

Adaptive Systems for Human Factors Engineering

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Pt I: The motivation for adaptive systems in HSI

Pt II: Pitfalls of adaptive systems

Pt III: T&E for adaptive HSI systems

Preparing for the Future

- Predict it
- Control it
- Prepare for the worst
- Be adaptable

Adaptive Systems in HSI

Desired Benefits

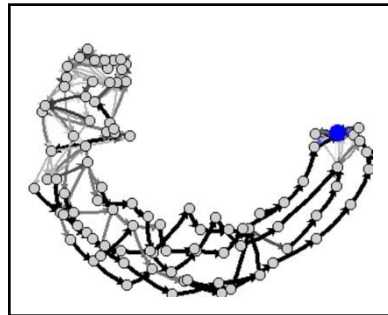
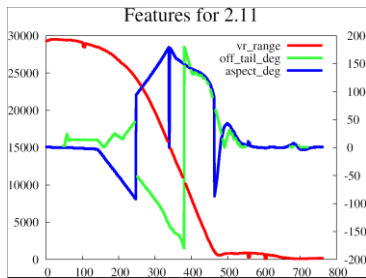
- Don't force users to accommodate the system; instead the system conforms to the user
- High degree of automation; self regulating
- Surprisingly useful in unforeseen circumstances

Examples from Sandia Cognitive Systems group...

AEMASE

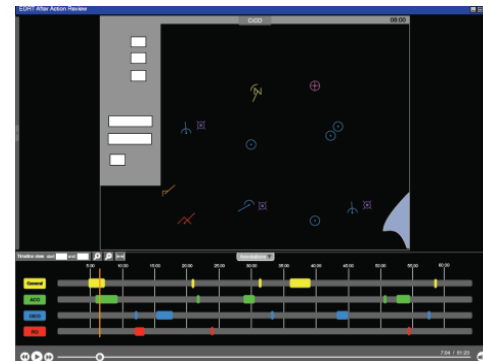
Automated Expert Modeling and Student Evaluation

1. Subject matter experts demonstrate desired behavior in a simulator or instrumented environment.



2. Machine learning techniques used to construct a model of expert behavior.

3. During training, student behavior is compared to expert model to identify and target training to individual deficiencies.



TAF – Trainable Automated Forces

1. Behavior demonstration



2. Behavior Modeling
(Model Fitting)

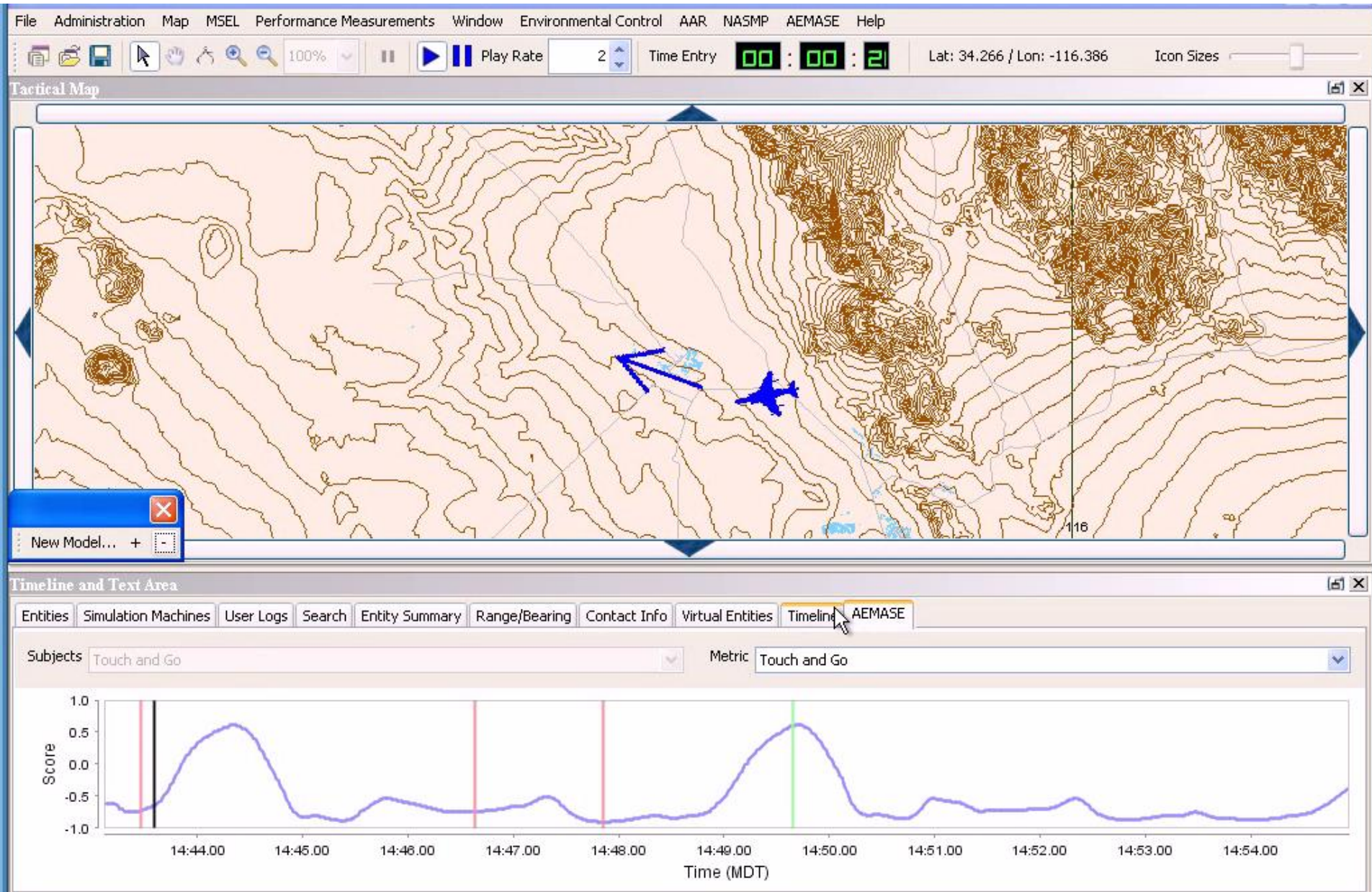


3. Automated Forces



4. Refinement through intervention

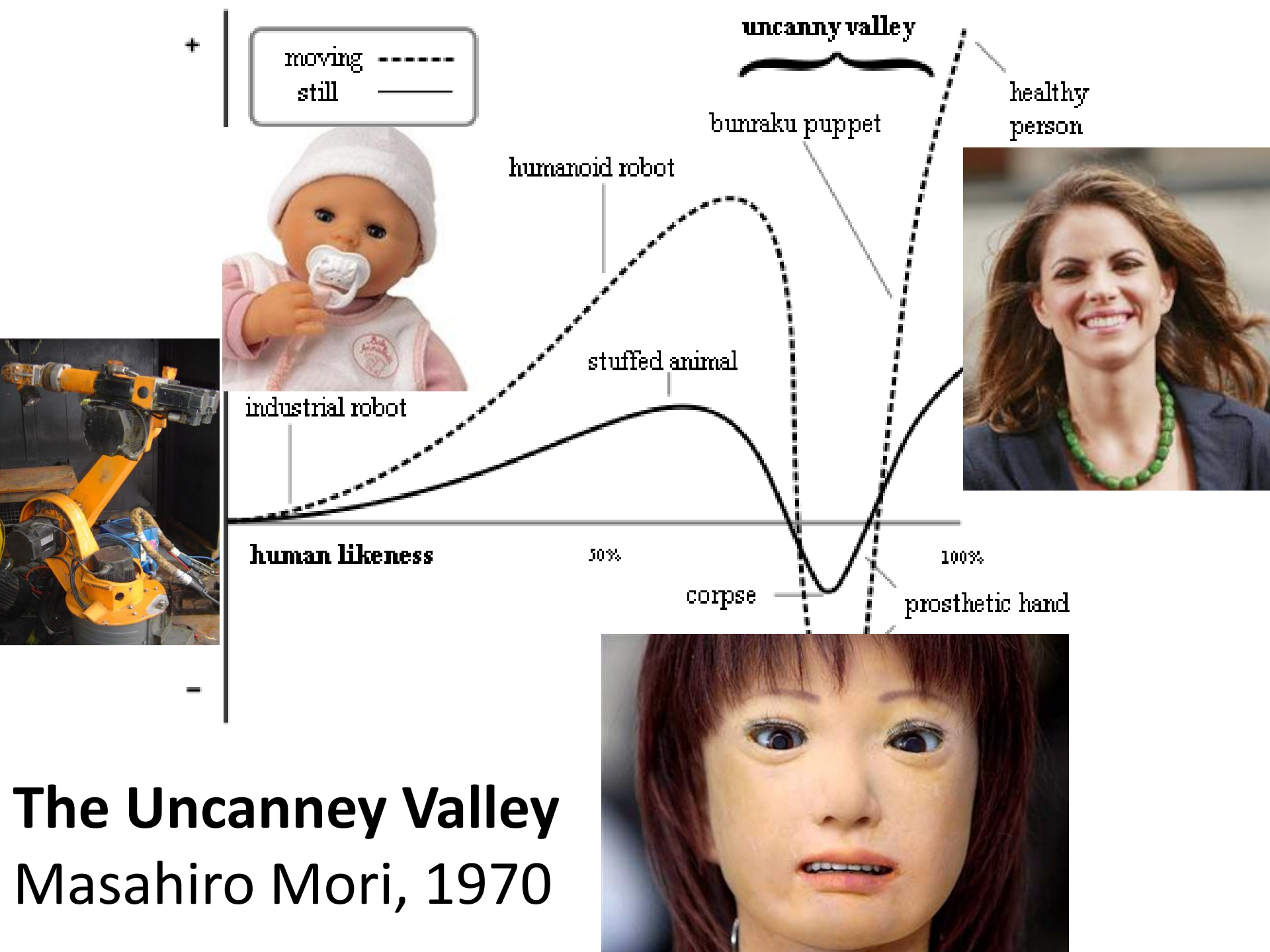
Interactive Model Construction in CDMTS



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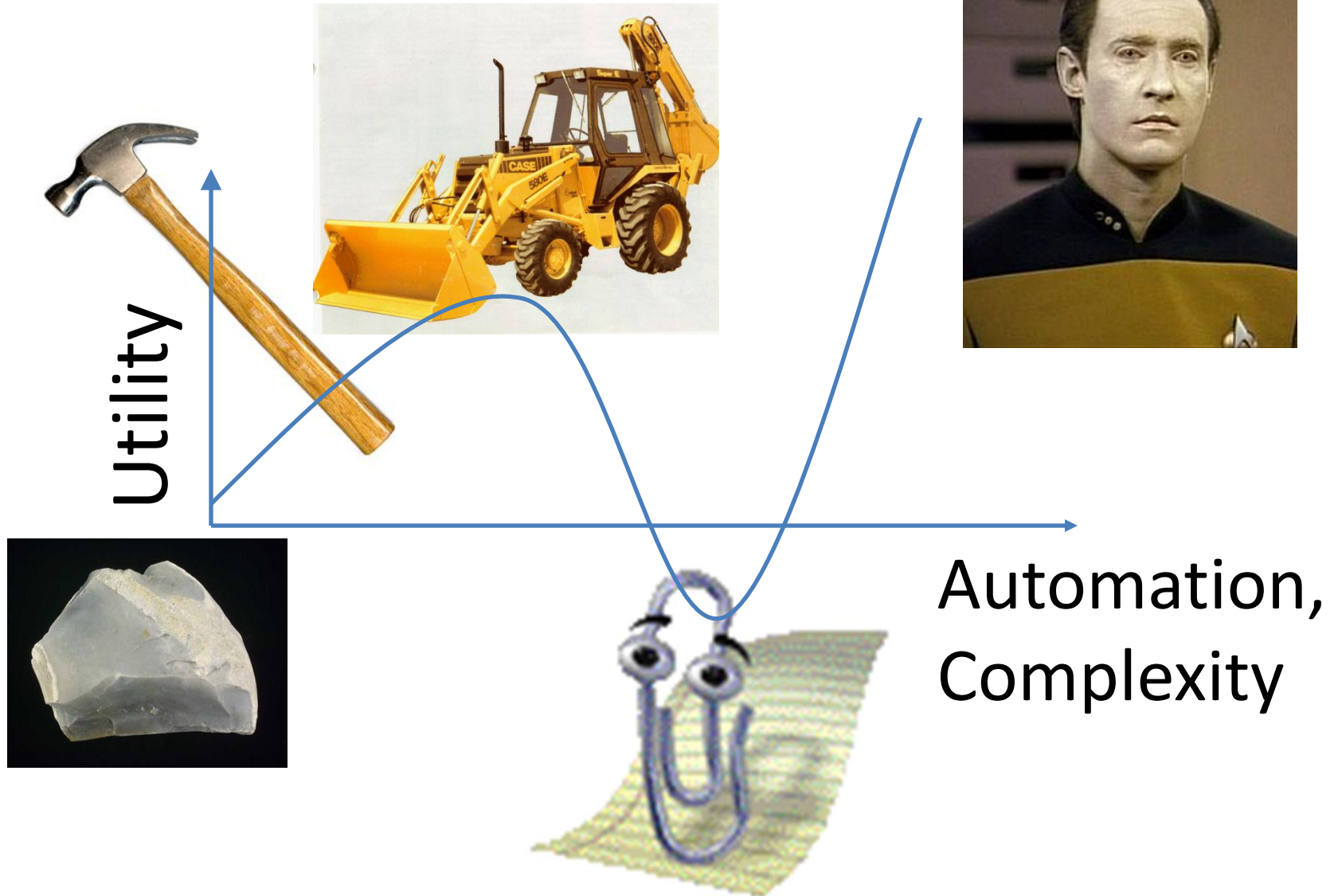
The Uncanny Valley

Masahiro Mori, 1970



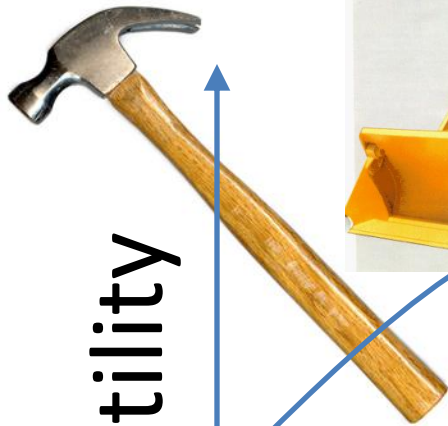
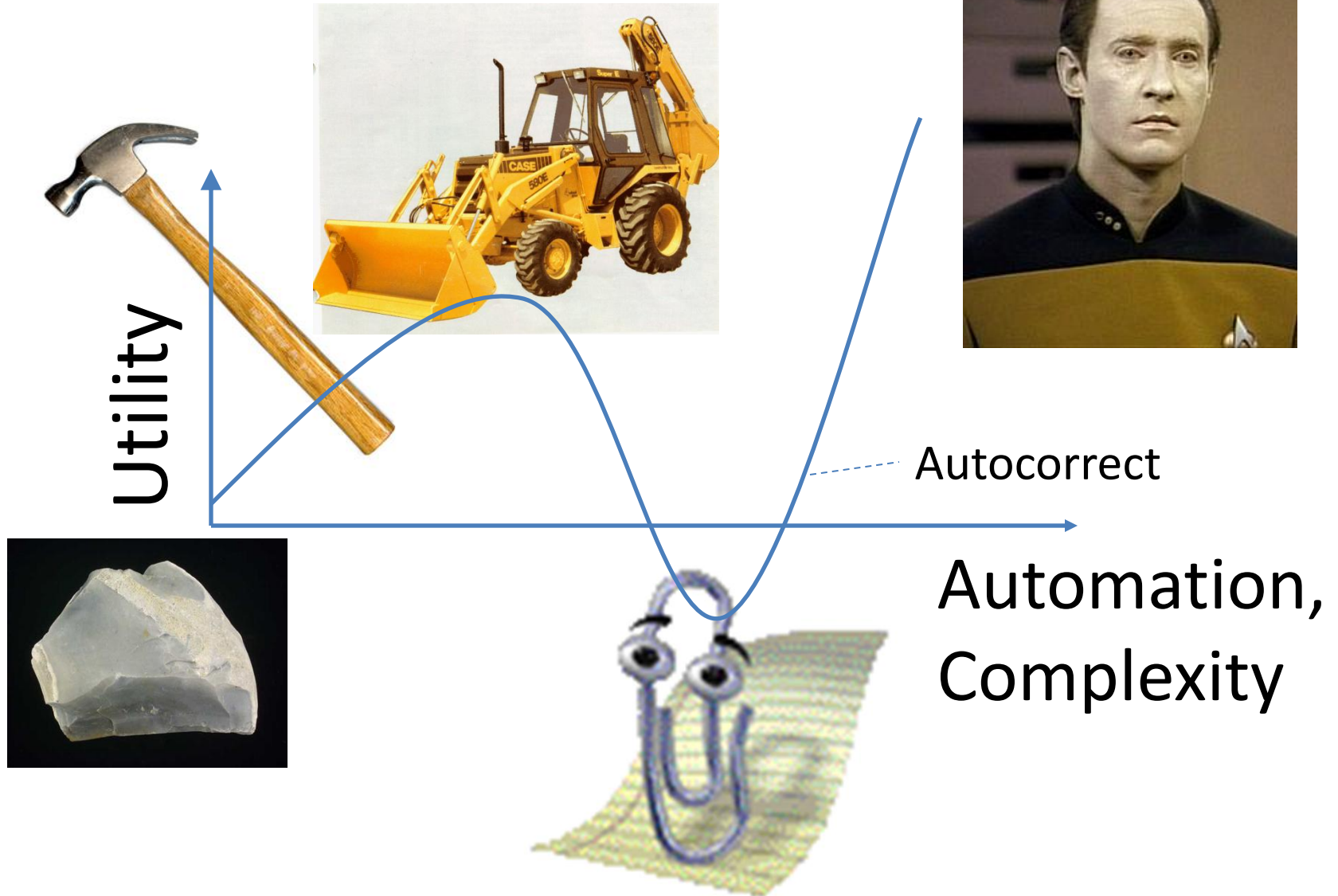
The Clippy Canyon

Inept assistance is worse than none at all



The Clippy Canyon

Inept assistance is worse than none at all



Autocorrect

Automation,
Complexity

Lost in Clippy Canyon



- Sells by the millions
 - No surprises (good nor bad)
 - Can't build skyscrapers or CPUs
-



- Solves unanticipated problems
 - Earns the trust of users who do not understand it
 - Can surprise you – usually in good ways
-



- Gives the right answer, except when it doesn't
- Does not listen or explain itself
- Knows just enough to be dangerous

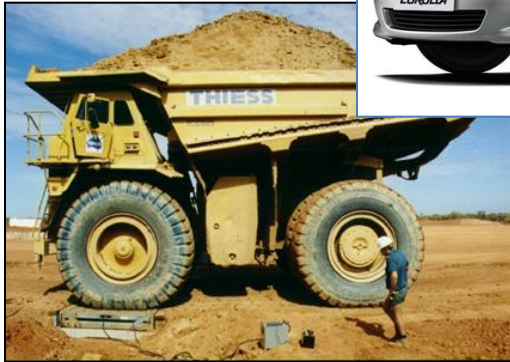
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Implications for T&E

- Point solutions always beat robust solutions in narrow niches
- Benchmarks tend to be narrow



The remarkably unremarkable Toyota Corolla is the world's best-selling car

Implications for TAF, AEMASE

- TAF: Behavior fidelity likely lower than special-purpose hand-coded agent
- AEMASE: Assessment accuracy likely lower than hand-coded student metric

Resolution 1: Use Broader Benchmarks

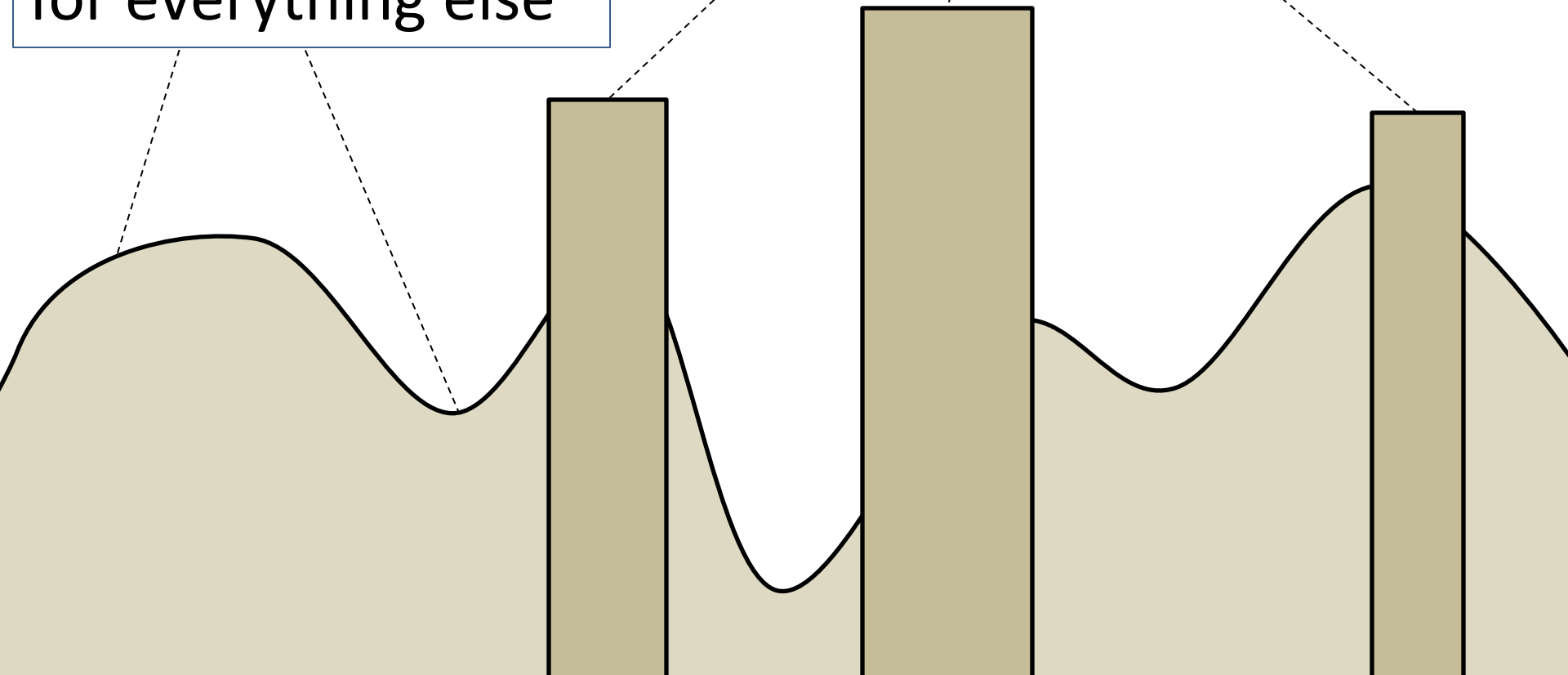
Levels of validation for TAF

- 1. Validated behavior:** TAF TTPs demonstrate behavior expected by SME in a scenario
- 2. Validated generalization:** TAF correctly adapts TTPs to scenario variation due to student actions, and instructor manipulations
- 3. Validated learning:** TAF learn new TTPs with a small number of interventions

Resolution 2: Use A Hybrid Approach

Point Solutions for critical functionality

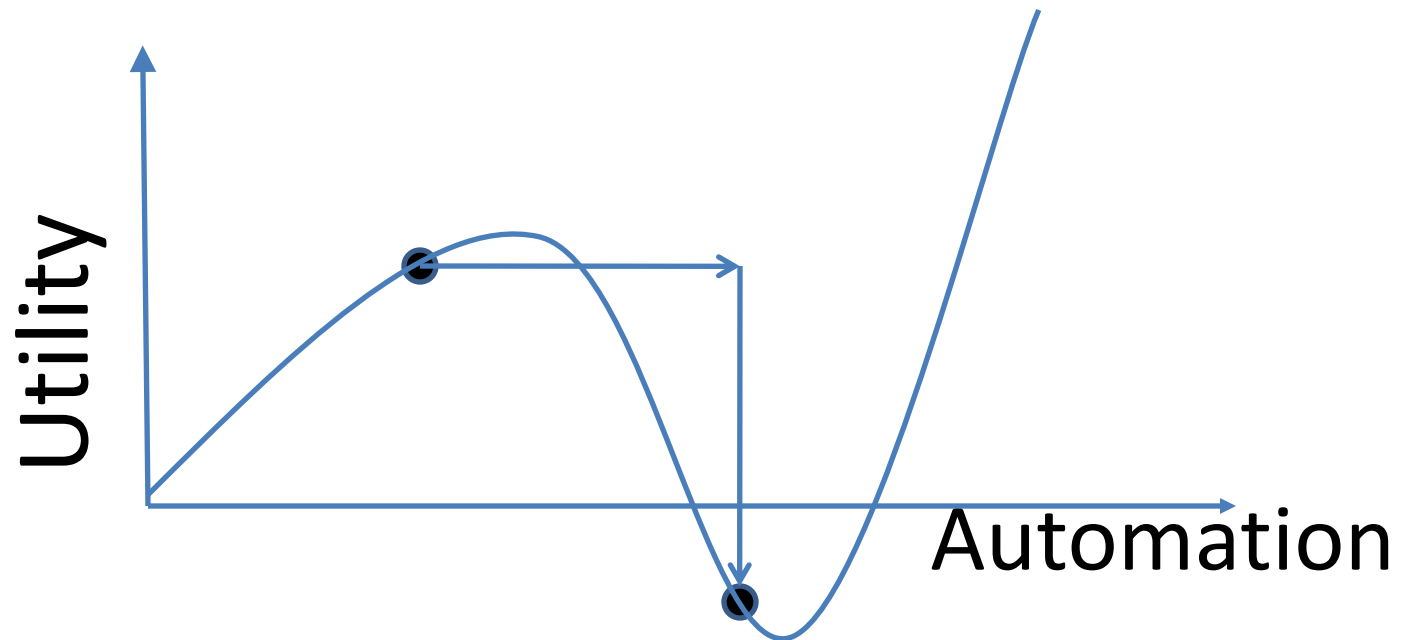
Adaptive Safety Net
for everything else



Further Implications for T&E

- In research, a worse solution might be a step in the right direction

(Even Clippy?)

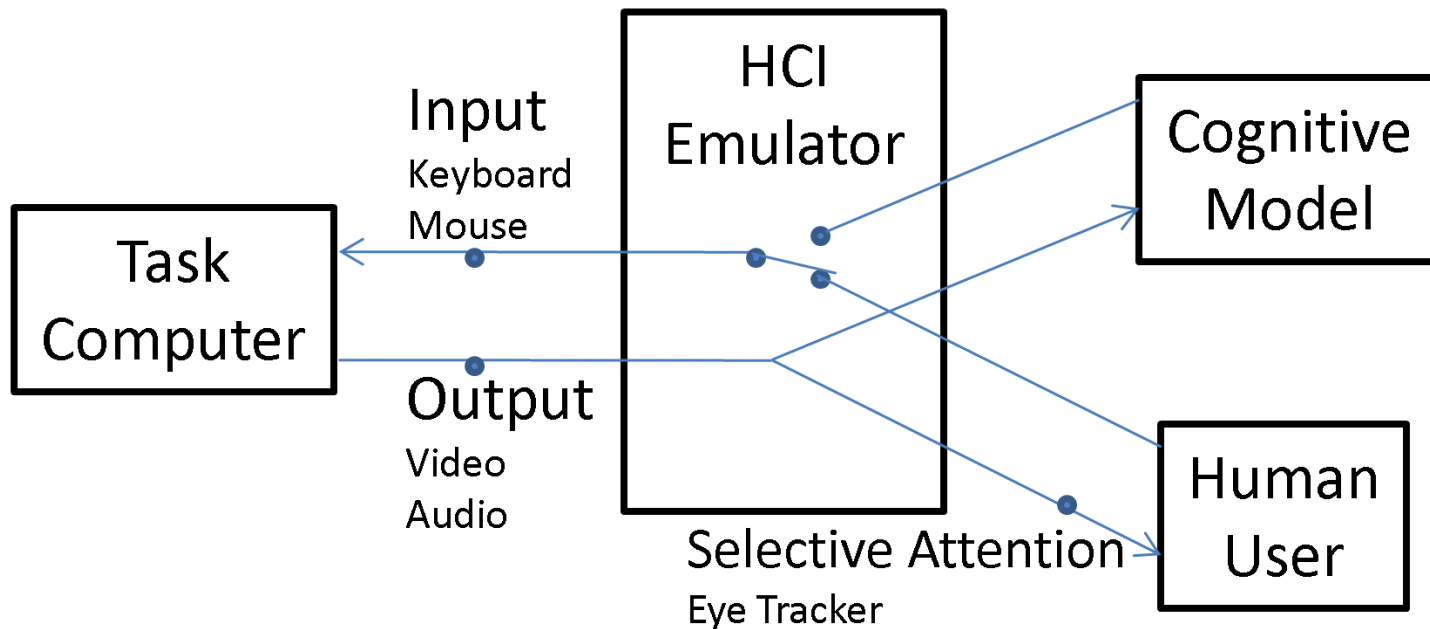


A Final Implication for T&E

- By definition, systems that handle the unexpected are not *exhaustively* tested
- Ultimately, automated adaptive tools will earn trust over time without being fully understood, much like comrades and colleagues

HCI Emulation

HCI Emulation = Cognitive model watches the GUI, listens to sounds, and synthesizes mouse/keyboard inputs



HCI Emulation is necessary to model aspects of HCI

- Selective attention
- Information / action affordances
- Display modality

HCI Emulation: System Diagram

- We Implemented HCI Emulation for MATB
 - now running at Memphis, Notre Dame
- Possible applications abound

