

Concentric Circles & Squares: Layers of Consciousness in Symbol and Design

Figure 1: Da Vinci's Vitruvian Man superimposed in a circle and a square, symbolizing the union of cosmic and earthly realms ¹. This Renaissance image echoes much older ideas linking geometric forms to levels of being.

1. Historical and Philosophical Origins

Across cultures, concentric circles and squares have long served as metaphors for layered reality and consciousness. **Mandalas** in Hindu and Buddhist traditions are classic examples: a sacred center radiating outward through nested squares and circles that map the cosmos and mind ² ³. In a typical tantric mandala, a square “palace” with four gated sides lies at the center of multiple rings – together forming a “sacred enclosure” of concentric geometry that represents an “adamant plane of being” on which the aspirant establishes focus ². Each outer circle signifies a transitional veil (e.g. a ring of fire for wisdom, a lotus circle for openness), encircling the inner square where deities reside ⁴ ⁵. Such layered mandalas are used as visual **maps of consciousness**, guiding meditation from the outermost worldly periphery to the innermost point of enlightenment. In Hindu yantras, similarly, a **square with four T-shaped gates** often contains an inner circle and bindu (dot) – symbolizing the microcosm within the macrocosm ⁶. The circle is infinity or spirit, and the enclosing square denotes the grounded world; together they unify transcendence and immanence. This circle-square pairing also appears in ancient Chinese and Masonic symbolism, where a **circle represents Heaven and a square represents Earth**, their union signifying cosmic harmony ⁷ ¹. The Renaissance icon of **Vitruvian Man** (Figure 1) explicitly embodies this union: Leonardo da Vinci drew the ideal human figure fitting perfectly in a circle and a square, echoing the medieval view of the circle as divine and the square as secular ⁷ ¹. The human at the center thus bridges higher and lower planes – a geometric allegory for the aligned consciousness of man with cosmos.

Beyond religious art, psychologists like **Carl Jung** observed similar concentric patterns arising from the psyche. Jung noted that across cultures the motif of a centered circle (often quartered or squared) emerges in dreams and art as an archetype of the **Self** – the totality of the psyche ⁸ ⁹. In Jungian theory, drawing mandalas in therapy often signified the creator's inner state and a striving for psychic wholeness. Jung found that these circular patterns form spontaneously during “moments of intense personal growth,” reflecting a natural attempt of the psyche to organize and harmonize itself ¹⁰ ¹¹. He wrote that “the mandala is the center... the path to the center, to individuation,” describing it as a concentric roadmap to one's **core of consciousness** ⁹ ¹². This idea dovetails with Eastern concepts like the **five koshas** in the Upanishads, which describe consciousness as nested layers (sheaths) around the divine Self. The koshas are often envisioned as **five concentric circles or spheres** – physical body, vital energy, mind, intellect, and bliss – each subtler than the last, enveloping the innermost Atman ¹³ ¹⁴. Such models present consciousness not as a single plane, but as stratified rings or shells that one can journey through in meditation or self-inquiry. In sum, from mandalas and yantras to esoteric diagrams and Jungian art, concentric geometry has provided a **spatial language for consciousness**, intuitively conveying how an awakening mind might expand through levels (circles) while remaining grounded by structure (squares).

2. Nested Rhythms: Modern Neuroscience Models

Contemporary neuroscience offers striking parallels to these age-old concentric metaphors. The brain's electrical activity is composed of **nested oscillatory bands** – gamma, beta, alpha, theta, delta – that correlate with different cognitive states and depths of consciousness. Rather than independent rhythms, research shows these bands are hierarchically coupled, with slower waves providing a temporal container for faster waves. In other words, brain activity is organized in concentric layers of frequency. For example, a slow **theta cycle (4–8 Hz)** in the hippocampus can nest multiple **gamma bursts (40–100 Hz)** within each of its phases, a mechanism thought to segment information (gamma packets) within the larger context of memory encoding or navigation (theta phase) ¹⁵ ¹⁶. This phenomenon, known as **cross-frequency coupling**, essentially “stacks” brainwave bands like concentric rings: the slower oscillation sets the outer ring or frame, within which the faster oscillation oscillates as an inner ring. Neuroscientists have found that such coupling is not arbitrary – it reflects how different “levels” of brain processing communicate. For instance, **delta-beta coupling** (a very slow wave modulating a faster ~20 Hz rhythm) has been linked to top-down executive control, whereas **theta-gamma coupling** tends to mark bottom-up sensory processing and memory formation ¹⁶ ¹⁷. In this way, higher-order attention or goal states (delta/beta) can influence finer-grained perception and thought patterns (theta/gamma) by literally **embedding one within the other**.

The “nesting” of frequencies has inspired theoretical models of consciousness as a hierarchy of temporal windows. One recent framework, the **Nested Observer Windows (NOW) model**, proposes that our awareness is built from multiple observer “windows” operating at different scales (from fast neural events to slower integrative states) ¹⁸ ¹⁹. These windows align with brain rhythms: a fast gamma-frequency window might correspond to a fleeting sensation or micro-perception, while slower alpha or theta windows integrate those micro-experiences into a cohesive moment of consciousness. Importantly, the coupling between layers (e.g. phase-amplitude coupling between a slow and fast wave) is what binds the levels into one conscious multilevel process ²⁰ ¹⁶. Empirical support for this comes from neurofeedback and stimulation studies. Delivering **interlaced dual-frequency stimulation** to mimic natural cross-frequency nesting can enhance cognitive performance – for example, simultaneous theta+gamma rhythm stimulation in the frontal lobe improved working memory more than either frequency alone ¹⁷. This suggests that the **mind is holistically reflected in concentric frequency layers**, much like an onion of oscillations. Some theorists even go further, suggesting the “**resonance**” of consciousness comes from a cascade of nested oscillators throughout the brain (and potentially body), each level resonating in broader fields of coherence ²¹ ²². In practical terms, modern EEG devices and brain-computer interfaces now commonly break down the user's mental state into the classic bands (delta through gamma) and treat these as concurrent layers. A person's state of focus or relaxation is often inferred by the relative power in these bands – essentially a concentric profile of their brain's rhythms at that moment ²³ ²⁴. The fact that EEG headsets can output real-time **band power readings (Delta, Theta, Alpha, Beta, Gamma)** underscores this layered view: consciousness can be quantitatively depicted as a set of concentric dials or rings, each representing a band's activity. In short, neuroscience is validating a “layered” model of mind – **slower waves (outer rings) set context for faster waves (inner rings)** – uncannily mirroring the concentric maps of consciousness found in sacred geometry and holistic psychology.

3. Concentric UI Patterns for States and Transitions

Translating these concepts into user interface design, we find a rich toolbox of **radial and grid-based metaphors** that echo the idea of layered or multi-level states. Concentric circles are naturally suited to

visualize a core and its surrounding layers, and modern UI/UX designers have used them in everything from data dashboards to meditation apps to represent nested information or progressive stages. For example, **radial progress charts** and **donut charts** use concentric rings to show multiple metrics on a common center – an outer ring might represent an overall score while inner rings show sub-components. This inherently conveys hierarchy (outer encompassing inner) much like levels of awareness. In interfaces specifically geared toward navigating mental or cognitive states (focus, relaxation, etc.), designers often employ **circular menus and radial graphs** because they spatially suggest wholeness and continuity. A prominent pattern is the **radial menu (pie menu)** for context navigation: options are arranged in a circle, sometimes with multiple concentric layers for sub-menus. These can be more intuitive than linear menus, as selection is by angle and nested options can rotate into view ²⁵ ²⁶. Notably, libraries like *RadialMenu.js* provide ready-made radial menu components where developers can define inner and outer radius, number of slices, rotation offset, etc., to create beautiful circular menus ²⁷ ²⁸. Such menus can even replace traditional right-click context menus, appearing as a ring of icons around the cursor – a fitting UI metaphor when building a “circle and square” panel that might pop up options in a round fashion for a given module.

Beyond static menus, more dynamic geometric **transformations** are used to signify shifts in state. One relevant technique is **morphing between a circle and a square**, which can symbolize a change from a fluid, open mode to a structured, focused mode (or vice versa). Modern CSS/SVG can interpolate shapes via path morphing, and even more powerfully, WebGL shaders can achieve smooth shape morphs using mathematical formulas. A common approach is using **Signed Distance Functions (SDFs)** to represent shapes like circles and squares in a shader, then blending these functions. This yields a perfectly fluid morph without losing crispness ²⁹ ³⁰. For instance, by defining a circle’s SDF and a square’s SDF, a shader can interpolate between them based on a parameter (morphFactor). The result is a real-time transition where the shape gradually rounds or sharpens – a visual metaphor for a state transitioning from “circular” (holistic) to “square” (analytical) or vice versa ³⁰ ³¹. Such an animation could be triggered by biofeedback (e.g. the UI is circular when the user is relaxed, but becomes a square grid when intense focus is detected). This **circle↔square morph** embodies the UI’s thematic metaphor while also providing functional feedback to the user. Crucially, implementing this via shaders is “shader-friendly” – it offloads the heavy lifting to the GPU, enabling smooth 60fps animations even with complex geometry ³² ²⁹. The use of GLSL and SDFs means the transition can include other effects (color shifts, pulsating outlines) tied to the morphing, enhancing the neuroaesthetic feel of the interface.

Another pattern is using **layered concentric rotations**. Imagine multiple ring segments (like a target or bullseye) that can rotate independently – this could visualize different “gears” of attention or modes of operation. In fact, some UX specs for attention-training apps describe “fractal bullseye” designs where each concentric ring represents a process and might rotate to indicate activity or phase ³³ ³⁴. For example, an outer ring might slowly turn to signify a breathing cycle, while an inner ring oscillates faster with heartbeat or EEG alpha waves – giving a live, nested visualization of physiological rhythms. Rotational interaction can also be used for input: one could twist a given ring (via drag or scroll gesture) to adjust a parameter associated with that level. This was hinted in the design notes for *DonutOS*, which mention “rotation as context shift” for navigating between layers ³⁵. A real-world inspiration is the **Polar Clock** concept (popularized as a screensaver) which shows time units (seconds, minutes, hours, day) as concentric arcs that rotate and fill – each ring a different speed. Translating this to a consciousness interface, one could have rings for “**Gamma, Beta, Alpha, Theta, Delta**”, each dynamically rotating or pulsing at a rate proportional to the current power in that band. This would create a living mandala on screen: a set of circles within circles, each turning and glowing according to the user’s mind-state in real time.

From an implementation standpoint, these concentric and radial patterns should be built with performance and flexibility in mind. **Three.js or WebGL-based UIs** are ideal for such graphics-heavy, animated interfaces in the browser. Three.js can render 3D torus shapes, rings, and planes that we can texture or shade dynamically. For example, developers have created custom Three.js radial menu classes and components (like GZ3D's RadialMenu for Gazebo/ROS interfaces) that allow only one radial menu open at a time and support touch interaction ³⁶. Using a 3D library also future-proofs the design for VR, where these concentric panels could be depth-positioned in a virtual space (imagine a floating torus with concentric rings you can literally step into). For 2D implementations, HTML5 Canvas or SVG can suffice for simpler concentric visuals (with D3.js offering convenient patterns for radial layouts like sunburst charts). But given the project's emphasis on "shader-friendly" and modular geometry, leaning on WebGL/Three.js is wise. We can create **fragment shaders for the circle-square morphs**, vertex shaders for any warping animations, and efficiently map real-time data to visual parameters. In summary, the UI/UX landscape offers many precedents of concentric layouts – from **radial navigation menus, pie charts, sunburst hierarchies, to animated rings and morphing shapes** – which can be combined to create an interactive "Circle & Square" panel that intuitively visualizes layered awareness. The key design goal is to make the interface feel alive and **symbolically clear**: circles and squares should not be merely decorative, but actively respond to mental state changes (e.g. rotating, morphing, expanding) in a way the user can immediately grasp.

4. Open-Source and Demo Implementations

To ground these ideas in practice, it's helpful to look at existing demos and libraries that we can draw upon. For radial interfaces, the open-source community has plenty of examples. **RadialMenu.js** (available on GitHub) is a pure JS/SVG library that makes it easy to spawn customizable pie menus on a webpage ²⁷ ²⁶. With a few lines of code, you can define menu items, inner/outer radius, colors, etc., and have a functional radial menu that could serve as the "collapsed circle" state of a panel. Another example is the collection of **CSS/JS circular menus** on sites like CodePen and FreeFrontend – these often demonstrate creative designs like navigation buttons arranged in a circle that expand on hover, multi-level radial menus with animation, and so on. While these are typically 2D DOM implementations, they illustrate interaction patterns that could translate to a WebGL scene (for instance, detecting a right-click and popping a textured circle in Three.js with menu options).

On the visualization side, **open-source EEG visualization tools** can inspire our design for showing brain states. For example, OpenBCI's GUI (which is Processing/Java-based, but conceptually relevant) displays EEG band powers in real time. One mode shows a **ring graph** where each band's magnitude is a radial bar – essentially a concentric bar chart. We can create a sleeker version of this in WebGL: five translucent rings (for δ , θ , α , β , γ) emanating from a center, whose radii or opacities fluctuate with the user's brainwaves. Since our project specifically mentions a *Donut-style geometric framework*, we can also incorporate 3D shapes like torus segments. Three.js demos exist for torus and spiral visualizations – for instance, some creative coders have made **3D spiraling timelines and circular loaders** using Three.js that could be repurposed to show time or phase in a concentric fashion. The **fractal/holographic** angle (alluded to by the "Flower-of-Life / hex" bullseye spec ³³) suggests using repeating patterns. We might generate a radial hexagonal grid or Flower-of-Life pattern as an overlay on the circles, giving a sense of nested symmetry (this could be a static SVG texture applied to a plane in Three.js and scaled through layers). There are open SVGs of the Flower of Life pattern which could be layered and blended with CSS or WebGL shaders to create a dynamic background that subtly rotates or pulses – reinforcing the idea of a "holographic" pattern where each concentric ring echoes a smaller motif.

In terms of code resources, for **shape morphing and shaders**, we have community examples like the Medium article and GitHub by Denis (2025) demonstrating shape morph via GLSL SDFs ²⁹ ³⁰. Denis provides full shader code (on his GitHub) for smoothly interpolating between circle, square, star, etc., including color transitions ³¹ ³⁷. This could be adapted directly in our project's WebGL materials – e.g., a fragment shader that takes a uniform `morphFactor` (0 to 1) and two shape IDs, and outputs the blended shape. For **layered rotations**, one can look at the open-source **D3.js sunburst** or **radial dendrogram** implementations. D3's examples (observable notebooks or blocks) show how to partition hierarchical data into rings and animate transitions when drilling down or zooming out. Adapting that logic to our UI, if the user “zooms” into a particular layer of consciousness, we could animate a sunburst zoom (inner rings expand to become the whole circle, revealing new inner layers) – a very literal metaphor of diving into a sub-layer of mind. D3 code could provide the math for positioning elements in polar coordinates, which we could then feed into Three.js objects for a 3D twist.

For more direct examples focused on cognitive or neurofeedback visuals: there have been interactive art installations and apps that use concentric, brain-driven visuals. One notable project (Met Museum's 2018 “Mapping the Mind” event) connected an EEG headband to an app that generated **Tibetan mandala patterns in real time** based on brain activity. Participants' brainwaves essentially “painted” a mandala, with certain bands controlling symmetries and colors. While proprietary, it shows the concept of a **brain-responsive mandala UI** is feasible. On the open-source side, we see things like “**Neurotune**” – a demo music application that uses the Neurosity Crown's EEG to modulate generative music and visuals ³⁸. The developer documented designing dynamic soundscapes that react to the user's focus level (high beta/gamma increases intensity, etc.). We could follow a similar approach for visuals: tie the Crown's focus/calm metrics or raw band powers to shader parameters (rotation speed, color bloom, shape morph amount). Since Three.js can easily receive realtime data via a simple subscription (e.g., using the Crown's JavaScript SDK), integrating these is straightforward. In fact, the **Neurosity SDK** itself provides some built-in high-level metrics like `focus()` and `calm()`, which output 0–1 values reflecting mental state, as well as raw `powerByBand` data streams ³⁹. One could imagine an open-source demo where a Three.js scene displays a concentric gradient circle that brightens and sharpens when `focus=1` (perhaps morphing into a square for full focus), or a set of five concentric rings that each pulse at the rhythm of its corresponding EEG band. These kinds of reactive visuals have precedents in biofeedback games – for example, meditation apps with floating orbs that rise when you're calm, or driving games where your alpha waves control speed. What we aim to do differently is use **concentric geometry as the primary UI**, not just a gimmick: the interface itself (menus, panels, transitions) will be built out of circles, rings, and squares that morph and animate with data. This blurs the line between data visualization and interaction – the user will be navigating a UI that is *itself* a metaphor for their mind. Fortunately, many of the pieces to build this exist in open form (radial menu libraries, D3 polar layouts, shader morph techniques), which we can assemble and refine.

5. Neurofeedback Integration (Neurosity Crown & Beyond)

Finally, to connect all this with real-world neurofeedback hardware: the **Neurosity Crown** EEG device provides a developer-friendly way to drive our “Circle & Square” interface with brain data. The Crown comes with an official JavaScript SDK that streams data from its 8 EEG sensors in real time ⁴⁰. Using the SDK, we can subscribe to band powers or device metrics and link them to UI elements. For example, the SDK's `brainwaves("powerByBand")` API gives us an object with the latest average Delta, Theta, Alpha, Beta, Gamma values (updated multiple times per second) ³⁹. These values could directly map to the radii of five concentric rings in our interface, or to five segments of a circular bar, effectively creating a real-time brainwave radar chart. In addition, the Crown SDK offers precomputed metrics like `focus()` and

`calm()`, which are distilled measures combining various bands (the Crown’s internal algorithms for attention and relaxation). One could use the `focus` level (0–100 or 0–1 scale) to determine the morph state of the central shape – e.g., when focus is high, the interface “locks in” to a sharp square (indicating a focused mode), and when focus drops, it relaxes into a circle (indicating an open, diffused awareness). Similarly, the `calm` score might modulate color themes (a cool blue glow when calm, versus orange when not). The **Neurocity API documentation** even encourages creative uses, saying it was designed to enable “powerful programs to be built” on raw and band data ⁴¹ ⁴². Our use – a geometrical UI that the mind can influence – is a prime example of that vision.

To implement this integration, we do not necessarily need to start from scratch. There are open-source projects and community examples that interface Crown (and similar EEG devices) with visual outputs. For instance, the open-source **BrainFlow** library supports Neurocity Crown, allowing one to pipeline Crown data into Python or Processing sketches easily ⁴³. While our project is web-based, BrainFlow’s existence shows that hooking into Crown’s data is straightforward and flexible. We could also use **OSC (Open Sound Control)** as a bridge: the Crown SDK can emit data that we send via OSC to other visualization software if needed, or even within the browser if using Web Bluetooth (Neurocity also supports direct BLE streaming for certain data). On the front-end, our Three.js app will simply call the Neurocity SDK’s `neurocity.brainwaves()` and update the scene on each new data event. Given the Crown samples at 256 Hz and provides power updates perhaps ~1–2 times/sec for each band, the UI updates will feel fluid without being overwhelming. We will have to smooth or interpolate the values to avoid jitter – likely using a rolling average or easing function so that the rings and shapes respond smoothly to changes in mental state. This smoothing itself can have a metaphorical aspect: sudden spikes in mind activity might cause a gentle ripple in the interface rather than a jarring jump, akin to how a well-trained mind handles distractions with equanimity.

Beyond Crown, our design can remain device-agnostic. Other EEG platforms like **OpenBCI**, **Emotiv**, or **Muse** also provide band powers and metrics that can feed into the same interface. In fact, Emotiv’s recent blog on “Top 6 EEG APIs” lists Neurocity’s SDK as a top choice for JavaScript developers ⁴⁴, highlighting how these tools are converging in capability. The **Notion (Neurocity’s earlier model)** and **Muse headbands** have open SDKs or community libraries that similarly output alpha, beta, etc. – so Circle & Square could potentially support multiple devices by abstracting the data source. An example of multi-device support is the open-source **EEG Notebooks** project, which now can ingest Crown data via BrainFlow ⁴⁵. We might not need that heavy framework, but it’s good to note that standardization is possible.

Crucially, integrating neurofeedback means we should consider the **feedback loop and user experience**. The interface should not only display brain-state info but also *influence* it in a positive way. This is where neuroaesthetics come in: the choice of calming colors, symmetric patterns, and smooth motions in the concentric visuals can actively guide the user toward certain states. For example, if the interface detects erratic beta activity (stress), it could respond by enlarging a soothing blue circle and gently pulsing at an alpha frequency, thereby cueing the user (subconsciously or consciously) to relax and entrain to that rhythm. There are neurofeedback systems that use similar principles – e.g., a **flower that only blooms when your mind is calm**. In our case, maybe the central circle only blossoms into a complex Flower-of-Life pattern when the user sustains a meditative state (high alpha/theta) for a period. The “Donut” framework mentioned in the context suggests a playful, gamified approach to attention training, so we can incorporate subtle game mechanics: concentric rings that align or light up when certain brain metrics reach targets, etc.

To summarize, **Neurofeedback integration is the bridge between the metaphor and the reality**. With devices like the Crown, we have real-time, nuanced data on the user's mental layers – and we have full control to craft concentric, morphing, rotating visuals to represent those layers on screen. By leveraging open-source SDKs and graphics libraries, we can create an interface that is not just a dashboard of the mind, but a two-way membrane: the user gazes at the concentric circles and squares to understand their own mind state, and in doing so, the very act of engagement (and the visual feedback provided) guides them toward the desired state. This fulfills the ancient promise of mandalas and sacred geometry as **tools for focusing consciousness** – now powered by modern technology. Our Circle & Square panel will essentially be a living mandala, one that updates with your EEG in real time and helps translate between the spatial language of geometry and the temporal language of the mind.

Sources: Historical symbolism of concentric mandalas ² ⁴⁵ ; circle and square as heaven & earth ⁷ ¹ ; Jungian mandala psychology ⁹ ¹⁰ ; Upanishadic kosha layers ¹³ ; neuroscience models of nested brain rhythms ¹⁵ ¹⁶ ; cross-frequency coupling in cognition ¹⁶ ¹⁷ ; radial UI design patterns ²⁷ ²⁶ ; shader morphing of circle↔square ³⁰ ³¹ ; Neurosity Crown API for EEG bands ³⁹ ; integration of EEG with dynamic interfaces ⁴⁶ ³⁸ .

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