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2019-05-13

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# Technology Trust: The impact of trust metrics on the adoption of autonomous systems used in high risk applications

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*Excellence Through Knowledge*



*“We had better be quite sure that the purpose put into the machine is the purpose which we desire”*  
- Norbert Wiener 1960

- This research focuses on identifying factors and attributes that contribute to trust in technology used in high-threat military scenarios
- The main research hypothesis is that a trust score can influence the initial formation of trust in autonomous systems by functioning as a surrogate for experience-based trust



*“Technology trust is a psychological state where a prediction about the use of technology entails risk, and is based on expectations of a positive outcome”*

- *Risk* is defined as a scenario where misplaced trust may lead to physical harm
- *Trust Factors* are anything that can influence or contribute to trust/distrust in a technology (ex. operating conditions)
- *Trust Attributes* are inherent characteristics of a technology that contribute to trust/distrust (ex. system speed, weight)



- Leveraging an ongoing USMC Rapid Capability Office effort to assess COTS systems for use by the Explosive Ordnance Disposal (EOD) community
- Operational testing through MCOTEA
- Results used to inform a Capability Development Document at USMC CD&I



- The adoption of new technologies by EOD requires high levels of trust
- A lack of trust may decrease the use of technology capable of improving operational performance
- Over-trust in technology may increase the exposure to risk



- To improve the EOD technicians ability to establish initial trust in technology
- To identify the factors and attributes that contribute to trust or distrust in technology used by EOD technicians
- To research methods for capturing experience-based trust in EOD technology



- Initial interviews conducted with EOD technicians reveal multiple themes associated with the use of technology in high risk scenarios
  1. Hands-on experience with technology is critical for establishing trust
  2. Team-based reputation for a technology is as important as personal experience
  3. Users favor simple technology containing only the features needed to accomplish a mission
  4. Users reject new technology in favor of older and more trusted systems



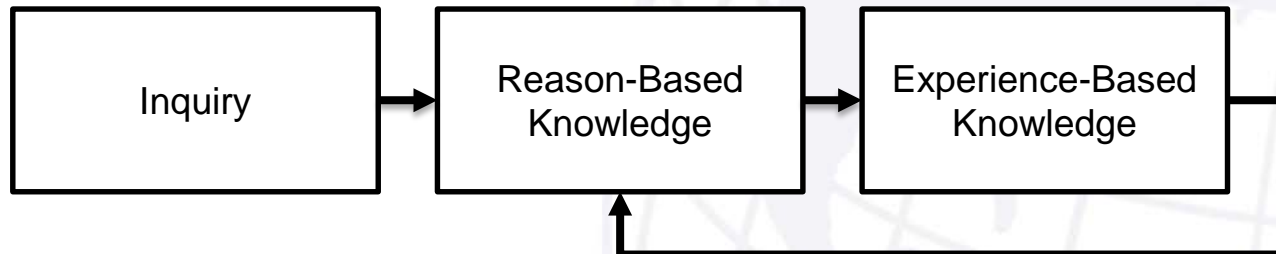


- What factors and attributes influence the development of trust in autonomous systems relevant to EOD?
- Can a surrogate (proxy) for experience based trust influence the establishment of initial trust in technologies used by EOD?

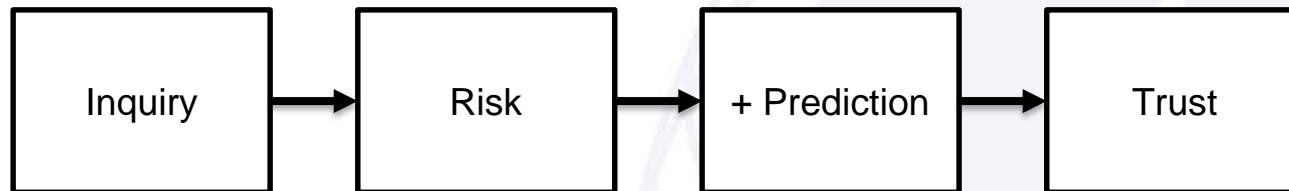


- Trust Theory (Castelfranci & Falcone)
- Technology acceptance model (Fred Davis)
- Lazy user theory (Tetard & Collan)
- Anthropomorphism (Waytz)
- Relevant disciplines researching technology trust:
  - Human-Computer Interaction (HCI) – McKnight, Michigan State University
  - Human-Robot Interaction (HRI) – Hancock, University of Central Florida
- There is a lack of available data on trust in technology used in high-threat military scenarios

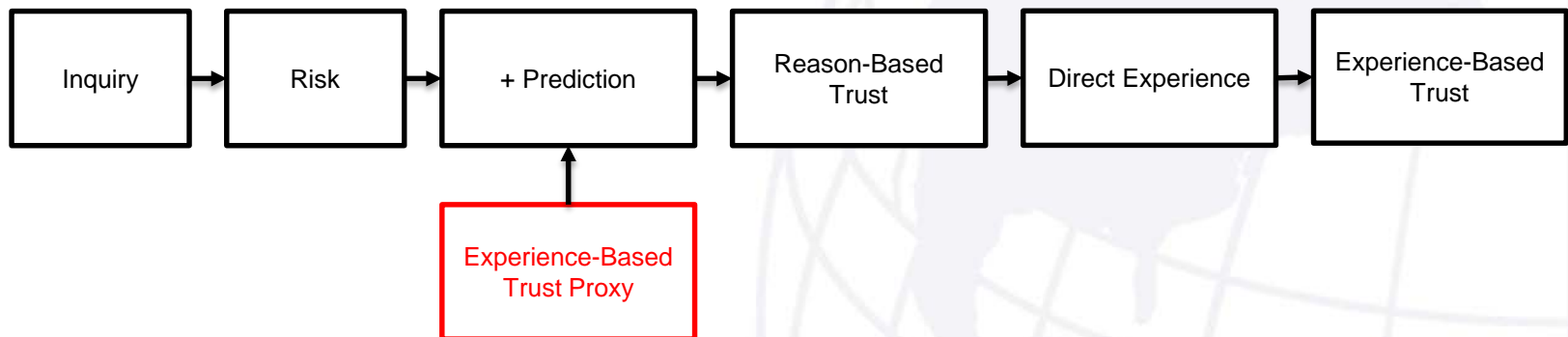
- How do we develop trust?
- Based on interpersonal trust research
- Obtained through both
  - Reason-Based Trust (Rationalism)
  - Experience-Based Trust (Empiricism)



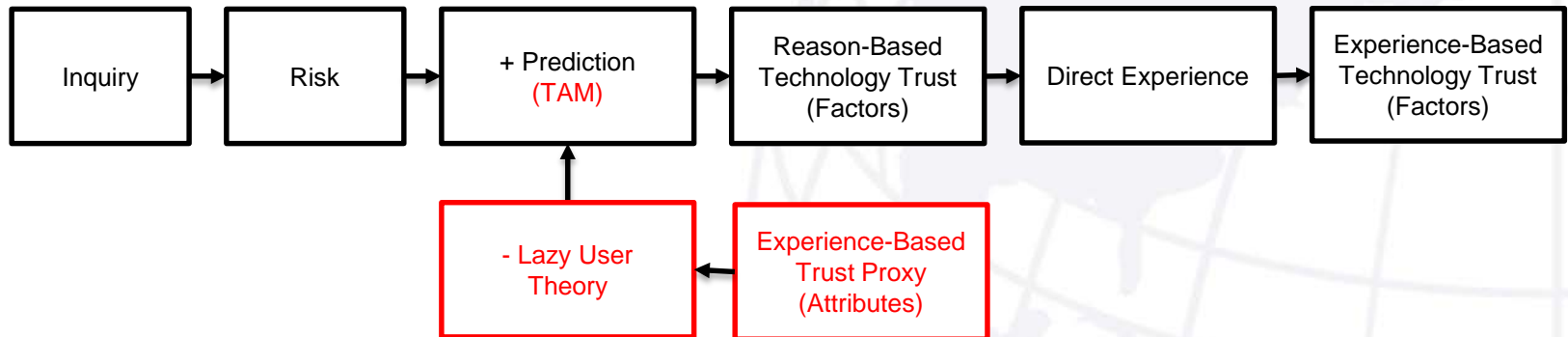
*“Technology trust is a psychological state where a prediction about the use of technology entails risk, and is based on expectations of a positive outcome”*



- Combines trust knowledge and formation
- Hypothesis : An experience-based trust proxy will influence the tendency to trust or distrust
- Addresses exploratory research themes 1&2

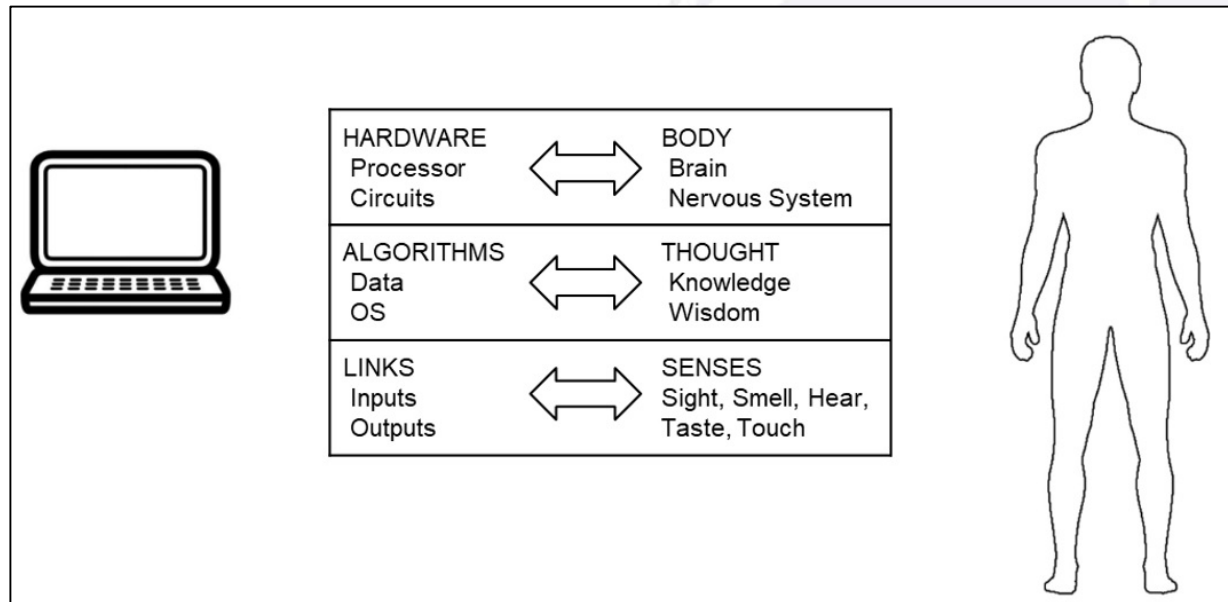


- Technology Acceptance Model (TAM)
- Lazy User Theory (LUT)
- Hypothesis: Category based anthropomorphism will influence both LUT and TAM
- Addresses exploratory research themes 3&4

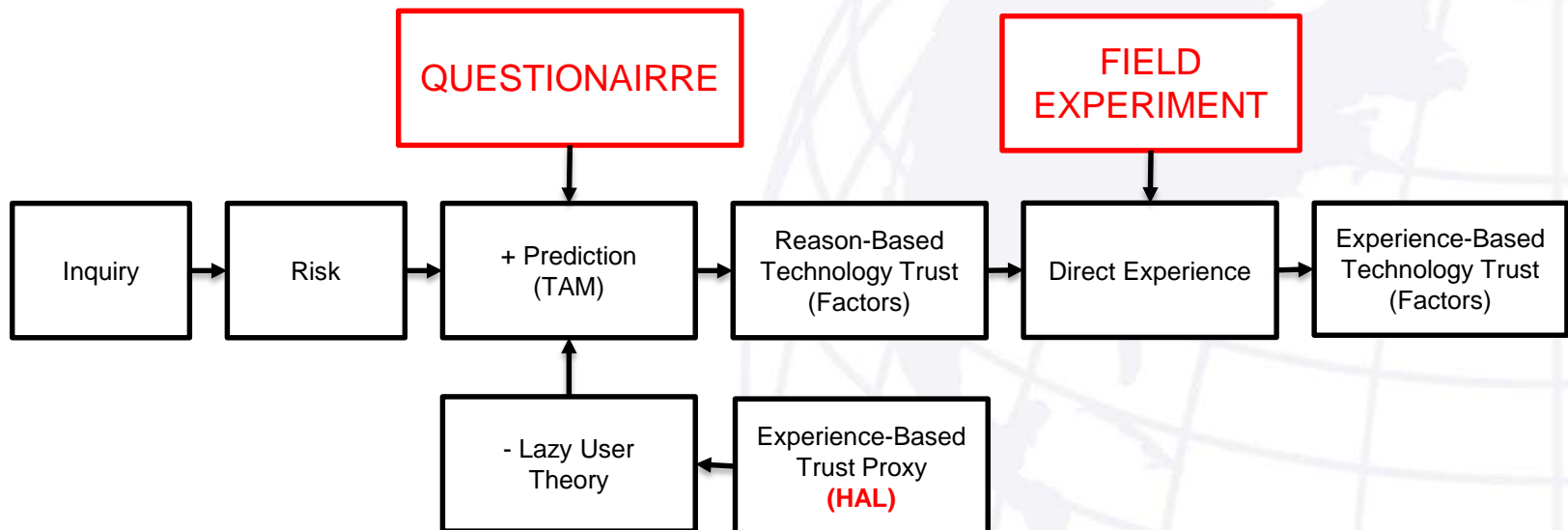


Conceptual Framework for Technology Trust

- Identified as a relevant trust factor
- Existing research based on appearance-based anthropomorphism (making technology look human)
- This work investigates the influence of category-based anthropomorphism (link technology to human attributes)
- HAL Categories: Hardware / Algorithms / Links



- Experiment 1 – Questionnaire to investigate influence of anthropomorphic HAL categories
- Experiment 2 – Field experiment to provide external validity of experiment 1 findings and establish trust proxy
- Experiment 3 – Questionnaire to investigate the influence of a trust proxy on acceptance of autonomous systems





- 2 x 3 factorial design
- IV1 : Systems (repeated-measure) Autonomous vehicle, Remote controlled, Tethered
- IV2 : Anthropomorphic Presentation (between-groups) introduce technology through anthropomorphic HAL categories or uncategorized data.

		SYSTEMS		
		Tethered	Remote	Autonomous
ANTHROPOMORPHIC CATEGORY SYSTEM PRESENTATION	NO	TAM1	TAM2	TAM3
	YES	TAM3	TAM4	TAM5



- Conducted prior to field experiment
- Questionnaire measures reason-based trust
- Questionnaire Section 1 : Measures the perceived importance of system attributes
- Questionnaire Section 2 : Measures the technology acceptance of systems with varying levels of autonomy
- Hypothesis: HAL categories will influence trust in autonomous systems



- Conducted following Field Experiment
- Questionnaire captures experience-based trust needed to establish a Trust Proxy
- Hypothesis: A causal relationship exists between system factors & attributes and technology trust



# Example Trust Proxies

**FICO**®



**CR** Consumer  
Reports™



**Angie's list.**



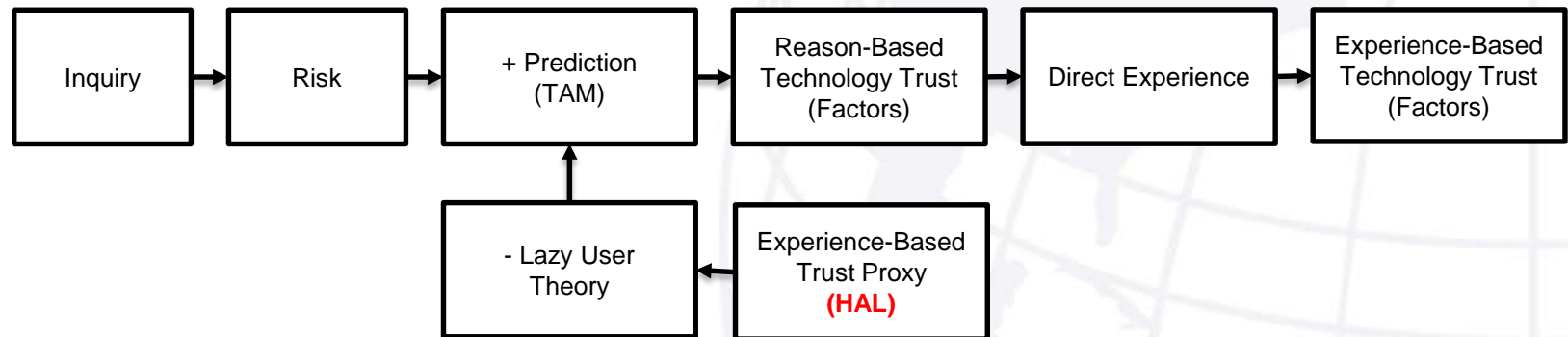
# Proposed HAL Trust Proxy

- Category-based anthropomorphic trust proxy
  - Hardware / Algorithms / Links
- Scored similar to USMC physical fitness test
- Formulated similar to FICO score (odds-based prediction of risk)

PFT SCORE	
<b>Pullups</b>	0-100
<b>Sit-ups</b>	0-100
<b>3-mile Run</b>	0-100
<b>TOTAL</b>	<b>0-300</b>

HAL SCORE		
<b>HARDWARE (body)</b>	Attribute (a) Attribute (b) Attribute (c)	0-100
<b>ALGORITHMS (thoughts)</b>	Attribute (a) Attribute (b) Attribute (c)	0-100
<b>LINKS (senses)</b>	Attribute (a) Attribute (b) Attribute (c)	0-100
<b>TOTAL</b>		<b>0-300</b>

- Controlled experiment to investigate the influence of hypothetical HAL trust scores on the adoption of autonomous systems
- Hypothesis: The HAL score will influence initial trust in autonomous systems





- The main research hypothesis is that a trust score can influence the initial formation of trust in autonomous systems by functioning as a surrogate for experience-based trust
- Experiment 1 questionnaire already conducted with 1MEF EOD
- Experiment 2 scheduled for field testing in late FY19
- Experiment 3 is under development