

Espresso Extraction Physics/Engineering

By Mauro Cipolla



Many have said that espresso extraction is both art and science. But is this sentence just a cliché? Has it been overused? Is espresso extraction just an art? ... In more simplistic terms, is espresso extraction just a “process” that only requires the understanding and practicing of certain basic “boiler plate” extraction systems?

After 12 years of green coffee purchasing, coffee roasting, fixing, building, and rebuilding many brands of espresso machines, and performing daily hands-on studies of extraction parameters while brewing espresso, I am confident in asserting once again that espresso extraction is *both* an art and a science which requires a lot more than the basic understanding and application of said boiler plate espresso brewing methods.

In fact, the experienced barista who doesn't have the flexibility of mind to want to keep on researching, learning, and improving is the barista who will be guided and trapped by his own close-minded and stubborn attitude. Knowing it all, and not having anything else to learn, will only lead to mediocre quality at best.

The dynamic and unstable parameters of espresso are the challenges to be overcome daily. Being a barista at its very best requires an open mind which is willing to embrace espresso extraction as an art and a science.

The question that now comes to mind may be: Where does a barista encounter the art and the science in espresso extraction? The art in espresso extraction is found by making sure all of your senses are involved while brewing each espresso. Your eyes, ears, hands, and nose must all be deeply concentrated in making a passionate marriage between you, your machine, and the extraction in progress. Allow me to give you an example of what I mean by this through illustrating the concept with an example of espresso extraction.

Step one: You take your porta-filter out of the group head and notice that spent coffee cake was left in the basket. The coffee cake got so hot in the basket that many of the basket's fine holes are plugged. Your visual sense should now tell you that unless you clean the porta-filter properly, you will have an espresso that will be negatively affected by flavors found within this clogged basket.

Step two: You now push the irrigation water button to preheat the porta-filter's basket, and you notice that the water is not spraying out of the group screen with a nice, even, spread water flow. Both your visual sense and your audible sense (as water that is not spreading evenly over the basket will be focused in a smaller area, and will in turn have a different sound due to differing water pressure and gravitational water flow) should tell you that the ground coffee bed will not receive the proper water pressure and water dispersion for optimum extraction of body, crema, and flavors.

Step three: You start the grinder to fresh grind the required seven to eight grams of coffee grounds for proper espresso extraction, and you notice the grinder is grinding slower than

usual, and the sound of the burrs hitting the beans is not as fluid. The speed and quality of grinding is probably effected by worn burrs. The peculiar and different sound is due to the dull edges of the burrs applying forced crushing onto the beans' surface, instead of grinding by shaving the beans' structure. Once again, both your visual and your audible senses should tell you that this slow, overheated, and uneven grind quality will not deliver anything close to the optimum espresso standards you want to have.

Step four: You are now dosing the coffee grounds into the basket. You have only done a couple of shots in the past few minutes and the smell of the coffee is not as fragrant and lively as usual. The temperature of the coffee grounds is also warmer than usual. It should be your nose and your hands at this point that should let you know that something is wrong with your grinder's burrs and / or motor or shaft. This should be your signal that the quality of the shot will most likely be diminished due to an uneven grind.

Step five: You are now getting busier, and the grinder is being used very heavily. You listen, you watch, you keep your sense involved. Then you pull the dosing lever to dispense the coffee grounds into the porta-filter's basket. In doing so, your fingers quickly touch the coffee grounds and the side of the grinder's body. The coffee ground are very warm and uneven in consistency of grind quality. The grinder's metal body feels very warm, indicating the motor inside the grinder is warm. Here, your hands are telling you to start paying closer attention to the temperature and quality of the coffee grounds. You may need to have a second grinder installed for these busy time in order to achieve the same extraction quality you would have in slower times with one grinder operating at proper temperatures.

These steps indicate the extraction process being artistically performed by a barista utilizing all his senses in a knowledgeable and passionate manner. The second part of the original question we must still answer is where the science is found in a barista's daily life. We will concentrate our answer on one particular area of changing elements: the physics / engineering area of extraction.

The first notion to understand is that there are real physical / chemical changes to the coffees handled by the baristas after the already applied changes to the same coffees by the roasting process. In other words, it must be remembered that even the finest roasted and blended coffees will be effected by both physical and chemical changes while in the hands of individual baristas. I should note that most of these changes can be controlled by the barista. The control parameters can bring very negative results in taste and overall quality - *or positive ones*, which will ensure the return of satisfied customers.

The first area where physical / chemical changes occur is at the storage stage. The aroma (one of coffee's most important attributes for taste) is made up of hundreds of volatile chemical compounds that need to be protected by proper storage, as it can easily be affected by oxidation which will in turn yield a great loss of flavor and the introduction of bad or “off” flavors.

The next stage at which a barista can have control over physical / chemical changes is in the grinding of the coffee beans. We must remember that many of the negative changes