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«[...] vibration may be defined as a phenomeno-technique, an epistemology of process in which phenomena are always mediated, not pure, and constructed through differential processes of interiorization and exteriorization.»

SPATIALISING IMPONDERABLES Clemens Finkelstein

Clemens Finkelstein, born 1988, is a PhD candidate in the History and Theory of Architecture at Princeton University, where his dissertation «Architectures of Vibration» renders modern architecture's complex relationship with the phenomenotechnique of vibration. His work engages the built environment at the junction of art and architectural history with the history of science and technology and has been supported by the History of Science Society and the Princeton-Mellon Initiative in Architecture, Urbanism & the Humanities. He is a Fulbright Scholar (Harvard University, 2015–2017).

The epistemological category of the «imponderable» — meaning, weightless — fluids emerged around 1800, as several natural philosophers puzzled over a wide range of physical occurrences. Where recourse to «ponderable» matter could not fashion adequate explanations, imponderables were rallied to define phenomena like cohesion, chemical affinity, light, heat, gravity, electricity, or magnetism, even life itself.⁽¹⁾ Although skepticism accompanied their ideation from the beginning, experimental philosophy frequently isolated imponderables when describing action at a distance, that is, physical objects that cause material effects in other objects ghostlike across presumably empty space. For instance, ether — «a material substance of a more subtle kind than visible bodies, supposed to exist in those parts of space which are apparently empty»⁽²⁾ — sustained its relevance as an imponderable and vibratory carrier substance for energy well into the twentieth century.

Vibration emerged alongside imponderables as a phantasmal boundary object that coalesced concrete physical and abstract metaphysical characteristics. As the physical disturbance of a body of fluid or semi-solid matter that registers and reacts to energy (force) by fluctuating, it materializes as waves that travel through a medium from point a to point B. This transformative, roaming quality connects to vibration's imponderable dimension. Except for a small range of sonic or tactile frequencies, vibration largely eludes the human sensorium while affecting organisms' physiological and psychological constitution on a broad spectrum. The phantasma of vibration thus forcefully roamed the scientific and cultural imaginaries of the nineteenth and twentieth century. The following four vignettes sketch brief episodes of a more extensive history that illustrates how architecture engaged and harnessed the phenomenon of vibration as an epistemic force and converted its boundary-permeating properties into a design technique. Accordingly, vibration may be defined as a phenomenotechnique, an epistemology of process in which phenomena are always mediated, not pure, and constructed through differential processes of interiorization and exteriorization.⁽³⁾

I TRACING THE ANTHOPOGENIC INTERIOR

Drastic environmental transformations characterized the modern metropolises of industrialized societies at the turn of the twentieth century. Exponentially growing numbers of motorized vehicles, electro-mechanical machinery, and novel building types such as skyscrapers, powerhouses, or industrial plants generated or absorbed immense rates of physical vibrations. These accumulated in the built environment, densifying into an otherwise invisible specter whose disorienting and dismantling properties haunted anyone or anything in its zone of influence. Lending credence to this psychological and physiological transgression, the American historian Henry Adams recalled his involuntary exposure to this toxic environmental condition, leaving him «to be nothing but a conscious ball of vibrating motions, traversed in every direction by infinite lines of rotation or vibration [...] A center of supersensual chaos.»⁽⁴⁾ In 1904, the French physician and parapsychologist Hippolyte

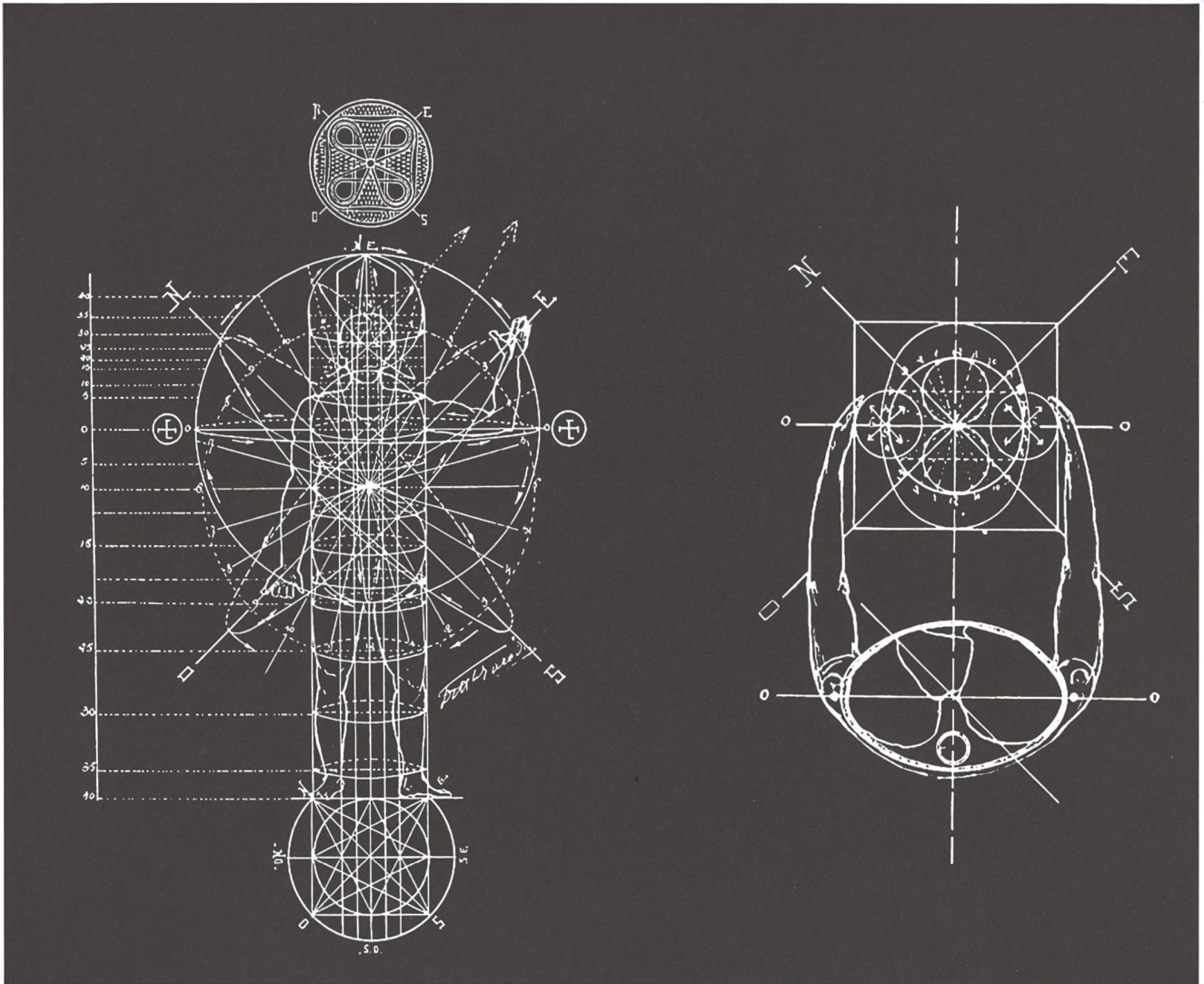
Baraduc correspondingly revised the classical Vitruvian figure — contained within and flattened by the two-dimensionality of its perfect circle and square — to reflect the modern shift enacted by the spatial and temporal spheres of ether (zoéthérique) vibrations.^(fig. a) These, Baraduc argued, permeated the human body at multiple points and all axes, gyroscopically spinning inside a four-dimensional cosmogonic square (carré cosmogonique) to synchronize the exterior vibrations of the environment and the cosmos with the interior polarized life forces and the transdimensional spirituality of the human.⁽⁵⁾

Uncontained, vibration permeated bodies, objects, and environments regardless of material envelopes such as soil, wood, concrete, or flesh that otherwise differentiated physical entities. Nineteenth-century physiologists like Claude Bernard or Ernst Haeckel even explored vibration's biological features in the cellular fluid «protoplasm» («Urschleim», «Sarcode»), which, they postulated, recorded environmental conditions as vibrations, passing adaptive characteristics on to offspring as vibratory coding.⁽⁶⁾ German biologist Jakob von Uexküll similarly negotiated this «vibrating nuance of being» describing vibration as an «Urelement» (primordial element). This original planetary force/matter sustains life-giving, form-producing processes connecting the organic and the inorganic, the animate and the seemingly inanimate.⁽⁷⁾

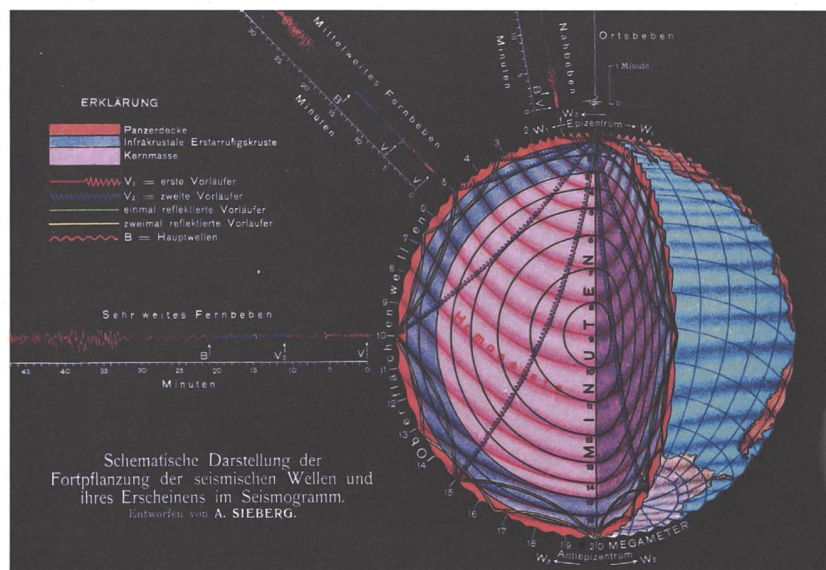
Combined with its material/immaterial superposition, vibration's pre-historical, pre-architectural characteristics potently enthralled Germanophone space theories in art and architecture at the turn of the century. Defining architecture as «Raumgestalterin» (creatress of space) and tectonics as its synthetic science, German-writing historians of art and architecture like Hildebrand, Riegl, Schmarsow, Vischer, and Wölfflin posited space formation to be elemental in the formulation of modern identity. It was conditioned, they argued, by the human organism's alliance with the «Schwingungen» (vibrations) of physical and metaphysical dimensions, mediated by architecture as a growing «Lebewesen» (living being) that ought to attune bodies and objects symbiotically to their changing environments.⁽⁸⁾ Entangling nineteenth-century physiology and psychophysics, twentieth-century physics, and earlier metaphysics of vibration, the hybrid figure of the architect-engineer emerged to conceive of architectural systems equipped for balancing the relationships between dynamic and static structures. Avantgarde institutions like the Bauhaus in Germany were instrumental in shaping this new mediator. Siegfried Ebeling's «Der Raum als Membran» (1926), for example, conceived architecture as «cosmological space-cells» — semipermeable, dynamic membranes that attuned human dwellers on the inside to the environmental condition of the planet outside.⁽⁹⁾

II TRACING THE PLANETARY INTERIOR

In 1898, Emil Wiechert assumed the world's first Chair of Geophysics at the Georg-August-Universität in Göttingen, Prussia. The geophysicist soon ventured to establish the rural enclave as a global supernode in the exponentially growing



(fig. a) Carré cosmogonique. Hippolyte Baraduc, Les vibrations de la vitalité humaine: Nerveux, sensitifs, névrosés, Paris 1904



(fig. b) Schematic representation of the propagations of seismic waves and their appearance in seismograms. August Sieberg, Der Erdball, seine Entwicklung und seine Kräfte, Esslingen 1908



(fig. c) Telegeodynamics, Nikola Tesla.
Image: collage by the author, illustrations unknown ⁽²¹⁾



(fig. d) Jimi Hendrix's Electric Lady Studios, acoustic multimedia «propeller»,
New York City, c. 1970. Image: Courtesy of John Storyk

network of planetary sciences that sought to deduce the Earth's interior structure through seismic vibrations. These disciplinary developments owed to the visionary contribution of Prussian astronomer-cum-seismologist Ernst von Rebeur-Paschwitz. On April 17, 1889, Rebeur-Paschwitz accidentally recorded seismic waves that originated 9,000 km (5,500 miles) from the Astrophysical Observatory in Potsdam, Prussia, and 45 minutes before his delicate horizontal pendulum sensed them at 5:21 pm. The vibrations had traveled from Japanese earthquake faults near Tokyo through the Earth's crust to Potsdam at 3,060 meters per second, providing the first proof for teleseismic events — vibrations dissipating while deforming the planetary body that pulses, in the words of seismologist Cargill Knott, «like a beating heart.»⁽¹⁰⁾ This discovery caused paradigmatic shifts in knowledge about the planet obtained through the physical phenomenon of vibration, altering fundamentally how modern science and architecture engaged the medium. What had previously been the ultimate obstruction to precise scientific observation, suddenly became geophysics' defining epistemological tool.^(fig. b) This turn was mirrored in architecture. Practitioners like Paul Emanuel Spieker recently innovated the structural design for scientific compounds such as the Astrophysical Observatory (built 1876–1879) to provide vibration-free environments.⁽¹¹⁾ Attention crucially shifted from insulating against parasitic exterior pulsations to isolating the symbiotic interior vibratory energies of the planet for study.

While geophysicists conceived buildings as regulatory milieus for unraveling the Earth's interior structure through seismic vibrations, architects absorbed geophysics' spatial logics to design responsive environments that mediated the transgressive vibrations of modern life. Its critical mechanisms (coherence/decoherence) analyzed natural vibratory phenomena or reproduced them artificially to obtain knowledge about materials and spatial bodies, applied vibrational technologies in architectural constructions, and managed Earth's atmospheric features to gain control over the planet.

III TRACING ENVIRONMENTAL BOUNDARIES

In an interview from 1935, the aging futurist Nikola Tesla excitedly recalled a failed experiment that sought to conjoin the natural vibration of an architectural structure with the artificially produced vibration of a machine: «I was experimenting with vibrations [...] I had one of my machines going, and I wanted to see if I could get it in tune with the vibration of the building. [...] Suddenly all the heavy machinery in the place was flying around. I grabbed a hammer and broke the machine. The building would have [...] [collapsed] in another few minutes. Outside in the street, there was pandemonium. The police and ambulances arrived. I told my assistants to say nothing. We told the police it must have been an earthquake. That's all they ever knew about it.»⁽¹²⁾

Tesla's earthquake machine, a steam-powered electro-mechanical oscillator, first introduced at the Chicago World's Columbian Exposition in 1893, gained its mythical moniker

after the near-catastrophic 1898 experiment in the engineer's New York City laboratory at 46-48 East Houston Street. There he had attempted more than once to tune the isochronous vibrations of his pocket-sized device to the unique resonance frequencies with which the building naturally vibrated. The oscillator connected via a steel link and transferred vibrations to the architecture, which quivered «until it dilated and contracted like a beating heart.»⁽¹³⁾ «Vibration will do anything»⁽¹⁴⁾ Tesla concluded, whether empowering him to raze the Empire State Building with five pounds of vibratory force or transform the Earth's lithic crust into a mechanical power transmission system of telegeodynamics.^(fig. c)

IV TRACING THE ARCHITECTURAL INTERIOR

Responsive environments — both object and method — were a trenchant theme in the architectural discourses of the 1960s and 1970s.⁽¹⁵⁾ Omnipresent in the psychedelic experiments of American counterculture as much as in the cutting-edge science of quantum mechanics or the cybernetic theories of biomechanical feedback, vibration gained renewed momentum at the time due to its transformative, transmaterial qualities, further unlocked by increasingly ubiquitous mediatechnological devices.⁽¹⁶⁾ And while multimedia artists Jackie Cassen and Rudi Stern turned the exhibition space of the Architectural League of New York into a responsive entity via their kinetic light installation «Environment V: Vibrations» (December 14, 1967 — January 13, 1968), musician Jimi Hendrix sought the young designer John Storyk to construct an «architecture of vibe.» In 1969, exhilarated by the responsive environment that Storyk had created a year earlier for the experimental nightclub Cerebrum in SoHo, Hendrix hired the twenty-four-year-old to transform the property he had just leased at 52 West 8 St, the basement of Frederick Kiesler's 1929 designed Film Arts Guild Cinema, into a personal recording studio.^(fig. d)

What is this «vibe» that led Hendrix to hire someone with no expertise in architectural acoustics to design his creative dwelling? Frequently reduced to its symbolic dimension — immaterial, invisible, purely qualitative, metaphysical — vibe's imponderable nature is rooted in the material physics of vibration. «To vibe» meant to either «transmit or express (a feeling, attitude, et cetera.) to others in the form of intuitive signals or «vibes» or «to perceive on the basis of such signals.»⁽¹⁷⁾ The increased linking of architectural space to vibe quickly transitioned from a descriptor of placeness — the quality of occupying a particular locality — to being densified into an exportable substance, an engineered affect. Produced by a systemic alliance of mediatechnological devices and architectural design, vibe could be performed and adapted in various locations. «What gives a vibe «authenticity»» argues literary theorist Peli Grietzer, «is its ability to evoke — using a small number of disparate elements — a certain time, place and milieu; [...] a systemic, structural gestalt representation of a worldly set whose vibe it idealizes.»⁽¹⁸⁾ This mode of remodeling elucidates the synthetic properties of vibe, emphasizing its proximity to architecture in worldmaking.

Echoing the contemporaneous concretization of vibe/vibration as a cybernetic element, Hendrix was obsessed with discovering a new abstract universal (musical) language that could reach individuals across apparent linguistic or cultural divides and evoke responses at an elementary level. To capture the imponderable qualities of vibe, he tasked Storyk to design an architecture where his unique creative vibe could be fostered and captured, musical vibrations recorded, everything enhanced and ultimately disseminated. Hendrix, unfortunately, died in 1970 before his Electric Lady Studios fully emerged as this architectural catalyst of vibe.

FAST FORWARD » METAVERSE

Emulating the elusive, oscillating characteristics of vibration, with its inherent capacity for essential transformation (for example, from vibration to vibe), the above vignettes are an experiment in teasing an extensive research project in progress. Neither architecture nor science delimits their engagement with the spatializing imponderable to the historical episodes or geographic locales described. Vibration instead sustained its transmedial character — always at the edge of phantasmal precarity — well into the twenty-first century. Whereas avantgarde artists and designers such as György Kepes, taking early stock of the twentieth-century environment in 1944, discerned «kaleidoscopic vibrations» as the reason for its incomparability «with any environment of the previous age» vibration is well underway to unfold its phenomenotechnical properties further in the contemporary.⁽¹⁹⁾ This ranges from doppler-laser vibrometry, computer-vision aided measurements aimed to reveal the vibratory emissions of the built and natural environments, to tech giant Meta's embodied internet, the «metaverse.» Seeking to trick the human brain through bodily vibratory signals into experiencing the metaverse's virtual architecture, including the materiality, texture, or weight of objects, Meta's VR/AR subsidiaries such as Meta Quest (formerly Oculus Quest) currently develop vibratory extensions such as force feedback haptic gloves — expanding, by the way, on cybernetician Norbert Wiener's «hearing glove» that already translated sonic to tactile vibrations in 1950.⁽²⁰⁾ Inverting natural philosophers' stride towards explaining physical reality via auxiliary imponderables around 1800, Meta sources the transsensorial, transmaterial properties of vibration to blur distinctions between objective or virtual reality and bridge human perceptual channels as means of sensory substitution. Tesla's words forebodingly echo a preliminary conclusion: «Vibration will do anything.»