CULTURAL VALUE AND EVOLVING TECHNOLOGIES: INSTANCES FROM MUSIC AND VISUAL ART

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Abstract: *Scientific advancement is inextricably linked to cultural advancement, and historically the arts have worked hand in hand with technological change. This essay explores some of the connections that exist between science, technology, and the arts, privileging instances where technological change resulted in new forms of artistic creation. Although the role of the arts in contemporary society has ebbed in comparison to that of technology and science, the essay argues that quality, meaningfulness, and longevity are key components in how the arts can retain cultural value in today's technocentric world. It explores significant instances from the history of music and visual art as the authors make the case that the methods of science and art are both distinct yet commensurate in their ability to shape the values and ideas of contemporary society.*

KEY WORDS: arts and culture, tuning, notation, photography, technology

I. Introduction

In the discipline and history of Western music, technical ideas and language are part and parcel of a nexus where notation, tuning, scale, and instrumentation are fundamental elements of the creative act. Similarly, scientific advancements such as mathematical perspective, optics, anatomical dissections, and photography—together with the objective observation of nature—have profoundly influenced the visual arts. These features and methods signify some important connections that exist between science and art—that is, with how one field affects the other. There is, of course, an impressive corpus of existing literature on this subject.[1] However, this essay not only discusses ways in which changing technologies influence artistic production, but more significantly, how such evolving modalities speak to

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[1] A few examples include Martin Kemp, *The Science Of Art: Optical Themes in Western Art From Brunelleschi to Seurat* (New Haven, CT: Yale University Press, 1990); Hans-Joachim Braun, *Music And Technology in The Twentieth Century* (Baltimore, MD: Johns Hopkins University Press, 2002); Caroline A. Jones and Peter Galison, eds., *Picturing Science, Producing Art.* With Amy Slaton (New York: Routledge, 1998); Judith Collard, ed., *Vision and Its Instruments: Art, Science, and Technology in Early Modern Europe* (University Park, PA: Penn State University Press, 2015).

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the *values* associated with cultural output in the aesthetic sphere, a viewpoint not dealt with adequately in previous investigations. More precisely, we explore a number of instances from music and the visual arts where (a) technological or scientific advancements led to new forms of artistic creation, in order to (b) highlight how those developments/examples affected certain cultural values as a result of that exchange.

The topic here is rich, but complex. Scientific advancement is inextricably linked to cultural advancement, and historically the arts have worked hand in hand with technological change. Yet, what do we mean by the term "culture," and how does it relate to the concept of "cultural value"? What does culture have to do with the arts, and how closely are the arts tied to the values that a given culture holds? Finally, what might some of those values be? Are they exclusively aesthetic, or do they include other avenues of social life? We draw on a variety of voices past and present in order to address these questions. Both the material objects of creative performance and representation, as well as the theoretical approaches that inform their experience and meaning, are involved. Indeed, while science and the arts are intricately entwined, they also represent two distinct methodological perspectives: one grounded in rationality and objectivity, the other more laden in emotional and subjective experience.

This epistemological distinction speaks to the cultural values at work in understanding the importance that the below examples entail. As technologies progress to create new forms of artistic expression—or put another way, as new technologies allow artists to express their creativity in different or innovative ways—the issue emerges as to whether these artworks are valuable over and above any novelty they possess. Technological advancement does not necessarily guarantee artistic advancement. Novelty, while important, only goes so far. In this discussion, we privilege the aesthetic values of quality, meaningfulness, and longevity as fundamental components of a successful work of art. These aesthetic standards act as a primary lens through which we understand how science and technology impact artistic production on the cultural level. They blend together as a society evaluates an artwork (for example, quality art typically tends to be meaningful, which then contributes greatly to its ability to transcend generational boundaries). While other aesthetic standards exist, and these values are not without their detractors—particularly those that challenge the concept of "high culture" as elitist and exclusionary—we demonstrate below that the aesthetic ideals of quality, meaningfulness, and longevity play a large role in whether an artwork has the capability of representing the values a culture holds.

Moreover, we ask whether these aesthetic values relate to any wider cultural values at work with respect to the arts and scientific or technological advancement? The answer to this question requires an investigation into the opposing, but also intertwining, epistemological viewpoints that art and science represent. For, in the present day, science and technology maintain a prestige, authority, and instrumental effectiveness that in many

ways overshadows the intrinsic value—we contend—the arts retain.[2] There is a sense in common culture that science and technology point to the future, while the traditional arts index the past. Twenty-first-century culture, both Western and non-Western, places a premium on what technology can do and what science can tell us about the world. So much so, that the arts and humanities spend a good amount of time justifying their existence in contemporary life and discourse. Understanding this broad dynamic helps to ground and frame this discussion, which reflects on science, technology, and value from the point of view of the arts and their cultural worth.

II. Music and Art: Technics and Beginnings

In the visual realm, our capacity to create art is likely tied to our concomitant abilities in linguistics and toolmaking, as scientists have identified a neurological connection between visual creativity and language.[3] Moreover, "As this includes artistic creativity, evidence of the increasing sophistication of tool technology, as well as evidence from crania of increasing brain size, suggests that our ancestors had the ability to create art or proto-art much earlier in evolution than is suggested by current knowledge of art-related artefacts."[4] It appears, then, that the origins of art as we understand it today go back millennia, further even than what the earliest known cave paintings imply.

This does not seem surprising. On the ethnological level, the artist and scientist both deal in technology. They belong to the distinct human group known as *homo faber* ("Man the maker or creator"). As George Kubler claims, they are of a kind, more similar to each other as artisans than they are to anyone else.[5] If this appears dubious, he further reminds us that "Tools and instruments, symbols and expressions [that is, art] all correspond to needs, and all must pass through design into matter."[6] Particularly in the visual arts, it is important to keep in mind that the concept of art is tied to the Greek word *technê*, which is translated as either "craft" or "art," and refers to "the skill and know-how by means of which artworks—and everything else—are made or organized."[7] *Technê* is a word that references the close connection between modern technology and aesthetic artifacts, insofar as they are both objects that humans create for instrumental purposes. So whatever

[2] Although, some have challenged the hegemony this statement implies. See Steven Yearley, *Science, Technology, and Social Change* (London; Boston: Unwin Hyman, 1988), 29–36.

[3] Dietrich Stout, Nicholas Toth, Kathy Schick, and Thierry Chaminade, "Neural Correlates of Early Stone Age Toolmaking: Technology, Language and Cognition in Human Evolution," *Philosophical Transactions. Biological Sciences* 363, no. 1499 (2008): 1939–1949.

[4] Gillian M. Morriss-Kay, "The Evolution of Human Artistic Creativity," *Journal of Anatomy* 216, no. 2 (2010): 159.

[5] George Kubler, *The Shape of Time: Remarks on the History of Things* (New Haven, CT and London: Yale University Press, 1962), 11.

[6] Ibid, 10.

[7] Henry Staten, *Techne Theory: A New Language for Art* (New York; London: Bloomsbury Academic, 2019), 4.

other definition one might attribute to the term "art," whether in the many esoteric debates on the subject or its manifold uses in the discourse of modern life (for example, think of "the Art of Cooking" or "The Art of War" or "Zen and the Art of Motorcycle Management"), on the most basic level it means "skill."

The same primeval background and definitions obtain in the aural arts. Music has been with us since the beginnings of humankind. There must certainly have been musical analogues to prehistoric cave paintings. Indeed, there is growing evidence that acoustics were an integral part of the visual aspect of prehistoric parietal art. Scientists contend that "acoustics offers a compelling explanation for the location of paintings in chambers deep inside caves, because these chambers have special acoustic properties; [which explains] the clustering of paintings in certain areas of the cave wall, because they are acoustic 'hot spots.'"[8] Of course, we have no idea what this music sounded like, as music was always of the moment in which it transpired, until the nineteenth century.[9] But before this occurred, there were only two methods of transmitting music from one person to another. In non-Western communities, this was mainly done by rote. A master would play musical material and the student would memorize it. Into the past century, this is exactly how all dance steps were learned for ballets—from the master to the student. For the musician, this requires a very high degree of musical cognition, and for a dancer, kinesthetic memory. We surmise that those who now can memorize vast amounts of musical material are akin to those who in the past memorized our sacred texts long before they were written down, as music helps the memorization of words.[10]

The origins of music lie in the human voice, in the sounds we create, and in our particular human hearing apparatus and its capabilities. The frequency range that we can hear is prescribed (dogs can hear higher than we do), and we hear differently in different ranges. Just as we developed tools to aid us in our quotidian activities—cutting, chopping, and so forth—we also developed our ability to manipulate matter that can create sound. The resulting items include those that can be hit or struck or plucked, such as wood, rock, the ground, and so forth, followed by the development of instruments made of strings (originally horse and sheep intestines), drums

[8] Shigeru Miyagawa, Cora Lesure, and Victor A. Nóbrega, "Cross-Modality Information Transfer: A Hypothesis about the Relationship among Prehistoric Cave Paintings, Symbolic Thinking, and the Emergence of Language," *Frontiers in Psychology* 9, no. 115 (2018): 315

[9] Thomas Edison is credited with inventing the phonograph, the first machine able to record and playback sound. A recitation of "Mary Had a Little Lamb," "Old Mother Hubbard," and someone playing the cornet was the recorded on June 27, 1878. Merrill Fabry, "What Was the First Sound Ever Recorded by a Machine?" *Time Magazine*, 5/1/2018. https://time.com/5084599/first-recorded-sound

[10] Bob Snyder has a detailed scientific study of the memory process in music. He identifies three memory processes—echoic, short-term, and long-term—that are related to three different time levels of musical experience: "event fusion," "melodic and rhythmic grouping," and "musical form." See Bob Snyder, *Music and Memory*: *An Introduction* (Cambridge, MA: MIT Press, 2000).

made of animal skins and wood, wooden slabs of different sizes and therefore varying pitch, reed and buzzed instrument (winds and brass), and of course air blown over a resonant chamber, leading to the flute. We see these instruments in Egyptian artifacts and paintings, and expressed in the Hebrew Bible. In Psalm 150, for instance, the Jews express their praise of God with the shofar (a trumpet-like ram's horn), harp, lyre, drum, lute, pipe, and various cymbals resounding and clanging, with some of these instruments borrowed from the Greeks.

Music also involves human interaction with the physics of sound. According to Roger Scruton, "Music is itself a special *kind* of sound, and not any art of sound is music."[11] Scientifically, we know that all sounds have frequency, or vibration. These vibrations must be picked up by the human apparatus of the ear and then processed by the mind. The basic materials of music are frequency (sound or pitch), rhythm (the articulation of sounds in time), timbre (or color), and volume (or loudness). All other musical parameters, including, harmony, melody, counterpoint (the combining of melodies), and orchestration, are human creations based on the more primordial nature of sound. It is a human response that very much calls into play the variable notion or decision of "what is pleasing to the ear," which can vary from culture to culture, as well as in one culture over time. For music to occur, sound had to be separated from "tone," and then a process of dividing that natural musical space had to emerge: namely, the octave (a 2:1 relationship of frequency). All cultures have done this in some shape or form. This process has created or involved notions of beauty, which have evolved or changed over time. The process also has been affected greatly by our increased ability to interact with the materials at our disposal, to bend them to our imaginative wishes, and to create instruments, which are extensions of our voice.

Pythagoras explored the nature, mathematics, and underlying properties of sound. At the same time, however, Grecian musicians were making music without needing to acknowledge his explorations. In fact, the ancient Greek aesthetic heritage has been an enormous factor in the visual arts, where musical nomenclatures permeate their understanding of the world and the often deeply emotional human relation to it. Important to Greek art and architecture were the aesthetic and mathematical values of *symmetria* (commensurability of parts that lead one toward "the perfect" or "the good"),[12] *rhythmos* (pattern—that which gives rational order to motion),[13] and *harmonia* (musical scale). For, according to Yale historian J. J. Pollitt, in virtually all endeavors the Greeks sought to achieve order (*kosmos*) in things

[11] Roger Scruton, *The Aesthetics of Music* (Oxford: Clarendon, 1997), 16.
[12] J. J. Pollitt, *Art and Experience in Classical Greece* (Cambridge: Cambridge University Press, 1972), 107.
[13] Ibid., 58.

to assuage a deep-seated anxiety at life's seemingly random, undefined, unmeasured, changes (*khaos*). In his treatise the *Canon*, Polykleitos detailed his use of *symmetria* as the best way to create the finest sculptural human bodies. For the Greeks, number and its ubiquitous properties help explain reality itself. As Aristotle claims, "The qualities of numbers exist in a musical scale (*harmonia*), in the heavens, and in many other things."[14]

The Western enterprise of music has for a long time been about journeys that can "move" from one place to another; it embodies the Western idea of progress and change through time. In the musical landscape, this is accomplished through various technical processes, which include: the use of notes in a scale or mode, and then the creation of a hierarchy of these notes, and thus the possibility for tension and release; moving from one set of pitches to another (in tonal music, modulation from one key area to another); the creation of architectural forms in sound, with beginnings, middles, and ends; the addition of chromatic notes (those found between the notes of the scale) that add tension to the passage of time as well as providing additional color; and language development over vast spaces of time that allow the composer to increase his emotional/intellectual input into the music.

Why explicate these technics of musical creation, as we do further below? Something over and above the mere appreciation of music is involved with respect to high art (or classical) music of the past and present (predominantly—but not exclusively—in the West). In previous centuries through the Victorian Era, musical ability was seen as an expression of good birth and good education. For better or for worse, it has been historically associated with the aristocratic, clerical, and scholarly classes. In these settings, a conversational knowledge of music was required for cultural discourse. In the Victorian Era, "[i]t was taken for granted that, at least among the intelligentsia, people both enjoyed contemporary music and understood it."[15] There still exists an acknowledgement of music's intrinsic value to society. Learning, performing, composing, and understanding music is not particularly easy, and there is a growing realization that the skills taught by the humanities (including art history) are valuable in today's hyper-technological and entrepreneurial society.[16] By demonstrating the technical elements of music and its creation, we can perhaps gain a deeper recognition of how the arts in general stand in relation culturally with the field of science and technology.

[14] Aristotle, *Metaphysics*, 1090 a 23, quoted in Pollitt, *Art and Experience in Classical Greece*, 107.
[15] Ruth A. Solie, *Music in Other Words: Victorian Conversations* (Oakland: University of California Press, 2004), 6.
[16] Timothy Aubry, "Don't Panic, Liberal Arts Majors. The Tech World Wants You," *The New York Times*, Aug. 21, 2017. https://www.nytimes.com/2017/08/21/books/review/you-can-do-anything-george-anders-liberal-arts-education.html; MaryAnne M. Gobble, "Innovation Needs the Liberal Arts," *Research Technology Management* 62, no. 2 (2019): 51–55.

III. The Arts, Culture, and Value

In present day intellectual circles, the terms "art" and "culture" are very often used synonymously. They are also aligned coextensively, with the inclusive operator "and" that merges the terms into one homogeneous field. Headlines in prominent publications demonstrate this coalescence, such as "How Art and Culture Can Help Us Rethink Time"[17] and "How Arts and Culture Fared in 2020,"[18] as well as the successful Google "Arts & Culture" online platform. Even though the individual terms retain their distinct semantic senses, exploring why they are so easily fused helps explain their relationship to the idea of value.

The definition of culture is somewhat plastic and all encapsulating. Its broad connotation allows it to act as a sort of palimpsest onto which individual disciplines can ascribe traits peculiar to their fields. For instance, for some in the business world, "culture is related to the relative strength of the relationship between personal attitudes and self-efficacy on the one hand and entrepreneurial intention on the other."[19] Similarly, "For digital humanists, culture is a field of the ever-expanding electrification and digitalization."[20] Although this latter definition seems somewhat hermetic to the Digital Humanities, its basis in technology is consistent with the ethnological notion of *technê* (art; craft) articulated above.

Moreover, if art has its beginnings in prehistory and skill in human societies, then its relationship to culture ought to similarly suggest some anthropological foundation. In her influential *Patterns of Culture*, social anthropologist Ruth Benedict states: "What really binds men together is their culture—the ideas and standards they have in common."[21] In a more expansive view, the American Sociological Association understands culture as "the languages, customs, beliefs, rules, arts, knowledge, and collective identities and memories developed by members of all social groups that make their social environments meaningful."[22] The Cambridge Dictionary of Sociology entry on culture refers to it as "the form, content, and effects of the symbolic aspect of social life."[23] Cultural anthropologists Bates and Plog's definition of culture has probably been the most stable over the last few decades: "The system of shared beliefs, values, customs, behaviors, and artifacts that the members of society use to cope with their world and with one another, and that are transmitted from generation to generation

[17] https://www.bbc.com/future/article/20190521-how-art-and-culture-can-help-us-rethink-time

[18] https://www.wsj.com/news/collection/arts-year-in-review-2020-c7c9d1a4

[19] Norris Krueger, Nabi Francisco, and Ghulam Liñán, "Cultural Values and Entrepreneurship," *Entrepreneurship and Regional Development* 25, nos. 9–10 (2013): 705.

[20] Piotr Celiński, "The Renaissance Roots of The Digital Turn," *Comunicacion* 34 (2016): 56.

[21] Ruth Benedict, *Patterns of Culture* (London: Routledge; Kegan Paul, 1961), 11.

[22] https://www.asanet.org/topics/culture. Last accessed 23 April 2021.

[23] Bryan S. Turner, *The Cambridge Dictionary of Sociology* (Cambridge: Cambridge University Press, 2006), 111.

through social learning."[24] We see in these descriptions why the term culture is so all encompassing. For the unifying theme here has to do with things that are *shared*, *collective*, *common*, and *social.* Indeed, for Peter L. Berger culture is a totalizing "human world" that we create for security and stability, a process in which we end up "creating ourselves."[25]

These definitions make clear that societal values and artistic/symbolic artifacts are an important aspect of culture. They highlight the intimate relationship between the objects we create (via skill, craft) and what they mean to us. In other words, we tend to create and value things that meaningfully express who we are and what we believe. The arts are a trenchant illustration of this tendency in that they are artifacts expressly created *to be* meaningful. These meanings can be intensely personal, while at the same time something that can be shared among many. They are simultaneously micro- and macroscopic. In fact, when one looks up the meaning of a word in a dictionary, the entry tells us what that particular (micro) word "means" in a more universal (macro) way to society in general.[26]

The notion of meaning is where the fields of art and science diverge methodologically. Ultimately, meaningful scientific knowledge is utilitarian in nature. Even speculative "theory of everything" research, such as string theory, seeks to be useful.[27] (See Section VII below on how speculative science and the arts intersect.) Science's technical value emerges in that it references phenomena that are predictable, controllable, and hence, useful. We need this objective knowledge in order to create the technologies that improve our lives. This is not exactly the case with aesthetic knowledge. The arts also improve our lives. Yet, we believe that aesthetic-oriented people tend to search for—and assert the importance of—finding meaning in the world. They do so by recognizing connections and interconnections and privileging the subjective, visceral, intuitive, or reflective reactions they instantiate. This is a universal faculty that we all share as humans. What is the nature of these connections? They are not austerely rational, but metaphorical, symbolic, personal, expressed quite often poetically. They are full of sentiment and various levels of emotion. There is an objective quality to them insofar as they index certain veridical attributes of one's experience. But in the end, we as humans find value in these experiences to the extent that they are personally meaningful: they tell us something about ourselves in the larger world we live in, just as they tell us something about the world we live in with respect to our inner life. In fact, a work in music,

[24] Daniel G. Bates and Fred Plog, *Cultural Anthropology* (New York: McGraw Hill, 1990), 7.

[25] Peter L. Berger, *The Sacred Canopy: Elements of a Sociological Theory of Religion* (New York: Anchor Books, 1969), 6.

[26] We acknowledge, but choose to sidestep here, the complex debate about meaning that the simplicity of this sentence evokes. A good place to start would be Gottlob Frege, "Sense and Reference," *The Philosophical Review* 57, no. 3 (1948): 209–30. Nevertheless, we believe that our observation stands on its merits.

[27] Lisa Grossman, "String Theory Finally Does Something Useful," *Wired*, September 2, 2010. https://www.wired.com/2010/09/stringy-quantum/

like most performed artistic artifacts, has a beginning, a middle, and an end. It is, therefore, a metaphorically representation of a life.

Science can go a long way in helping elucidate these interconnections. Scientific knowledge and aesthetic knowledge are akin insofar as they both are powered by human imagination. However, according to the philosopher of science Gaston Bachelard, for the former (rationalist) to come in tune with the latter (aesthete) entails coming to grips with the "poetic image." The process is phenomenological: "By this should be understood a study of the phenomenon of the poetic image when it emerges into the consciousness as a direct product of the heart, soul, and being of man, apprehended in his actuality."[28] The artifacts of music and visual art have been an essential and enduring tradition in this regard. Created in conjunction with various scientific and technological means, the arts have been a primary way for humans to culturally express their shared beliefs, viewpoints, and values, while also seeking to transcend that human community for something beyond. Given this analysis of culture, we begin to see why the aesthetic values of quality, meaningfulness, and longevity are so significant. Works of art and music (or any other creative outlet) that do not sufficiently exhibit these traits will tend not to adequately inspire the human heart and soul, or achieve an impact reaching the higher and wider plane of culture.

IV. Technology and Ideas in Music

Music has been a method of seeking community; musicians play *with* each other and *for* others; and from the beginning a formalized way for this to take place was needed. The systematized mechanisms to do this have changed from the primitive to the more sophisticated, from something presented orally to a written artifact, and from the less to the more personal. This has been accomplished due to a number of technical advances, including notation, scale, tuning, and instrument creation and development. Below, we delve into some of the technological aspects of music in order to explicate how these elements have affected musical composition. These mechanical processes helped Western music in particular achieve the high level of quality and meaningfulness that has made its classical music tradition culturally enduring.

Notation is the means of writing down the manifestations of the mind's creation. Music is thought in sound, and the ability to write these thoughts down took a long process of testing and experimentation. Human ingenuity gradually developed solutions to the problems of carving up, dividing, and sculpting time. Pitches—discrete frequencies of sound in some relationship to each other—were designated as high and low. Thus, a discrete system of lines and spaces written on a page came to serve as defining pitch space.

[28] Gaston Bachelard, *The Poetics of Space*, trans. Maria Jolas, reprint edition (Boston: Beacon Press, 1994), xviii.

Our five line and four space staff was a long time in coming, and was settled on only after trial and error determined what best suited the human eye and mind. A clef was created, which is a governing tool to define where a particular pitch would be found, and thus orients all other pitches around it. Rhythm also had to be described and defined, and then written analogues (or abstract graphics) had to be created.

On the techno-humanistic level, music, like speaking, developed out of a need to explain ourselves to each other. Both are, in fact, languages. Speaking and writing communicate matters of meaning, with greater or lesser specificity or clarity, and regarding matters mundane as well as those rich in meaning. Words work well for situations that are relatively simple: "John walks up the hill." "The dog ate the cat." They work well for the objective. They do less well for states of feeling, or the subjective. For this, music is a particularly fecund modality. Moreover, music is formed of ideas, similar to, but not exactly like, the ideas created with words. It hence bears some relationship to poetry. In fact, poems are generally written in a certain meter, which is a way to organize emotionally infused words musically. A single tone has little meaning, as does a single letter. But as these tones are put together their potential for meaning increases. As Roger Scruton notes, "Tones seem to incline towards each other, fall away from each other … To a certain extent they resemble words in a language, which are restless and ambiguous until surrounded by a completing sentence."[29] As these tones form phrases (sentences) and then multiple phrases (paragraphs), the possibility for greater meaning increases, until a small or large structure is created. Tones come in various frequencies, and the distance between any two—called an interval—can be found in various sizes inside of an octave. Any interval that is larger could be described as the interval plus the number of octaves. In the music of the West, the octave is primarily divided into twelve parts, or semi-tones. The distances of those semi-tones grouped together create smaller or larger intervals. Different patterns of semi-tones and whole tones (two semi-tones added together) within the range of an octave create modes or scales.

Furthermore, these scalar or modal patterns became somewhat fixed over time, and eventuated during the periods of the Baroque and Classical eras in the usage of primarily two scales, the major and the minor (our current popular music is by and large created with these scales). While the intervals of these scales are fixed in their ordering of half and whole steps, the *exact* frequencies tend to be altered slightly depending on various factors, including the arrangement of the patterns of the pitches and if a pitch sequence ascends or descends. These "tunings" are done quite naturally by singers and those playing string instruments (non-fretted). But for instruments like the harp and guitar, piano/organ and marimba, instruments plucked or

[29] Scruton, *The Aesthetics of Music*, 52.

struck, there can be no alteration of pitch. And thus the matter of tuning is of great importance.

It is thought that "just intonation" (a system of tuning)—calculated by different additions and subtractions of pure natural thirds and fifths, and primarily used for monody (a single line)—was used until about AD 1500. "Meantone tuning," a variant of this system, was used from approximately AD 1500 until the early eighteenth century, and emphasized major thirds, with the result that the tri-tone and certain chords (usually three notes played together) were quite out of tune. This resulted in a move to what is called equal temperament, a process "in which some or all of the concords are made slightly impure in order that few or none will be left distastefully so. Equal temperament, in which the octave is divided into 12 uniform semi tones, is now the standard western temperament …."[30] As mentioned, this did not happen overnight, but through a gradual process. It occurred for various reasons. As composition became more contrapuntal (the use of counterpoint, or blending of melodies), a better tuning system was required to "harmonize" the various independent parts. Then, as harmony itself (the simultaneous sound of notes together) became more important, an even newer tuning system was needed so that all of these chords sounded—more or less—in tune. This final development also became more necessary as composers wished to expand their compositional journeys to more-distant key areas, and to realize a wider emotional palette. While formerly done solely by ear, this tuning of equal temperament is now accomplished with the aid of a finely calibrated machine. It is interesting and salient to our argument that this involves, or can be defined quite clearly, with the technical language of mathematics. Equal temperament tuning is a compromise to satisfy the human ear. It also allows for the greatest compositional discoveries, and therefore, the emotionally oriented human understanding of musical beauty.

Why is all of this so important? It is a form of standardization that allows a larger number of performers to play together and in tune. For example, in the sixteenth century it would have been impossible to have the unlikely combination of guitar and clavichord (an early keyboard instrument) play in tune together without this standardization. Today, there are pieces written for the combination of guitar and piano (the clavichord's later relative). The development of the orchestra from its humble beginnings in the eighteenth century to its more complex and complicated form today would not have been possible without this tuning transformation. More importantly, it paved the way for creative journeys that were able to go further than ever before. This technical shift propelled Bach to write *The Well-Tempered Clavier*. While it is clear that his work was not specifically written for modern equal temperament, Bach was experimenting with various standards that could test the limits of any given tuning of the instrument and modern

[30] Mark Lindley, "Temperaments," *Grove Music Online* (2001). Retrieved April 20, 2021

equal temperament as well. Therefore, the work demonstrates the capabilities that this new tuning system provides and is a creative and scientific symbiosis of major proportions.

The twentieth and twenty-first centuries have seen bursts of energy in new ways of thinking about scale, or the lack thereof altogether. One might note scales of quarter tones, or the use of quarter tones as an expressive deviation in an otherwise tonal setting. This is certainly found in jazz, the blues, and rock and roll. Composers have also used just intonation, finding that it comports more closely to their sense of the music "being in tune." Examples are La Monte Young's "The Well-Tuned Piano" as well as Ben Johnston's String Quartets. One should also then mention the use of electronically created sounds, that might be better described by frequency rather than pitch, and concrete sounds, those that are found in the environmental—both natural and manmade—world. Disparate composers from John Cage, Milton Babbitt, Edgar Varèse, Olly Wilson, Karlheinz Stockhausen, Pauline Oliveros, Jacob Druckman, and Pierre Boulez to The Beatles and Miles Davis have made use of these new materials.

The human desire for greater expressiveness combined with technological development is also found in the creation of new, and the refinement of old, instruments. Let us take, for example, keyboard instruments. The early keyboard, the clavichord, was an instrument of limited sonic scope and volume. The harpsichord, which followed, was also prescribed in range, but had increased volume. As both instruments create sounds by the plucking of the string, there is a very narrow dynamic range. (Not so with the earliest of instruments, the lyre or harp, which is played directly with the hands, whereas all keyboard instruments rely, on its namesake, a key, to do the plucking.) Volume can only be affected by the density of the number of notes sounded. One should also keep in mind that each note sounded cannot be altered in frequency once struck, nor altered in the course of music performed (unlike with the voice or an unfretted string instrument, for instance, a violin or cello). The successor instrument to the harpsichord, the forte piano, is an instrument whereby the strings are struck (it is actually therefore a percussion instrument!) rather than plucked. This striking is affected by the force of the finger/hand/arm/body, and hence can be either softer or louder (piano means soft; forte means loud) based on the composer's notational designation. This capability allowed for a rapid change of volume, previously unheard of in a keyboard instrument, and a greater expanse of emotional range. As a result, the keyboard could finally duplicate the rapid changes or gradations of volume that are possible for strings and winds, which are directly affected by the physical relationship between the performer and instrument.

Moreover, the forte piano was followed by the concert grand piano, a product of the industrial revolution that is used to this day. For only with the use of a metal frame, forged and rigid, and metal and wound strings, could the instrument be held in tune. The change from wood to metal, or to the

addition of metal components also allowed woodwind instruments to play louder and in better tune. Also, volume increased exponentially to accommodate a composer's desire for a wider range of dynamics, and to fill the ever-larger concert spaces necessary to accommodate a burgeoning bourgeoisie. At the same time, the instrument expanded in register space, adding both higher and lower notes. The increased range was certainly done at the desire of composers to have more "space" with which to create, while at the same time technological and industrial advances in metallurgy allowed this to occur.

Something similar took place in the nineteenth century with the great expansion of new orchestral instruments. These include the Wagner tubas, the tuba itself, the heckelphone (a low oboe again thought of by Wagner), and those instruments of jazz: the soprano, alto, tenor, and baritone saxophones. In other words, individual instruments became families. To the flute and piccolo family were added the alto and bass flute. One might also add the horns, or brass instruments generally, when valves were added early in the century. These instruments, consequently, became fully chromatic (all half steps within an octave), and as a result their expressive potential exploded. This, again, allowed for the composer's imagination to construct music for these instruments that was never before possible. Indeed, with the addition of the concert grand piano, and then synthesizers, the orchestra grew to proportions and in sonic capability, both in regard to volume and timber possibilities, formerly beyond imagination. The expansion of the timbrel landscape is an example of the combination of the creative mind demanding sounds not heard previously, the creative craftsman coming up with solutions for such physical creation, and the general ability of the culture and the free economic system to support such creation technologically.

We conclude this section by noting that music, while not exactly having the rules or grammar of a language, is governed by a certain logic fundamental to its materials that lie in the possibilities of nature expressed through the human imagination. This is true no matter which instrument is played and how the music is actually written down or improvised. We thus might wish to say that music is not about an inquiry into the nature of the universe, or about the nature of sound itself, or even about disembodied sound. Rather, music is a medium in which a human describes emotion in sound, something about our interior world and our relation to the exterior world that cannot be located in words: a desire for self-understanding of who and what we are. The human musical impulse comes from this urge to capture something beyond those things that can be quantified. They are those impulses that include feelings such as joy, hurt, sadness, love, longing, desperation, impatience, contentment, and wonder.

V. Aesthetic and Cultural Values

Technological innovation has the ability to significantly alter the social conditions of a society.[31] Sometimes even a seemingly minor technical advance can reverberate so profoundly as to instigate a cultural paradigm shift. The invention of the metal stirrup in eighth-century Europe, for example, made possible mounted shock combat: a military structure that shifted martial importance away from axe-wielding footmen to heavily-armored knights carrying lances. The stirrup greatly improved lateral support for the rider, which fused him to his horse in such a way as to be able to inflict greater damage to an enemy than ever before. According to Lynn White, this created a new chivalric society that led directly to feudalism, to a political and social culture of cavalry "that was to endure for a thousand years," as society shifted its institutions, values, and customs to accommodate the monetary expenses needed to maintain expensive horses and armor.[32]

Has any similar technological innovation in the world of art resulted in such a consequential cultural change? Interestingly, the opposite occurred in the pictorial and sculptural arts as Western European culture emerged out of its classical past. In the world of late antiquity (roughly AD 150–750), medieval values became decidedly ecclesiastical. The Catholic Church—promulgated into the institutions of the Roman Empire when it became the official religion in the fourth century—dominated the political, social, and personal aspects of European life.[33] By the sixth century, the classical emphasis on the veristic and idealized human form had grown incongruent with Christian religious values. In a deliberate move away from paganism, the aesthetic and technical advances in naturalism of the Greek and Roman periods, in depicting the bodily form in such a heightened and privileged manner, were increasingly abandoned as prideful and self-centered. For Christians since Augustine of Hippo, the body and its earthly form became the seat of sin and corruption (lascivious, base, appetitive) and needed to be de-emphasized in order to focus one's heart and soul on spiritual values. Greco-Roman art that appeared to lionize humanity was eschewed, since "the human race is sick and sore … from Adam to the end of the world. And every child born from this tainted root is marked with original sin, so its punishment—misery on this earth, and death at the end of this mortal life—is the lot of every human being … "[34] Thus, in a reversal of technical and

[31] See Vyacheslav Stiopin, "Modern Technologies and Perspectives of Civilization," in *Technology and Cultural Values: On the Edge of the Third Millennium*, ed. Peter D. Hershock, Marietta Stepaniants, and Roger T. Ames (Honolulu: University of Hawaii Press: East-West Philosophers Conference, 2003), 17–25.

[32] Lynn Townsend White, *Medieval Technology and Social Change* (London: Oxford University Press, 1962), 6.

[33] Peter Brown, *The World of Late Antiquity: AD 150–750* (New York: Harcourt Brace Jovanovich, 1971), 86–89.

[34] Herbert A. Dean, *The Political and Social Ideas of St. Augustine* (New York; London: Columbia University Press, 1963), 18–19.

aesthetic accomplishment, the classical naked human form of avarice was hidden and draped in robes during the medieval period. Pictorial art became religiously didactic. The body was rendered generically in deference to the soteriological biblical teachings they illustrated. The technologically advanced large-scale bronze sculptures of antiquity ceased to be created. It would take a millennium for the artistic and technical successes of the Classical period to re-emerge in full force with the Italian Renaissance.

Of course, much has been written about the Renaissance in Europe (roughly 1350–1600) that need not be recapitulated in this essay. But for our purposes here, it was a time when larger cultural values (such as a renewed interest in rationality and humanism) aligned energetically with certain aesthetic values (illusionism, naturalism, and objective observation of nature). Technological innovations opened up a new world of knowledge for the artist, scientist, and society. Discoveries and inventions infused the creative guilds and aristocratic classes with a sense of generative and scientific excitement: the printing press, telescopes and optics, the New World, rediscovered Greek texts, anatomical inquiry, a heightened sense of individualism. With these, the static medieval model "would be blown apart … in an atmosphere permeated with new economics and new politics."[35] Starting with the proto-Renaissance Giotto, we see the skills of the artist, architect, and engineer sometimes collapse into one individual (the putative "Renaissance man"). For the proficiencies required of one profession closely aligned to those of the others. Leonardo, for instance, claimed that painting is a science (*scientia*):[36] "Those who become enamoured of the practice of the art, without having previously applied to the diligent study of the scientific part of it, may be compared to mariners, who put to sea in a ship without rudder or compass."[37] There was no hard and fast distinction between aesthetic, humanistic, religious, and scientific values. As renowned Leonardo expert Martin Kemp states, "No artist or scientist has ever possessed a sense of man in motion as a sentient, responsive, and expressive being."[38] For example, the psychological postures of the figures and his use of mathematical perspective in the *Last Supper* (1498), where orthogonal lines create three-dimensional space in order to focus our attention on the "Son of man," contained the unambiguous message that science leads humanity—with all its worldly failures and imperfections—closer to God.

The synergy between the aesthetic values and those of the larger cultural climate during this early modern period was generated by the quest for thinkers to understand nature and humanity's central place in it (that is,

[35] Kenneth J. Atchity, ed., *The Renaissance Reader* (New York: HarperCollins Publishing, 1994), xv.

[36] Frank Fehrenbach, "Leonardo's Point," in Collard, *Vision and Its Instruments*, 70.

[37] Leonardo Da Vinci and John Francis Rigaud, *A Treatise on Painting* (Newburyport: Dover Publications, 2012.), 49.

[38] Martin Kemp, *Leonardo da Vinci, the Marvellous Works of Nature and Man* (Cambridge, MA: Harvard University Press, 1981), 137.

humanism). Perspectival space and naturalistic figurative modeling were understood as veristic, scientific ways to express knowledge of the world based on how we actually observe it. Visual illusionism represented a desire "that the arts and sciences shared in their perpetual effort to understand nature through the eye."[39] It should not be surprising, then, that artists began using lenses and mirrors to create some of the most high quality, meaningful and enduring artworks of the time. Grounded in the Arab scientist Ibn al-Haytham's (eleventh century) work on optics and the *camera obscura*, Renaissance and Baroque artists such as Campin, Holbein, Caravaggio, and others were able to create paintings with seemingly impossible detail. Concave lenses can project an extremely detailed image onto a surface, which the artist can either trace or use as a visual aid to access details for his painting. Jan van Eyck's famous *Arnolfini Portrait* (AD 1434) is quite small (82.2 x 60 cm), and includes an even smaller image of a convex mirror that is the visual and mathematical focal point of the painting. The figures within that mirror are rendered even smaller with remarkable precision. The meaning of this portrait is mired in speculation. However, by placing the lens-like mirror in such a prominent place in the painting, almost as if its orbicular form is an eye looking back at the viewer, van Eyck appears to be demonstrating just how he was able to achieve such extraordinary visual exactitude. According to the artist David Hockney and Charles Falco, Professor of Optical Science at the University of Arizona, "European artists began using optical devices as aids for creating their work early in the Renaissance well before the time of Galileo." Moreover, their work has been important in demonstrating that "the incorporation of optical projections for producing certain features coincided with the dramatic increase in the realism of depictions at that time."[40] Indeed, the quality of art created during the Renaissance and the subsequent Baroque period retain an aesthetic longevity that still reverberates today.

We can see how these technological advances signified a concomitant affirmation of scientific and aesthetic cultural values by briefly considering how a non-Western society reacted to such artwork. When Jesuit missionaries brought various scientific instruments to China and Japan during the sixteenth and seventeenth centuries, they also brought contemporary paintings rendered in perspective. The Chinese were particularly impressed with the Europeans' tremendous overall scientific advancement. In terms of art, even the established literati (scholar-artist-official) painter could not deny the compelling scientific exactitude of these illusionist artifacts, and a number of Chinese painters even began using perspective. But ultimately, for many aristocratic thinkers these were considered mere technical

[39] Alina Payne, "Introduction," in *Vision and Its Instruments: Art, Science, and Technology in Early Modern Europe*, 6.

[40] Charles M. Falco, "*Optics and Renaissance Art*," in Mohammad D. Al-Amri, Mohamed El-Gomati, M. Suhail Zubairy, *Optics in Our Time* (Cham: Springer International Publishing, 2016), 266.

achievements, and not considered valuable as "art."[41] The "Three Perfections" of painting, poetry, and calligraphy guided the Chinese aesthetic tradition from at least the Song dynasty (960–1279), which emphasized how brushstrokes captured the expressiveness, subtlety, and energy of the artist and the scene. The Chinese reaction to Renaissance painting is one where we see a disconnect between their wonder and fascination with the instruments and potential of Western science, compared to the values they espoused when scientific methods were applied to visual art. It is the converse of what we see in the Italian Renaissance. Traditional Chinese painting strove toward more of the subjective, spiritual qualities associated with the natural world, of which the human being was just a part; on the other hand, Western illusionism sought to capture nature visually, objectively, with humanity seen as central to its understanding. However, today Eastern cultures have fully assimilated their societies to Western technology, demonstrating their full-fledged acceptance of its scientific advances, even in the arts. While in the West, the fervent desire to capture the truth and reality of the world visually persisted well into the twentieth century, with the technical achievement of photography in the previous century leading the way.

VI. Technology and Art Today

The nineteenth-century invention of photography was a monumental technological development in the history of visual art. It was a modern-era innovation that combined the well-known effects of Renaissance optics (lenses and the *camera obscura*) with a baroque-era familiarity with chemical photosensitivity, with how "certain chemicals, especially silver halides, turned dark when exposed to light. The inventors of photography used such chemicals to render permanent the insubstantial image formed in the camera obscura."[42] Photography changed the world, and has helped the field of science immeasurably. It led to what is arguably *the* most significant image in humanity's history: "Earthrise," the photograph of Earth as seen from the moon. On the other hand, stripped of its duty to capture reality with pictorial certitude, the arts were (only?) left to explore other avenues of social impact and relevance, but always with an eye on photography, which ultimately has become an art form of its own. Realism, impressionism, and the various permutations of abstraction, were to some extent all reactions to the photographic image. Yet, visual art has never shaken free of its Classical past (humanistic naturalism) or its Renaissance-era zenith (optical illusionism). This tradition has been either a point of departure or a call to arms—or both—for modern and contemporary artists. The twentieth-century artist

[41] Hui-Hung Chen, "Chinese Perception of European Perspective: A Jesuit Case in the Seventeenth Century," *The Seventeenth Century* 24, no.1 (2009): 120.

[42] Peter Galassi and Museum of Modern Art, *Before Photography: Painting and the Invention of Photography* (New York; Boston: Museum of Modern Art, 1981), 11.

Marcel Duchamp, for example, memorably disparaged art of this lineage, eventually drawing a mustache and goatee on a reproduction of the *Mona Lisa* (*L.H.O.O.Q.*, 1919, private collection), and creating mechanically based experimental artworks that explored ironic conceptions of perspective and alternative notions of "opticality."

Duchamp is an important touchstone in the visual and musical arts (he inspired creators in both, such as Erik Satie, Robert Rauschenberg, John Cage, Andy Warhol, and many others). He is best known for his "readymades," everyday manufactured objects designated as art merely by the artist's nomination as such. The fact that mass-produced objects—such as a comb, a bottle rack, a window, or a hat rack—could simply be deemed "art" continues to inspire debate, disbelief, and even outrage among the general public. The most controversial of these, *Fountain* (1917), a urinal simply turned on its side and submitted to an art exhibition, embodies what many find objectionable about current artistic practices. Duchamp ostensibly "created" the piece to test the institutional parameters of art.[43] However, although it does not appear to exhibit any skill whatsoever, *Fountain* is, somewhat surprisingly, "widely seen as an icon of twentieth-century art."[44]

How did art arrive at such a place given its long and auspicious history? Technological advancement beyond photography played a large role in this transformation. Just as the technology of the stirrup changed armed conflict in medieval Europe, centuries later it was the new military technologies of poison gas and industrialized warfare that helped bring about a wholesale change in aesthetic thinking. The horrors of World War I inspired an entire generation of countercultural, avant-garde (a martial term) artists, who saw in this military catastrophe brought about by technological "advance," every reason to detest the conventional "rationality" that led to such devastation, including those of traditional art. *Fountain* and the readymades emerged in the midst of the war and its buildup, during which Duchamp fled to New York City. The readymade is seen as the beginning of contemporary "conceptual art," and signifies an important transition in the discussion about the cultural value of the arts in general. For, if art no longer requires *technê*, then what happens to quality and meaningfulness? To Duchamp's detractors, such as Clement Greenberg, Barnett Newman, and Roger Scruton, *Fountain* and the other readymades simply do not have any.

On the other hand, *Fountain* draws on many interconnected ideas that relate to traditional art. Naming the urinal *Fountain* and characterizing it as art provided the object with aesthetic meaning; it was a language-based act intended to ascribe cultural value to a technological aspect of American society that Duchamp found creatively significant: plumbing in the New

[43] David Hopkins, "Marcel Duchamp's Readymades and Anti-Aesthetic Reflex," in Paul Smith and Carolyn Wilde, eds., *A Companion to Art Theory* (New York: Blackwell Publishers Ltd., 2002), 253.

[44] https://www.tate.org.uk/art/artworks/duchamp-fountain-t07573

World. Compared to the stodgy Old World infrastructure he had just left, he enthusiastically proclaimed that "The only works of art America has given are her plumbing and her bridges."[45] Moreover, to demonstrate his disdain for art's Western past, he selected a porcelain white object that would evoke the white marble of Classical Greek art, but place upon it the connotation of urine to disparage it (hence "fountain"). This aspect alone compelled his critics in 1917 to label the piece lewd and immoral. The urinal's shape also retains the abstract outline of a seated Buddha (it was sometimes dubbed "the Buddha of the bathroom"), whose non-Western reference (just like porcelain) also situated the work away from Western art's traditional lineage, while thwarting its conventional employment of optical illusionism. For his supporters, the fact that Duchamp found an object that could say all of that without him having to do anything but turn it over proves that a conceptual artwork *does* take skill—conceptual skill—and can thus exhibit quality and meaningfulness. In fact, in 1913 he famously repudiated what he termed modern art's overriding "retinal" qualities—art made primarily to appeal to the eye—in favor of a mental or conceptual creative work.[46] In addition to its longevity mentioned above, *Fountain*, and the readymades in general, cancel out the manufactured objects' utility by removing them from their useful function in society and imbuing them with an aesthetic valence based on their vectors of conceptual meaning. Indeed, many of Duchamp's other readymades can claim similar multivalent semantic content, which is a major reason for the artist's enduring influence on art today.

Still, Duchamp's legacy is one that has told the world that *anything* can be a work of art. The idea that anything goes and that anyone can be an artist has led to art that is increasingly outrageous, less grounded on quality and expertise, and increasingly divorced from the enduring or universal human condition as a matter of form. Thus, when John Cage "composed" a Duchamp-inspired piano piece entitled 4'33" (1952) that forced the audience to listen to silence for that amount of time, it is hard to discern any taste, quality, or skill. Nothing comes from nothing, it seems. One can claim it as a novel experiment, a nonscientific one despite the veneer of technicality in its use of number, but it is hard to image it as a work of art, despite Cage's claim of environmental conceptuality.

Nevertheless, the last few centuries have seen the creation of new technologies that have greatly changed the face of music. These include the discovery of electricity and its introduction into the recording and creation of music. Electricity affected musical creation both in the compositional and performative realms. In the compositional world, it began with what were perceived as the two separate realms of "electronic music" and "music concrète." The former was based on the newly created tools of oscillators

[45] Marcel Duchamp, in Charles Harrison and Paul Wood, eds., *Art in Theory 1900–1990: An Anthology of Changing Ideas* (Malden, MA: Blackwell Publishers, Inc., 1993), 248.
[46] Rosalind Krauss, *The Optical Unconscious* (Cambridge, MA: MIT Press, 1993), 123.

(sound generators), filters (sound manipulators), and amplifiers (determinative of volume or relative loudness). This music was made from the ground up, as it were, building sounds from simple wave forms into more complex sounds. It relied on the discoveries in the branch of physics called acoustics, the study of sound. In fact, many compositions in the nascent electronic medium were about the nature of the sound itself, as with Robert Ashley's "She Was a Visitor"(1967) and Alvin Lucier's "I Am Sitting in a Room" (1969).

Electronic and recording technologies change very quickly, exponentially, relative to past advances. One problem is that as new compositional tools appear at a rapid rate, how is one to learn to command them, rather than being subservient to them? The ability to master them is more fraught, which may account for the paucity of great works in these new genres. Yet, there are also great benefits of this technology. For example, Beethoven could only hear in his mind's ear his Third Symphony before hearing its first live performance. With current sampling technology, one can use a virtual library of orchestral instruments to assemble a musical realization that sounds quite real. In so doing, one hears all of the instruments with their inherent timbrel qualities, dynamics, and variations of speed, and the architecture of the work. This could be a real benefit for the composer before the work ever gets its first live (real?) performance. Therefore, such fast change should not be feared, but understood as consistent with our human history. As the poet Paul Pines has written:

> It may be impossible to endure the crushing G-Force, that propulsive rate of change, without a degree of protective numbness. At the same time, the structure of the psyche remains the same since it gave birth to Paleolithic images on cave walls. Symbols rising spontaneously from its depth inform and guide us … Two dynamic principles are at work here: self-renewal and self-transcendence—the ability to reach beyond physical and mental boundaries in the process of learning, development and evolution.[47]

VII. In Conclusion

Artists today use technologies prodigiously (video, computers, and so on), and many artworks are quite complex and take a tremendous amount of skill and cleverness to create. But, in our view, art has taken a back seat in present-day society in part because the contemporary art world has yet to produce art that truly moves people as it did in the previous eras discussed

[47] Paul Pines, "High Culture, Poetic Imagination and the Submerged Center: Essay— Paul Pines," *NC Magazine* 5, no. 8 (August 2014). http://numerocinqmagazine.com/2014/08/08/high-culture-poetic-imagination-and-the-submerged-center-essay-paul-pines/

above. We now have so-called "'masterpieces' without masters" of pop culture, as Terry Teachout has noted.[48] These factors and more contribute to the declining status of the arts in today's scientific and technological culture.

Although the role of the arts in contemporary society has ebbed in comparison to that of technology and science, the situation should not necessarily imply any hierarchy of culture broadly construed. It was argued earlier that aesthetic minded people tend to look for connections and interconnections in the world as a way to find emotional and subjective meaning. In this regard, we notice that most of the new technologies of the modern world, underwritten by their objective/scientific methodology, also are created to establish connections. The telegraph, the phonograph, the telephone, computers and the Internet, television, the railroad, automobiles, the airplane, even the spaceship, all to one extent or another connect humans to each other and to the wider world about us. They augment our human faculties of touch, sight, hearing, and mobility, and make us feel better on a humanistic level through this movement and human contact. In this sense, in accord with Bachelard's poetic image, we like to say that all science works in service of the heart. Even pure scientific research—the kind of which does not seem to result in any tangible technological innovation—at the very least satisfies the itch of curiosity, the very human desire to know what lies beyond us. In this respect, science is aligned with what Charles Murray has claimed are "transcendental goods."[49] Indeed, for most of humanity's history, religion and science were not separate realms, but one holistic enterprise of human endeavor. With respect to the arts, perhaps we are seeing this re-emerge once again, to our great benefit. As we have argued elsewhere:

> Of course, people still paint and sculpt, and thousands visit museums that exhibit contemporary art and historic masterpieces, but those creative instruments are no longer the way for an individual to make an influential, large-scale social or political statement. Film, telecommunication, even video games are now the prime locus of humanity's creative energy. The great minds of today are likely to be computer programmers and not aesthetically-oriented polymaths.[50]

Not that traditional music and art are passé. The Fourth Industrial Revolution is "built around shared values of the common good," where norms and

[48] Terry Teachout, "'Masterpieces' without Masters," *Commentary* 142, no. 1 (2016): 56–59.

[49] Charles Murray, *Human Accomplishment: The Pursuit of Excellence in the Arts and Sciences, 800 BC to 1950* (New York: HarperCollins, 2003), 418–20.

[50] Robert Edward Gordon and Daniel Asia, "Heaven and Earth: Points of Convergence in the Arts and Adam Smith," AdamSmithWorks.org, September 2, 2020. https://www.adamsmithworks.org/documents/heaven-and-earth-points-of-convergence-in-the-arts-and-adam-smith

beliefs are mediated via technologies such as artificial intelligence, genome editing, augmented reality, robotics, and 3-D printing.[51] In this environment, a unified notion of *technê* in art and science is required more than ever. Perhaps a large part of the arts' cultural value ahead will be its ability to help keep humanity from falling astern of the pitfalls that technology can wreak upon itself. War is ever present, and Frankenstein's monster, as a product of *homo faber*'s scientific imagination, is a constant danger. Some fear that we are building machines whose intelligence could "swamp and overwhelm ours." As David Gelernter has stated, "Thoughtful people everywhere ought to resolve that it would be unspeakably stupid to allow technologists to fool around with humanlike and superhuman machines—except with the whole world's intense scrutiny."[52] Yet, the unsung soliloquy of the arts is that, in the end, the eyes do not see; the ears do not hear. They simply allow the brain to translate the world aesthetically into a personal conversation with our souls. Therefore, in the creation of our human world, objective data must keep in tune with our subjective voice, to which it is subservient. As we learn from Fritz Lang's *Metropolis* (1927), the first film to deal with scientific and technological progress and the human desire to create: "The mediator of the head and the hands must be the heart."[53]

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[51] *Britannica Academic*, s.v., "The Fourth Industrial Revolution." Retrieved April 30, 2021. https://academic-eb-com.ezproxy3.library.arizona.edu/levels/collegiate/article/The-Fourth-Industrial-Revolution/630837.

[52] David Gelernter, "REVIEW—Machines That Will Think and Feel," *Wall Street Journal. Eastern Edition* (2016).

[53] There are various translations of this sentiment. The 1927 program states: "The mediator between the brain and the muscle must be the heart." See also Michael Cowan, "The Heart Machine: 'Rhythm' and Body in Weimar Film and Fritz Lang's *Metropolis*," *Modernism/modernity* 14, no. 2 (2007): 239.