

Hanumanthrao Kannan, Ph.D.

Assistant Professor

ISEEM department

The University of Alabama in Huntsville, Huntsville, AL

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Research Interests

Formal needs/requirements representation, Formal logic, Ontologies, Verification & Validation, Digital Twins; Knowledge representation and reasoning in Systems Engineering, Systems Engineering for AI-based systems, Decision Analysis

Experience

Assistant Professor

2022-present

ISEEM department

The University of Alabama in Huntsville, Huntsville, AL

Assistant Professor

Grado Department of Industrial and Systems Engineering

Virginia Tech, Blacksburg, VA

Postdoctoral Associate

2017-2018

Grado Department of Industrial and Systems Engineering

Virginia Tech, Blacksburg, VA

Postdoctoral Research Associate

2015-2017

Department of Aerospace Engineering

Iowa State University, Ames, IA

Research Assistant

2012-2015

Department of Aerospace Engineering

Iowa State University, Ames, IA

Teaching Assistant

2012-2014

Department of Aerospace Engineering

Iowa State University, Ames, IA

Education

Ph.D., Aerospace Engineering

2015

Department of Aerospace Engineering

Iowa State University, Ames, IA

M.S., Astronautical Engineering

2011

Department of Astronautical Engineering

University of Southern California, Los Angeles, CA

B.S., Aeronautical Engineering

2010

Anna University, Tamilnadu, India

Sponsored Research

1. Kannan, H (PI), “CAREER: Theoretical Foundations for Problem Space Representation and Reasoning in Systems Engineering”, \$500,000, NSF, March 2025 – Feb 2028.
2. Mesmer (PI), Kannan, H (Co-PI), Menon, V (Co-PI), Weger, K (Co-PI), Vangsness (Co-PI), Chen (Co-PI), Wooley (Co-PI), “W911NF-23-S-0003 Advancements in Human-Systems Integration Analysis and Artificial Intelligence”, \$1,350,000, U.S Army, July 2024- July 2027
3. Thomas, D (PI), Kannan, H (Co-PI), “Digitally-Integrated Early-Phase Systems Engineering Research and Technology of Space Systems”, \$290,000, NASA MSFC ACO, Feb 2024 – Oct 2025
4. Thomas, D (PI), Kannan, H (Co-PI), “Development of a Common Space Systems Ontology”, \$118,500, NASA MSFC ACO, Jan 2024 – Oct 2024.
5. Mesmer (PI), McDermott, T (Co-PI), Kannan, H (Co-PI), Menon, V (Co-PI), Weger, K (Co-PI), “WRT-1078: Improving and Assessing Architectures and Architecture Decision-Making,” \$345,922, U.S. Army through SERC, Sep 2023 – Sep 2024.
6. Thomas, D (PI), Kannan, H (Co-PI), Patrick, J (Co-I), “Problem space and Solution space Ontology Development”, \$72,000, NASA MSFC ACO, June 2023 – Dec 2023.
7. Kannan, H (PI), Mesmer, B (PI), “NASA/MSFC Aerospace and Systems Engineering Program/ Systems Engineering Research and Technology”, \$230,767, NASA MSFC, May 2023 - May 2024.
8. Mesmer (PI), Kannan, H (Co-PI), Menon, V (Co-PI), Weger, K (Co-PI), Tenhundfeld, N (Co-PI), “Performance Enhancement through Human Systems Integration (HIS)” \$300,000, U.S. Army, Sep 2023 – Sep 2024.
9. Mesmer (PI), Kannan, H (Co-PI), Menon, V (Co-PI), Weger, K (Co-PI), Tenhundfeld, N (Co-PI), “Testing & Evaluation for Soldier-Device Teaming Compatibility, Vulnerability, and Durability in Emergent Situations: How to assess the efficacy of AI in human agent teams” \$1,500,000, U.S. Army, Jan 2023 – Jan 2025.
10. Thomas, D (PI), Kannan, H (Co-I), Patrick, J (Co-I), “Formal Ontologies development”, \$44,905, NASA MSFC ACO, Jan 2023 – May 2023
11. Kannan, H (PI), Salado, A (PI), Merchant, N (PI), Son, Y (PI), Rouse, W (PI), Szajnfarder, Z (PI), “Policy test laboratory reference architecture” \$25,000, SERC, Aug 2022 – Sep 2022.
12. Trent, S (PI), Tao, H (PI), Kannan (Co-I), “AIRC Defense data grand prix” \$12,289, AIRC, July 2022 – Aug 2022
13. Salado, A (PI), Kannan, H (Co-PI), “Risk aggregation of safety for third parties of unmanned aircraft”, \$102,000, NAVAIR, 2019-2020.
14. Trent, S., Kannan, H., Knapp, B., “Tactical mission engineering, \$150,000, AIRC. 2021-2022

Journal Papers

1. Kannan, H., Salado, A., “A Theory-Driven Interpretation and Elaboration of Verification and Validation”, under review, *Systems Engineering*
2. Fitzpatrick, N., Kannan, H.. “Quantifying the Intrinsic Value of Verification: An Information-Theoretic Approach”, under review, *Systems Engineering*.
3. Kannan, H., “A Formal Metric to Measure Inconsistencies in Stakeholder Preferences in Systems Engineering”, *Systems Engineering*, (0), 1-18, 2024

4. Stephen, C., Kannan, H., Salado, A., "Formal Inconsistencies of Expertise Aggregation Techniques Commonly Employed in Engineering Teams", *Systems*, 12(5), 180, 2024
5. Kannan, H., "Formal Reasoning of Knowledge in Systems Engineering Through Epistemic Modal Logic", *Systems Engineering*, 24(1), 3-16, 2021.
6. Kannan, H., Bloebaum, C.L., Mesmer, B., "Incorporation of Risk Preferences in a Value-Based Systems Engineering Framework", *Systems Engineering*, 23(2), 237-257, 2020.
7. Kannan, H., Bhatia, G., Mesmer, B., Jantzen, B., "Theoretical Foundations for Preference Representation in Systems Engineering", *Systems*, 2019, 7(4), 55.
8. Kannan, H., Bloebaum, C.L., Mesmer, B., "Increased System Consistency through Incorporation of Coupling in Value-based Systems Engineering", *Systems Engineering*, 20(1), 21-44, 2017.
9. Salado, A., Kannan, H., "A Mathematical Model of Verification Strategies", *Systems Engineering*, 21(6), 593-608, 2018
10. Simpson, T., Miller, S., Tibor, E., Yukish, M., Stump, G., Kannan, H., Mesmer, B., Winer, E., Bloebaum, C.L., "Adding Value to Trade Space Exploration when Designing Complex Engineered Systems", *Systems Engineering*, 20(2), 131-146, 2017.
11. Wang, M., Kannan, H., Bloebaum, C.L., "Beyond Mean-Variance: The Mean-Gini Approach to Optimization Under Uncertainty", *ASME Journal of Mechanical Design*, 2017, 140(3).
12. Salado, A., Kannan, H., "Elemental Patterns of Verification Strategies", *Systems Engineering* 22 (5), 370-388.

Conference Papers

1. Johnson, H., SureshKumar, M., Thomas, D., Kannan, H (2025). "Ontological Methods of Functional Analysis for Aerospace Concepts", *IEEE Aerospace 2025*, Bigsky, MT.
2. Fitzpatrick, N., Kannan, H. (2025). Understanding the Value of Verification. *Conference on Systems Engineering Research (CSER) 2025, Los Angeles, CA*.
3. Gossman, D., Mesmer, B., Kannan, H. (2025). Dynamic Alignment Strategies for AI-Driven Systems: An Iterative Evaluation Framework. *Conference on Systems Engineering Research (CSER) 2025, Los Angeles, CA*.
4. SureshKumar, M., Johnson, H., Thomas, D., Kannan, H. (2025). A Systems Theoretic Perspective on Understanding Functional Equivalence in Systems Engineering. *Conference on Systems Engineering Research (CSER) 2025, Los Angeles, CA*.
5. Gossman, D., Adedokun, O., White, C., Mesmer, B., Kannan, H (2025). "A Systems Theoretic Framework for Understanding Emergent AI Behavior", *ALAA SciTech 2025*, Orlando, FL.
6. Johnson, H., SureshKumar, M., Thomas, D., Kannan, H (2025). "Ontology-Based Functional Analysis of an Aerospace System", *ALAA SciTech 2025*, Orlando, FL.
7. Fitzpatrick, N., Kannan, H (2025). "Towards a Metric for Optimal Verification Strategy using Information Theory", *ALAA SciTech 2025*, Orlando, FL.
8. Kannan, H., "Towards a Rigorous Metric for Measuring Inconsistencies in Stakeholder Preferences in Systems Engineering", *Conference on Systems Engineering Research (CSER) 2024*, Tucson, AZ
9. Kannan, H., Davis, B., & Sureshkumar, M. (2024). Developing a Theoretical Basis for Validation in Systems Engineering. *Conference on Systems Engineering Research (CSER) 2024*, Tucson, AZ

10. Holmes, R., & Kannan, H. (2024). Addressing Safety in AI-Based Systems: Insights from Systems Engineering. *Conference on Systems Engineering Research (CSER) 2024*, Tucson, AZ
11. Johnson, H., Sriman, Thomas, D., H., Kannan, P., Lewis, P., “Demonstrating the practicality of a Space Systems Ontology through an Example System”, *ALAA SciTech 2024*, Orlando, FL.
12. Kannan, H., “A Formal Approach to Engineering AI-based Systems: An Introduction”, *ALAA SciTech 2023*, Maryland.
13. Kannan, H., Jantzen, B., Mesmer, B., “A Formal Approach to Identify Inconsistencies in Stakeholder Needs in the Context of Systems Engineering”, *ALAA SciTech 2022*, San Diego, CA.
14. Wilhelm, C., Kannan, H., “Engineering a Resilient Mega-Constellation to Reduce Orbital Debris”, *ALAA SciTech 2022*, San Diego, CA.
15. Stephen, C., Salado, A., Kannan, H., “Understanding Formal Aggregation of Expert Assessments in Safety Decision-making”, *ASEM 2020*, Denver, CO.
16. Kannan, H., “Knowledge Representation and Reasoning in the Context of Systems Engineering”, *CSER 2020*, Redondo beach, CA.
17. Salado, A., Kannan, H., “Properties of the Utility of Verification”, *2018 IEEE International Systems Engineering Symposium*, Rome, Italy
18. Farkhondehmaal, F., Kannan, H., Salado, A., “Capturing the Information Dependencies of Verification Activities with Bayesian Networks”, *CSER 2018*, Charlottesville, VA
19. Kannan, H., Shihab, S., Zellner, M., Salimi, E., Bloebaum, C.L., Abbas, A.E., “Preference Modeling for Government-Owned Large Scale Complex Engineered Systems: A Satellite Case Study”, *CSER 2017*, Redondo Beach, CA
20. Wang, M., Kannan, H., Bloebaum, C.L., “Value Driven Optimizations in a Dynamic Market: Measuring Uncertainty with the Gini Coefficient”, *ALAA SciTech 2017*, Grapevine, TX.
21. Kwasa, B., Kannan, H., Mesmer, B., Bloebaum C.L., “Capturing Trust as Organizational Uncertainty in A Value-Based Systems Engineering Framework” *2017 ASEM International Conference*, Huntsville, Alabama, USA
22. Basha, N.S, Kwasa, B., Kannan, H., Bloebaum C.L., “Cynefin Sensemaking Framework for Decision Support in Design and Development of Large Scale Complex Engineered Systems” *2017 ASEM International Conference*, Huntsville, Alabama, USA
23. Kannan, H., Bloebaum, C.L., Mesmer, B., “Incorporation of Risk Preferences in a Value-Based Systems Engineering Framework for a Satellite system”, *ALAA Scitech 2016*, San Diego, CA.
24. Bhatia, G., Kannan, H., Bloebaum, C.L., “A Game Theory Approach to Bargaining over Attributes of Complex Systems in the context of Value-Driven Design: An Aircraft System Case Study”, *ALAA Scitech 2016*, San Diego, CA.
25. Murugaiyan, S., Kannan, H., Mesmer, B., Abbas, A.E., Bloebaum, C.L., “A Comprehensive Study on Modeling Requirements into Value Formulation in a Satellite System Application”, *CSER 2016*, Huntsville, AL

26. Kwasa, B., Kannan, H., Bloebaum C.L., “Capturing Organizational Uncertainty in a Value-Based Systems Engineering Framework”, *2016 ASEM International Conference*, Concord, NC
27. Sikkandar Basha, N., Kwasa, B., Kannan, H., Bloebaum C.L., “Sense-Making in a Value-Based Context due to Requirements Creep”, *2016 ASEM International Conference*, Concord, NC
28. Kwasa, B., Kannan, H., Bloebaum C.L., “Impact of Organization Structure on the Value of a Commercial Communication Satellite”, *CSEER 2016*, Huntsville, AL
29. Jung, S., Simpson, T., Bloebaum, C., Kannan, H., Winer, E., Mesmer, B., “A Value-Driven Design Approach to Optimize a Family of Front-Loading Washing Machines”, *ASME 2016 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference*, Charlotte, NC
30. Subramanian, T.R., Kannan, H., Mesmer, B., Bloebaum, C.L., “Understanding the Impact of Uncertainty on the Fidelity of the Value Model”, *ALAA Scitech 2016*, San Diego, CA.
31. Kannan, H., Bloebaum, C.L., Mesmer, B., “Incorporation of Coupling Strength Models in a Value-based Systems Engineering framework for optimization”, *ALAA Aviation 2015 (16th ALAA/ISSMO Multidisciplinary Analysis and Optimization Conference)*, Dallas TX
32. Kwasa, B., Kannan, H., Bloebaum C.L., “Impact of Organization Structure in a Value-based Systems Engineering Framework” *2015 ASEM International Conference*, Indianapolis, IN.
33. Hupman, A., Abbas, A.E., Tibor, E., Kannan, H., Bloebaum, C.L., Mesmer, B., “Calculating Value Gaps Induced by Requirements, Deterministic Modeling, Fixed Targets” *ALAA Scitech 2015*, Kissimme, FL.
34. Kwasa, B., Bloebaum, C.L., Kannan, H., Mesmer, B., “Organization Design in the Context of Value-Driven Design” *ALAA Scitech 2015*, Kissimme, FL.
35. Kannan, H., Bloebaum, C.L., Mesmer, B., “Incorporation of Coupling Strength Models in Decomposition Strategies for Value-Based MDO”, *ALAA Aviation 2014 (15th ALAA/ISSMO Multidisciplinary Analysis and Optimization Conference)*
36. Richardson, T., Kannan, H., Bloebaum, C.L., Winer, E., “Incorporating Value-Driven Design in to the Visualization of Design Spaces using Contextual Self-Organizing Maps: A Case Study of Satellite Design”, *ALAA Aviation 2014 (15th ALAA/ISSMO Multidisciplinary Analysis and Optimization Conference)*
37. Mesmer, B., Bloebaum, C.L., Kannan, H., “Incorporation of Value-Driven Design in Multidisciplinary Design Optimization”, *10th World Congress of Structural and Multidisciplinary Optimization (WCSMO)*, Orlando, FL, May 2013
38. Kannan, H, S. Ragothaman, B. Arun Kumar, M. Giri Prasad, V.R.Sanal Kumar, “Studies on Fluidic Injection thrust Vectoring in Aerospike Nozzles”, *49th ALAA Aerospace Sciences Meeting*, Orlando, FL, January 2011

Presentations

1. Holmes, R., & Kannan, H. (2024, Summer). Navigating Uncertainty: Enhancing AI System Safety through the Integration of Systems Theory and R3+ Concepts. *AI4SE and SE4AI Workshop - Systems Engineering Research Center (SERC)*.

2. Gossman, D., & Kannan, H. (2024). A Systems Theoretic Perspective of the Outer Alignment Problem. *Conference on Systems Engineering Research (CSER) 2024*, Tucson, AZ
3. Holmes, R., & Kannan, H. (2023, Autumn). A Systems Engineering Perspective on Safety of AI-based Systems. *AI4SE and SE4AI Workshop - Systems Engineering Research Center (SERC)*.
4. Adedokun, O. J., & Kannan, H. (2023, Autumn). Challenges with Developing Requirements for AI-based Systems. *RAM Summit 2023*.

Notable Awards

- NSF CAREER Award, 2025
- Wayne Wymore Best paper award, CSER 2024
- Best paper award in Systems Engineering, AIAA SciTech
- Best journal paper award, Wiley Systems Engineering Journal
- James E. Long Memorial Post-Doctoral Fellowship, INCOSE
- Research Excellence Award - Outstanding research in Ph.D., Iowa State University, Ames, IA

Teaching

- Operations Research (ISE 340), UAH
- Problem Formulation in Systems Engineering (ISE 639), UAH
- Introduction to Operations Research (ISE 634), UAH
- Decision Analysis (ISE 734), UAH
- Decision Analysis for Engineers (ISE 5834), Virginia Tech
- Multi-stakeholder decision-making (ISE 5984), Virginia Tech
- Management Systems (ISE 4015), Virginia Tech
- Industrial Cost Control (ISE 3004), Virginia Tech
- Large-Scale Complex Engineered Systems (AerE 568), Iowa State
- Metaheuristic Optimization and Modeling for Complex System Design (AerE 554X), Iowa State
- Aerospace Systems Integration (AerE 362), Iowa State
- Engineering Mechanics (EM 274), Iowa State

Ph.D. Students

- Brian Davis – “A Formal Framework for Validation in Systems Engineering”. Spring 2023
- Daniel Gossman – “A Systems Engineering Framework for Alignment of AI-based systems”. Fall 2023
- Reginald Holmes – “Safety of AI-based systems”. Fall 2023
- Noah Fitzpatrick – “Quantifying Verification using Information Theory”. Spring 2024
- Mayurnath SureshKumar – “Problem Space formulation in Systems Engineering”. Summer 2024

Professional Societies

AIAA Systems Engineering Technical Committee
 International Council on Systems Engineering (INCOSE)
 IEEE
 Institute of Industrial and Systems Engineers (IISE)
 American Institute of Aeronautics and Astronautics (AIAA)

**Professional
Service**

Reviewer

AIAA SciTech
Journal of Engineering Design
Systems Engineering (INCOSE) journal
AIAA Ascend
Project Management journal
IEEE Systems Journal
Conference on Systems Engineering Research
Engineering Management Journal

Service

- Conference on Systems Engineering Research Session Chair, 2024
- AIAA SciTech Conference Session Chair, 2024
- AIAA SciTech Conference Session Chair, 2023
- Technical program committee member, Conference on Systems Engineering Research, 2022

**University
Service**

Committees

Member, UAH Faculty Senate Committee
Member, Systems Engineering faculty search committee (UAH)
Member, Industrial Engineering faculty search committee (UAH)
Member, Staff Assistant search committee (UAH)
Coordinator, Mission Engineering Graduate Certificate Program (Virginia Tech)
Member, Systems Engineering faculty search committee (Virginia Tech)
Advisor, INCOSE student chapter (Virginia Tech)
Member, Undergraduate Program Committee (Virginia Tech)
Member, Graduate Recruitment Committee (Virginia Tech)
Member, Honors and Awards Committee (Virginia Tech)
Member, Invited Seminar Series Committee (Virginia Tech)