Using a Functional Simulation of Crisis Management to test the C2 Agility Model

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Main issues

- Major operations require several players
  - Different levels of government, departments, international governments, and non-governmental actors.
- No one agency has the staff or capability to successfully act on its own
  - The Comprehensive Approach
- Inherent cost: groups with different cultures, procedures and potentially conflicting mandates have to work together to accomplish a joint mission.
- Organizational Agility: minimizing these costs while maximizing effectiveness

Other challenges

- Decision making under severe constraints:
  - High risk
  - Time pressure
  - Complexity and ambiguity
- Principal functions of C2
  - Planning, directing, coordinating, and controlling the employment of available resources.
- Cognitive domain is paramount!

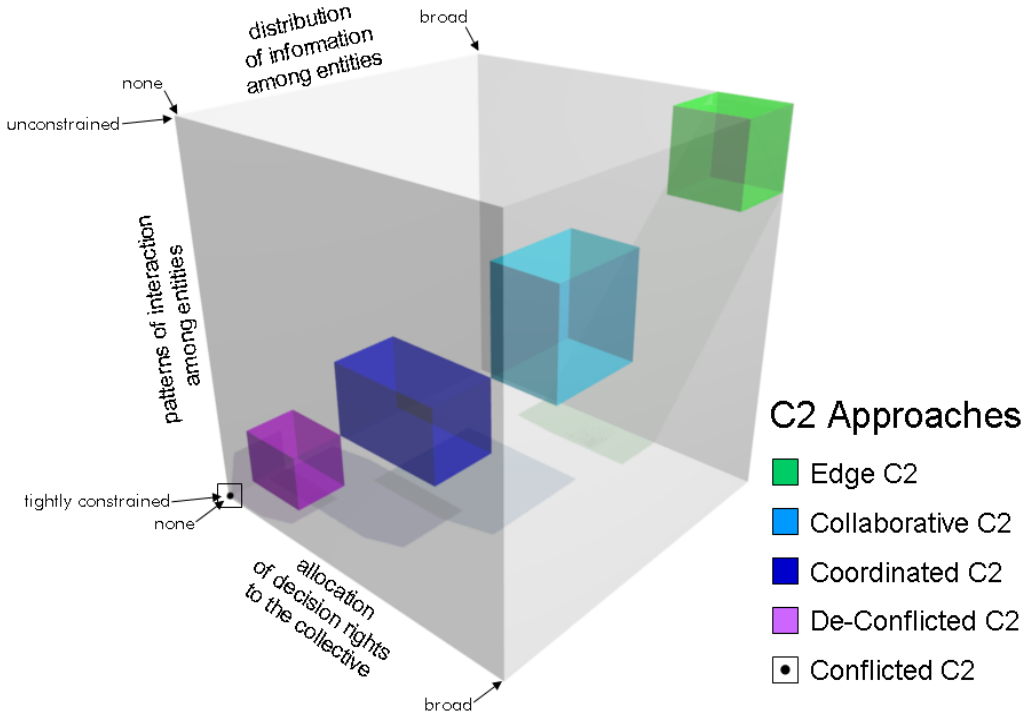
Other challenges

- Cognitive resources
  - Situation assessment, monitoring, recognition, problem solving, causal learning, search, planning, judgment, and choice
  - Promote Agility
    - Improving and adopting situation-tailored C2 approaches
- Validating the model
  - Decision-making tool
- More research is needed !

C² Approaches

3 Primary dimensions

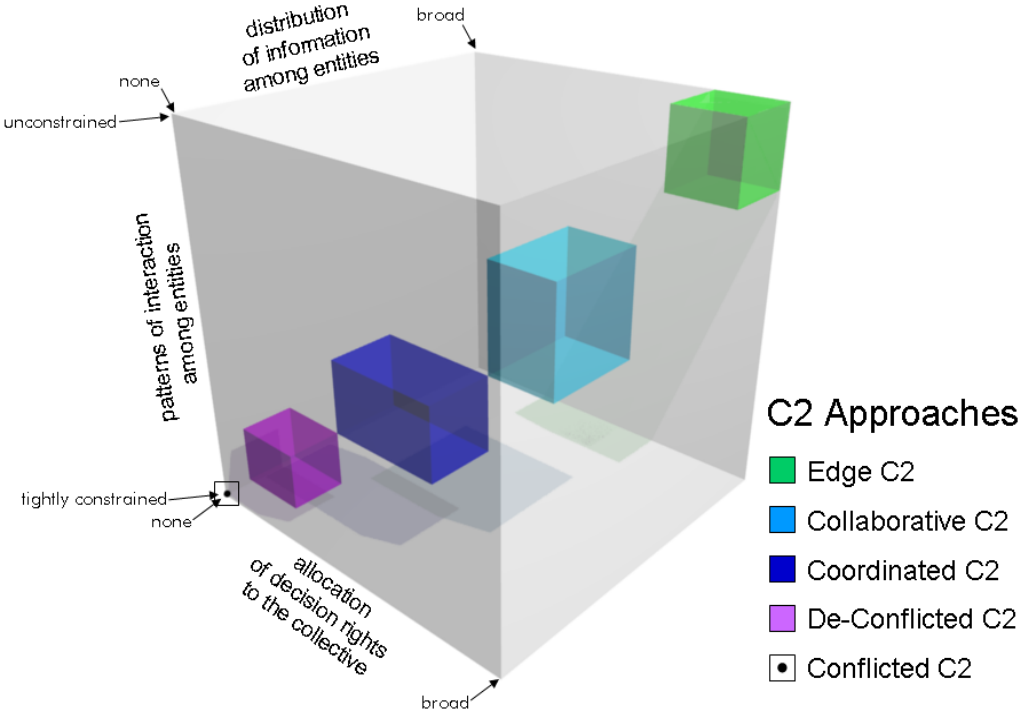
- Allocation of Decision Rights
- Distribution of Information
- Patterns of Interaction



C² Approaches

Primitives

- Size
- Resistance
- Stiffness



Assumptions:

↓ Size : respond faster

↓ Resistance : facilitate the transition

Complexity

Objectives

- To test and evaluate the key concepts of the C^2 Agility Model
  - Settling time

	Low resistance	High resistance
Low size	t_1	$t_2 > t_1$ over-damped
High size	$t_3 \approx t_2 > t_1$ under-damped	$t_4 = t_1$

- To evaluate the impact of team size and resistance on team performance

Hypotheses

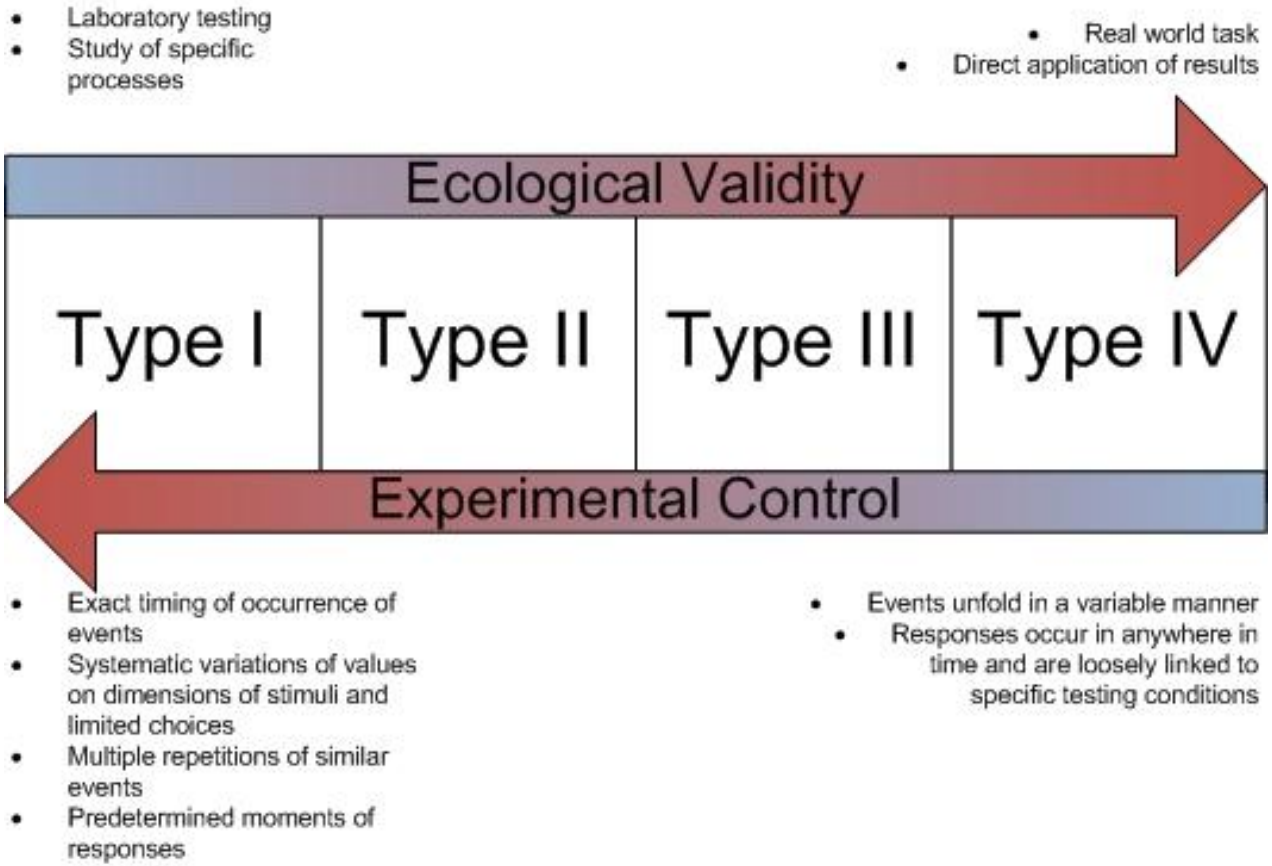
1) ↓ Size ↓ Resistance: making the transitions in time

2) ↓ Size ↑ Resistance: would yield an over-damped response

3) ↑ Size ↓ Resistance would yield an under-damped response

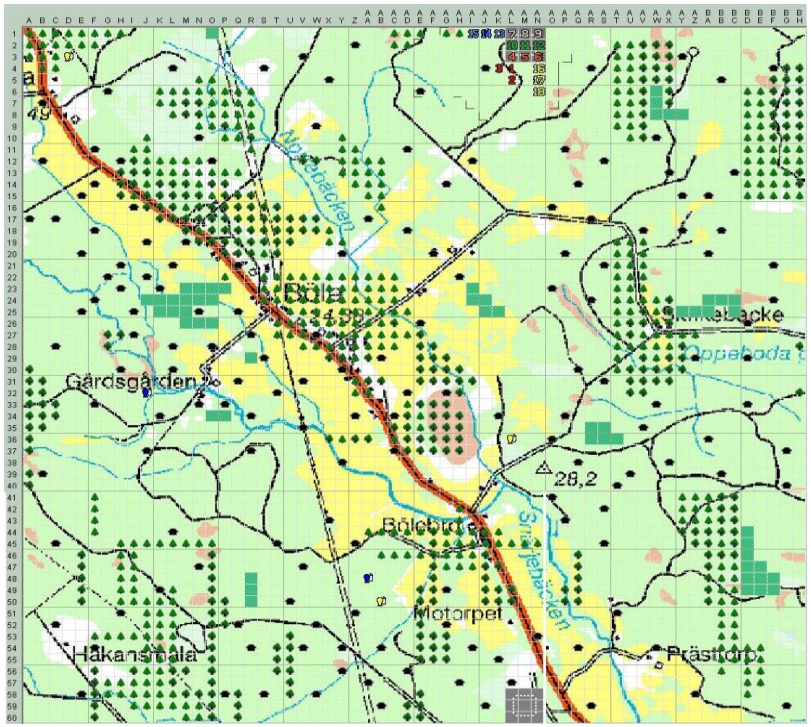
4) ↑ Size ↑ Resistance would equally scaled from low size and low resistance

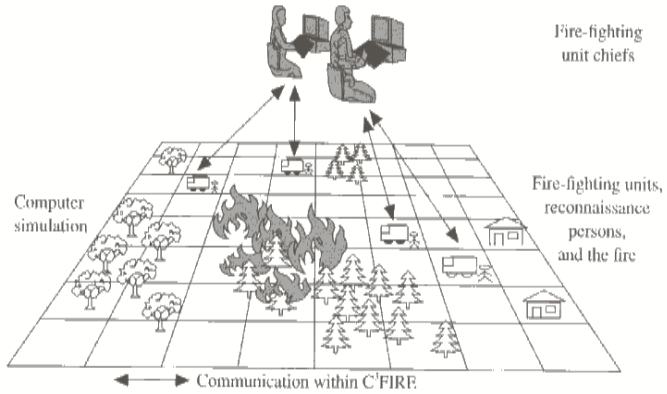
Microworld - C3Fire (Granlund, 2002)



Microworld - C3Fire (Granlund, 2002)

- Simulated environment of command, control and communication.
- Fires spread in real time, both autonomously and as a consequence of human actions.
- Team members pursue multiple objectives:
  1) Rescue population
  2) Extinguish houses already on fire
  3) Prevent spread to houses





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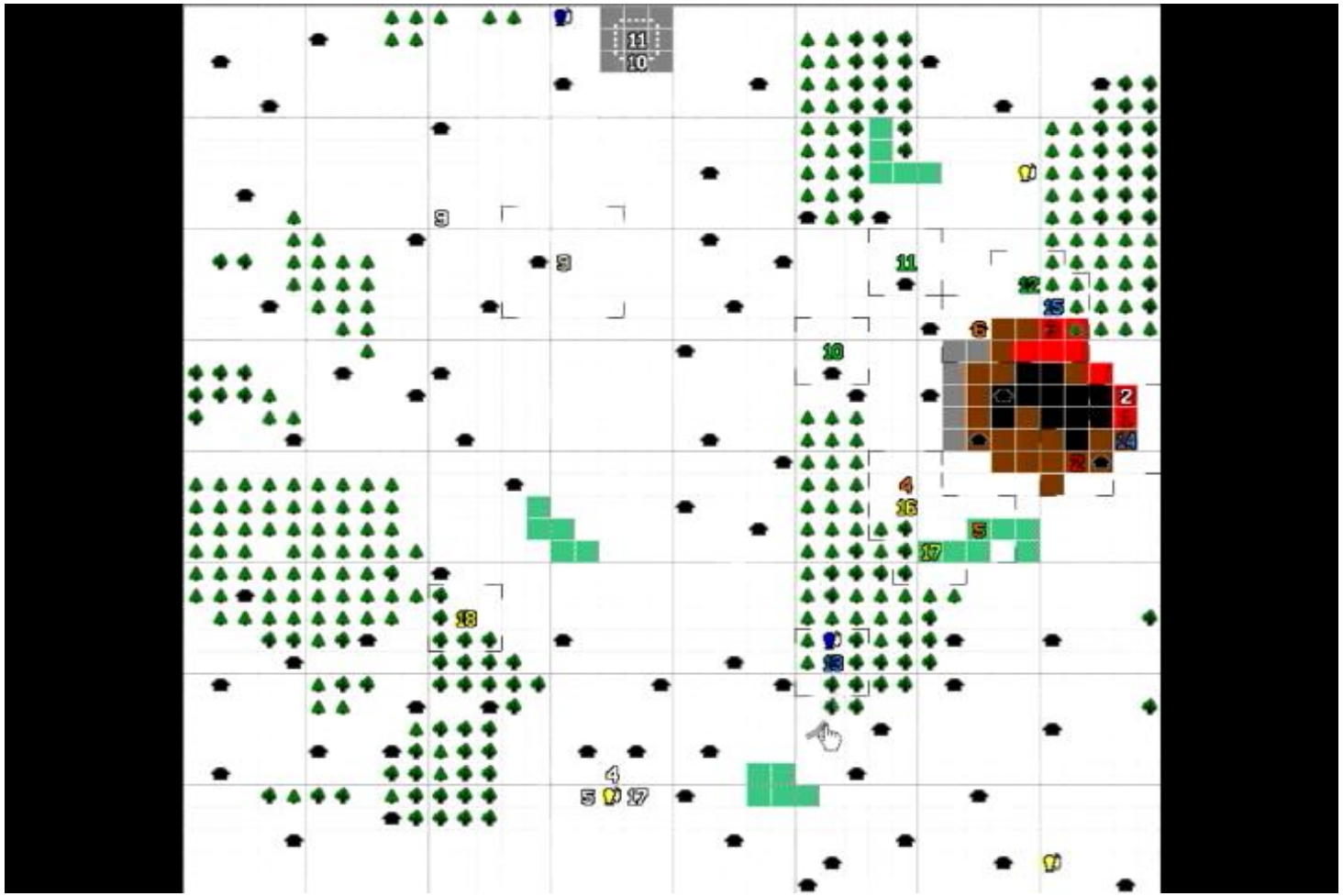


Design of the study

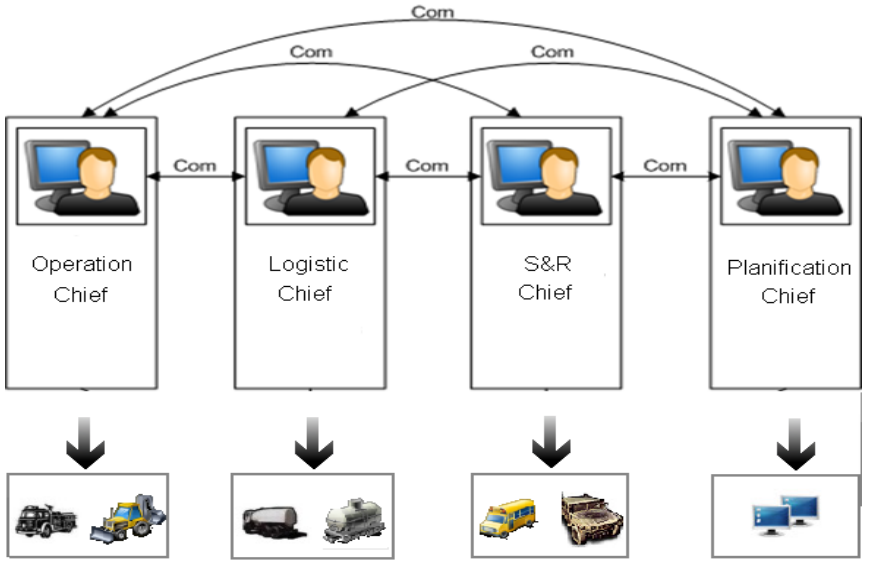
- Team size
  - 15 Teams of 4 and 15 teams of 6
  - Each team includes 2 confederates

- Resistance
  - High:
    - Confederate resisting to structure change
  - Low:
    - Confederate promoting structure change

Design of the study

De-Conflicted (function-based role allocation)

Allocated responsibility for specific units in C3Fire (e.g., Firefighter, Fire Breaker, Water Tanker, Fuel Tanker, Search Unit, and Rescue Unit). What goals were allocated to which team member was randomized



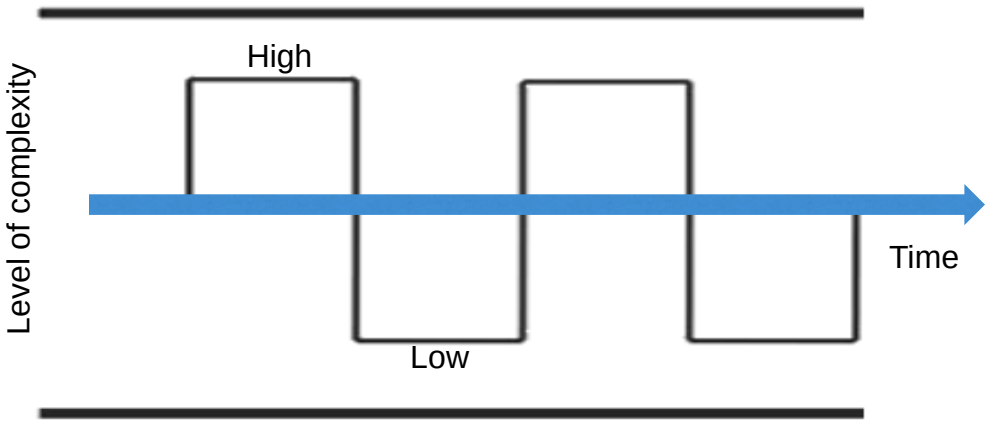
Collaborative (goal-based)

No a priori allocation of goals or functions was given in this condition. What goals and units were allocated to which team member was left to the team to decide

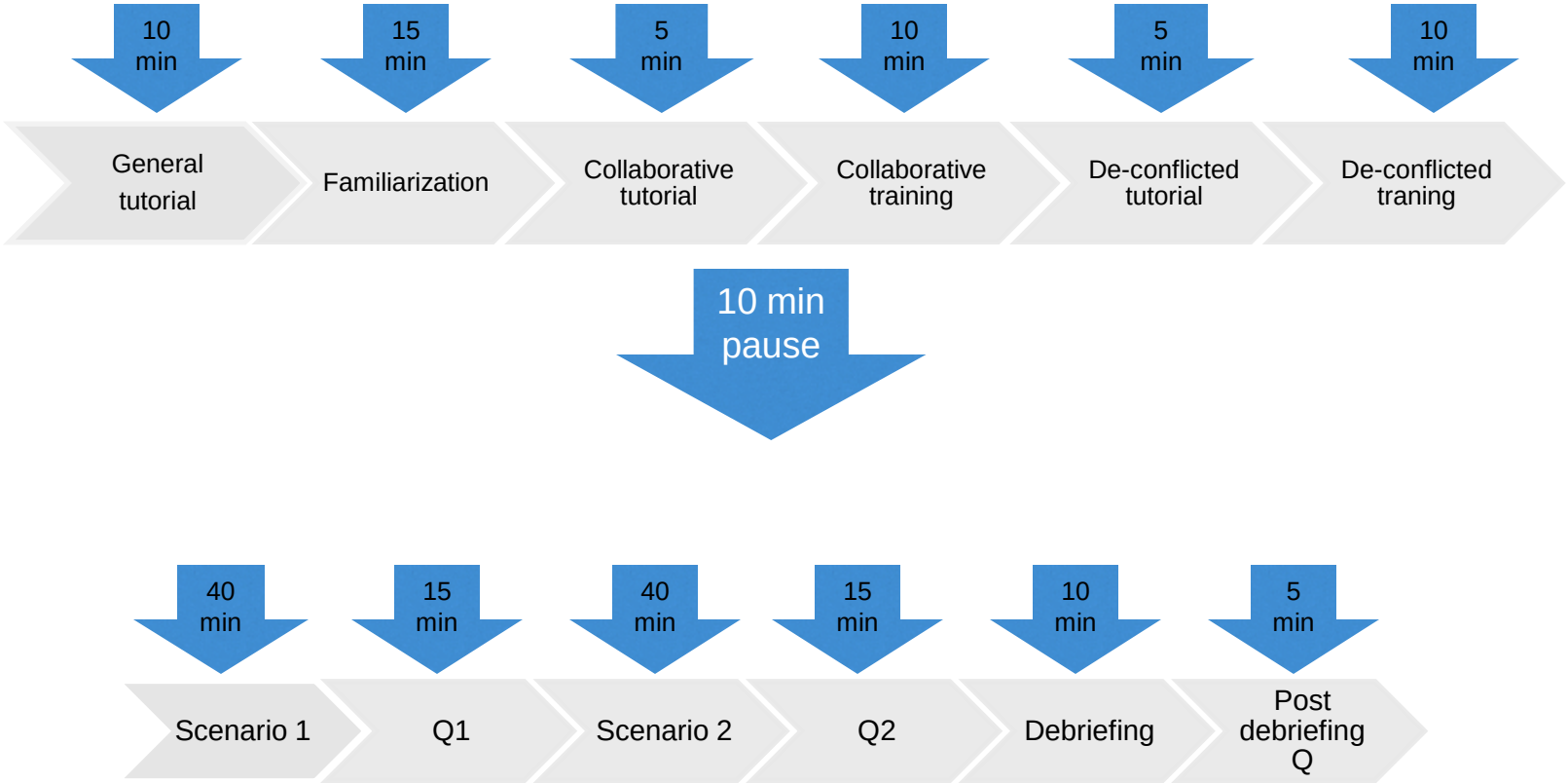
Design of the study

- Complexity of the situation

  - High:
    - Apparition of new fire
    - Sabotage unit
  - Low:
    - Aircrafts filled with water



Procedure



Q.1 and Q.2:
Goal Commitment, Trust & NASA TLX

Objective measures

- Settling time
  - the time from t = 0 to the point in time where the response is always within 3% or 4% of the steady state value
- Performance

$$\frac{Total\ number\ of\ cells\ extinguished}{Duration\ of\ the\ period}$$

- Coordination

$$\frac{Duration\ of\ the\ period\ -Average\ time\ without\ resources\ for\ all\ units}{Duration\ of\ the\ period}$$

Subjective measures

- Goal commitment questionnaire:
  - Measures the degree of team investment in achieving their goals
    - 5 point Likert scale (*not true at all* to *totally true)*
- Post-debriefing questionnaire:
  - Measures participants' awareness of the experimental conditions (situation complexity and the presence of confederates)
    - 5 point Likert scale (*strongly disagree* to *strongly agree*)

Results

- Subjective measures

Goal commitment

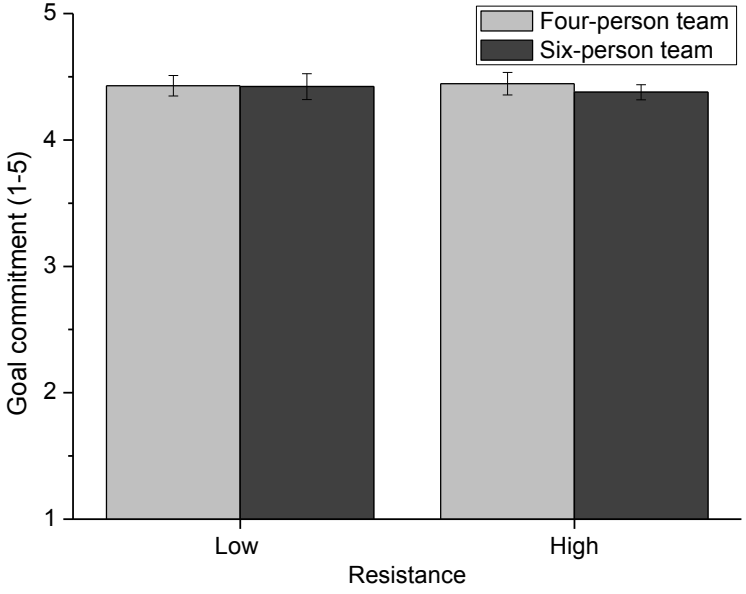


Figure 1. Mean goal commitment score as a function of team size and resistance. Error bars represent standard errors.

Post-debriefing

62% perceived workload

95% did not perceive confederates

Results

- Objective measures

Performance

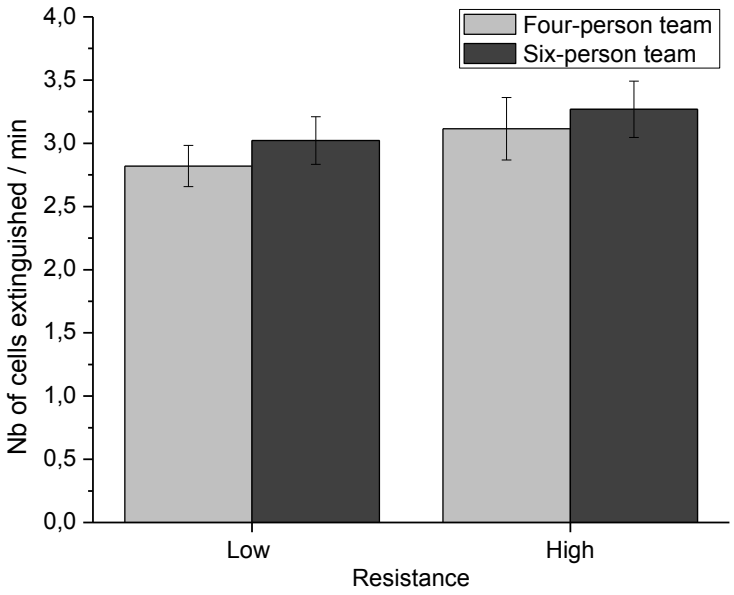


Figure 2. Mean number of cells extinguished as a function of team size and resistance. Error bars represent standard errors.

Coordination

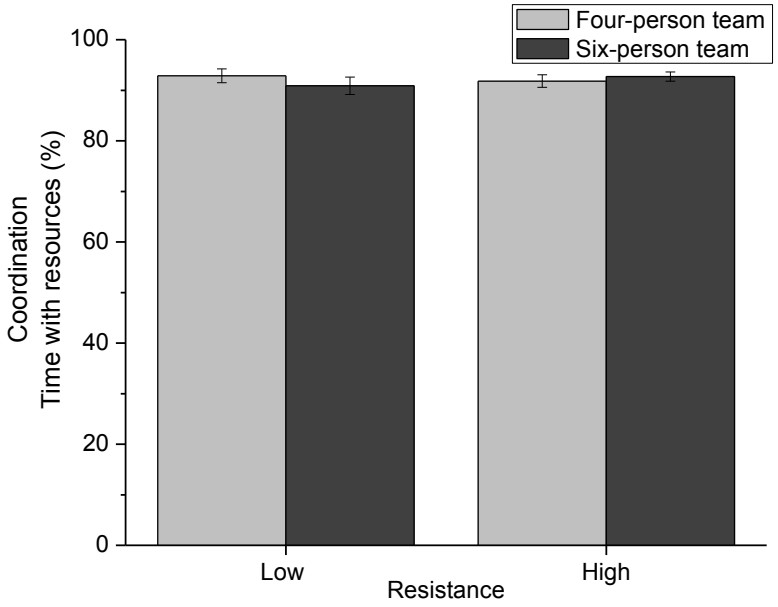


Figure 3. Mean coordination effectiveness as a function of team size and resistance. Error bars represent standard errors.

Discussion

- Team size
  - Does not seem to affect team performance or coordination
    - Variability between team structures
      - Role ambiguity?
- Resistance
  - Does not seem to affect team performance or coordination

Conclusion

- Validity of the study design
  - High levels of goal commitment
  - Situation complexity perceived, presence of confederates
  - Resistance manipulation
  - Larger team size ?
- Still to come…
  - Other questionnaires
  - Complexity parameter
  - Social network analyses