Seeking information within a system dynamics simulation: Relation between information types and decision making

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Introduction

- Strategic decision making requires dealing with many factors related to each other in a complex fashion (Sterman, 2006).
- In this context, decision makers are prone to error due to their limited cognitive capacities (Simon, 1980).
- Systems thinking is an approach that seeks to augment understanding of complex issues by enabling individuals to "see" and "experience" the dynamics generated by complex systems with the help of diagrams and simulation tools (Richmond, 1993).
- Despite the use of systems thinking, there seems to a very strong tendency of our cognitive system to use heuristics. Indeed decision makers rarely examine dynamic models exhaustively (Gigerenzer, 2007).
- This study investigates how decision makers seek two types of information – action-oriented information and system-oriented information – and how this is related to performance in a strategic decision making context.

Results

- **Average performance** = 17.72% (SD = 13.78%)

Overall information seeking ratio	Overall information seeking time
• Decreases from turn 1 to turn 2, (t = 6.44, p < .001) and then stays stable across turns (t = 1, *N.S.*) • At 1st turn positively correlated to performance (r = .298, p = .049, one-tail). • At turn 2+ is not correlated to performance.	• Decreases from turn 1 to turn 2, (t = 7.57, p < .001) and then stays stable across turns (t = 1, *N.S.*) • At 1st turn positively correlated to performance (r = .373, p = .018, one-tail). • At turn 2+ is not correlated to performance.

1st turn analyses

- **Action-oriented information seeking ratio** is positively correlated to performance (r =.315, p = .040, one-tail)
- **Action-oriented information seeking time** is positively correlated to performance (r =.358, p = .022, one-tail)
- **System-oriented information seeking ratio** is not correlated to performance (r = .219, p = .114, one-tail).
- **System-oriented information seeking time** is not correlated to performance (r = .285, p = .057, one-tail).

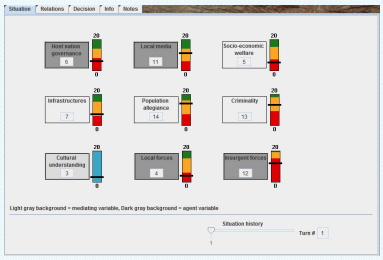

Figure 1. Situation tab

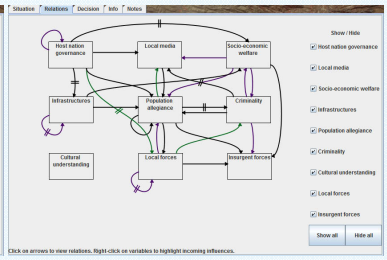

Figure 2. Relation tab

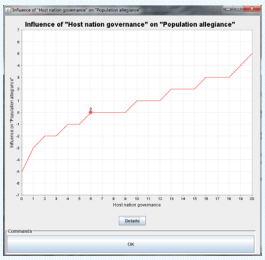

Figure 3. Relation detail

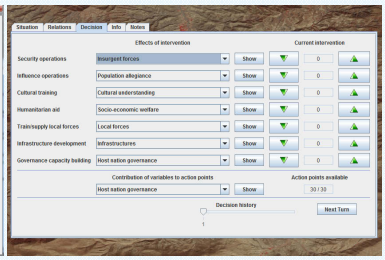

Figure 4. Decision tab

Method

Scenario and procedure

- 21 men, 11 women (mean age = 31.91, SD = 10.22)
- Mix of civilians and military officers

- A complex counter-insurgency scenario was embedded in the COmplex DEcision Making experimental platform (CODEM; Lafond et al., 2011)
  - The complex situation is represented by 9 indicators like host nation governance and infrastructures (Figure 1 and 2)
  - Complex relationships between indicators are represented by graphs that are available to the participants (Figure 3)
  - Participants influence the evolution of the situation by allocating "points" to 7 possible actions (Figure 4). The goal is to improve the state of 8 colored indicators and ideally get each one out of the red zone (i.e., critical state).
  - The simulation lasts up to 10 years (10 turns), but may end before this if population allegiance is too low or if all sub-goals are achieved.
  - Participants complete a tutorial (approx. 15 minutes), a training scenario (approx. 30 minutes), and then the experimental scenario (approx. 30-60 minutes).

- **Performance** (0-100): Based on the relative distance from the 8 sub-goals, and on the proportion of the 10-year mandate completed.

- **Information seeking ratio** (0-1)
  - **Action-oriented:** Ratio of consulted relationships that are directly associated with decision making.
  - **System-oriented:** Ratio of consulted relationships that are associated with the autonomous evolution of the system.

- **Information seeking time**
  - **Action-Oriented:** Time spent in the "decision tab" of CODEM, corresponding to the time exposed to action-oriented information.
  - **System-Oriented:** Time spent in the "relations tab" of CODEM, corresponding to the time exposed to system-oriented information.

Discussion

- Overall performance is far from optimal, stressing the importance of education, training and using decision aids.
- The fact that information seeking at the first turn of the simulation is associated with performance stresses the importance of assessing the system early when making decisions within the context of complex dynamic systems.
  - This can be interpreted as a result of the butterfly effect (Lorenz, 1969), a critical property of complex systems. Consequences of early decisions will tend to have a great influence on the mid and long term evolution of the system. It is therefore important to understand the effects of decisions early on.
- Results suggest that the importance of the different types of information varies in the context of complex decision making. Action-oriented information seeking seems to play a more critical role in decision making than system-oriented information seeking.
- Understanding and integrating all the information about a complex system's interrelations may be too cognitively demanding, i.e. exceed human limited processing capacity (Simon, 1980).
- From an educational perspective, findings can be taken to suggest that the use of influence diagrams alone may not be sufficient to improve decision making in this context. Perhaps education and training may help decision makers make better use of these diagrams and improve their performance.
- Future work will investigate whether a simulation-based training with corrective feedback can help decision makers make better use of system-oriented information and accomplish more effective interventions.

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