Research Statement

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My scholarship is situated within Engineering Education Practice and is operationalised through a research-as-practice approach. It focuses on cognitive governance and value-oriented diagnostic reasoning and problem-solving in indoor air quality and sustainable building engineering education and practice. My research interests include mental modelling, cognitive governance, value-oriented diagnostic reasoning, risk assessment, and value-oriented problem-solving.

As a Design Theorist in Engineering Education Practice, I develop and refine design principles for communication solutions that empower mental model development, stimulate value-oriented questioning for cognitive ability enhancement, support sound judgement and decision-making, and ultimately guide action for value-oriented problem diagnosis and solving.

The central premise of my work is that many persistent problems in indoor air quality and sustainable building engineering are not only technical problems. They are also cognitive problems. In many situations, relevant information already exists, but learners and practitioners may lack the mental models needed to connect variables, interpret interactions, ask the right questions, and make value-oriented judgements. My research therefore addresses the cognitive barriers that prevent people from transforming information into knowledge, understanding, judgement, decisions, and effective action.

In operationalising this design theory, I systematically identify cognitive barriers that hinder value-oriented problem-solving. These barriers often arise from absent, incomplete, or inadequate mental models. They limit the ability of learners and practitioners to interpret information, generate understanding, reason through uncertainty, make sound judgements, and take appropriate actions. Through research-as-practice, I design, develop, and disseminate communication solutions that function as cognitive and emotional tools for strengthening the cognitive capabilities required for self-directed learning and value-oriented problem-solving.

The primary vehicle through which this work is developed, applied, and refined is the Indoor Air Cartoon Journal, a non-commercial living book series published as peer-level public scholarship. The journal serves not only as a dissemination platform but also as a design laboratory through which communication solutions are continuously created, applied, reflected upon, and refined. Through communication, storytelling, and cognitive scaffolding, the series explores how communication solutions can reduce cognitive barriers, strengthen cognitive governance, and improve value-oriented problem diagnosis and solving in real-world engineering contexts.

The Indoor Air Cartoon Journal is not a communication supplement. It is a primary research-as-practice output. Each article is designed to do more than transmit information. It is designed to develop mental models, stimulate value-oriented questioning, enhance cognitive capabilities, and support judgement, decision-making, and action. The resulting publications represent meaningful, purpose-driven, and rigorous scholarship operationalised through research-as-practice.

As the series evolves, each volume reflects deeper articulation, greater coherence, and more rigorous integration of design, experience, reflection, and practice-based insight. Collectively, the works contribute to an emerging design theory of communication solutions for cognitive governance. They demonstrate how communication can be intentionally designed to help learners and practitioners develop mental models, reason through complexity, and act more effectively in engineering education and professional practice.

To support the integration of these communication solutions into teaching and learning, I developed a teaching note for the Indoor Air Cartoon Journal. This enables educators across disciplines to adapt the journal's communication solutions for their own modules and learning contexts. In this way, the journal extends beyond individual articles and becomes a reusable educational resource for reducing cognitive barriers and strengthening value-oriented problem-solving.

The visibility, public nature, and scholarly character of this work are supported by the Google Scholar indexing of the Indoor Air Cartoon Journal and its institutionalisation through SIT Library curation. This positions the journal as a public scholarly resource that contributes to engineering education practice, public scholarship, and applied learning within and beyond the university context.

The originality of my work lies in five main areas. First, I develop and cognitively internalise original mental models for value-oriented problem-solving, including value delivery equations for producers and consumers of solutions, the human performance equation, an education definition equation, and a value delivery spectrum. Second, I reinterpret and cognitively internalise existing mental models to support value-oriented problem-solving, including the repurposing of epidemiological risk assessment and lean thinking concepts for broader diagnostic reasoning. Third, I integrate art, science, engineering, and literature

through fictional case stories that function as cognitive and emotional tools. Fourth, I support the cognitive internalisation of IAQ mass balance equations for value-oriented problem-solving. Fifth, I define and clarify key terms, including indoor air quality, healthy indoor air, building information modelling, communication, and sources of waste.

While my work does not primarily produce empirical or field-based engineering evidence, it provides scientifically grounded and plausible representations of engineering phenomena. More importantly, it generates evidence of how people can be guided to think, reason, judge, decide, and act more effectively. My contribution therefore lies in developing, refining, and applying design principles for communication solutions that strengthen cognitive governance and support value-oriented problem diagnosis and solving in real-world settings.

Over time, I have come to recognise that many challenges in indoor air quality (IAQ) and sustainable building engineering are not primarily constrained by a lack of technical knowledge. Rather, they are constrained by cognitive barriers that limit the ability of learners and practitioners to understand relationships between variables, reason through complexity and uncertainty, ask meaningful questions, and make value-oriented judgements. In many cases, relevant information already exists. The challenge lies in transforming that information into knowledge, understanding, judgement, decisions, and actions that support effective problem-solving.

This challenge is particularly evident in IAQ, where large volumes of scientific knowledge are available through peer-reviewed publications, standards, guidelines, and technical reports. While these resources are valuable, they are often written to maximise technical precision rather than cognitive accessibility. Consequently, many learners, practitioners, and members of the public struggle to develop the mental models required to understand how pollutants, exposure pathways, mitigation strategies, occupant behaviour, and health outcomes are connected and interact. The result is not necessarily a lack of information, but a lack of cognitive capability to transform available information into effective action.

These cognitive barriers have significant consequences. They limit the ability of non-experts to engage meaningfully with IAQ issues that affect their daily lives. They also constrain the ability of practitioners to diagnose problems holistically and make value-oriented decisions under uncertainty. In some situations, even experts may become constrained by fragmented disciplinary perspectives that obscure important interactions between technical, human, ethical, and practical considerations. As a result, the challenge extends beyond knowledge acquisition to the broader question of how people think, reason, judge, decide, and act.

Given that people spend a substantial proportion of their lives indoors, poor reasoning about indoor air quality can translate directly into unhealthy behaviours and poor decisions. These may include inappropriate ventilation practices, the selection of high-emission

materials, overreliance on ineffective mitigation strategies, or failure to recognise exposure risks. Such outcomes often arise not because people are indifferent, but because they lack the cognitive frameworks needed to understand complex interactions and assess available options in a value-oriented manner.

This diagnosis led me to a different research focus. Rather than concentrating primarily on generating additional technical knowledge, I became interested in how communication solutions could be designed to strengthen the cognitive capabilities needed to use knowledge effectively. My work therefore focuses on the design of communication solutions that support mental model development, stimulate value-oriented questioning, and strengthen the cognitive capabilities required for judgement, decision-making, and action. The objective is not merely to improve access to information, but to improve the ability to think with information.

This orientation gave rise to a research-as-practice approach. Rather than separating research from practice, research becomes embedded within the process of designing, applying, reflecting upon, and refining communication solutions. Knowledge is generated through iterative cycles of design, implementation, observation, reflection, and improvement. Within this approach, communication solutions themselves become research outputs, while the design principles underlying them become objects of scholarly inquiry.

The Indoor Air Cartoon Journal emerged from this research philosophy. The journal was developed as a public educational resource through which communication solutions could be designed, applied, evaluated through practice, and continuously refined. Through the integration of communication, storytelling, visual representation, cognitive scaffolding, and engineering concepts, the journal provides a platform for investigating how communication solutions can support cognitive governance and value-oriented problem-solving.

The journal adopts an artistic-educational approach in which storytelling and visual communication function not merely as dissemination tools but as cognitive and emotional tools for learning and problem-solving. The purpose is not to simplify complexity through oversimplification, but to make complexity cognitively accessible without compromising intellectual rigour. In this way, communication becomes an active intervention designed to strengthen cognitive capability rather than a passive mechanism for transferring information.

The fundamental research questions that guide my work are:

How should fictional case stories be designed to function as communication solutions that bridge knowing and doing in real-world practice by empowering mental model development, stimulating value-oriented questioning to enhance cognitive capabilities, supporting sound judgement and decision-making, and ultimately guiding value-oriented problem diagnosis and solving?

This question positions communication solutions not as supplementary educational tools but as primary objects of design and scholarly inquiry. They also reflect my central interest in understanding how communication can be intentionally designed to strengthen cognitive governance and support value-oriented problem diagnosis and solving.

The methodology through which these questions are explored is documented publicly through the Indoor Air Cartoon Journal. Each article represents a unique design experiment in communication. The cartoons, fictional case stories, and accompanying narratives are not simply vehicles for presenting information. Rather, they are designed communication solutions intended to stimulate mental model development, encourage value-oriented questioning, strengthen cognitive capabilities, and support effective judgement, decision-making, and action.

As a consequence, the Indoor Air Cartoon Journal functions simultaneously as a public educational resource, a scholarly output, a design laboratory, and a research platform through which communication solutions for cognitive governance are continuously developed and refined. The effectiveness of my scholarship is not measured solely by the transmission of information. Rather, it is reflected in its ability to strengthen the cognitive capabilities required for value-oriented problem diagnosis and solving.

The communication solutions developed through the Indoor Air Cartoon Journal are designed to support the development of critical and reflective thinking, abstract reasoning, logical deduction, and creative imagination. These cognitive capabilities are essential for understanding complex engineering problems, evaluating alternatives, reasoning through uncertainty, and making informed decisions that create value for individuals, organisations, and society.

Critical and reflective thinking are strengthened by exposing learners to multiple perspectives, competing priorities, and realistic decision contexts. Through fictional case stories and visual narratives, readers are encouraged to question assumptions, challenge existing beliefs, evaluate evidence, and reflect on the implications of alternative actions. Rather than presenting predetermined answers, the communication solutions create opportunities for active cognitive engagement and self-directed learning.

Abstract reasoning is strengthened by helping learners recognise relationships, patterns, and interactions among variables that may not be immediately visible. Through storytelling, visual representation, and mental modelling, complex engineering concepts are transformed into cognitively accessible forms that enable learners to move from isolated facts to systems-level understanding. This supports the development of transferable knowledge that can be applied across different contexts and situations.

Logical deduction is strengthened through structured narratives that reveal how conclusions emerge from evidence, assumptions, and reasoning processes. Readers are guided to examine causal relationships, evaluate competing explanations, and understand

the implications of different decisions. This supports more rigorous and defensible problem diagnosis and decision-making.

Creative imagination is strengthened through the integration of engineering, science, art, and literature. The fictional nature of the stories creates opportunities for exploration beyond conventional disciplinary boundaries, encouraging learners and practitioners to consider alternative possibilities, novel perspectives, and innovative solutions. In this way, creativity becomes a practical capability that supports value-oriented problem-solving rather than an isolated artistic skill.

The educational significance of this work lies not in the use of cartoons or storytelling alone. Cartoons and stories have long been used within educational contexts. My contribution differs in both purpose and design. The communication solutions developed through the Indoor Air Cartoon Journal are intentionally designed as cognitive and emotional tools that support mental model development, value-oriented questioning, and cognitive capability enhancement. Their purpose is not merely to increase engagement, motivation, knowledge acquisition, or information retention. Rather, their purpose is to strengthen the cognitive capabilities required for effective judgement, decision-making, and action in real-world contexts.

The originality of this contribution lies in the repositioning of communication solutions as primary interventions for cognitive governance. Within my work, communication is not viewed as a mechanism for transferring information from one person to another. Instead, it is viewed as a designable solution capable of influencing how people think, reason, judge, decide, and act. This perspective shifts attention from information transmission to cognitive transformation.

The impact of this work extends beyond formal educational settings. The communication solutions developed through the Indoor Air Cartoon Journal support learning within universities, industry, and the wider community. Their purpose is to strengthen the practice of problem-solving rather than merely increase the accumulation of knowledge. Consequently, the work contributes not only to educational practice but also to professional practice, where real-world engineering decisions are routinely made under uncertainty and resource constraints.

The scholarship also contributes to curriculum innovation through the integration of artistic expression, storytelling, visual communication, engineering reasoning, and cognitive scaffolding. These approaches encourage learners to view engineering problems from multiple perspectives and to recognise the interactions between technical, human, ethical, and practical considerations. In doing so, the work helps prepare learners to communicate complex ideas effectively to both technical and non-technical audiences while strengthening their ability to diagnose and solve problems in a value-oriented manner.

Beyond its educational contribution, the Indoor Air Cartoon Journal supports industry and community sensing by identifying cognitive barriers, emerging needs, overlooked assumptions, and practical challenges within indoor air quality and sustainable building engineering. Through its stories and narratives, the journal captures dimensions of practice that are often difficult to identify through conventional surveys, technical reports, or statistical analyses. In this way, the journal functions as a platform for revealing opportunities for learning, innovation, research, and capability development.

The journal also provides researchers, educators, practitioners, and students with mental models, conceptual frameworks, and contextualised problems that support question generation and scholarly inquiry. By making complex systems and interactions cognitively visible, the communication solutions create conditions for deeper understanding and more meaningful engagement with engineering challenges. This contribution is particularly important because high-quality research and innovation often begin with the ability to frame meaningful questions and identify problems worth solving.

The value of my scholarship therefore lies not in producing generalisable empirical proof of educational or engineering phenomena. Rather, it lies in developing and refining communication solutions that strengthen cognitive governance and improve the cognitive capabilities required for value-oriented problem diagnosis and solving. The evidence of effectiveness resides in the cognitive transformation experienced by individuals who engage thoughtfully with the communication solutions and apply the resulting understanding to real-world contexts.

Consequently, my scholarship should be evaluated according to the cognitive problems it addresses, the quality and originality of the communication solutions it produces, the cognitive capabilities it strengthens, and the value it creates for learners, practitioners, industry, and society. Because the primary investment required for this work is cognitive effort rather than extensive laboratory infrastructure or research funding, its value is more appropriately assessed through its intellectual contribution, practical relevance, educational impact, and ability to improve human capability for value-oriented problem-solving.

In conclusion, my scholarship does not seek to explain teaching and learning phenomena, nor does it seek to investigate unexplained indoor air quality or sustainable building engineering phenomena. Instead, it focuses on the design, development, refinement, and application of communication solutions that strengthen cognitive governance and support value-oriented problem diagnosis and solving. Through research-as-practice, I contribute an emerging design theory of communication solutions that demonstrates how communication can be intentionally designed to develop mental models, stimulate value-oriented questioning, enhance cognitive capabilities, and guide effective judgement, decision-making, and action across education, professional practice, industry, and the wider community.

Useful links:

Teaching Integration

To support the adoption of the Indoor Air Cartoon Journal in higher education, I developed a teaching note that guides educators in integrating the journal's communication solutions into their academic modules. The teaching note provides practical strategies for using the journal's fictional case stories and communication solutions to reduce cognitive barriers and strengthen value-oriented problem-solving across disciplines.

https://indooraircartoon.com/teaching-note/

Research Methodology

The research methodology underpinning my research-as-practice scholarship and the development of communication solutions in the Indoor Air Cartoon Journal is described at:

https://indooraircartoon.com/research-methodology/

Curriculum Innovation and Educational Impact

The impact of my scholarship on engineering education and curriculum development is further evidenced through Built Environment Artistic Research Sharing (BEARS), a public educational resource that showcases student-generated outputs reflecting the application of cognitive governance principles and value-oriented problem diagnosis and solving capabilities developed through engagement with communication solutions and learning activities informed by my scholarship.

https://bearsmof.com