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THE C-OODA: A COGNITIVE VERSION OF THE OODA LOOP TO REPRESENT C^2 ACTIVITIES.

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Despite many critics and proposed alternatives, the original version of the OODA is still extensively used to represent C^2 decision cycle.

Advantages with the OODA loop:

- the high level of abstraction of the OODA loop provides a valid representation of own and enemy decision cycle

- The simple representation of the OODA loop stresses also the importance of two critical factors in the environment, time constraints and information uncertainty, on the decision cycle execution

  It is often said that the superiority of the C^2 on the battlefield is attained by performing own decision cycle faster and better than the opponent.

- The central aspect is that the OODA loop captures the continuous nature of C^2.

  The implementation of a given decision (Act), at a given moment has an influence on the environment and that effect is observed by the ongoing Observe process of the next decision cycle.

Despite many critics and proposed alternatives, the original version of the OODA is still extensively used to represent C^2 decision cycle.

Problems with the OODA loop:

- The first type of problems concerns its limited ability to represent dynamic and complex situations typical of C^2.

  It suggests a bottom-up linear sequential process system.

  The loop has no representation of the feedback or feed-forward loops needed to effectively model dynamic decision-making.

  It also suggests a process model with a single entry point triggered by events in the environment. This results in a single possible sequence of processes.

  It cannot adapt to different levels of expertise in decision-making and to the diverse task contexts existing in real situations.

Despite many critics and proposed alternatives, the original version of the OODA is still extensively used to represent C^2 decision cycle.

Problems with the OODA loop:

- A second type of limitations is a consequence of its simple and high-level representation of processes.

  The loop includes abstract concepts that do not provide the kind of details required for it to be used as an efficient analytical tool for adequate support systems design and training programs development.

  In fact, the loop provides a low granularity level of representation.

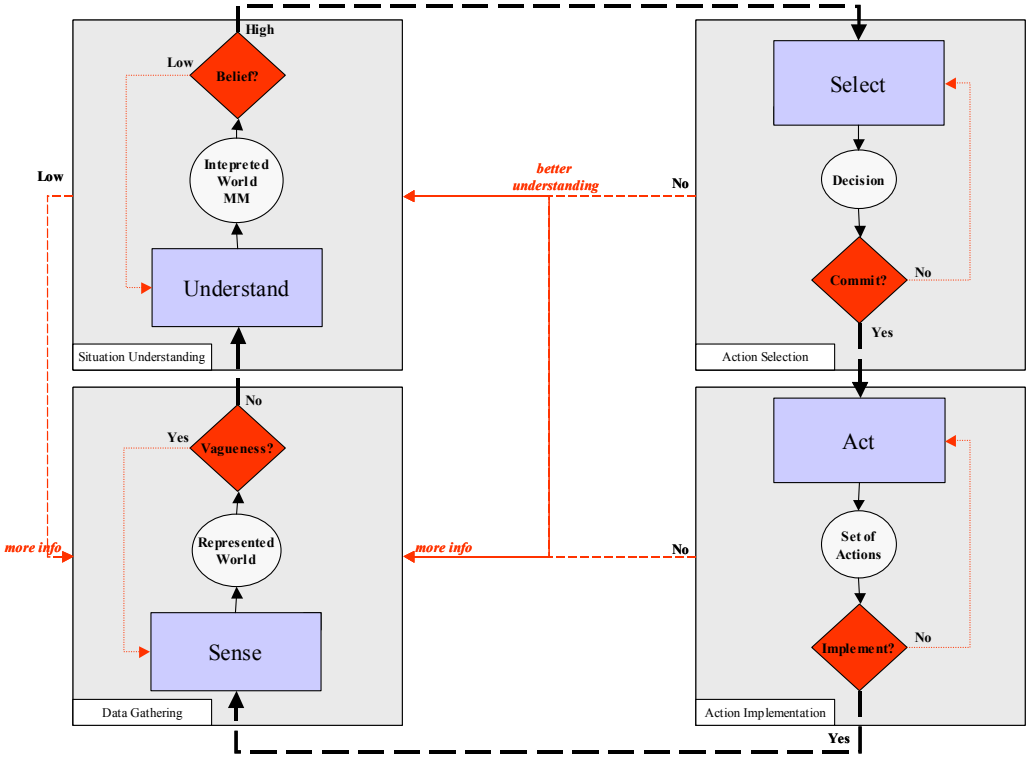
To cope with these problems many alternatives have been proposed to represent C^2 decision cycle.

It is our point of view that to remain a useful and accepted tool in the context of documents defining the armed forces doctrine on C^2, any C^2 model has to keep explicit the high-level representation typical of the OODA loop.

The objective of this paper is to increase the level of granularity of the OODA loop by formulating a detailed cognitively valid representation of the C^2 decision cycle, the C-OODA (Cognitive-OODA).

This version should present a high level of granularity and still include components required to represent dynamic and complex situations typical of C^2.

The C-OODA loop takes its roots in the classical version of the OODA loop and uses the modular architecture defined in the M-OODA loop proposed by Rousseau & Breton (2004)



The M-OODA offer good possibilities for representing the dynamic and complex nature of C^2 decision cycle process.

The C-OODA loop takes its roots in the classical version of the OODA loop and uses the modular architecture defined in the M-OODA loop proposed by Rousseau & Breton (2004)

The M-OODA model modifies the OODA loop based on the following principles:

- It adopts a modular, or building blocks, approach in which each process of the OODA loop is represented as a generic module structured around three components: Process, State and, Control;
- It incorporates explicit control elements within and across modules enabling a bi-directional data/information flow between modules. It also includes a feedback loop within each module;
- It provides a basic architecture for modeling a variety of team decision-making.

The M-OODA can be seen as a layered system in which different parts can be exploded for more details.

The M-OODA loop provides a powerful means to represent dynamic control in the OODA, but it still operates at the low level of cognitive granularity that is a known limitation of the classical OODA.

The C-OODA loop takes its roots in the classical version of the OODA loop and uses the modular architecture defined in the M-OODA loop proposed by Rousseau & Breton (2004)

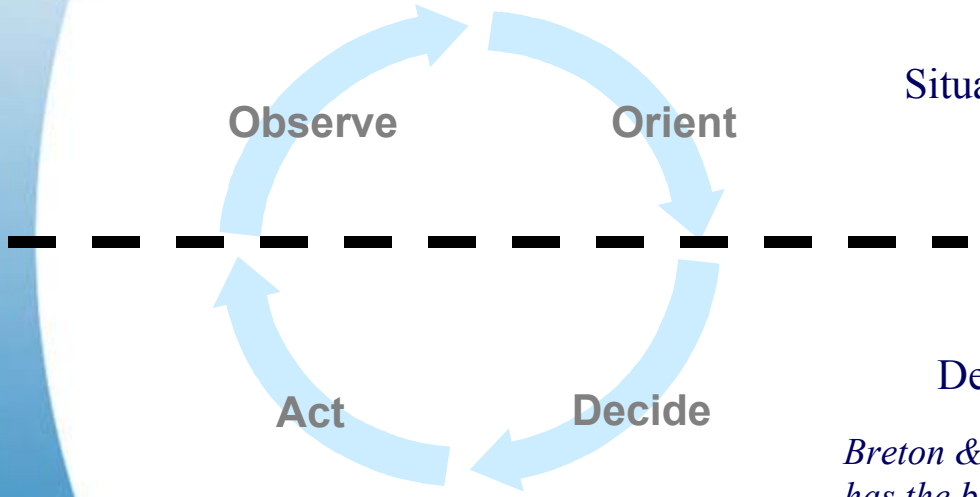
The C-OODA model is an attempt at reducing the distortion that often results from modifications of the OODA loop aiming at a high granularity representation.

Most alternatives to the OODA loop focus their modifications on a given process, often on the Orient one.

By using known cognitive theories and models to provide details on each component, it avoids the biases that come from focusing on a subset of OODA components.

The cognitive background of the C-OODA

The first two processes of the OODA loop can be associated with Situation Awareness represented with Endsley's model.

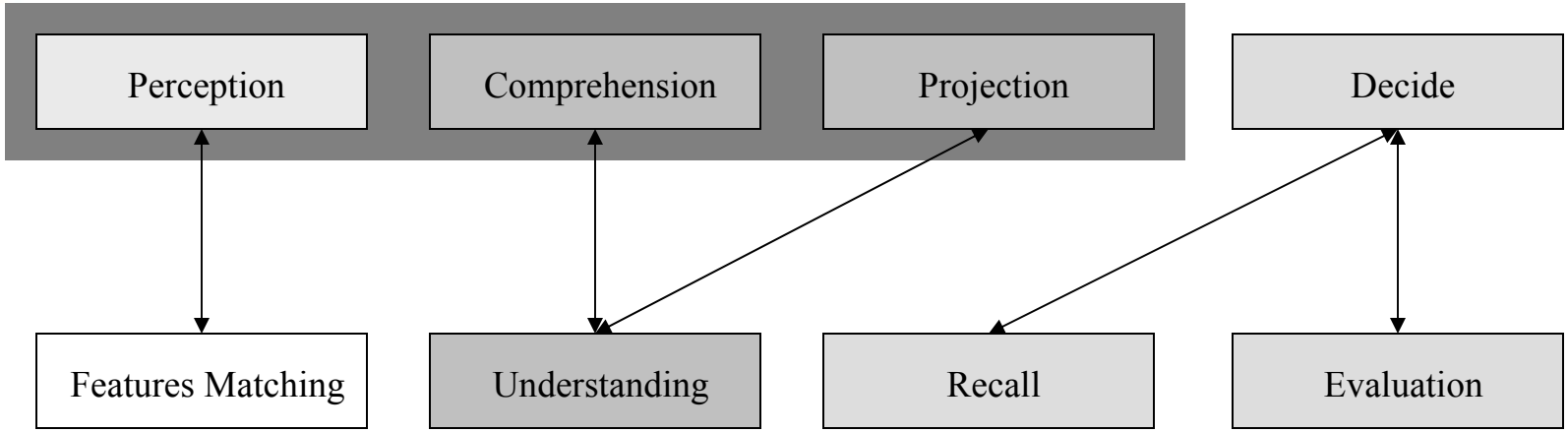


Situation Awareness

Decision-Making

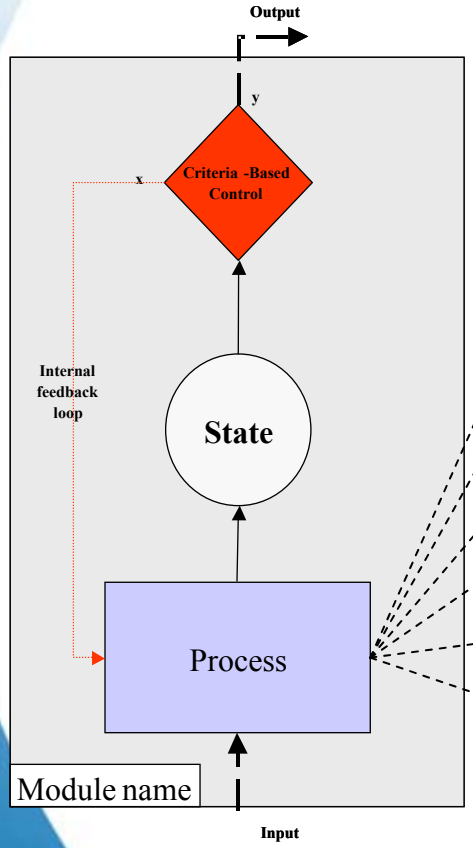
Breton & Rousseau (2001) have identified the RPD model has the best candidate to provide cognitive details in the decision-making side (Decide-Act) of the loop.

Endsley's model of Situation Awareness (Endsley, 1995)



Recognition Primed Decision model of Klein (Klein, 1988; 1993)

Improve the cognitive granularity…



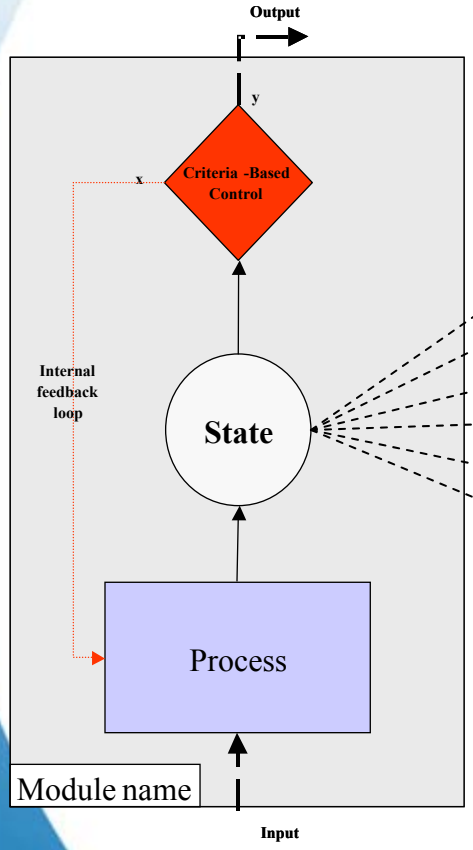
Decide

Orient

Observe

- Evaluating
- Recalling
- Projecting
- Comprehending
- Features Matching
- Perceiving

Improve the cognitive granularity…



Decide

Orient

Observe

Evaluating

Recalling

Projecting

Comprehending

Features Matching

Perceiving

Pros & Cons

Prototypical Actions

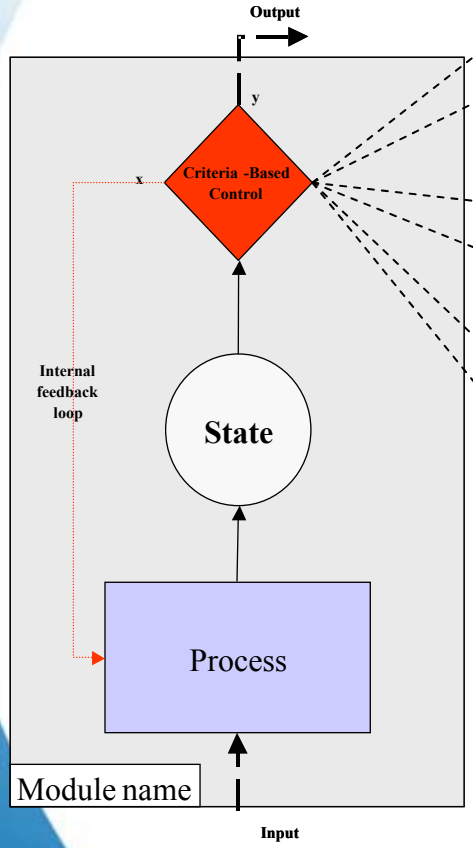
Mental Models

Cause-Effect links

Structured objects

Features

Improve the cognitive granularity…



Decide

Orient

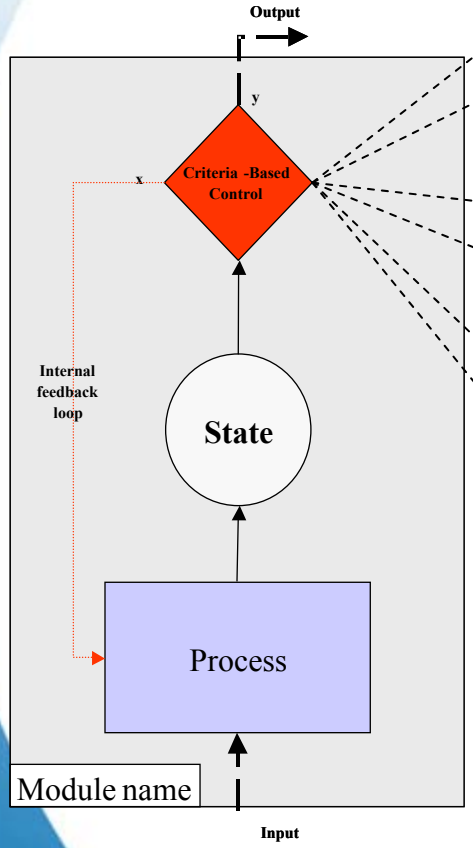
Observe

Story optimistic?
Iteration useless?
Time elapsed?
Action plausible?
Iteration useless?
Time elapsed?
Temporal certainty?
Iteration useless?
Time elapsed?
Causality logical?
Iteration useless?
Time elapsed?
Familiar?
Iteration useless?
Time elapsed?
Data clear?
Iteration useless?
Time elapsed?

Specific

General

Improve the cognitive granularity…



Decide

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Time elapsed?
Familiar?
Iteration useless?
Time elapsed?
Data clear?
Iteration useless?
Time elapsed?

Uncertainty

Time constraints

Always a trade-off between speed and accuracy!!!

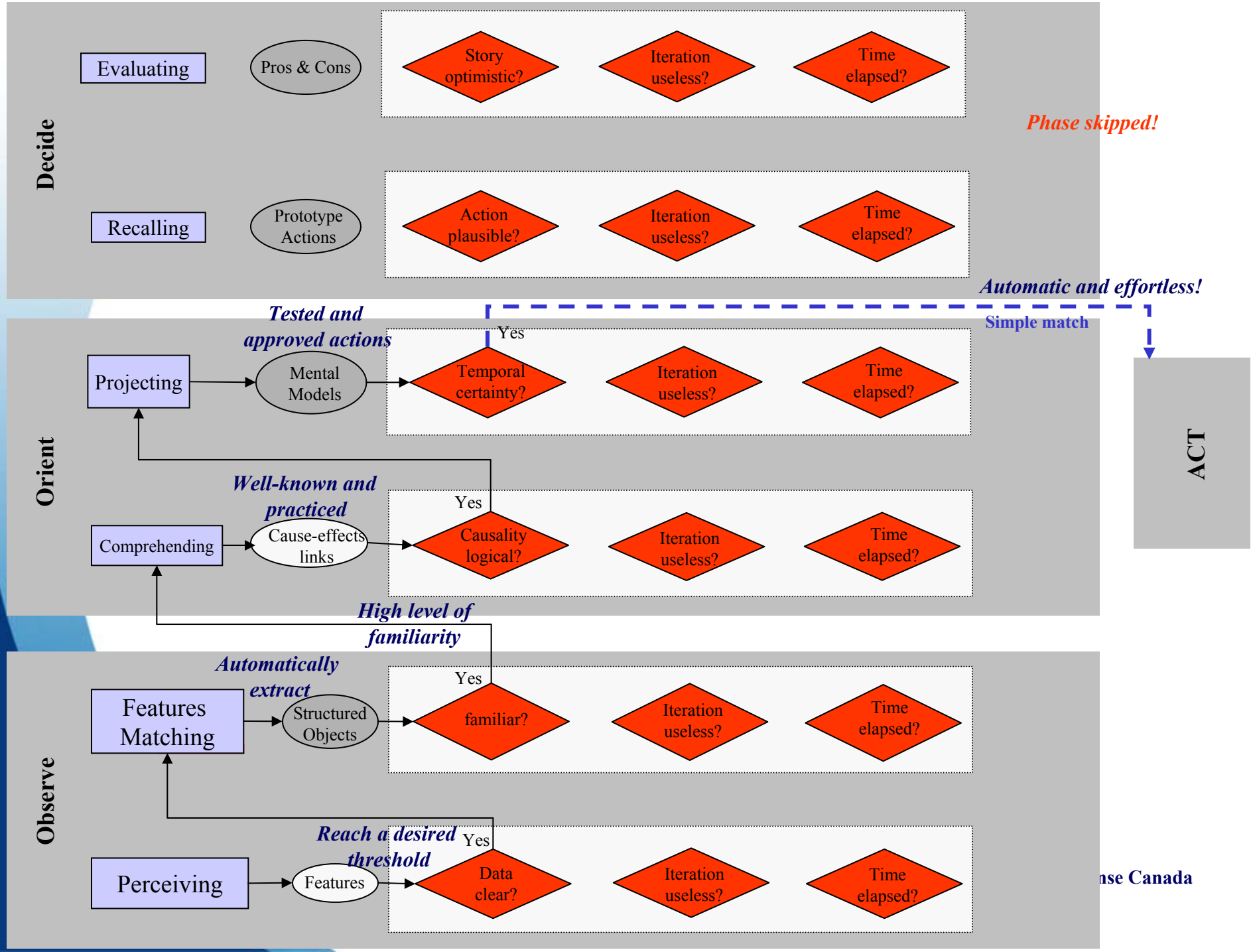
Two factors that affect C^2 decision process…

Some basic rules to develop the C-OODA model:

- The high-level OODA processes must be represented explicitly;
- The architecture of the C-OODA is based on the M-OODA loop in order to keep explicit the notion of control and to allow an adequate representation of dynamic and complex situations;
- The Act process of the OODA loop is not modeled;
- All modules of the C-OODA are symetrical, they all include a process, a state and three control components.

In order to show the functioning of the C-OODA loop, we illustrate three different decision-making situations, Simple Match, Diagnosis and Evaluate Course of Action, typical of Klein's RPD model.

Simple Match: The Simple Match level depends on the environmental features that are registered. It is activated when the current situation is simple and straightforward; that is when the crucial elements of the situation, the objectives, and the typical course of action to implement are easily recognized and identified (Klein, 1996; 1997).

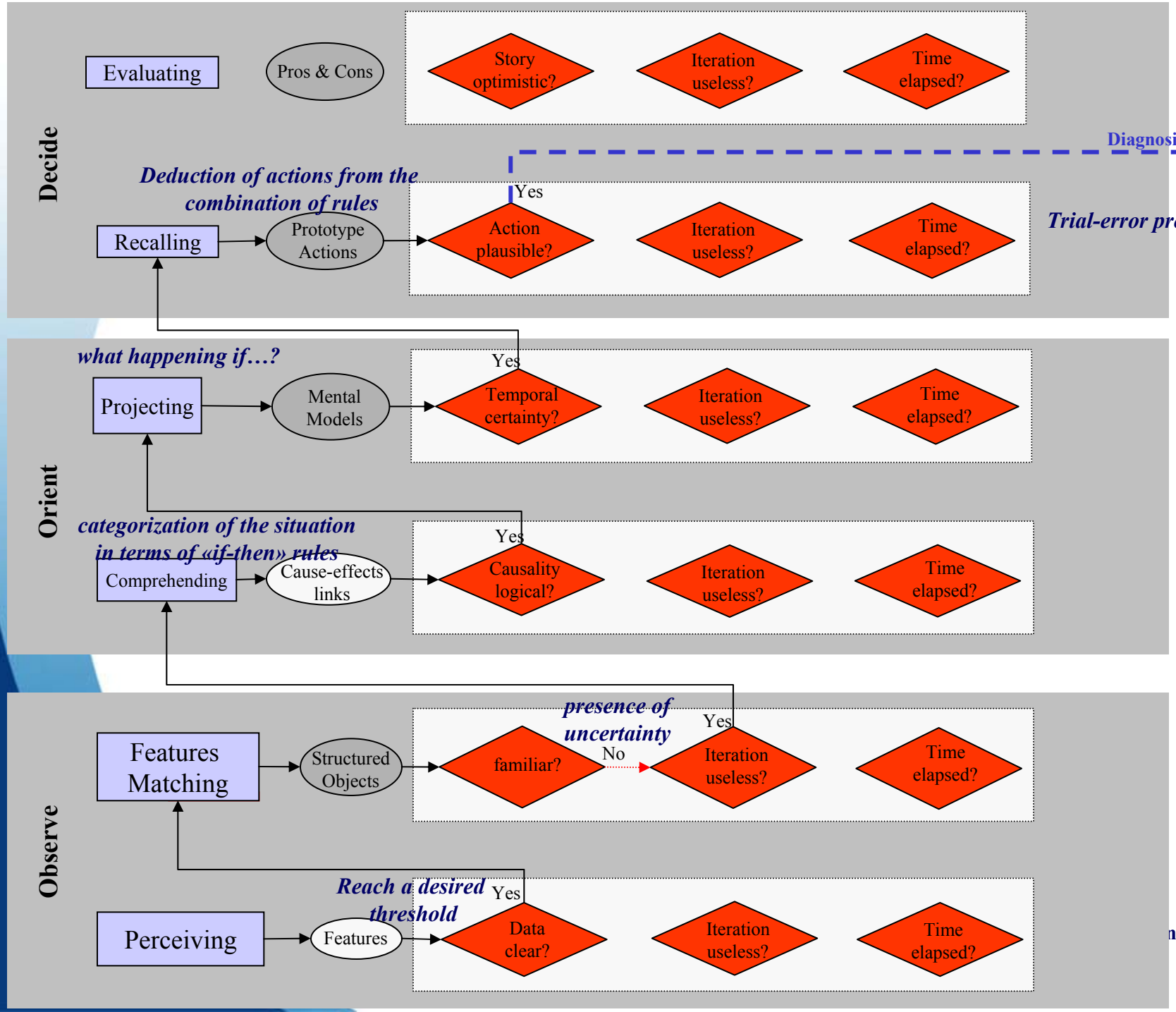

Decide
Evaluating
Pros & Cons
Story optimistic?
Iteration useless?
Time elapsed?
Phase skipped!
Recalling
Prototype Actions
Action plausible?
Iteration useless?
Time elapsed?
Automatic and effortless!
Simple match
Tested and approved actions
Orient
Projecting
Mental Models
Yes
Temporal certainty?
Iteration useless?
Time elapsed?
ACT
Well-known and practiced
Comprehending
Cause-effects links
Yes
Causality logical?
Iteration useless?
Time elapsed?
High level of familiarity
Observe
Automatically extract
Features Matching
Structured Objects
Yes
familiar?
Iteration useless?
Time elapsed?
Reach a desired threshold
Perceiving
Features
Yes
Data clear?
Iteration useless?
Time elapsed?

In order to show the functioning of the C-OODA loop, we illustrate three different decision-making situations, Simple Match, Diagnosis and Evaluate Course of Action, typical of Klein's RPD model.

Diagnosis: The Diagnosis level is required to cope with the presence of uncertainty concerning the situation. This given situation is not necessarily complex, but it does not refer to familiar mental models.

Diagnosis represents an attempt to establish a relationship between an event and causal factors in order to define the situation and find an acceptable explanation for it

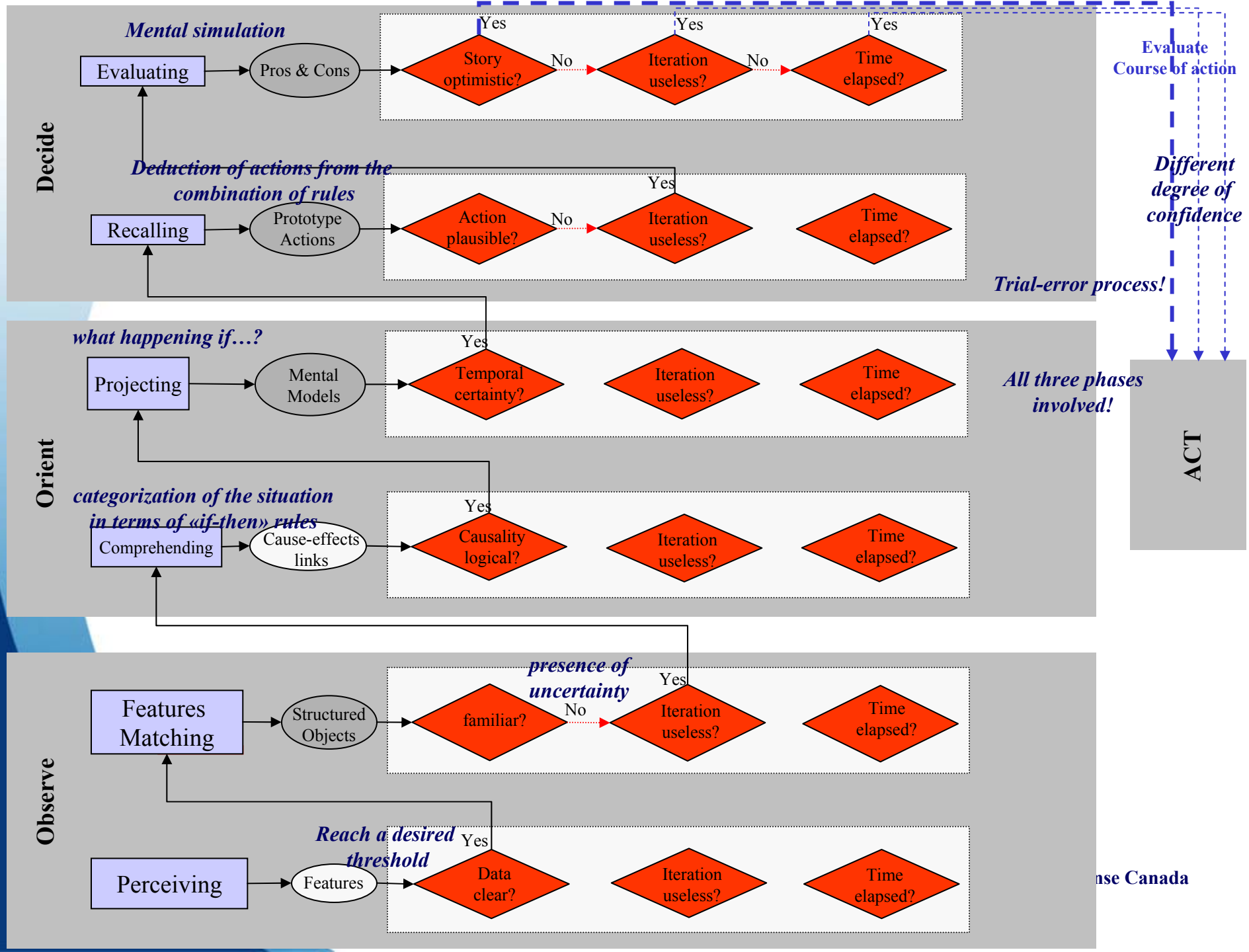
Diagnosis processing implies a greater cognitive effort than Simple Match, because the decision maker must heed a variety of information.


Decide
Evaluating
Pros & Cons
Story optimistic?
Iteration useless?
Time elapsed?
Diagnosis
Deduction of actions from the combination of rules
Recalling
Prototype Actions
Yes
Action plausible?
Iteration useless?
Time elapsed?
Trial-error process!
Orient
what happening if…?
Projecting
Mental Models
Yes
Temporal certainty?
Iteration useless?
Time elapsed?
categorization of the situation in terms of «if-then» rules
Comprehending
Cause-effects links
Yes
Causality logical?
Iteration useless?
Time elapsed?
Observe
presence of uncertainty
Features Matching
Structured Objects
familiar?
No
Yes
Iteration useless?
Time elapsed?
Reach a desired threshold
Perceiving
Features
Yes
Data clear?
Iteration useless?
Time elapsed?
ACT

In order to show the functioning of the C-OODA loop, we illustrate three different decision-making situations, Simple Match, Diagnosis and Evaluate Course of Action, typical of Klein's RPD model.

Evaluate Courses of Action: This level requires the mental simulation of the envisaged course of action to evaluate potential difficulties, possible solutions and, consequently, to determine if this action must be implemented or if further evaluation is required to identify a new course of action (Klein, 1997).

That level of decision-making is based on a more evaluative process that takes time and resources. Consequently, the use of such process can be significantly hampered by the presence of time constraints in the situation.


Decide
Mental simulation
Evaluating
Pros & Cons
Yes
Story optimistic?
No
Yes
Iteration useless?
No
Yes
Time elapsed?
Evaluate Course of action
Deduction of actions from the combination of rules
Recalling
Prototype Actions
Yes
Action plausible?
No
Yes
Iteration useless?
Time elapsed?
Different degree of confidence
Trial-error process!
Orient
what happening if…?
Projecting
Mental Models
Yes
Temporal certainty?
Iteration useless?
Time elapsed?
All three phases involved!
ACT
categorization of the situation in terms of «if-then» rules
Comprehending
Cause-effects links
Yes
Causality logical?
Iteration useless?
Time elapsed?
Observe
presence of uncertainty
Features Matching
Structured Objects
familiar?
No
Yes
Iteration useless?
Time elapsed?
Reach a desired threshold
Perceiving
Features
Yes
Data clear?
Iteration useless?
Time elapsed?

Conclusion

The C-OODA is modelled within the M-OODA framework in order to benefit from the capacity of representation of complex and dynamic situations and to keep explicit the notion of control inherent to the M-OODA loop model.

One advantage…

it does not focus the modelling effort on a specific subset of OODA process, namely the Orient process, as was the case for other attempts at modifying the OODA loop .

Another advantage…

it keeps explicit the well-accepted low granularity representation of the classical OODA loop. Other models have the paradoxical effect of providing a solid cognitive model while discarding the benefits associated with the classical representation of the OODA loop.

Conclusion

Nevertheless, the improvement of the cognitive granularity necessarily brings, as a side effect, the increase in the modelling complexity. The OODA loop is much more simple than the C-OODA.

There might be a way to address the issue by adjusting the complexity level of the model to the modelling need. That would require:

1) *to identify the specific need for modelling and*
2) *adjust the level of cognitive granularity and modelling accordingly.*

… if the objective of the model is to simply represent the major phases included in the C^2 decision cycle

The OODA loop!

… if the objective of the modelling effort is to illustrate complex and dynamic situations, and to show the role of the control components

The M-OODA loop!

… if a high-level of cognitive granularity is favoured to the detriment of the representation simplicity

The C-OODA loop!

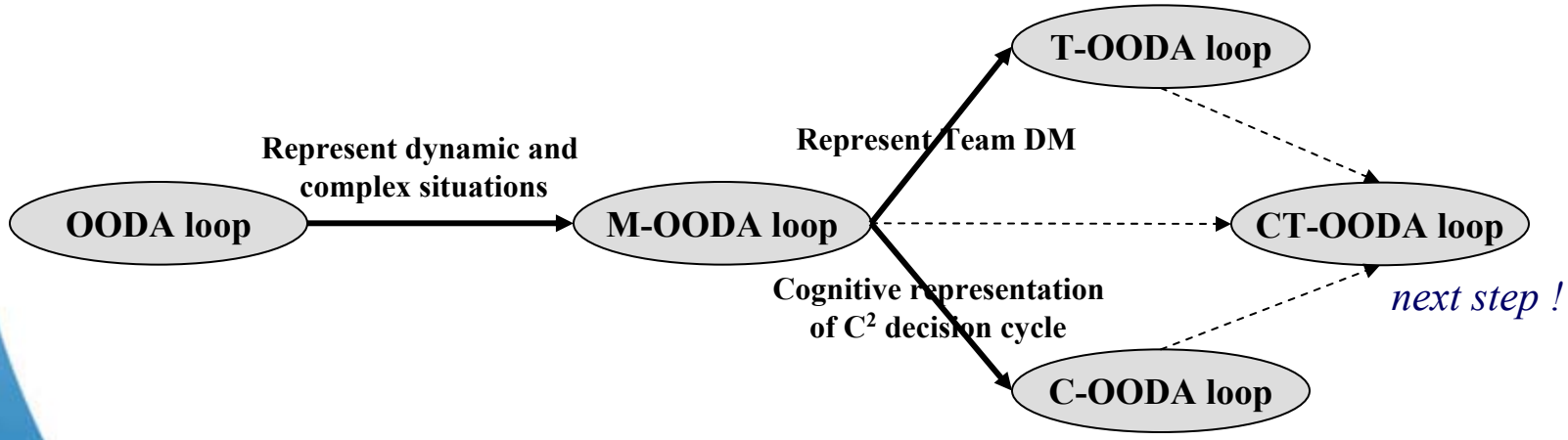
… if teamwork in C^2 environment needs to be modeled

The T-OODA loop!

Conclusion

The fact that all these models that address different aspects of C^2 take their roots into the classical version of the OODA loop can be a positive factor in the acceptance of these models by the military community.

By taking their roots in the OODA loop and being based on the same architecture, these models are compatible altogether. They benefit from the advantages related to the OODA loop while addressing specific OODA loop limitations.



Questions?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