

Personalized Manufacturing

Designing Manufacturing Systems around
Human Emotion to Give the Most and Get
the Most from our People

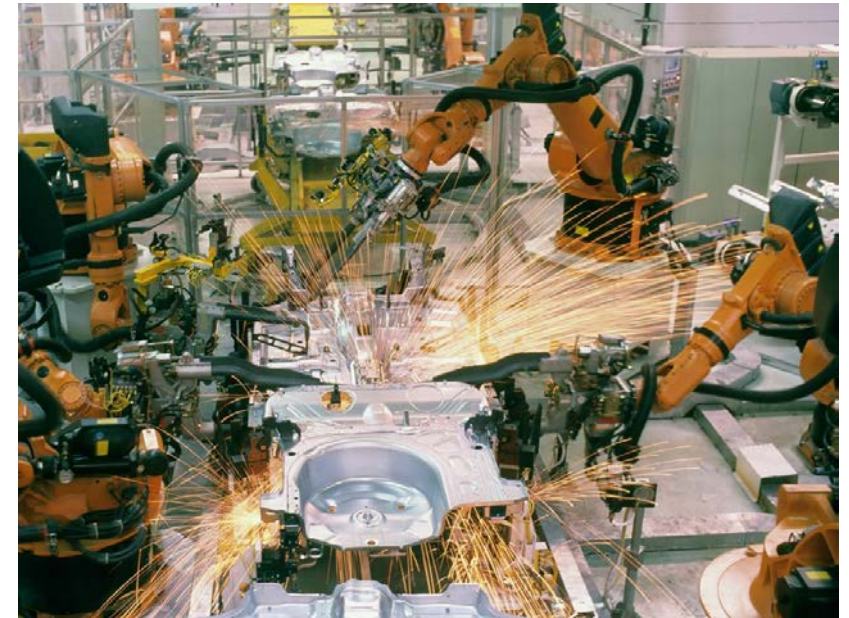
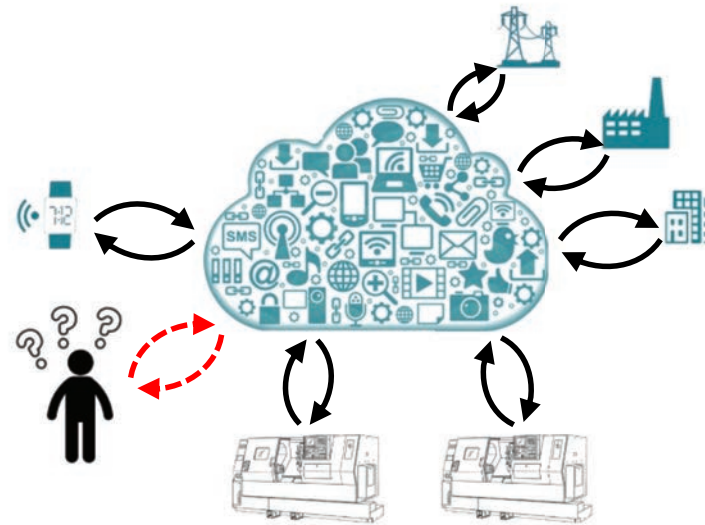
Laine Mears, BMW SmartState Chair of Automotive Manufacturing, Clemson University
Laura Stanley (IE), Eric Muth (Psych), Richard Pak (Psych), Yuyi Jia (AuE), Farbod Akhavan Niaki (AuE)

2nd Annual blue sky competition



What's Wrong?

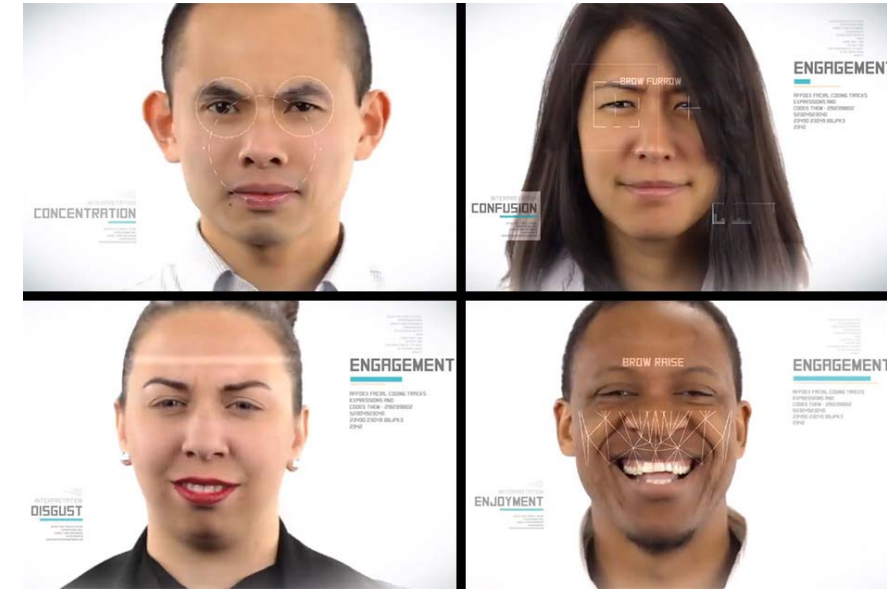
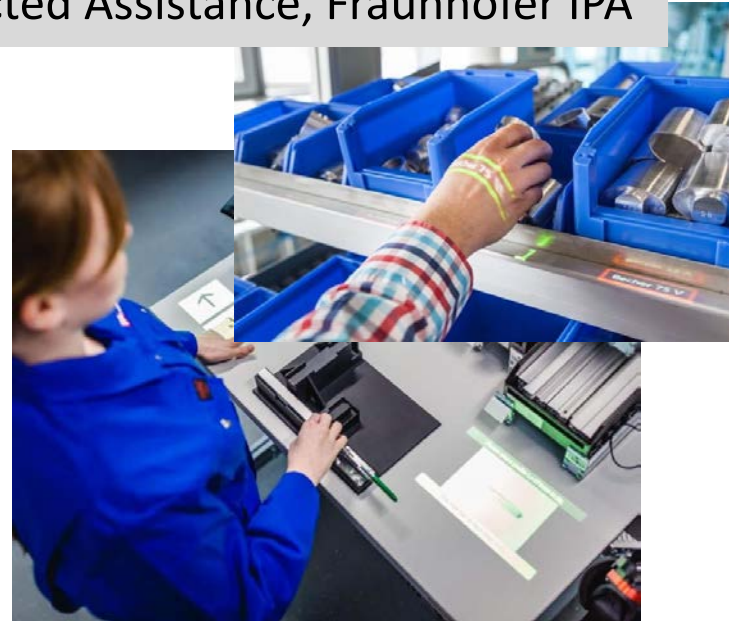
- The Industrial Internet of Things (IIoT, Industry 4.0) is connecting machines - robots - software - supply chain, automatically generating and moving information and adapting processes to changing conditions
- Workers are anxious, stressed, apathetic, disengaged, even derisive or offended, unsure of their role in the New Manufacturing



Current Steps

- Human Factors
- Collaborative Robotics
- Augmented and Virtual Reality
- Human-Systems Integration
- Persuasive technology (e.g., Gamification)
- Facial recognition / voice processing
- Kansei (Affective) Engineering

Projected Assistance, Fraunhofer IPA



:) **Affectiva**
(el Kaliouby, MIT)

MIRO, Consequential Robotics



Bosch Active Assist



Sophia, Hanson Robotics



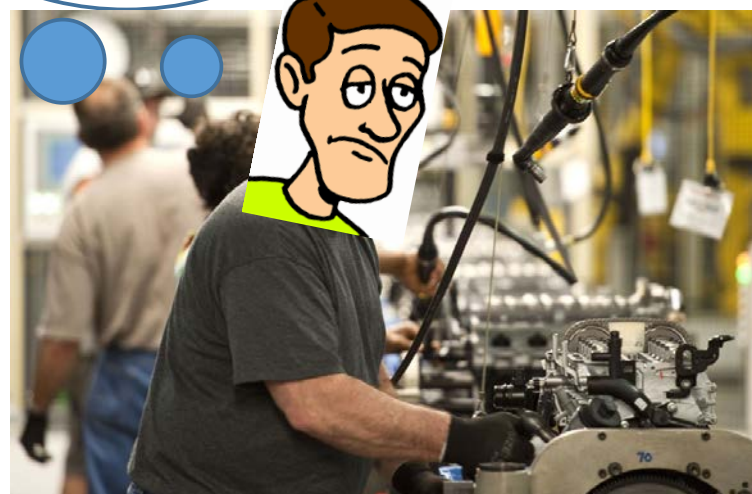
What's missing: Exciting people about their jobs



“We can say without exaggeration that the present national ambition of the United States is unemployment. People live for quitting time, for weekends, for vacations, and for retirement; moreover, this ambition seems to be classless, as true in the executive suites as on the assembly lines. One works not because the work is necessary, valuable, useful to a desirable end, or because one loves to do it, but only to be able to quit - a condition that a saner time would regard as infernal, a condemnation.”

~ WENDELL BERRY

How could we deal with this??



Example: Define “Manufacturing Emotion”

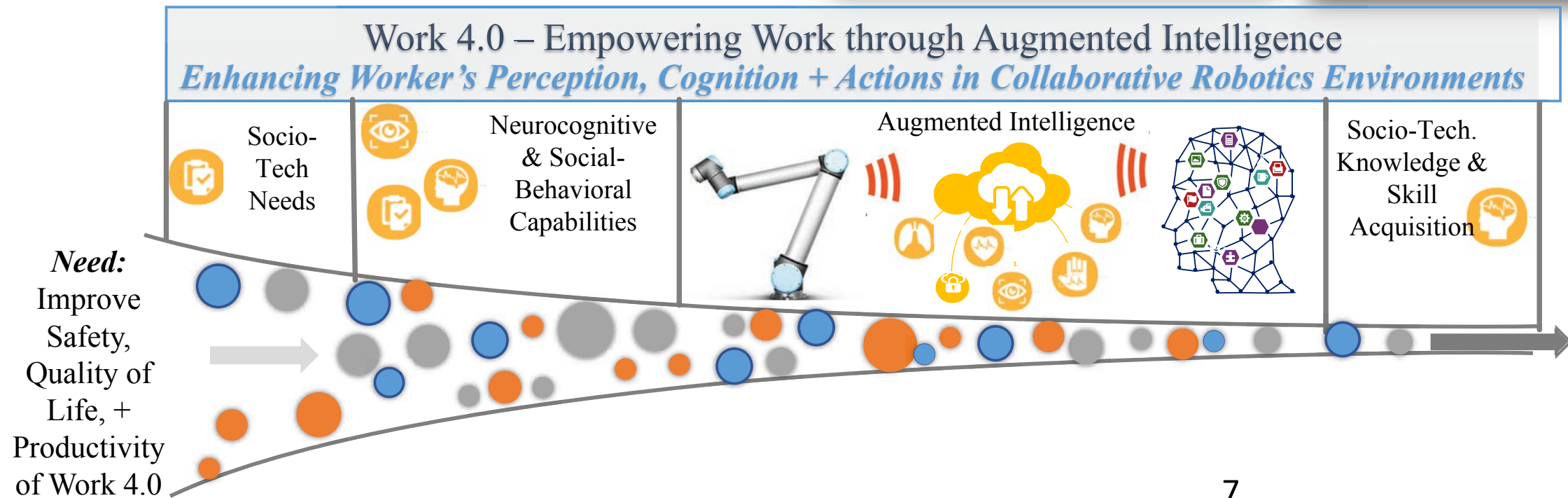
- Keeping workers excited and motivated over the long term; stimulating pleasure centers for engagement.
- Rules and reward systems to stimulate instinctual and intermittent behavior reinforcements.

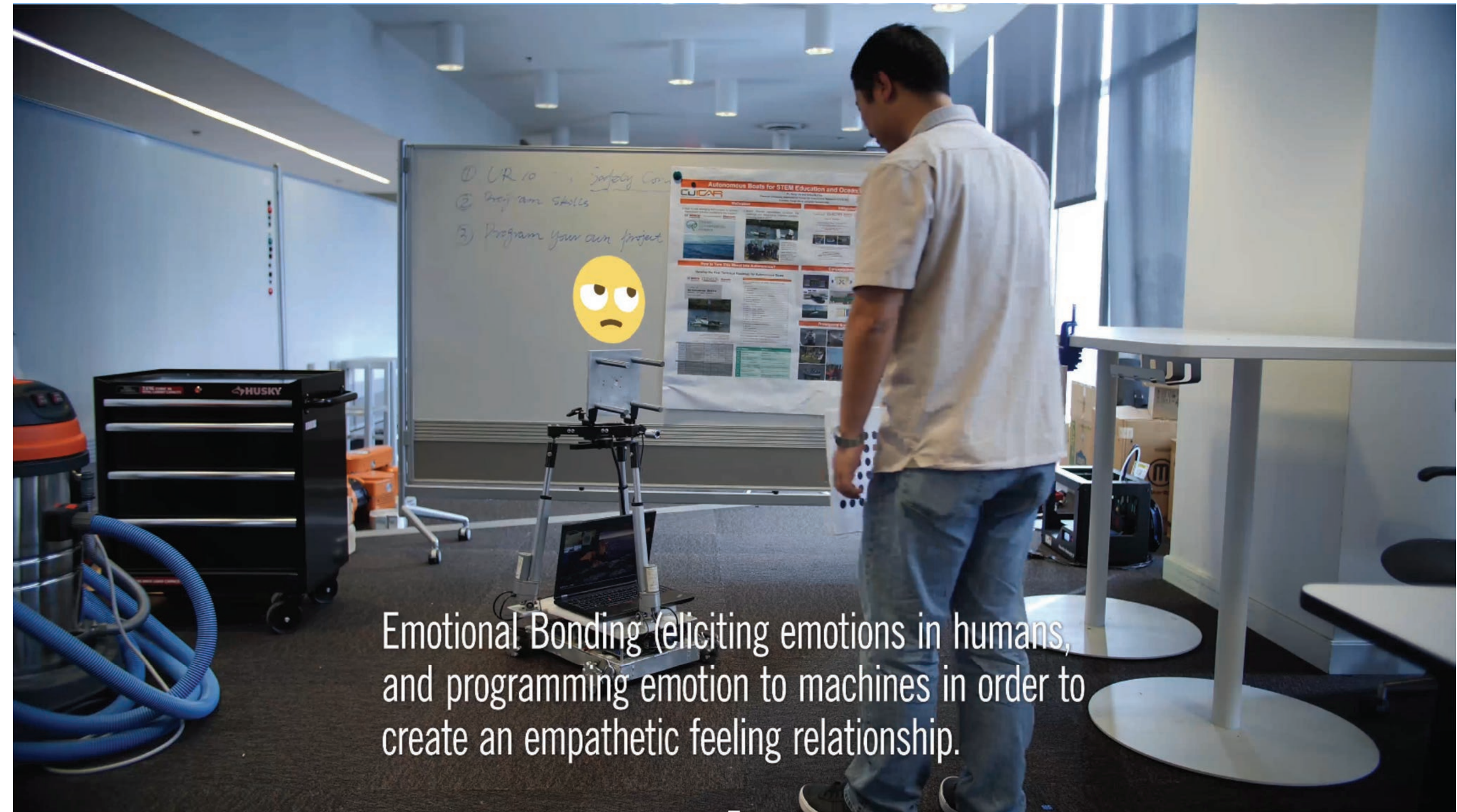





Example: Define “Manufacturing Emotion”

- Emotional control of robots and machines
 - Affective engineering applied to manufacturing
 - Companionship! Trust!





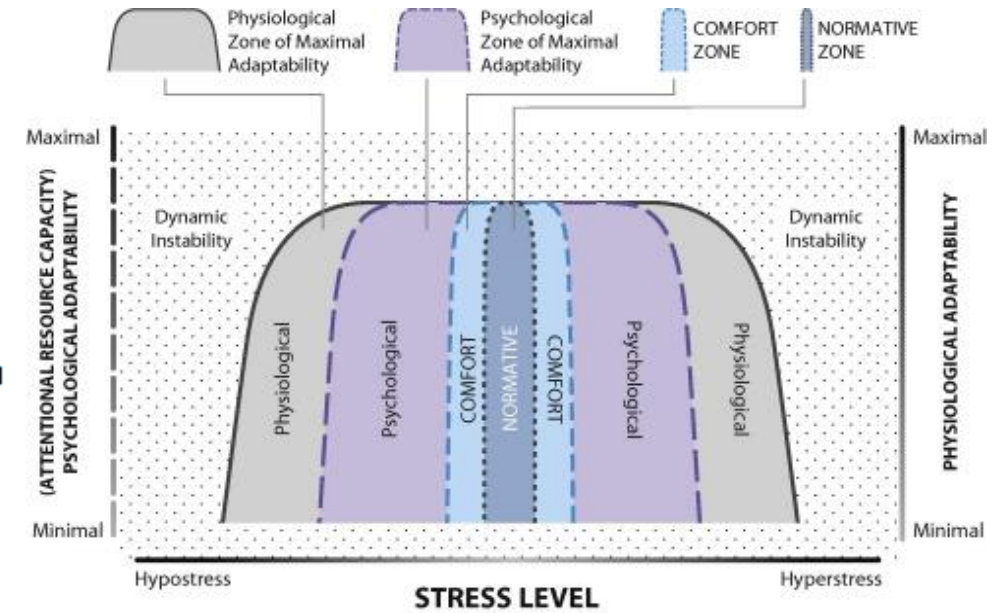
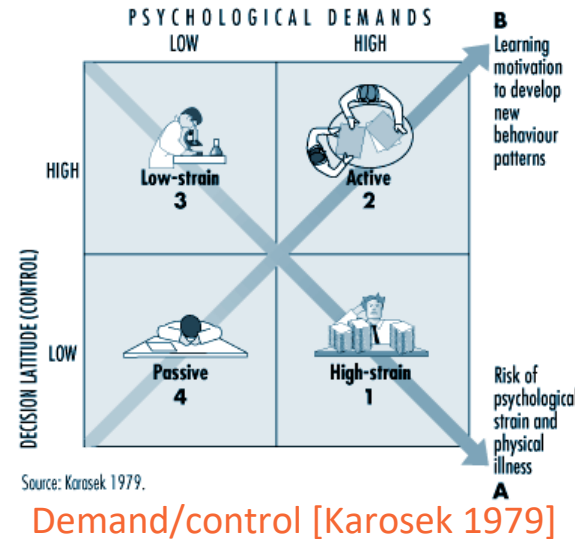
Emotional Bonding (eliciting emotions in humans, and programming emotion to machines in order to create an empathetic feeling relationship.



Extract human information, apply it to control, state identification of human behaviors... bonding AI capability and fusing it with human ability.

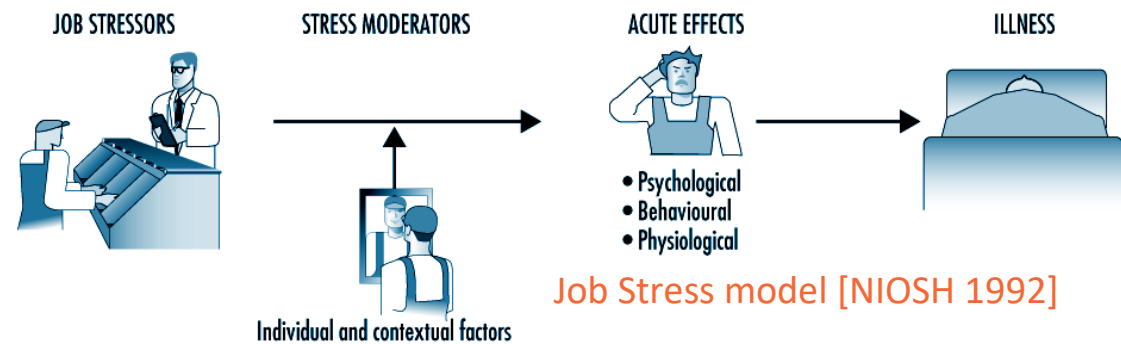
Example: Designing using Psychosocial Models

- People need to experience and perceive environments differently
 - Deliver information in customized formats, personalization of interfaces & communication
 - Users have control!



Erikson's Stage Theory in its Final Version			
Age	Conflict	Resolution or "Virtue"	Culmination in old age
Infancy (0-1 year)	Basic trust vs. mistrust	Hope	Appreciation of interdependence and relatedness
Early childhood (1-3 years)	Autonomy vs. shame	Will	Acceptance of the cycle of life, from integration to disintegration
Play age (3-6 years)	Initiative vs. guilt	Purpose	Humor; empathy; resilience
School age	Industry vs. inferiority	Competence	Humility; acceptance of the course of one's life and
Adolescence (12-19 years)	Identity vs. Confusion	Fidelity	Sense of complexity of life; merging of sensory, logical and aesthetic perception
Early adulthood (20-25 years)	Intimacy vs. Isolation	Love	Sense of the complexity of relationships; value of tenderness and loving freely
Adulthood (26-64 years)	Generativity vs. stagnation	Care	Caritas, caring for others, and agape, empathy and concern
Old age (65-death)	Integrity vs. Despair	Wisdom	Existential identity; a sense of integrity strong enough to withstand physical disintegration

Stage Theory [Erikson 1950]

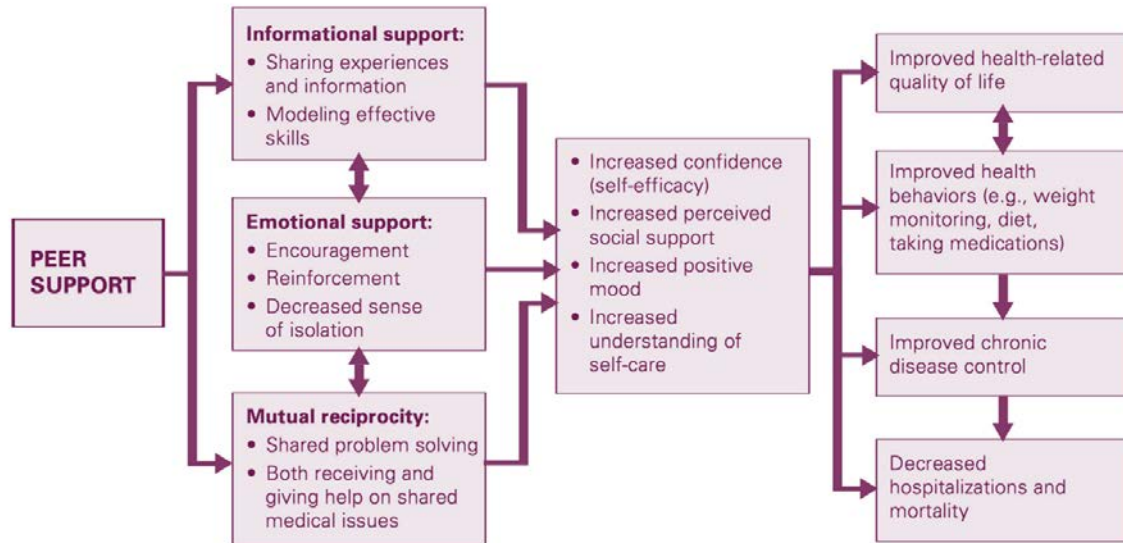




If the system understood in real time how a human would respond, it could adapt presentation of work and parts, and modes of communicating information.

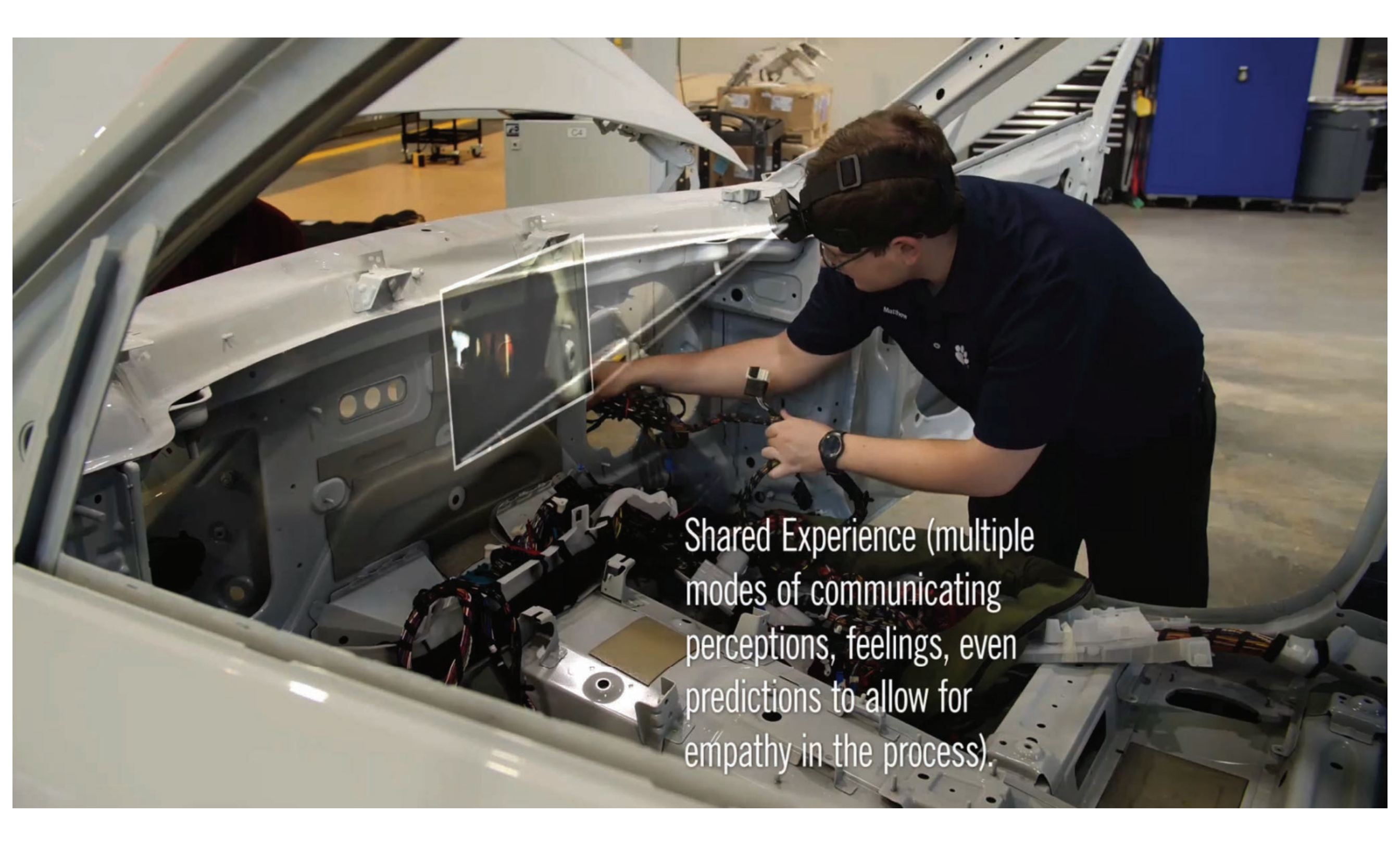
Example: Behavior Prediction in Teaming

- Sensing and models to gage human intent in teams
- Technology for shared experiences, support, reinforcement



Caregiver Peer Support model [Heisler 2006]

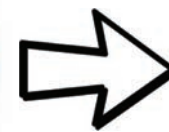




Shared Experience (multiple modes of communicating perceptions, feelings, even predictions to allow for empathy in the process).

Example: Human Adaptive Control

- Sensing and models to gage human condition
 - Fusion of physical and psychological measures
- Adaption of machine control to that human, at that moment





ENTHUSIASM ENERGY APATHY STRESS



- What are the critical metrics of a human, important to manufacturing system integration, and how do we measure?
- How can (soft, subjective, uncertain) human data be well-fused with (hard, objective, deterministic) machine data?
- What information models apply?
- How could one use the tools of digital manufacturing such as Big Data Analysis and Deep Learning on human data streams, in order to understand the patterns of people's performance and feeling, integrate this data to control, and interpret the effect on manufacturing output and overall quality of life?

What is the Science (and how will it be used)?

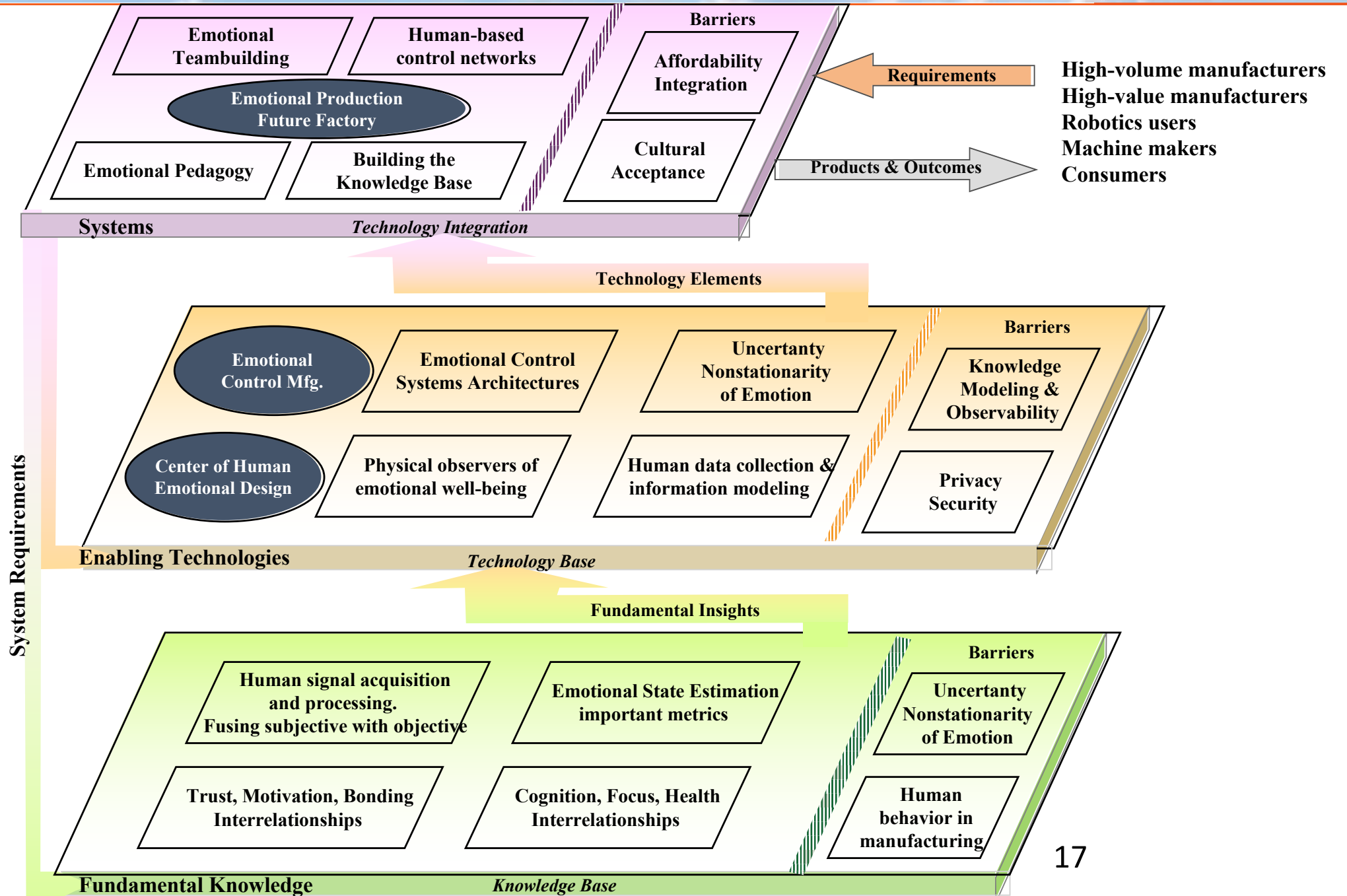
How will knowledge be integrated?



What artifacts will emerge?



What basic understanding is generated?



Who is needed to really address this?

- Convergent effort will require researchers (in addition to engineers):
 - psychologists,
 - sociologists,
 - biologists,
 - pedagogy researchers,
 - computer scientists,
 - logicians,
 - systems thinkers,
 - experts in privacy, security and philosophy
- Plus users:
 - Machine & robot builders, industrial implementers...

- An Internet-of-People-and-Systems, understanding, cooperating, and leveraging machines and one another
- Humans and machines are indistinguishable as data generators and information consumers, but take advantage of
 - Human creativity, cognition, adaptability, interpretation
 - Machine/cloud precision, capability and computational prowess
- People are excited about their job because they are in control, feeling loved, being positively reinforced, and the system is working for them instead of the other way around.



Thank you (from the concept team, doing the things they think about when they should be working)!