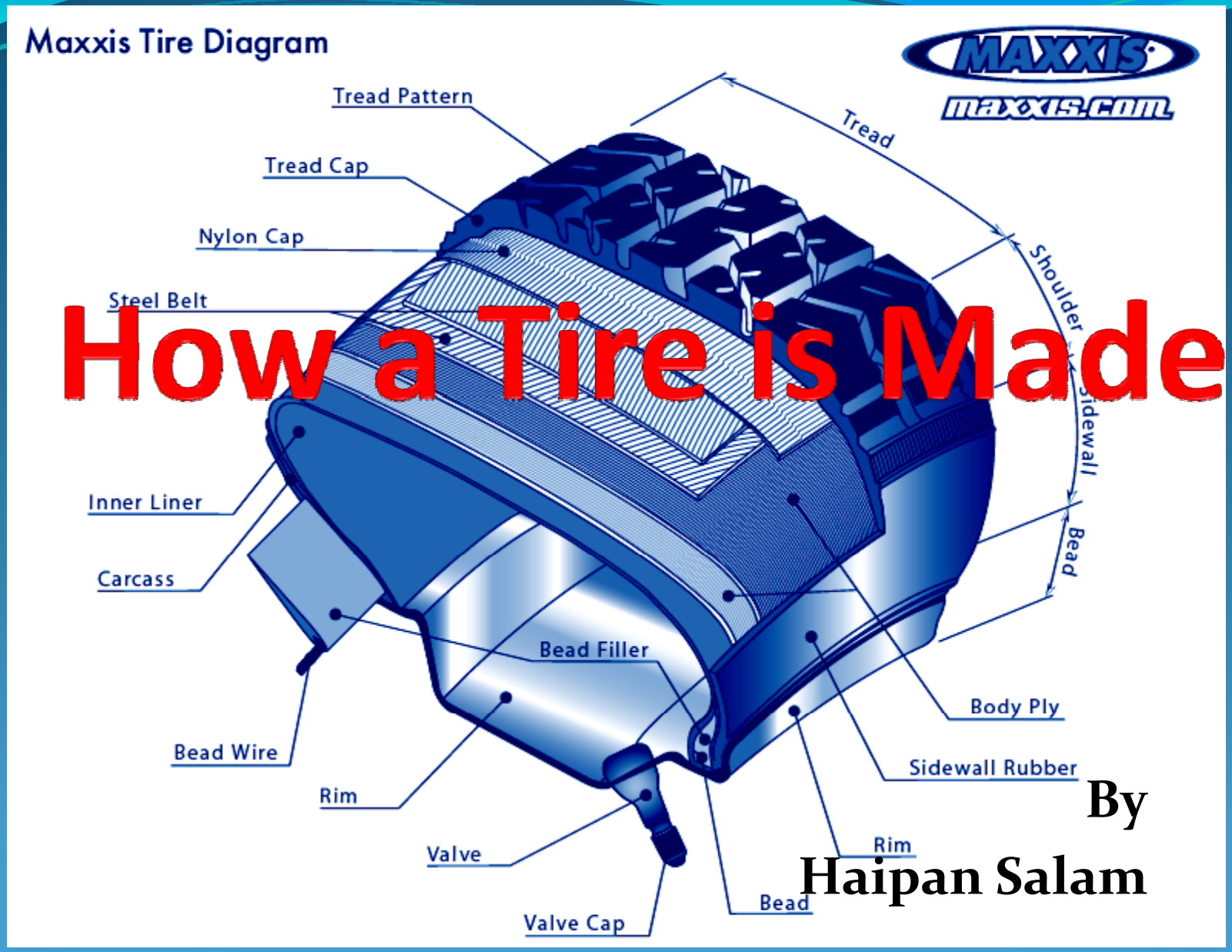

Maxxis Tire Diagram
MAXXIS
maxxis.com
Tread Pattern
Tread Cap
Nylon Cap
Steel Belt
Inner Liner
Carcass
Bead Filler
Bead Wire
Rim
Valve
Valve Cap
Bead
Rim
Body Ply
Sidewall Rubber
Tread
Shoulder
Sidewall
Bead
How a Tire is Made
By
Haipan Salam

History

- Invention of the Wheel
- **Vulcanized Rubber**
  - **Designed by Charles** Goodyear
  - Weather and water proof after heated
- Pneumatic Tires (tubeless)
  - Used one solid piece
  - Less complicated

History

- Scottish inventor Robert Thomson developed the pneumatic tire with inner tube in 1845, but his design was ahead of its time and attracted little interest.
- The pneumatic tire was reinvented in the 1880s by another Scotsman, John Boyd Dunlop, and became immediately popular with bicyclists.

History

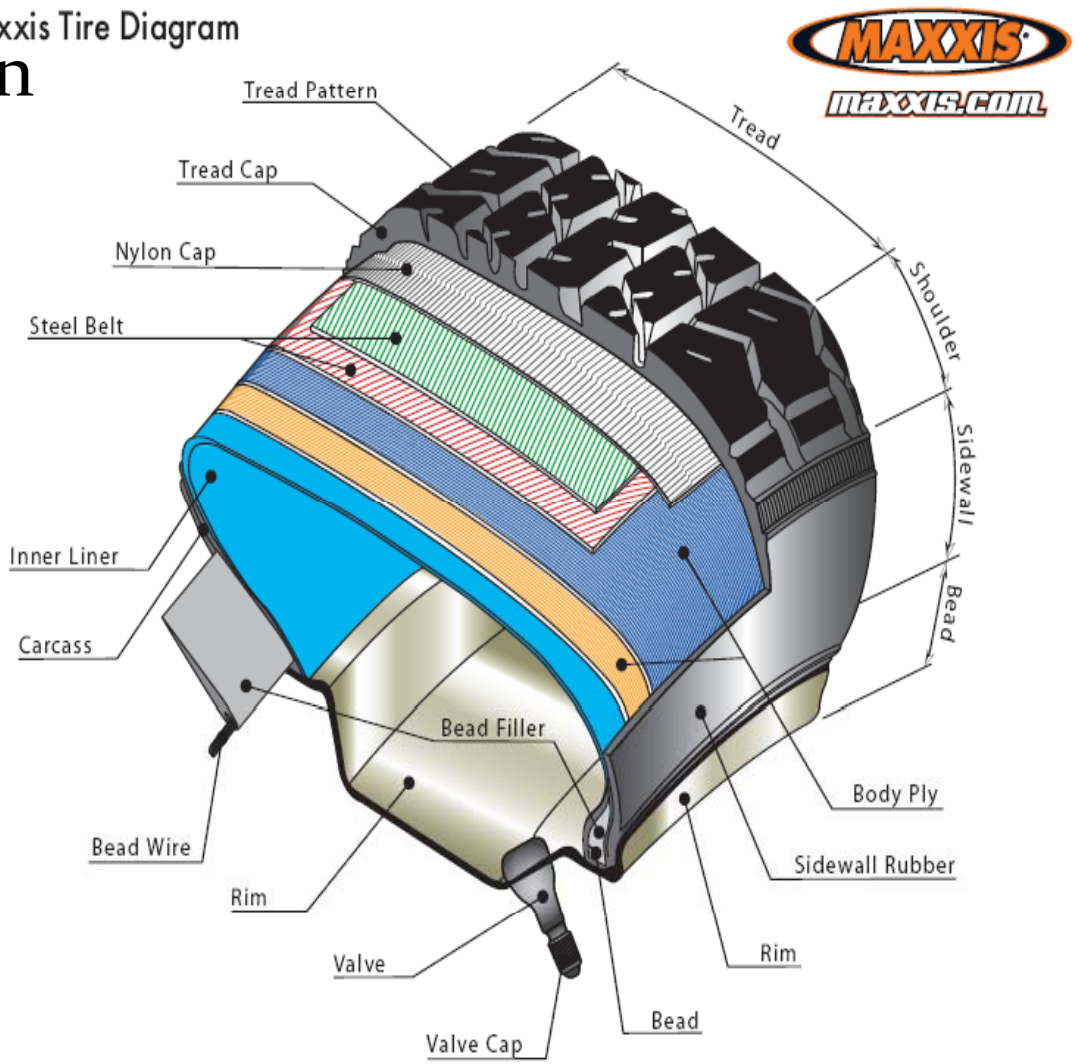
- American inventor Charles Goodyear discovered the process of strengthening rubber, known as *vulcanization* or *curing,* by accident in 1839.

- He had been experimenting with rubber since 1830 but had been unable to develop a suitable curing process.

- During an experiment with a mixture of india rubber and sulfur, Goodyear dropped the mixture on a hot stove.
- A chemical reaction took place and, instead of melting, the rubber-sulfur mixture formed a hard lump. He continued his experiments until he could treat continuous sheets of rubber.

Radial Tires

- Uses plies to stiffen in the radial direction
- Steel belt improves seal on the rim and adds durability
- Eliminates need for inner tubes



Raw material

- Natural rubber is the main raw material used in manufacturing tires, although synthetic rubber is also used.

- In order to develop the proper characteristics of strength, resiliency, and wear-resistance, however, the rubber must be treated with a variety of chemicals and then heated.

Tire construction

- Starts with acquisition of raw materials
- Use combination of rubber, steel and synthetic materials.
- Often combined by another company and bought for the tire manufacturing process.

Rubber Combination

- Four types of rubber used
  - natural rubber
  - styrene-butadiene rubber (SBR)
  - polybutadiene rubber (BR)
  - butyl rubber
- First three are used in the sidewalls and tread. Butyl is used in the inner lining

Fillers

- Used to add desired characteristics such as stiffness or wear ability.
- Include:
  - carbon black
  - Silica
- Other additives increase wear life

RUBBER PERCENT BY WEIGHT IN A NEW RADIAL PASSENGER TIRE

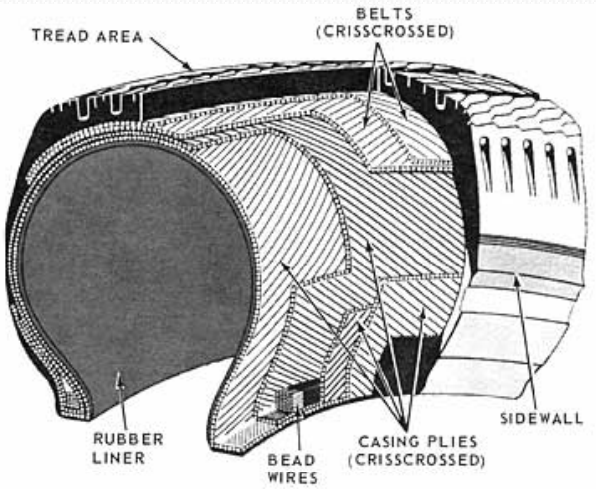
TREAD	32.6%
BASE	1.7%
SIDEWALL	21.9%
BEAD APEX	5.0%
BEAD INSULATION	1.2%
FABRIC INSULATION	11.8%
INSULATION OF STEEL CORD	9.5%
INNERLINER	12.4%
UNDERCUSHION	3.9%
	100.0%

Cords

- Made from either steel or some form of fabric
- Fabric is twisted and then a few strands are combined.
- These “cords” are then braided to form a ply.
- Different ply braids posses different performance characteristics.

Belts

- A belt consists of several plies.
- Typical to have alternating 45 degree
- Formed by pressing together and adding uncured rubber

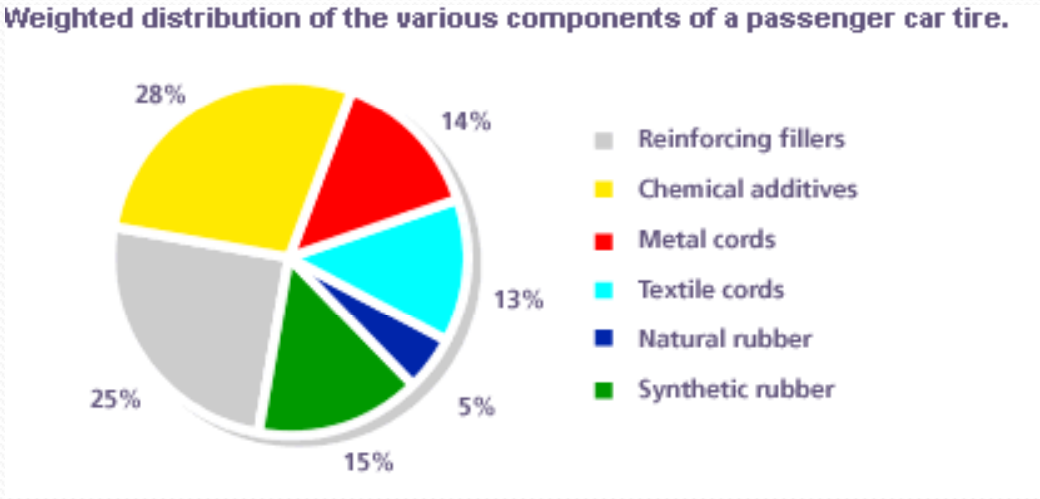


Rubber Components

- Next tread, sidewall and apex are formed.
- Each is made from different rubber composition.
- Each is formed in a separate extruder.
- Each part is then passed through a single extruder head.

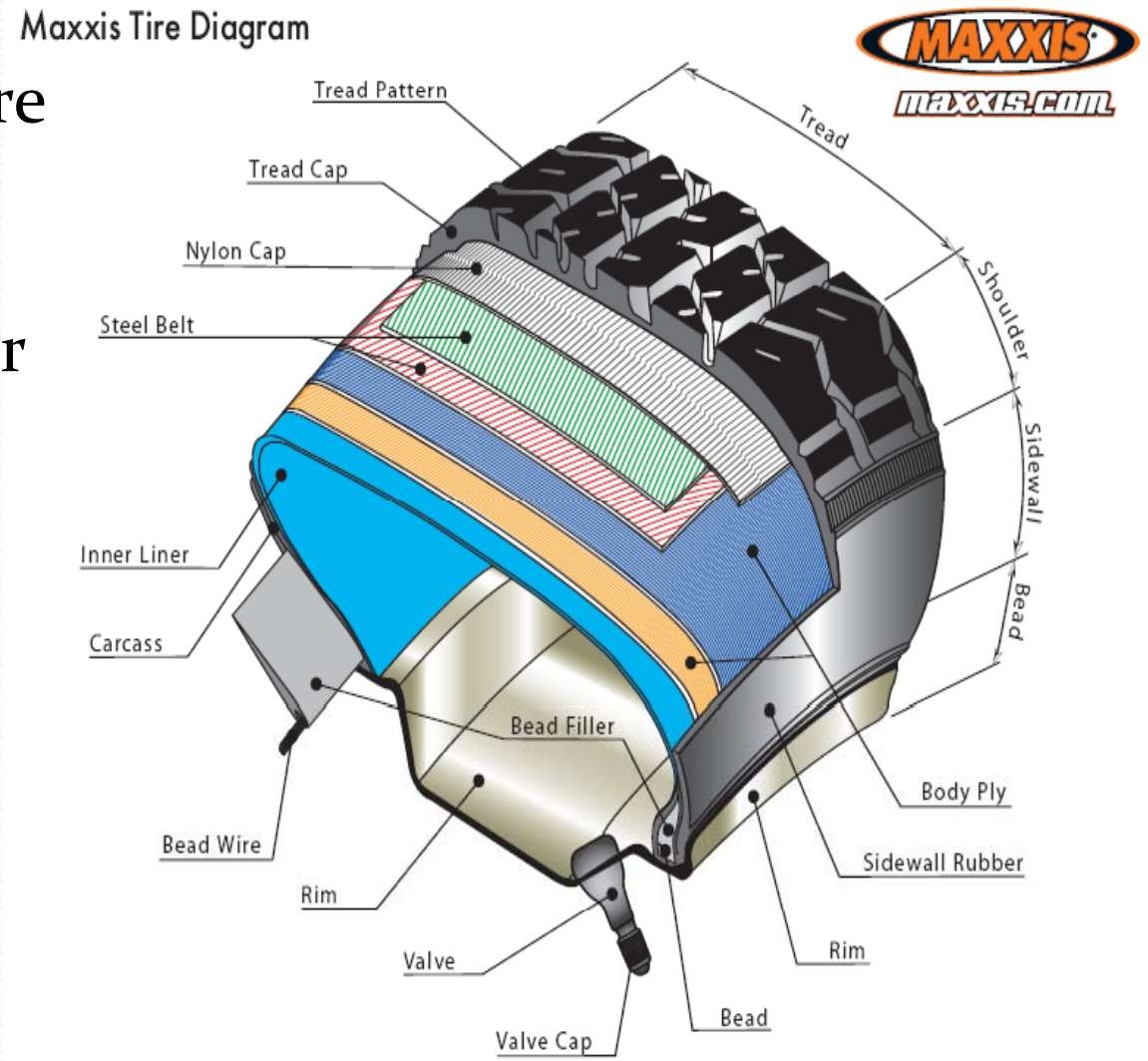
Putting it Togeather

- All pieces are assembled on a drum.
- Tire is now called a “green” tire and shows no tread.
- The tire goes into a mold where heat, pressure and chemicals form the tread.
- Also bonds all pieces of the tire togeather

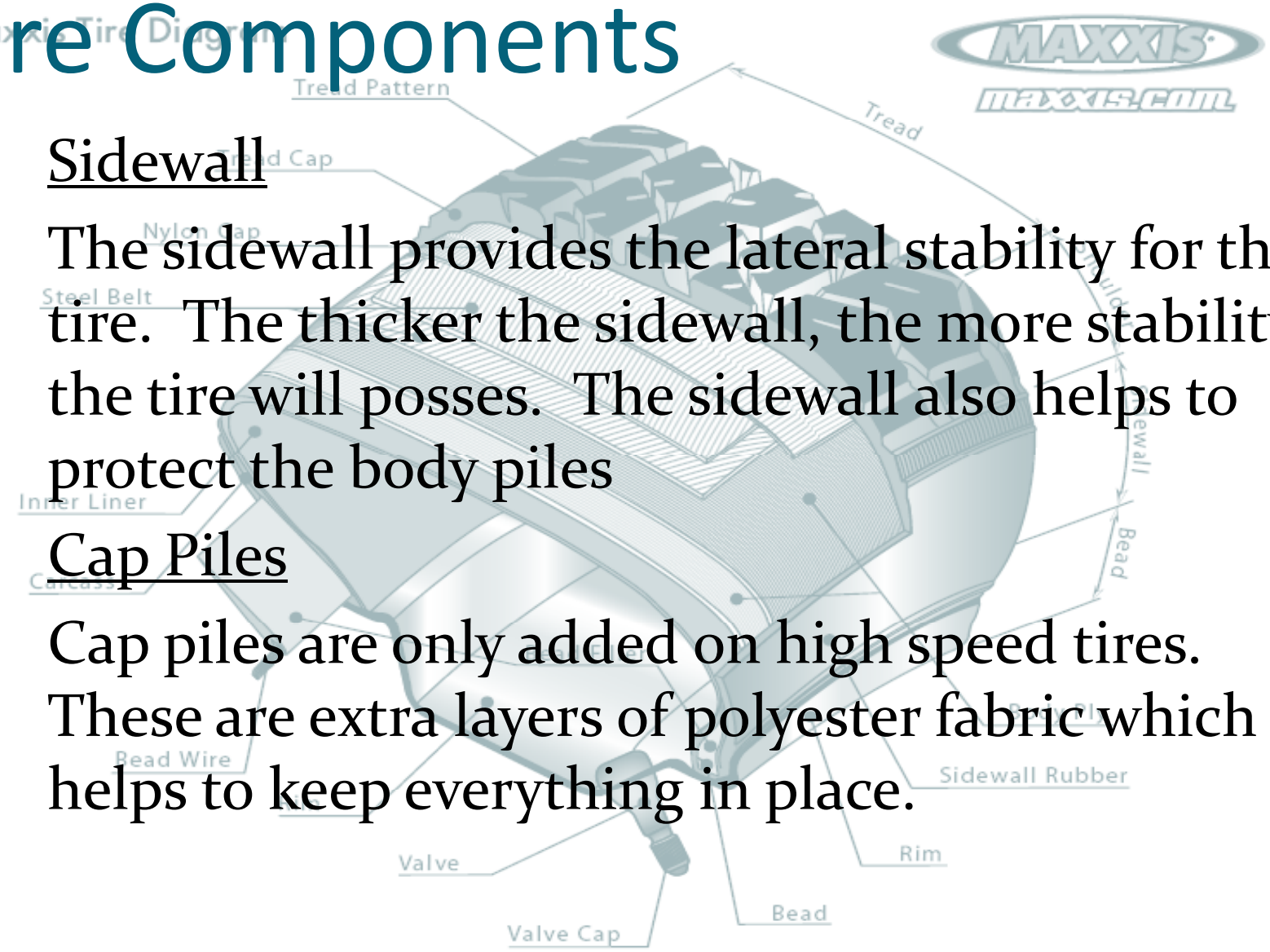


Parts of the Tire

- Each part of the tire either serves to protect the tube, provide strength or keep the tire in place



Tire Components



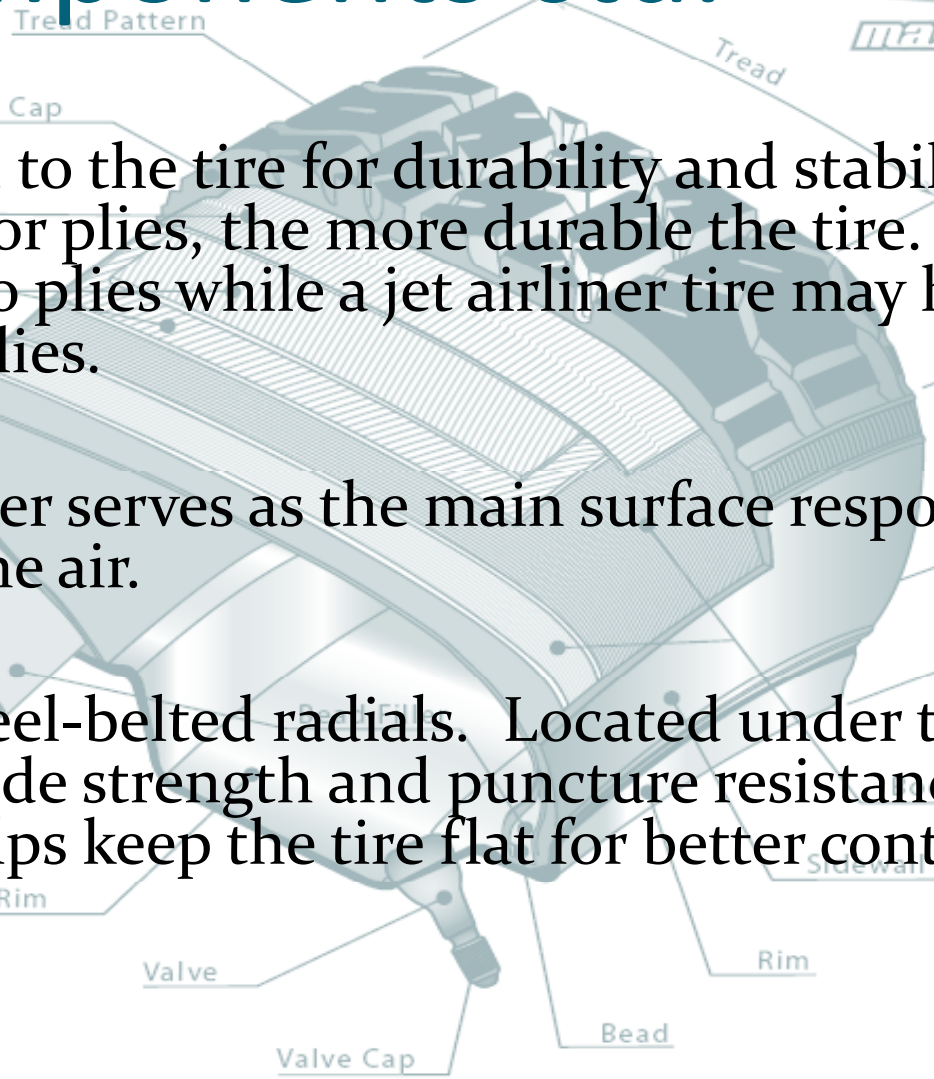
- <u>Sidewall</u>

  The sidewall provides the lateral stability for the tire. The thicker the sidewall, the more stability the tire will posses. The sidewall also helps to protect the body piles

- <u>Cap Piles</u>

  Cap piles are only added on high speed tires. These are extra layers of polyester fabric which helps to keep everything in place.

Tire Components ctd.



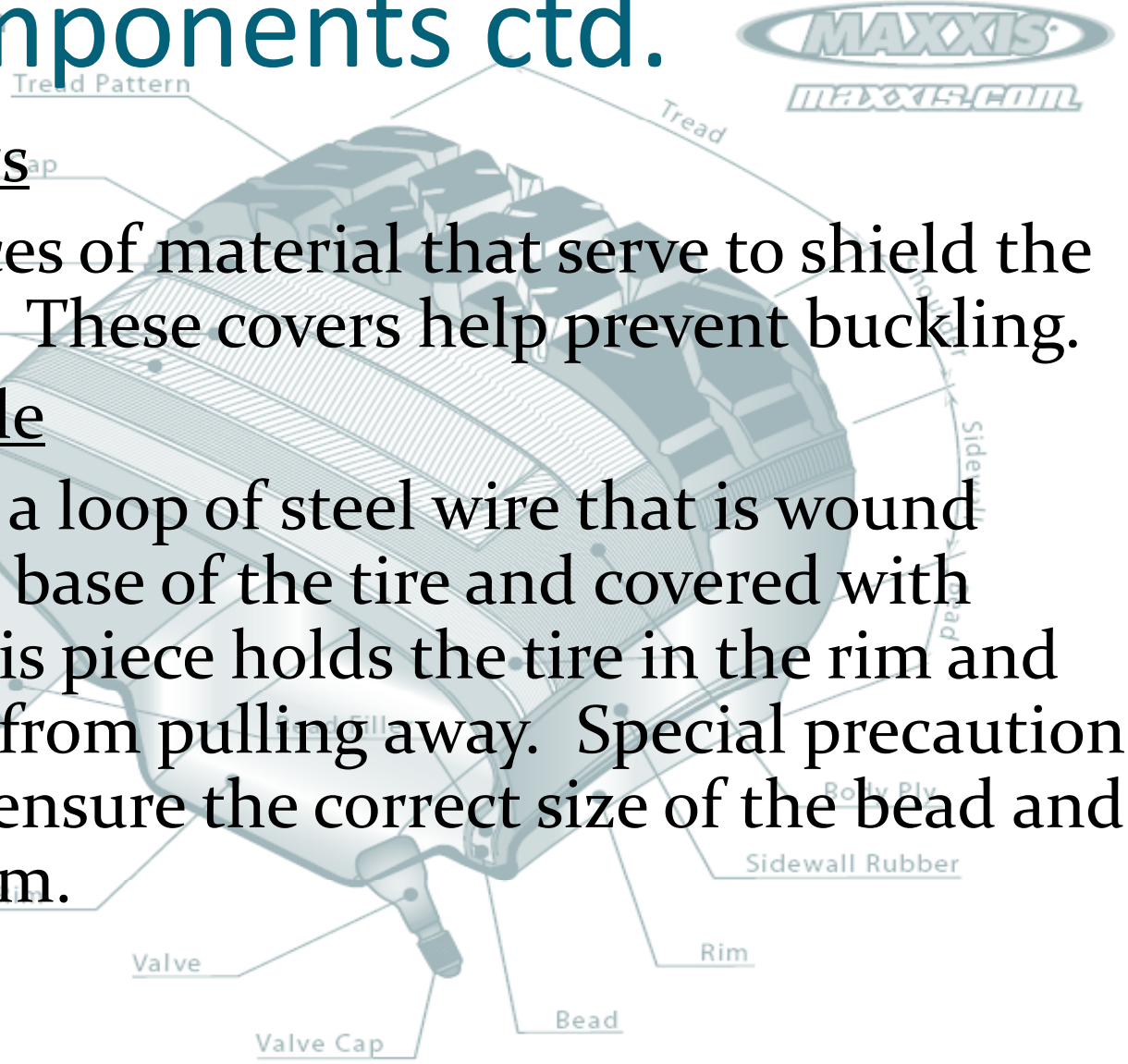
- Body Piles

  Layers added to the tire for durability and stability. The more layers, or plies, the more durable the tire. Typical car tires have two plies while a jet airliner tire may have as many as 30 plies.
- Inner Liner

  The inner liner serves as the main surface responsible for containing the air.
- Steel Belts

  Present in steel-belted radials. Located under the tread. Help to provide strength and puncture resistance to the tire. Also helps keep the tire flat for better contact patch.

Tire Components ctd.



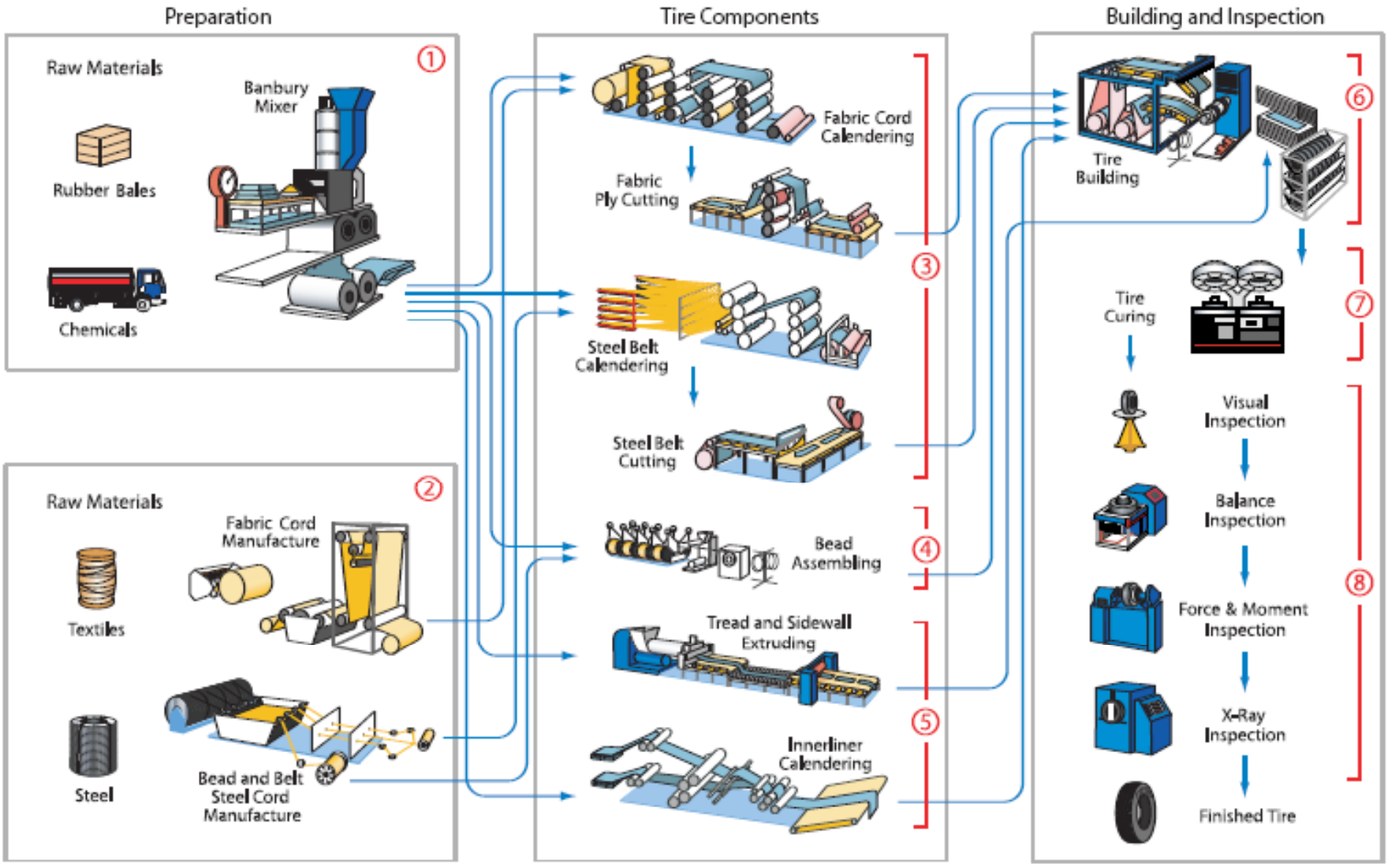
- Edge Covers

  Added pieces of material that serve to shield the inner liner. These covers help prevent buckling.

- Bead Bundle

  Consists of a loop of steel wire that is wound around the base of the tire and covered with rubber. This piece holds the tire in the rim and prevents it from pulling away. Special precaution is taken to ensure the correct size of the bead and lip of the rim.

Maxxis Tire Production Flow Chart



Rubber Compound Mixing Operation (section 1)

Rubber compound formulation

- ✓ The two major ingredients in a rubber compound are the rubber itself and the filler.
- ✓ Depending on the intended use of the tire, the objective may be to optimize performance, to maximize traction in both wet and dry conditions, or to achieve superior rolling resistance.
- ✓ In general, there are four major rubbers used: natural rubber, styrene-butadiene rubber (SBR), polybutadiene rubber (BR), and butyl rubber (along with halogenated butyl rubber).

Rubber Compound Mixing Operation (section 1)

Rubber compound formulation

- ✓ The first three are primarily used as tread and sidewall compounds, while butyl rubber and halogenated butyl rubber are primarily used for the innerliner, or the inside portion that holds the compressed air inside the tire.

- ✓ The most popular fillers are carbon black and silica, and there are several types of each. The selection depends on the performance requirements, as they are different for the tread, sidewall, and apex.

- ✓ Other ingredients also come into play to aid in the processing of the tire or to function as anti-oxidants, anti-ozonants, and anti-aging agents. In addition, the “cure package”—a combination of curatives and accelerators—is used to form the tire and give it its elasticity.

Rubber Compound Mixing Operation (section 1)

Rubber compound mixing

- ✓ Once the compound is determined, the next challenge is how to mix it all together.
- ✓ The mixing operation is typically a batch operation, with each batch producing more than 200 kilograms of rubber compound in less than three to five minutes.
- ✓ The mixer is a sophisticated piece of heavy equipment with a mixing chamber that has rotors inside.
- ✓ Its main function is to break down the rubber bale, fillers, and chemicals and mix them with other ingredients.
- ✓ The sequence in which the ingredients are added is critical, as is the mixing temperature, which can rise as high as 160 - 170 degrees Celsius.

Rubber Compound Mixing Operation (section 1)

Rubber compound mixing

- ✓ If the temperature is too high, the compound can be damaged, so the mixing operation is typically accomplished in two stages.
- ✓ The curative package is normally added in the final stage of mixing, and the final mixing temperature cannot exceed 100-110 degrees Celsius or scorching may occur.
- ✓ Once the mixing is completed, the batch is dumped out of the mixer and sent through a series of machines to form it into a continuous sheet called a “slap”.
- ✓ The slap is then transferred to other areas for bead wire assembly preparation, innerliner calendering, steel and/or fabric belt/ply cord calendering, tire sidewall extrusion, and tire tread extrusion.

Fabric/Steel Cord Preparation (section 2)

Because tires have to carry heavy loads, steel and fabric cords are used in the construction to reinforce the rubber compound and provide strength. Among those materials suitable for the tire application: cotton, rayon, polyester, steel, fiberglass, and aramid.

Fabric cord

- Fabric cord quality is based on its strength, stretch, shrinkage, and elasticity.
- The yarn used is first twisted, and then two or more spools of yarn are twisted into a cord. Before shipping the cord to the tire factory, the manufacturer pre-treats the cord and applies an adhesive to promote good bonding with the rubber.
- The temperature, humidity, and tension control are critical before the fabric cords are calendered with rubber compound.
- For this reason, fabric cord is kept in a temperature-and-humidity-controlled room once it arrives at the factory.

Fabric/Steel Cord Preparation (section 2)

Steel cord

- Steel wire cord quality is based on tensile strength, elongation, and stiffness.
- It is manufactured from steel rod with high carbon content; and while the steel wires used have different configurations, all are brass-coated strands twisted together into cords.
- If the wire is used in a multi-ply tire rather than a belted tire, the fatigue performance will be important.
- If used in belted tires, then stiffness is of primary concern. Since the steel wire is brass coated, storage conditions are important to maintain the steel wire to rubber bonding properties.
- Therefore, the steel wires are also kept in a temperature and humidity controlled room once they arrive at the factory.

Belt and Ply Calendering (section 3)

- To produce fabric or steel belts, the fabric or steel cord must go through a calendering process—an operation in which the rubber compound is pressed on and into cords. Because the bonding of fabric to rubber or steel to rubber is critical to performance, the calendering process is an important step.

- The calender is a heavy-duty machine equipped with three or more chrome-plated steel rolls which revolve in opposite directions. The roller temperature is controlled via steam and water. In this process, the rubber compound is applied to the cords.

Belt and Ply Calendering (section 3)

- First, a pre-set number of fabric or steel cords under proper tension are continuously pressed through two steel rollers, and rubber compound is added to the opening area between the rollers.
- Then the rubber compound is pressed into, on top of and on the bottom of the fabric or steel cords.
- A continuous sheet of cord-rubber composite goes through several more rollers to ensure good penetration and bonding between the rubber and cords.
- Quality is measured by the thickness of the sheet, spacing between cords, the number of cords and the penetration of rubber into the composite sheet.
- The composite sheet is then cut into appropriate sizes, shapes, and angles depending on the desired contour of the tire.

Innerliner Calendering (section 3)

- The innerliner is just what it sounds like -- the inner-most layer of the tire. Its main functions are to retain the compressed air inside the tire and maintain tire pressure.
- Due to its low air permeability, butyl rubber—or halogenated butyl rubber compound—is the primary rubber compound used. Because this is a thin layer, it is also produced using the calender.
- The gauge control and no-defect surface finish are critical to retaining air pressure. Innerliner calendering is also a continuous operation.
- The proper length of innerliner sheet is pre-cut to be ready for the tire building process.

Bead Component Preparation

(section 4)

- The bead component of the tire is a non-extensible composite loop that anchors the body plies and locks the tire onto the wheel assembly so that it will not slip or rock the rim.
- The tire bead component includes the steel wire loop, apex or bead filler; the chafer, which protects the wire bead components; the chipper, which protects the lower sidewall; and the flipper, which helps hold the bead in place.
- The bead wire loop is made from a continuous steel wire covered by rubber and wound around with several continuous loops.

Bead Component Preparation

(section 4)

- The bead filler is made from a very hard rubber compound, which is extruded so as to form a wedge.
- The bead wire loop and bead filler are assembled on a sophisticated machine.
- The precision of the bead circumference is critical. If too small, tire mounting can be a problem; but if too loose, the tire can come off the rim too easily under loading and cornering conditions.
- After the circumference is checked, the bead component is ready for the tire building operation.

Tire Tread and Sidewall Extrusion Operations (section 4)

- Tire components such as tread, sidewall, and apex are prepared by forcing uncured rubber compound through an extruder to shape the tire tread or sidewall profiles.

- Extrusion is one of the most important operations in the tire manufacturing process because it processes most of the rubber compounds produced from the mixing operation and then prepares various components for the ultimate tire building operation.

Tire Tread and Sidewall Extrusion Operations (section 4)

- The extruder in a tire manufacturing process is a screw-type system, consisting primarily of an extruder barrel and extruder head.
- First, the rubber compound is fed into the extruder barrel where it goes through a heating, blending, and pressurizing process.
- Then, the rubber compound flows to the extruder head where it is shaped under pressure.
- The modern cold-feed extruder is computer-controlled for accuracy.

Tire Tread Extrusion (section 5)

- Tire tread, or the portion of the tire that comes in contact with the road, consists of tread itself, tread shoulder, and tread base.

- Since there are at least three different rubber compounds used in forming this complex tread profile, the extruder system consists of three different extruders sharing an extruder head.

- Three rubber compounds are extruded simultaneously from different extruders and are then merged into a shared extruder head.

Tire Tread Extrusion (section 5)

- The next move is to a die plate where the shape and dimensions are formed, and then through a long cooling line—from 100 to 200 feet long—to further control and stabilize the dimensions.

- At the end of the line, the tread is cut according to a specific length and weight for the tire being built.

Tire Sidewall Extrusion (section 5)

- The tire sidewall is extruded in a way similar to the tire tread component; however, its structure and the compound used are quite different from tread.

- Sometimes the sidewall extrusion process can be more complicated, and four extruders may be needed; for example, when building a tire with white sidewalls or with white lettering on the sidewalls.

Tire Building (section 6)

- Finally, the tire is ready to be built by a highly robotized machine which ensures quality and efficiency.

- All components—bead assemblies, calendered plies, belts and innerliner, tread and sidewall sections—are assembled and the building process begins.

Tire Building (section 6)

- A typical radial tire is built on a flat drum in a two-stage process.
  a) In the first stage, the innerliner is wrapped around a drum and the first body ply is wrapped on top, followed by the second body ply.
     The bead assemblies are then positioned, and a bladder on the drum is inflated and pushed in from both ends of the drum, forcing the body plies to turn up to cover the bead assemblies.
     The sidewall sections then are pressed onto both sides.

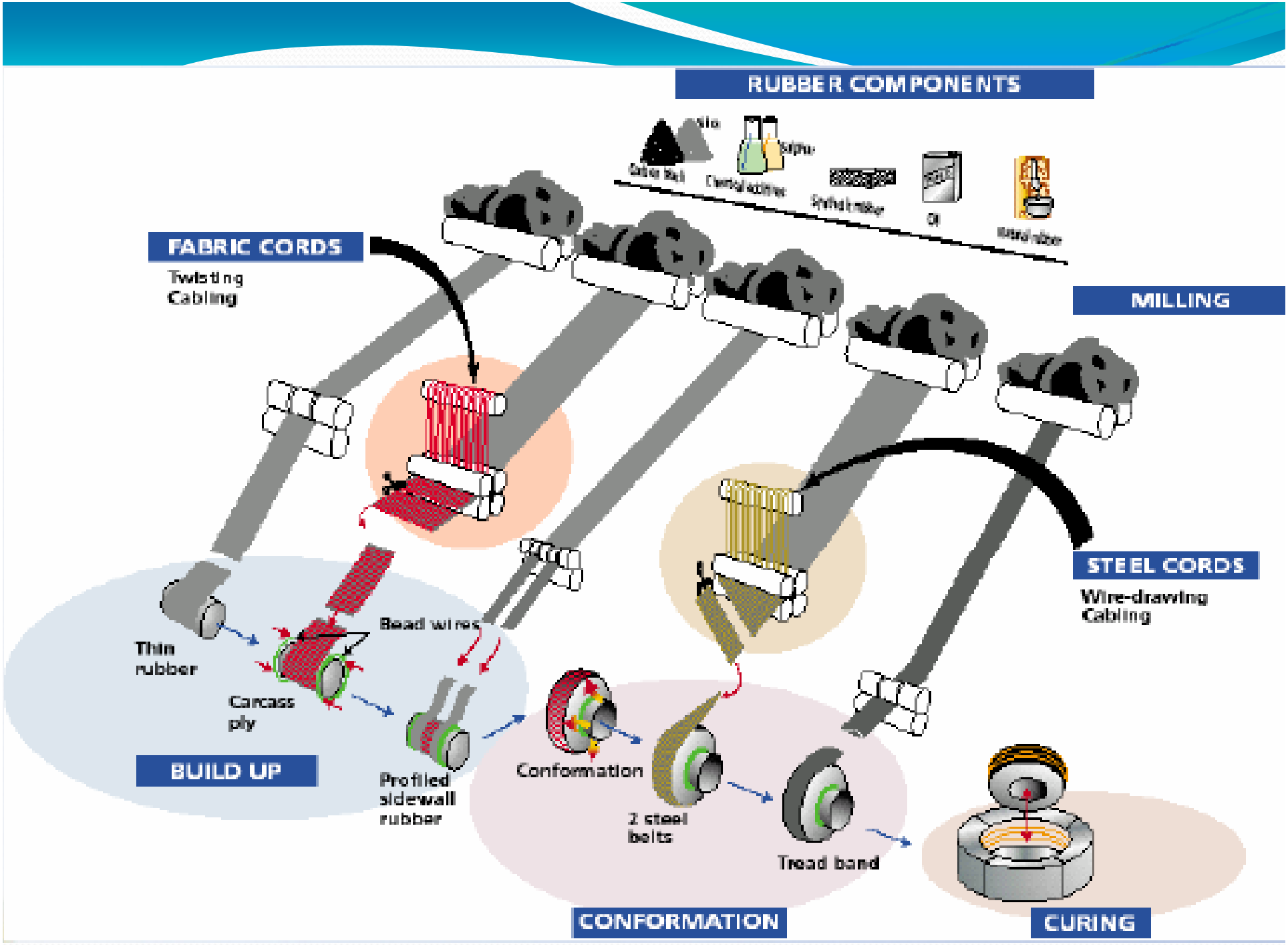
  b) In the second stage of the tire building process, another machine is used to apply the belts, nylon cap, and tread on top of the first stage.
     At this point, the tire still needs curing because there is no tread pattern on it.

Tire Curing (section 7)

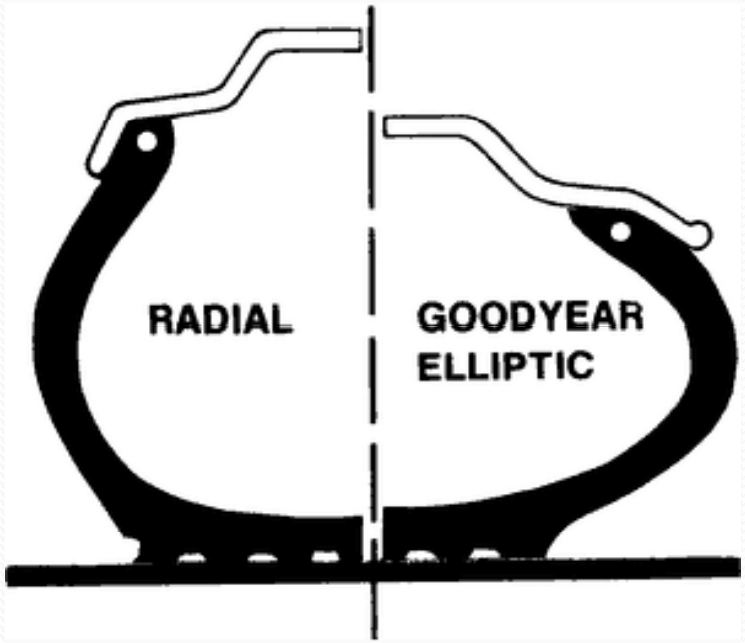
- In this final step, curing occurs through a series of chemical reactions.
- In addition, the sidewalls and tread are molded.
- Tire curing is a high-temperature and high-pressure batch operation in which the uncured tire is placed into a mold at a specified temperature.
- After the mold is closed, the rubber compound flows in to mold the shape and form the tread details and sidewall.
- The mold cannot be opened until the curing reaction is completed.

Tire Inspection (section 8)

- Tire inspection is the last step in the tire manufacturing process—an important step in ensuring quality in both performance and safety. The tire inspection includes:
  - Trimming of the mold flash and micro-vents
  - Visual inspection for appearance and to spot obvious defects
  - X-ray examination to check internal structure and to spot defects
  - Tire durability, uniformity, and weight balance inspection
- After a tire passes these rigorous inspections, it's time for the rubber to meet the road! Our tire is ready to be put into service.


RUBBER COMPONENTS
FABRIC CORDS
Twisting
Cabling
MILLING
STEEL CORDS
Wire-drawing
Cabling
Thin
rubber
Bead wires
Carcass
ply
BUILD UP
Profiled
sidewall
rubber
Conformation
2 steel
belts
Tread band
CONFORMATION
CURING

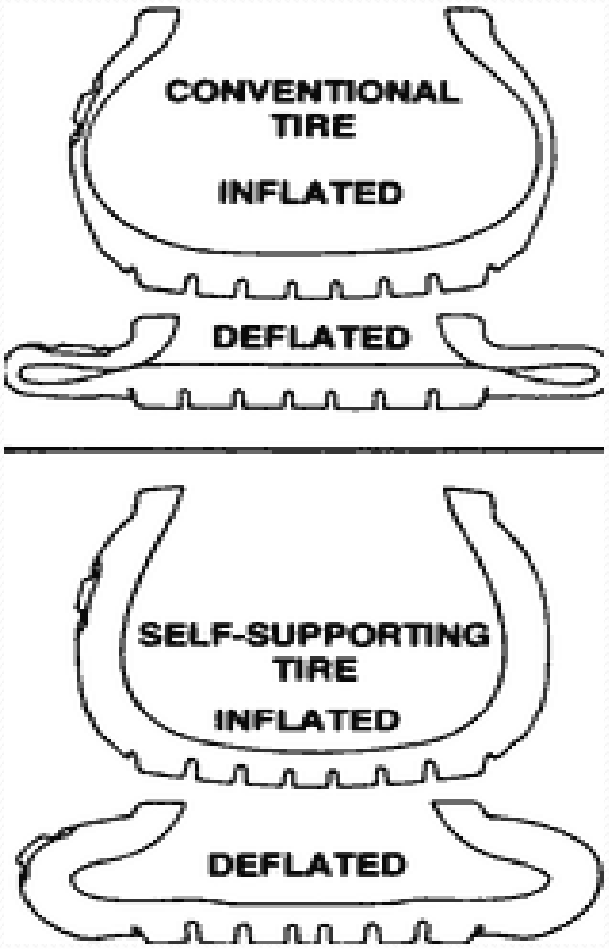
Elliptical



- Thicker Sidewalls
- Shorter Profile
  - Better seal allows for higher inflation pressures
  - Less rolling resistance
- Requires a special rim
  - Rim only accept elliptical tires

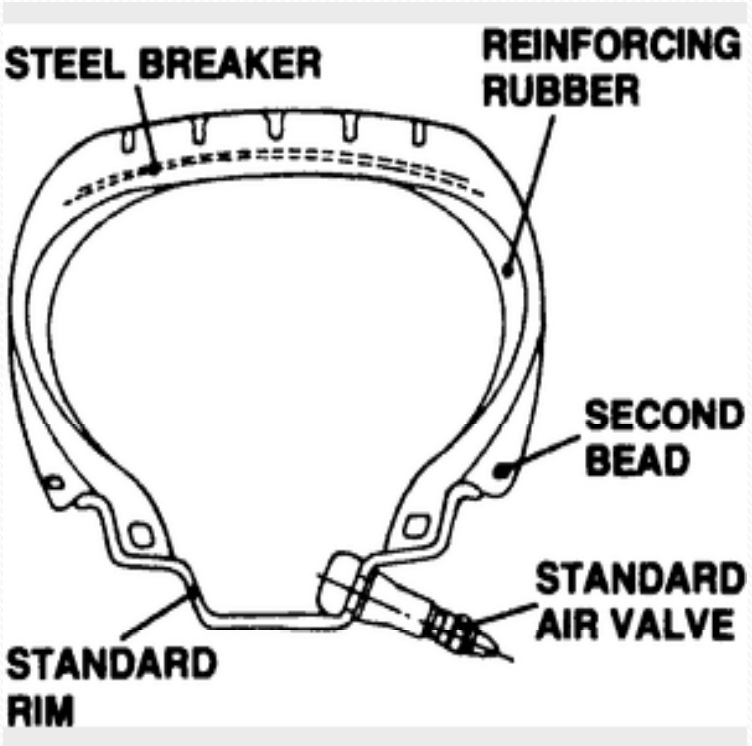
Self-Supporting

- Early design of the run-flat
- Thick sidewalls
  - Allows for self support when deflated
  - Doesn't shred like traditional tires
- No warning after deflation occurs



Run-Flat

- Newest production technology
- Thicker sidewall and inner support
  - Retains more shape when deflated
  - Allows for longer distances after deflation



SEKIAN

DAN

TERIMA KASIH

References

- www.maxis.com
- *Robert C. Miller, How Product are made.*
- *www.wikipedia.org, "How tire is made".*
- G.W Barett, Chris Gibbs, Patrick Townsend, "Tires", Lc. Note, NC State University.