The Harmony of Opposites in Design and Philosophy

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ABSTRACT

In an era marked by increasing polarisation and conflict, the philosophical concept of harmony seems to offer guidance for designing a more positive future. Building upon our previous review (Lomas and Xue, 2022) of the role of harmony in design, this chapter explores the seemingly paradoxical concept of the "harmony of opposites." In our investigations of the ancient idea that opposites can create harmony, like Yin and Yang, we hope to draw meaningful insights that contribute to design theory and practice in the field of Human-Centered Design. How might opposition in ideas serve as a generative force for design innovation?

1. CONCEPTIONS OF HARMONY: POP CULTURE TO CLASSICAL PHILOSOPHY

The concept of harmony is found in the wisdom traditions of many societies. Typically, these philosophical conceptions of harmony can be contrasted with a more common but naive perspective that treats harmony as perfect agreement. The problem with this naive perspective is that, if harmony requires perfect agreement, then it necessarily leads to a kind of totalizing uniformity (Li & Düring, 2022:3).

To illustrate how common it is for harmony to be viewed as uniformity or perfection, we lightly note that conceptions of the nature of harmony serve as the primary narrative theme in several pop culture films. In *Myth: A Frozen Tale* (2019), harmony is presented as the esoteric underpinning of the *Frozen* universe. Then, in *Trolls World Tour* (2020), the music-loving protagonists reject the naive conception of harmony, saying 'A world where everyone looks the same and sounds the same? That's not harmony.' This rejection of a naive view of harmony-as-sameness is not new. In fact, the philosopher Confucius addressed it as early as the sixth century BCE. He explains that '[the virtuous person] harmonises but does not seek sameness, whereas the petty person seeks sameness but does not harmonise' (Li, 2006:586).

Many other classical philosophers in ancient China and ancient Greece also articulated the key role of variation, difference, opposition, and even conflict in harmony. For instance, the 6th century BCE Greek philosopher Heraclitus emphasised the creative or generative potential of the harmony of opposites. His perspective was that 'things are brought into harmony by the clash of opposing currents' and that 'all things come into being by conflict of opposites, and the sum of things flows like a stream' (Diogenes Laertius, 1925:414). How can a clash of opposition bring things into harmony? And, why might the conflict of opposites generate all things, as a flowing whole? An example of this can be found in the flow of a conversation: different perspectives in communication can generate insights neither party had initially. From this perspective, harmony is not a perfect state of agreement but rather a flowing process that unfolds over time, creating greater integration and wholeness. Indeed, the tension between different perspectives produces a flow of energy that can create harmony. This idea echoes similar Chinese ideas, such as in chapter 42 of the *Dao de Jing* where the opposites Yin and Yang flow and blend together create harmony and wholeness, even as the Yin and Yang remain independent. 'All Things carry Yin and hold to Yang; Their blended influence brings Harmony' (Lee et al, 2009:68).

To better understand the dynamics of how opposites can generate harmony, we can look to the Chinese philosopher

Yanzi (fl. 500 BCE). He uses music as an example of harmony and presents a series of ten musical opposites including 'short and long, quick and slow, sad and merry' etc. Yanzi then claims that each opposite complements the other; when brought together, they make up for their individual deficiencies. Importantly, the differences between each opposite remain, for the harmony in a song occurs through the very nature of their differences. In this manner, opposites produce harmony through complementarity. In contrast, pure agreement is undesirable. Yanzi argues that, if a ruler says something wrong, a good minister will point this out and complement the ruler's deficiencies. If a minister merely echoes his ruler in perfect agreement, this cannot be harmony, for, 'If you have musical instruments just play a single note, who would want to listen to it? That is how I demonstrate that it is wrong to just agree' (Milburn, 2015:373-375).

This idea of music as a model for harmony is also found in the classical Greek philosophy of the Pythagoreans. The fifth century BCE philosopher Philolaus reflected on the harmony of opposites in both the material cosmos and within music: 'music is the combination of opposites, a unification of many things, and the agreement of the disagreeing' (Philolaus B 10 DK, in Huffman, 1993:132-133). In a harmonisation process, diverse elements are integrated into a whole system that is somehow more beautiful, more functional or more excellent than the elements alone. For instance, consider a jazz ensemble: the interplay between the steady rhythm of the drums, the harmonic foundation of the piano, and the melodic improvisation of a saxophone can create a cohesive musical experience. Each instrument maintains its unique voice, yet together they create something more compelling than any could achieve alone.

In summary, we see that classical philosophical perspectives often portray harmony as emerging from the interplay of differences. These classical perspectives do not present harmony as sameness, uniformity or perfect agreement. Instead, differences are essential for creating harmony and wholeness. Harmonisation requires the existence of opposing forces as a basis to harmonise. For if everything was the same, how could it be harmonised?

II. MUSIC AS A MODEL FOR HARMONIZATION

Music has long served as a powerful model for understanding the broader concept of harmony. In this section, we wish to address some misconceptions about musical harmony in order to shed light on the role of harmony in design. One misconception is that harmony is only a static state rather than a dynamic process unfolding over time. This misconception can occur from the widespread use of the word harmony in music theory to only refer to the simultaneous sounding of notes in chords. However, modern theories of musical harmony specifically explain how musical harmony unfolds over time "to produce a pleasing effect greater than the sum of its parts" (Chan et al, 2019:1). This broader understanding of harmony in music refers to the theoretical principles explaining how diverse sonic elements can be pleasingly integrated into a whole or unified musical experience (e.g., a song). Principles of harmony can be mathematical, psychophysical, cultural or otherwise, yet in every case, they explain how the parts of music effectively integrate together into whole musical experiences. In other words, musical harmony explains how distinct sounds become whole songs.

This broader perspective on musical harmony can be especially valuable as a model for design because it offers examples for understanding the role of imperfections and dissonance in harmony. Another misconception is that dissonance is incompatible with harmony. In fact, dissonance often helps create greater harmonies by introducing the tensions necessary for musical resolution. These tensions motivate musical changes or movement within a song that lead towards resolution. The tension of dissonance actually serves as a foundation for harmonisation, which is the creation of wholeness. Nearly all melodies use dissonance to create cycles of tension and release to create greater musical wholeness (for discussion of this complexity and a range of other opposites in contemporary music theory, see Parncutt & Hair, 2011:159-161).

Storytelling serves as a clear example. All non-trivial stories have some kind of conflict or tension (Gottschall, 2012: 54). Stories are made whole because they have problems or tensions that motivate resolution through the completion of the story. Similarly, musical tensions and their resolution also creates a sort of narrative wholeness in music, as well. The harmony of a piece of music does not occur only in individual chords nor just in the final cadence of a song; rather, musical harmonisation is a process that binds together individual elements into a whole musical experience.

Consider the example of a punk rock song that is filled with clashing dissonances and imperfections. These songs

are clearly not "harmonious" as the term is commonly understood. Nevertheless, these songs have a clear wholeness as an experience. In fact, the characteristic imperfections of musical performances are often precisely what makes the songs distinct and memorable. These imperfections seem to play an important role in creating emotional resonance (Lomas et al, 2022: 10) with an audience. Imperfections give music "soul" (here we refer to the common usage of soul in the arts, not the more controversial metaphysical entity). Indeed, characteristic imperfections tend to be lacking in so-called soulless music (Joosten, 2023). For instance, corporate "elevator music" or certain AI-generated music may be harmonious yet lack the peculiarity of character necessary to create an emotionally resonant experience.

Digital rhythm production provides an excellent example of the importance of imperfections in emotional resonance. Computer-generated drum tracks are so precise in their rhythm that they are perceived to lack "groove," which is formally defined as the sensation of "wanting to move" (Davies et al, 2012: 1). To make music feel more soulful and resonant, producers "humanise" drum tracks using small imperfections in timing (Max Planck Institute for Dynamics and Self-Organization, 2024). Similarly, researchers have found that a small degree of dissonance in piano chords tends to be preferred over exact tuning (Lahdelma and Tuomas, 2016). These examples show how dissonance and imperfections can actually contribute to the overall harmony and distinctive wholeness of a piece of music.

Musical experiences can help frame the value of tension and conflict in harmonisation processes in other domains, from product design to the development of interpersonal relationships or even in the formation of individual conscious experience. In each case, harmonisation can be understood as the creative process of integrating diverse parts into a more functional or pleasing whole. From this perspective, the practice of design can be understood as harmonisation, or the creation of new functional *wholes*.

III. DESIGN AS HARMONIZATION

An excellent example of design as harmonisation is the fish-rice farming system. This system integrates seemingly unrelated or even opposing elements (e.g., rice plants, water, fish, and their waste) to create a more productive and sustainable whole. A fish-rice farming system leverages the differences between its components to enhance overall productivity. The fish benefit from the shade and water filtration provided by the rice, while the rice benefits from the fertilisation and pest control provided by the fish. Due to this harmonious interaction, fish-rice farms need much less fertiliser and pesticide to achieve the same level of productivity as a monocultural rice farm (Xie et al, 2011). When all components of a system are designed to harmonise together in synergy, there will be maximal positive effect and minimal waste, demonstrating how harmonious integration can significantly enhance efficiency and sustainability.

Designing refers to the intentional shaping of forms to serve specific functions. This human activity spans from ancient tasks like making a fire to advanced activities like designing microchips. The outcome of designing is a design—a form with a function. The many designs in nature, of course, have evolved without an intentional designer. Natural designs are forms that have evolved to serve specific functions. For instance, the human hand: its arrangement of opposing bones and muscles creates a harmonious form that is functionally capable of powerful grips and delicate manipulations.

Whether natural or intentional, all designs are defined by their functional wholeness. These functions result from the integration of differentiated parts. For example, a zipper's function results from the integration of two rows of interlocking teeth, a slider, a pull tab, etc. When integrated, these parts create a new function that none of the parts can achieve alone. This example points to the necessity of both differentiation and integration in creating new functional wholes: if harmony is wholeness, it is not achieved merely by integration but also differentiation.

Functions are not possible unless the parts of a design are well-fitted together. Not all designs "hold together" mechanically, aesthetically, conceptually or otherwise. Some designs seem to exhibit greater harmony—and this is reflected in their function. In so far as harmony results from the integration of parts into a more functional whole, the overall harmony of a design results from both internal and external integration. That is, the quality of a design is based on the integration of internal parts but also upon the integration of the design into a broader functional system. For instance, the different parts of a bicycle must be well-integrated mechanically; yet, a bicycle can only effectively function when it is well-integrated into the broader transportation infrastructure of a city. For instance, an otherwise excellent bicycle may lack harmony in a car-focused city that is lacking bicycle lanes.

So far we have been discussing harmony as an abstract concept in design. However, there is also a distinct experience of harmony as a quality; humans can qualitatively feel harmony. For instance, a well-designed building often creates the experience of harmony. This feeling or experience of harmony is essential to practical design work.

Acclaimed architect Christopher Alexander describes his work directly in terms of harmony: 'As architects, builders, and artists, we are called upon constantly—every moment of the working day—to make judgments about relative harmony. We are constantly trying to make decisions about what is better and what is worse' (Alexander, 2002:17). A designer's internal sense of harmony may be implicit, yet it leads to products, services, and systems that are visually pleasing, functionally integrated, and enriching. In this manner, a designer with a strong sense of harmony can create designs that also convey the experience of harmony to others.

Designers often seek designs that create the feeling of harmony in interaction with the broader world. As observed by design anthropologist Fulton Suri, designers are often 'excited by the opportunity to create new objects that live in more intentional harmony with their surroundings' (Fulton Suri, 2011:20). When interacting with such a design, individuals often notice a profound sense of "rightness"—an alignment that goes beyond the functionality and touches the emotional and spiritual dimensions of human experience. This perception may spark feelings of connectedness, awe, and admiration towards the creator behind the design. In this way, the experience of harmony can transform an ordinary encounter with an object or an environment into a deeply moving and inspirational journey.

Synthesising these perspectives, we consider designing as a human creative effort aimed at harmonising the aesthetic, functional, meaningful, and emotional dimensions of our world. In their harmonising process, designers engage in a deliberate and thoughtful process of balancing and synergizing the interactions of diverse elements. In doing so, design activities become a medium through which we can realise our innate desire for harmony, within the system we create, with one another, and with the natural world. From our perspective, to design is to harmonise.

IV. DESIGN THINKING IN OPPOSITES

Having established the key role of harmonisation in design, now we wish to demonstrate the importance of opposites and opposition in design processes. Designers need to deal with opposition, conflict and tensions to generate desirable design outcomes (i.e., functional designs with internal and external harmony). Below, we share an examination of opposites in design processes and "design thinking" (Dam and Teo, 2002). This examination is based on our own personal experiences teaching design at the Faculty of Industrial Design Engineering at Delft University of Technology in The Netherlands. In our work, we often use opposites to broaden student thinking in their search for wholeness and harmony. These opposites are shared here as indicative of a broader set of 'designerly ways of knowing' (Cross, 1982:221) that involve thinking in opposites.

Opposites are pervasive in reasoning; opposites may even be 'an organizing principle in the human mind' (Branchini et al, 2021:1). One role for opposition and opposites in design is the "bisociation" mechanism of creativity, which involves the combination of two divergent ideas to create a new concept (Koestler 1981, 2). Opposites can also be used to explore the space of possible variations for a particular design or the "design space" (Lomas et al, 2021:1). For instance, there is evidence that deliberately prompting people to "think in opposites" can help improve creative problem solving by helping people break out of their frames and consider alternatives (Branchini et al, 2023:91).

Designers often deal with *fixation* (Crilly, 2015:54), a dynamic that occurs when designers become attached to a particular idea and struggle to consider alternatives. Many design methods are intended to help designers break out of fixation by providing time and space for considering diverse alternatives before focusing on a single outcome (van Boeijen et al, 2020:65). Thinking in opposites can help designers consider such alternatives. We have found that each of the following pairs of opposites can complement and support each other during a design process.

Diverging vs Converging: One of the most popular design processes is the "double diamond" (Hehn, 2019:26), which involves a deliberate oscillation between "diverging" phases of differentiation (where new ideas are developed and expanded) and "converging" phases of integration (where focus is placed on developing a single concept). In a somewhat Darwinistic process of artificial selection in design, many ideas and possibilities are generated, yet only the most "fit" or harmonious manage to be integrated. This can be described as 'the survival of the harmonised' (Lin and Lomas, 2022:214).

Up the Ladder of Abstraction vs. Down the Ladder: Thinking up the ladder of abstraction involves identifying the higher-level abstract values associated with a concrete problem or solution. In contrast, thinking down the ladder of abstraction can help designers imagine new concrete examples of abstract values (Victor, 2011). For example, when designing a new smartphone, thinking up the ladder might lead to the abstract value of "connection;" thinking down the ladder might then inspire designers to explore alternative ways of fostering this connection, such as creating shared social spaces. A ladder of abstraction is sometimes called an abstraction hierarchy (Sanders and Stappers, 2012:203).

Zooming In vs. Zooming Out: Zooming in refers to paying close attention to the particular qualities of an experience, e.g., of using a specific design in a specific environment. In contrast, zooming out involves considering the broader context in which the design must operate. For instance, when designing a new kitchen appliance, zooming in might involve examining the detailed user experience of operating the appliance, while zooming out could lead to considering how the appliance fits into the broader context of a user's cooking habits or their home environment.

Left Brain vs. Right Brain: In design, both "left brain" and "right brain" approaches are important to integrate (Sanders and Stappers, 2012:59). Left brain design approaches describe systematic, logical modes of rational thought while right brain approaches describe holistic modes of intuitive thought. Rather than expecting a designer to maximise both types of thought at all times, it is common to oscillate between these holistic and rational modes.

Social vs. Solitude: Alternating between time spent brainstorming in solitude and brainstorming in groups often produces the best outcomes (Korde and Paulus, 2017:177). For instance, when designing a new public space, individual designers might first spend time brainstorming ideas in solitude before coming together to collaboratively refine and develop the strongest concepts.

Purpose vs. Playfulness: Engaging in both goal-directed activities and fun, exploratory experiences can lead to more creative outcomes. For example, when working on a design project for a new sustainable packaging solution, designers might spend time pursuing the explicit goal of minimising environmental impact. However, they might combine this with playful experimentation with whimsical, unexpected forms.

Thinking Big vs. Thinking Small: "Thinking big" refers to ambitious and visionary thinking while "thinking small" refers to a focus on the specific details of small tasks that can incrementally move a project closer to the bigger vision. This "visionary incrementalism" aligns with classical management approaches to large-scale system change by "muddling through" (Lindblom, 1957).

Goals vs. Vision: Setting concrete, measurable goals improves design efficiency. However, too tight of a focus on metrics or key performance indicators can lead to inadvertent negative consequences. Goal-driven design can therefore be tempered with visionary design, which focuses on the more vague imaginaries of an intended future experience (Lomas et al, 2021).

Each of these opposites can produce tension and conflict with one another. As pragmatist philosopher John Dewey says 'discord is the occasion that induces reflection' (Dewey, 1934:15). By thinking in opposites, designers can reveal these discords or qualitative feelings of tension. Once revealed, these tensions can then be harmonised through innovations in design. In other words, thinking about one opposite and then the other can help reveal signals of conflict and misalignment. These dissonant signals can attract our attention to the additional work necessary to achieve alignment and harmony in our design outcomes. By recognizing and embracing conflict, rather than avoiding it, designers are positioned to create more holistic and effective design solutions.

Reflecting back on our discussion of classical philosophy, the tension of opposition can create a flow of energy that can drive harmonisation. For instance, consider the process of brainstorming in a diverse team: the tension between different perspectives and ideas generates creative energy. An engineer's practical approach might clash with a designer's aesthetic vision, creating initial conflict. However, provided that the team remains in a spirit of trust, the tension of opposition can spark innovative solutions that neither would have conceived alone. The energy from their disagreement fuels exploration of new possibilities, ultimately leading to a harmonised solution that integrates both practical functionality and aesthetic appeal.

Indeed, inner tension, cognitive dissonance and conflicts between needs is often used to motivate design innovation. "Dilemma-Driven Design" (Ozkaramanli et al, 2020:58) is a design method that uses personal dilemmas and conflicts as a starting point for design ideation and concept develop-

ment. By focusing on personal and interpersonal tensions, designers can create solutions that address the root causes of user problems and create more meaningful experiences. When dealing with conflicting motivations, a designer might seek to resolve the conflict (e.g., by serving both concerns), moderate the conflict (e.g., by prioritising one concern over another), trigger the conflict (e.g., by creating awareness of the conflicting concerns), or giving space to the conflicting motivations (e.g., so that each can operate independently). Opposition provides an interface where the flow of differences can create the energy to create new experiences or innovations.

Thinking with opposites supports diverse perspectives that can inform and enhance designs. By attending to tensions and misalignments between the opposite modes of thought, designers can discover better designs. By deliberately engaging with contrast and difference, designers can overcome fixation, explore a wider range of possibilities, and generate novel solutions. Each dimension of oppositeness serves as a different dimension to explore within a design space of possibilities. Allowing for this interplay of opposing elements can support greater harmony in design.

Across the arts, beautiful creations often involve some form of conflict or contrast. As previously mentioned, a novel or film will lack narrative wholeness if there is no conflict to resolve. Indeed, the very purpose of a narrative arc is to address and resolve conflicts; thus, conflict becomes an essential contributor to the story's overall harmony. This concept extends beyond art and design. Each person is a creator and each must individually construct their own ideas and courses of action (Rubin, 2023). To do this, it is necessary to harmonise internal and external motivations, motivations which are often in conflict or tension. Life's basic challenge is to harmonise conflicting elements into coherent, meaningful activities. Indeed, challenges can enrich our lives and give it meaning, in the pursuit of harmony.

V. THE UNIFIED MODEL OF AESTHETICS

Part of a design's function can be *aesthetic*, i.e., the purpose of the design is to shape our qualitative experience and to produce sensory pleasures. The term "aesthetic" originates from the Greek word aisthesis, which refers to sensory experiences (Vichnar and Armand, 2017:1). In modern use, aesthetic experiences are specifically those that cause sensory pleasure or displeasure (Hekkert, 2006:157). As harmony appears to play an important role in aesthetic pleasure, we wish to better understand how and why the harmony of opposites produces positive aesthetic experiences. Over the next few pages, we will unpack and explain the "Unified Model of Aesthetics," a contemporary design theory, which explains aesthetic pleasure as a harmony of opposites.

The Unified Model of Aesthetics was developed by a consortium of researchers, led by Dr. Paul Hekkert, to explain how and why people experience aesthetic pleasure—or beauty—in design (Berghman and Hekkert, 2017). Hekkert claims that the sensation of 'beauty arises from simultaneously addressing and harmonising apparent opposites' (Hekkert, 2020). As this theoretical model deals with harmonising apparent opposites, by investigating this model, we seek to gain insights into the role of harmony in design. The model itself aims to provide a theoretical account for why satisfying opposing desires can maximise aesthetic pleasure. These opposites include:

- **Unity-Variety:** People tend to value richness and variety in designs yet also value coherence and unity. As an example, the iPhone offers many varied features and apps, yet it also provides a consistent interface design language that gives all the varied features coherence.
- **Typicality-Novelty:** Novelty and typicality are the basis of the so-called MAYA principle ("Most Advanced Yet Acceptable"), a design theory popularised by the mid-20th century designer Raymond Loewy who used the principle to explain the challenge of designing new products for a fickle public; people always want something new yet they want new things to be recognizable as a familiar type (Hekkert et al, 2003).
- **Connectedness-Autonomy:** People tend to value products that enable them to express their autonomy or individuality, yet they also value products that signal their connection or belongingness to their social group (Blijlevens and Hekkert, 2019).
- **Maximum Effect-Minimum Means:** This principle suggests that we value designs that achieve the greatest effect with the least effort or resources (Da Silva et al, 2017). For instance, the Apple AirPods case is both a charging mechanism and a storage mechanism.

The Unified Model of Aesthetics organises each of these pairs of opposites at distinct levels of human existence: for instance, the opposites of unity-variety operate at the perceptual level; the opposites of novelty-typicality operate at a

cognitive level; the opposites of autonomy-connectedness operate at a social level. At each of these levels, Hekkert and his colleagues propose that the pairs of opposites reflect a deeper and more fundamental set of opposites, namely Safety and Achievement, which is understood from the perspective of human evolution.

What do aesthetics have to do with human evolution? Hekkert proposes that ancient humans had to balance, on a moment to moment basis, their intrinsic need for achievement with their need for safety. Specifically, he claims that the human aesthetic sense evolved to motivate our ancient ancestors to achieve (by pursuing new, varied, autonomous & high impact experiences) while, at the same time, motivating their desire for safety (by pursuing experiences of familiarity, unity, connectedness and ease). Intrinsic aesthetic pleasures, shaped by our cultural experience, would therefore be capable of guiding humans through a dangerous and uncertain world. 'On the one hand, humans seek that which is safe to approach, offers security, and makes little demand on their limited processing capacity. On the other hand, humans are motivated to take risks, engage in exploratory behaviour, extend their capabilities, and promote their learning' (Hekkert, 2014:281).

If ancient humans only found familiar, stable, and safe stimuli beautiful, this would have inhibited growth and the potential for reproduction. Humans would never leave the cave, as it were. On the other hand, if ancient humans had only sought growth and achievement through an untempered free pursuit of novel and varied experiences, they would end up dead and unable to pass on our genes. In this manner, evolution is believed to have shaped the human aesthetic sense. The Unified Model of Aesthetics uses this evolutionary theory to account for why humans seem to share a natural drive to jointly satisfy our mutual needs for safety and achievement. This underlying need for safety and achievement therefore *manifests* at different levels of the human experience. Each pair of opposites in the unified model are thought to reflect this fundamental adaptive conflict of opposites.

Another key idea is that each pair of opposites does not represent ends of a single dimension like hot and cold or up and down. Instead, each opposite is an independent factor that only tends to oppose the other. To prove that the opposites in the model were not ends of a single dimension, Hekkert and colleagues conducted several studies that asked hundreds of participants to rate the aesthetics of various product designs using the different opposites in the Unified Model of Aesthetics (Post et al, 2016). Their data revealed that the ratings of opposites in the products tended to be inversely correlated; yet, certain products could be very high in both unity and variety, for instance. Their work showed that products that maximise *both* unity and variety are perceived as more beautiful than a product with equally balanced or more average rankings.

The opposites in the Unified Model of Aesthetics are not antonyms. While hot and cold reflect a single dimension of temperature, the opposites in the Universal Model of Aesthetics are distinct and, importantly, mutually virtuous. Nevertheless, each opposing virtue tends to conflict with the other (See Cheng, 1977:226). The implication is that it is undesirable to eliminate conflict by simply suppressing one opposite in favour of another other. Because the different opposites are mutually virtuous, maximising each opposite is more desirable than trying to find the average between the opposites. The harmony of opposites is not found by choosing the middle ground between extremes but by supporting the strength of both parts (in this case, the strength of each opposite) to the greatest extent possible.

VI. ON THE NATURE OF OPPOSITES

Opposites are an intuitive concept and easily learned by children (Branchini, 2021:1)—however, they are surprisingly difficult to precisely define (Begley, 2022:85). What is clear, however, is that "real opposites" don't need to be perfect antonyms like up and down or true and false. The opposition of an opposite implies contrast or difference, but it does not require the perfect mirroring of an antonym.

To make this clear, consider that a thermometer cannot simultaneously go up and down because hot and cold are true antonyms—they are opposite ends of a single dimension, not independent factors. In contrast, we've discussed how novelty and typicality are independent factors that can both go up and down at the same time (even though they are usually moving in the opposite direction). Or consider pleasure and pain: these opposites tend to move in opposite directions, where increases in pain tend to lead to decreases in pleasure. However, psychologists have actually found that pleasure and pain are independent factors that can increase or decrease at the same time (Schimmack, 2001:81). For instance, a spicy soup can increase both pleasure and pain; on the other hand, eating an unexpectedly tasteless soup when very hungry can suddenly decrease both the hunger pains

and decrease one's pleasure. For another example, a film might simultaneously evoke both pleasure and pain: the pain of a tragic moment can contribute to the overall pleasure of the narrative. This helps show why it is a misconception that opposites are necessarily antonyms.

VII. SYNTHESISED TABLE OF OPPOSITES

Across our research, we have uncovered a wide variety of opposites. We have assembled all of these together into a synthesised table of opposites (Table 1), following a classical tradition (Golden, 2015:171). We have organised the opposites as twelve different categorical levels, each representing a distinct domain or aspect of reality.

Table 1: A Synthesised Table of Opposites

CATEGORY	OPPOSITES
Metaphysical & Mathematical	**Dao De Jing:** yin-yang, oneness-twoness · **Heraclitus:** all-one, wholes-parts, change-permanence, something-nothing · **Pythagorean:** finite-infinite, one-many, odd-even, straight-curved, square-oblong, unity-diversity · **Yanzi:** harmony-sameness · **Other:** monad-dyad, being-nonbeing, one-zero
Physical	**Heraclitus:** condensation-rarification, hot-cold, dry-wet, day-night, winter-summer · **Aristotle on Democritus:** fullness-void · **Pythagorean:** resting-moving · **Other:** cause-effect, kinetic-potential, energy-matter, wave-particle, matter-antimatter, positive charge-negative charge, action-reaction, force-extension, crests-troughs, shadow-light
Biological	**Pythagorean & Heraclitus:** male-female · **Heraclitus:** life-death, hunger-satiety, heath-disease · **Other:** organism-environment, inhalation-exhalation, anabolism-catabolism, excitation-inhibition of neurons, flexion-extension of muscles
Perceptual	**Heraclitus:** consonance-dissonance, high-low · **Pythagorean:** left-right, light-dark, straight-curved, white-black, sweet-bitter, great-small · **Yanzi:** big-small (loud-quiet), long-short, fast-slow, pure tones-impure tones, sorrow-joy · **UMA:** unity-variety · **Other:** smooth-rough, perceptual-motor, central-peripheral vision
Emotional	**Pythagorean:** good-bad · **Yanzi:** conflicting hearts-balanced hearts, excessive-deficient · **UMA:** immediate gratification-long term wellbeing · **Other:** tension-release, pleasure-pain, arousal-calm, approach-avoidance, attraction-aversion, like-dislike, submission-dominance, intrinsic-extrinsic motivation, control-acceptance, courage-caution
Cognitive	**Pythagorean:** feelings-reason (pathos-logos) · **Heraclitus:** asleep-awake · **UMA:** novelty-familiarity · **Other:** intuition-logic, focus-perspective, exploration-exploitation, reductionism-holism, left brain-right brain, synthesis-analysis, conscious-unconscious, sensible-intelligible
Conceptual	**Heraclitus:** agreement-disagreement, name-function, brought together-pulled apart · **Other:** thesis-antithesis, freedom-necessity, chance-necessity, identity-difference, form-content, subjectivity-objectivity, means-ends, subject-object, abstract-concrete, theory-practice, universal-particular, questions-answers, quantitative-qualitative
Social & Cultural	**Heraclitus:** war-peace · **Yanzi:** ruler-minister · **UMA:** connectedness-autonomy · **Other:** individuality-association, ingroup-outgroup, tightness-looseness, diversity-inclusion, leadership-followership, popularity-authenticity, competition-collaboration, self-other, tradition-progress, teacher-learner, local-global
Economic	**Heraclitus:** goods-gold, buying-selling · **Other:** supply-demand, imports-exports, assets-liabilities, revenue-expenditures, competition-coordination, public-private, capitalism-socialism, individuality-association, interdependence-independence
Designerly	**Heraclitus:** convergence-divergence · **UMA:** ease-effect, intention-outcome · **Design Thinking:** converging-diverging, differentiation-integration, play-purpose, left brain-right brain, abstracting up-abstracting down, zooming in-zooming out, goals-vision, social-solitude, thinking big-thinking small · **Other:** needs-solutions, tradition-innovation, freedom-constraints, simplicity-abundance, natural-artificial, top down-bottom up, standardisation-customization, form-function, form-experience
Technological	**Other:** on-off, sensors-actuators, input-output, analog-digital, centralised-decentralised, hardware-software, user-interface
Evolutionary & Ecological	**UMA:** safety-achievement · **Other:** specialisation-generalisation, competition-mutualism, decomposers-producers, predator-prey, competition-symbiosis, growth-stability

This table provides examples of important conceptions of opposition across diverse domains, from mathematics to ecosystems. As an extension of our discussion of opposites in design thinking in the beginning of this chapter, we anticipate that this collection and organisation of opposites has promise as a practical tool for helping designers to "think in opposites." In this manner, we suggest that the table can support design thinking about harmony by considering the creative interaction of opposing forces.

During ideation, designers might use the table of opposites to explore divergent possibilities across multiple dimensions. The table can also facilitate design exploration workshops or creativity methods like concept mapping to help designers to intentionally expand their solutions into oppositional spaces they may have missed. Mapping ideas onto specific opposites like immediate gratification versus long-term wellbeing can reveal insightful tensions to resolve.

In a design process, opposites like these might be useful to support broader perspectives. Sometimes the differences between the opposites give rise to a new functional whole—a harmony. Sometimes conflicts or tensions can emerge between the opposites—and we suggest that these tensions will be useful to create designs with greater harmony.

For example, consider the opposites of simplicity and abundance in user interface design. A designer might think: how might I make the most minimalist, streamlined interface possible? They could then think in the opposite direction: how might I make an interface that supports an abundance of desirable features and options? From these mind-stretching oppositions, they might discover valuable new ways to harmonise these values and enhance the user experience. By thinking in opposites, designers can gain a more nuanced understanding of how to deliberately engage with contrast and difference in their pursuit of harmony.

For designers, these philosophical perspectives might also help shift mindsets around tension and polarisation. Rather than seeing oppositions as obstacles to resolve, contrasting needs and constraints could be embraced as fertile ground for creative synthesis. This perspective allows designers to appreciate conflict and challenge as opportunities for greater harmony.

VIII. LIMITATIONS AND FUTURE RESEARCH QUESTIONS

While this chapter offers a promising foundation for leveraging opposition in design, we have not fully explored the potential for conflict to lead to intractable problems and poor design outcomes. Despite our emphasis on the importance of opposition in harmony, we want to clearly acknowledge that conflict and opposition are not always positive forces. Conflicts can drain energy, weaken capabilities, frustrate us, and harm relationships. Many conflicts might be needless, creating discord that disrupts positive experiences. Disharmony is not the overarching goal.

Further, we wish to clarify the difference between "binary thinking" and thinking in opposites. Binary thinking or "black and white thinking," is the tendency to take an extreme view of possibilities, rather than seeing finer grained distinctions or shades of grey. Thinking in strict dichotomies, where complex situations are cognitively reduced to simple binary options, is often associated with psychological pathologies (Bonfá-Araujo et al, 2022:461) or 'belief traps' (Scheffer et al, 2022). Binary thinking leads individuals to seeing people or ideas as wholly good or bad, or wholly for them or wholly against them. Simplifying complex issues into good versus bad or right versus wrong fails to capture the nuance of situations, especially when it comes to understanding concepts that are not inherently moral in nature. This lack of middle ground and nuance can lead to rigidity and hostility. Unlike thinking in opposites, where each side has mutual virtues, with binary thinking the opposites are locked in battle, with each side of the opposite antagonistically seeking to overcome and destroy the other. The psychologist Carl Jung noted that internal conflicts were sometimes resolved through a complete repression of an opposing tendency and he suggested that this dualistic perspective was the source of many psychological pathologies.

> *The obvious analogy, in the psychic sphere, to this problem of opposites is the dissociation of the personality brought about by the conflict of incompatible tendencies, resulting as a rule from an inharmonious disposition. The repression of one of the opposites leads only to a prolongation and extension of the conflict, in other words, to a neurosis. The therapist therefore confronts the opposites with one another and aims at uniting them permanently. (Jung 1963, 20)*

In contrast to binary thinking, thinking in opposites rejects the moral lens of good versus bad and instead frames opposites as complementary forces that provide depth and meaning to each other. For instance, consider light and shadow in visual art: these are complementary forces that work together to create a composition. Neither is inherently superior. We don't appreciate the light in spite of the shadow; instead, we experience the shadow-light and appreciate their nuanced combination.

This chapter raises several research questions for the future study of conflict and harmony. To begin, what are the

factors that distinguish productive conflicts from destructive ones? Understanding why some conflicts lead to harmony and some to disharmony might help designers to more effectively leverage the creative potential of opposition. Perhaps all dissonance has the potential to contribute to harmony, but perhaps some conflicts are truly irreconcilable. The opposition in our sources are not suggestive of a battle to the death. We are not discussing the opposition of mutual hatred, where each opposing force seeks to destroy the other. Instead, our focus is on oppositions where contrast and difference can mutually support one another and lead to greater harmony. Yet, we don't wish to be naive about the potential for opposition to spiral into harmful extremes.

Future research might explore specific strategies for managing opposition, such as giving space and separation to the dynamic interplay of opposites. This research could lead to new insights into how designers might support productive tension and resolution. This includes the provision of space for opposite factors (such as the oscillation between phases of convergence and divergence) and the creation of deliberate spaces for airing conflict. In general, does creating space for conflicting opinions amplify latent conflicts or does it support mutual co-existence and resolution?

Opposites clearly play an important role in the human mind. The Unified Model of Aesthetics, for instance, clearly illustrates how the harmony of opposites underpins our aesthetic motivations. Perhaps novel psychological theories might be discovered that describe a broader motivational role for harmony (e.g., motivating the harmonisation of conflicting forces in the mind)?

Finally, the prevalence of opposites in both human cognition and fundamental physical phenomena (Table 1) raises deeper questions about the nature of opposition and its role in shaping our understanding of the world. Are opposites an artefact of the human mind? Or are these oppositions a key feature of physical reality? Engaging with these questions at the intersection of design, philosophy, and science could open up new avenues for interdisciplinary collaboration and discovery.

IX. CONCLUSION

The central argument of this chapter is that opposition and conflict can (paradoxically) serve as a generative force for harmony in design. We have provided numerous practical examples for how designers can harness thinking in opposites to create greater harmony in their design. Rather than eliminating conflict by suppressing one or more sources of opposition, designers have the opportunity to use the opposition between forces as a source of energy that can support the flow of innovation. Indeed, conflicts and contrasts are arguably the very material that designers work to harmonise. High notes and low notes, shadow and light, life and death; the interactive conflict between opposites provides the energy and drive for harmony. Similarly, gaps in value create opportunities for designers to innovate. At a personal level, challenges motivate growth. Tension is intrinsic to the sweetness of resolution. And, imperfections can lend character and emotional resonance to designs.

By providing a more nuanced understanding of how opposition contributes to harmony and the generative value of conflict, we hope to equip designers with new ways of thinking about harmony. We hope that our reflections can help designers better harmonise competing demands, as in the case of balancing user needs with business goals. By deliberately incorporating and appreciating the creative power of opposition, designers may be able to create more harmonious experiences that succeed in resonating with stakeholders. Designers seeking harmony must be able to navigate and integrate conflicting needs, dissenting voices, and negative emotions. Rather than suppressing, eliminating, or avoiding conflict, skilled designers may be able to discover tension as a creative energy for harmonisation and harness conflict as the motivation for new value creation. This does not imply that we should directly pursue conflict, but rather that we might learn to appreciate the "beauty in the storm."

This chapter aims to make several key contributions. First, we clarify the nature of opposition in harmony using classical philosophy and the Unified Model of Aesthetics. Second, we present designing itself as a harmonising activity; objectively, because designing involves the creation of functional wholes through the integration of diverse elements and, subjectively, because designing relies on a qualitative experience of harmony. Third, we examine music as a model for harmonisation, showing how imperfections and dissonance can contribute to richer experiences. Fourth, we reframe conflict and opposition as sources of creative energy in design. To support this, we provide practical methods for thinking in opposites and a table of opposites to promote creative problem-solving. Finally, we propose research questions to guide further inquiry into the harmony of opposites. Each of these contributions aim to support our key

objective: to enhance our understanding of the harmony of opposites and to apply this understanding towards the design of a more positive future.

BIBLIOGRAPHY

Alexander, Christopher (2002), *The Phenomenon of Life. Book two of The Nature of Order.* Berkeley, CA: The Center for Environmental Structure.

Ardley, Gavin (1967), "The role of play in the philosophy of Plato." *Philosophy* 42, no. 161: 226-244.

Begley, Keith (2022), "Knowing opposites and formalising antonymy." *Epistemology & Philosophy of Science* 59, no. 2: 85-101.

Berghman, Michaël, and Paul Hekkert (2017), "Towards a unified model of aesthetic pleasure in design." *New Ideas in Psychology* 47: 136-144.

Blijlevens, Janneke, and Paul Hekkert (2019), "Autonomous, yet Connected." *Psychology & Marketing* 36, no. 5: 530-546.

Bonfá-Araujo, Bruno, et al. (2022), "Seeing Things in Black-and-White." *Japanese Psychological Research* 64, no. 4: 461-472.

Branchini, Erika, et al. (2021), "Opposites in reasoning processes." *Frontiers in Psychology* 12: 715696.

Branchini, Erika, et al. (2023), "Training People to Think in Opposites." *Journal of Intelligence* 11, no. 5: 91.

Chan, Paul Yaozhu, et al. (2019), "The Science of Harmony." *Research: A Science Partner Journal*.

Cheng, Chung-ying (1977), "Toward constructing a dialectics of harmonization." *Journal of Chinese Philosophy* 33, no. 5: 25-59.

Cross, Nigel (1982), "Designerly ways of knowing." *Design Studies* 3, no. 4: 221-227.

Crilly, Nathan (2015), "Fixation and creativity in concept development." *Design Studies* 38: 54-91.

Da Silva, Odette, et al. (2017), "Beauty in efficiency." *Empirical Studies of the Arts* 35, no. 1: 93-120.

Dam, Rikke Friis, and Yu Siang Teo (2022), "The History of Design Thinking." *Interaction Design Foundation*.

Davies, Matthew, et al. (2012), "The effect of microtiming deviations on the perception of groove." *Music Perception* 30, no. 5: 497-510.

Dewey, John (1934), *Art as Experience*. New York: Minton, Balch & Company.

Diogenes Laertius (1925), *Lives of Eminent Philosophers, Volume II: Books 6-10*. Cambridge, MA: Harvard University Press.

Evans, Jonathan St BT (2008), "Dual-processing accounts of reasoning, judgment, and social cognition." *Annu. Rev. Psychol.* 59: 255-278.

Goldin, Owen (2015), "The Pythagorean table of opposites." *Science in Context* 28, no. 2: 171-193.

Gottschall, Jonathan (2012), *The Storytelling Animal*. Boston, MA: Houghton Mifflin Harcourt.

Hehn, Jennifer, et al. (2019), "On integrating design thinking for human-centered requirements engineering." *IEEE Software* 37, no. 2: 25-31.

Hekkert, Paul (2006), "Design aesthetics: principles of pleasure in design." *Psychology Science* 48, no. 2: 157.

Hekkert, Paul (2014), "Aesthetic responses to design: A battle of impulses." In *The Cambridge Handbook of the Psychology of Aesthetics and the Arts*. Cambridge University Press.

Hekkert, Paul (2020), "Paul Hekkert Delivers TU Delft's Foundation Day lecture." TU Delft News.

Hekkert, Paul, et al. (2003), "'Most advanced, yet acceptable': Typicality and novelty as joint predictors." *British Journal of Psychology* 94, no. 1: 111-124.

Hennig, Holger, et al. (2011), "The Nature and Perception of Fluctuations in Human Musical Rhythms." *PLoS ONE* 6, no. 10: e26457.

Hokkanen, L., et al. (2016), "Minimum viable user experience." In *Agile Processes, XP 2016*, Springer.

Huffman, Carl (1993), *Philolaus of Croton: Pythagorean and Presocratic*. Cambridge University Press.

Joosten, Wessel (2023), "A.I. Music and Identity Shaping." *Diggit Magazine*.

Jung, Carl Gustav (1963), "Mysterium coniunctionis." *Collected Works of Carl Jung*, volume 14.

Koestler, Arthur (1981), "The three domains of creativity." In *The Concept of Creativity in Science and Art*, Springer.

Korde, Runa, and Paul B. Paulus (2017), "Alternating individual and group idea generation." *Journal of Experimental Social Psychology* 70: 177-190.

Lahdelma, Imre, and Tuomas Eerola (2016), "Mild dissonance preferred over consonance." *i-Perception* 7, no. 3.

Lee, Y. T., et al. (2009), "Daoist Harmony as a Chinese Philosophy and Psychology." *Peace and Conflict Studies* 16, no. 1: 68-78.

Li, Chenyang (2006), "The Confucian Ideal of Harmony." *Philosophy East and West* 56, no. 4: 583-603.

Li, Chenyang, & Dascha Düring (2022), *The Virtue of Harmony*. Oxford University Press.

Lin, Albert and J. Derek Lomas (2022), "The Enigma of Mind." In *Enigmas: Darwin College Lectures*, Cambridge University Press.

Lindblom, Charles E (1959), "The Science of Muddling Through." *Public Administration Review* 19, no. 2: 79-88.

Lomas, J. Derek, et al. (2021), "Design space cards." *Proc. ACM on Human-Computer Interaction* 5, CHI PLAY: 1-21.

Lomas, J. Derek, et al. (2021), "Designing Data-informed Intelligent Systems." In *RSD10*, pp. 154-170.

Lomas, J. Derek, et al. (2022), "Resonance as a design strategy for AI and social robots." *Frontiers in Neurorobotics* 16: 850489.

Lomas, J. Derek, and Haian Xue (2022), "Harmony in design." *She Ji* 8, no. 1: 5-64.

Max Planck Institute (2024), "Electronic Music with a Human Rhythm."

Milburn, Olivia (2015), *The Spring and Autumn Annals of Master Yan*. Vol. 128. Leiden: Brill.

Norman, Donald (2023), *Design for a Better World*. Cambridge, MA: MIT Press.

Ozkaramanli, Deger, et al. (2020), "From discovery to application." *Diseña* 17: 58-83.

Parncutt, Richard, and Graham Hair (2011), "Consonance and Dissonance in Music Theory and Psychology." *JIMS* 5, no. 2: 119-166.

Post, R. A. G., et al. (2016), "To preserve unity while almost allowing for chaos." *Acta Psychologica* 163: 142-152.

Rubin, Rick (2023), *The Creative Act: a Way of Being*. Penguin.

Sanders, Elizabeth, and Pieter Jan Stappers (2012), *Convivial Toolbox*. Bis.

Scheffer, Marten, et al. (2022), “Belief traps.” *PNAS* 119, no. 32: e2203149119.

Schimmack, Ulrich (2001), “Pleasure, displeasure, and mixed feelings.” *Cognition & Emotion* 15, no. 1: 81-97.

Suri, Jane Fulton (2011), “Poetic observation.” In *Design Anthropology*, Springer, Vienna.

van Boeijen, Annemiek GC, et al. (2020), *Delft Design Guide*. Bis Publishers.

Vichnar, David, and Louis Armand (2017), “Aisthēsis.” In *Oxford Research Encyclopedia of Literature*.

Victor, Bret (2011), “Ladder of Abstraction.” Worrydream.

Xie, Jian, et al. (2011), “Ecological mechanisms underlying the sustainability of the agricultural heritage rice-fish coculture system.” *PNAS* 108, no. 50: E1381-E1387.