Human-Autonomy Teaming (HAT) Foundational Activity

m:N Working Group

Eric Chancey (Activity Lead) & Mike Politowicz (Co-Activity Lead)

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Transformational Tools and Technologies Project

Innovative solutions through foundational research and cross-cutting tools

autonomous systems

Overview

- HAT Activity & Research Question
- HAT Framework
- HAT Foundational Activity Approach
- Brief Overview of Completed and Planned Research & Development
- Contact Info and Relevant Publications

HAT Foundational Research Question

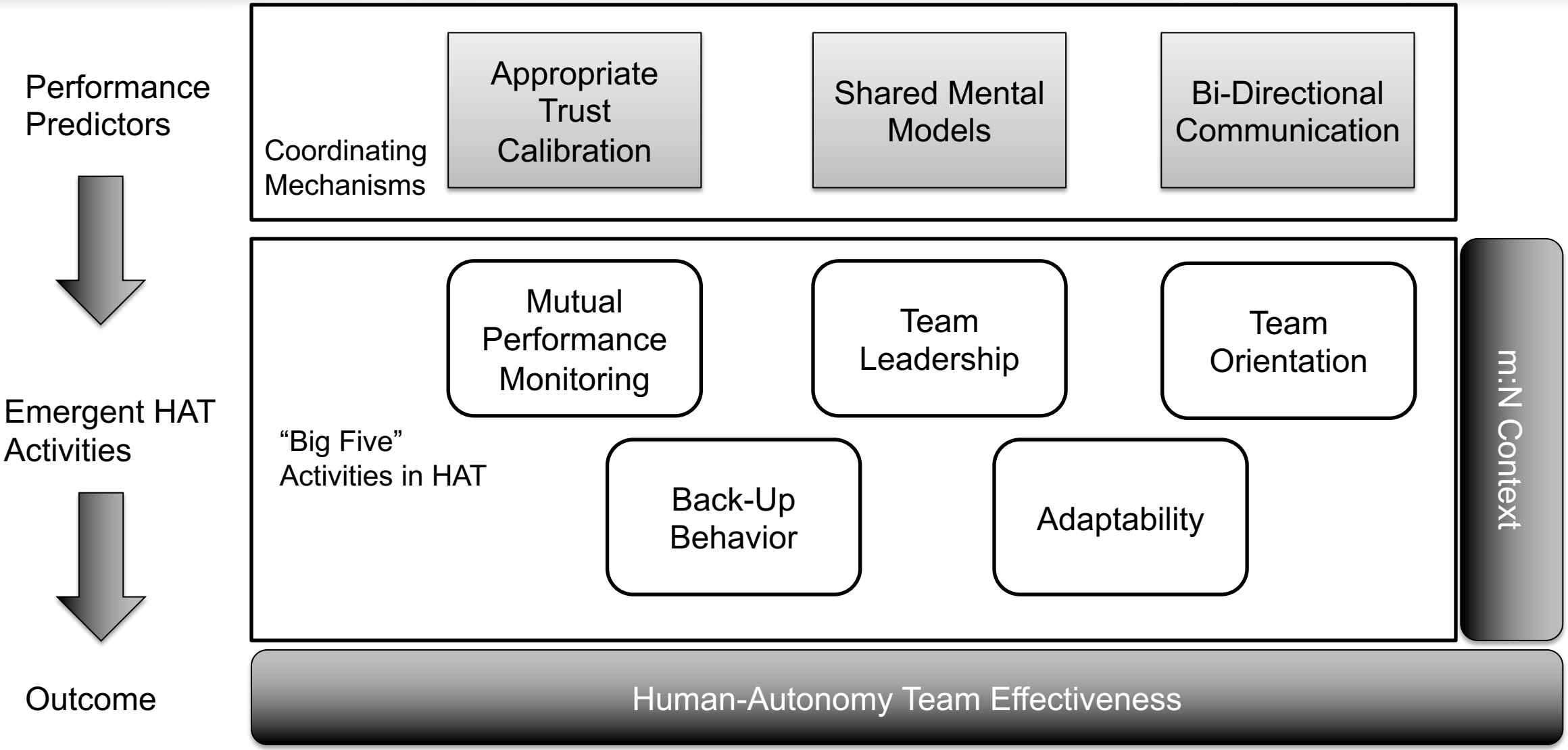
HAT-Foundational Research Question: What HAT approaches (design principles, technologies) will facilitate fewer remote operators (m) to manage more vehicles (N) in AAM Operations (UML4+)?

- HAT Definition: A distinguishable set of two or more *agents (e.g., human operator, increasingly autonomous system)* who interact, dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission (adapted from Salas et al., 1992, p. 7 – italicized text changed from “humans”)
- HAT Research Goal: Humans and increasingly autonomous systems working and thinking better together (Holbrook et al., 2020)

HAT Foundational Research Question

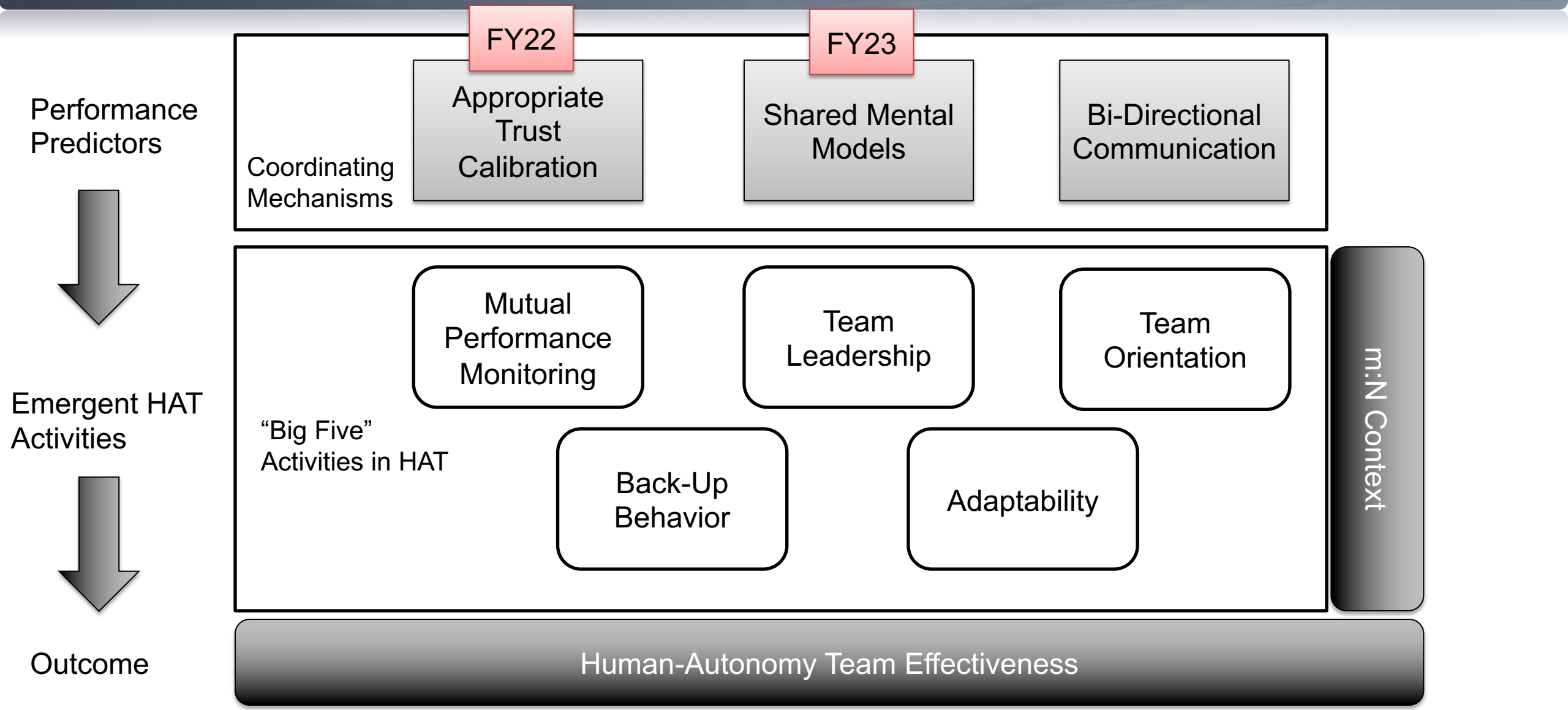
- How to achieve scalability with m:N?
  - Shift responsibility and authority away from the human and toward the technology →**Increasingly autonomous systems** (Pritchett et al., 2018)
    - "Spans the spectrum of system capabilities that begin with the abilities of current automatic systems, such as autopiloted and remotely piloted (non-autonomous) unmanned aircraft, and progress toward the highly sophisticated systems that would be needed to enable the extreme cases" (NRC, 2015)
  - Increasingly autonomous: Automation → Autonomy
    - Automation (Parasuraman et al., 2000): a device or system that accomplishes (partially or fully) a function that was previously, or conceivably could be, carried out (partially or fully) by a human operator
    - Autonomy (Kaber, 2018):
      1. The autonomous agent is viable in a target context
      2. The autonomous agent possesses self-governance in goal formation and fulfilment of roles
      3. *The autonomous agent possesses independence or capacity for function/performance without assistance from other agents (e.g., humans)*
- AAM UML 4+ is going to require a paradigm shift from automation to autonomy – what is holding it back?
  - "People" constrain or underuse potential autonomous capacities because of a lack of **trust** in the system to execute safety-critical tasks (Kaber, 2018; Lee & See, 2004)
  - Trust development will likely predict the rate at which m:N transitions from automation (human oversight) to autonomy (i.e., scalability/close the business case)

HAT Framework



Adapted from: Salas, Sims, & Burke (2005). Is there a "Big Five" in teamwork?. *Small Group Research, 36* (4). 333-559.

HAT Framework



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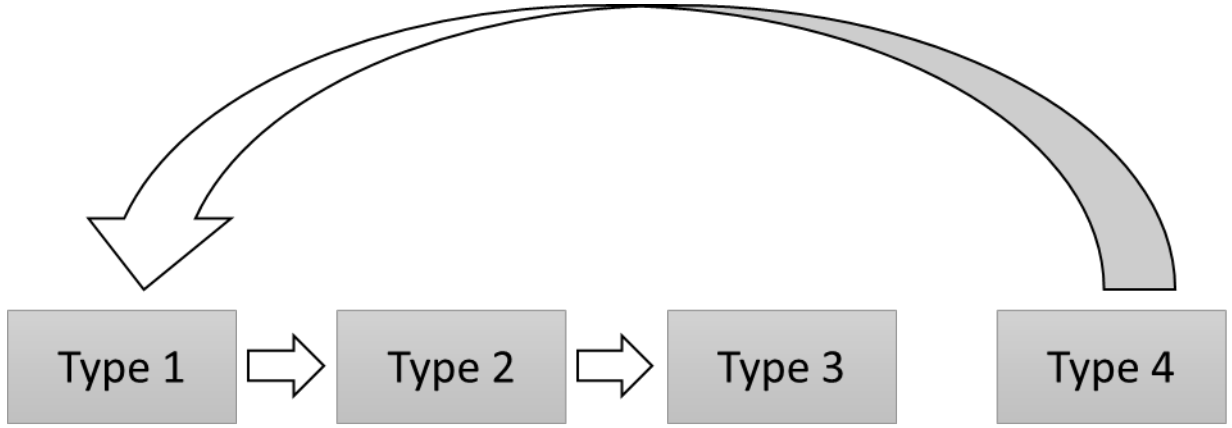
HAT Foundational Approach

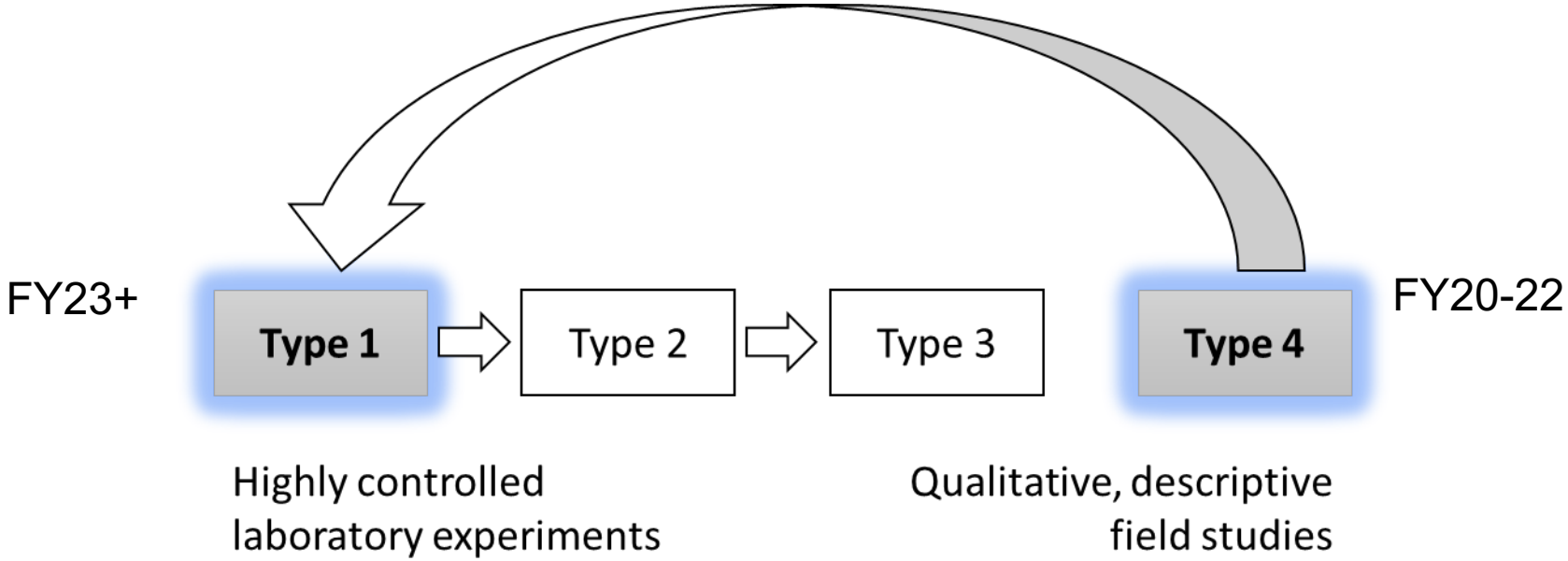
"An alternative model for defensible, generalizable human factors research"



Vicente, K. J. (1997). Heeding the legacy of Meister, Brunswik, & Gibson: Toward a broader view of human factors research. *Human Factors, 39* (2), 323-328.

HAT Foundational Approach

"An alternative model for defensible, generalizable human factors research"



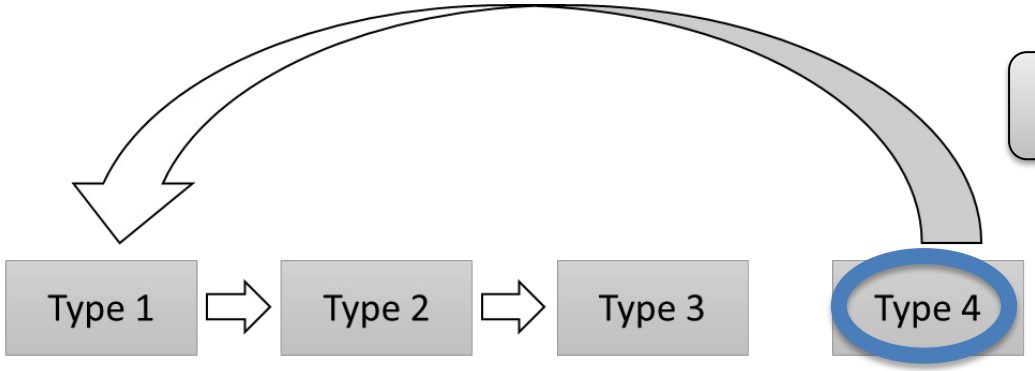
Type 4 Research: Applied, Field Studies

Completed:

- FY19 NASA UTM-Pathfinder Study – First instantiation of ROAM*
- ROAM Buildup: interviews, role-based ontology framework
  - Manuscript in progress
- NASA AAM/High Density Vertiplex (HDV) Subproject Collaboration
  - 2021 Simulation HITL study & 2022 Live Flight HITL study (EVLOS; 3 GCSOs)
    - Hierarchical Task Analysis → Error Identification Analysis
    - Usability Assessments (MPATH, ROAM)
      - Results in SciTech 2023
    - HF Assessment: SME Interviews, After-Action Review, SA, Workload, Perceived Risk, Eye Tracking, Trust
      - Results in DASC 2022 and SciTech 2023
      - Upcoming manuscript on human-automation trust
- NASA MaRERA Collaboration (9/2022) – m:N Live/Virtual Demo

(Remote Operations for Autonomous Missions)

MPATH GROUND CONTROL STATION



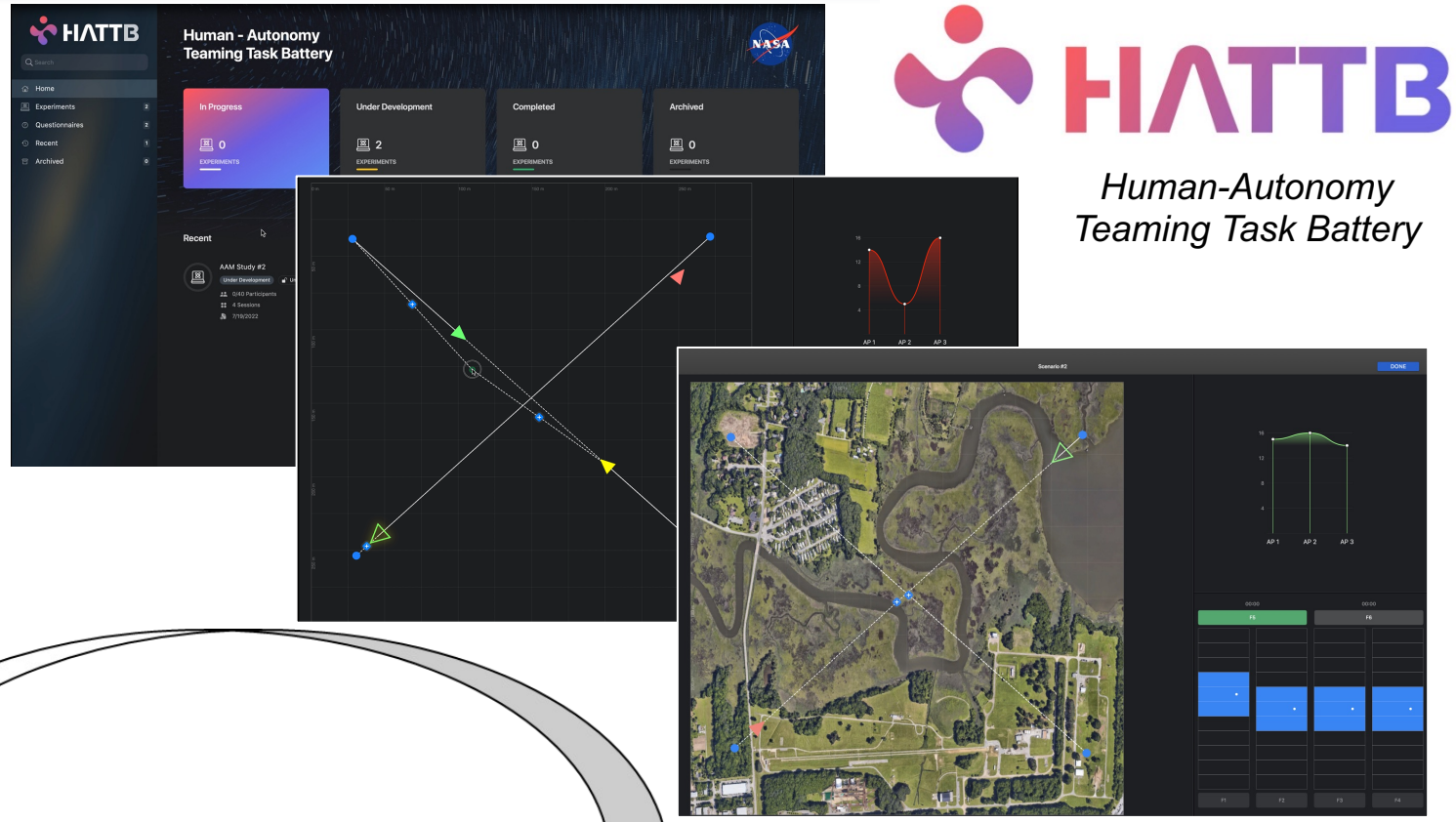
Observational Studies

Characteristics:
- Minimal-to-no control
- Real-world task
- Inductive, not deductive approach

Goals:
- Generate hypotheses
- Find as many issues as possible

*Politowicz, M. S., Chancey, E. T., & Glaab, L. J. (2021). Effects of autonomous sUAS separation methods on subjective workload, situation awareness, and trust. AIAA SciTech Forum. Virtual Event.

Type 1 Research: Controlled, Lab Studies



Human-Autonomy Teaming Task Battery

Planned HAT studies:

- Using mental models to predict trust and automation dependence
- The role of mental models in predicting multi-vehicle management performance
- Attentional limitations in multi-vehicle management

Experiments (Basic)

Characteristics:

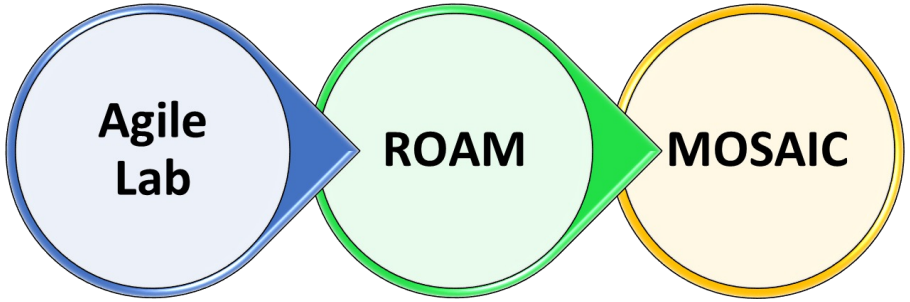
- Abstracted versions of real-world tasks
- High control over experimental manipulations and testing environment
- Do NOT require expert participants
- Low fidelity

Type 1 → Type 2 → Type 3 → Type 4

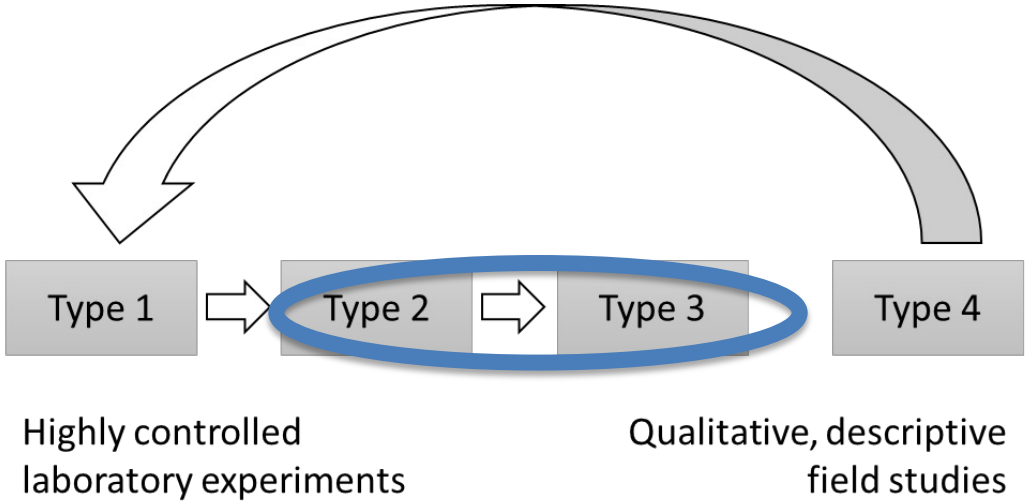
Highly controlled laboratory experiments

Qualitative, descriptive field studies

Transition of Research



- Agile Lab is D318's Human Factors Research and Development Laboratory led by Dr. Eric Chancey and Mike Politowicz
- ROAM is the Remote Operations for Autonomous Missions, a UAS Operations Center for AAM-HDV and TTT-RAM led by Bill Buck
- MOSAIC is the Mission Operations & Autonomous Integration Center for the CERTAIN Smart Center at NASA Langley Research Center



HAT Foundational Activity
Contact Info and Relevant Publications

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Chancey, E. T., Politowicz, M. S., Buck, B. K., Ballard, K., Unverricht, J., Houston, V., Chandarana, M., Le Vie, L. R. (2023). Human-autonomy teaming research and development in remotely operated unmanned aerial system operations: Initial work and approach. *2023 AIAA SciTech.* National Harbor, MD.

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Politowicz, M. S., Chancey, E. T., & Glaab, L. J. (2021). Effects of autonomous sUAS separation methods on subjective workload, situation awareness, and trust. *2021 AIAA SciTech.* Virtual Meeting.

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Wing, D. J., Chancey, E. T., Politowicz, M. S., & Ballin, M. G. (2020). Achieving resilient in-flight performance for Advanced Air Mobility through Simplified Vehicle Operations. *2020 AIAA Aviation.* Virtual Meeting.

Chancey, E. T., & Politowicz, M. S. (2020). Designing and Training for Appropriate Trust in Increasingly Autonomous Advanced Aerial Mobility Operations: A Mental Model Approach (Version 1). (NASA Technical Memorandum-20205003378). Hampton, Virginia: Langley Research Center. 0 maps, 2 tables, 7 figures, 43 pages, 125 references, 0 appendices.

Chancey, E. T. (2020). Effects of Concepts of Operation Factors on Public Acceptance and Intention to Use Urban Air Mobility (UAM) – Trust and Technology Acceptance Modeling. (NASA Technical Memorandum-20205003359). Hampton, Virginia: Langley Research Center. 0 maps, 83 tables, 36 figures, 102 pages, 52 references, 13 appendices.