Chapter 3: Coffee, Tea and Wine

Coffee, Tea and Wine

Coffee, tea, and wine are three of the most consumed beverages in the world, and each of these beverages has played a substantial role in the modern era of colonization. Tea shrubs, coffee trees, and grapevines were planted by Europeans in India, Australia, South and North America beginning in the 15th century as European migration and occupation proliferated around the planet. These plants experienced one of the earliest “assisted migrations” in mass quantity in the history of the world. Because of the global proliferation of these plants, and the extensive beverage industries that have grown up around them, there are now vast amounts of agricultural waste generated each year as agricultural by-products of these industries.

The production and consumption of coffee offers many opportunities to harvest waste. This begins beginning in the field where the coffee beans are picked. The coffee bean can be found at the center of the coffee tree’s fruit, the coffee cherry. The coffee bean goes through a process of drying or washing as it is separated from the cherry’s pulp and outer skin. The bean continues on its path to roasting, but the cherry becomes a waste product of coffee. It often is dumped into rivers or left to rot in heaps. In 2016 the world produced 2.886 billion kilograms of coffee cherry fruit and skin waste[[1]](#footnote-1). In an effort to upcycle coffee cherry, coffee flour is a new product that is made by collecting, drying and pulverizing the cherry fruit into a fine powder for baking.

Another source of coffee waste lies in the industrial production of instant coffee. To create instant coffee, coffee first must be brewed and subsequently dehydrated, which means that tons of spent coffee grounds are produced by large companies who produce instant coffee. The grounds that are left over after a pot or cup of coffee is made in restaurants, coffee shops, and homes around the world also create a significant source of waste. [Figure 43]

Much like coffee, the production of tea generates vast amounts of waste during the cultivation, brewing, and consumption processes. During the harvesting of tea, mature leaves are undesirable and are left in the field to rot, as are the stems and stalks of the tea bushes. Later, more waste is created when tea is refined and packaged. A by-product called “tea fluff, a fine dust comprised of broken tea leaves, accumulates on the factory floor and is disposed of. Similar to what occurs in the production of instant coffee, the manufacturing of instant tea generates mountains of brewed leaves that can be recycled, and billions of pounds of tealeaves are disposed of every morning in teashops and homes around the world creating a vast network of waste material sources.

Pomace is the solid remains of grapes after pressing the fruit to make wine. It contains the skins, pulp, seeds, and stems of the fruit. Grape pomace has traditionally been used to produce brandies, such as Grappa, which the Italians have done since around 1000 AD, but even after its second use, remnant material remains. Pomace can be used as fodder and fertilizer, but much like the coffee cherry, grape skins and seeds are often unproductive and remains a waste product of wine production.

Recycled tea leaves have been used to manufacture synthetic resins, which can be used in building applications and upcycled tea leaves are also used to create boards, called tea board), which are used to make tatami mats and plaster boards that may be used for interior insulation boards and as finished interior surfaces.[[2]](#footnote-2) These tea-building products are known to have antibacterial and odor-killing effects. Similarly, the non-profit design company Re-worked, uses coffee waste to make furniture.[[3]](#footnote-3) Used coffee grounds are combined with recycled waste plastics to create a composite material that is durable, waterproof, and easy to form into sheets that can then be cut and milled.

Engineers in Melbourne, Australia, at the Swinburne University of Technology, are using spent coffee grounds from local coffee shops to develop sustainable pavement materials for use in road construction[[4]](#footnote-4). They dry the coffee grounds in a 50°C oven for five days, then sift the grounds to filter out lumps. The sifted coffee grounds are then mixed with rice husk ash and blast furnace slag in a 7:2:1 ratio. The rice husk ash is a by-product of rice production and the slag is an industrial by product of steel production. A liquid alkaline solution is added to bind everything together. The outcome is a coffee grounds geopolymer that leads to a cleaner environment.

Coffee grounds can also be used to add color and texture to other materials in the built environment. The grounds can be mixed with vinegar to stain wood which gives it an aged appearance, and used coffee grounds can be mixed with ironite and oil to give concrete a brown tint.

Remarkably, there is also an innovative yarn made of recycled coffee grounds that can be knitted or woven into sustainable fabrics that enhance odor adsorption, control moisture, and offer UV light protection[[5]](#footnote-5). The yarn blends coffee residue with a polymer to produce a coffee / plastic thread. Fabrics can be backed with the coffee residue thread, can have a microencapsulated baked coffee residue applied to their surface or contain microencapsulated coffee essential oil. Additionally, the material is further comprised of a carbonized or “burned” coffee nanoparticle that is made by sieving coffee residue, removing organic contents from the sieved mixture, and then obtaining carbonized particles from the mixture to apply to the fabric as an odor absorber. The end result is a super high tech eco-fabric made from coffee grounds that can be used for clothing or upholstery.

3D Printing Coffee, Tea and Wine Waste

The waste material generated by coffee, tea and wine production are abundant, inexpensive and readily available in almost every region of the world and are suitable for 3D printing. What’s more is that the 3D printed objects made of these materials have unique visual and aromatic properties that emerge from their material origins. 3D printed coffee produces a dark, rich umber color that patinas and darkens as it ages. Black tea produces a reddish, tawny tone. The skins from various grape varietals produce different colors as well, ranging from the chardonnay, which produces a rich brunette color to cabernet sauvignon, which is almost black like the raisin it was destined to become if left to dry. The coffee, tea, and wine aromas emanate from the 3D printed objects themselves and they are able to retain the scent of their raw material for an exceptionally long time, especially in the case of coffee and tea, which are used in the drying process to preserve their ability to entice the olfactory senses.

We have created a series of material formulations with the by products of coffee, tea, and wine production for 3D printing, and fashioned a series of meta drinking utensils including a tea pot, tea cups, coffee cups, ice bucket and wine goblets. And while it may seem novel and rarified to make drinking utensils out of agricultural materials, it is in fact, quite traditional. Before the introduction of glassware and ceramics as we know them today, people in east Asia made drinking utensils and vessels out of agricultural fibers and resin, what we commonly know as lacquer ware. The practice of lacquer ware has been ongoing for over 10,000 years since the Neolithic era[[6]](#footnote-6). Lacquered vessels are very light and are typically woven of very fine strips of bamboo that are wrapped around a wood mold. The bamboo strips are then coated with sap obtained from the bark of a tree. The vessels are then allowed to harden before they are finished with a mix of calcined bone dust, pulverized rice husks and teak sawdust.

The technique of using broken down and pulverized agricultural materials and then strengthening them with a resinous material is how many of the oldest drinking utensils were made, especially teacups, and remarkably it is very similar to how these materials can be combined to make 3D printed drinking and serving utensils today.

When using the by products of coffee, tea and wine for 3D printing, materials are sourced or pulverized into a fine powder and fiber. Other organic materials are introduced into the matrix and an edible adhesive that reacts to water is used to solidify the objects in the build bed of the printer. The solid, printed vessels are then coated and infused with a food safe epoxy resulting in a collection of sustainable and beautiful vessels made from the ingredients that they serve.

Objects:

*The Utah Tea Set*

The Utah Teapot, also known as the Newell Teapot, was one of the first objects ever depicted as a three-dimensional object in the computer. Created in 1975 by the pioneer computer graphics researcher Martin Newell at the University of Utah, this humble teapot has become a standard reference object in the computer graphics community. Whereas the Utah Teapot for decades remained trapped in its translation from physical object to virtual object, it is through 3D printing that we liberate the object from the screen. While the original teapot was ceramic, the bits of data that comprised the teapot in its digital state, when translated through our material process to the physical, manifested in a teapot 3D printed out of actual tea! [Figure 44] It would not make sense to have a teapot without teacups. These teacups, however, are also printed from tea. [Figure 45] Furthermore, if you have a teapot and teacups, an obvious necessity would be teaspoons! [Figure 46] Of course, the teaspoons are also printed using tea and are exactly the volumes of a single teaspoon, (4.92 cubic centimeters), two teaspoons, and a tablespoon. Therefore the *Utah Tea Set*, is printed from a meta-material—and the object is doubly self referential — meta — and then meta again.

*Sugar Sugar Spoons*

Obviously, one does not add tea-teaspoons to their tea. Therefore, the *Sugar Sugar Spoons* are also 3D printed in sugar and by volume. 4.92 cubic centimeters equals one teaspoon, 9.82 equals two teaspoons and so forth. These sugar spoons can be stirred down and dissolved into one’s coffee or tea. [Figure 47]

*Coffee Coffee Cup*

The *Coffee Coffee Cups* and saucers are 3D printed from upcycled coffee grounds. The grounds are finely pulverized, held together with a water-based binder, and formed into cups as part of the meta-material series of objects. [Figure 48] [Figure 49]

*Chardonnay Wine Goblets*

A goblet is a drinking cup with a foot and a stem typically filled with wine and drunk during special occasions. Throughout history, goblets have been made of many different materials—earthenware, gold, silver and glass. Continuing the meta-material series, these wine goblets are printed from upcycled chardonnay grape skins and seeds. The skins and seeds are collected from vineyards in Sonoma County and are dried in a kiln and then pulverized to the consistency of flour. Both the wine, and the goblets themselves can be studied for color, viscosity, texture, notes, and body.

[Figure 50]

Chardonnay Ice Bucket

Manufactured using the Chardonnay 3D printing material, the Chardonnay Ice Bucket, called *Marc Metamorphosis* designed by Andrew Kudless / Matsys for Perrier-Jouët, is composed of seven leaves that rotate around a central, circular base. The pattern on the tiles of the ice bucket references the wrinkled skin of a raisin and the ice bucket reproduces the texture of a grape as it dries, creating a beautiful and meaningful textured surface tied directly back to the wine-making process.

[Figure 51]

*Ombré Decanters*

An ombré occurs when dark smoothly transitions to light or from one color to another. The *Ombré Decanters* are part of a series of experiments that examine material ombrés. The *Ombré Decanters* demonstrate how the material that comprises the object graduates from 3D printed chardonnay to 3D printed cement. A material ombré makes it possible to have transitions that are smooth and seamless and move from an agricultural material to a geologic material without joints or fasteners.

The forms of the decanters are inspired by ancient ceramic wine carafes and amphorae and the texture on the surface is inspired by the diamond pressed texture one frequently finds in wine glasses and decanters.

The use of cement can be found in vinification culture. Concrete vats are sometimes used in the fermentation of wine. Because of its thermal mass, concrete allows the wine to ferment at a slower pace to retain the flavor of the fruit. The porosity of the concrete allows the vats to breathe, naturally fermenting the wine. The oldest fermentation vats from ancient Greece and Rome were made of ceramic materials, thus the return of cement-based materials used in the storage and serving of wine is a look back and forward at the same time. [Figure 52]

1. <http://www.intracen.org/coffee-guide/world-coffee-trade/conversions-and-statistics/>

   and http://www.ico.org . 14.8 million 60 kg bags were produced in 2016. Each bag corresponds

   to 195 kgs of cherry fruit and skin. 14.8 million x 195 = 2,886 million kilograms or 2.886 billion kilograms. [↑](#footnote-ref-1)
2. http://www.itoen.com/corporate-social-responsibility/environment [↑](#footnote-ref-2)
3. http://inhabitat.com/re-worked-brews-up-furniture-from-recycled-coffee-grounds/ [↑](#footnote-ref-3)
4. [https://researchbank.swinburne.e](https://researchbank.swinburne.edu.au/items/f8d2f408-1b46-437a-8a09-4e027ab2f996/1/)du.au/items/f8d2f408-1b46-437a-8a09-4e027ab2f996/1/ [↑](#footnote-ref-4)
5. http://www.scafefabrics.com/en-global [↑](#footnote-ref-5)
6. Rev. G.R. Wedgewood, *The History of the Tea Cup* (London: Wesleyan Conference Office, 1883), 21. [↑](#footnote-ref-6)