526	970
1939	604	534	1138
1940	662	510	1171
1941	793	540	1134
1942	401	492	892
1943	496	427	923
1944	723	421	1145
1945	812	334	1146
1946	1056	537	1492
1947	1141	725	1866
1948	1087	971	2058
1949	1005	1060	2064
1950	1279	1230	2508
1951	1233	1323	2557
1952	1281	1321	2602
1953	1361	1443	2805
1954	1253	1574	2817
1955	1555	1724	3279
1956	1459	1900	3360
1957	1489	2041	3531
1958	1387	2270	3658
1959	1655	2463	4118
1960	1585	2751	4336
1961	1554	3022	4576
1962	1746	3239	4985
1963	1793	3429	5222
1964	1965	3698	5663
1965	2088	4107	6195
1966	2248	4468	6716
1967	2151	4630	6781
1968	2518	5169	7687
1969	2665	5700	8365
1970	2458	6060	8518

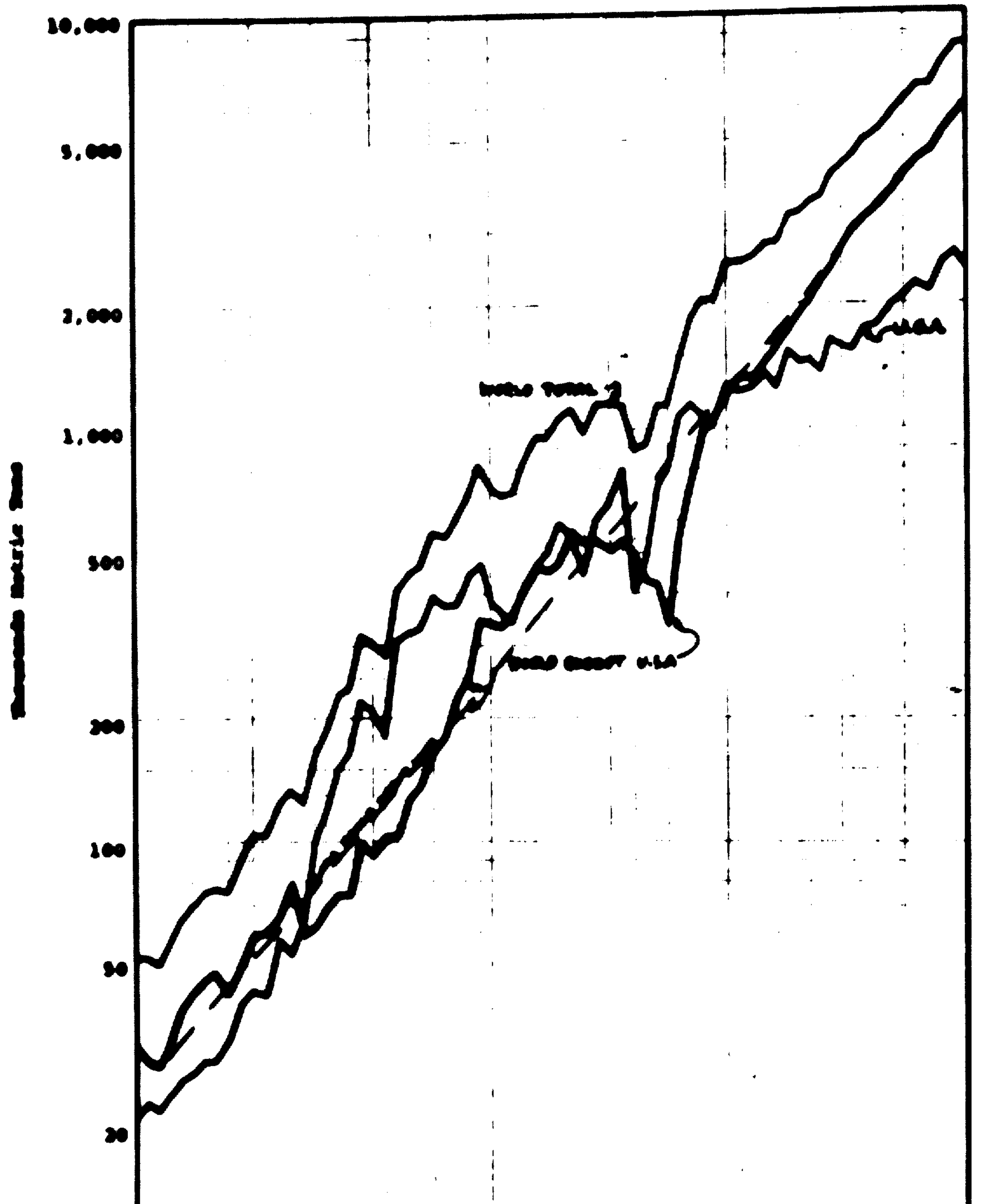
Source: Principally International Rubber Study Group (London). Partially estimated.

Notes: *Excluding Mainland China.

CONSUMPTION OF ALL RUBBER

United States and Rest of World

1900-1970



period, however, the average growth rate was 4.4% from 1925 to 1941; 3.0% from 1946 to 1960; and about 4.7% during the 1960's.

The influence of the United States in world rubber consumption has been particularly marked. The U.S. continues to be the largest consumer of rubber, but Western Europe as a whole will surpass it in 1971 or 1972.

Rest of the World

Looking at consumption in the rest of the world, we find that the long range growth rate has averaged 8.2% per annum over the entire period 1902 to 1970.

In the years before World War II growth was rather sporadic, but from 1920 to 1930 consumption rose steadily at the average rate of almost 14% a year. Since World War II consumption has again grown steadily with an average rate of 9.0% from 1948 to 1960 and 8.2% from 1960 to 1970.

Total Rubber Usage

In predicting the future course of rubber consumption we have first projected the total usage of rubber in each major regional segment of the market, i.e., U.S., Western Europe, Japan, other developed areas of the world, and the developing areas - Latin America, Asia and Africa.

We have noted that the growth rate in the U.S.A. has recently been 4.7% a year. In view of predicted growth in GNP of about 7% and in tire production of about 5% over the decade of the 70's, we estimate the growth in rubber consumption will continue at 4.7% a year during the next ten years (except for short term fluctuations).

Likewise, we have noted that there has been a very strong growth rate of about 8.2% a year in the rest of the world outside the U.S., and that this is a continuation of a long term trend from 1900 through 1970. Because of the 70 year history of that average growth rate and the exceptionally smooth continuation of the 8.2% rate over the decade of the 60's, (See Chart C), we would see no reason to expect that rate to diminish within the next ten years.

If Japan is treated separately, the rate of growth during the 1960's for the rest of the world (except the U.S. and Japan) is 7.6%. It is of particular interest to note that in the various segments of the "rest of the world" the growth rate has been close to that average -- Western Europe with 7.6%, Eastern Europe 6.25 (last five years), Latin America 7.4%, Asia and Africa (Developing) 8.2%. Japan is the real exception, with a growth rate of 13% over the last ten years -- nearly as high as the growth rate for the World except U.S.A. between 1920 and 1930.

These growth rates are not surprising, because all these regions are lagging the U.S. in usage of rubber, and it will be years before they will catch up with the U.S. per capita consumption of about 30 lbs. per person. Whether it be in developed or developing countries, highway transportation, both private and public, are increasing rapidly, and this will remain the largest part of the rubber market for many years. Non-tire uses such as footwear, waterproof products, and molded goods for the consumer; and belting, hoses and cables for industrial use, will probably have at least as rapid a rate of growth from the relatively small current base in developing countries as is occurring in the more industrialized areas of the world.

Percentage of Natural Rubber Used

The relative percentage use of natural rubber has been declining steadily in every country of the world. (See Table D). A plot of the percentage of natural rubber used in the United States (See Chart D) shows a continuous smooth decline (except for the Korean War period) from the first days of synthetic rubber availability after World War II, and shows an unmistakable leveling off at about 20%. It is of interest to note that after natural rubber again became available, the U.S. picked up natural rubber usage at a point apparently roughly equivalent to where it might have been had synthetic rubber become available without the advent of World War II. Every other country has a similar declining curve of natural rubber usage, although each is at its own stage of that decline.

TABLE D

PERCENT NATURAL RUBBER

1939 - 1970 AND PROJECTED TO 1980

	U.S.A.	Rest of World
1939	99.8	97.6
1940	99.5	90.0
1941	99.3	87.5
1942	95.4	80.3
1943	64.8	71.0
1944	26.5	58.0
1945	13.2	47.9
1946	26.7	52.7
1947	50.1	76.8
1948	58.7	83.0
1949	58.1	82.7
1950	57.2	82.8
1951	37.4	81.3
1952	36.0	77.7
1953	41.4	77.5
1954	48.4	76.3
1955	41.5	73.9
1956	39.2	70.4
1957	36.8	67.8
1958	35.6	68.3
1959	34.1	64.3
1960	30.7	58.5
1961	27.9	57.2
1962	26.9	55.2
1963	25.9	52.5
1964	24.9	48.7
1965	25.0	46.2
1966	24.7	45.5
1967	23.1	43.2
1968	23.5	43.6
1969	22.8	41.0
1970	22.2	39.0
1975	21.0	31.0
1980	20.0	26.0

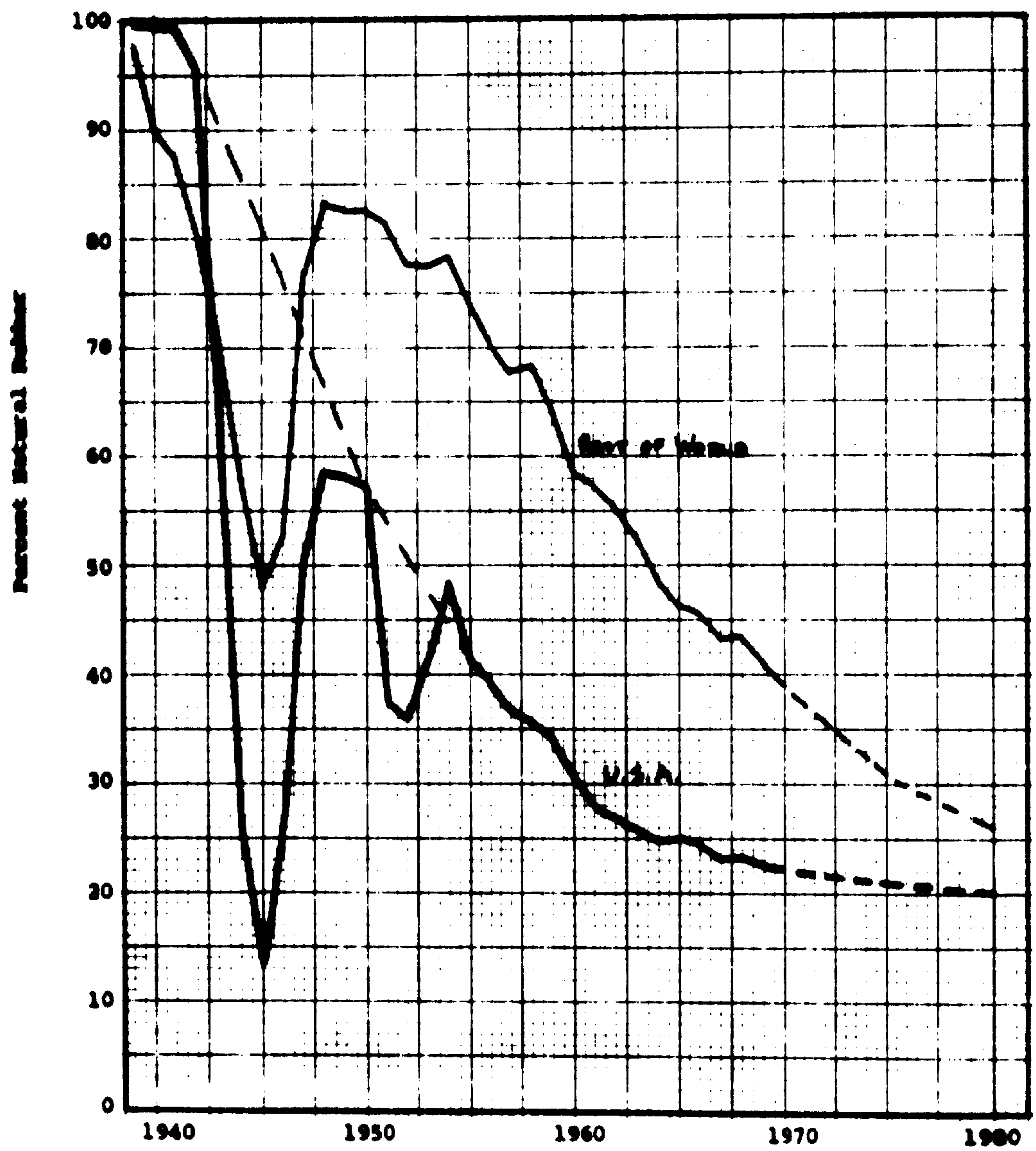
Source: Derived from International Rubber Study Group (London) and European Chemical News.

Chart D

PERCENT NATURAL RUBBER USED

United States and Rest of World

1939-1970 and Estimated to 1980



The composite curve of percentage Natural Rubber usage for the Rest of the World (See Chart D) shows a remarkable correlation with the U.S. curve, following it closely, but trailing it by a slowly increasing lag period. For instance, the lag was about 10 years in 1960, 11 years in 1965, and 14 years in 1970.

By using a trend correlation technique it is possible to predict quite accurately for any year in the future the probable percentage which Natural Rubber will share in total usage. Barring any drastic change in market preferences for a particular type of rubber, this technique can be applied to any country or region by spotting the current percentage of Natural Rubber usage on the master curve, and projecting the usage pattern forward along the master curve.

It is by this trend correlation method that the individual consumption of natural and synthetic rubber for each region has been predicted, after having first estimated the total rubber consumption for 1975 and 1980 based on the appropriate growth rate. The rates we have used are 4.7% for the U.S.;

12% to 1975 and 10% to 1980 for Japan; and 7.5% for the Rest of the World.

End Product Usage

Statistics for both natural and synthetic rubber usage in tires and in non-tire products, as reported regularly by eight countries, (See Exhibits 8A and 9A), show that in each country natural rubber is now used to a greater extent in tires than it is in non-tire products. This is undoubtedly due to the fact that the rugged demands of over-the-road motor truck tires still require the superior low-heat-buildup characteristic of natural rubber. Few, if any, other rubber products have such a stringent requirement.

We see no reason for any dramatic change in this situation except the strong possibility that the new stereo rubbers may meet some of these requirements satisfactorily, especially if available at a lower price or with more consistent quality than natural rubber.

Competition between Rubbers

The main fact to be faced is that all rubbers are in direct competition with each other. Certain specialty rubbers have less competition than others because of their very specific properties such as resistance to deterioration from oil, or heat, or oxygen, or ozone, or their air permeability, etc. These characteristics are of such importance in certain applications that the specific rubbers, such as Neoprene, Thiokol, Hypalon, nitrile, butyl, etc. command premium prices.

As the ability to meet specific requirements of an end product become more nearly comparable among rubbers, the price differential decreases or disappears entirely. This has been the undeniable trend in the price of natural rubber which is in direct competition principally with oil-extended SBR. Solution type butadiene rubber, one of the "stereo regular" rubbers, has made inroads on SBR, and in fact some sizeable capacities for producing emulsion SBR have been converted to solution type butadiene polymer production. The price of butadiene rubber has been somewhat higher than SBR Type 1500, but it is making inroads on both SBR and natural rubber usage.

Polyisoprene, although not the newest synthetic rubber, is beginning to invade the market for SBR, butadiene rubber (BR), and natural rubber as its price comes down. The only deterrent to price reduction of isoprene rubber is the current high cost of the isoprene monomer. When and if a breakthrough occurs in cost of producing isoprene, the price of polyisoprene rubber will drop to the point where it will be in direct price competition with natural rubber, butadiene rubber and possibly even oil-extended SBR.

<u>Prices</u>

It should be expected that prices of all general purpose rubbers, including the stereo rubbers, will continue to decline because of capacity pressure on the market. It is generally felt by knowledgeable persons in the synthetic rubber industry that prices will decline to the neighborhood of 16 US¢ a pound (US$350 per metric ton) for straight SBR (1500 grade), which will mean about US$280 per ton for oil-extended SBR (1712 grade).

There is the further possibility of a drop in the price of polyisoprene rubber to the vicinity of 12 US¢ (US$265 per metric ton) if a technical breakthrough is achieved in producing the isoprene monomer at lower cost that that at which it is now available. The past experience with butadiene would augur for that possibility. Already two companies in Japan have announced development of new isoprene monomer extraction technology, and the Institute of Physical & Chemical Research claims to have developed a process which will eventually make it possible to produce isoprene at a cost of 60Yen/kilo (7¢ per pound).

Mr. B. C. Sekhar, Director of the Rubber Research Institute of Malaya is reported to have said, in an interview early in April 1970, that efficiently produced natural rubber is competitive with cispolyisoprene at the cost of the isoprene monomer itself.

Our forecasts of probable prices for the principal grades of natural rubber and synthetic rubber appear in the Appendix in

Exhibits 6 and 7, and are plotted in Charts 6B and 7B.

Capacity

Synthetic Rubber

The synthetic rubber industry is anticipating considerable growth in rubber usage and already has plans for, or is building capacity sufficient to meet all forecast consumption estimates.

Exhibit 5A shows planned capacity of 10,266 million metric tons at the beginning of the year 1975. This will need to operate at only 87% of capacity in order to fill our projected worldwide demand for synthetic rubber in 1975. (See Exhibit 9)

Natural Rubber

Malaysian production of natural rubber is expected to increase 500,000 tons in the next five years. Indonesia, Thailand and Ceylon also expect to increase their production. If done on a like scale to that of Malaysia, 1975 would see natural rubber available to the extent of over 4 million tons, whereas forecast consumption of natural rubber is only 3.5 million tons. (See Exhibit 8)

Thus, it is apparent that competition in the rubber industry may force prices well below present or projected levels. As the Straits Times said in an editorial October 7, 1970, "Better rubber at the lowest possible cost is the only formula for the plantation industry's prosperity."

Demand

Exhibits 8 and 9 show the actual demand for natural and synthetic rubber by regions and countries, divided between the Developed Countries and the Developing Countries, for the years 1960 to 1970, with projections of demand by major regional segments and key industrial countries for the years 1975 and 1980. Tables E and F present a summary of the principal figures.

It will be seen that the principal growth in both natural and synthetic rubber will continue to be in the already developed countries which today represent 80% of natural and 93% of synthetic rubber demand, and by forecast will represent 81% and 91% respectively, of demand in 1980.

TABLE E

DEMAND FOR NATURAL RUBBER

(000 Metric Tons)

	Actual 1960	1970	Projected 1975	1980
TOTAL WORLD	2133	2978	3465	4310
DEVELOPED COUNTRIES	1779	2362	2740	3450
NORTH AMERICA	530	622	750	900
WESTERN EUROPE	681	884	950	1150
ASIA, AFRICA, AUSTRALIA	235	372	450	650
EASTERN EUROPE	333	484	590	750
DEVELOPING COUNTRIES	354	616	725	860
LATIN AMERICA	111	131	125	160
ASIA AND AFRICA	243	485	600	700

TABLE F

DEMAND FOR SYNTHETIC RUBBER

(000 Metric Tons)

	Actual 1960	1970	Projected 1975	1980
TOTAL WORLD	2314	5791	8950	13200
DEVELOPED COUNTRIES	2215	5436	8300	12100
NORTH AMERICA	1191	2172	2800	3600
WESTERN EUROPE	489	1479	2450	3750
EASTERN EUROPE	420	1170	1770	2650
ASIA, AFRICA, AUSTRALIA	115	615	1275	2100
DEVELOPING COUNTRIES	99	355	650	1100
LATIN AMERICA	63	226	350	500
ASIA AND AFRICA	36	129	300	600

Establishment of additional tire factories in developing countries will shift the locus of some rubber consumption because of import substitution, but the effect will be minimal as can be seen from the fact that production of tires in 90 tire factories in 40 developing countries, with capacity for 30 million tires a year, is already included in the 20% of natural and 7% of synthetic rubber consumed in the developing countries in 1970. By contrast, the United States produced 190 million tires in 1970, which accounted for over 1.6 million tons (about two thirds of total U.S. rubber consumption) - almost exactly half of the total rubber consumption for tires of eight major tire producing countries.

Consumption by Major Sectors

Tire production in the U.S. has been gaining at the rate of only 3.8% in the last twenty-five years, although in the last ten years the growth rate would appear to be about 5.3%. The U.S. Department of Commerce predicts a 4.9% compound annual growth rate for tires over the decade 1970 to 1980.

Actual U.S. consumption of rubber for tires and tire products shows a growth rate of 4.8% from 1960 to 1970 and rubber for non-tire products shows a growth rate of 4.5% in the same period.

Seven other countries that produce tires in quantity and regularly report their usage of rubber, show a combined compound growth rate of 8.25% for tire and tire products over the last decade, and a rate of about 8% for non-tire products.

These eight countries, including the U.S., represent 72-73% of world consumption. The rest of the world, representing 27-28% of total rubber consumption, shows a corresponding compound growth rate for all rubber uses of 7.0%. It is also interesting that the growth rate in Western Europe is almost identical with the growth rate in the world excluding the U.S.A. -- about 7.6% annually.

As an indication of the relative importance of various types of rubber used in tires and non-tire products, a note at the end of Exhibit 8A shows percentage consumption of various types of natural rubber in tires and non-tire products in the United States. A similar note at the end of Exhibit 9A shows percentage consumption of various types of synthetic rubber in tires and non-tire products in the United States.

Of particular significance,on the natural rubber side is the gradual increase in "other" types of natural rubber, which represents primarily the new SMR grades.

Of significance on the synthetic side is the rapidly increasing use of stereo-regular rubbers in tires at the expense of SBR, and a less rapid increase in use of stereo-regular rubbers for non-tire products, also at the expense of SBR.

NATURAL RUBBER

Technology, Grades, Qualities, Uses

Although many trees and plants contain a milk-like liquid, called latex, which is a suspension of rubber in an aequeous serum, it was in 1869 that James Collins, Curator of the Museum of the Pharmaceutical Society in England, asserted the hevea tree, a native of Brazil, to be unrivalled by any other rubber tree, and he suggested that it should be acclimatised in the British possessions in the East. Over the following three decades this was accomplished, and by the turn of the century exportation of plantation rubber had begun.

Today all natural rubber is Hevea rubber, and 99% of it comes from descendents of the trees grown from seeds brought from Brazil in 1876, germinated in Kew Gardens, London, and then sent to Ceylon for cultivation.

The early plantations were all of the seedling type. On these plantations, occasionally some trees yielded considerably more rubber than others. By grafting buds from these "high yielders" onto the lower stems of ordinary seedlings, it was possible to obtain a large number of high yielding trees. Careful records of all these trees have been kept, in which all descendents of a single tree are classed as part of a "clone". Rubber produced by these trees is referred to as "clonal rubber". Today most plantations have been replanted with high-yielding clonal rubber. In West Malaysia, for example, 87% of the planted area is high yielding material. In Ceylon it is about 60%. It is estimated that not over 25 clones make up the majority of clonal rubber plantations.

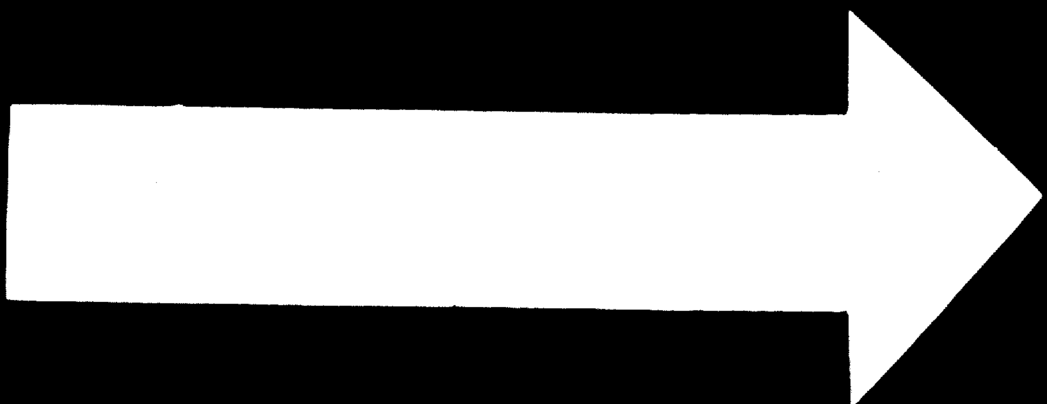
Preparation of Natural Rubber

Rubber occurs in the latex of Hevea, which is an emulsion or dispersion of rubber in water. The dispersing agent is a natural protein material. The latex occurs in the bark of the Hevea tree outside the cambium or green-growing layer. It occurs in tubes or ducts which spiral from left to right as they ascend the tree. The exact function of the latex in the physiology of the tree is not known.

In view of the above, in order to obtain rubber it is necessary first to get the latex from the tree and then recover it from the water phase or serum. The first operation is called "tapping". This is done by making a spiral cut downward from left to right, almost, but not quite through the bark, with a specially shaped knife that makes a shallow trough in the upper edge of the bark on the lower side of the cut. The latex ducts are thus cut, and the latex flows out into the cut or trough which ends in a metal spout which conducts it to a plastic, glass, or earthenware cup. A small amount of preservative is placed in the cup to prevent coagulation. After the latex stops flowing, the tapper empties the latex from the cup into a bucket. Tapping is usually done in the early morning hours just after daylight because more latex flows in the cooler morning hours. It stops flowing after about 3 hours. Collection by the tapper is generally completed by eleven o'clock, or noon at the latest.

The latex is carried in the tapper's buckets to a central factory, or,on a large plantation, to a collecting station, where it is strained through a sieve to remove particles of bark and dirt. It is put into a tank truck, and more preservative, generally sodium sulfite, is added if necessary to that already used by the tapper to insure its arrival at the main factory in a liquid condition. Upon arrival at the central factory, the latex is diluted with clean water to a standard rubber content (generally about 15 per cent), coagulated with dilute formic or acetic acid, formed into sheets or crepe, dewatered on a roller mill (and washed in the case of crepe), hot-air-dried (with wood smoke in the case of smoked sheets), inspected, and packed into bales. In the case of fine pale crepe, the drying temperature is generally not raised above normal temperature (90-115° F) in order to prevent darkening of the light-colored rubber by heat.

The above procedure is followed to produce various grades of smoked sheets and crepes directly from latex. However, there is a considerable amount of rubber which is obtained from naturally coagulated or dried rubber which occurs in the course of regular plantation operations. The "tree lace" and "cup lump" which are the dried strips of rubber removed from the



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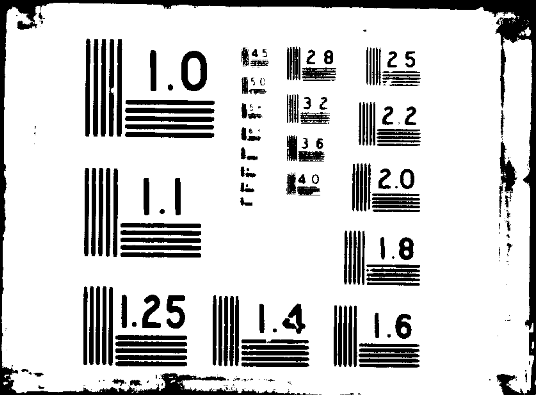

old cuts and the dried films and lumps of rubber found in the cups at the beginning of tapping (from the "after-drip" of the previous tapping), the "bark scrap" recovered from the bark removed during tapping, and "earth scrap" recovered from the ground at the base of the tree, are each processed into crepe grades. These so-called "off-grade" crepes are known as "Amber, or Blanket Crepe," "Brown Crepe," and "Flat Bark Crepe."

On a well managed plantation the yield is approximately:

85% Pale Crepe or Smoked Sheets

8% Blanket Crepe (Ambers)

2.5% Estate Brown Crepe, or Thin Brown Crepe

4.5% Flat Bark Crepe

Some smallholders, or small plantation owners, do not make crepe or sheets but allow their latex to coagulate naturally, and the resulting "slab" is sold in varying stages of moisture content and fermentation, or "maturation", to processors who wash, dry, and ship it as "Ambers" or "Blanket Crepe".

hosing and belts, and wire insulation. These uses were estimated to be about 38% of total general purpose rubber usage.

This left an estimated 35% of the market where natural and synthetic rubber are considered generally interchangeable.

The history of rubber consumption to date appears broadly to bear out the conclusion of the 1954 study, with the actual percentage of preference for natural rubber seeming to settle out around 20% rather than 27%. This lower percentage is probably due to two causes - new and improved synthetic rubbers, and increasing uses for rubber which have been satisfied by synthetic rubber.

Note: Much of this section is quoted from Morton - Introduction to Rubber Technology (1963)

SYNTHETIC RUBBER

Technology, Grades, Qualities, Uses

Synthetic rubbers are made by the polymerization or polycondensation of one or more (usually two) monomers resulting respectively in a homopolymer or a copolymer. Most synthetic rubbers are produced by polymerization, which can be carried out in the mass of the monomer, or in a solution, or in an emulsion.

Polymerization is a reaction by which the molecules of a monomer, such as butadiene, isoprene, styrene, etc. are combined with each other in such a way that the percentage chemical composition remains the same, but the molecular weight is increased.

In contrast to the polymerization of isoprene which occurs in the biosynthesis of natural rubber (whereby the isoprene units are joined end to end, always in the same direction, to give a long, thread-like molecule), during a chemical polymerization different types of arrangement may occur, with the result that the final structure of the molecule may correspond to a whole system of chain units of varying lengths, comprising cross links and side chains. This structure has an important effect on technological properties of the polymer, and is a source of differences between the performance of natural and synthetic rubbers.

Much effort has been expended on devising means for regularizing the molecular structure of the synthetic rubbers, out of which have come low temperature polymerization techniques, and especially the development of "stereo-specific" catalytic processes. The former has led to the manufacture of "Cold" SBR, and the latter to the stereo regular rubbers, polybutadiene and polyisoprene. The properties of polyisoprene are almost identical with those of natural rubber, and its use is expanding rapidly, although price is still high because of cost of the monomer.

The first synthetic rubber produced in large quantity, and still the major factor in the synthetic rubber industry, is the Butadiene-Styrene Copolymer first developed in Germany as Buna S, and put into crash production in the United States in 1942 as GR-S. It is now known as SBR and represents over

60% of U.S. synthetic rubber production and about 63% of world production.

SBR is classed as a general purpose rubber, but it has certain limitations. For example, its vulcanisates possess satisfactory mechanical properties only if they contain reinforcing fillers; without these, tensile and tear strengths, in particular, are quite low and the elastomer is not suitable for uses in "pure gum" goods. In the case of tires, cold SBR gives a somewhat higher abrasion resistance than natural rubber in passenger tires but in heavy duty or aircraft types, abrasion resistance is decidedly less.

It was found that low temperature polymerization yields very high viscosity products which are difficult to process, but could be rendered workable by the addition of a relatively large proportion of oil without impairing the mechanical properties after vulcanization. The oil in amounts of 25 to 37.5 parts per 100 parts of polymer is added to the latex in the form of an emulsion prior to coagulation. Oil-extended "master batches" have been very successful and have reduced cost of the rubber substantially.

Carbon black is also incorporated in the rubber at the plant by adding aequeous dispersions of carbon black to the latex, thus producing master batches which are available for direct use by the rubber goods manufacturers.

The second (until recently) most important synthetic rubber is Butyl rubber, a copolymer of isobutylene and a small portion of isoprene. It has high resistance to oxygen and oxidizing agents, and most important, extremely low gas permeability, making it especially valuable for inner tubes.

The Nitrile rubbers (butadiene acrylonitrile copolymers) are "special purpose" rubbers characterized by their resistance to solvents. They are used principally in articles which come in contact with solvents, such as gasoline hoses, oil immersed belting and joints, etc.

The chloroprene polymers, first introduced in 1931 as Neoprene, have excellent resistance to aging, low swelling in oils, and flame resistance. They are particularly useful in conveyor belting, cable sheaths and various mechanical goods.

The stereo-regular rubbers, polybutadiene and polyisoprene, have been known since the 1950's, but have come into prominence only in the 1960's, during which period their production rose from nothing to over 400,000 tons in the United States alone, each of them surpassing every special purpose type of synthetic rubber and together surpassing all other types (except SBR). These are general purpose rubbers and are finding their way into tire production at the expense both of SBR and natural rubber.

Other specialty rubbers include Thiokol, a polysulfide polymer introduced in 1930; Hypalon, a chlorosulfonted polyethylene, introduced commercially in 1957; and the ethylene-prophylene coplymers, introduced in 1962, and classified by the International Rubber Study Group as a stereo-regular rubber.

Note: Much of this section is quoted from Le Bras - Introduction to Rubber(1965)

R & D FACILITIES FOR NATURAL RUBBER IN DEVELOPING COUNTRIES

Research and Development facilities directed to the problems of natural rubber exist in seven of the significant natural rubber producing countries. These include:

Malaya

Indonesia

Ceylon

India

Cambodia

Viet-Nam

Ivory Coast

Malaya

The oldest and most comprehensive facilities are those of the Rubber Research Institute of Malaya (RRIM) which began functioning in 1926, taking over from the Department of Agriculture of the Federated Malaya States the rubber research work it had been doing since 1900.

The RRIM is a dependent organization of the Malayan Rubber Fund Board, which is financed by a cess of one Malayan cent per pound of rubber exported from West Malaysia, and allocates more than half of this to the Institute.

The RRIM has a staff of about 1300 including 150 graduate professionals, as well as a labor force of almost 1,000 at its 3,400 acre Experiment Station, sixteen miles from Kuala Lumpur. It operates on an annual budget of almost U.S. $5 mill

The RRIM is concerned with "production research". Its activities are organized as follows:

<u>Botany Division</u>	Hevea Breeding Methods of Propagation Exploitation (Tapping) System Physiology of Growth and Latex Production and Flow
<u>Soils Division</u>	Nutrition and Fertilization under different soil conditions and soil management
<u>Pathology Division</u>	Control of Diseases and Pests
<u>Applied Chemistry and Development Division</u>	Processing into Latex Concentrate Processing into Dry Rubber New Forms of Rubber

Technical and Specifications Division	Evaluation of Technological Properties Evaluation of Cure Characteristics Control of SMR Scheme
Fundamental Chemistry and Physics Division	Biochemistry of Latex Chemistry and Physics of Rubber Particles and Processed Rubbers
Analytical Chemistry Division	General Analytical Services Special Analytical Services
Economics and Planning Division	Economic Aspect of Field Management and Factory Production

During the last five years major areas of development have been:

Yield stimulation by chemical means (Ethrel)

Development of the Standard Malaysian Rubber Scheme

Oil extended natural rubber (OENR)

Current research on new rubbers development is concentrated in the following areas:

The conferment of controlled viscosity (CV) characteristics into raw rubber of lower grade.

The development of OENR starting from latex base as opposed to the present dry rubber base.

Carbon Black Master Batch by incorporation of black at the latex processing stage.

Development of a special or ideal tire rubber aimed specifically at tire manufacturers.

Improvement in consistency of cure behavior within SMR rubber.

Associated with the RRIM is the Natural Rubber Producers' Association (NRPRA), another dependent organization of the Malayan Rubber Fund Board, which operates facilities at Welwyn Garden City in England. The NRPRA employs 85 qualified techni-cal staff at its laboratories which are extensively equipped fo all types of rubber research and development work.

The NRPRA is concerned with "Consumption Research", the main objectives of which are:

Improvement of the performance of natural rubber in order to strengthen its competitive position

Establishment of new uses for natural rubber

Research and development activities concentrate on:

Vulcanization and Processing

Durability and Aging

Wear and Friction

In addition, the NRPRA operates the Technical Advisory Service of the Malayan Rubber Fund Board in Great Britain, and provide laboratory support service to the network of Technical Advisory Service offices of the Board, including five in the United States, four in Europe, and one each in Australia, New Zealand, Japan and India.

Indonesia

In Indonesia the Institute for Rubber Research and Development is engaged in rubber research, but no details of its operation have been made available.

Ceylon

In Ceylon the Rubber Research Institute of Ceylon in Dartonfield, Agalawatta is engaged in rubber research, but no details of its operations have been made available.

India

The Rubber Research Institute of India was established in 1954 under the Rubber Board, and is financed completely by the Board from funds which it collects in the form of a cess on rubber consumption.

Although the Institute started functioning in 1955 it had only a skeleton staff until 1963. At the present time the Institute has a staff of nearly 100 persons including 34 professionals, and operates a 33 hectare experiment station at the locus of the laboratory, and a Central Experiment Station of 150 hectares elsewhere.

As a first step, the Institute developed cultivation and production methods suited to local conditions, based on the accumulated knowledge of the Rubber Research Institutes of Malaya, Ceylon, Indonesia and Indo-China.

The work of the Institute is organized in four divisions as follows:

<u>Agronomy/Soils</u>	Study and General Classificat[ion] of Rubber Growing Soils in In[dia]
	Cultural and Soil Management Problems
	Nutritional Requirements of Rubber in the Varied Agro-Climatic Regions of the Country

Botany	The Rubber Tree, its Improvement, and all Botanical Problems from Planting to Harvesting
Mycology/Plant Pathology	Pests and Diseases of Rubber and Their Control
Chemistry/Rubber Technology	Chemistry of the Crop, the Latex, and all Problems Relating to Processing and Preparation for Marketing

At the time when research was started, the main problems were those of increasing production. Now India is able to supply all of its own needs for natural rubber, and the problems of research have turned to coping with the radical changes that are taking place in the processing of rubber for the international market. Hence, the Institute is reorienting its research activities to give more emphasis to studies in the production of solid block rubbers, technical specification of rubber, and problems of the consumers of rubber.

Cambodia

In Cambodia the Institut des Recherches sur le Caoutchouc au Cambodge in Kompong-Cham is engaged in rubber research, but no details of its operations have been made available.

Viet-Nam

In Viet-Nam the Institut des Recherches sur le Caoutchouc au Viet-Nam in Saigon is engaged in rubber research, but no details of its operations have been made available.

Ivory Coast

In the Ivory Coast the Institut des Recherches sur le Caoutchouc en Afrique in Abidjan is engaged in rubber research, but no details of its operations have been made available.

R & D CONTRIBUTION AROUND THE WORLD IN IMPROVING THE QUALITY OF NATURAL AND SYNTHETIC RUBBER

The search for more and better products in the synthetic rubber field goes on unabated in the laboratories of all the major synthetic rubber companies around the world. Year by year there is an increase in the number of grades and types of synthetic rubbers that are made available for special uses.

Many laboratories are working vigorously towards the goal of a polymer which has all the properties of a normal rubber vulcanizate at ambient working temperature, but which processes as easily as such well known thermoplastics as PVC, polyethylene or polypropylene at higher temperatures, thus eliminating the costly processes of labor, mastication of compounds and vulcanization.

Search is also being made for liquid polymers with the objective of producing a liquid elastomeric product which can be processed without power-consuming slow processes.

With regard to natural rubber, it is fair to say that the principal, if not the only, concerted effort towards improving the quality of natural rubber is being carried out by Malaysia through the Rubber Research Institute of Malaya, the Natural Rubber Producers Research Association and the fourteen offices of its Technical Advisory Service network around the world, all operating under the aegis of the Malayan Rubber Fund Board, and financed exclusively by a cess on all rubber exported from West Malaysia.

These organizations, which are jointly concerned with the breeding and cultivation of the rubber tree, the harvesting of latex, the processing of the latex into latex concentrate and dry rubber, technical specifications, control of quality, packaging, and adaption to the production methods of rubber goods manufacturers, have faced the problems of natural rubber improvement in a most realistic manner.

While directing a great deal of effort to "production research" by developing high yielding clones, development of the 3-part tree to provide strength for storm protection, and yield stimulation by chemical means (Ethrel), at least equal effort has been spent on the development of efficient and mechanized methods of processing, purifying, controlled technical specifications of the various grades including controlled viscosity rubbers, and uniform packaging under the Standard Malaysian Rubber Scheme.

The SMR scheme was developed by the RRIM with the rubber goods manufacturers in mind. It had and has active contact with the factory consumer through its world-wide Technical Advisory Service network which provides advice to rubber goods manufacturers on natural rubber use in any application, and also works with end users on design and testing of natural rubber products. Thus, its quality improvement program in Kuala Lumpur is keyed directly to the needs of the market.

The SMR scheme has achieved such rapid success that Indonesia is adopting an identical grading and packaging scheme, known as SIR, and last year the Association of Natural Rubber Producing Countries (ANRPC) was founded by Ceylon, Indonesia, Malaysia, Singapore, Thailand and Viet-Nam with the probable ultimate result of adopting a world-wide Standard Natural Rubber scheme based on the Malaysian SMR scheme.

There is at least one other organization in the world outside the natural rubber producing countries which conducts research on natural rubber. This is the Kautschukinstitut an der Technischen Hochschule in Hanover, West Germany, where Professor Dr. Scheele has been working for some years on three areas of interest:

Compounding (combining) natural and synthetic rubbers with special attention to the chemical kinetics involved.

Thermodynamic research relative to improving the elasticity of rubber through the use of different dry extenders.

Radiochemical analysis of special problems in the field of vulcanization.

The results of this research have been published in over 10(treatises in the periodicals "Kautschuk und Gummi, Kunststoffe", "Kolloid-Zeitschrift", and "Rubber Industry and Technology".

IMPORTS OF RUBBER GOODS INTO DEVELOPING COUNTRIES

There are very few published statistics on imports into the developing countries, and no comprehensive compilation of those which are published. Starting with statistics for the year 1964, however, the United Nations began publishing its World Trade Annual which reports imports and exports of the principal countries of the world, showing the source of imports and the destination of exports. Beginning with statistics for the year 1965, a Supplement to the World Trade Annual has been published showing, for individual countries, by SITC classification, the exports made to them by the principal exporting countries of the world. All figures are in U.S. dollars.

It is from these figures for the years of 1965 to 1969 that Exhibit 10 - Imports of Tires and Non-Tire Rubber Goods - was compiled, and then converted to the national currency at prevailing rates of exchange for each year. Exhibit 10A summarizes the information by region in U. S. dollars.

The statistics are combined in three groups:

Tires and Tubes

Non-Tire Products (Manufactured Articles)

Vulcanised Rubber Materials
(for further Processing)

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A summary of each by regions is shown in Tables G, H and J

Table G

Imports of Tires and Tubes into Developing Countries
(U. S. Dollars 000,000)

1965 - 1969

	1965	1966	1967	1968	1969
Latin America	32	35	32	30	31
Mid-East Asia	42	55	45	49	52
South & Southeas Asia	60	40	39	39	40
Africa	45	41	46	56	53
TOTAL	179	171	162	174	176

Table H

Imports of Non-Tire Products into Developing Countries
(U. S. Dollars 000,000)

1965 - 1969

	1965	1966	1967	1968	1969
Latin America	12	14	13	14	17
Mid-East Asia	4	4	5	7	6
South & Southeast Asia	10	12	13	14	20
Africa	12	10	9	10	13
TOTAL	38	40	40	45	56

Table J

Imports of Vulcanised Rubber Materials into Developing Countries

1965 - 1969 (U.S. Dollars 000,000)

	1965	1966	1967	1968	1969
Latin America	7	7	7	7	8
Mid-East Asia	3	4	5	4	5
South & Southeast Asia	6	8	7	9	12
Africa	7	8	7	10	11
TOTAL	23	27	26	30	36

These tables indicate a relatively strong upward trend in total imports between 1967 and 1969 - 9% for tires, 14% for rubber articles other than tires, and 14% for rubber materials for further processing. It would be meaningless, however, to attempt to forecast imports for 1975 and 1980 for several reasons:

- We do not have available figures for the most recent year - 1970
- Each region is made up of a number of relatively small countries whose rates of growth or decline vary widely

- The future performance of each country will depend on many factors of which we do not have adequate knowledge.
  Among these are:

  Building of a tire plant

  Establishment of non-tire manufacturing plants

  Availability of reclaim rubber

  Import substitution programs

  Import restrictions

Suffice it to say that Exhibit 10 supplies valuable information about imports into 60 developing countries which can serve as a basis for individual country projections when additional information is available.

EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

Exhibit XI shows the extent of existing rubber processing industries by country in the developing countries, in detail with regard to automobile tire manufacture, but in summary only (in most cases) with regard to non-tire manufacture.

Every effort was made to secure information about the rubber processing industries of each developing country through its Embassy in the United States. Many of these responded cooperatively, but were unable to supply the information requested. In only one or two cases was information available regarding the uses of latex or reclaimed rubber. (Israel reported using 18% reclaimed rubber and 8% latex. Ceylon reported 1% reclaimed rubber in tires and less than 400 tons latex.) No factual information was provided regarding expansion plans.

The information recorded in Exhibit XI concerning non-tire rubber processing plants has been derived almost entirely from the International Rubber Directory published in Zurich in 1967. No more recent worldwide information on this subject is available, and the next edition of the directory will not be available until 1972.

The individual non-tire processing plants (over 3000) were not listed separately for two reasons:

a. Many of the listings gave no details of products produced or of number of employees

b. Easy access to information about each specific company may be had by consulting the International Rubber Directory, or (in the case of India) the Indian Rubber Directory (published in 1970 by the Indian Rubber Industries Association of Bombay).

It should be noted that in order to keep the main tire products portion of the exhibit clear, no manufacturers of bicycle or other small tires were included with tire manufacturers. Retreaders (where identified in the Directory) were indicated separately in the non-tire section of the Exhibit. It is our belief that in a number of countries tire retreaders were <u>not</u> listed in the Directory, so that the Exhibit probably understates the number of retreaders.

A glance at the Summary shows that the developing countries have in operation or under construction capacity for about 125,000 tires a day, of which more than half is located in Latin America and more than a quarter in the Far East, leaving only about 20% in Africa and the Middle East. With only about 15% of the population of the Developing Countries (excluding Mainland China) Latin America has over 50% of the tire capacity. South and Southeast Asia, with over 60% of that population, has slightly over 25% of the tire capacity.

Over the years it has been true that production of tires consumes by far the major portion of all rubber, and consumption for other purposes follows along with tire consumption. It would appear that if the transportation portion of the infrastructure in the developing countries can be stimulated, this will not only help all other phases of development, but will also generate greater use of rubber in products other than tires.

Already there is evidence of moves in this direction with expansion of tire manufacturing facilities under way in the Congo, Kenya, Morocco, Nigeria, Tanzania, Iran, India, Malaysia and Singapore.

Latex

We see no reason to expect any unusual growth in the use of latex, although undoubtedly some growth will occur, especially in foam goods, including backing for tufted carpets.

Reclaimed Rubber

Reclaimed rubber has advantages in certain types of product but its main appeal has probably been price. With the general lowering of new rubber prices, however, as well as rising labor costs for processing reclaim, this advantage for reclaimed rubber is fast disappearing. Its use in general has been falling off except in Brazil.

QUALITY CONTROL FACILITIES FOR RUBBER IN DEVELOPING COUNTRIES

Real control of quality for natural rubber has been nonexistent until inauguration of the Standard Malaysian Rubber scheme. There are specifications for the various RMA grades, but grading is visual, and each producer makes his own decision as to the grade of his product.

With the advent of the SMR scheme, a tight set of specifications cover the limits allowed for:

Dirt

Ash

Volatile Matter

Nitrogen

Color

Initial Plasticity

Plasticity-Retention Index

The Cure Indicator (MOD value) must be stated on each package.

In the case of Extra Quality SMR, the clones from which the latex is drawn are specified, and procedures for bulking and coagulation, milling, and drying, are also specified.

Methods of test sampling are established, and the form of packaging is specified.

Although each estate does its own inspection and grading, and each shipment carries the estate identification and its own certification as to the various test sample values, the Chemistry Division of RRIM maintains overall control of specifications and testing procedures, with proper facilities for testing and inspection, and with legal powers to exert control on rubber before it is shipped. Any rejections by a customer are handled through the regional offices of the Malaysian Rubber Fund Board.

In the case of smallholders, it is necessary to have the rubber processed at local central points. Already

Malaysia has four large strategically placed factories operating, which enable smallholders to turn out SMR.

As other countries adopt their own Standard Rubbers they will have to set up equally stringent quality and inspection standards, and central processing factories if the image of the new natural rubber is to be maintained.

When, and if, a Standard Natural Rubber is established by the Association of Natural Rubber Producing Countries, the members will have to agree on uniform international standards and set up the procedures for maintaining adherence to those standards.

OPEN PROBLEMS IN THE STANDARDIZATION OF NATURAL RUBBER QUALITY

We see no problems in quality standardization that have not been faced and solved by the Rubber Research Institute of Malaysia. Over the last six years since Standard Malaysian Rubber was introduced, the Institute has had the opportunity to modify and improve its procedures to the point that the SMR scheme works smoothly. If any unexpected problems arise, the RRIM will learn of them promptly through their associated world-wide Technical Advisory Service network, and corrective action can be taken promptly.

Malaysia has been more than willing to share its experience and knowledge of the production and marketing of natural rubber with the rest of the industry. In joining in the Association of Natural Rubber Producing Countries, it has shown its willingness to provide leadership in setting up the procedures and controls for a Standard Natural Rubber.

CONCLUSIONS

Synthetic Rubber

Price

In view of the generally rising costs of operation in every industry, and of the increasing squeeze on supplies of petroleum, we see little prospect for a major reduction in the price of basic general purpose rubbers such as SBR and BR below the current (June 1971) prices as quoted in European Chemical News. These prices in U.S. Dollars per Metric Ton are:

SBR 1500	$375	(France)
SBR 1712	298	(France)
Polybutadiene	390	(France)
Polyisoprene	507	(U.K.)

Although projected world capacities for all synthetic rubbers of 10.266 million Metric Tons by 1975 are not out of line with our forecasts of 8.950 million Metric Tons world demand for that year, which would result in 87% utilization of capacity, the competitive pressures which may develop in local areas might bring these prices down somewhat.

The increasing use of petroleum for transportation, heating and chemicals, plus increasing costs of capital investment in the petroleum industry, increasing costs of producing, transporting and refining the crude petroleum, etc. may tend to raise the costs of all monomers, and thus the prices of synthetic rubbers generally.

However, much of the U.S. synthetic rubber capacity is 25 to 30 years old, and considerable European capacity is at least 10 years old. Thus, a large part of world capacity is or will shortly be fully depreciated, and could conceivably be used to produce synthetic rubber on a marginal cost basis.

Furthermore, a breakthrough in isoprene monomer production appears more than likely at this time, and this will certainly bring down the price of polyisoprene which is already cutting into other general purpose rubber usage, including particularly SBR, BR, and natural rubber.

Throughout Europe and Japan new or expanded plants are being built - not only for the older type general purpose rubbers, but also for polyisoprene. Polyisoprene projects scheduled for startup in 1971 - 1973 total 370,000 metric tons, on top of 246,000 tons already in existence outside the United States.

As was stated earlier, two companies in Japan have announced development of new isoprene monomer extraction technology, and the Institute of Physical and Chemical Research claims to have developed a process which will eventually make it possible to produce isoprene at a cost of 7 US¢ per pound.

Two companies in Europe also have new isoprene monomer processes. One major U.S. rubber producer is now involved in construction of polyisoprene plants in Europe and Japan after having previously (in 1966) scrapped a similar project because use of the monomer then available was not economically viable.

Taking all aspects of the situation into account, we conclude that the prudent view is to be prepared for a possible drop in the price of all general purpose rubbers to approximately these prices:

	US$ Per Metric Ton	
	1975	1980
SBR 1500	350	325
SBR 1712	280	260
Polybutadiene	350	325
Polyisoprene	400	350

Quality

Quality can be expected to be improved gradually in all general purpose rubbers. At the same time, we can look for the continued development of new special purpose rubbers, some of which may find uses as blends with general purpose rubbers for improving certain characteristics such as abrasion and heat resistance.

Natural Rubber

Price

Natural rubber prices will have to be competitive with the general purpose rubbers if the natural rubber industry is to thrive. This means basically that RSS#3 (or the corresponding TC grade) will be generally competitive with SBR grade 1712, although it may command a slight premium because of its superior properties in some respects.

Progress which is being made by the RRIM not only in increasing the yield of rubber trees, reducing the cost of latex production and controlling the rate of production, but also in applying the same techniques as the synthetic rubber industry in reducing the cost of dry rubber through oil extension, seems to assure attainment of that goal.

On balance we conclude that natural rubber producers must be prepared for a possible drop in price of natural rubber approximately as follows:

	US$ Per Metric Ton-N.Y.	
	1975	1980
RSS#1	360	335
RSS#3	350	325
Oil Extended NR	280	260
#3 Blanket Crepe	340	315

Quality

Quality should be improved primarily by removal of impurities, standardization of grading, identifying cure rate, viscosity, etc. in conformance with the SMR scheme or a similar scheme.

Accommodation between the Natural and the Synthetic Rubber Industries

It does not appear likely that any planned modus vivendi between the synthetic rubber industry and the natural rubber industry would be possible or practicable. These two groups of rubber producers are essentially segments of one industry, and they are in direct competition with each other.

Even in the synthetic branch of the industry, the producers of polyisoprene or polybutadiene are in direct competition with the producers of SBR as well as with natural rubber. Nothing short of a cartel could attempt to guarantee that there would be no gap or overlap in the available supply of natural and synthetic rubber.

Natural rubber has its own properties and characteristics which are distinct in varying degrees from those of the various synthetic rubbers. Basic quality of natural rubber, if guaranteed by a standard scheme of quality control and certification, will assure it of a substantial share in the total general purpose rubber market. How big that share is will depend both on price and on the effectiveness of the marketing efforts exerted by the producers, either unilaterally or in concert.

For the last decade Malaysia has led the way in organizing for an effective quality control and market presentation scheme. It has tied in its rubber development efforts with its rubber utilization and customer service efforts. It has achieved remarkable success in a relatively short time and has shown what can be done when concerted effort is applied to a well planned program.

What the rest of the natural rubber producing world needs to do is to emulate the efforts of Malaysia, and this is exactly what is beginning to happen with the formation of the Association of Natural Rubber Producing Countries.

It may be of interest to note that our projected growth rate in natural rubber demand from 1970 to 1975 works out to only 3.0%, but the projected growth rate from 1975 to 1980 is 4.4%.

The reason for this increasing growth rate is tied into the fact that all countries of the world have lagged the U.S. in converting from natural to synthetic rubber usage. At this time in their rubber usage development, their rapidly dropping curves of percentage of natural rubber are just beginning to flatten out, while that of the U.S. has almost reached the stationary point.

In the period from 1975 to 1980 these curves in the rest of the world will become flatter as they approach the apparent minimum of about 20% natural rubber usage. The actual drop in percentage natural usage will be less than in the preceding five years, resulting in a greater increase in total natural rubber consumption.

When all countries reach the apparent minimum level of 20% usage of natural rubber, then the growth in actual consumption of natural rubber will be approximately the same as the rate of growth in total rubber consumption.

Thus, it is to be expected that the growth rate of natural rubber consumption will increase slowly but continuously during the 1970's and the 1980's. This will require increasing the production of natural rubber by chemical stimulation, by replanting of unselected seedling acreage with high yielding material, and by continuing cyclical replanting of all acreage as the trees pass their period of maximum yield. When it is remembered that it takes seven years for a tree to mature, it is obvious that the appropriate steps must be taken shortly to be ready for the 1980 forecast consumption of 4.3 million metric tons of natural rubber, and probably 5.5 to 6.0 million tons in 1985.

RECOMMENDATIONS

General

The needs of the developing countries for help in establishing or improving their position in natural rubber production and marketing have been fully recognized for many years by Malaysia, and an aggressive attack on these needs was mounted a decade ago. All elements of technical development in breeding, propagation, nutrition, tapping, and yield stimulation of the hevea tree; evaluation of the technological properties and cure characteristics of raw rubber; and standardization of the marketing aspects of natural rubber, have been pursued vigorously by the Rubber Research Institute of Malaya under very adequate financing by the Malayan Rubber Fund Board. Malaysia is willing and anxious to share its knowledge with all natural rubber producing countries.

The coverage of these developments by Malaysia has been so complete that it is highly questionable whether undertaking completely new projects in these areas by other developing countries would be economically justifiable. The principal need of the other producing countries is to have existing knowledge transferred to them, and to adapt that knowledge to local agricultural and ethnic conditions. For example, this is the approach which the Rubber Research Institute of India has taken, relying heavily on the accumulated knowledge of the RRIM and the smaller Rubber Research Institutes of Ceylon, Indonesia and Indo-China.

UNIDO can be helpful to the natural rubber producing countries by lending support in encouraging and assisting in the dissemination of such information.

So far as synthetic rubber is concerned, when a developing country has reached the point where a synthetic rubber plant is economically justifiable, the technical know-how must and will be supplied by the licensor of the process used. UNIDO's contribution, in our opinion, should be limited to assistance in helping determine if such a project is or is not economically feasible.

With regard to the use of natural or synthetic rubber in the manufacture of rubber articles, we believe any major manufacturing facility should and would be built with technical assistance from a foreign firm which has already done the necessary development work for the contemplated tire or non-tire products. Here, again, UNIDO's contribution should be in helping determine the economic feasibility of the project.

Cottage industry type of rubber article manufacture needs primarily basic training in the necessary procedures, and advice on the marketing aspects of the undertaking. This might be supplied by UNIDO technical personnel.

Specific

In the major aspects of natural rubber production, we recommend that UNIDO and other UN agencies provide support to the natural rubber producing countries in the following ways:

1. Actively encourage all natural rubber producing countries to join the Association of Natural Rubber Producing Countries (ANRPC).

2. Actively encourage and assist in the formation of producers' cooperatives among the small holders.

3. Assist financially where needed in establishing central factories for processing smallholders' latex into standard natural rubber.

4. Assist in the establishment or improvement of national research institutes which will work in collaboration with the well established Rubber Research Institutes, first in adapting available technical knowledge on rubber culture, processing and marketing to local conditions; and later in pursuing areas of process or product development which appear to be inadequately covered by other research.

5. Provide technical assistance where needed in educating smallholders in the planting, cultivation and harvesting of their rubber acreage.

6. Provide technical assistance where needed in educating smallholders in the best methods of intercropping.

7. Provide financial assistance to smallholders for replanting their acreage with high yielding material, and tiding them over for the five to seven years of maturation before the trees begin to produce. This might be done through cooperatives established with the help of UNIDO.

8. Encourage and assist in the establishment of non-tire manufacturing plants in rubber producing countries to utilize the native natural rubber for making locally needed and exportable rubber products.

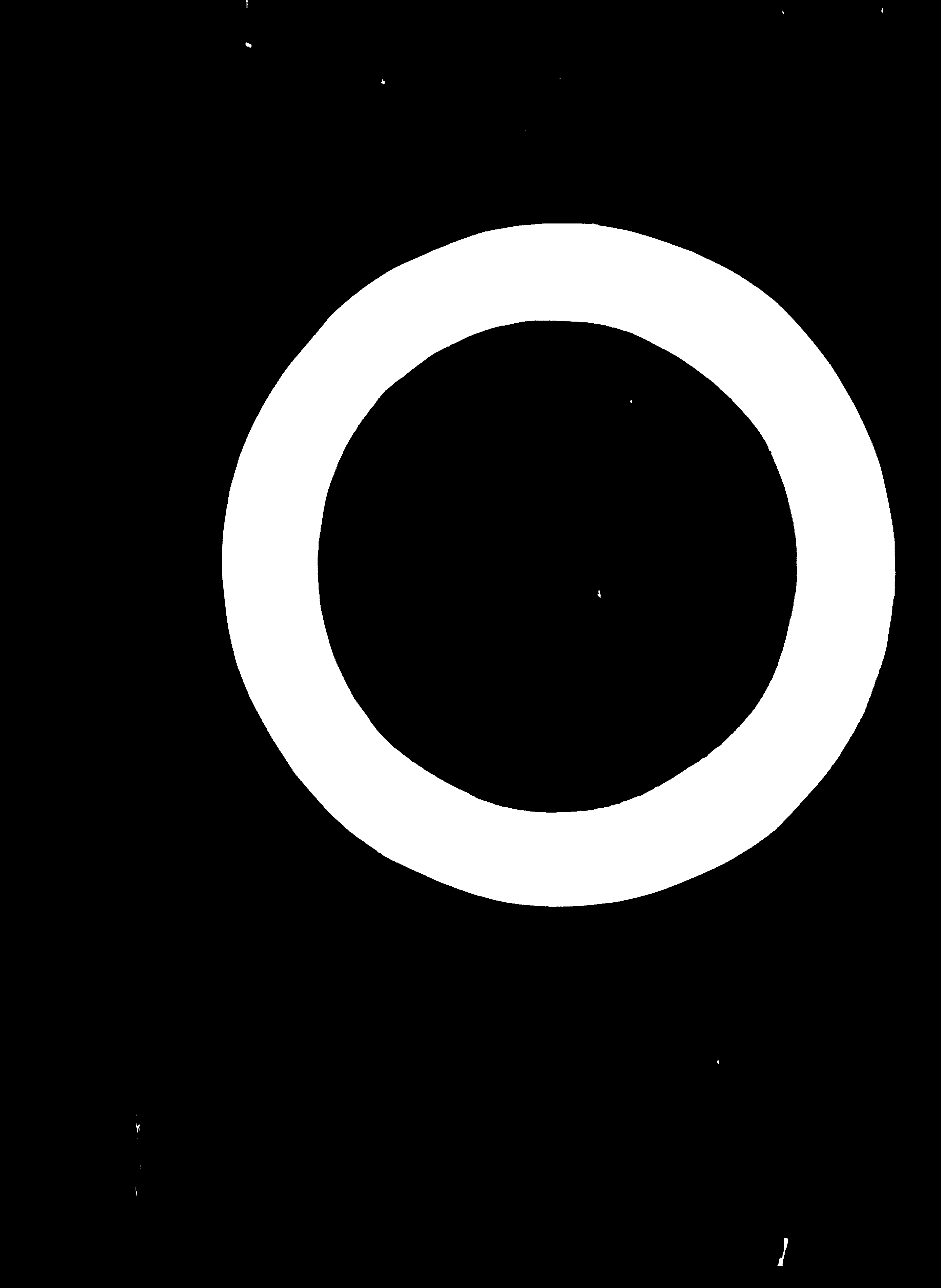

EXHIBIT 1 - 1

APPENDIX

NATURAL RUBBER ORGANIZATIONS AND INSTITUTES OF RESEARCH AND DEVELOPMENT IN DEVELOPED AND DEVELOPING COUNTRIES

EUROPE

ENGLAND

Natural Rubber Producers' Reseach Association
56 Tewin Road, Welwyn Garden City, Herts
Int'l. Coordinator of Technical Advisory Service:
Dr. G. F. Bloomfield

FRANCE

Institut Francais du Caoutchouc
42 Rue Scheffer
Paris 16
President: J. de Padirac
Scientific Inspector General: Jean LaBras

Laboratoire de Recherches et de Controle du Caoutchouc
8 Rue de Ridder
Paris 14
President: H. Jacqueau
Secretary General: M. Morin

HOLLAND

Netherlands Rubber Institute T.N.O.
Julianalaan 67
Delft
Director: Dr. Geldof

WEST GERMANY

Kautschukinstitut an der Technischen Hodkschule Hannover
Callinstrasse 46
Hannover
Director: Professor - Dr. Scheele

ASIA

CAMBODIA

Institute des Recherches sur le Caoutchouc au Cambodge
P. O. Box II
Kompong-Cham, Cambodge
Director: P. Compagnon

CEYLON

Rubber Institute of Ceylon
Dartonfield, Agalawatta
Director: Dr. R. T. Wijewantha

INDIA

Rubber Research Institute
Kottayam, Kerala State

INDONESIA

Indonesian Research Institute
Djalan Salak 18
Bogor

EXHIBIT 1 - 3

JAPAN

Foundation for Natural Rubber Research and Development
1118 Kugahara, Machi, Ota-ku
Tokyo

MALAYSIA

Rubber Research Institute of Malaya
3rd Mile Jalan Ampang
P. O. Box 150
Kuala Lumpur
Director: B. C. Sekhar

VIET-NAM

Institut des Recherches sur le Caoutchouc au Viet-Nam
Lai-Khe, P. O. Box 456
Saigon
Director, P. Campagnon

MIDDLE EAST & AFRICA

ISRAEL

Rubber Research Association, Ltd.
Technion City
Nveh-Sha'anan, Haifa
Head of Laboratory: D. Czimerman

74.09.12

3 OF 4

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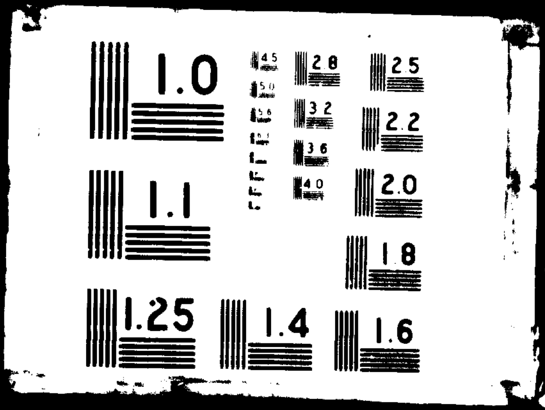

EXHIBIT 1 - 4

IVORY COAST

Institut de Recherches sur le Caoutchoc en Afrique
Bimbresso, P. O. Box 1536
Abidjan, Cote d' Ivoire, A.O.F.
Director: H. S. Breuvery

EXHIBIT 3 - 6

Rubber Board Bulletin
The Rubber Board
Kottayam, Kerala

Rubber India
12 Rampart Row, Fort
Bombay 1

Rubber News
17G, Cawasji Patel Street
Bombay 1

INDONESIA

Archives of Rubber Cultivation
Termolpos 706
Djakarta, Kota

MALAYSIA

Journal of the Rubber Research Institute of Maylaya
P. O. Box 150
Kuala Lumpur

Planter's Bulletin
(of the Rubber Research Institute of Malay)
P. O. Box 150
Kuala Lumpur

The Planter
P. O. Box 262
Kuala Lumpur

EXHIBIT 3 - 7

BOOKS

Not From Trees Alone
British Assn. of Synthetic Rubber Manufacturers, London 1970

Rubber - Natural and Synthetic - Stern
Maclaren and Sons, Ltd., Croyden Revised 1968

Introduction to Rubber - Jean Le Bras
Maclaren and Sons Ltd., London 1965

Rubber Technology, a Basic Course - Alexander S. Craig
Oliver and Boyd - Edinburgh 1963

Introduction to Rubber Technology - Maurice Morton
Reinhold Publishing Corp., New York Revised 1963

Chemistry of Natural and Synthetic Rubbers - Henry L. Fisher
Reinhold Publishing Corp., New York 1963

The Chemistry and Physics of Rubber-like Substances -Leslie Bateman
John Wiley and Sons, New York 1963

DIRECTORIES

International Rubber Directory
Verlag fur International Wirtschaftsliteratur GmbH, Zurich 1967

Indian Rubber Directory
Indian Rubber Industries Association, Bombay 1970

EXHIBIT 4

PRODUCTION OF NATURAL RUBBER

1960 - 1970

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
MALAYSIA	785	815	818	865	904	949	998	998	1100	1279	1275e
INDONESIA	620	682	681	582	648	717	716	762e	752e	790	795e
THAILAND	171	186	195	190	222	216	207	214	259	282	287
CEYLON	99	98	104	105	112	118	131	143	149	151	159
VIET-NAM	77	79	75	72	74	[illegible]	49	41	30	26	28
CAMBODIA	37	40	42	41	46	49	51	54	51	52	na
INDIA	25	27	31	37	44	49	53	63	69	80	90
OTHER ASIA & OCEANIA	23e	25e	26e	27e	23e	25e	24e	23e	26e	26e	27e
BURMA	*9*	*10*	*11*	*11*	*6*	*8*	*7*	*6e*	*9e*	*9e*	*9e*
SINGAPORE & BRUNEI	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*1e*
PAPUA - NEW GUINEA	*4*	*5*	*5*	*5*	*5*	*6*	*6*	*6*	*6*	*6*	*6*
PHILIPPINES	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*6e*	*7e*	*7e*
AFRICA	149e	144e	152e	154e	162e	160e	177e	164e	170e	182e	202e
NIGERIA	*59*	*56*	*60*	*64*	*72*	*69*	*71*	*48*	*53*	*57*	*61e*
LIBERIA	*48*	*41*	*45*	*41*	*43*	*49*	*53*	*62*	*64*	*67*	*69*
CONGO DEMOCRATIC REP.	*36*	*38*	*38*	*38*	*34*	*21*	*28e*	*31e*	*33e*	*35e*	*40*
CAMEROON	*5*	*9*	*8*	*9*	*9*	*11*	*12*	*12*	*8*	*10*	*12e*
IVORY COAST	-	*.1e*	*.2e*	*.4*	*2*	*3*	*6*	*6*	*7*	[illegible]	*na*
CENTRAL AFRICAN REP.	*.6*	*.5*	[illegible]	*1*	*1*	*1e*	*1e*	*1e*	*1e*	*1e*	*1e*
GHANA	*.8*	*.4*	*.3*	*.3*	*.3*	*.2*	*.0*	*.4*	*.2*	*.2*	*na*
BRAZIL	23	23	22	21	28	29	24	21	23	24	23e
OTHER LATIN AMERICA	7e	7e	7e	7e	7e	7e	7e	7e	7e	7e	7e
TOTAL WORLD	2015	2125	2153	2100	2270	2380	2437	2490	2635	2900	2913e

Source: International Rubber Study Group (London).

Notes:
e Estimated.
na Not Available.
Italics represent Net Exports.

EXHIBIT 5

PRODUCTION OF SYNTHETIC RUBBER

1960 - 1970

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
UNITED STATES	1460	1426	1600	1634	1793	1842	2002	1943	2165	2286	2231
*S-TYPE**	1185	1128	1213	1178	1275	1282	1358	1264	1412	1425	1352
BUTYL	100	89	92	110	101	102	105	116	114	132	120
N-TYPE	38	41	47	48	53	60	71	63	72	70	68
POLYBUTADIENE	-					156	189	205	221	268	284
POLYISOPRENE	-	168	94	142	191	66	88	106	142	111	122
E. P.	-									76	64
*OTHER***	137		154	156	173	176	191	189	204	204	221
CANADA	162	167	171	182	200	206	203	200	197	199	205
S-TYPE	104	111	113	126	137	138	131	129	129	127	132
BUTYL	29	29	29	31	34	32	31	32	31	35	31
OTHER	29	27	29	25	29	36	41	39	37	37	42
UNITED KINGDOM	92	107	119	127	156	175	194	204	237	273	303
WEST GERMANY	81	87	90	108	138	164	196	190	238	292	302
FRANCE	17	41	64	99	130	148	164	189	223	275	316
NETHERLANDS	12e	40e	45e	85e	90e	100e	110e	125e	163	214	206
ITALY	67	83	87	96e	112e	120e	122e	118e	125e	135e	160e
BELGIUM	-	-	-	-	15e	20e	20e	20e	25e	35e	40e
SPAIN	-	-	-	-	-	-	1	11	27	35e	40e
JAPAN	23	51	70	103	122	161	233	281	381	526	697
AUSTRALIA	-	3	14	17	18	21	20	26	30	33	33
INDIA	-	-	-	7	12	16	16	22	25	25	30
REP. OF SOUTH AFRICA	-	-	-	-	6	16	19	24	25	24	30
BRAZIL	-	-	16	30	32	36	54	52	59	62	75
ARGENTINA	-	-	-	-	-	3	10	17	23	38e	36e
MEXICO	-	-	-	-	-	-	1	20e	34e	36e	40e
TOTAL WORLD-Except Eastern Europe and Mainland China	1915	2007	2275	2487	2825	3029	3363	3442	3977	4485	4746
PARTIAL INFORMATION REGARDING EASTERN EUROPE:											
U.S.S.R.	301	na	na	423	434	573	630	674	na	na	na
EAST GERMANY	87	na	na	90	94	95	101	110	102	na	na
POLAND	20	31	33	36	40	39	37	40	41	48	62
CZECHOSLOVAKIA	-	-	-	-	20e	30e	30e	33e	35e	40e	40e
RUMANIA	-	-	-	6	19	31	35	51	54	na	na
HUNGARY	-	-	-	vs	vs	vs	vs	vs	vs	vs	vs
BULGARIA	-	-	-	-	-	-	-	-	-	-	su
YUGOSLAVIA	-	-	-	-	-	-	-	-	-	-	su

Sources: International Rubber Study Group (London).
European Chemical News.

Notes:
* Includes oil content of oil-extended rubbers, which rose from 17.6% of dry SBR production in 1960 to 26.3% in 1969 and 1970.
** Neoprene only in 1960.
e Estimated.
vs Very small.

EXHIBIT 5A
(Page 1 of 4)

SYNTHETIC RUBBER PLANT CAPACITIES

COUNTRIES - BY TYPES

1960-1971 AND ESTIMATED 1975

(000 Metric Tons Net Rubber)

	End 1960	End 1961	End 1962	End 1963	End 1964	End 1965	End 1966	End 1967	End 1968	End 1969	End 1970	End 1971	Est. 1/1/75
UNITED STATES	1735	1971	1952	2159	2206	2244	2336	2498	2586	2674	2772	2987	3107
SBR	1385	1477	1418	1526	1531	1539	1573	1601	1627	[illegible]	1686	[illegible]	1876
BR	20	125	120	155	174	[illegible]	206	282	311	[illegible]	349	264	364
IR			40	74	63	85	90	104	111	141	140	138	139
EP/EPDM			2	15	42	42	42	30	92	106	107	132	230
BUTYL	119	156	156	170	173	172	190	174	[illegible]	164	164	164	164
NEOPRENE	145	145	145	145	145	145	145	152	[illegible]	[illegible]	[illegible]	207	207
NITRILE	66	68	71	71	78	81	90	85	115	[illegible]	117	128	128
CANADA	165	165	165	210	210	210	210	210	225	235	237	242	242
SBR	100	100	100	125	125	125	125	[illegible]	[illegible]	[illegible]	[illegible]	150	153
BR				20	20	20	20	20 *	20 *	20 *	20 *	25	35
IR													
EP/EPDM													
BUTYL	35	35	35	35	35	35	35	35	35	35	37	37	37
NITRILE	30	30	30	30	30	30	30	30	30	30	30	30	30
MEXICO	-	-	-	-	3	30	47	77	79	71	72	74	117
SBR					3	30	47	[illegible]	[illegible]	71	70	72	94
IR								10	10				20
NITRILE											2	2	3
TOTAL NORTH AMERICA	1900	2136	2117	2369	2419	2484	2513	2785	2890	2950	3081	3303	3466
BRAZIL	-	40	40	40	68	73	79	98	104	88	88	108	138
SBR		40	40	40	40	45	[illegible]	[illegible]	[illegible]	60	60	80	[illegible]
BR					28	28	28	[illegible]	[illegible]	[illegible]	28	28	35
ARGENTINA	-	-	-	-	-	35	38	[illegible]	40	43	45	46	66
SBR						[illegible]	38	[illegible]	[illegible]	[illegible]	45	46	[illegible]
BR													[illegible]
VENEZUELA	-	-	-	-	-	-	-	-		-	-	-	40
IR													40
TOTAL SOUTH AMERICA	-	40	40	40	68	108	117	136	144	131	133	154	244

EXHIBIT 5A
(Page 2 of 4)

SYNTHETIC RUBBER PLANT CAPACITIES

COUNTRIES - BY TYPES

1960-1971 AND ESTIMATED 1975

(000 Metric Tons Net Rubber)

	End 1960	End 1961	End 1962	End 1963	End 1964	End 1965	End 1966	End 1967	End 1968	End 1969	End 1970	End 1971	Est. 1/1/75
UNITED KINGDOM	108	132	122	159	174	223	240	263	285	348	386	404	498
SBR	79	103	93	100	104	139	151	162	183	229	257	265	314
BR					10	30	30	30	30	30	40	40	40
EP/EPDM											3	3	15
BUTYL				30	30	24	24	24	24	36	36	44	44
NEOPRENE	20	20	20	20	20	20	20	30	30	30	30	30	60
NITRILE	9	9	9	9	10	10	15	17	18	23	20	22	25
WEST GERMANY	135	150	150	162	184	202	225	288	288	330	346	403	570
SBR	120	120	120	120	122	122	130	183	183	215	227	257	329
BR				12	32	40	55	55	55	55	54	54	70
IR													50
EP/EPDM												12	20
NEOPRENE	5	5	5	5	15	25	25	35	35	40	40	50	70
NITRILE	10	25	25	25	15	15	15	15	15	20	25	30	31
FRANCE	20	86	91	117	172	176	196	246	278	318	338	425	528
SBR		50	50	57	81	86	88	135	142	167	179	223	261
BR		10	15	27	55	55	58	58	73	73	73	100	100
IR													35
EP/EPDM													30
BUTYL	20	20	20	27	27	27	27	30	30	38	40	40	40
NEOPRENE							10	10	20	20	25	30	30
NITRILE		6	6	6	9	8	13	13	13	20	21	32	32
ITALY	50	80	94	96	121	126	128	149	162	169	173	208	403
SBR	50	80	81	81	101	101	101	121	126	131	131	130	231
BR			10	10	10	15	15	15	20	18	20	20	35
IR												30	30
EP/EPDM					5	5	5	5	5	10	10	16	40
BUTYL													30
NEOPRENE													20
NITRILE			3	5	5	5	7	8	11	10	12	12	17
NETHERLANDS	5	60	56	66	92	112	121	148	148	199	204	216	311
SBR	5	59	55	55	65	72	74	89	88	111	114	116	161
IR				10	25	38	45	45	45	70	70	70	110
EP/EPDM								12	12	13	15	25	30
NITRILE		1	1	1	2	2	2	2	3	5	5	5	10

EXHIBIT 5A
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SYNTHETIC RUBBER PLANT CAPACITIES

COUNTRIES - BY TYPES

1960-1971 AND ESTIMATED 1975

(000 Metric Tons Net Rubber)

	End 1960	End 1961	End 1962	End 1963	End 1964	End 1965	End 1966	End 1967	End 1968	End 1969	End 1970	End 1971	Est. 1/1/75
BELGIUM	-	-	-	27	27	27	27	27	37	82	97	97	97
SBR										45	45	45	45
BR									10	10	10	10	10
BUTYL				27	27	27	27	27	27	27	42	42	42
SPAIN	-	-	-	-	-	-	40	40	40	40	40	55	92
SBR							36	36	36	35	25	35	44
BR							4	4	4	5	15	20	40
EP/EPDM													8
SWEDEN	-	-	-	-	-	-	-	-	-	-	-	-	2
SBR													2
TOTAL WESTERN EUROPE	318	508	513	627	770	866	977	1161	1238	1486	1584	1808	2501
JAPAN	28	38	85	105	147	246	263	345	439	563	742	935	1721
SBR	26	36	75	93	105	193	193	240	321	358	481	576	1013
BR					10	20	35	60	65	105	150	190	353
IR												25	110
EP/EPDM											14	35	55
BUTYL										30	30	30	70
NEOPRENE			8	10	14	23	25	27	27	44	44	56	90
NITRILE	2	2	2	2	18	10	10	18	26	26	23	23	34
AUSTRALIA	-	30	30	30	30	30	50	60	60	60	60	66	81
SBR		30	30	30	30	30	40	40	40	42	42	45	45
BR							10	20	20	18	18	21	36
INDIA	-	-	20	20	30	30	30	30	30	30	30	30	52
SBR			20	20	30	30	30	30	30	30	30	30	52
TURKEY	-	-	-	-	-	-	-	-	-	-	-	-	46
SBR													32
BR													14
SOUTH KOREA	-	-	-	-	-	-	-	-	-	-	-	-	20
SBR													20

EXHIBIT 5A
(Page 4 of 4)

SYNTHETIC RUBBER PLANT CAPACITIES

COUNTRIES - BY TYPES

1960-1971 AND ESTIMATED 1975

(000 Metric Tons Net Rubber)

	End 1960	End 1961	End 1962	End 1963	End 1964	End 1965	End 1966	End 1967	End 1968	End 1969	End 1970	End 1971	Est. 1/1/75
REP. OF SOUTH AFRICA	-	-	-	-	30	30	30	32	32	32	32	36	43
SBR					*30*	*30*	*30*	*30*	*30*	*31*	*32*	*36*	*43*
NITRILE								*2*	*2*	*1*			
TOTAL ASIA, AFRICA & AUSTRALIA	28	68	135	155	237	336	373	467	561	685	864	1067	1963
CENTRALLY PLANNED COUNTRIES	682	742	767	767	771	801	866	937	959	1004	1201	1248	2092
SBR	*607*	*667*	*692*	*692*	*696*	*696*	*709*	*680*	*702*	*722*	*871*	*866*	*1290*
BR	*	*	*	*	*	*30*	*30*	*75*	*75*	*75*	*65*	*65*	*170*
IR	*	*	*	*	*	*	*50*	*75*	*75*	*75*	*100*	*120*	*330*
EP/EPDM											*30*	*30*	*30*
BUTYL	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*30*	*30*	*50*
NEOPRENE	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*55*	*55*	*80*	*75*	*105*	*130*
NITRILE	*20*	*20*	*20*	*20*	*20*	*20*	*22*	*27*	*27*	*27*	*30*	*32*	*52*
WORLD GRAND TOTAL	2928	3494	3572	3958	4265	4595	4926	5486	5792	6286	6863	7580	10266
SBR	*2372*	*2762*	*2774*	*2939*	*3066*	*3273*	*3416*	*3637*	*3803*	*4041*	*4348*	*4816*	*6158*
BR	*20*	*135*	*145*	*227*	*339*	*417*	*491*	*657*	*741*	*814*	*941*	*947*	*1305*
IR	-	-	*40*	*84*	*88*	*123*	*185*	*234*	*241*	*287*	*310*	*383*	*863*
EP/EPDM	-	-	*2*	*15*	*47*	*47*	*47*	*107*	*109*	*129*	*179*	*253*	*498*
BUTYL	*199*	*236*	*236*	*314*	*317*	*311*	*328*	*315*	*319*	*355*	*379*	*387*	*477*
NEOPRENE	*200*	*200*	*208*	*210*	*224*	*243*	*255*	*309*	*329*	*386*	*421*	*478*	*603*
NITRILE	*137*	*161*	*167*	*169*	*184*	*181*	*204*	*227*	*250*	*274*	*285*	*316*	*362*

Source: C. F. Ruebensaal - "World Synthetic Rubber - Its Manufacture and Markets" - Rubber and Plastics Age (London) annually 1960-1969; Proceedings of the International Institute of Synthetic Rubber Producers 1970, 1971.

Notes:
1. Capacities are all Net Rubber = Net Polymer plus Oil, but no Carbon Black.
2. Net Polymer = Basic Polymerized Monomer.
3. Gross Rubber = Net Rubber plus Carbon Black.
4. All capacities reported as Metric Tons. No adjustment made in U.S.A. and Canadian plant capacities which are still reported in Long Tons.
5. Country totals do not always agree with corresponding totals on Exhibit 5B because of:
   a) Elimination in whole or part of High Styrene-Butadiene capacities from SBR capacities in Ruebensaal's summaries of plant capacities by type by country.
   b) Retroactive adjustment of company capacities where revised capacities appeared in subsequent years of Ruebensaal's papers.

Key:
SBR - Styrene-Butadiene Rubber
BR - Butadiene Rubber - Solution Type
IR - Isoprene Rubber
EPM - Ethylene-Propylene Copolymer
EPDM - Ethylene-Propylene Terpolymer

* Capacity existed but size unknown.

EXHIBIT 5B
(Page 1 of 5)

SYNTHETIC RUBBER PLANT CAPACITIES

COUNTRIES - BY COMPANY

1960-1971 AND ESTIMATED 1975

(000 Metric Tons Net Rubber)

	End 1960	End 1961	End 1962	End 1963	End 1964	End 1965	End 1966	End 1967	End 1968	End 1969	End 1970	End 1971	Jan. 1975
UNITED STATES	1735	1971	1960	2176	2248	2275	2347	2490	2591	2646	2783	3022	3170
AMERICAN SYNTHETIC RUBBER	69	105	110	175	175	175	175	185	185	200	200	200	200
ARMSTRONG RUBBER CO.										11	11	11	11
ASHLAND CHEMICAL CO.	44	60	60	60	60	60	60	60	60	60	60	60	60
BORDEN CHEMICAL											5	5	5
CITIES SERVICE CO.				18	18	18	18	19	38	38	38	38	38
COPOLYMER RUBBER & CHEMICAL CO.	96	116	116	116	116	125	125	150	150	155	155	155	174
DOW CHEMICAL CO.	na	na	na	na	na	na	na	na	na	20	20	20	20
DU PONT	145	145	145	145	159	159	159	179	179	179	214	214	234
ENJAY CHEMICAL CO.	119	156	156	153	169	169	169	178	163	149	149	149	165
FIRESTONE	241	289	289	317	327	325	325	343	353	358	363	437	437
G. A. F.					1	1	1	1	20	20	20	20	20
GENERAL TIRE	41	50	50	65	65	65	70	90	90	113	133	135	135
B. F. GOODRICH	288	286	264	309	327	327	327	373	384	320	320	358	377
GOODYEAR TIRE & RUBBER	272	307	311	359	367	379	404	404	445	445	504	591	591
W. R. GRACE	17	12	12	12	12	12	12	15	15	15	15	15	15
HERCULES, INC.											5	5	5
HOOKER CHEMICAL CO.									5	5	5	5	5
PETRO-TEX CHEMICAL CORP.										20	20	20	20
PHILLIPS PETROLEUM CORP.	135	135	135	115	102	102	109	97	99	93	93	91	91
POLYMER CORP.													50
SHELL CHEMICAL CORP.	97	118	118	134	134	142	142	142	134	134	134	153	153
SINCLAIR-KOPPERS							6	6	13	20	20	20	20
SOUTHWEST LATEX CO.										5	5	5	5
STANDARD BRANDS CHEM. IND.		8	8	11	16	16	26	26	41	41	46	46	46
TEXAS-U. S. CHEMICAL CO.	127	140	140	140	140	140	148	148	148	148	148	148	148
UNIROYAL INC.	44	44	46	46	59	59	70	73	64	85	98	109	133
WICA CHEMICALS INC.				1	1	1	1	1	5	12	12	12	12
CANADA	165	165	165	210	210	210	210	210	225	235	239	247	247
DOW CHEMICAL OF CANADA							na	na	na	10	10	10	10
POLYMER CORP. LTD.	165	165	165	210	210	210	210	210	225	225	229	237	237+
MEXICO					3	30	47	77	79	71	72	74	117
HULES MEXICANO S.A.						27	44	44	44	44	45	[illegible]	48
NEGROMEX S.A.								30	30	20	[illegible]	20	60
RESISTOL S.A					3	3	2	3	5	7	[illegible]	7	9
TOTAL NORTH AMERICA	1900	2136	2125	2386	2461	2515	2604	2777	2895	2952	3094	3343	3534

EXHIBIT 5B
(Page 2 of 5)

SYNTHETIC RUBBER PLANT CAPACITIES

COUNTRIES - BY COMPANY

1960-1971 AND ESTIMATED 1975

(000 Metric Tons Net Rubber)

	End 1960	End 1961	End 1962	End 1963	End 1964	End 1965	End 1966	End 1967	End 1968	End 1969	End 1970	End 1971	Jan. 1975
BRAZIL		40	40	40	68	73	79	98	104	88	88	108	108
COPERBO					28	28	28	28	28	28	28	28	28
PETROQUISA		40	40	40	40	45	51	70	76	60	60	80	100
ARGENTINA						35	38	38	40	43	45	46	76
INDUSTRIAS DOW											2	3	6
PASA PETROQUIMICA						35	38	38	40	43	43	43	70
VENEZUELA													40
NAME NOT ANNOUNCED													40
TOTAL SOUTH AMERICA		40	40	40	68	108	117	136	144	131	133	154	244
UNITED KINGDOM	108	132	132	172	184	240	243	263	288	361	406	418	549
BP CHEMICAL (U.K.) LTD.	6	6	6	6	6	6	6	7	7	10	10	12	12
DOVERSTRAND LTD.	10	10	10	10	10	23	23	23	23	23	23	25	35
DOW CHEMICAL (U.K.)										6	6	6	15
DUNLOP CHEMICAL CO.	2	2	2	2	3	3	3	6	9	11	13	13	13
DU PONT CO. (U.K.) LTD.	20	20	20	20	20	20	20	30	30	30	30	30	60
ESSO CHEMICAL				30	30	24	24	24	24	36	36	44	44
INTL. SYNTHETIC RUBBER CO.	70	90	90	100	110	155	155	160	180	220	263	263	345
MARBON CHEMICAL					1	1	4	5	5	10	10	10	10
UNIROYAL LTD.		4	4	4	4	8	8	8	10	15	15	15	15
NETHERLANDS	5	60	60	70	90	112	121	148	148	201	226	243	356
N.V. NEDERLANDSE (DSM)								12	12	15	15	30	30
N.V. CHEM. IND. AKU-GOODRICH	5	5	5	5	5	5	5	5	5	5	30	30	60
DOW CHEMICAL (NETHERLANDS)		5	5	5	5	9	11	11	11	11	11	11	11
MARBON NV								5	5	10	10	10	10
SHELL NEDERLAND CHEMIE		50	50	60	85	98	105	115	115	160	160	162	245
WEST GERMANY	135	150	150	182	187	205	231	288	288	334	361	413	570
BUNAWERKE HUELS	120	120	120	120	120	120	120	160	160	160	180	217	265
CHEMISCHE WERKE HUELS					3	3	14	18	18	50	50	50	80
DOW CHEMICAL										5	5	5	5
FARBENFABRIKEN BAYER AG	15	30	30	30	30	40	40	50	50	60	60	75	85
STEREOKAUTSCHUK-WERKE				32	32	40	55	55	55	54	54	54	120
SYNTHOMER CHEMIE					2	2	2	5	5	5	12	12	15

EXHIBIT 5B
(Page 3 of 5)

SYNTHETIC RUBBER PLANT CAPACITIES

COUNTRIES - BY COMPANY

1960-1971 AND ESTIMATED 1975

(000 Metric Tons Net Rubber)

	End 1960	End 1961	End 1962	End 1963	End 1964	End 1965	End 1966	End 1967	End 1968	End 1969	End 1970	End 1971	Jan. 1975
FRANCE	20	86	91	123	177	178	198	246	278	315	338	435	553
DISTUGIL SA							10	10	20	20	25	30	30
FIRESTONE-FRANCE		10	15	15	19	20	23	23	26	26	26	38	76
CIE. FRANCAISE GOODYEAR					7	7	7	7	8	8	10	20	20
MICHELIN & CIE.				12	20	20	20	20	35	35	35	40	40
PLASTIMER		6	6	6	6	6	6	6	9	10	12	27	27
CIE. DU POLYISOPRENE													40
POLYMER CORP. (SAF)				13	18	18	25	70	70	88	100	135	135
CIE. FRANCAISE SHELL		50	50	50	80	80	80	80	80	90	90	115	115
SOCABU	20	20	20	27	27	27	27	30	30	38	40	40	70
ITALY	50	80	94	96	121	126	128	149	162	173	175	217	438
ANIC	60	80	90	92	112	117	117	137	150	158	160	190	302
DOW CHEMICAL												5	5
GRACE ITALIANA			1	1	1	1	1	1	1	1	1	1	1
MONTECATINI EDISON			3	3	8	8	10	11	11	14	14	21	65
SNAM PROGETTI°													
SOCIETA ITALIANA RESINE													65
SWEDEN													5
DOW													5
BELGIUM					27	27	27	27	37	82	97	97	97
PETROCHIM NV									10	55	55	55	55
POLYSAR BELGIUM NV					27	27	27	27	27	27	42	42	42
SPAIN							40	40	40	40	40	55	98
CALATRAVA							40	40	40	40	40	55	80
DOW UNQUINESA													5
IND. QUIMICAS DEL CARRION													5
POULAR S.A.													8
TOTAL WESTERN EUROPE	308	508	527	643	786	888	988	1161	1241	1506	1643	1878	2666

EXHIBIT 5B
(Page 4 of 5)

SYNTHETIC RUBBER PLANT CAPACITIES

COUNTRIES - BY COMPANY

1960-1971 AND ESTIMATED 1975

(000 Metric Tons Net Rubber)

	End 1960	End 1961	End 1962	End 1963	End 1964	End 1965	End 1966	End 1967	End 1968	End 1969	End 1970	End 1971	Jan. 1975
JAPAN	20	38	85	105	147	246	263	345	448	563	742	942	1752
AA CHEMICAL CO.										20	20	20	20
ASAHI CHEMICAL INDUSTRY CO. LTD.					10	10	10	25	25	40	60	100	225
ASAHI-DOW LTD.						12	12	18	24	26	26	26	26
DENKI KAGAKU KOGYO KABUSHIKI				2	6	13	15	17	27	30	30	42	42
HITACHI													36
HODOGAYA CHEMICAL												6	12
JAPAN BUTYL CO.										30	30	30	45
JAPAN EP RUBBER CO.												10	15
JAPANESE GEON CO.	8	8	8	8	30	50	65	85	115	150	210	235	305
JAPAN SYNTHETIC RUBBER	20	30	69	87	93	151	151	180	224	236	321	363	662
LACSTAR CORP.								2	2	2	2	2	5
MITSUI PETROCHEMICAL											4	15	15
MITSUBISHI CHEMICAL													30
NIPPON ALFIN RUBBER CO.												20	70
NIPPON PETROCHEMICALS													30
NIPPON POLYISOPRENE													30
NIPPON SODA CO.												7	7
SHOWA NEOPRENE KK			8	8	8	10	10	10	10	14	14	14	34
SUMITOMO CHEMICAL CO.											10	10	65
SUMITOMO-NAUGATUCK								4	7	9	9	11	11
TAKEDA CHEMICAL								4	4	6	6	6	6
TOYO SODA MANUFACTURING CO.													6
UBE INDUSTRIES LTD.												25	25
KANEGAFUCHI CHEMICAL													
KURASHIKI RAYON													30
INDIA				20	20	30	30	30	30	30	30	30	54
SYNTHETICS & CHEMICALS LTD.				20	20	30	30	30	30	30	30	30	50
POLYCHEM LTD.													4
TURKEY													46
PETKIM PETROKIMYA A.S.													46
SOUTH KOREA													
KOREA SYNTHETIC RUBBER CO.													
REPUBLIC OF SOUTH AFRICA					30	30	30	32	32	32	32	36	42
SYNTHETIC LATEX CO.								2	2	2	2	2	5
SYNTHETIC RUBBER CO.					30	30	30	30	30	30	30	34	37

SYNTHETIC RUBBER PLANT CAPACITIES

COUNTRIES - BY COMPANY

1960-1971 AND ESTIMATED 1975

('000 Metric Tons Net Rubber)

	End 1960	End 1961	End 1962	End 1963	End 1964	End 1965	End 1966	End 1967	End 1968	End 1969	End 1970	End 1971	Jan. 1975
AUSTRALIA		30	30	30	30	30	50	60	60	60	64	67	72
AUSTRALIA SYNTHETIC RUBBER CO.		*30*	*30*	*30*	*30*	*30*	*30*	*40*	*40*	*38*	*40*	*43*	*48*
DOW CHEMICAL (AUSTRALIA) PTY.										*o*	*o*	*2*	*o*
PHILLIPS IMPERIAL CHEMICAL LTD.							*20*	*20*	*20*	*20*	*22*	*22*	*22*
TOTAL ASIA, AFRICA & AUSTRALIA	28	68	115	155	227	336	373	467	570	685	868	1075	1966
TOTAL NON-COMMUNIST WORLD	2236	2752	2807	3224	3542	3847	4082	4541	4850	5274	5738	6450	8410
CENTRALLY PLANNED COUNTRIES	701	716	716	716	721	736	792	937	959	1004	1219	1248	2092
BULGARIA									*22*	*22*	*22*	*21*	*50*
CHINA		*15*	*15*	*15*	*15*	*15*	*15*	*15*	*15*	*15*	*25*	*25*	*55*
CZECHOSLOVAKIA					*5*	*20*	*30*	*30*	*30*	*75*	*75*	*75*	*88*
EAST GERMANY	*90*	*80*	*90*	*90*	*90*	*80*	*102*	*102*	*102*	*102*	*117*	*117*	*157*
HUNGARY													*30*
NORTH KOREA													*20*
POLAND	*38*	*38*	*38*	*38*	*38*	*38*	*40*	*40*	*40*	*40*	*40*	*40*	*102*
ROUMANIA	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*55*	*120*
YUGOSLAVIA												*5*	*50*
USSR	*525*	*525*	*525*	*525*	*525*	*525*	*556*	*700*	*700*	*700*	*890*	*910*	*1420*
WORLD TOTAL	2937	3468	3523	3940	4263	4583	4874	5478	5809	6278	6957	7698	10502

Source: C. P. Ruebensaal - "World Synthetic Rubber - Its Manufacture and Markets" - Rubber and Plastics Age (London) annually 1960-1969; Proceedings of the International Institute of Synthetic Rubber Producers 1970, 1971.

Notes:
1. Capacities are all Net Rubber = Net Polymer plus Oil, but no Carbon Black.
2. Net Polymer = Basic Polymerized Monomer.
3. Gross Rubber = Net Rubber plus Carbon Black.
4. All capacities reported as Metric Tons. No adjustment made in U.S.A. and Canadian plant capacities which are still reported in Long Tons.
5. Country totals do not always agree with corresponding totals on Exhibit 5A because of:
   a) Elimination in whole or part of High Styrene-Butadiene capacities from SBR capacities in Ruebensaal's summaries of plant capacities by type by country.
   b) Retroactive adjustment of company capacities where revised capacities appeared in subsequent years of Ruebensaal's papers.

o 400 lb./day Pilot Unit inaugurated 1968.

EXHIBIT 6

PRODUCTION AND PRICE TREND

NATURAL RUBBER

1960-1970 AND ESTIMATED TO 1980

	PRODUCTION - 000 Metric Tons					PRICES - US$/Metric Tons - New York				
							RSS#3			
	World Total	Latex d.r.c	Sheets *	Crepe *	Standard Graded Rubber	RSS#1 Average	High	Average	Low	#3 Blanket Crepe Average
1960	2015	167	1146	702		841	1041	830	623	769
1961	2125	159	1241	725		651	722	643	598	580
1962	2153	174	1207	772		630	692	616	595	585
1963	2100	173	1197	730		579	645	565	507	538
1964	2270	198	1397	675		557	601	549	507	492
1965	2380	205	1526	648	1	566	612	556	518	423
1966	2437	209	1593	626	9	521	565	514	466	496
1967	2490	214	1570	682	24	439	477	430	375	398
1968	2635	230	1587	737	81	437	515	430	355	417
1969	2900	247	1717	797	139	578	686	568	474	525
1970	2913e	232e	1695	762	224	463	576	454	375	445
1975	3600	250	1500	600	1250	360		350		340
1980	4400	300	900	400	3000	335		325		315

Source: International Rubber Study Group (London).

Notes:
- * Estimated, based on relative percentages exported by Malaysia, Singapore and Ceylon.
- e Estimated.
- d.r.c Dry Rubber Content.

Chart 6A

NATURAL RUBBER PRODUCTION

By Principal Types

1960-1970 and Estimated to 1980

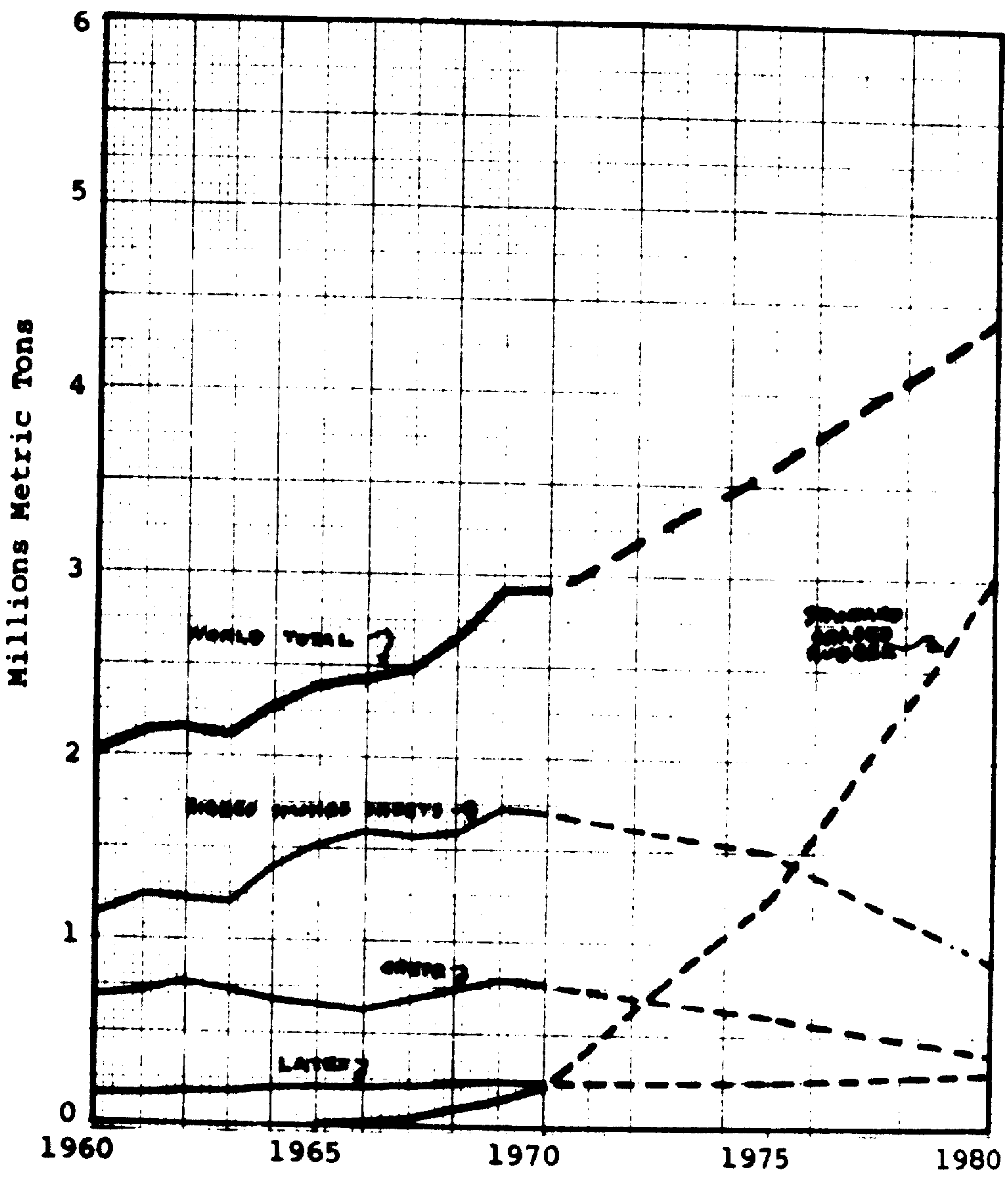

Chart 6B

NATURAL RUBBER PRICES

Yearly Average Price for Grade RSS#3

1960-1970 and Estimated to 1980

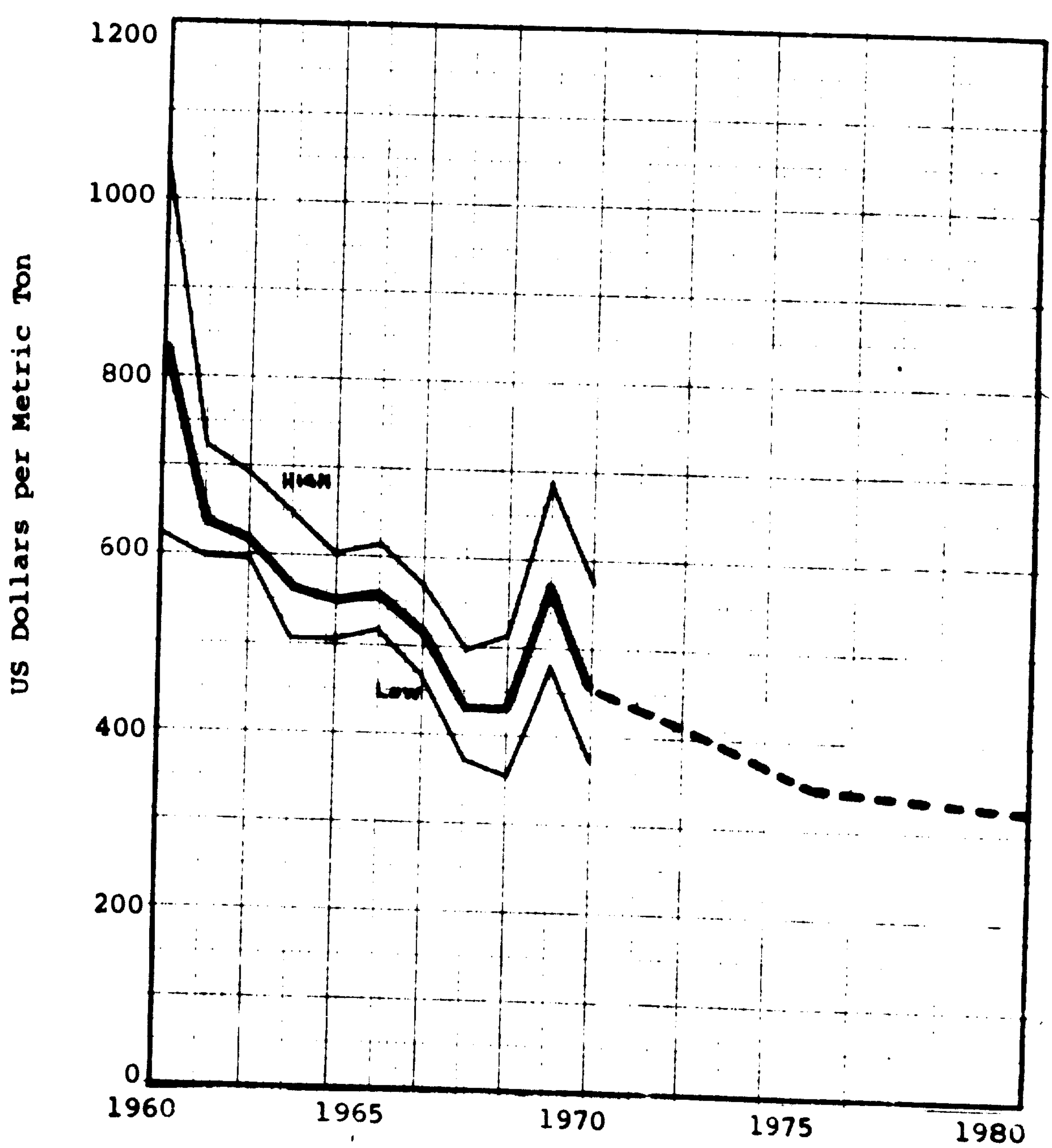

EXHIBIT 7

PRODUCTION AND PRICE TREND

SYNTHETIC RUBBER

1960-1970 AND ESTIMATED TO 1980

	PRODUCTION*- 000 Metric Tons						PRICES - US$/Metric Tons - Mid Year							
							S-Type							
							1500		1712		Polyisoprene		Polybutadiene	
	World* Total	S-Type	Butyl	N-Type	Stereo - Regular+	Neoprene & Others	U.S.	France	U.S.	France	U.S.	U.K.	U.S.	France
1960	1914	1538	133	82	2	159	507		391					
1961	2005	1590	127	98	33	157	507	556	391					
1962	2276	1746	133	112	112	173	507	487	391		531			
1963	2488	1796	189	102	217	184	507	366	391	401	535	549	619	606
1964	2824	1963	198	118	331	214	507	441	391	344	485	489	551	505
1965	3028	2074	196	122	409	227	507	441	391	344	485	489	551	505
1966	3365	2234	198	158	529	256	507	441	391	344	485	489	551	505
1967	3442	2251	221	148	560	262	507	420	391	324	507	489	551	505
1968	3977	2606	214	158	693	306	507	392	391	306	452	419	551	428
1969	4485	2830	281	187	862	325	507	392	391	306	452	441	551	428
1970	4746	2995	261	165	939	386	507	375	391	298	529	507	551	390
1975	7500	3400	300	200	3000	600		350		280		400		350
1980	11000	4000	400	250	6500	850		325		260		350		325

Sources: International Rubber Study Group (London).
European Chemical News.

Notes: Prices are published prices for single deliveries in 10 ton lots. Most sales are at negotiated prices.

\+ Includes polysoprene, polybutadiene and ethylene-propylene polymers.
* Excluding Eastern Europe and Mainland Chir .

Except for the U.S.A. and Canada, total production of each country for each year has been allocated by type of rubber in proportion to known or estimated capacities existing in that year as shown in Exhibit 5A.

Chart 7A

SYNTHETIC RUBBER PRODUCTION

By Principal Types

1960-1970 and Estimated to 1980

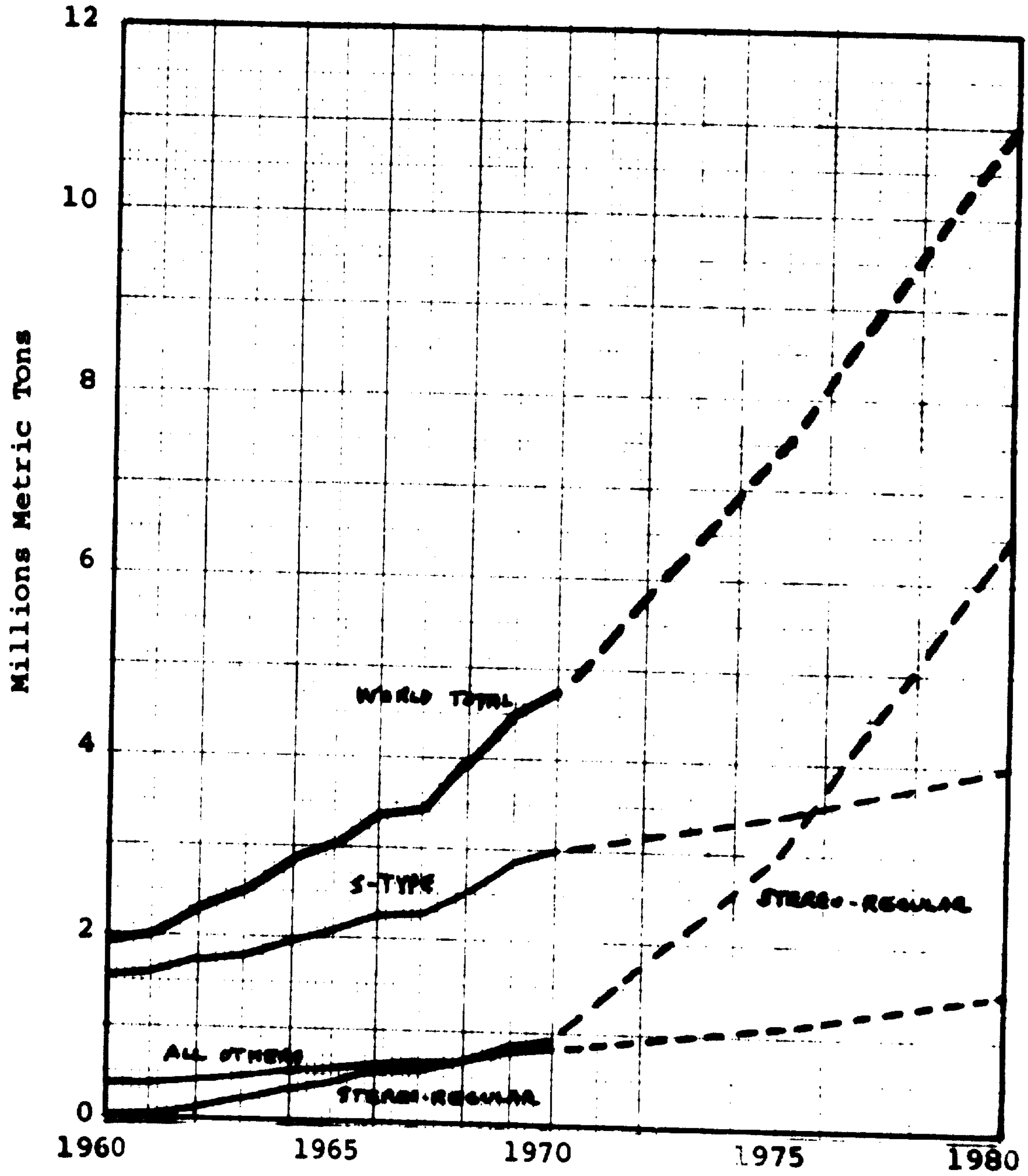

Chart 7B

SYNTHETIC RUBBER PRICES

Midyear Prices for Principal Grades

<u>1960-1970 and Estimated to 1980</u>

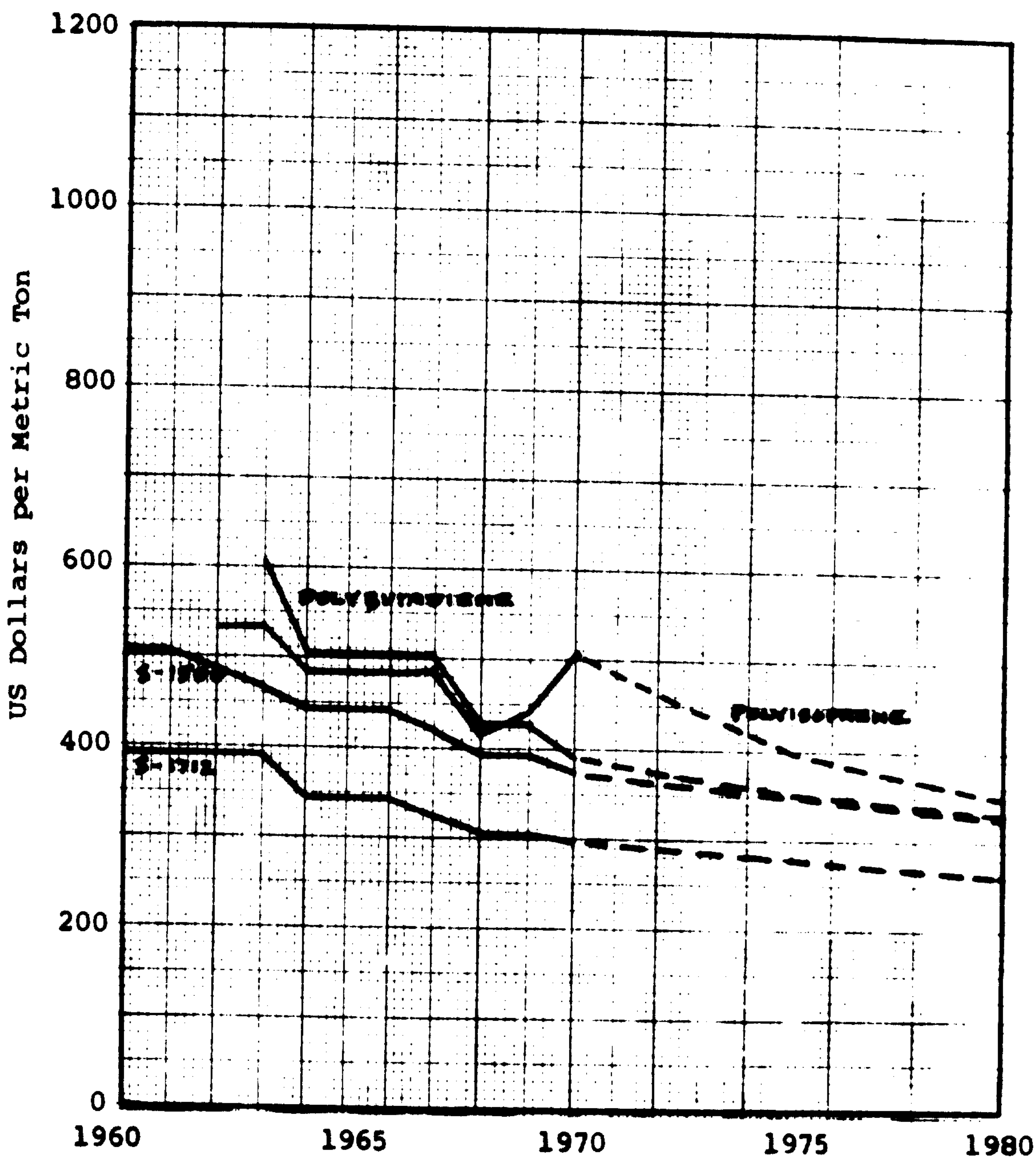

EXHIBIT 8
(Page 1 of 3)

DEMAND FOR NATURAL RUBBER

1960-1970 AND ESTIMATED TO 1980

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1975	1980
DEVELOPED COUNTRIES	1779	1814	1895	1872	1918	2010	2086	2028	2240	2318	2362	2740	3450
NORTH AMERICA	530	449	515	490	560	583	598	564	629	659	622	750	900
UNITED STATES+	495	417	477	454	517	538	548	519	582	607	569	680	820
CANADA	35	32	38	36	43	45	50	45	47	52*	53*	70	80
Known N.R. Latices Included Above:													
UNITED STATES	46	39	46	42	51	51	46	50	60	64	62		
CANADA	3	2	2	2	2	2	2	1	1	2	1		
WESTERN EUROPE	681	626	646	679	715	716	720	713	760	840	884	950	1150
UNITED KINGDOM+	206	163	167	172	196	195	184	187	197	200	199	180	185
FRANCE	132	125	122	126	126	120	129	132	126	160	161	160	190
WEST GERMANY	153	136	143	152	166	170	161	143	173	134	104e	135	185
ITALY	69	80	80	88	89	83	86	101	99	108	128	140	190
SPAIN	22	23	34	33	34	36	42	40	51	55	67		
NETHERLANDS	21	21	21	21	21	22	22	21	21	22	20		
BELGIUM-LUXEMBOURG	15	16	14	16	17	17	18	18	21	24	23e		
SWEDEN	23	20	23	23	24	25	23	21	22	23	22		
AUSTRIA	12	11	11	11	12	13	12	13	16	17	18	335	400
SWITZERLAND	7	7	8	9	7	7	8	7	6	9	9		
FINLAND	3	5	6	8	6	7	13	9	7	7	10e		
DENMARK	6	6	5	5	5	6	6	6	6	6	5		
NORWAY	4	4	5	5	4	5	6	5	5	5	5		
PORTUGAL	5	7	4	6	5	7	6	7	7	7	8		
GREECE	3	2	3	4	3	3	4	3	3	3	4e		
Known N.R. Latices Included Above:													
UNITED KINGDOM	28	23	24	24	28	29	26	25	29	28	21		
FRANCE	14	13	13	15	16	16	17	15	14	16	12		
WEST GERMANY	15	14	17	19	23	24	25	24	29	30	29e		
ITALY	10	10	11	12	10	9	11	15	15	18	13		
SPAIN	2	3	5	4	5	5	6	6	6	7	6		
NETHERLANDS	2	2	3	3	3	3	3	4	2	2	2		
BELGIUM-LUXEMBOURG	2	2	1	1	2	2	2	4	5	6	7e		
SWEDEN	3	2	2	3	3	3	2	3	3	3	3		
FINLAND	1	1	1	1	1	1	1	1	1	1	1		

EXHIBIT 8
(Page 2 of 3)

DEMAND FOR NATURAL RUBBER

1960-1970 AND ESTIMATED TO 1980

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1975	1980
ASIA, AFRICA, AUSTRALIA	235	239	251	253	291	282	289	314	330	357	372	450	650
JAPAN	172	186	193	188	215	207	229	243	258	281	282	360	550
SOUTH AFRICA	19	18	18	21	30	29	21	26	28	27	32e		
AUSTRALIA	37	29	35	38	40	38	32	38	37	40	39	90	100
NEW ZEALAND	7	6	5	6	6	8	7	7	7	9	9e		
Known N.R. Latices Included Above:													
JAPAN	16	17	19	15	16	14	17	19	19	21	19e		
AUSTRALIA	6	5	5	5	4	3	3	3	3	3	3		
EASTERN EUROPE	333	500	483	450	352	429	479	437	521	462	484	590	750
USSR	177	340	346	282	169	256	294	262	326*	270	270e	360	500
CZECHOSLOVAKIA	62	57	27	53	46	46	46	43	45	43	45e		
POLAND	33	35	36	33	40	36	41	39	43	47	47e		
RUMANIA	9	12	14	19	22	19	25	27	31	29	43e		
YUGOSLAVIA	13	15	16	16	18	18	17	16	18	23	18e	230	250
HUNGARY	10	11	13	15	16	16	16	17	17	[illegible]	16e		
BULGARIA	6	6	8	8	11	9	10	7	14	10	16e		
OTHER EASTERN EUROPE	23	24	23	24	30	29	30	26	27	23	29e		
Known N.R. Latices Included Above:													
USSR	4	5	8	7	7	8	11	9	11e	11e	19e		
DEVELOPING COUNTRIES	354	327	361	376	442	453	504	501	585	680	616	725	860
LATIN AMERICA	111	114	105	106	112	108	111	103	116	119	131	125	160
MEXICO	15	13	13	14	16	19	18	19	21	23	25e		
BRAZIL	48	43	41	42	38	31	30	26	36	34	38e		
ARGENTINA	22	34	22	19	29	28	23	21	23	26	23e		
CHILE	4	3	3	6	5	5	6	5	6	6	7e		
CUBA	2	4	3	5	4	1	2	2	1	2	5e		
OTHER LATIN AMERICA	20	17	23	20	20	24	31	30	29	28	33e		

EXHIBIT 8
(Page 3 of 3)

DEMAND FOR NATURAL RUBBER

1960-1970 AND ESTIMATED TO 1980

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1975	1980
ASIA & AFRICA	243	213	256	270	330	345	392	398	469	561	485	600	700
CHINA (ESTIMATED)	122	84	109	109	144	140	173	158	212	275	181		
INDIA	48	49	55	62	60	67	69	80	74	101	93		
OTHER ASIA (EST.)	61	68	80	84	104	106	120	126	144	153	167		
TURKEY	5	4	4	7	9	16	12	18	20	11	17		
EGYPT	4	4	5	4	5	4	3	3	5	4	4e		
OTHER AFRICA (EST.)	3	4	3	4	6	12	15	13	14	17	23e		
TOTAL WORLD	2133	2141	2256	2248	2360	2463	2590	2529	2825	2998	2978	3465	4310
Total Known N.R. Latices Included Above	169	159	182	179	199	200	206	215	235	257	253		

Source: International Rubber Study Group (London).

Notes: For most countries the figures represent "Net Imports".
Figures for "Other Africa" include rubber retained for consumption in producing areas.

+ Includes deliveries from Government stockpiles.
* Gross Imports.
e Estimated.

Chart 8

DEMAND FOR NATURAL RUBBER

Developed and Developing Countries

1960-1970 and Estimated to 1980

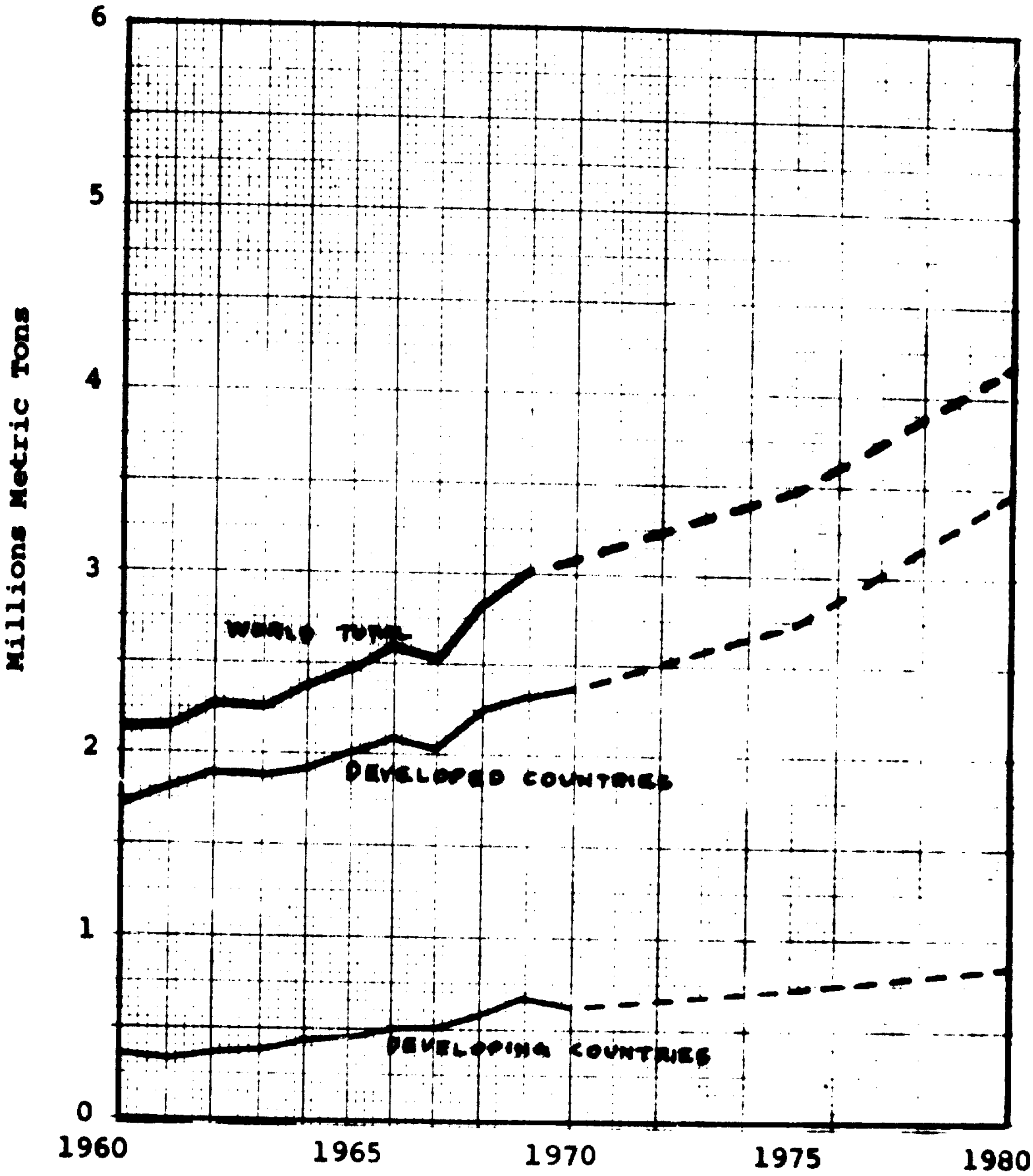

EXHIBIT 8A
(Page 1 of 2)

RUBBER CONSUMPTION BY MAJOR SECTORS

NATURAL RUBBER

EIGHT REPORTING COUNTRIES

1960-1970 AND ESTIMATED TO 1980

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1975	1980
UNITED STATES													
Tires & Tire Products	329	282	309	300	319	361	393	341	403	436	395+	475	575
Non-Tire Products	158	152	161	165	171	162	161	156	189	172	175+	205	245
% Tires	68%	65%	66%	65%	65%	69%	71%	69%	68%	72%	69%+	70%	70%
CANADA													
Tires & Tire Products	25	23	25	26	29	31	35	34	33	37	40	56	64
Non-Tire Products	10	10	11	11	12	12	12	12	13	12	10	14	16
% Tires	72%	70%	70%	70%	71%	72%	75%	74%	72%	76%	80%	80%	80%
UNITED KINGDOM													
Tires & Tire Products	84	79	79	79	84	89	89	86	94	94	96e	90	92
Non-Tire Products	99	90	88	93	100	98	95	93	100	97	94e	90	93
% Tires	46%	47%	47%	46%	46%	48%	48%	48%	48%	49%	51%	50%	50%
FRANCE													
Tires & Tire Products	77	79	78	77	77	77	79	82	86	101	114	120	150
Non-Tire Products	53	50	49	51	50	46	47	46	42	47	43	40	40
% Tires	59%	61%	62%	60%	61%	63%	63%	64%	67%	68%	73%	75%	80%
WEST GERMANY													
Tires & Tire Products	77	71	74	78	78	83	80	72	80	99	na	63	93
Non-Tire Products	71	67	74	74	77	75	77	70	90	92	na	62	92
% Tires	52%	51%	50%	51%	50%	52%	51%	51%	47%	52%		50%	50%
ITALY													
Tires & Tire Products	45	50	50	58	54	53	53	56	56	59	67e	85	115
Non-Tire Products	31	30	30	30	29	34	39	44	44	4'	47e	55	75
% Tires	59%	62%	63%	66%	65%	61%	58%	56%	56%	57%	59%	60%	60%
JAPAN													
Tires & Tire Products	77	86	90	94	98	95	101	117	125	140	153	210	330
Non-Tire Products	91	92	103	102	108	107	115	126	130	129	125	150	220
% Tires	46%	48%	47%	48%	48%	47%	45%	48%	49%	52%	55%	58%	60%
BRAZIL													
Tires & Tire Products	34	29	29	26	24	20	23	24	28	26	27	35	45
Non-Tire Products	10	10	11	10	9	6	8	8	10	9	8	10	15
% Tires	77%	74%	73%	72%	73%	77%	74%	75%	74%	74%	77%	75%	75%

EXHIBIT 9A
(Page 2 of 2)

RUBBER CONSUMPTION BY MAJOR SECTORS

NATURAL RUBBER

EIGHT REPORTING COUNTRIES

1960-1970 AND ESTIMATED TO 1980

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1975	1980
TOTAL 8 COUNTRIES													
Tire & Tire Products	748	699	734	738	763	809	853	812	905	992	1000e	1161	1504
Non-Tire Products	523	501	527	536	556	540	554	555	618	602	600e	644	831
% Tires	59%	58%	58%	58%	58%	60%	61%	59%	59%	[illegible]	63%	64%	64%

Sources: International Rubber Study Group (London).
Natural Rubber News.

Notes:

e Estimated.
+ NRN June 1971.

1. The above 8 countries account for about 55% of the world natural rubber consumption.

2. Distribution by grades of Malayan exports, representing 41% to 48% of total exports, is as follows:

Ribbed Smoked Sheets	58%	55%	56%	58%	61%	61%	60%	58%
Crepe	32	34	33	26	24	23	25	25
Latex	9	10	10	14	13	13	11	10
Other Grades	1	1	1	2	2	3	4	7

EXHIBIT 9
(Page 1 of 3)

DEMAND FOR SYNTHETIC RUBBER

1960-1970 AND ESTIMATED TO 1980

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1975	1980
DEVELOPED COUNTRIES	2215	2359	2665	2887	3213	3569	3944	4080	4575	5175	5436	8300	12100
NORTH AMERICA	1191	1204	1388	1452	1590	1701	1848	1807	2056	2265	2172	2800	3600
UNITED STATES	1121	1137	1305	1365	1499	1596	1734	1679	1932	2134	2025	2570	3280
CANADA	70	87	83	87	91	105	114	128	124	131	147	230	320
Known S.R. Latices Included Above:													
*UNITED STATES**	113	115	128	131	140	130	136	131	141	161	130		
CANADA+	3	3	3	3	4	4	4	4	4	4	5		
WESTERN EUROPE	489	516	564	644	751	808	937	978	1129	1292	1479	2450	3750
UNITED KINGDOM	130	127	142	146	171	178	197	219	242	264	279	410	555
FRANCE	104	101	109	131	150	154	182	196	208	228	274	430	610
WEST GERMANY	110	119	129	146	179	209	229	220	271	324	353	515	735
ITALY	64	70	63	87	105	114	149	156	157	184	234	410	650
SPAIN	9	13	16	21	27	32	48	42	54	68	78		
NETHERLANDS	17	27	15	34	24	15	18	26	51	51	70		
BELGIUM-LUXEMBOURG	13	14	17	20	23	27	26	27	34	39	46		
SWEDEN	16	17	20	22	27	33	35	37	46	53	51		
AUSTRIA	9	9	12	13	16	16	18	20	22	27	32		
SWITZERLAND	8	9	9	8	11	11	13	12	14	17	18	685	1200
FINLAND	1	2	3	3	4	4	6	5	9	10	14		
DENMARK	3	3	3	4	4	4	5	5	6	9	10		
NORWAY	2	2	3	4	4	4	5	5	6	6	7		
PORTUGAL	3	3	3	5	6	7	6	8	9	11	12		
GREECE	.1e	.1e	.1e	.1e	.1	.1	.1	.1	.2	.8	1e		
Known S.R. Latices Included Above:													
UNITED KINGDOM	7	9	6	8	13	20	28	31	36	43	52e		
FRANCE	3	3	3	4	5	6	9	6	12	13	14		
SWEDEN	na	na	na	na	2	4	4	4	na	na	na		
EASTERN EUROPE	420	506	554	591	648	819	869	950	964	1090	1170	1770	2650
U.S.S.R.	301x	350e	400e	423x	434x	573x	630x	674x	700e	800e	850e	1290	1870
*OTHERS***	119	156	154	168	214	246	239	276	264	290	320	480	780

EXHIBIT 9
(Page 2 of 3)

DEMAND FOR SYNTHETIC RUBBER

1960-1970 AND ESTIMATED TO 1980

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1975	1980
ASIA, AFRICA, AUSTRALIA	115	133	159	200	224	241	290	345	426	528	615	1275	2100
JAPAN	73	91	114	149	163	180	231	272	355	451	536	1100	1800
SOUTH AFRICA	15	15	17	19	26	23	23	32	30	32	34		
AUSTRALIA	27	27	28	32	35	38	36	41	41	45	45	175	300
NEW ZEALAND	na	na	na	na	na	na	na	na	na	na	na		
Known S.R. Latcies Included Above:													
AUSTRALIA	.5	.5	.7	1	2	2	2	2	2	2	2		
DEVELOPING COUNTRIES	99	121	126	145	179	192	214	237	302	309	355E	650	1100
LATIN AMERICA	63e	85e	100e	109e	139	144	152	159	198	204	226e	350	500
MEXICO	18	23	24	25	33	30	37	42	42	43	48		
BRAZIL	17	23	34	38	41	39	54	57	76	72	85		
ARGENTINA	12	19	17	16	29	41	19	23	31	45	48		
CHILE	na	na	na	na	5	5	5	4	3	4	na		
COLOMBIA	na	na	na	na	10	13	15	10	14	12	na		
PERU	na	na	na	na	2	2	3	3	3	3	na		
VENEZUELA	na	na	na	na	14	11	15	15	22	18	na		
OTHER LATIN AMERICA	na	na	na	na	5	3	4	5	7	7	na		
ASIA AND AFRICA	36e	36e	26e	36e	40	48	62	78	98	105	129e	300	600
TURKEY	2	1	2	3	5	6	9	12	15	12	11		
INDIA	8	9	10	17	16	19	21	26	28	28	36		
PAKISTAN					1	1	1	2	1	2	na		
MALAYSIA & BRUNEI					1	1	2	2	2	4	na		
CHINA (MAINLAND)	16e	14e	.3e	-	.5e	1e	5e	10e	14e	11e	22e		
CHINA (TAIWAN)					1	2	2	4	7	10	na		
KOREA (REP. OF)					8	5	5	6	7	11	na		
PHILIPPINES					.2	8	8	9	10	9	na		
THAILAND					.4	1	1	1	1	3	na		
ISRAEL					4	4	4	3	6	7	na		
IRAN					1	1	3	2	5	5	na		
UAR (EGYPT)					2	1	1	1	2	3	na		

EXHIBIT 9
(Page 3 of 3)

DEMAND FOR SYNTHETIC RUBBER

1960-1970 AND ESTIMATED TO 1980

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1975	1980
TOTAL WORLD	2314	2480	2791	3032	3392	3761	4158	4317	4877	5484	5791	8950	13200

Source: International Rubber Study Group (London).

Notes: Figures represent production (if any) plus imports minus exports (if any).

* S-Type, N-Type and Neoprene 1960-64; S-Type and N-Type only 1965-1970.
\+ S-Type only.
x European Chemical News 9/25/70, p. 4.
xx IRSG and European Chemical News 9/25/70, p. 4.

Chart 9

DEMAND FOR SYNTHETIC RUBBER

Developed and Developing Countries

1960-1970 and Estimated to 1980

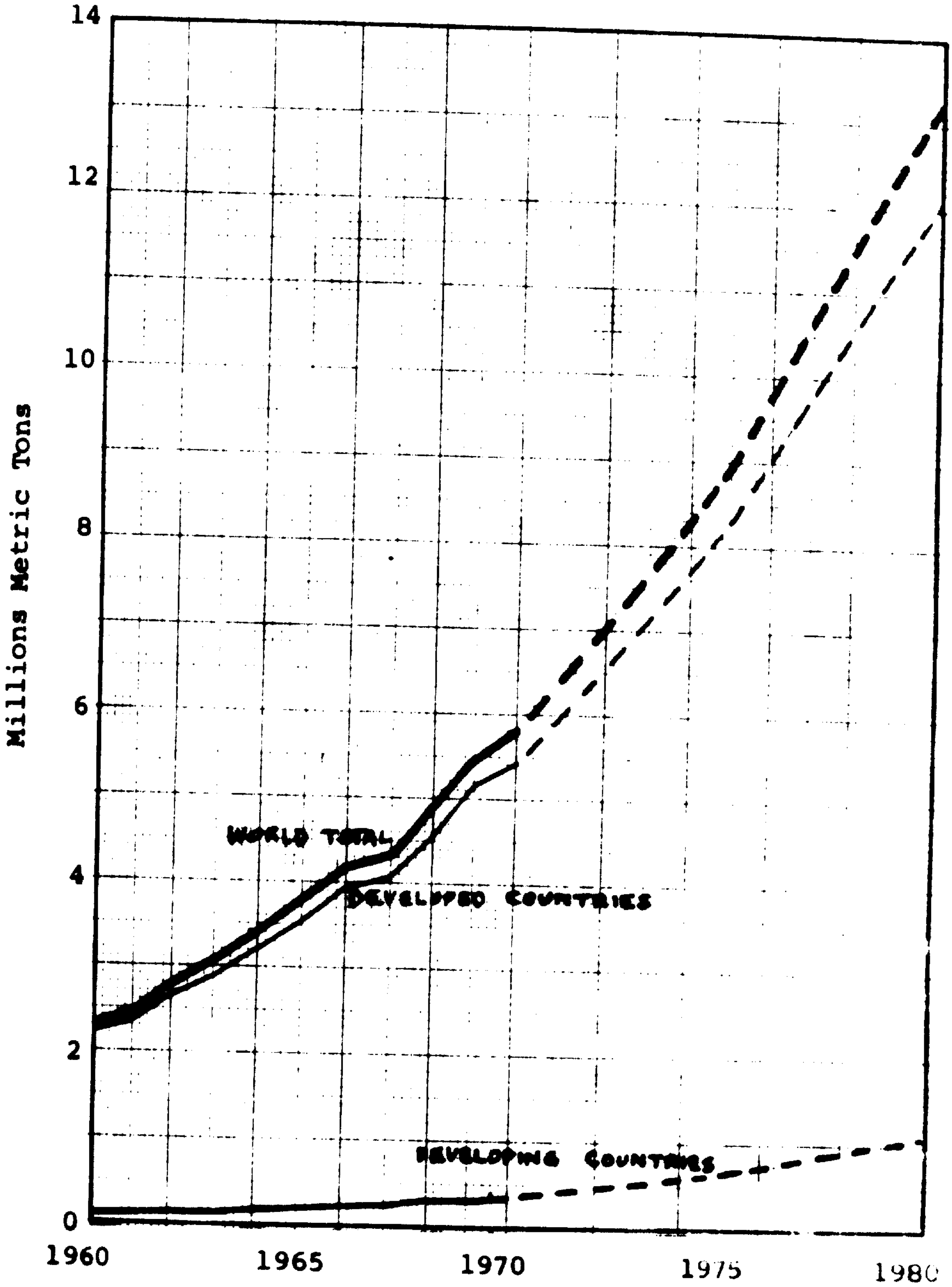

EXHIBIT 9A
(Page 1 of 2)

RUBBER CONSUMPTION BY MAJOR SECTORS

SYNTHETIC RUBBER

EIGHT REPORTING COUNTRIES

1960-1970 AND ESTIMATED TO 1980

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1975	1980
UNITED STATES													
Tires & Tire Products	682	690	774	798	899	966	1041	1006	1229	1314	1227e	1650	2100
Non-Tire Products	415	430	502	529	576	599	652	648	697	743	711e	920	1180
% *Tires*	62%	62%	61%	60%	61%	62%	62%	61%	64%	64%	64%	64%	64%
CANADA													
Tires & Tire Products	39	44	53	60	65	69	80	81	79	99	105	170	240
Non-Tire Products	18	19	22	25	27	28	29	29	27	30	31	60	80
% *Tires*	68%	70%	71%	71%	71%	71%	73%	74%	75%	77%	77%	75%	75%
UNITED KINGDOM													
Tires & Tire Products	74	76	82	87	98	104	111	113	130	136	134e	195	250
Non-Tire Products	44	47	53	59	70	78	88	93	104	120	134e	215	305
% *Tires*	63%	62%	61%	60%	58%	57%	56%	55%	56%	51%	50%	47%	45%
FRANCE													
Tires & Tire Products	49	52	57	67	77	84	95	105	110	130	149	265	400
Non-Tire Products	43	45	53	59	70	71	80	84	86	97	104	165	210
% *Tires*	53%	54%	52%	53%	52%	54%	54%	56%	56%	57%	59%	62%	65%
WEST GERMANY													
Tires & Tire Products	63	71	78	87	102	124	123	119	140	176	na	258	330
Non-Tire Products	43	51	53	58	75	84	90	82	113	152	na	257	405
% *Tires*	59%	58%	60%	60%	58%	60%	58%	59%	55%	54%		50%	45%
ITALY													
Tires & Tire Products	27	31	34	44	49	58	66	79	76	80	89e	185	290
Non-Tire Products	32	34	40	48	48	55	66	76	84	98	105e	225	360
% *Tire*	46%	48%	46%	48%	51%	51%	50%	51%	47%	45%	46%	45%	45%
JAPAN													
Tires & Tire Products	22	35	47	65	81	88	103	134	175	212	235e	550	900
Non-Tire Products	39	51	59	63	82	87	119	139	173	214	252e	550	900
% *Tires*	36%	41%	44%	51%	50%	50%	46%	49%	50%	50%	48%	50%	50%
BRAZIL													
Tires & Tire Products	13	17	22	24	28	25	34	37	43	44	51e	80	115
Non-Tire Products	3	4	7	11	13	13	18	20	28	28	32e	50	80
% *Tires*	81%	81%	76%	69%	68%	66%	65%	65%	61%	61%	61%	60%	60%

EXHIBIT 9A
(Page 2 of 2)

RUBBER CONSUMPTION BY MAJOR SECTORS

SYNTHETIC RUBBER

EIGHT REPORTING COUNTRIES

1960-1970 AND ESTIMATED TO 1980

(000 Metric Tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1975	1980
TOTAL 8 COUNTRIES													
Tires & Tire Products	969	1016	1147	1232	1399	1518	1653	1674	1982	2191	2200e	3390	4725
Non-Tire Products	637	681	789	852	961	1015	1142	1171	1312	1482	1550e	2485	3645
% Tires	*60%*	*60%*	*59%*	*59%*	*59%*	*60%*	*59%*	*59%*	*60%*	*60%*	*59%*	*58%*	*56%*

Source: International Rubber Study Group (London).

Notes:

e Estimated.

1. The above 8 countries account for 82% to 87% of world synthetic rubber consumption.

2. Distribution by type of rubber for United States Tire and Non-Tire products, representing 33 - 39% of total synthetic rubber consumption is as follows:

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Tires & Tire Products											
S-Type	92.6%	89.9%	85.8%	81.0%	78.6%	78.0%	75.6%	73.1%	72.4%	69.2%	65.8%
Butyl	6.6	6.8	6.2	6.1	5.4	5.4	5.8	6.0	5.5	5.3	5.7
N-Type	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Stereo-Regular	-	2.6	7.3	12.2	15.1	15.8	17.8	20.4	21.6	25.1	28.2
Other Rubbers	.6	.7	.7	.7	.9	.8	.7	.5	.5	.4	.3
Non-Tire Products											
S-Type	69.5%	67.3%	66.1%	64.9%	64.7%	60.4%	59.0%	60.0%	59.1%	57.0%	54.8%
Butyl	3.9	3.6	4.3	4.5	4.7	3.9	3.5	3.4	3.4	3.4	3.2
N-Type	7.8	7.7	7.1	7.5	7.4	8.2	8.9	8.6	8.7	9.3	9.1
Stereo-Regular	-	1.4	2.0	2.4	3.2	6.3	7.8	7.3	8.0	9.5	12.3
Other Rubbers	18.8	20.0	20.5	20.7	21.0	21.2	20.8	20.7	20.8	20.8	20.6

EXHIBIT 10
(Page 1 of 6)

IMPORTS OF TIRES AND NON-TIRE RUBBER GOODS

DEVELOPING COUNTRIES

1965 - 1969

LATIN AMERICA

(National Currency)

	1965			1966			1967			1968			1969		
	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls
ARGENTINA (Peso New 000)	229	85	67	329	144	67	663	208	79	580	197	117	585	284	133
BOLIVIA (Peso 000)	37426	2245	1152	28903	2316	1435	22964	2566	1972	27120	3944	1556	28888	2340	1793
BRAZIL (Cruzeiro - New 000)	239	279	79	401	247	199	702	627	428	732	1156	964	1625	1682	670
CHILE (Escudo 000)	11958	5801	1697	15374	7061	1945	16942	6624	2269	21982	11720	4119	31667	24950	7215
COLOMBIA (Peso 000)	7971	13591	3391	9679	22127	6628	9903	9002	8654	13792	15814	6135	14667	23793	9987
COSTA RICA Colon 000)	8791	1781	967	5772	2012	847	5389	1662	1139	4183	2244	669	4323	2959	622
DOMINICAN REPUBLIC (Peso 000)	1928	208	45	3527	274	85	2628	264	109	3055	240	124	3411	289	154
ECUADOR (Sucre 000)	13544	4981	3381	13035	4072	3345	15344	5236	4527	15762	6599	4545	15180	8272	5054
EL SALVADOR (Colon 000)	2748	708	420	1933	603	495	1790	638	348	1402	718	393	1695	775	428
GUATEMALA (Quetzal 000)	760	383	160	799	298	164	1098	263	108	986	289	124	1077	312	125
HONDURAS (Lempira 000)	2614	346	138	3462	370	150	4194	400	158	3870	538	224	3638	472	236
MEXICO (Peso 000)	33061	18223	14138	38469	18735	14151	33148	19509	12440	32561	22345	12914	34722	21196	16486
NICARAGUA (Cordoba 000)	14699	1199	1212	10053	1389	1008	12118	1290	1163	9975	1029	1029	9235	1558	1177

IMPORTS OF TIRES AND NON-TIRE RUBBER GOODS

DEVELOPING COUNTRIES

1965 - 1969

LATIN AMERICA (National Currency)

	1965			1966			1967			1968			1969		
	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls
PANAMA (Balboa 000)	2464	249	158	2689	252	178	2912	311	213	3083	291	292	2801	352	373
PERU (Sol 000)	36394	47310	33685	93762	44146	39908	97137	103910	43847	69969	73453	32662	52902	76007	34830
URAGUAY (Peso 000)	2635	7907	3953	3810	6553	6324	13200	48400	16000	33500	35500	23250	25750	47500	19000
VENEZUELA (Bolivar 000)	5314	13901	5674	5431	11943	3897	4864	11394	3478	5382	13041	3388	5620	13356	4009
JAMAICA (Pound 000)	1395	258	149	1373	603	152	1188	276	234	858	235	213	2615	442	505
TRINIDAD & TOBAGO (TT Dollar 000)	3090	386	551	3081	410	569	3586	546	508	2194	562	772	1240	576	604
NETHERLAND ANTILLES (Guilder 000)	1205	183	281	1457	213	264	1297	256	309	1286	298	275	1374	307	354
TOTAL LATIN AMERICA (US Dollar 000)	31970	12377	6992	35211	14199	7139	32344	13183	6830	30090	13967	7108	31322	16621	7851

EXHIBIT 10
(Page 3 of 6)

IMPORTS OF TIRES AND NON-TIRE RUBBER GOODS

DEVELOPING COUNTRIES

1965 - 1969

MID-EAST ASIA

(National Currency)

	1965			1966			1967			1968			1969		
	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls
SOUTHERN YEMEN (Rial 000)	8260	640	625	6795	475	590	6750	425	490	6070	725	425	8190	480	200
KUWAIT (Dinar 000)	1504	89	106	2120	139	204	1869	157	343	2267	194	143	2018	210	210
JORDAN (Dinar 000)	915	46	37	949	47	52	730	58	27	761	129	32	753	52	37
ISRAEL (Pound 000)	3474	1755	1356	2607	1164	1335	4959	1677	2870	6989	2153	2604	6482	3182	4487
IRAN (Rial 000000)	776361	102414	66281	1007550	94385	75901	709298	176195	74159	865551	201571	86203	1122766	193769	85597
IRAQ (Dinar 000)	1661	152	123	3234	146	159	2194	117	115	1172	159	148	1082	119	90
SAUDI ARABIA (Riyal 000)	34987	1521	1692	43006	1859	2353	43420	2142	2700	48793	3744	2142	51970	3227	1597
LEBANON (Pound 000)	13345	1145	2035	16335	1442	2415	15891	1193	1749	12302	1647	2054	18284	2015	2109
SYRIA (Pound 000)	20131	1089	905	14382	1341	1508	16895	1161	1210	13354	1581	1703	21155	1918	1210
TOTAL MID-EAST ASIA (US Dollar 000)	41883	3879	3475	55075	3878	4471	44711	4982	4733	49460	6553	4444	51835	6467	5016

EXHIBIT 10
(Page 4 of 6)

IMPORTS OF TIRES AND NON-TIRE RUBBER FOODS

DEVELOPING COUNTRIES

1965 - 1969

SOUTH AND SOUTHEAST ASIA

(National Currency)

	1965			1966			1967			1968			1969		
	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls
BURMA (Kyat 000)	20797	2621	866	8173	2532	2609	3029	883	485	5575	1501	693	7255	1859	585
CEYLON (Rupee 000)	20636	1235	522	22461	1499	613	28187	1289	748	20333	1628	1045	16579	2687	782
INDIA (Rupee 000)	3591	6761	3261	3144	8978	4356	4875	12868	4279	7636	15332	3434	10137	22753	3832
PAKISTAN (Rupee 000)	31509	4509	2439	27561	7645	1797	19029	7705	1785	28378	10118	1832	39861	20165	3229
MALAYSIA (Dollars 000)	10052	5009	2925	8390	7290	3274	7006	6668	3036	9933	6360	3755	10308	7122	6396
HONG KONG (Dollar 000)	9987	7896	7151	8690	5721	7848	9248	5036	7975	12290	6557	11914	13259	7733	15071
CHINA (TAIWAN) (Dollar 000)	52170	9023	7378	53012	14276	12190	30035	25183	17203	32080	34526	35047	25063	51889	24662
VIETNAM-REP. OF (Piastre 000)	397680	11220	11460	645932	72688	25252	363204	38940	30916	432352	63602	18290	572418	68794	26314
INDONESIA (Rupiah 000000)	2539	178	166	1282	223	265	2848	204	286	1689	221	293	1856	341	683
KOREA - REP. OF (Won 000)	267495	29835	31875	91545	62985	37330	60945	70890	69360	92055	92055	150705	132345	115005	213180
PHILIPPINES (Peso 000)	14169	8210	2859	15681	8042	3408	17285	8428	4399	18603	8108	4645	12776	9984	4345
THAILAND (Baht 000)	128544	24856	15392	181002	32718	22526	180589	38958	21403	173909	38605	23608	128544	46342	26915
TOTAL SOUTH AND SOUTHEAST ASIA (US Dollar 000)	59671	10404	6031	40017	12372	7490	38787	12572	7334	39161	14127	9081	39837	19654	11884

EXHIBIT 10
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IMPORTS OF TIRES AND NON-TIRE RUBBER FOODS

DEVELOPING COUNTRIES

1965 - 1969

AFRICA

(National Currency)

	1965			1966			1967			1968			1969		
	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls	Tires & Tubes	Non-Tire Prod.	Vulc. Rubber Matls
LIBYA (Pound 000)	1165	97	270	1217	122	231	1193	169	205	1944	292	506	1573	560	633
SUDAN (Pound 000)	946	33	66	718	51	112	1127	49	75	961	84	155	1110	60	72
UAR (Pound 000)	583	200	245	327	249	345	213	105	360	126	64	305	138	120	535
ETHIOPIA (Dollar 000)	1523	68	36	1486	85	46	1774	83	50	1429	116	34	1368	66	34
KENYA (Shilling 000)	29886	2714	2642	35657	3314	2621	30650	2986	2150	34393	3200	2178	27686	3279	1871
TANZANIA (Shilling 000)	10150	1136	385	13964	1171	578	19293	1507	707	24443	2621	928	17336	1414	105
UGANDA (Shilling 000)	4036	586	221	3622	829	429	6036	629	371	11600	850	464	9000	864	571
GHANA (Cedi 000)	3795	341	378	2278	279	191	2897	302	216	3117	403	343	5932	528	408
NIGERIA (Pound 000)	885	291	495	669	273	620	813	262	413	969	161	296	1108	262	472
RHODESIA (Pound 000)	179	221	89	33	35	46	5	35	55	1	18	25	1	1	0
ZAMBIA (Pound 000)	225	117	11	638	514	42	1147	146	69	2988	301	84	2564	571	181
IVORY COAST (CFA Franc 000000)	1005	72	96	920	95	129	1025	83	171	1308	101	206	1291	141	201

EXHIBIT 10
(Page 6 of 6)

IMPORTS OF TIRES AND NON-TIRE RUBBER GOODS

DEVELOPING COUNTRIES

1965 - 1969

AFRICA

(National Currency)

	1965 Tires & Tubes	1965 Non-Tire Prod.	1965 Vulc. Rubber Matls	1966 Tires & Tubes	1966 Non-Tire Prod.	1966 Vulc. Rubber Matls	1967 Tires & Tubes	1967 Non-Tire Prod.	1967 Vulc. Rubber Matls	1968 Tires & Tubes	1968 Non-Tire Prod.	1968 Vulc. Rubber Matls	1969 Tires & Tubes	1969 Non-Tire Prod.	1969 Vulc. Rubber Matls
CONGO (Zaire 000)	1789	314	146	1372	259	175	1742	201	120	3054	373	248	2577	347	265
ANGOLA (US Dollar 000)	480	183	62	523	349	110	500	315	203	663	396	388	556	894	260
MOZAMBIQUE (US Dollar 000)	341	213	58	416	197	48	502	214	100	775	222	145	671	314	233
LIBERIA (Dollar 000)	906	335	113	1497	319	165	1163	519	155	1658	413	179	2037	830	262
ALGERIA (Dinar 000)	33422	5696	5387	24207	5620	4982	27279	6243	5310	34809	9248	11143	36648	8684	9736
MOROCCO (Dirham 000)	7383	8116	2348	6062	9620	1736	6021	8374	1822	5779	4853	2525	7018	7848	2398
TUNISIA (Dinar 000)	1057	259	449	1075	303	293	1012	451	289	608	627	237	261	955	268
TOTAL AFRICA (US Dollar 000)	44925	11907	7320	41036	10026	7759	46051	8909	7379	55744	10092	9737	53393	13443	10737

Source: Supplement to United Nationals World Trade Annual.

Exchange Rates - United Nations Bulletin of Statistics.
International Monetary Fund -
Schedule of Par Values
Fifty-first Issue March 15, 1971.

Chart 10

IMPORTS OF RUBBER PRODUCTS

By Developing Countries

1965-1969

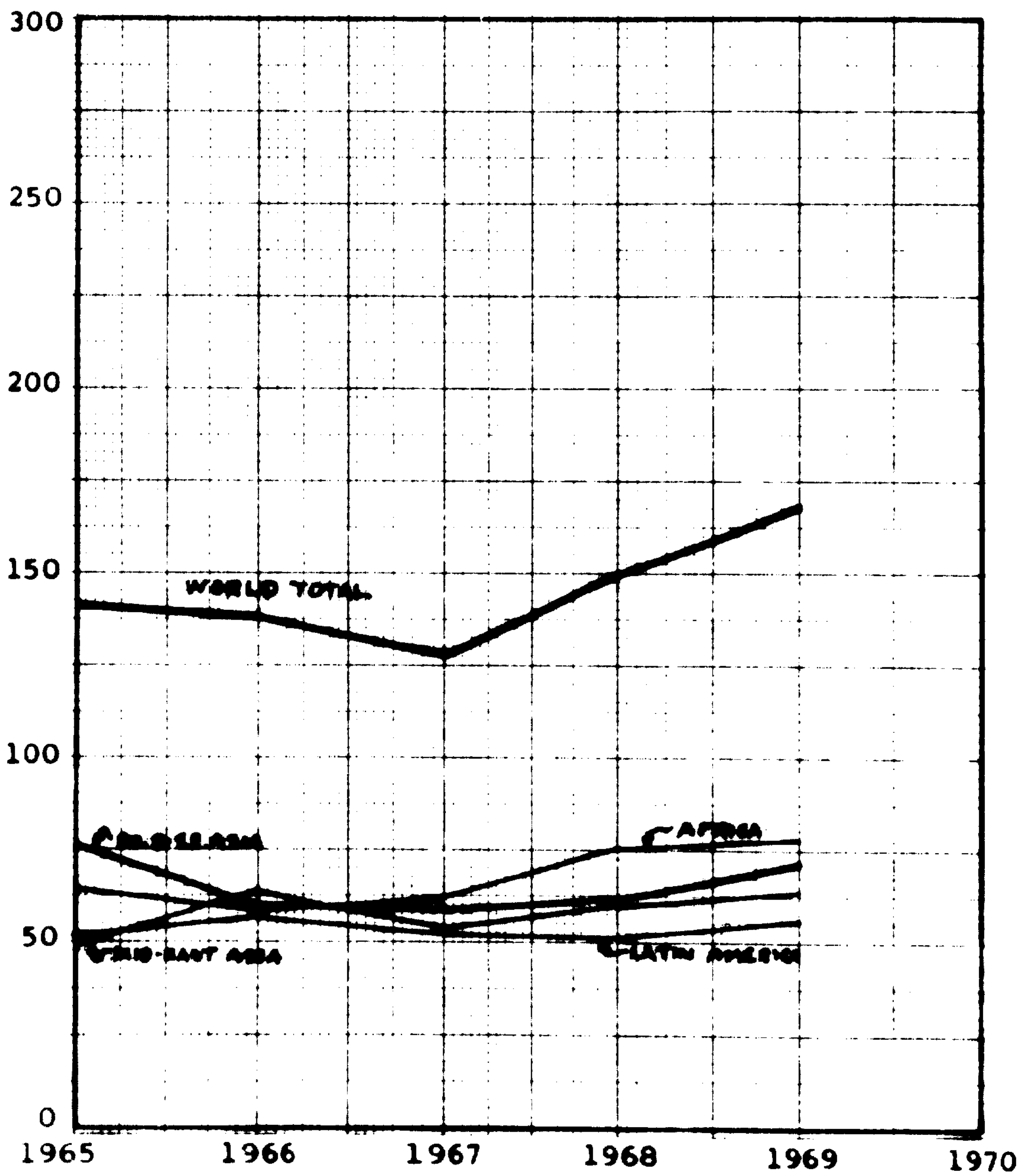

EXHIBIT 10A

IMPORTS OF TIRES AND NON-TIRE RUBBER GOODS

DEVELOPING COUNTRIES

SUMMARY BY REGIONS

1965 - 1969

(US Dollars 000)

	1965	1966	1967	1968	1969
DEVELOPING COUNTRIES	240834	238673	227815	249564	268060
TIRES AND TUBES	178449	171339	161893	174455	176387
NON-TIRE PRODUCTS	38567	40475	39646	44739	56185
VULCANIZED RUBBER MATERIALS	23818	26859	26276	30370	35488
LATIN AMERICA	51339	56549	52357	51165	55794
TIRES AND TUBES	31970	35211	32344	30090	31322
NON-TIRE PRODUCTS	12377	14199	13183	13967	16621
VULCANIZED RUBBER MATERIALS	6992	7139	6830	7108	7851
MID-EAST ASIA	49237	63424	54426	60457	63318
TIRES AND TUBES	41883	55075	44711	49460	51835
NON-TIRE PRODUCTS	3878	3878	4982	6553	6467
VULCANIZED RUBBER MATERIALS	3475	4471	4733	4444	5016
SOUTH AND SOUTHEAST ASIA	76106	59879	58693	62369	71375
TIRES AND TUBES	59671	40017	38787	39161	39837
NON-TIRE PRODUCTS	10404	12372	12572	14127	19654
VULCANIZED RUBBER MATERIALS	6031	7490	7334	9081	11884
AFRICA	64152	58821	62339	75573	77573
TIRES AND TUBES	44925	41036	46051	55744	53393
NON-TIRE PRODUCTS	11907	10026	8909	10093	13443
VULCANIZED RUBBER MATERIALS	7320	7759	7379	9737	10737

Source: Supplement to United Nations World Trade Annual.

EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES*

Exhibit 11
Summary
Page 1

SUMMARY

Region and Country	Tire Products: Number (1970)	Tire Products: Capacity** (1970)	Tire Products: Capacity** Under Constr.	Non-Tire Products: Misc. Products (1967)	Non-Tire Products: Tire Retreads (1967)
LATIN AMERICA	33	67,400		787	85+
Mexico	5	11,450		64	na
Costa Rica	1	1,350		3	2
El Salvador	-	--		7	6
Guatemala	1	1,000		4	4
Honduras	-	--		3	5
Nicaragua	-	--		-	3
Panama	-	--		-	2
Domincan Republic	-	--		2	4
Jamaica	1	300		3	7
Trinidad	1	500		5	2
Argentina	5	13,300		268	2
Bolivia	-	--		1	na
Chile	1	3,000		48	na
Brazil	5	23,600		255	18
Colombia	4	4,100		65	na
Ecuador	1	300		13	4
Peru	2	1,000		15	18
Uraguay	2	2,000		16	6
Venezuela	4	5,500		15	2
SOUTH & SOUTHEAST ASIA	30	31,325+	800+	1,334	303+
India	8	13,800		825	14
Ceylon	1	1,000		6	2
Thailand	4	3,350		5	1
Malaysia	3	2,800+	na	42	176
Singapore	1	1,400	na	33	29
Indonesia	3	2,025		188	72
Cambodia	1	500		27	2
Vietnam	-	--		25	6
Hong Kong	3	2,000		14	1
Philippines	4	3,800		20	na
Korea	2	650		30	na
Taiwan	-	--		119	na
MIDDLE EAST ASIA	9	11,200	NA	124	6+
Iran	3	2,000	na	16	2
Iraq	-	--		5	2
Israel	2	3,000		22	na
Jordan	-	--		4	2
Lebanon	-	--		12	na
Pakistan	1	750		53	na
Turkey	3	5,450		12	na

EXISTING RUBBER PROCESSING INDUSTRIES
IN
DEVELOPING COUNTRIES

Exhibit 11
Summary
Page 2

SUMMARY

Region and Country	Tire Products: Number (1970)	Tire Products: Capacity ** (1970)	Tire Products: Capacity ** Under Constr.	Non-Tire Products: Misc. Products (1967)	Non-Tire Products: Tire Retreads (1967)
AFRICA	18	7,550+	1,100+	57	43+
Egypt	1	1,300		7	na
Ethiopia	-	--		-	1
Algeria	1	1,000		3	na
Angola	1	350		3	2
Congo	1	--	600	1	na
Ivory Coast	-	--		-	1
Ghana	1	450		1	1
Kenya	4	na	500	4	6
Liberia	-	--		-	2
Malawi	-	--		-	1
Morocco	2	1,000	na	11	5
Mauritius	-	--		-	1
Mozambique	-	--		4	na
Nigeria	3	1,350	na	5	13
Rhodesia	1	750		6	1
Sudan	-	--		-	1
Southwest Africa	-	--		-	1
Swaziland	-	--		-	1
Tanzania	1	--	na	3	na
Tunisia	1	900		6	5
Zambia	1	450		3	1
TOTAL DEVELOPING COUNTRIES*	90	117,475	1,900+	2,302	733+

*Excluding Mainland China

**Tires per Day

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

LATIN AMERICA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Mexico	Mexico City	Cia Hulera Euzkadi (Goodrich)	Tires, tubes, belting, flooring, hose, reclaim, sheeting, heels & soling	1927	3000	2000	(1)
Tires:		Firestone El Centenario, S.A.	Tires, tubes for pass. cars, trucks & tractors, repair material & cements	1940	850	1200	
		General Popo, S.A.	Tires, tubes for commercial cars & trucks, ventilation belts, hose	1925	2500	450	
		Cia Hulera Goodyear, Oxo, S.A.	Tires, tubes for cars & trucks, hosing, belting, rubber soles & heels	1941	3500	1200	
		U. S. Rubber Mexicana, S.A.	Tires, tubes for pass. cars, trucks & bicycles, tread rubber, repair material & tank lining	1935	1600	na	
Non-tires:	Guadalajara	4 Plants	Miscellaneous Products				
	Mexico City	42 Plants	Miscellaneous Products		na	na	
	Monterrey	3 Plants	Miscellaneous Products		na	na	
	Naucalpan	11 Plants	Miscellaneous Products		na	na	
	Other Places	4 Plants	Miscellaneous Products		na	na	

(1) New Plant in Guadalajara due 1971 - Capacity 2500 Tires per Day

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

LATIN AMERICA (Cont'd.)

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Costa Rica							
Tires:	San Jose	Firestone	Tires & tubes	1965	1350	na	
Non-tires:	San Jose	La Bilvaina, S.A.	Footwear, flooring, foam		na	160	
		4 plants including 2 tire retreaders	Miscellaneous Products		na	na	
El Salvador							
Non-tires:	Salvador	10 plants including 5 retreaders	Miscellaneous Products		na	na	
	Other Places	3 plants including 1 retreader	Miscellaneous Products		na	na	
Guatemala							
Tires:	Guatemala City	Gran Industria de Neumaticos Centro-Americano, S.A.	Tires & tubes for cars & trucks, retreading materials, molded boots, latex tipped boots	1958	1000	500	
Non-tires:	Guatemala City	8 plants including 4 retreaders	Miscellaneous Products		na	na	
Honduras							
Non-tires:	All Places	8 plants including 5 retreaders	Miscellaneous Products		na	na	
Nicaragua							
Non-tires:	Managua	3 retreaders	Tire retreading		na	na	

EXHIBIT 11 EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

LATIN AMERICA (Cont'd.)

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Panama							
Non-tires:	Celon & Panama City	2 retreaders	Tire retreading		na	na	
Dominican Republic							
Non-tires:	Santo Domingo	6 plants including 4 retreaders	Miscellaneous Products		na	na	
Jamaica							
Tires:	Kingston	Goodyear Jamaica Std.	Tires & tubes	1967	300	na	
Non-tires:	Kingston	10 plants including 7 retreaders	Miscellaneous Products		na	na	
Trinidad							(2)
Tires:	Point Fortin	Dunlop	Tires & tubes	1968	500	na	
Non-tires:	Port of Spain S. Fernando	7 plants including 2 retreaders	Miscellaneous Products		na	na	
Argentina							
Tires:	Buenos Aires	Fabrica Argentina de Tejidos Engomados	Pass. car, truck, tractor & bus tires, repair materials, raincoats, latex foam, soles & heels	1942	2300	750	

(2) $1.2 Million Expansion Underway

LATIN AMERICA (Cont'd.)

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Argentina							
Tires:	Buenos Aires	Neumaticos Goodyear S.A.	Tires & tubes of every description	1931	5700	na	
	Buenos Aires	Companhia Platense de Neumaticos (Pirelli)	Tires & accessories for automobiles		1400	na	
	Buenos Aires	Zapate, Diaz I.C.S.A.	Cycle, motorcycle and automobile tires & tubes and general moldings		na	200	
	Llavallol	Firestone de la Argentina S.H.I.C.	Tires & tubes, repair materials, textiles, garden hose, battery boxes, rubber cements, reclaimed rubber	1932	3900	1500	(3)
Non-tires:	Buenos Aires	Industrios Pirelli S.A.I.Y.C.	Technical hygienic & sporting goods, bicycle tires & accessories, latex foam, rubber cloth, electrical wires, etc.			3700	
	Buenos Aires	240 plants including 2 retreaders	Miscellaneous Products		na	na	
	Other Places	29 plants	Miscellaneous Products		na	na	

(3) $5 Million Expansion due in 1971

LATIN AMERICA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Bolivia							
Non-Tires	La Paz	Manufacturos de Goma Macional S.A.	Rubber boots, tennis shoes, rubber soles, rubberized garments, tiles		na	100	
Chile							
Tires:	Santiago	Industria Nacional de Neumaticos	Tires, tubes, batteries, belting, hose, mechanical rubber goods		3000	800	
Non-tires:	Peneflor	CATECU, S.A.	Boats, sport goods, gym shoes, mats, flooring tiles, etc.		na	1100	
	Santiago	47 plants	Miscellaneous Products		na	na	
Brazil							
Tires:	Campinas	Pirelli (formerly Dunlop do Brasil)	Tires for cars, trucks & buses	1954	2500	800	
	Sao Paulo	Firestone S.A.	Tires & tubes	1940	7400	2820	
		B. F. Goodrich do Brasil	Tires & tubes	1959	1700	571	
		Companhia Goodyear do Brasil	Tires & tubes, industrial products, shoe products	1939	6200	3000	
		Pirelli S.A.	Tires & tubes, electrical wires, mechanical goods	1929	5800	6500	(4)

(4) $11 Million Expansion Planned

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

LATIN AMERICA (Cont'd.)

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Non-tires:	Rio Janeiro	67 plants including 10 retreaders	Miscellaneous Products		na	na	
	Sao Paulo	261 plants including 5 retreaders	Miscellaneous Products		na	na	
	Other Places	45 plants including 3 retreaders	Miscellaneous Products		na	na	
Colombia							
Tires:	Bogota	Industria Colombiana de Llantas S.A. (Goodrich)	Tires, tubes, fan belts, batteries, soling, etc.	1944	2000	1140	
		Industrial de Caucho S.A.	Tires & tubes, floor tile, rubber footwear			375	
	Cali	Cia Croyden del Pacifico S.A. (Uniroyal)	Tires & tubes for autos and trucks, & a wide range of rubber wearing apparel, floor tiles, hose, foam products, etc.	1954	900	2500	
		Goodyear de Colombia S.A.	Tires & tubes for all types of vehicles	1945	1200	na	
Non-tires:	Baranguilla	7 plants	Miscellaneous Products		na	na	
	Bogota	38 plants	Miscellaneous Products		na	na	
	Cali	3 plants	Miscellaneous Products		na	na	
	Undellin	10 plants	Miscellaneous Products		na	na	
	Other Places	7 plants	Miscellaneous Products		na	na	

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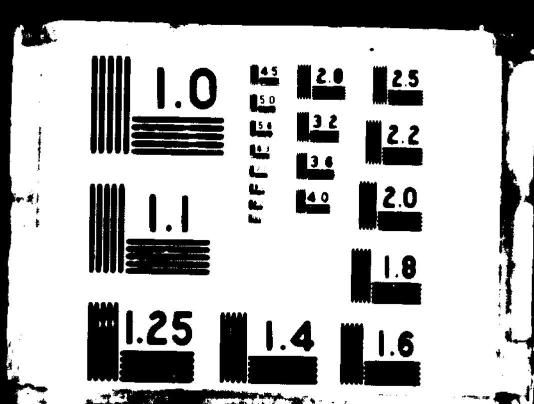

LATIN AMERICA (Cont'd.)

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Ecuador							
Tires:	Cuenca	Ecuadorian Rubber Co. C.A. (General)	Passenger & truck tires & tubes	1961	300	350	
Non-tires:	All places	17 plants including 4 retreaders	Miscellaneous Products			na	
Peru							
Tires:	Lima	B. F. Goodrich - Lima Rubber Co.	Tires & tubes, molded goods, extrusions, fish floats	1955	300	400	
		Compania Goodyear del Peru	Tires & tubes for all types of vehicles	1943	700	490	
Non-tires:	Lima	Fabrica de Calzado Peruana S.A.	Rubber footwear, raincoats, technical products			1250	
		32 plants including 18 retreaders	Miscellaneous Products			na	
Uraguay							
Tires:	Montevideo	Fabrica Uraguay de Neumaticos S.H.	Tires & tubes for all types of vehicles, mechanicals, hose, sponge, flooring, shoes	1963	1500	2000	
		Enrique Ghiringhelli S.A.	Tires, tubes, mechanical goods & custom molding		500	na	
Non-tires:	Montevideo	22 plants including 6 retreaders	Miscellaneous Products		na	na	

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

MIDDLE EAST ASIA

Country	Location	Company	Products Manufactured	Year Begun	Tires Day	No. Empl.	Notes
Lebanon							
Non-tires:	**Beirut**	12 plants	Miscellaneous Products			na	
Pakistan							
Tires:	**Karachi**	General Tyre & Rubber Co. of Pakistan, Ltd.	Tires & tubes	1964	750	500	
Non-tires:	**Dacca**	8 plants	Miscellaneous Products			na	
	Karachi	16 plants	Miscellaneous Products			na	
	Lahore	8 plants	Miscellaneous Products			na	
	Sialkot	18 plants	Miscellaneous Products			na	
	Wazirabad	3 plants	Miscellaneous Products			na	
Turkey							
Tires:	Istanbul	Goodyear Lastikleri TAS	Tires & tubes for cars, buses, trucks, tractors & cycles	1963	1750	na	
	Istanbul	Pirelli Lastikleri, A.S.	Tires & tubes	1962	[illegible]	550	
	Istanbul	U.S. Royal Lastik Turk A.S.	Tires & tubes for cars, buses & tractors	[illegible]	[illegible]	na	
Non-tires:	Istanbul	12 plants	Miscellaneous Products			na	

AFRICA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Egypt							
Tires:	Alexandria	Transport & Engineering Co. (Public Sector)	Tires & tubes for pass. cars, and buses		1300	1317	
Non-tires:	Cairo	El Nasr Co. for Rubber Products (Public Sector)	Hoses, belts, shoes, flooring, heels & soles, latex Products			1720	
	Other Places	6 plants	Miscellaneous Products			na	
Ethiopia							
Non-tires:	Asmara	Tyre Retreading Industry Asmara, Ltd.	Reconditioning off-the-road tires			na	
Algeria							
Tires	Algiers	Michelin	Tires & tubes	1964	1000	na	
Non-tires:	Algiers	3 plants	Miscellaneous Products			na	
Angola							
Tires:	Luanda	Mobor	Tires & tubes	1968	350	na	
Non-tires:	Luanda	5 plants including 2 retreaders	Miscellaneous Products			na	

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

AFRICA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Congo (Kinshasa)							
Tires:	Kinshasa	Goodyear	Tires & tubes	due 1972	600	na	
Non-tires:	Kinshasa	Maison de Pneu	Tire retreading and industrail rubber goods			na	
Ivory Coast							
Non-tires:	Obidjan	Manufacture de Reconcitionnement de Pneumatiques	Tire retreading			na	
Ghana							
Tires:	Bonsaso	Firestone	Tires & tubes	1969	450	na	
Non-tires:	Accra	A. E. Ritzi	Vulcanized transmissicn & conveyor belts			na	
	Sekondi	Vacu-Lug Ltd. (W. Africa)	Reconditioning off-the-road			na	
Kenya							
Tires:	Nairobi	Avon India Rubber Co. Ltd.	Tires of all types, inflatable craft, boats, soles, heels		na	na	
	Nairobi	Michelin (E.A.) Ltd.	Cars, motorcycle & chcle tires		na	na	
	Nairobi	Firestone	Tires & tubes	1970	500	na	

EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

AFRICA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
	Nairobi	Whiteline Tyre Factory	Tires & repair materials		na	na	
Non-tires:	Nairobi	6 plants including 4 retreaders	Miscellaneous Products			na	
	Other Places	4 plants including 2 retreaders	Miscellaneous Products			na	
Liberia							
Non-tires:	Monrovia	2 retreading plants	Tire retreading			na	
Malawi							
Non-tires:	Blantyre	Advanx, Ltd.	Reconditioning off-the-road tires			na	
Morocco							
Tires:	Casablanca	General Tire & Rubber Co.	Tires & tubes of all types	1960	1000	na	
	Casablanca	Goodyear	Tires & tubes	due 1972			(10)
Non-tires:	Casablanca	16 plants including 5 retreaders	Miscellaneous Products			na	

(10) Plans Announced for a New $13 Million Plant

EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

AFRICA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Mauritius							
Non-tires:	Port Louis	Vacu-Lug (Mauritius) Co. Ltd.	Retreading off-the-road tires			na	
Mozambique							
Non-Tires:	Lourenco Marques	4 plants	Miscellaneous Products			na	
Nigeria							
Tires:	Ikeja	Dunlop Nigerian Industries, Ltd.	Tires & tubes	1963	800	811	
	Lagos	Dunlop Nigerian Industries, Ltd.	Tires & Tubes	due 1971	na	na	(11)
	Port Harcourt	Michelin (Nigeria) Ltd.	Tires & tubes	1962	550	350	
Non-Tires:	All Places	18 plants including 13 retreaders	Miscellaneous Products			na	
Rhodesia							
Tires:	Bulawayo	Dunlop Rhodesia, Ltd.	Tires & tubes	1959	750	710	
Non-Tires:	All Places	7 plants with 1 retreader	Miscellaneous Products			na	

(11) New Tire Plant Under Construction

AFRICA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Sudan							
Non-Tires:	Khartuom	Bittar & Co.,Ltd.	Reconditioning of off-the-road tires			na	
South West Africa							
Non-Tires:	Windhoek	Terrys Motors,Ltd.	Reconditioning of off-the-road tires			na	
Swaziland							
Non-Tires:	Mbabane	Williamson & Patterson (Swaziland) Ltd.	Reconditioning of off-the-road tires			na	
Tanzania							
Tires:	Dar Es Salam	General Tyre Co.	Tires & tubes	due 1972	na	na	(12)
Non-Tires:	Dar Es Salam	3 plants	Miscellaneous Products			na	
Tunisia							
Tires:	Menzal Bourguiba	Firestone	Tires & tubes	1967	900	na	
Non-Tires:	All Places	11 plants including 5 retreaders	Miscellaneous Products			na	

(12) New Tire Plant Under Construction

EXHIBIT 11. EXISTING RUBBER PROCESSING INDUSTRIES IN DEVELOPING COUNTRIES

AFRICA

Country	Location	Company	Products Manufactured	Year Begun	Tires /Day	No. Empl.	Notes
Zambia							
Tires:	Ndola	Dunlop	Tires & tubes	1969	450	na	
Non-Tires:	All Places	4 plants including 1 retreader	Miscellaneous Products			na	

SOURCES: International Rubber Directory - Zurich (1967).
Information gathered through Embassies of various countries in the United States (very incomplete).
Information on tire manufacturers provided by Corporate Planning Department of Uniroyal.

NOTE: Bicycle, motorcycle, scooter, rickshaw and horse-drawn vehicle tires classed with non-tire products except where produced by a major tire company.

Tire retreaders appear not to be recordsd consistently in the Rubber Directory, but their numbers are indicated to the extent shown. No distinction made between large and small non-tire plants in most instances because many plants, including some large plants, do not report number of employees.

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