

Mark Miodownik

The sound of materials



We live in a visually orientated culture, and so it is natural, when talking about a beautiful city, to allude to its visual qualities, such as a haunting skyline or a maze of cobbled streets. We judge people similarly, with fashion magazines full of men with chiseled jaw lines and women with hair like wild straw. But our relationships with people are not based solely on looks, we care how they smell, how they feel, how they warm us, and how they sound. The same is true of our relationship with our cities, and our environment in general.

We know the sounds of the doors in our houses, and can distinguish between someone leaving or entering from the subtle differences in keys rattling and hinges creaking. As a child, I could always tell whether it was my mother or my father coming up the stairs from the subtle differences in the sound of the creaky stairs. These acoustic qualities of a home are important but often overlooked in bouts of home improvement. When we carpet over the tiles in the hall, we make it feel warmer, but lose our ability to announce our choice of footwear to the rest of the house. The click-clack of high heels and the imminent cocktails that they imply are no longer announced to those slumbering on the sofa. The squeak of rubber tennis soles is banished and the comforting solid thump of sensible shoes on their way to work is no longer proclaimed. Installing carpet in the hall is a kind of auditory gag that stifles a house's launch pad into the world.

Sounds are no less important in that other launch pad of our life, the bedroom. The loss of sprung, squeaky bed frames and their sensual symphonies is surely a great loss to the human sexual psyche, and is perhaps implicated in the population decline of Western Europe. Hotels too have suffered from acoustic vandalism. Each time a lock is replaced with a card swipe we lose the sound of metal sliding and clicking permission for you to enter. Hotel rooms with card entry feel less secure without the reassuring sound of a steel bolt grunting its guard-like obedience. Good architects know about the importance of auditory signatures and put as much attention into how a building will sound as to how to will look. The architect and musician Daniel Libeskind tests his designs for their acoustic qualities and this is one of the reasons he was chosen as the architect of the new 9/11 memorial in New York.

The materials science of acoustic properties has a long and interesting history starting from the early design of musical instruments. Brass trumpets range from very hard nickel silver, through to softer red and yellow brass, and onto to an extremely soft ambronze (copper, tin, zinc) alloy. The pitch of instruments is linked to the modulus and density, whereas the 'brightness' of an instrument is linked to its loss coefficient, allowing higher overtones in the musical spectrum. Softer alloys tending to sound warmer and duller; lead is an extreme case, it is so dull that trumpets made from lead can be used as a treatment for insomnia.

Designing the acoustic properties of materials for instruments is thus a strange combination of art and science in that it must take into account the musicians cultural sensibilities and musical taste, but also have a handle on the fundamental materials science of manipulating density, hardness, and modulus while producing an alloy that can be formed or cast into the instrument's shape. The sophistication of church and clock bell design is a good example of this, with artists, musicians, and metallurgists all involved in designing unique sounds for civic buildings; sounds that embody the activity within the building. The sound of Big Ben in the Houses of Parliament in London is a good example of a bronze auditory signature of democracy; it is measured, grave, and earnest. Sets of bells with unique peals have been culturally important throughout history, not only signaling time, but ringing out declarations of love on wedding days and warning of danger in times of war.

Despite their contemporary importance, brass and bronze instruments feel very 17th century. Surely the 20th century has something to say on the materials design of musical instruments? The answer is yes and no. Mostly no. Unlike tennis and golf professionals, the virtuosos of the music world haven't been that impressed with the qualities of carbon fiber or new titanium alloys. This may have been mostly for cultural reasons, but there was another factor too, and his name was Jimmy Hendrix.

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