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TECHNOLOGY TRUST: THE IMPACT OF ANTHROPOMORPHIC SYSTEM INFORMATION ON THE ACCEPTANCE OF AUTONOMOUS SYSTEMS USED IN HIGH-RISK APPLICATIONS

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Excellence Through Knowledge

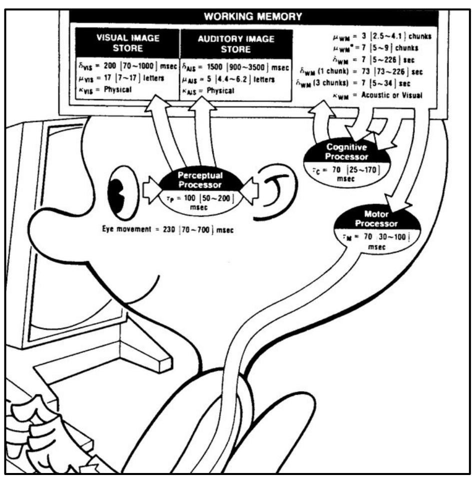
Problem / Purpose

The **problem** is technology rejection due to a lack of trust. This is a problem because our enemies are using increasingly sophisticated technologies in combat and it is becoming a disruptive threat to the United States' technological superiority. (Murphy & Shields, 2012)

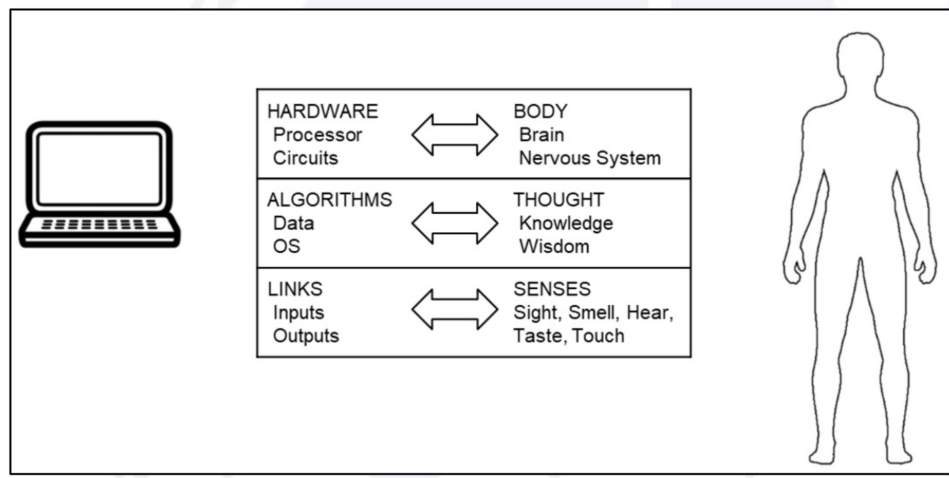
The **purpose** is to research the effect of anthropomorphic system information on trust in autonomous systems. This is important because autonomous systems can save the lives of military personnel by increasing the distance between human and combat related threats, such as improvised explosive devices.

Anthropomorphism

- Human-like system presentation can increase technology trust (Waytz et. al., 2014)
- Human-like system information can increase technology trust (Lankton et. al., 2015)
- Human Processor Model uses technology to explain the body and measure performance. (Card et. al, 1983)
- Can we use the human body to explain technology and measure trust?



Human Processor Model (Card et. al., 1983)



Hardware Algorithms Links

System Presentation

- A *presentation* is the act of providing information to explain something
- HAL (hardware, algorithms, links) is a concept for presenting technology as human-like information
- Two types of trust information, reason-based & experience-based (Castelfranchi & Falcone, 2010)

Human-Human

HARDWARE	HA1	Brain
	HA2	Body
	HA3	Endurance / Strength
ALGORITHMS	AL1	Data
	AL2	Information
	AL3	Knowledge
	AL4	Wisdom
LINKS	LN1	Sight
	LN2	Touch
	LN3	Hearing
	LN3	Smell
	LN5	Taste
	LN6	Balance

Human-Automation

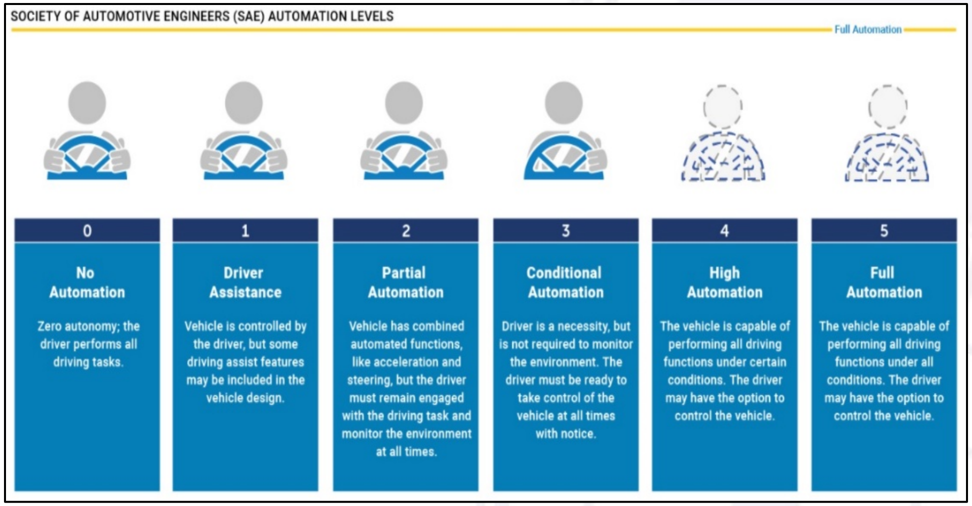
HARDWARE	HA1	Processor / CPU
	HA2	System Capabilities
	HA3	Endurance / Power
ALGORITHMS	AL1	Data
	AL2	Direct Control
	AL3	Remote Control
	AL4	Autonomous Operation
LINKS	LN1	Imagery
	LN2	Haptic Feedback
	LN3	Comms RX
	LN3	Comms TX
	LN5	Environmental
	LN6	Geolocate/Navigate

Human-Computer

HARDWARE	HA1	Processor / CPU
	HA2	Peripheral Components
	HA3	Power / Battery
ALGORITHMS	AL1	Data
	AL2	Instruction Sets
	AL3	Operating Systems
	AL4	Artificial Intelligence / ML
LINKS	LN1	Monitors / Cameras
	LN2	Keyboards / Printers
	LN3	LAN
	LN3	WAN
	LN5	Wired Comms
	LN6	Wireless Comms

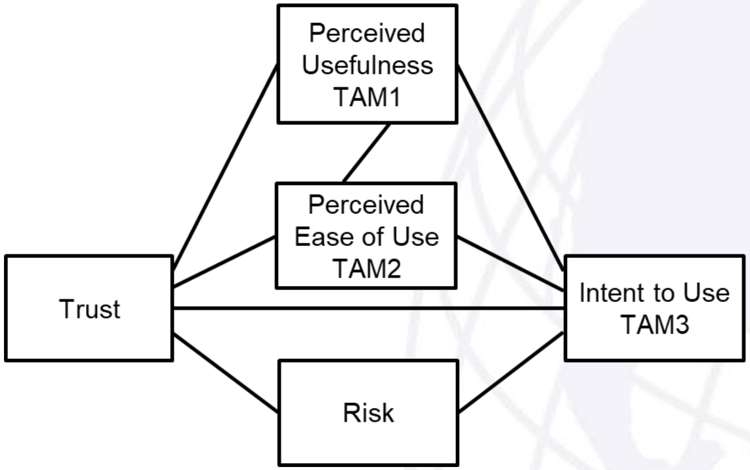
Automation

- **Level of Automation (LOA)**
  - Multiple ordinal scales; 1-10 (computer) and 0-5 (vehicle)
  - In high-risk scenarios some operators prefer manual control over high levels of autonomy (Hoff & Bashir, 2013)
  - Efficient user theory contributes to disuse of autonomy in high-risk scenarios (Tetard & Collan, 2009)



Trust Concepts

- Technology Trust is a mental state where a prediction about the use of technology entails risk and is based on the expectation of a positive outcome (Castelfranchi & Falcone, 2010; Rousseau et al., 1988)
- **Technology Acceptance Model (TAM)**
  - TAM is strongly correlated to trust and perceived risk (Pavlou, 2003)
  - TAM appears to have never been tested under extreme conditions of risk



Adapted from Pavlou, 2003

Methodology

		LEVEL OF AUTOMATION (LOA)		
		Low LOA *Direct Control*	**Med LOA** *Remote Control*	**High LOA** *Autonomous*
SYSTEM PRESENTATION	**Vendor Info** *(n = 23)*	RISK PU PEOU IU	RISK PU PEOU IU	RISK PU PEOU IU
	HAL Info *(n=20)*	RISK PU PEOU IU	RISK PU PEOU IU	RISK PU PEOU IU
	Operational Info *(n=19)*	RISK PU PEOU IU	RISK PU PEOU IU	RISK PU PEOU IU

Procedures

A convenience sample of participants were organized into three treatment groups (n=62).

Experiment stimulus scenario provided for a new USMC EOD LOCE/EABO mission (Littoral Operations in Contested Environment & Expeditionary Advanced Base of Operations).

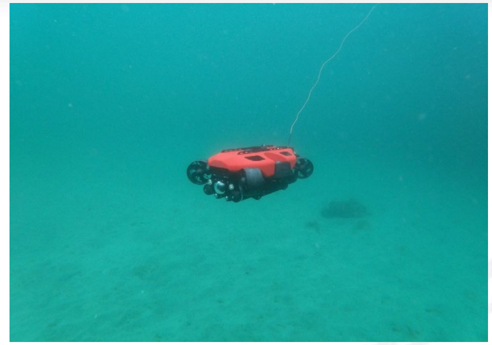
Three different LOA (low, med, high) systems are presented to participants using one of three system presentation treatments (vendor info, HAL info, operational info)

Following system presentation treatment, surveys are provided to participants in near-identical settings (Naval conference center).

Participants were NOT incentivized financially or otherwise.

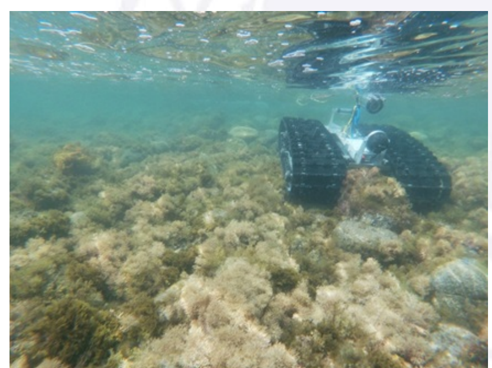
Systems

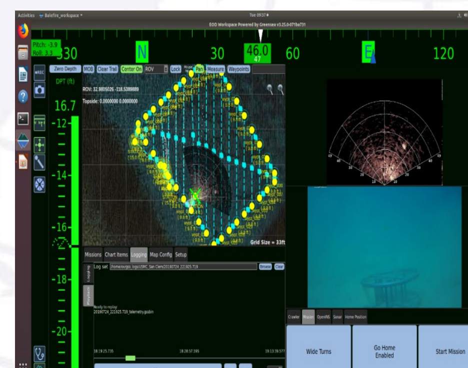
SRS Fusion ROV
Low LOA



Sonar EMILY USV
Medium LOA

Sea OX
High LOA





Analytics

1. Distribution Fitting Tests
   - Parametric Akaike Information Criterion, Anderson–Darling, Kolmogorov–Smirnov, Kuiper's Statistic, Schwarz Criterion, and the Nonparametric Shapiro-Wilk Test
   - ICC – Interclass Correlation and Kendall's W
2. Grouped Tests
   - Hotelling T2
   - Bonferroni
3. General Linear Models: ANOVA (IV,DV)
   - (1,1) Single ANOVA Multiple Treatments
   - (1,1) Single ANOVA with Blocking Variables
   - (2,1) Two-way ANOVA
   - (1,n) Single Factor MANOVA
   - (2,n) Two-way MANOVA
4. Two Variable Equal Variance T-Tests & Mann–Whitney Tests
5. Multivariate Nonlinear Regression & Econometric Models
6. Principal Component Analysis

Results

- No evidence that LOA effects TAM on average
- HAL information showed an increase in Medium LOA systems for two of four perceived usefulness scores.

  (PU1: p<0.008; PU2: p<0.10*)*
- Operational information increased TAM in all cases.

  (Vendor<Operational: p= 0.0453 & HAL<Operational: p=0.0698*)*
- Operational information decreased perceived risk of failure in the Hardware, but not the Algorithms or Links.

  (Ops Risk < Vendor Risk: p= 0.0299 & Ops Risk < HAL Risk: p=0.0463*)*

* Significant at $\alpha = 0.10$