

Silicon Movement

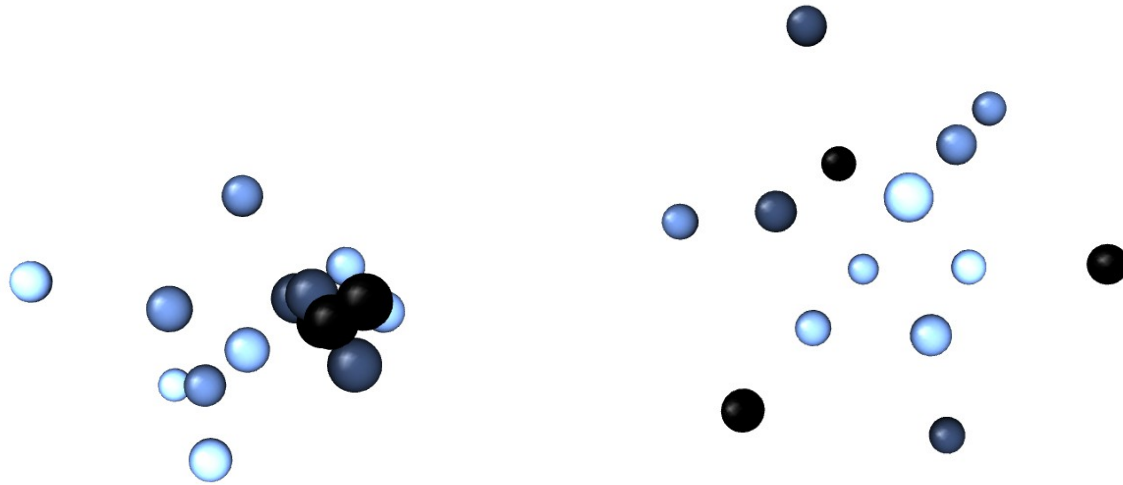
After oxygen, silicon is the second most common element on Earth. The planet's crust is largely made up of silicate minerals, like quartz, which contain atoms of silicon and oxygen bonded together in intricate crystals. By comparison, the pure elemental form of silicon is much rarer in nature. The super-flat, shiny, and exceedingly pure silicon wafers that we use for electronic components are only a recent human invention. They are produced by refining silica sand into pure blocks of silicon, which are sliced into thin sheets (about the thickness of a human fingernail) on which electronic circuits can be etched. Over the past half century, these silicon wafers and their embedded circuits have provided the literal backbone supporting the rapid growth of digital technologies around the globe.

The semi-conducting properties of silicon have made it an essential building block for ever denser electronic circuits, which can switch current on and off at extremely high speeds. The three-year old laptop I used to compose the silicon movement of the *Heavy Metal Suite*, contains several billion transistors. Today, a processor chip in a new laptop has 20 billion or more transistors. This density of transistors is starting to approach the number of neurons in the human brain (about 100 billion). Although a transistor isn't a neuron, the scale of the circuitry that can be built with silicon is nonetheless remarkable. Equally remarkable is silicon's ability to harvest energy from the Sun. Silicon wafer technology is used in 95% of the solar panels in the USA, and solar power is increasing rapidly as a renewable energy source, currently providing as much commercial electricity as the country's entire hydroelectric supply.

My home near the San Francisco Bay in northern California is in Silicon Valley, one of the world's great research and development hubs for digital technologies. Despite the name, no silicon is actually mined or processed in Silicon Valley. It is a place for mining of a different sort, known worldwide for its deposits of cash (not sand) and synonymous with techno-investment. The history of this region has been shaped, time and time again, by change and upheaval from earthquakes, mountain building and sea-level rise, and also colonialism, climate change and globalization. All of these forces, whether slow-paced or cataclysmic, natural or human, have made the place what it is today; an area with stories that need to be told. On the surface, it is a resplendent, affluent place. Without reflection, you wouldn't know that its ancient trees had been completely clear cut, its animals wiped out, and the first inhabitants horrifically ill-treated.

Before computers, Silicon Valley was the home of Indigenous populations who, for millennia, used silicon in its natural mineral forms for tools and other purposes. Spain's colonization of Alta California caused abrupt, extreme upheaval, initiating several centuries of subjugation and displacement of Indigenous peoples, and wanton resource and labor extraction. The story of this colonialism has been largely silenced in the dominant historical narrative. But that is now slowly changing, as descendants of the early inhabitants are driving an awareness of the dynamics of exploitation and consumption, world political economies, and the limits of nature's resources and resilience.

The silicon movement of the *Heavy Metal Suite* was inspired by the properties of two substances; sand and pure silicon. As a starting point, I created 3D software models representing the chaotic distribution of sand grains (left image below), as compared to the regular lattices of silicon atoms in its pure form (right image below).



To represent these graphical designs in a musical form, each point in the diagrams was translated into features in the scores for each member of the brass quintet. The models are allowed to change over time as their particles move around, resulting in detailed melodies, rhythms, dynamics and articulations, with interlocking ensemble textures following the changing geometries of the grains and atoms. For example, a blue sphere in the graphic above represents an event assigned to the horn part. As time advances, its position changes, providing new spatial coordinates that produce new musical information. One spatial coordinate might be mapped to loudness, as a compositional choice that depends on where we are in the unfolding music. Further along, the same blue sphere might instead produce an element of a rhythmic motive. The movement's overall form is a contrasting sequence of motifs derived from the sand and lattice models, and these motifs are tied together by the fundamental property of silicon – it's (semi)conductivity, following the motif written by Augusta Reid Thomas.

If Silicon Valley itself has a form to draw upon, it should include the stark juxtapositions in a turbulent history. Unlike the smooth shiny surface of highly-refined silicon wafer, or a real estate depiction of the "good life", the truth underneath is bumpy and wrinkled, filled with interesting textures of an Indigenous world that has largely been undone and glossed over. The theme, and the software models used in this movement, are my musical carriers for the Valley's millenia, its turbulent recent centuries, its high-speed present, and even some whispers of its possible future.

The ambiguity of interpretations from music back to its primary subject is one essence of the art form. The same music can mean different things to different ears, and even to the same listener at different times. Sometimes, music can even convey different messages at the same time. Listen to the Silicon movement for reflections of the Valley, how its living and natural resources have been eroded or blended together, or perhaps forgotten altogether. The change of form and shape is a fundamental property of the natural world, and of human civilizations; how stones become sand, and eventually how the sand becomes the silicon wafers that have shaped our world.

[Khrushchev Visits IBM: A Strange Tale of Silicon Valley History](#)

[Native American Response and Resistance to Spanish Conquest in the San Francisco Bay Area](#)

Gustavo Adolfo Flores Santis, Native American Response and Resistance to Spanish Conquest in the San Francisco Bay Area, 1769–1846, MA Thesis, San José State University (2014)