

Thesis Project Portfolio

Tempo: A Personalized Audio Experience
(Technical Report)

Nature Is All You Need: A New Paradigm in Machine Learning
(Technical Report)

The Theory of Everything
(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Introduction

This portfolio investigates how engineering ingenuity and sociotechnical reflection can co-evolve to tackle contemporary challenges in computing efficiency, user-centered design, and our understanding of reality itself. Four projects—two technical reports, a prospectus, and an STS research paper—form a cohesive narrative: harnessing nature’s principles to build more balanced, sustainable, and human-aligned systems. Together they reveal that breakthroughs in hardware, software, and theory are most powerful when viewed as interlocking responses to the same underlying question: *How can we design technology that mirrors the elegant economy and equilibrium of the natural world?*

Electrical Engineering Technical Capstone

This paper presents *Tempo*, an integrated system consisting of an innovative iOS application paired with a custom-designed Bluetooth speaker, aiming to enhance music listening experiences through personalized recommendations and social connectivity. Leveraging Spotify's Web API alongside OpenAI's natural language processing, the app generates tailored music playlists based on user prompts, visualizes musical compatibility with friends, and provides comprehensive listening analytics. The Bluetooth speaker complements the app by delivering high-fidelity audio playback and interactive visualizations via an integrated touchscreen. The project emphasizes user engagement, seamless hardware-software integration, and adherence to regulatory standards, showcasing a balanced combination of technological innovation, practical functionality, and social interactivity to redefine modern music consumption.

Computer Science Technical Capstone

This paper introduces an innovative machine learning approach inspired by biological efficiency, addressing the excessive computational and environmental demands of current digital models. By utilizing photorefractive crystals that naturally encode data through interacting light beams, the method mimics the brain's adaptive, energy-efficient pattern reinforcement processes. Unlike traditional models that require vast computational resources and extensive data, this optical platform delivers rapid, low-power inference with minimal environmental impact. Its innate ability to generalize and adapt quickly, enabled by easily resetting crystals, offers a sustainable, biologically inspired alternative to conventional machine learning techniques, paving the way for environmentally responsible and efficient artificial intelligence.

STS Research Paper

This paper introduces a theory of everything grounded not in new categorical frameworks, but in the recognition of reality's fundamental neutrality, a state of intrinsic balance underlying all phenomena, empirical and subjective alike. Traditional attempts to understand existence through defined structures such as science, philosophy, or religion invariably encounter anomalies, revealing inherent limitations in any categorical approach. By reconceptualizing measurable reality as interference patterns within a universal neutral "field," quantum mechanics and general relativity emerge naturally as complementary, scale-dependent expressions of a single underlying wave dynamic. The theory extends seamlessly into subjective domains, explaining emotions and beliefs as internal informational states whose external reflections create

predictable, self-fulfilling circumstances. Emotions thus become directional indicators guiding systems back to equilibrium. By integrating previously separate domains into a single coherent principle of balance, this theory offers a universally applicable framework capable of addressing classical paradoxes and supporting interdisciplinary advancement, providing practical insights into how shifts in internal definitions can reliably influence external outcomes across all fields and everyday experiences.

Prospectus

This prospectus introduces *Tempo*, an innovative iOS application designed to redefine music engagement by seamlessly integrating artificial intelligence with social interactivity. Addressing a clear gap in current streaming platforms, *Tempo* combines personalized AI-driven music recommendations and social sharing to enhance user experience. Beyond technical innovation, the prospectus explores the broader implications of AI through Kuhn's model of scientific revolutions and the Collingridge Dilemma, emphasizing the inherent balance between beneficial and detrimental outcomes of technological advancement. It argues that innovation inherently carries both positive and negative potentials, which ultimately remain in equilibrium; thus, responsible governance and user choices determine the direction technology takes within society. *Tempo* serves as a tangible illustration of this principle, demonstrating how thoughtful application of AI can maintain this balance while enriching everyday experiences.

Conclusion

Across radically different scales, photons in a crystal lattice, audio signals in a living-room speaker, or the metaphysical foundations of experience, each work in this portfolio leverages nature's own strategies of balance, efficiency, and pattern reinforcement. The optical ML system shows how to compute like a brain; *Tempo* demonstrates how to curate culture like a friend; the prospectus situates those tools within societal momentum; and *The Theory of Everything* supplies a philosophical compass that keeps engineering innovation aligned with universal neutrality. Collectively, they argue that future breakthroughs will not come from ever-greater complexity alone, but from harmonizing our technologies with the elegant constraints and possibilities already woven into the fabric of the universe.