toward engineering system transparency through human machine system studies
cross-cultural anthropology - theory on social interaction

proxemics

transparency
neuropsychology

extrapersonal space
peripersonal space
percutaneous space

focal-extrapersonal: lateral temporal-frontal pathway
action-extrapersonal: medial temporal-frontal pathway
ambient-extrapersonal: peripheral parieto-occipital visual pathway
TECHLA\textsuperscript{V} - testing | evaluation | verification of large-scale autonomous vehicles

systems engineering through anthropology and neuropsychology

social anthropology

neuropsychology

human-system interaction
Engineered Transparency—The Technical, Visual, and Spatial Effects of Glass

Michael Bell and Jeannie Kim, editors

michaelbell
architect | professor at Columbia university
Brunswik (1952)

Originally called as the probabilistic functionalism and expanded by Brunswik's former student Hammond and his colleagues, the lens model was created as a device for representing how the various concepts involved in probabilistic functionalism could be summarized. As Hammond put it, because the data received via the various intersubstitutable receptor functions must be combined, or "recollected" by the organism, the entire process from distal causes to central effect can be represented by the manner in which a convex lens functions. As a result Brunswik referred to his theory as a "lens model" of behavior ... The distal cause in the environment scatters its effects and the organism "re-combines" them.

Cognitive control (Rs): represents the subject's cognitive control over the execution of his/her judgment policy.
Ecological predictability (Re): degree of predictability of the ecology given the set of cues included in the ecology model
Achievement (ra): correspondence between the ecology and judgment subsystem
Linear knowledge (G): agreement between models of ecology and judgment
Unmodeled knowledge (C): agreement between ecology and judgment model residuals

Lens Model Equation

\[ r_a = GR_e R_s + C \sqrt{1 - R_e^2} \sqrt{1 - R_s^2} \]
If we can tell something about the automation, i.e., how it came up with the environmental estimates, we might be able to better support human judgment and decision making performance, and calibrate their trust appropriately.

"...all tasks can be differentiated with reference to the number of indicators they offer, the ecological validity of the indicators, the reliability of the indicators (to what extent the information they offer can be trusted), and the extent to which each indicator is related to other indicators (the redundancy of the indicators),..." - Hammond (2007)
toward an integrated model of human judgment performance with autonomous systems

C: Unmodeled Knowledge

Cues

R_e: Predictability

R_s: Cognitive control

r_a: achievement

G: Linear Knowledge

Ecological Criterion

Human Subject

Lens Model Equation

\[ r_a = G R_e R_s + C \sqrt{(1 - R_e^2)} \sqrt{(1 - R_s^2)} \]
TECHLA\textsuperscript{V} - testing | evaluation | verification of large-scale autonomous vehicles

framework to investigate human interaction with complex systems

soft vs. hard sensors
Capturing human judgment policy
Brunswik’s lens model allows to capture human/judge’s judgment policy using the multiple regression and correlation analyses. The policy captured can be represented by some parameters, called lens model parameters, which include cognitive control, and cue utilization weights. Also, some performance evaluation parameters can be produced such as achievement, linear knowledge, and unmodeled knowledge (which are part of the functional validity information feedback).

Evaluation of Automation’s Competence
Proxy assessment of automation contained by the lens model constructs the degree of competence of such automation, also represented by the lens model parameters. With regard to human trust in automation, this level of competence can be a correspondence for the level of automation’s trustworthiness.

Compatibility between human and automation
Correlating automation with human judgments with (or without) automation can be a useful indication for the correspondence between the two judgment agents. The hybrid lens model captures the similarity (or lack there of) between these agents.

Human reliance on automation
On the similar note by correlating human judgment before and after automation, the effect of automation on human judgment performance can be captured within the hybrid lens model framework. Corresponding and objective measurements for human trust in automation can also be captured in this methodology.
Hybrid Lens Model for Human Automation Interaction

1. Capturing human judgment policy
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   Correlating automation with human judgments with (or without) automation can be a useful indication for the correspondence between the two judgment agents. The hybrid lens model captures the similarity (or lack there of) between these agents.

4. Human reliance on automation
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information analysis/uncertainty information visualization

Information (and therefore uncertainty) visualization has been enlightened due to the recent explosion in security interests.

Inspired by Minard’s graphical representation of Napoleon’s March to Moscow in 1812 during the French invasion of Russia (praised by Tufte), and Hammond (along with his colleagues) with regard to the cognitive/task continuum, information visualization should exemplify the deep fundamental principles of analytical/intuitive design in action.

This approach to ecological psychology is well represented by these two statements.

Tufte—“What are the content-reasoning tasks that this display is supposed to help with?”

Hammond—“What are the properties of the tasks with which judgment must contend?”

If it were to support human judgment and decision making performance and trust calibration in automated systems thereof, “content-reasoning tasks” or “properties of tasks” needs to be examined.