



# An initial assessment of the Endeavour Space dimensions

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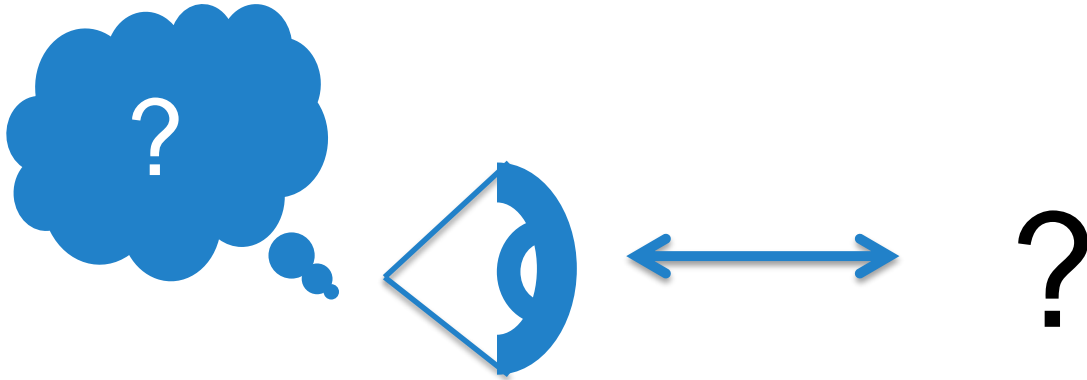
Jacob Weilandt

David S Alberts

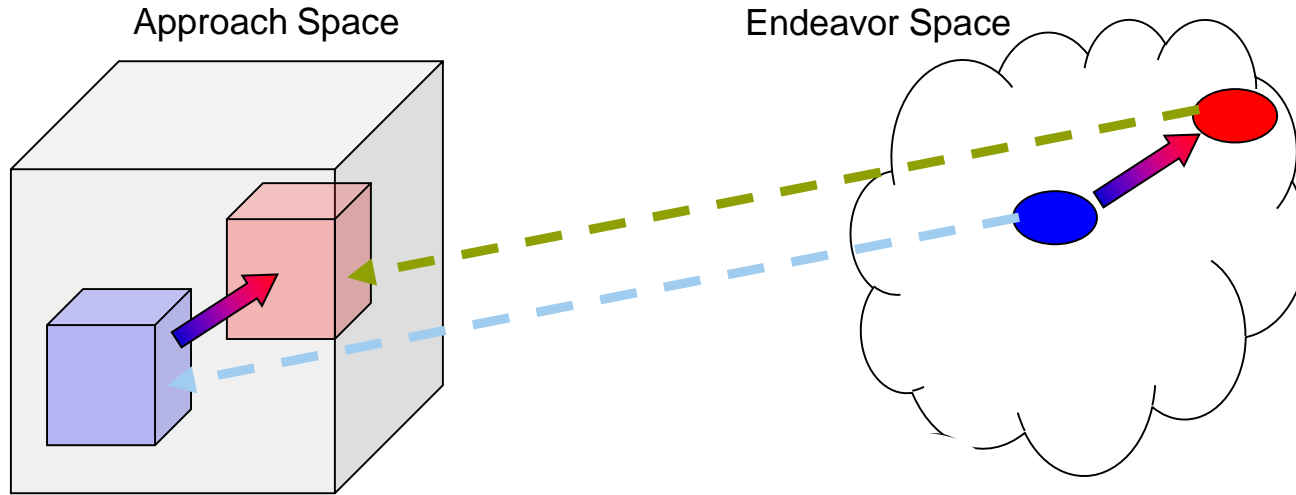
Mats Carlerby

# Purpose

- Can the Endeavor Space dimensions be instantiated in ELICIT?
  - Map the Endeavor Space dimensions to configurable settings in ELICIT
- Validate through subjective perception of Endeavor Space dimensions – can an instrument that captures subjective perceptions of the Endeavor space be designed?

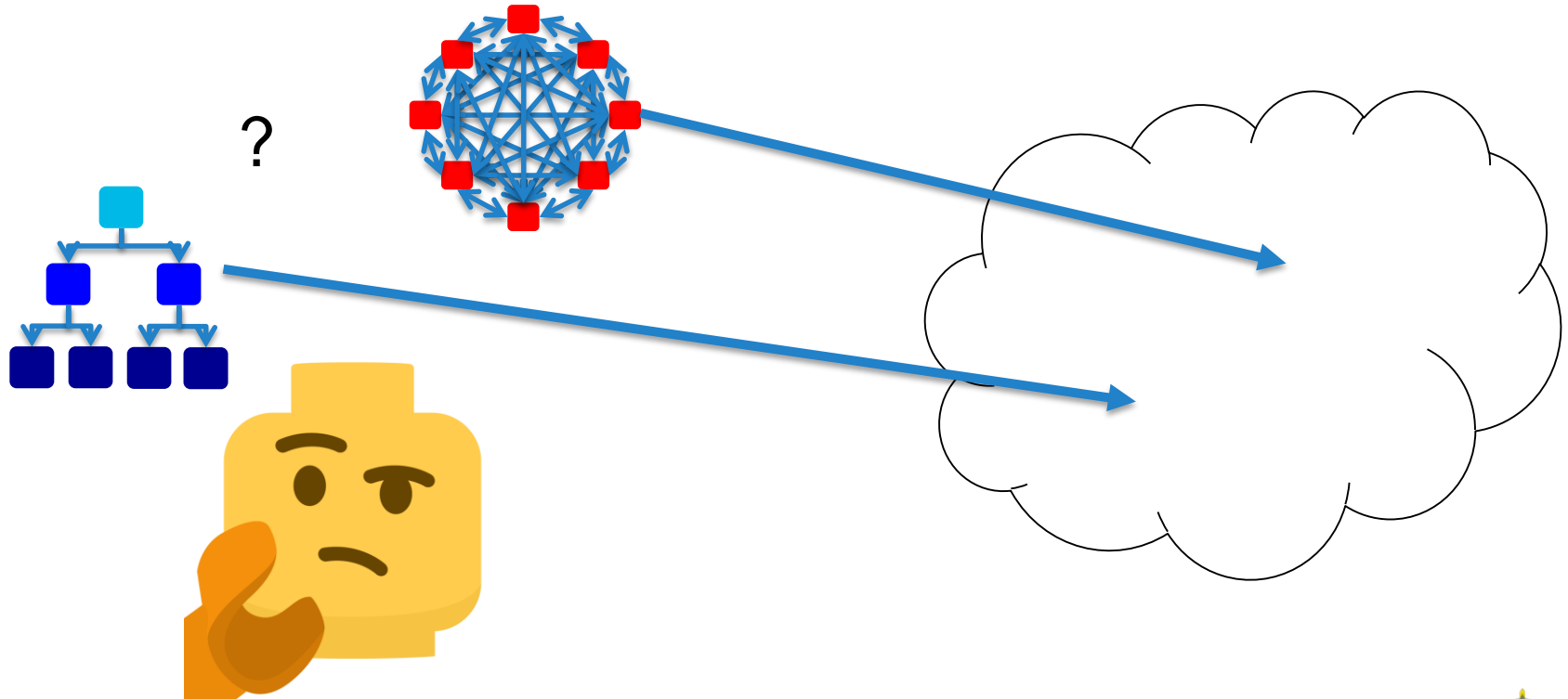


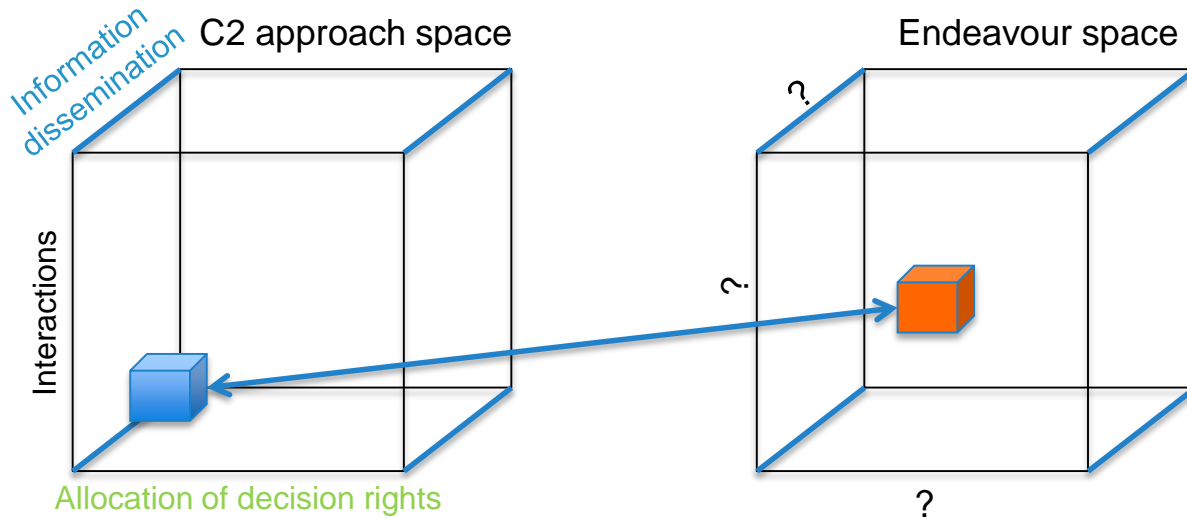
# C2 Agility and the Endeavor space



- SAS-085 hence postulated that there is an “appropriate” C2 approach for each region of the Endeavour Space
- Agile C2 requires an understanding of which C2 approach is most appropriate for a given location in the Endeavour Space

# But the Endeavour space is just a fluffy cloud?



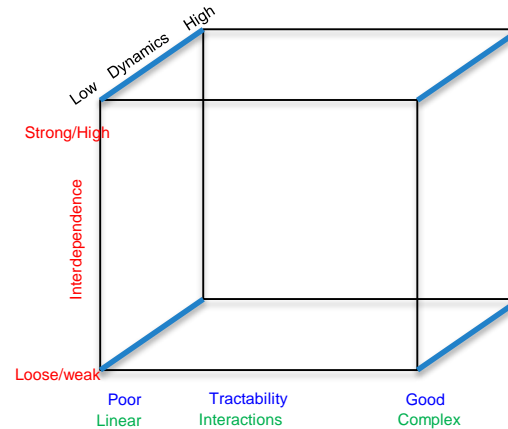


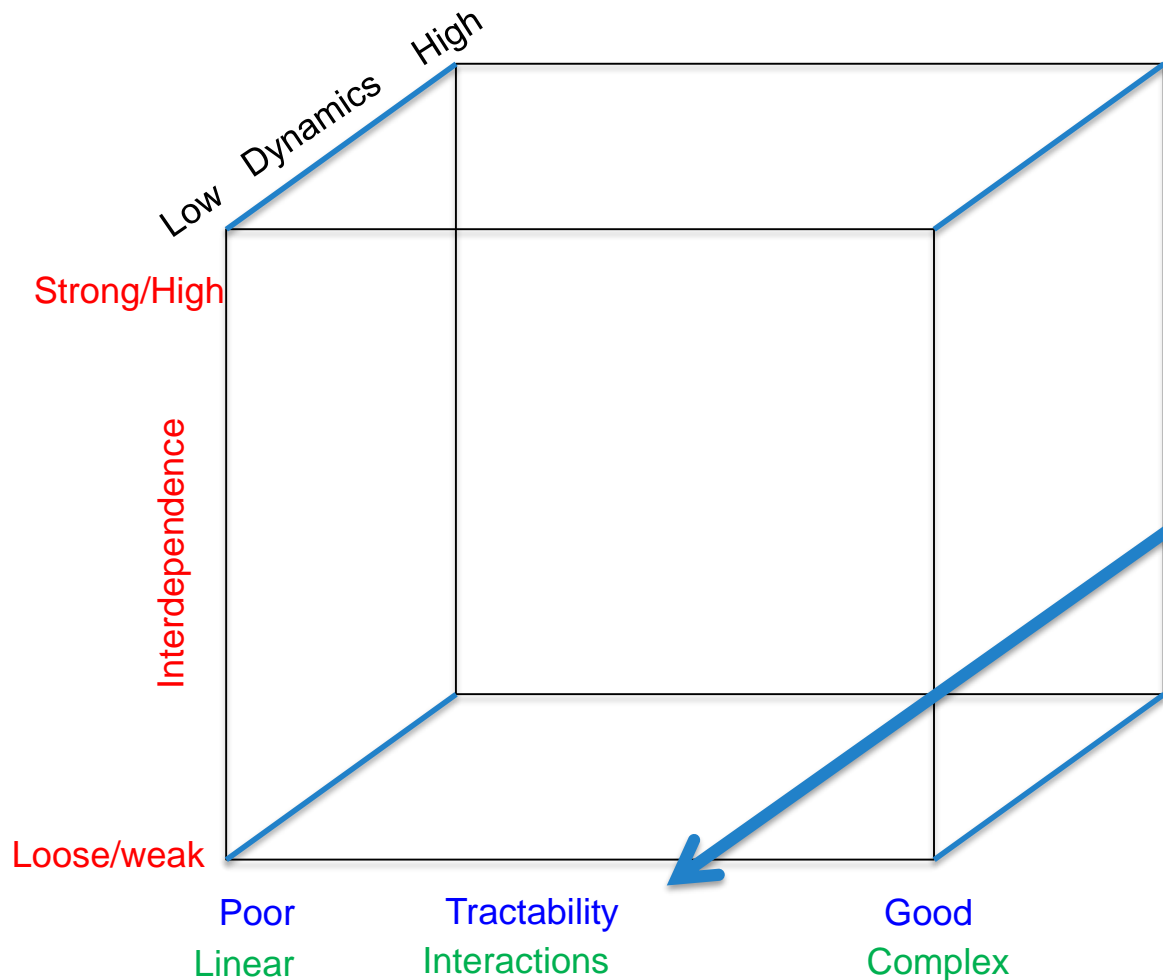
The C2 approach space has a set of dimensions that allow for analysis

The Endeavour space does not

# Endeavor space dimensions

- The following Endeavour space dimensions were suggested by Johansson, Carlerby and Alberts (2018)
  - Dynamics
  - Interdependence
  - Complexity/Tractability



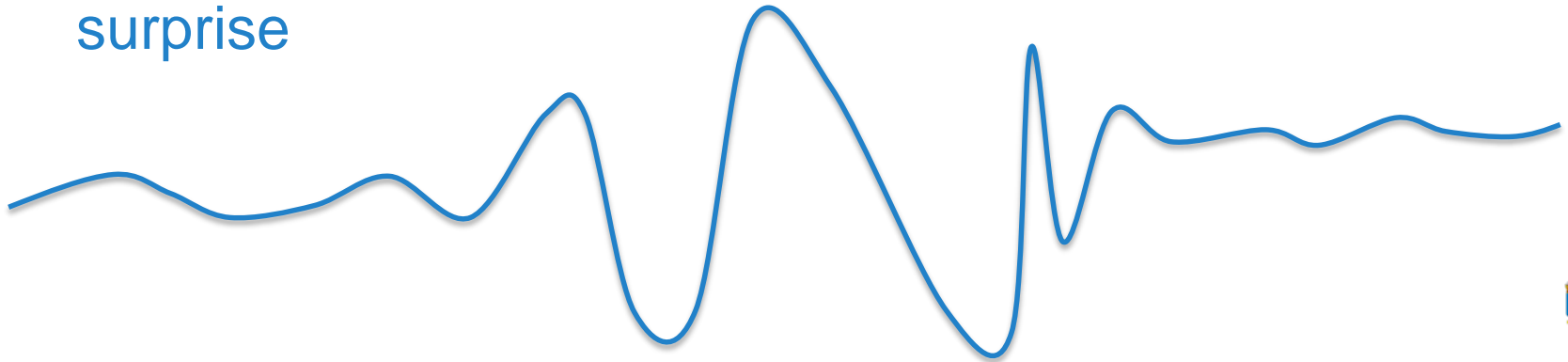


Researcher/experi-  
 menter =  
*Complexity*

Experiment  
 participant/resear-  
 ch subject =  
*Tractability*

# Dynamics

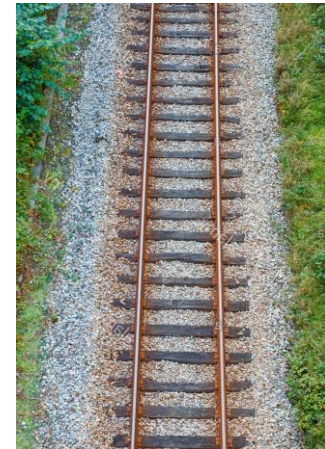
- The potential rate and amplitude of change in the environment
- Dynamics determine response time requirements (time pressures)
- Dynamics reflects the potential for surprise





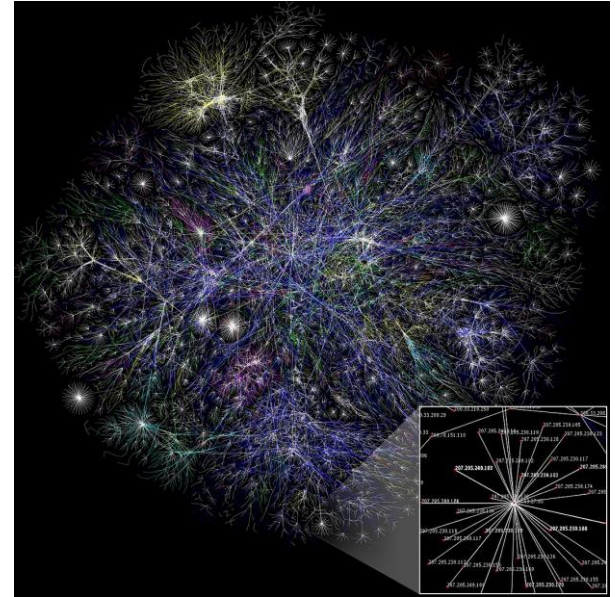
# Interdependence

- The degree of interdependence between and among entities, the operations they undertake and/or the effects they create
  - Can operations in the same or multi domains operate effectively independently without interfering with on another?
  - Does creating an effect require more than one action to be taken?
  - Does an effect created in one domain impact the state of another domain?



# Degree of Complexity/Tractability

- Complexity is related to amount of nodes/entities as well as the type of interactions that occur between them.
- Complexity is also related to predictability (potential for surprising events)
- Tractability is related to the ability to perceive the environment, gain an understanding, and develop and implement effective courses of action (solutions)



# Implementing the Endeavor space in ELICIT

- Map ELICIT scenarios to the E-space
- ELICIT is an “information puzzle” where participants collaboratively tries to solve a “who”, “what”, “when”, “where” task
- Participant organization, information dissemination, and relevance/noise of information sources can be manipulated
- Earlier research has ELICIT configurations reflecting the C2 approaches as reported in the SAS 085 final report

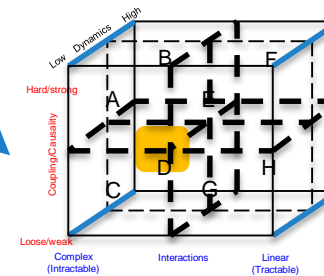
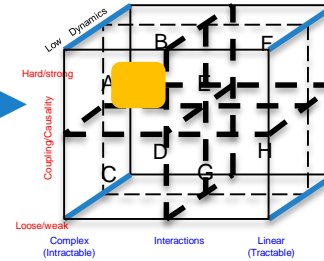
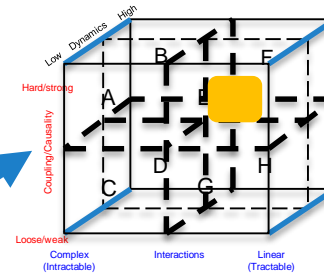
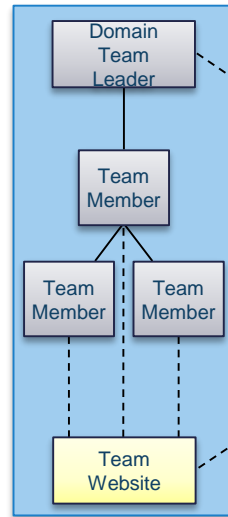
ELICIT= The Experimental Laboratory for Investigating Collaboration, Information-sharing and Trust



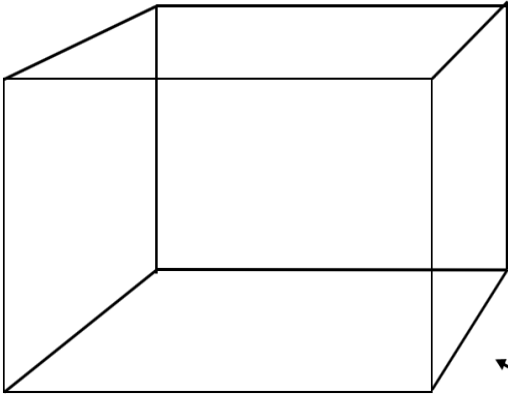
# Research questions

- RQ1: How can the Endeavor Space dimensions be implemented and manipulated in the ELICIT simulator?
- RQ2: How do manipulations of the Endeavor Space dimensions manifest as subjective experiences?
- RQ3: How do manipulations of the Endeavor Space dimensions affect how individuals perceive difficulty, and how does it impact their performance?
  - Hypotheses:
    - High Complexity/Low Tractability = increased subjective difficulty, lower performance
    - High Dynamics = increased subjective difficulty, lower performance
    - High Dependencies = increased subjective difficulty, lower performance

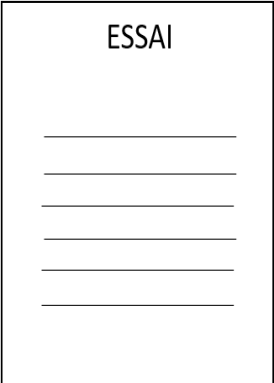
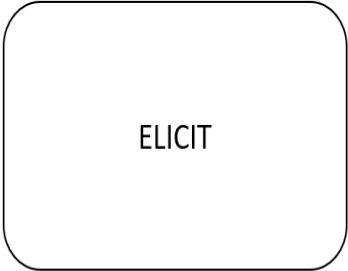
# Research outline



Endeavor Space (The problem)



Observer



# The Endeavor Space Subjective Assessment Instrument (ESSAI) (1/2)

- The E-Space dimensions are represented as a set of 7-point Likert-style items.
  - Tractability: 3 questions
  - Dynamics: 4 questions
  - Dependencies: 3 questions
- Dimension score = mean score of dimension questions
- Control questions
- Perceived difficulty

# The Endeavor Space Subjective Assessment Instrument (ESSAI) (2/2)

1                      2                      3                      4                      5                      6                      7

**2. I understood what actions to take given my understanding of the problem.**

*Entirely Disagree*

*Fully Agree*

1                      2                      3                      4                      5                      6                      7

**3. Given my understanding of the problem, I could anticipate how it would change over time.**

*Entirely Disagree*

*Fully Agree*

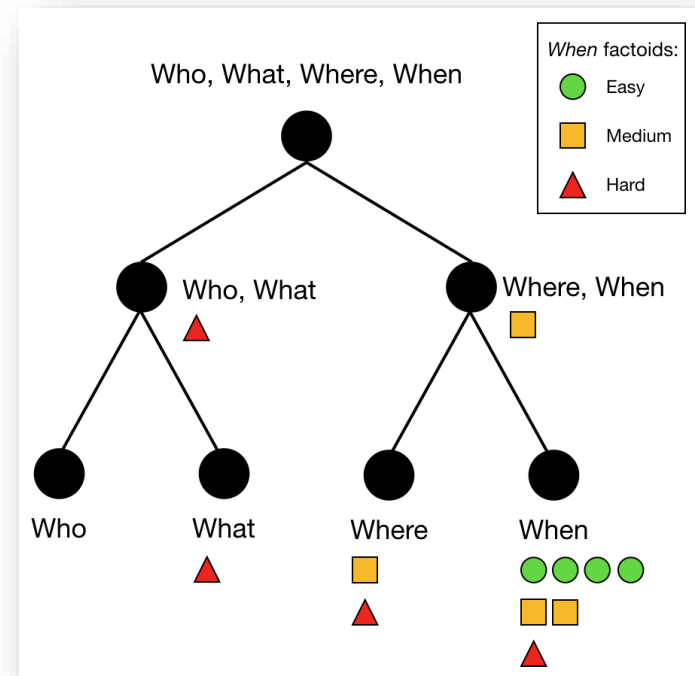
1                      2                      3                      4                      5                      6                      7

**4. I felt that the problem -and our task as a team- was complex and difficult to understand**



# Design

- Within-teams design
- 56 participants divided into 8 teams.
- Hierarchy
- Who, What, Where, and When?
- 3 scenarios
  - Easy
  - Medium
  - Hard



# Operationalization of the dimensions in ELICIT

- Tractability
  - The total number of factoids in each scenario.
  - The signal-to-noise ratio, i.e. the amount of useless or distracting information compared to the amount of relevant and important pieces of information in the factoid set
- Dynamics
  - Time available (scenario length).
  - Number of factoid distribution waves.
  - Frequency of factoid distribution waves
- Dependencies
  - The amount of non-organic information, i.e. the amount of information being distributed to the wrong person, requiring more communication and cross-level information sharing

# ELICIT runs

- Procedure
  - Consent forms, ELICIT instructions.
  - Play the Easy, Medium, and Hard scenarios (counterbalanced)
  - Each scenario = 15 minutes
    - Play 10 minutes -> ESSAI #1 -> play 5 minutes -> ESSAI #2
    - ESSAI score = mean of ESSAI #1 and ESSAI #2.

# Results (1/4)

- RQ1: How can the Endeavor Space dimensions be implemented and manipulated in the ELICIT simulator?
- From a theoretical point of view, yes. However:
  - Tractability – Good settings, no subjective effects?
  - Dynamics – Unclear. Direct and indirect manipulations.
  - Dependencies – Challenging. Tasks were not perceived as dependent.
- ELICIT overall
  - Tasks – Processing task
  - Lacks emotional impact
  - Meaningful context needs to be added (for non-military participants)

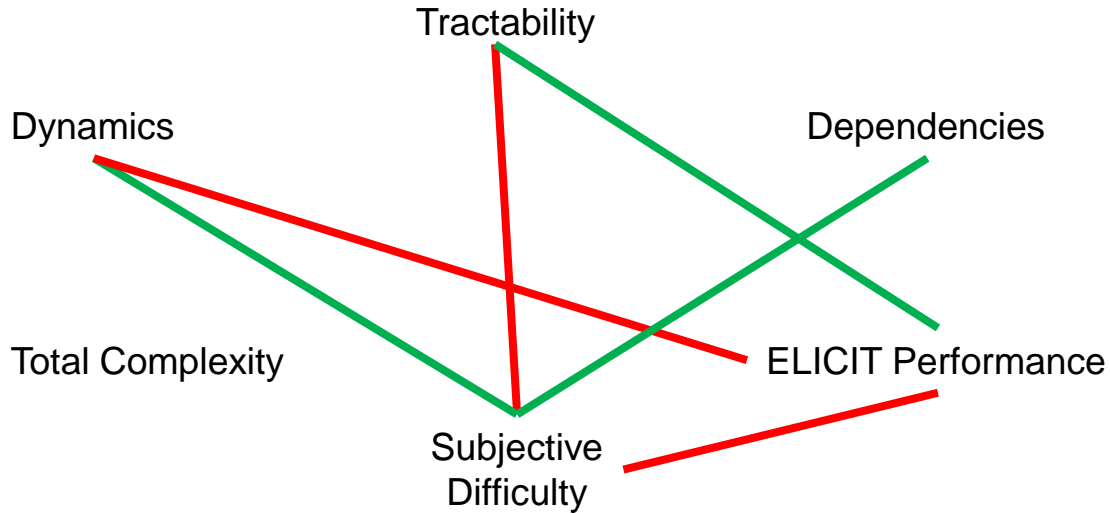
# Results (2/4)

- RQ2: How do manipulations of the Endeavor Space dimensions manifest as subjective experiences?
  - No differences between scenarios (in tractability, dynamics, or dependencies)
  - Why?
    - Tasks
      - Arbitrary, information processing
      - Weak experiences
      - Difficult to measure
    - Domain knowledge
      - Students, not officers
      - More training needed?

# Results (3/4)

- RQ3: How do manipulations of the Endeavor Space dimensions affect how individuals perceive difficulty, and how does it impact their performance?
  - We found that Tractability, Dynamics, and Dependencies all correlate with perceived difficulty
  - Low Tractability was associated with an increased sense of difficulty, as were high Dynamics and high Dependencies
  - Furthermore, high ratings of perceived difficulty (and low Tractability and high Dynamics) were associated with reduced ELICIT performance
  - Hence, Tractability, Dynamics, and Dependencies were indirectly associated with performance through perceived difficulty (although most correlates were weak)
  - This pattern suggests that more data would have confirmed the effects of the manipulations.

# Results (4/4)



# Conclusions (1/2)

- From a researcher point of view, it is possible to manipulate parts of ELICIT that in theory should reflect the dimensions of the E-space
- However, this does not seem to reflect strongly in performance or the subjective ratings of Tractability, Dynamics and Dependencies in the ESSAI instrument
- On the other hand, Tractability, Dynamics and Dependencies correlate with perceived difficulty
- There are challenges associated with using university students as research participants in ELICIT:
  - Lack of domain understanding
  - Need for training?
  - The system does not seem to evoke emotions



# Conclusions (2/2)

- Is the ESSAI a valid tool for measuring subjective perception of the E-Space?
  - Tractability – good validity, good reliability
  - Dynamics – good validity, ok-ish reliability
  - Dependencies – bad validity, bad reliability
  - Why?
    - The ESSAI is designed to be a general purpose tool – not 100% fit to ELICIT
- We consider trying the ESSAI with single player applications
- The ESSAI could also be tested with other platforms, such as C3Fire
- The ESSAI may have to be adapted to fit the specific endeavor – although this goes against the original design criteria

Thank you!/Questions ?