Natural Rubber

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E/Switching Planning I

Rubber

(Hevea brasiliensis)

extremely good for rubbing out pencil marks on paper
- Joseph Priestley in 1770 – England

Natural rubber is a polymer of isoprene units, a hydrocarbon diene monomer.
Hevea brasiliensis

The trees have a smooth bark, palmately compound leaves, small inconspicuous flowers. The seeds are akin to castor beans. On ripening, the fruit capsule explodes and propels the seeds away from the trees.

The Pará rubber tree  (*Para* is a state of Brazil)

- **Family**: Euphorbiaceae (about 20 latex bearing families)
- **Genus**: Hevea.
- **Species**: *H. brasiliensis*  (about 18000 latex bearing species)

Location of latex in the tree depends on the species

- Major economic importance – due to its sap-like extract (known as **latex**)
- Planting - usually about 15 X 15 feet apart.
- Height of the tree - can reach over 30m.
- The colour of the latex - white or yellow
- Latex occurs - in vessels in the bark
- Vessels - spiral up the tree in a righthanded angle of about 30 degrees with the horizontal.
- Incisions - orthogonal to the latex vessels

- Deep enough to tap the vessels without harming the tree’s growth.

**The harvest** – **After 5-6 years**
- Older trees yield more latex
- **Stop producing after 26-30 years.**
Para rubber tree contd....

Christopher Columbus – During Second visit to South America, 
- wondered about the heavy black ball 
  the natives were using in games(Story). 
- made from the vegetable gum of the 
  Parawood tree.

Prior to 1900, natural rubber was obtained solely from wild plants.

The following were most extensively utilized.

  Hevea brasiliensis
  Ficus elastica
  Castilla elastica

Both of the later species had to be killed in order to extract the latex. 
This factor, among others made Hevea brasiliensis is the best.

Historical origin of rubber in the world

Native place – South America - Discovery in 1500’s 
- But the cultivation in South America was unsatisfied.

By 1770 - rubber cubes were used in England as erasers

In 1820’s - methods of reliequifying rubber were developed and used to produce water-proof two-ply clothing.

By 1840’s - American inventor Charles Goodyear using the findings of the two chemists discovered the method of vulcanization which can be used to make rubber stable in hot and cold temperatures.

In 1873 - Attempts were made to to grow rubber outside Brazil. Twelve seedlings were germinated at Royal Botanical gardens, Kew and sent to India for cultivation, but died.
Successful cultivation

After repeated efforts – successful cultivation in South Asia
Sir Clements Markham – (a Civil Servant) arranged the expeditions to
the Amazon to collect seeds and seedlings for transfer to
South Asia (and eventually to South East Asia).
In 1875 - Henry Wickhem successfully gathered 70,000 seeds
of Hevea brasiliensis in the Amazon region
and shipped them back to Britain
to germinate in the Royal Botanical Gardens.
In 1876-about 2000 seedlings were shipped to Sri Lanka
22 to Singapore
Those were used to establish plantations
first in Sri Lanka and then in other
tropical regions of the eastern hemisphere.

Henry Wickhem

Once established outside its native country,
extensively propagated in the British colonies.
In 1898 – Established rubber plantation in Malaysia
The implications of this transfer failed to be appreciated until estate
production in South East Asia actually began a long time after the
seeds were gathered.
Collins and Cross also were involved.

Tapping methodology
Ficus elastica plantation - established in Indonesia in 1876 and Hevea had flowered in
Malaysia in 1881
Plantation industry was slow to establish because the investment in plantations had
to await the demand created by pneumatic tyres and motoring.
To encourage the establishment of plantations Henry Ridley did much to refine this
methodology.

Henry Ridley
Historical origin of rubber in the world contd...

Some uses:

**Elastics** - produced for clothing and attempted to create tubing for **medical uses**

**Temporary rubber shoe** - dipping their feet into a latex mixture strips to hold stone and metal tools to wooden handles **padding for the tool handles.**

In Brazil - **water resistant cloth made in rubber.**

A story says that the first European to return to Portugal from Brazil with samples of such water – repellent rubberized cloth

So shocked people that he was brought to court on the charge of witchcraft.

The **para rubber** tree initially grew in South America where it was the main source for limited latex rubber consumers during 19th century and about 100 years ago, the **Congo Free State in Africa** was a significant source of natural rubber latex, mostly gathered by **forced labor**. Millions of Africans died as a result of lust for rubber and rubber profits.

Uses contd.....

This Victorian locomotive could attain speeds of 80 mile/hour and ran on rubber springs

O-Rings (Seal)

The **o-ring** -most widely adapted **seal** in history because of its simplicity, low cost, ease of installation, and small space requirements without supporting structures.

- suitable for dynamic or static **seals within the temperature limits of elastomeric materials**, Successful use depends upon proper groove dimensions and selection of the right compound
Rubber cultivation in Sri Lanka

The first rubber tree is at Henarathgoda Botanical garden in Gampaha district. This garden is home to trees from every corner of the tropical world – especially from Brazil.

In 1876 these first seedlings, about 2000 were transported to the warm, moist climatic conditions at Henarathgoda.

Climatic condition: required a warm, moist moderate condition.

Areas: Rubber cultivation takes the first place in Kalutara and the Ratnapura district areas. Total area under rubber in Sri Lanka is approximately 559,257 acres.

Products:
Latex products (exported as sheet rubber or crepe rubber)
Wooden products (exported as finished products or parts of products)

Principle markets for Sri Lanka rubber:
China, U.S.S.R., USA, German, Italy, Poland

Latex
- is a milky colloidal suspension collected from a tapped rubber tree.
- coagulates on exposure to air
- some regards it as a form of stored food
- others regards as an excretory product (waste products of the plant are deposited)
- Also believe as to protect the plant by prevent entering of fungi and bacteria, against browsing animals (since latex of some plants are very bitter or even poisonous)

The shell of half a coconut or any other vessel is used as the collection container for the latex.

The shells are attached to the tree via a short sharp stick and the latex drips down into the shell.

The latex from multiple trees are then poured into flat pans, and it is mixed with formic acid, as a coagulant.

After a few hours, the very wet sheets of rubber are wrung out by putting them through a press.

Next send to factories for vulcanization and further processing.
Rubber tapping in Kerala

Before vulcanization

A wet sheet of rubber                    after putting them through rollers
and air – or smoke - dried
Vulcanization

The successful development of vulcanization is most closely associated with Charles Goodyear from the year 1840. Natural rubber is often vulcanized.

**Process** - the rubber is heated and sulfur, peroxide or Bisphenol are added.

**Carbon black** is often used as an additive to rubber to **improve its strength**, especially in **vehicle tires**.

Vulcanization - creates **more disulphide bonds** between chains.

- So it makes each free section of chain shorter. and
- The **chains tighten** more quickly for a given length of **strain**.
  - This increases the **elastic force** constant and
  - makes rubber **harder** and **less extendable**.

**Results** - **improve resilience** and **elasticity**
- prevent it from **perishing**.
- greatly **improve the durability** and **utility** of rubber.

The ancient Mesoamericans - not vulcanized
- developed **organic methods** for similar results
- mixed the raw latex with various **saps and juices** of other vines.

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**Vulcanization contd…**

At very **cold temperatures** rubber is actually rather **brittle**; it will break into **shards** when struck.

This critical temperature is the reason that **winter tires** use a **softer version** of rubber than normal tires.

**Uses** : Most industrial uses are in **vibration control** and **dampening** used in automotive components such as **stabilizer bushings**, jounce bumpers, and **motor mounts**. Also used to create **seals.tires** in vehicles.
Some Latex Products

Socks, bodysuits, stocking and gloves, as well as most items that can be made from 'traditional' fabrics. Also used to make specialist garments like hoods and rubber cloaks.

Latex Products contd..
In 1823 - Charles Macintosh invented waterproof cloth - made the first Mackintosh coats in the family's textile factory, Charles Macintosh and Co. of Glasgow.

In 1830 - merged with the other clothing company of Thomas Hancock in Manchester. Hancock had also been experimenting with rubber coated fabrics since 1819.

Early coats had problems with smell and a tendency to melt in hot weather.

In 1843 - Hancock further improved waterproof fabrics, patenting a method for vulcanising rubber which solved many of the problems.
**Rubber wood**

After 25 to 30 years of latex production, the tree ceases to produce sufficient quantities of latex.

Then the tree is cut and the wood of this tree is marketed for a wide variety of end products, such as furniture, parquet, paneling, flooring, and also indoor building components, as an alternative timber species

*Parawood (rubber wood)* is very hard and very prevalent in the furniture industry because of its durability. It's sometimes referred to as Malaysian Oak because of its strength.

The potential of rubber wood as a source of timber has already been recognized in *India, Sri Lanka, Indonesia and Malaysia*.

An increasing volume of sawn rubber wood is being used for furniture manufacturing and a variety of other applications.

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**Preservative treatment of rubber wood**

Rubber wood possess excellent properties for interior designing, wood working and furniture making.

But it is very much susceptible to sap stain and mould fungi which decreases the service life.

For profitable uses, it is necessary to increase the service life of rubber wood.

To protect the rubber wood from degrading agents, the sawn timber were treated with Borax – boric acid solution and Copper-chrome-boron solution by soaking process and Lowry empty cell pressure process following moderate treatment schedule.

It was found that rubber wood can be treated satisfactorily by both processes with acceptable penetration and retention.
A sawing machine (to saw large logs)

Sawing machine (to saw large logs)
Kiln drying

After the completion of chemical treatment, the treated timber is dried in a special kiln to reduce the moisture content of them. In this process, the hot air is allowed to pass through the timber inside the kiln and the amount of moisture is taking out by using the blowers.

A boiler used to prepare hot steam

Inside a kiln
Plainer machine (4 side)

Using a plainer machine
Sanding machine

Drilling
Spray painting

Ready for exports (brush handles)
Wooden Products contd..

Productivity in Sri Lanka

Sri Lanka - 9th largest producer
- 10th largest exporter of natural rubber (NR).
- the major supplier of high quality latex crepe to the world market.

The BOI approved rubber industry projects consume nearly 75% of Sri Lanka’s total domestic NR production.

Nearly 60% of the NR production in Sri Lanka is used for value added rubber products.

The bulk of these value added products are for the export market.

Foreign investors from 20 countries have set up lucrative and long standing world class ventures under BOI approval.
No. of projects, investment & employment by product type - 2005

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<tr>
<th>Product type</th>
<th>No. of projects</th>
<th>Investment (Rs. Mn)</th>
<th>Employment (No.s)</th>
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<td>Tyre Retrading</td>
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<td>558</td>
<td>235</td>
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<tr>
<td>Pneumatic tyres &amp; tubes</td>
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<td>4825</td>
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<tr>
<td>Solid tyres</td>
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<tr>
<td>Total</td>
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After the end of its latex producing cycle, the tree is cut for manufacturing furniture and a new tree is planted in its place.

This is an example of man’s ability to fully utilize our natural resources, without harming the environment. Therefore, the Rubber wood has been accepted in the International market as an environmentally friendly wood.