Chapter 4: Rubber

Rubber

Automobile tires are one of the planet’s biggest waste problems. In fact, the world's largest tire graveyard in Kuwait is so vast that it contains over 7 million tires and is visible from outer space[[1]](#footnote-1). Worldwide, there are almost one billion tires discarded annually—and 290 million of those come from the United States alone. In the United States, about 80% of these tires are recycled, but that still leaves 60 million tires that are going to landfill every year.[[2]](#footnote-2) [Figure 53] Discarded tires are so problematic because of the large amount of tires produced each year, their inability to degrade, and the fact they contain a number of components that are environmentally damaging. Tires are made of five main ingredients: natural rubber, synthetic rubber, carbon black (a material produced by the incomplete combustion of heavy petroleum products such as coal tar), metallic and textile reinforcement cable, and numerous chemical agents. These different materials are literally layered and bonded together to create a product that is flexible, airtight, watertight, and has a far higher resistance to abrasion than steel. Almost no other material in the world can claim this kind of robustness.

Natural rubber comes from mature rubber trees, *Hevea brasiliensis,* which are largely grown on plantations in tropical regions around the world. Originally, rubber could only be found in the Brazilian Amazon rainforest and was first called “cauchu” or weeping wood. The Olmec, who inhabited this region, were the first to harvest rubber—the name “Olmec”, literally means “rubber people”[[3]](#footnote-3). The Olmec were the first civilization to develop a sport which was played using a rubber ball and depictions of the game dates back 3,500 years[[4]](#footnote-4) Rubber was also used for making sandals, for waterproofing cloth, for making drumstick ends, and was also burned as incense and used for glue.

At the end of the 18th century, the dawn of the Industrial Revolution, rubber had become one of the world’s foremost indispensable commodities. It was used to make waterproof fabric, airtight hot air balloons, and rubber hoses, as well as a vast array of other products, but it still had its problems. The material had a terrible odor, and if warmed too much by the body, it became brittle and hard. In 1839, the boffin genius Robert Goodyear, radically transformed industrial rubber. He innovated a process to “vulcanize” rubber, (named after Vulcan, the ancient roman god of fire), by mixing it with sulfur at high temperatures. This process profoundly changed the material’s properties enabling it to withstand extreme heat and cold, as well as eliminating its noxious smell. This invention opened the door for rubber to be used in many new ways, including its use in the production of tires.

Pneumatic tires were first invented 1888 by Ulster Dunlop, whose son was a noted bicyclist. And another keen cyclist, a Frenchman named Edouard Michelin, tried Dunlop’s tires on a bicycle ride from Paris to Roen and adopted the pneumatic tire for use on motor vehicles thus creating the single largest market for raw rubber.[[5]](#footnote-5) By the early 1900’s companies such as The Goodyear Tire & Rubber Company and The Firestone Tire & Rubber Company, located in the United States, were using millions of tons of natural rubber to make tires. However, at the onset of World War II, the United States was cut off from the natural rubber supply of Southeast Asia which accounted for 90% of production. This caused the United States to embark on a journey to create an inexpensive synthetic rubber that built on experiments that were taking place in Europe and Russia at the time, which led to the creation of a synthetic rubber. In 1941, Jersey Standard, Firestone, Goodrich, Goodyear, and the United States Rubber Company signed a patent and information sharing agreement under the supervision of the Rubber Reserve Corporation, founded by sitting President Franklin D. Roosevelt.[[6]](#footnote-6) The new synthetic rubber, engineered under the Rubber Reserve Corporation’s oversight, and jointly by these corporations, is comprised chiefly of a petroleum by product, butadiene, and today 70% of rubber used in manufacturing is synthetic[[7]](#footnote-7) and approximately 60% of the rubber used in the modern tire is synthetic.[[8]](#footnote-8)

Rubber is frequently used in the construction of buildings and increasingly recycled rubber is being developed as products for the construction industry. Rubber O-rings, gaskets, foamed rubber insulation, rubber bearings, and silicone rubber beads to make watertight seals, are all examples of how rubber is used in construction.

Recycled rubber tires are also used in building construction, both formally and informally. For example, architects Vaillo + Irigaray in Navarro, Spain have made recycled rubber tire gabions into an office building facade that allows for the passage of dappled light into the building interior, and the Israeli pavilion in the 2015 Venice Biennale was clad in recycled rubber tires. Both serve as examples of how tires can be used as building materials by designers who are simultaneously addressing aesthetics and environmental issues. Discarded rubber tires are also used to make crude “earth ships”,—buildings constructed of stacked rubber tires that are filled with rammed earth to stabilize the tires against movement, and to serve as a thermal mass. The stacked tire walls are often stuccoed to conceal the fact an earthship is made of garbage.

Recycled rubber tires can also used to make very refined building products such as floor tiles, carpet padding, roofing tiles, and waterproof membranes. Most recycled rubber products are made of rubber crumb. A common way to manufacture rubber crumb is to freeze chipped tires pieces in a bath or shower of liquid nitrogen. At -80°C the rubber becomes as brittle as glass and the frozen rubber is pulverized using a hammer mill. This process reduces the rubber to particles ranging from 1/4 inch to 600 microns. Cryogenic grinding avoids heat degradation of the rubber and produces a high yield of product that is free of almost all fiber or steel, which is extracted during the process using magnets and screens. The resulting material is shiny and clean —a raw material, ready to be transformed into something new.

3D Printing with Rubber

The Emerging Objects rubber used for 3D printing is ground into even finer particle sizes and are as small as 50 microns[[9]](#footnote-9). The rubber powder is inert and therefore is mixed with other additives to make it printable and the mixture is adhered together with an organic binder. 3D printing has the potential to turn end-of-life tires into high value sustainable products for the built environment, such as outdoor furniture, embossed rubber flooring and custom tiles for wall cladding.

Objects:

*Rubber Pouf*

The *Rubber Pouf* is a playful piece of furniture that can be used as a low seat or footstool. [Figure 54] The form of the *Rubber Pouf* resembles a six-pointed star with rounded heads on the ends of all six points. The pouf is printed in eight parts that are adhered together to make one solid object. [Figure 55] The detailed, beveled texture on the surface of the pouf gives the appearance of button tufting which makes the piece look padded and soft and contributes to the overall materiality and playful quality of the object. [Figure 56]

*Haeckel Bowl* in Rubber

The *Haeckel Bowl* is one of the first objects 3D printed in rubber. The form of the bowl includes a cantilever, varying wall thicknesses and dimensions of the lattice like structure become progressively thinner as they move away from the center. The entire structure is very shallow, less than two inches thick, and can be printed very quickly. One of the most exciting aspects of 3D printing with rubber is that the rubber particles retain their pliability.

[Figure 57]

1. “Worlds Biggest Tyre Graveyard”, last modified June 7, 2013, http://www.dailymail.co.uk/news/article-2337351/Worlds-biggest-tyre-graveyard-Incredible-images-Kuwaiti-landfill-site-huge-seen-space.html [↑](#footnote-ref-1)
2. “Advancing Sustainable Materials Management 2013 Fact Sheet”, last modified June 2015, https://www.epa.gov/sites/production/files/2015-09/documents/2013\_advncng\_smm\_fs.pdf [↑](#footnote-ref-2)
3. “Olmec”, last modified March 3, 2017, https://www.britannica.com/topic/Olmec [↑](#footnote-ref-3)
4. “The 3,500-Year-Old Rubber Ball That Changed Sports Forever”, last modified January, 20, 2016, http://www.history.com/news/the-3500-year-old-rubber-ball-that-changed-sports-forever [↑](#footnote-ref-4)
5. John Tully, *The Devil’s Milk: A Social History of Rubber*, (New York: NYU Press, 2011), 32. [↑](#footnote-ref-5)
6. *United States Synthetic Rubber Program 1939-1945*, commemorative booklet produced by the National Historic Chemical Landmarks program of the American Chemical Society, 1998. [↑](#footnote-ref-6)
7. “The US Synthetic Rubber Program”, last accessed June 16, 2017, http://www.acs.org/content/acs/en/education/whatischemistry/landmarks/syntheticrubber.html [↑](#footnote-ref-7)
8. “Materials”, last modified 2017, http://thetiredigest.michelin.com/an-unknown-object-the-tire-materials [↑](#footnote-ref-8)
9. “Mycro Dyne”, last modified 2017, http://www.lehightechnologies.com/index.php/products\_services/overview [↑](#footnote-ref-9)