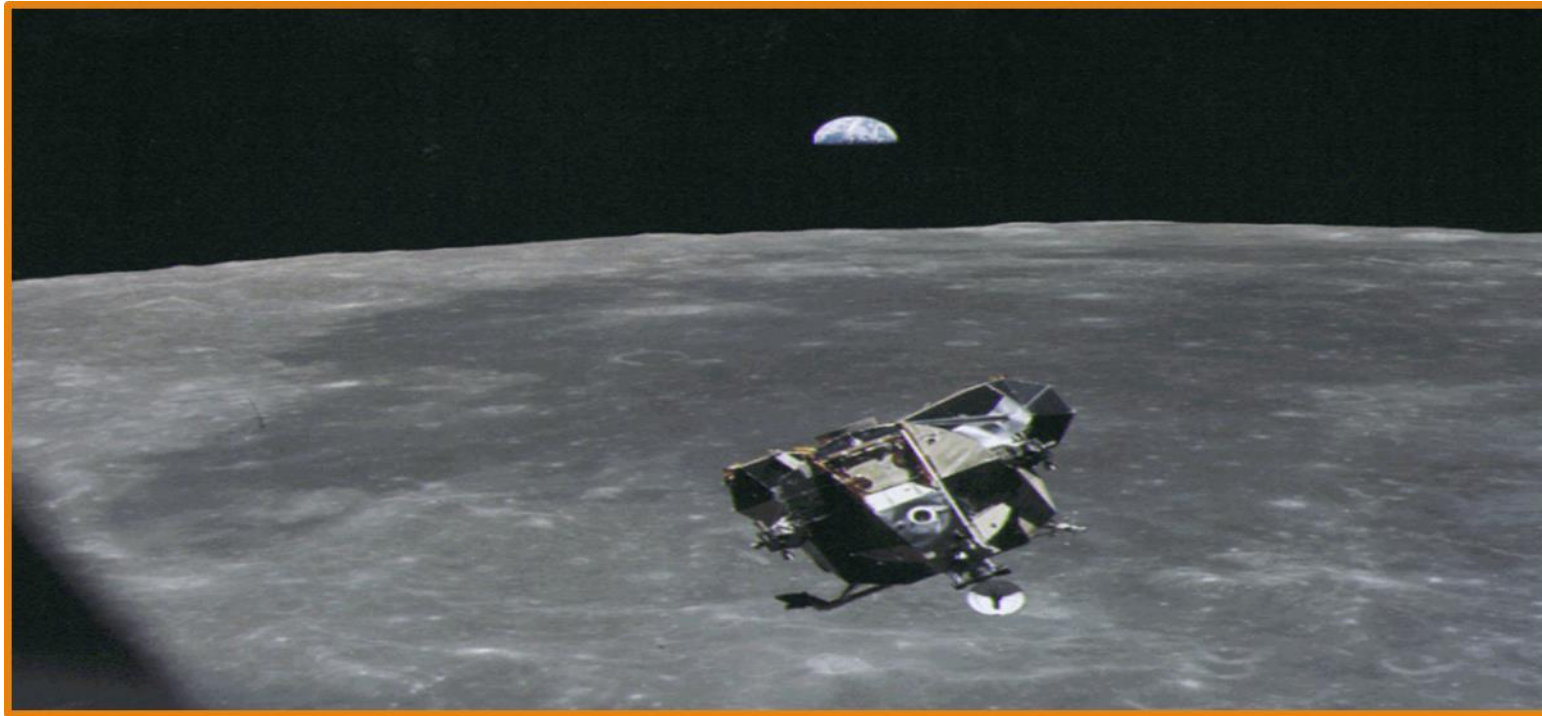# Going The Last Mile For Scan Transition
CREATING IMPACT THROUGH COMMERCIALIZATION

JAY F. NUNAMAKER, JR. AND BRADLEY WALLS

Agenda

* Steps in the Last Research Mile

* A model for transition success

* Proof of concept

* Proof of value

* Proof of use

* Pay-offs for going the last mile

Academic Partnerships

- No one university has the resources / expertise to solve a major real-world issue

- Granting agencies fund multi-university, multi-disciplinary, multi-methodological research
  - NSF IUCRC – Industry University Cooperative Research Center
  - DOD MURI – Multidisciplinary University Research Initiative
  - DHS COE Centers of Excellence

Academic Partnerships

- Form alliances with top researchers in other departments, universities for joint projects
- Fills knowledge gaps
- Increases credibility of proposals
- Builds a larger pool of resources
- Supports investigation of larger major issues
- Increases real-word impact
- More publications, patents

Why Detecting Deception in Groups Important?

- Need to understand
  - Understand who is being honest and who is being deceptive

- But they have their own agendas….
- Need to detect deception in diverse settings.

- DOD personnel meet with groups of people all the time.
  - Security screenings
  - Tactical planning sessions
  - Rescue missions
  - Strategic planning sessions
  - Base security

- DOD meet with foreign delegations all the time

https://www.deviantart.com/chlodulfa/art/Police-Presence-Supreme-Court-292524573

The Need to Study Socio-Cultural Attitudinal Networks

- Military personnel encounters a new group
- Unsure who to trust, must rely on others
- How to identify in a group who is:
  - In charge
  - Well-liked
  - Trusted
  - Being deceptive

Project Goals

Automatic Inference of:

- **Vertical relationships** (dominance/deference)
  Horizontal relationships (like/dislike, trust/distrust)

- **Deceptive behavior**

- **Computationally validate social science theories**

Prediction from videos of people-people interactions:

- X likes/dislikes Y
- X trusts/distrusts Y
- X defers to or dominates Y
- X is being deceptive
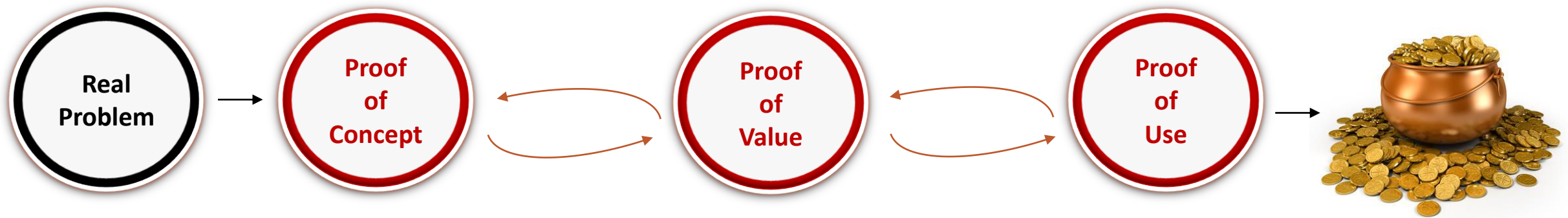
SCAN CONSTRUCTION
Distrust/Trust Example in Dynamic Group Interaction

Distrust - Trust

1 2 3 4 5

Beginning
(few trust each other)

Middle
(some trust develops)

End
(trust and distrust)
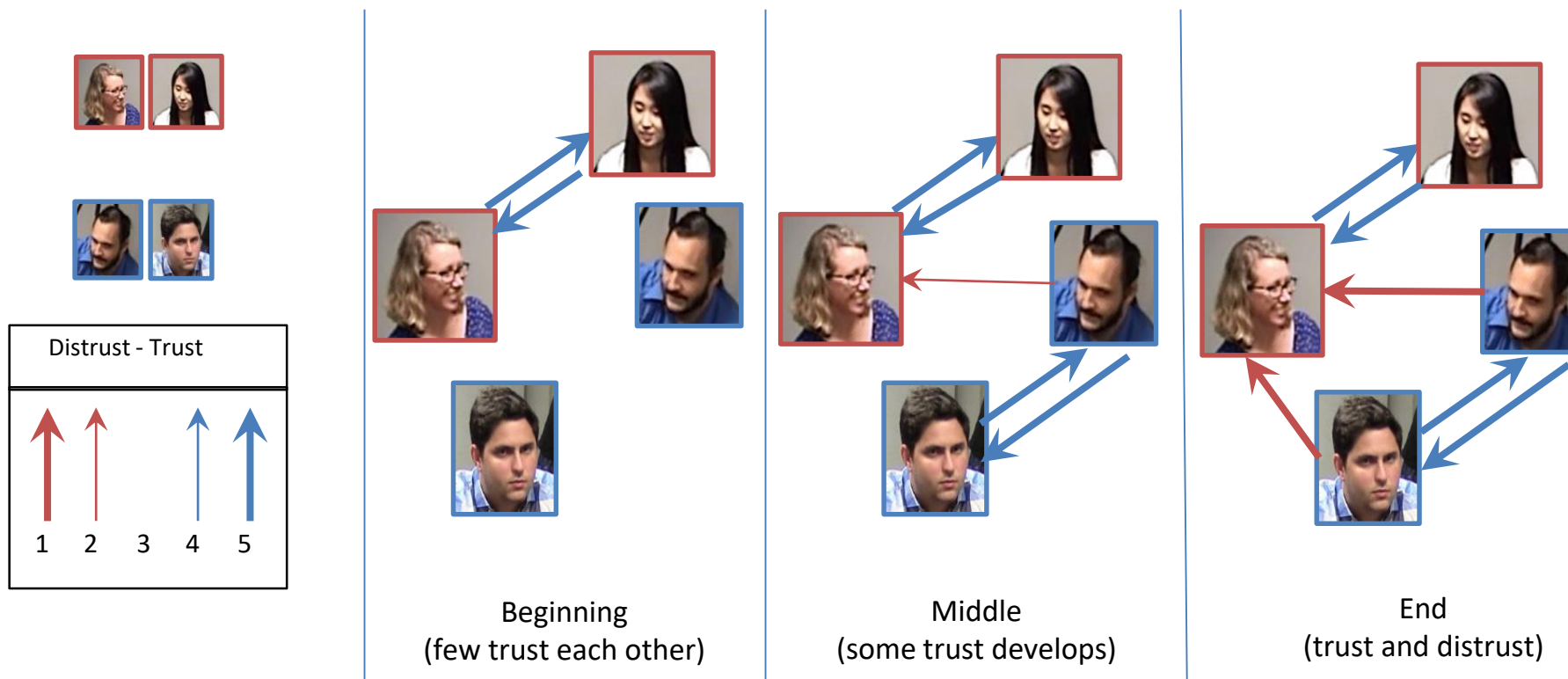
Transition: Research to Commercialization

The Last Research Mile

Use your insights to solve problems for real people

Facts of Life

* You will not guess correctly from your office chair

* You will only see it in the lab and field

Facts of Life

* The devil is in the details
  - Your "interesting idea" is naive until *someone* takes it through the last mile

  - Your understanding is rudimentary until you go through the last mile

  - The work you've done is trivial until it has been worked through the last mile

Why Go the Last Mile?
To Create Impact

Until your system is in the hands of users *without* a vested interest in the success you, won't get to the <u>Nuggets</u> for success

* Researchers are interested in finding what makes a system to create impact

* Scientific facts are in the details that create impact

* The scientific facts are found in POV and POU

WHAT IF THE 1969 MOON-DESTINED ASTRONAUTS HAD **STOPPED 1 MILE** BEFORE LANDING?

Neil Armstrong Explained

"…experts had, prior to the flight, predicted… difficulty might be encountered attempting to work on the surface of the Moon due to the variety of strange atmospheric and gravitational characteristics that would be encountered. This didn't prove to be the case. After landing we felt very comfortable in the lunar gravity. It was, in fact, preferable both to weightlessness and to the Earth's gravity."

Neil Armstrong, 1969, NASA website,
http://www.hq.nasa.gov/office/pao/History/ap11ann/FirstLunarLanding/ch-3.html
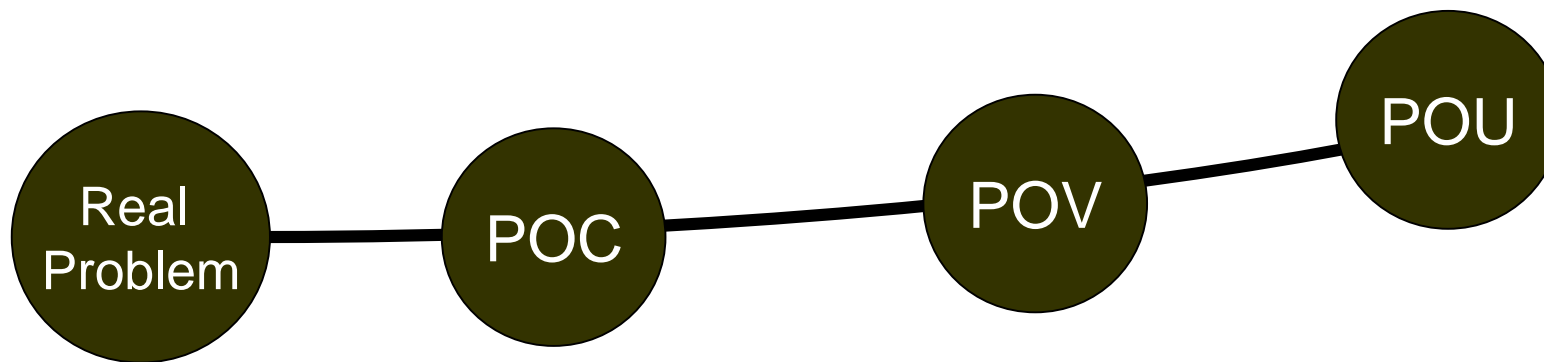
Photographs of the footprints were actually part of a planned experiment by Aldrin to study the nature of the lunar dust and the effects of pressure on the surface.

Going The Last Mile For Scan Transition
CREATING IMPACT THROUGH COMMERCIALIZATION

- Proof-of-concept: Does it work?

- Proof-of-value: Does it create value?

- Proof of use: Is it being used?

PROOF OF CONCEPT

The Need to Study Socio-Cultural Attitudinal Networks

- Law enforcement personnel encounters a new group

- Unsure who to trust, must rely on others

- How to identify in a group who is:

  - In charge

  - Well-liked

  - Trusted

  - Being deceptive

PROOF OF CONCEPT

Socio-Cultural Attitudinal Networks

- Group deception occurs in the context of a network of relationships

- These relationships change over time and are impacted by culture and task

- One way to investigate potentially deceptive communication is to measure communication and perceived relationship features

Pay-offs from Proof of Concept

⚜ Gained Credibility – It works

– The roughest demo is better than the best lecture

Pay-off from Proof-of-Concept

* Discover under which condition proof of concept is satisfied

* Discover interesting phenomena that you can't explain

PROOF OF CONCEPT
Research Thrust 2:
Audio, Video, Verbal, Nonverbal Signal Extraction

From Audio/Video
- **Kinesic/Proxemic** – eye, head, facial, torso, body movements
- **Nonverbal Cues** – pitch, amplitude, pauses, disfluencies
- **Verbal Cues** – text, sentiment, emotions

Builds on past work by Metaxas et al; Burgoon, Metaxas and Nunamaker on deception detection

PROOF OF CONCEPT
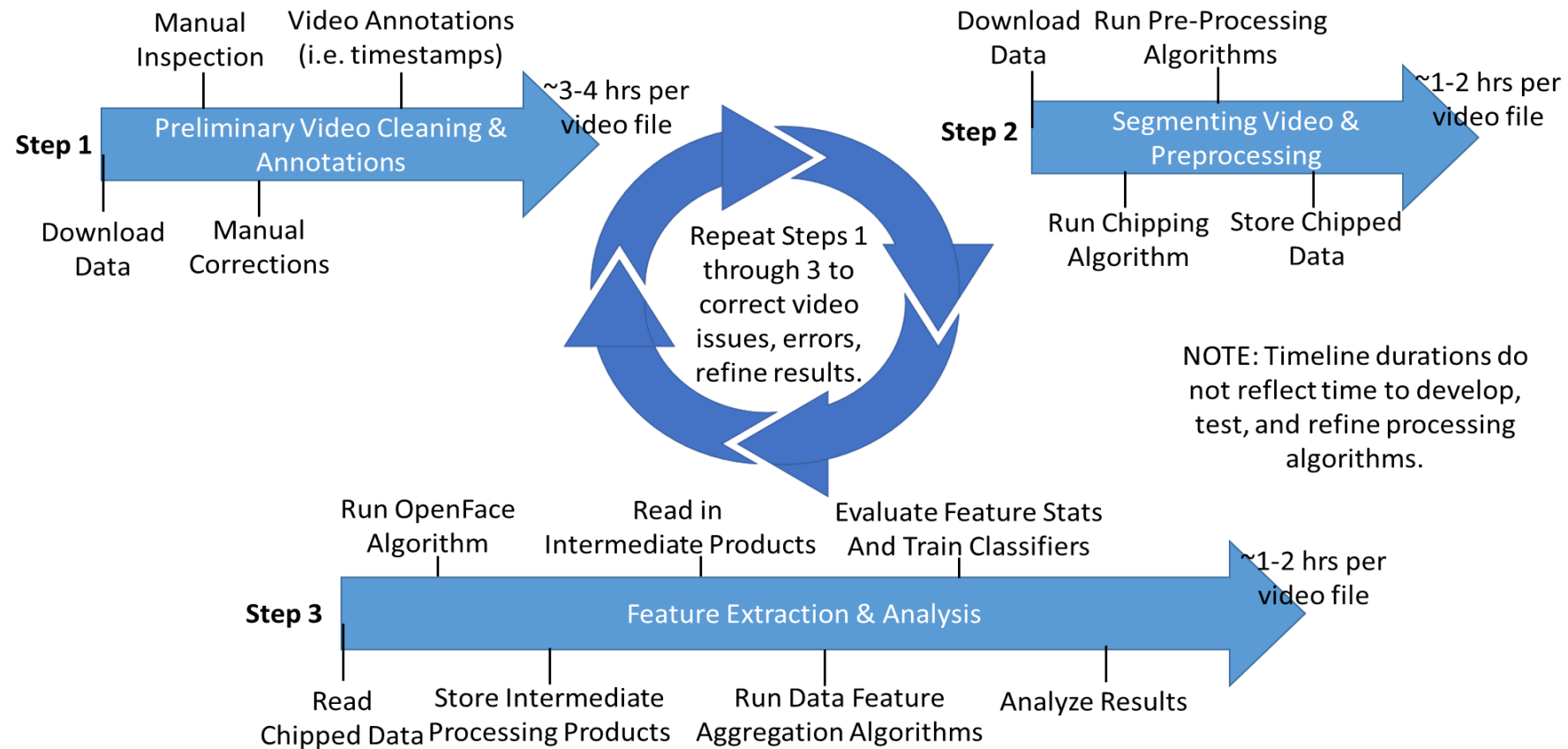# Additional Details and Results

- Challenges In Data Wrangling
  - Data Management
  - Data Cleaning
  - Processing Timeline
- Who's Looking At Who
  - Game Set Up Geometry
  - Intro Round Ground Truthing for Look Validation
  - DEMO

- Expressions and Emotions
  - OpenFace
  - AU's and Emotions
  - Prediction
  - DEMO
- Revealing Features
  - Added Behavior Detection
  - Facial Rigidity
  - OpenPose

Video Processing Timelines for Facial Analysis

Step 1 — Preliminary Video Cleaning & Annotations

Manual Inspection · Video Annotations (i.e. timestamps) · ~3-4 hrs per video file

Download Data · Manual Corrections

Step 2 — Segmenting Video & Preprocessing

Download Data · Run Pre-Processing Algorithms · ~1-2 hrs per video file

Run Chipping Algorithm · Store Chipped Data

Repeat Steps 1 through 3 to correct video issues, errors, refine results.

NOTE: Timeline durations do not reflect time to develop, test, and refine processing algorithms.

Step 3 — Feature Extraction & Analysis

Run OpenFace Algorithm · Read in Intermediate Products · Evaluate Feature Stats And Train Classifiers · ~1-2 hrs per video file

Read Chipped Data · Store Intermediate Processing Products · Run Data Feature Aggregation Algorithms · Analyze Results

24

Survey Instruments

In addition to video recording to capture verbal and nonverbal behavior, survey instruments are used to gather covariates and attitudinal measures

- Players complete a pre-game survey, intra-game survey, and post-game survey
  - **Pre-Game Measures**: demographics, personality, individualism and collectivism, & self image
  - **Intra-Game Measures**: game round roles & likability, dominance, nervousness, and trust of other players
  - **Post-Game Measures**: affective response to stressors, motivation, cognitive absorption, deceptive strategies, task orientation, attitude towards other players
- Player ratings taken every-other round
- These survey instruments record more than 700 variables

Establish Ground Truth

Game Environment

- Configuration allows for identical setup/results at each location
- Octagonal layout using portable tables, which can be carried to each site in suitcases
- Each participant has a Microsoft Surface 3
  - Front-facing camera records participants
- 360 degree camera in center
- Overhead cameras in room corners
- Experiment facilitator at separate table
- Total of 10+ cameras recording each session

Experiment Layout
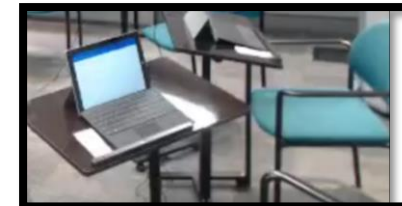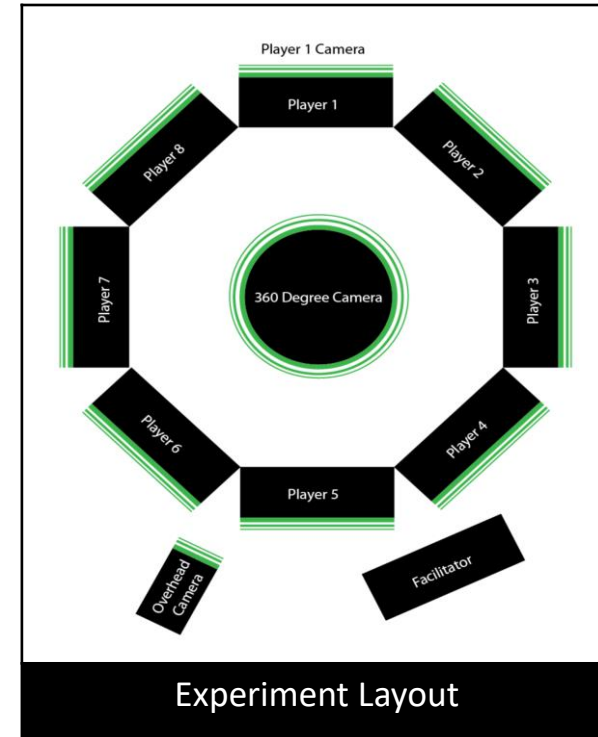
Standardized Experiment Set-up

U Arizona

UCSB

NTU, Singapore

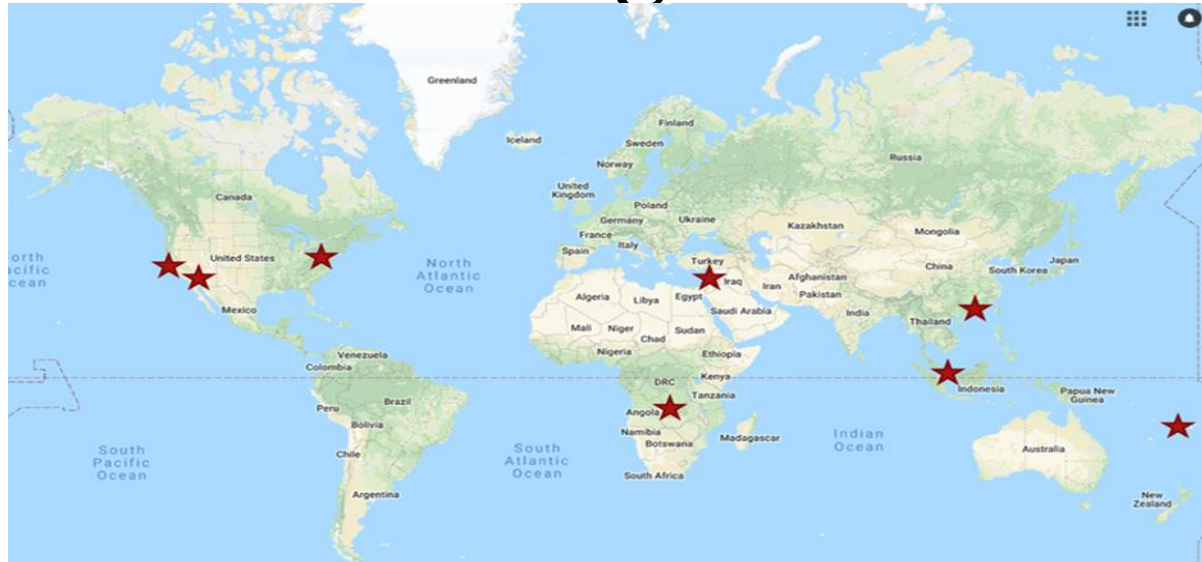
U Maryland

Bar-Ilan, U Israel

Sample Game Play from Singapore

Research Progress to Date

US Sites	International Sites
Arizona (N= 61, 9 games)	Israel (N = 64, 9 games)
California (N = 78, 11 games)	Singapore (N = 84, 12 games)
Maryland (N = 70, 10 games)	Fiji (N = 106, 14 games)
	Zambia (N = 117, 15 games)
	Hong Kong (N = 115, 15 games)

8 Collections Sites Visited

95 Games Played

695 Participants

Many Unique Nationalities

~ 800 Hours of Videos Recorded

> 8 TB of Raw Video Data Collected

Next Steps: Signal Extraction

From Audio/Video

- **Kinesic/Proxemic** – Eye, head, facial, torso, body movements
- **Nonverbal Cues** – Pitch, amplitude, pauses, disfluencies
- **Verbal Cues** – Text, sentiment, emotions

PROOF OF CONCEPT
Issues and Lessons

- Many unanticipated issues arose during data collection

- Made best efforts to anticipate and mitigate damage

- Based on our experience, present a preliminary description of practical lessons learned

PROOF OF CONCEPT

Unanticipated Issue: Temperature

Too hot: equipment overheats

- Laptops fail to respond or crash (causing delays)
- Cameras drop frames or shut off entirely
- Fans reduce heat but add noise
- Participants frustrated by heat (discomfort) and slow equipment

**Too cold:** frustrates participants, body language and movement changes, but equipment works great

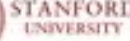**Israel**

Singapore

PROOF OF CONCEPT

Unanticipated Issue: Equipment Failure

- Some equipment broke due to shipping issues (speaker)
  - Low-tech resolution: clap replaces digital syncing noise

- Some equipment broke due to software issues (surface)
  - High tech resolution: alternate equipment
  - Low tech resolution: manual version of game (untested)
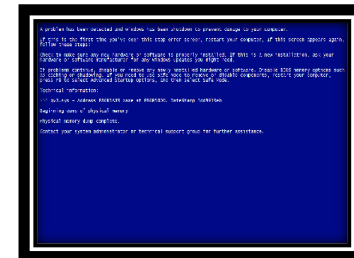
PROOF OF CONCEPT

Unanticipated Issue: Storage Failure

- Hard drives begin failing
  - Ongoing solution: maintain backup copies of data
    - File size makes this a time-consuming task
    - Redundant hardware for temporary storage (extra hard drive space on in-use drives and collection-device disk)
  - Temporary solution: disk repair

  *No disks or files lost to date, though we have had early indications of hard disk issues

PROOF OF CONCEPT
Unanticipated Issue: Site Compatibility

- Incompatible voltage fried power strips
  - High-tech solution: purchase equipment on-site

- Network configuration differs from site to site (no access, site equipment failure)
  - Solution A: contact IT department before arriving
  - Solution B: deploy local server and offline Qualtrics app (have not had to implement yet)
  - Solution C: work with on site IT staff to remedy issues

- Participants do not show up: contact mechanisms may vary

PROOF OF CONCEPT
Data Issues

- 360 camera video availability inconsistent for early data collection sites: multiple 360 cameras and heat-reducing techniques (fans, swapping) are now used

- Surface videos stopped recording in some instances resulting in missing video for participant-specific cameras: device maintenance in between data collections

- Logitech software for overhead camera results in sections of missed data

- Participant misreporting identifiers result in survey responses that can't be linked to videos: process is now completed by facilitator

- Forced to cancel sessions where participants did not show up: contact participants in a variety of ways with reminders, schedule alternate participants to arrive
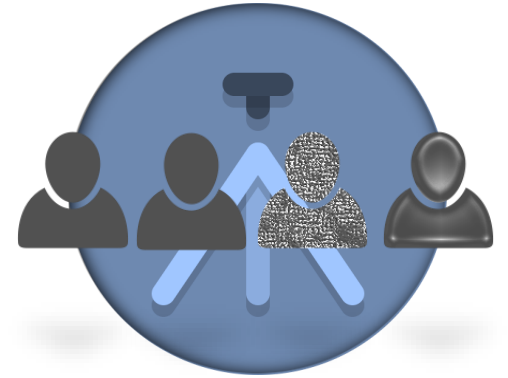
PROOF OF CONCEPT
Data Cleaning

- Reconciling missing or mistakenly entered identifiers
- Joining Pre, Mid, Post-game and software data
- Consolidation of free form responses (e.g. US, USA, U.S., America)
- Reshaping data for specific analyses (wide vs long)

Data Collection: Lessons Learned

- Consistent, accurate, and complete data collection is goal:
  - Standardized processes and layout enable this

- Getting usable data early in game:
  - The ice breaker activity boosts player familiarity and increases communication of interest in early rounds

- Participants often move out of frame
  - showing them their video and asking them to stay in frame is fairly effective at eliminating this issue

- Static spy assignment resulted in leaked game information
  - spy roles are now randomized

- Enormous computational resources required for data processing
  (~10 GB / game / participant results in over 100 GB per game)

PROOF OF CONCEPT
Thrust 2 Additional Features

- Linguistics: SPLICE
  - Quantity
  - Diversity
  - Complexity
  - Immediacy
  - Certainty
- Dyadic patterns:
  - Interactional synchrony
  - Visual dominance ratio

- Fused Features
  - Periodicity of eyebrow movements
  - Periodicity of lip movements
  - Dominance composite (e.g., gaze, gesturing, body lean, loudness)
  - Recognition of important keywords in audio/speech channel
  - Recognition of important sentiments and emotions from the text channel

Pay-off from Proof-of-Value

✦ Explain the unexplainable phenomena
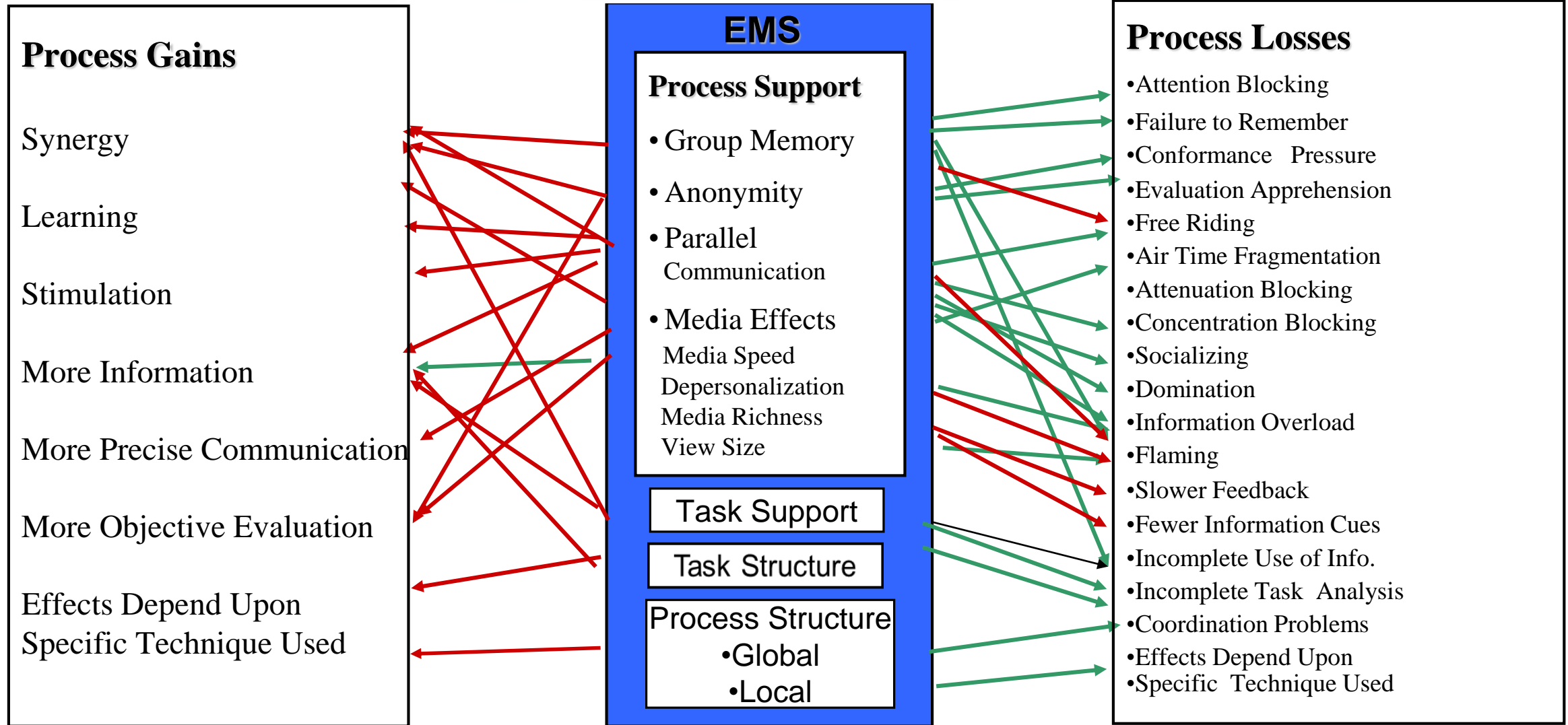
✦ Initial theoretical foundations

What We Have Learned from Lab and Field Studies

- Establish Theories of Operation

- Conduct experiments

Process Gains

Synergy

Learning

Stimulation

More Information

More Precise Communication

More Objective Evaluation

Effects Depend Upon
Specific Technique Used

EMS

Process Support

• Group Memory

• Anonymity

• Parallel
  Communication

• Media Effects
  Media Speed
  Depersonalization
  Media Richness
  View Size

Task Support

Task Structure

Process Structure
  •Global
  •Local

Process Losses

•Attention Blocking
•Failure to Remember
•Conformance   Pressure
•Evaluation Apprehension
•Free Riding
•Air Time Fragmentation
•Attenuation Blocking
•Concentration Blocking
•Socializing
•Domination
•Information Overload
•Flaming
•Slower Feedback
•Fewer Information Cues
•Incomplete Use of Info.
•Incomplete Task Analysis
•Coordination Problems
•Effects Depend Upon
•Specific Technique Used

Increases: ——→

Decreases: ——→

Proof-of-Value

* Value of Anonymity

* Value of Participation

* Measures of Productivity
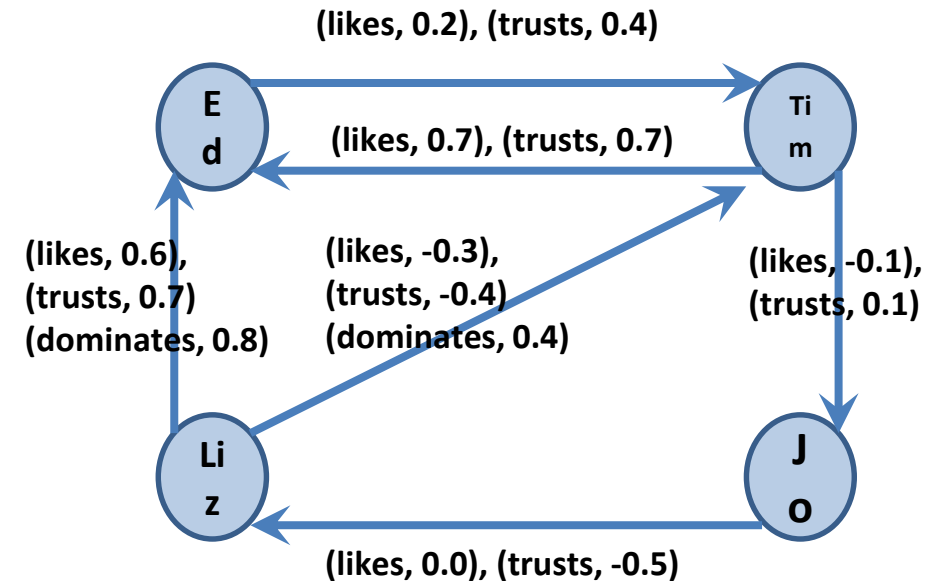
* Measures of Satisfaction

Lessons Learned

- Spy behavior consistent with dyadic results on dominance during deception (Zhou et al., 2004)
- Spies direct attention outward, with fewer first person pronouns and more second person pronouns (consistent with Hauch et al., 2015 meta-analysis)
- Spies on average speak less
- Players in homogeneous games used fewer words and less complex language to communicate – may be able to rely more on non-verbal communication

PROOF OF VALUE
Research Thrust 3:
Culture-Dependent SCAN Construction

- **Input**
  - **Kinesics/proxemics** - eye, head, facial, torso, body movements
  - **Nonverbal cues** – pitch, amplitude, pauses, disfluences
  - **Verbal cues** – text, sentiment, emotions
  - Response features
- **Output**: a network with like, dominate and trust relationships between players

(likes, 0.2), (trusts, 0.4)

(likes, 0.7), (trusts, 0.7)

Ed

Tim

(likes, 0.6),
(trusts, 0.7)
(dominates, 0.8)

(likes, -0.3),
(trusts, -0.4)
(dominates, 0.4)

(likes, -0.1),
(trusts, 0.1)

Liz

Jo

(likes, 0.0), (trusts, -0.5)

PROOF OF VALUE

Research Thrust 4: Deception Detection

- Features will be generated from the game (Thrust 1) using methods developed in Thrusts 2 and 3.
- Attempt to identify Deception Centrality – a measure of how people might "hide" in a group
- Goal: Predict who is being deceptive in a multi-player game context.
  - **Visual features** such as eye movements, lip movements, gestures (generated by Thrust 2)
  - **Audio features** such as pitch, amplitude, stuttering (generated by Thrust 2)
  - **Temporal features** derived from deception transition graphs (generated by Thrusts 3,4)
  - **Network features** derived from the SCAN network such as deception centrality (generated by Thrusts 3,4)

PROOF OF USE

- Test the system with actual users

- Prepare for commercialization

Pay-offs for Proof of Use

✳ Deep understanding of technical, operational, and economic aspects of the problem domain

✳ Your experience will unify into a sophisticated understanding of the domain

The Last Mile

* The last mile is where the value is created

* The last mile is where you make a lasting difference