

Uncertainty Modeling for Threat Analysis

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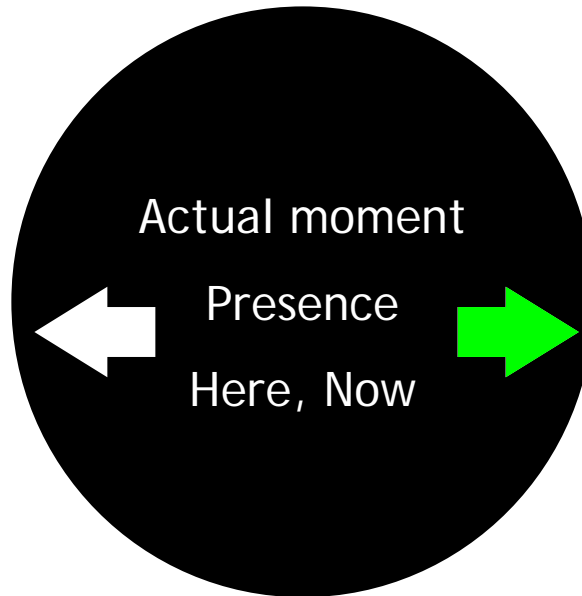
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- Purpose of paper
 - Create basic understanding to enable...
 - A framework for situation- and threat analysis
 - Situation awareness solutions for C2-systems, in particular decision-aids
 - Machine intelligence enhancements
 - Powerful, organized, and guided operations
 - Individual action
 - Prevent misapplication of socio-technical systems
- Concepts: Fundamental (maybe trivial, maybe imprecise in English language)
- Generic terms (concerning staff member, soldiers, but also others...)
- We do NOT...
 - Provide guidelines or solutions
 - Present experimental results
 - Solve specific operative problems
 - Elaborate on threats

Cognitive perspective

Inside world matters more

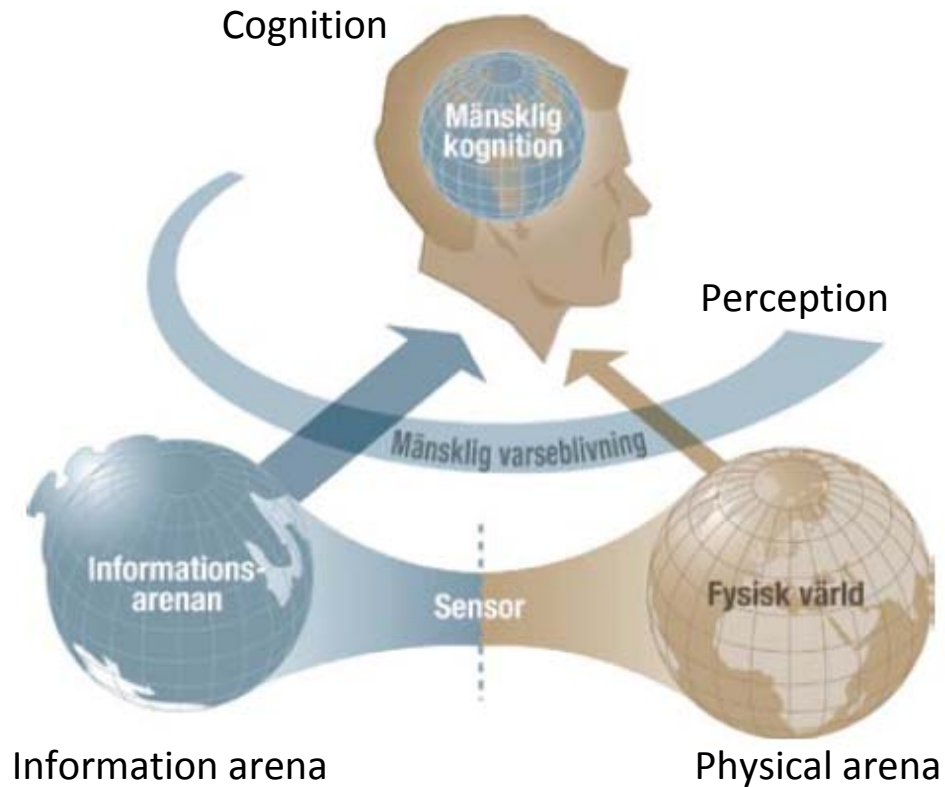
- Acting on "the moment"
- Holistic, Adaptive
- State-based, timeless
- Adjusting mind to world
- Reflection/intuition
- Central: Creativity!
- "We live in the best of all possible worlds"
 - Leibniz



Outside world matters more

- Acting on specified information
- Databased, Systemic, Complex
- Logical timeline
- Adjusting world to mind
- Formalised procedures
- Central: C2-system!
- "We must cultivate our garden"
 - Voltaire

Information perspective



The problem: Situation management



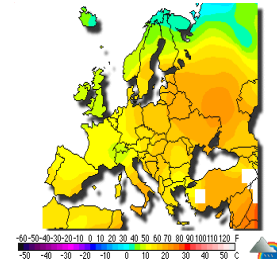
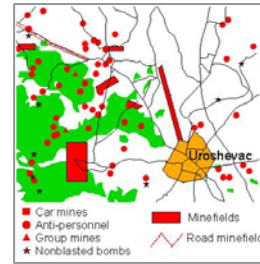
- What must we know in order to act?
- What does the situation picture mean?
- What is a threat? Where? When?
- How do we prevent/prepare/respond?



Decision support

KNOWLEDGE

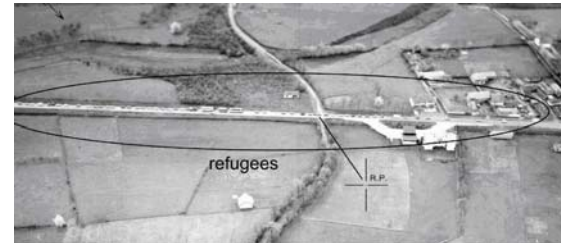
- Ex. Maps provide background information
 - Nature and climate geography
 - Human and political geography
 - Minefields



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SITUATION AWARENESS (SA)

- Ex. Drone provides situation imagery
 - Refugees traveling in a convoy
 - Time, location, speed



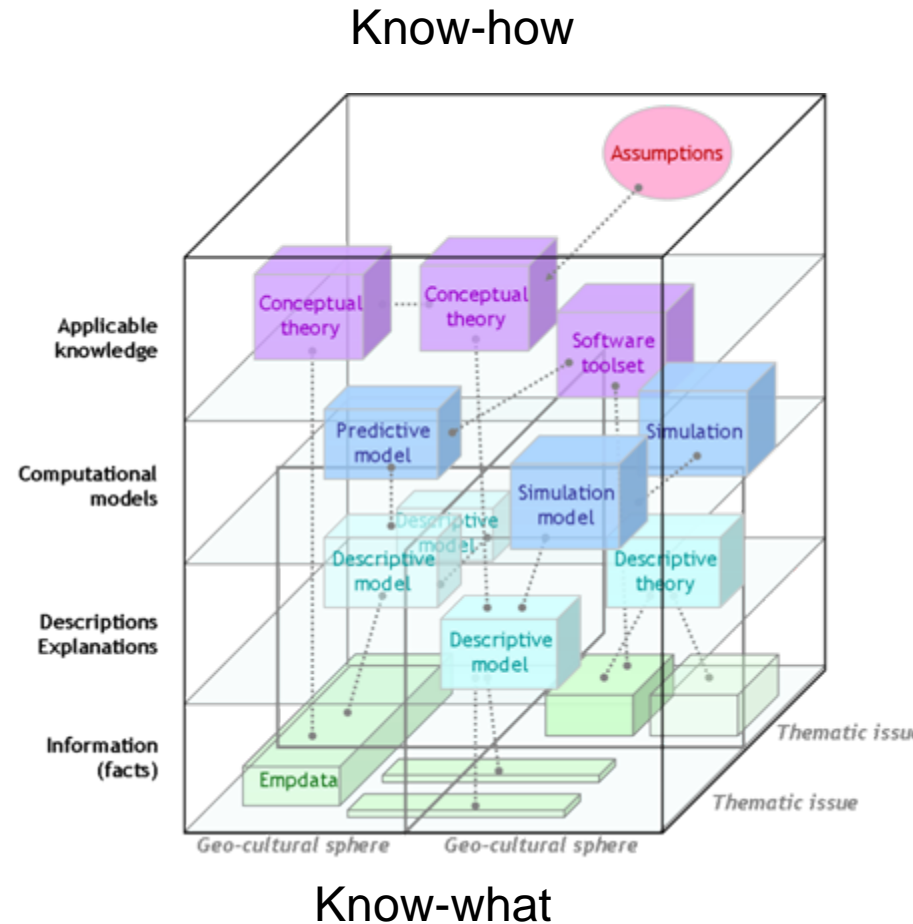
PLANNING, DECIDING, ACTING

- Based on KNOWLEDGE and SA
 - Time refugees will reach village?
 - Need of blankets, food, water?
 - Intersecting adversary groups?
 - Crossing of mine-fields?



Knowledge, Learning, Models

- “Know-how” models
 - Principles, techniques, heuristics, etc
 - Expertise ← Acquiring experience
 - Ability ← Training/doing
- “Know-what” models
 - Informs, guides perception, empirical
 - Understanding ← Analyzing
 - Facts ← Memorizing



Self-awareness

- Central to decision quality
 - Optimal: Knowing our ability
- Limits courses of action, based on what we...
 - ...think we don't or do know
 - ...think we can't or can do

	Knowledge acquired	Knowledge gap
Aware	What we know we can do	What we know we can not do
Unaware	What we don't know that we can do	What we don't know that we can not do

- Central to enable our full potential
- Manifested in our requests for information (RFI)

Knowledge of own system → Quality of questions → Quality of info requested → Quality of decisions

Expectations & Negative Information

- Expectations among people are due to multiple sources:
 - Prejudice, World knowledge, self-awareness, Normality, Rules & Schemas, Task, Role, Situation development
- Expectations are coupled with situation reactions, such as:
 - Evaluation
 - Better or worse?
 - Surprise
 - Something we never seen before...
 - Consequences and complexity
 - Demand on reasoned response...
- Negative information: Something actively searched for and expected due to...
 - Relevance
 - Earlier measurements
 - Experience
 - ...but not found when looking
- Opposed to Positive Information...
...but not same as lack of information!



Situation Awareness



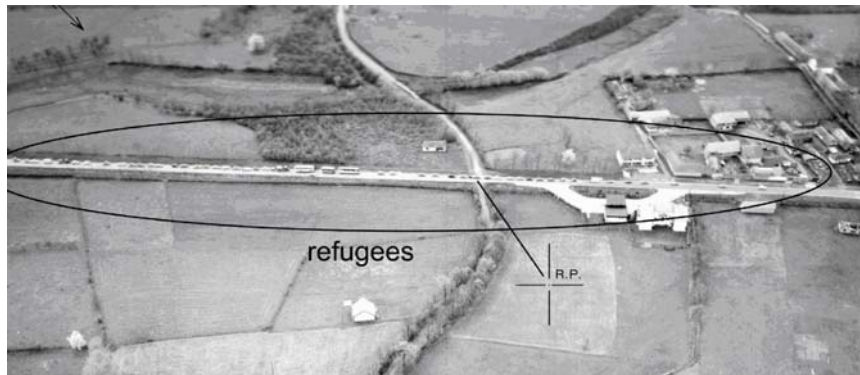
- "The perception of the **elements** in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future"

– Endsley

- **Elements** correspond to data representations in a knowledge system

Objective uncertainty in situation picture

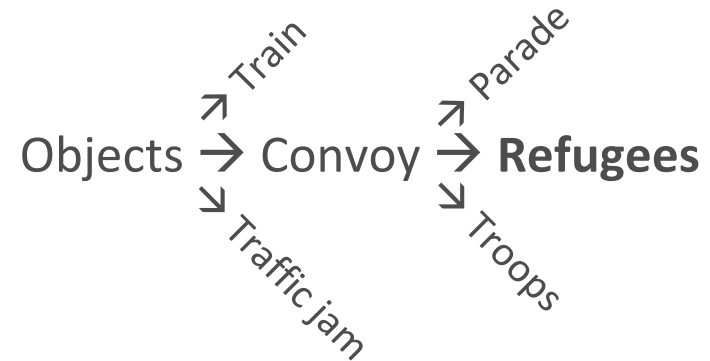
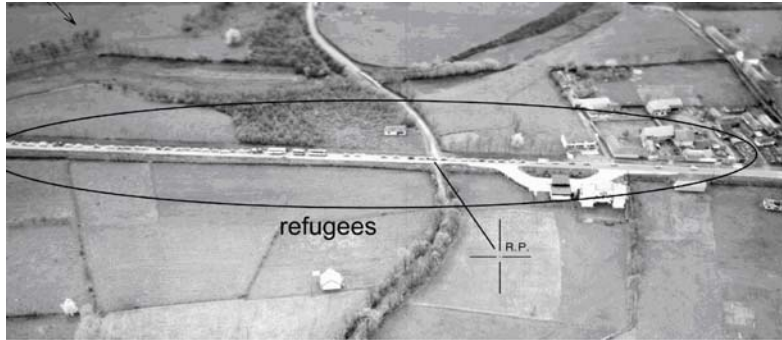
- The *elements* are associated with *objective* uncertainties (from statistics)



- In all Kosovo: Probability of ethnicity:
 - $P(\text{Serb}) = 0.07$
 - $P(\text{Albanian}) = 0.93$
- On this road: Probability of destination
 - $P(\text{Mitrovica}) = 0.8$
 - $P(\text{Pristina}) = 0.2$

Subjective uncertainty in situation picture

- The *registration of elements* are associated with *technical* uncertainties



- The *perception of the elements* are associated with "*human factors*" uncertainties



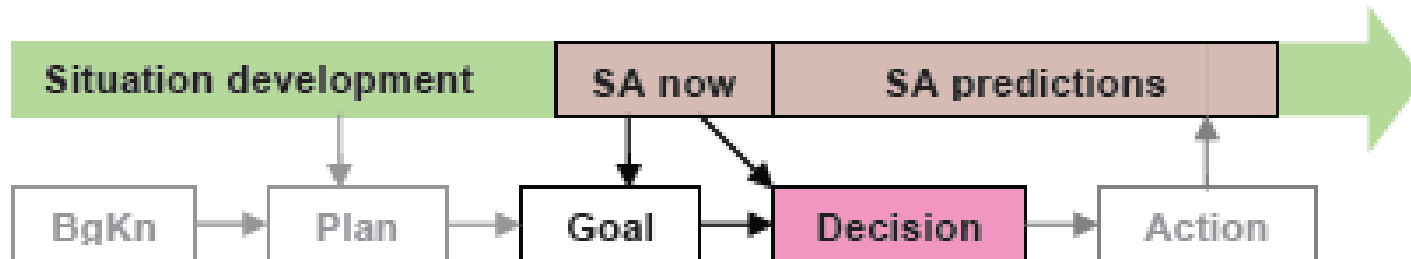
"I just saw something strange on the sensor picture. I'm 90% sure it is troops."

"No, Sgt Expert said it is refugees, and he is always right about images."

"About supermodels he is..."

Uncertainty in decisionmaking

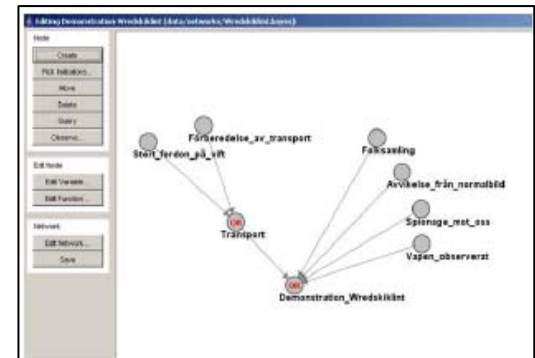
- Observe-Orient-Decide-Act (OODA-loop) in different time frames
- Uncertainties about situation picture
 - Diagnosis
 - Prognosis



- Uncertainties in Planning & Acting
 - Appropriate goal to achieve
 - Whether decision leads to goal fulfillment
 - Own abilities (performance, organization, loyalty)

Indicators

- Signs of something that has happened, is happening, will happen
- Different from verified facts: Contains uncertainty
- Can be combined during the exploration of an event or process
- Pierce: Indicators are *indexical signs* (in contrast to iconic or symbolic signs)
 - Temporally linked pattern elements (e.g., pre-quake seismic motions)
 - Direct effects (e.g., submarine engine sound)
 - Manifestations (e.g., expression of emotions)
 - Traces (e.g., a window left open)
- Indicators can be registered as an indication of...
 - Positive information (expected and found)
 - Negative information (expected but not found)
- Uncertainty of an indicator can be represented mathematically with a probability
- Indicators can be linked to each other in networks



Bayesian network for probabilistic reasoning with indicators

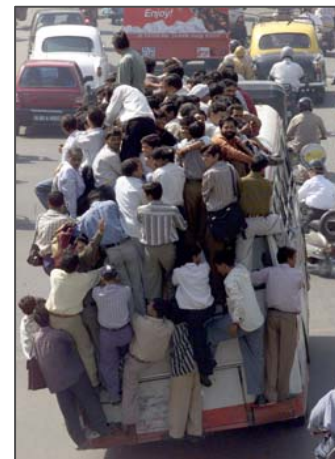
Impactorium

- Based on a formalized situation description model, with: *events*, *states*, *indicators*, *situations*, etc
- *Visualize events* and the likelihood that they will occur.
- *Sort and filter reports*, depending on criteria that the user sets
- *Visualize activation of events within an impact matrix*
- Links reports to a map

The screenshot displays the 'Events and Reports' interface. On the left, a map shows event locations with markers for 'Narkotikasmuggling', 'Vapensmuggling', 'Bombdåd', 'Upplopp', 'Demonstration Wredskikint', and 'Trafficking'. A legend on the right lists various indicators such as 'Fredspröcessen fallerar', 'Gisslantagande', 'Hamnattentat', 'Strid', 'Utländskt vapensöld', and 'Westland Intervenerar'. Below the map, a detailed report for 'Fredspröcessen fallerar (71%)' is shown, including a description and a list of indicators like 'Ovanligt vapenslag observerat (reported)', 'Westland: Evakuering', and 'Infrastruktur skadad (reported)'. On the right, a 'Reports' table lists various events with their dates and counts, and a detailed report for '13:39 Aug 30 Sprängningsförsök mot kraftledningsstolpe' is displayed below it, showing indicators like 'Infrastruktur skadad set to medel' and 'Events' like 'Upplopp' and 'Fredspröcessen fallerar'.

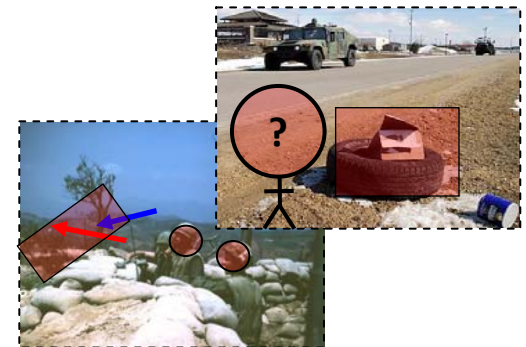
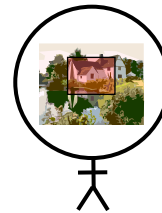
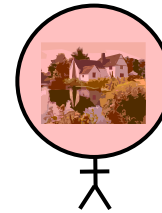
Insecurity

- A sub-optimal mental or physical state, often manifested by danger, pain, or disability.
 - Caused externally (violence, threat)
 - Caused internally (deficiency or imbalance)
- "Osäkerhet" (Swedish) or "Unsicherheit" (German) can mean...
 - Insecurity
 - Uncertainty
 - Shakiness
 - Unsureness




Uncertainty * Insecurity in Decisionmaking

- Decisionmaking under stress (or in danger)
 - Uncertainty about situation picture caused by mental distortion (fear, fatigue, suppression, etc)
 - Diagnosis problem
- Uncertainty about a danger in situation picture
 - Risk = Uncertainty * Security
 - General: Probability * Consequence in risk mgmt.
 - Uncertainty about object existance
 - Uncertainty about dangereous nature
 - Prognosis problem
- Combination: *Diagnosis and prognosis* under stress
 - Ex. Analyzing a potential IED
 - Ex. Calling in air support/artillery on moving targets under on-going red-blue force battle

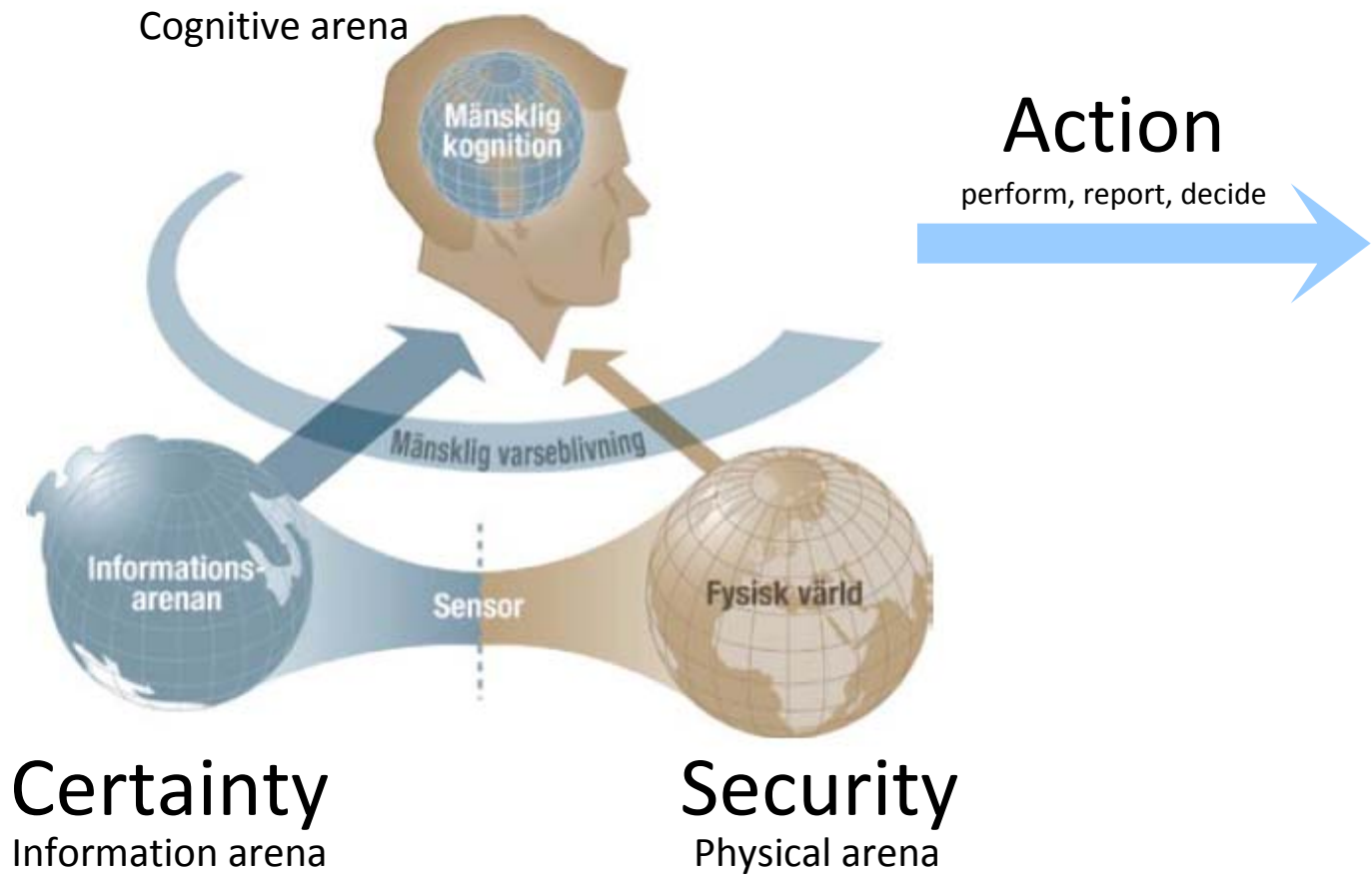


Can we act...? Do we want to act...?

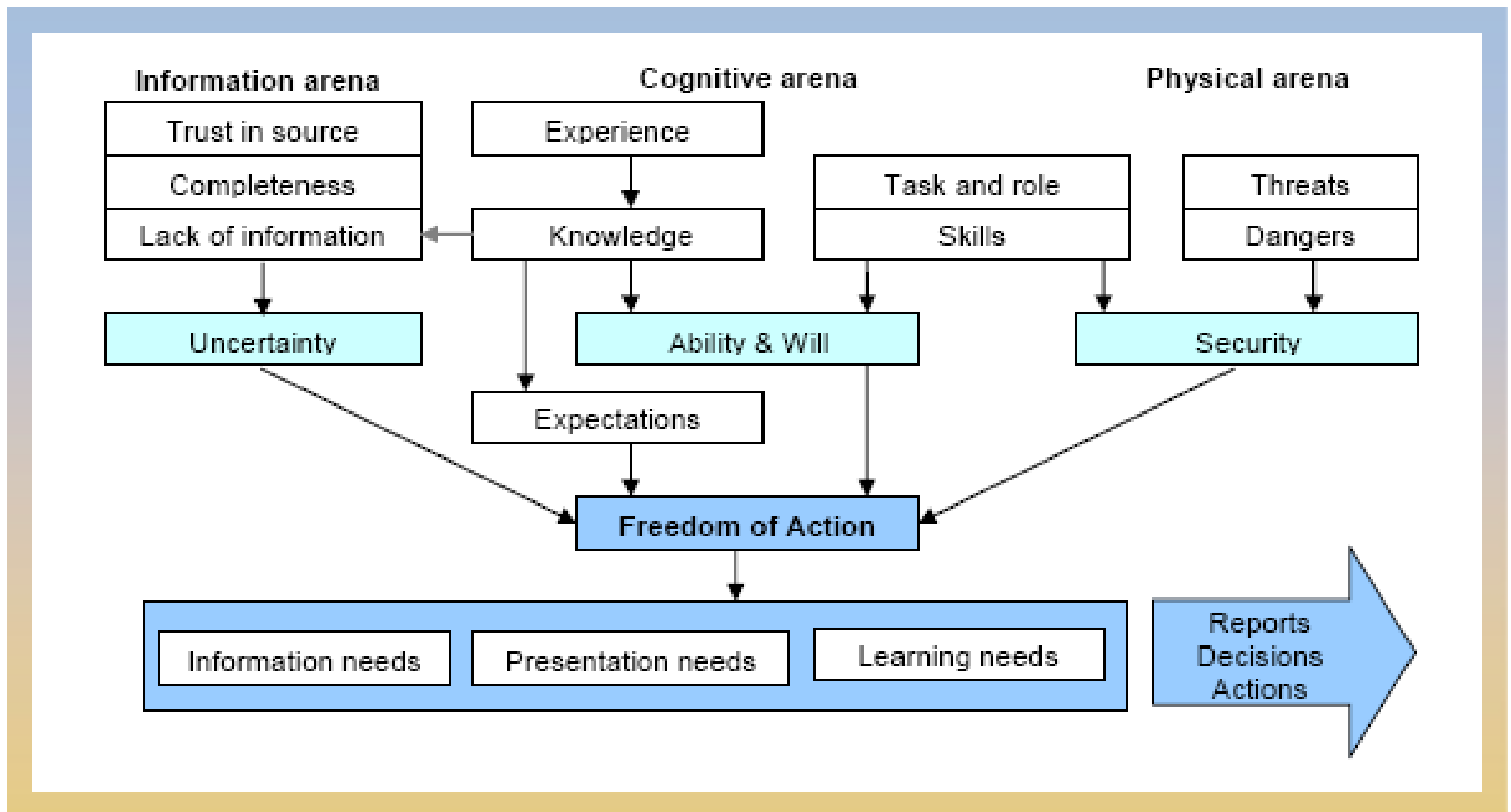
	Inability	Unwillingness
Caused from environment	 <ul style="list-style-type: none">- High demands, stress- Chaos, Attack, Dangers- Unfamiliar dynamic situation	 <ul style="list-style-type: none">- High costs, low benefits- Conflict with other objectives and interests
Caused in individual	 <ul style="list-style-type: none">- Lacking qualities or focus- Low endurance, performance- Injuries	 <ul style="list-style-type: none">- Expected regrets- Belief in lacking qualities, low performance, endurance

Freedom of Action

Ability & Will



Freedom of Action



Application of technology

Right



- Regarding knowledge-gap



- Regarding uncertainty

Wrong

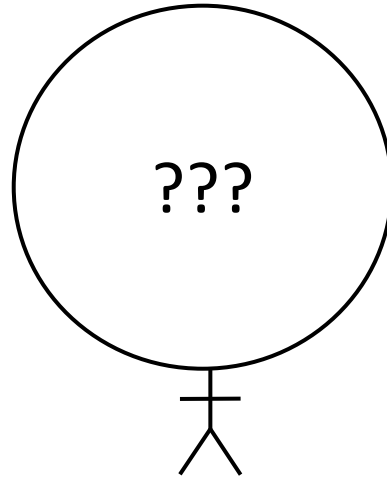


- Disregarding security



- Disregarding disability

Questions?



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Thank you!