MULTIMEDIA C3I

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ABSTRACT

At the dawn of the third millennium, a Control, Command and Communication Intelligence (C3I) system can no longer be designed as a large set of technical systems. The operational context of these systems tends towards a dynamic crisis management in the frame of a distributed organisation - it becomes compulsory to take into account the global man-machine system, by specifying the modes of cooperation with artificial agents that decision-makers will accept.

The representation of the cooperation modes between agents, human or artificial, is the only way to efficient design of how artificial agents will be implemented by technical systems.

This kind of approach follows an operational experience capitalisation process using the format of multiagent cooperation models, and supposes that judicious metaphors are found out for supporting the translation of intersubjective behaviour into abstract cooperation models.

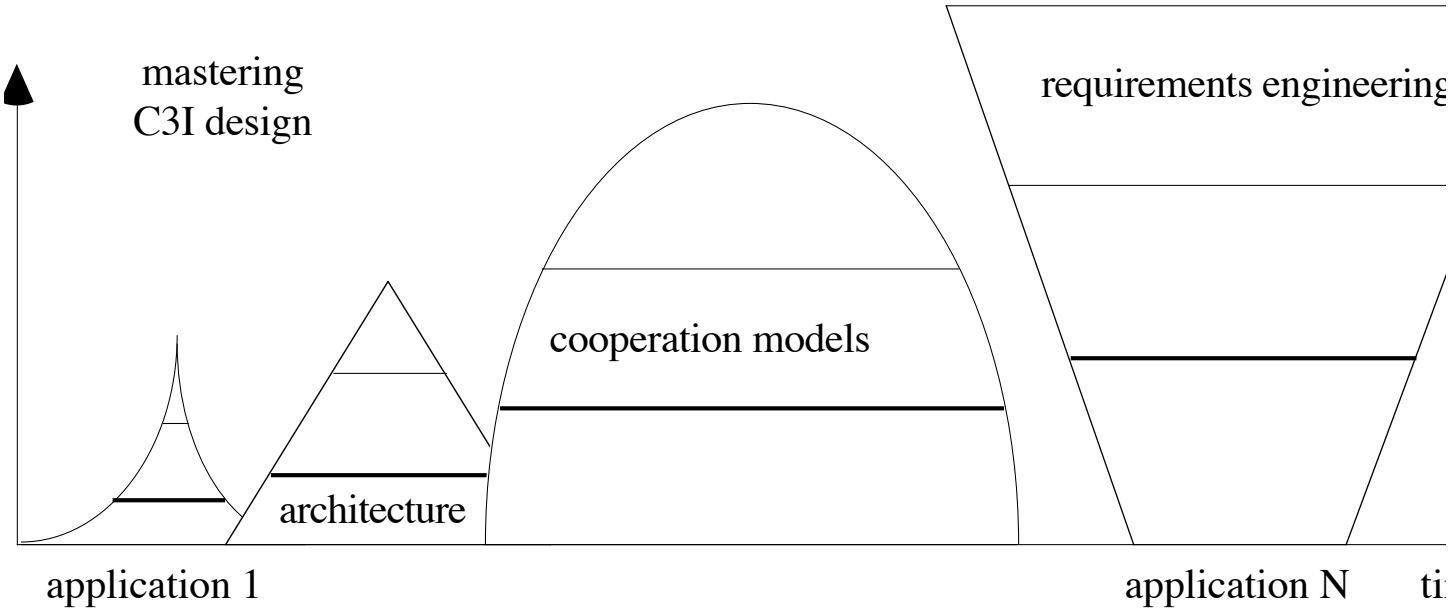
This paper aims at showing, on the basis of a concrete example resulting from field experiments, the benefits of considering multimedia analysis of human behaviour as a support for such metaphors.

1. DESIGNING THE C3I AS A GLOBAL MAN-MACHINE SYSTEM

At the dawn of the third millennium, it is impossible to design a C3I by reducing it to a large set of technical systems. In fact, the operational context of these systems tends towards a dynamic crisis management in the frame of a distributed organisation (termed also “unprogrammed decision”) - each operational case becomes particular, so that it is compulsory to take into account, as soon as the design is started, the interactive character of the global man-machine system, by specifying how decision-makers will accept to cooperate with artificial agents.

The central idea, is that human agents have a better cooperation with artificial agents that seem to embody them, and are naturally alleged to intend to act like agents - this is the essential part of Turing’s argument in Turing (7), continued by Newell in Newell (3), and founds "knowledge acquisition as a constructive modelling process" and finally “multiagent cooperation”, recent disciplines which inherit many of the Artificial Intelligence’s problems and results. The main benefit of the approach lays in the fact that this is the only way to address correctly the issue of unprogrammed decision.

The representation of dynamic cooperation modes between agents, human or artificial, is the only way to design how artificial agents will be implemented through technical systems. In practice, the global design process is very alike to Business Process Engineering, as specified in Rousseaux (5), which concurrently elaborates multiagent cooperation models, operational contexts and efficient design techniques.



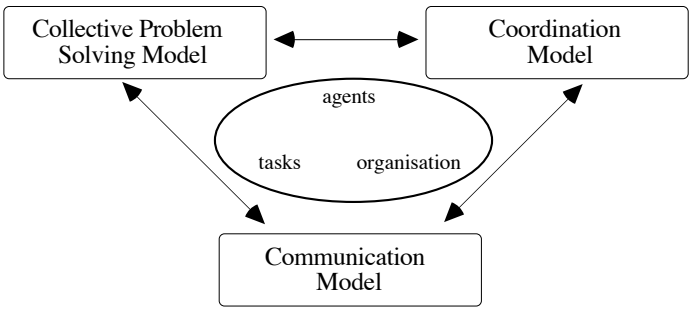
This kind of approach is often very costly in its initial phase, because it requires Reverse Engineering actions, based upon the capitalisation of operational experience in the form of multiagent cooperation models. To do this, the matter is to find out judicious metaphors which could support the translation of some very efficient intersubjective behaviours into abstract cooperation models.

Hereafter, C3I designates the global man-machine system, including its users.

2. MODELLING C3IS AS MULTIAGENT COOPERATIVE SYSTEMS

To build a C3I model as a multiagent cooperative system, the best solution is undoubtedly based on Peirce's works in semiotics, e.g. described in Peirce (4). We shall consider a problem solving activity (semantics), a coordination activity (pragmatics), and a communication activity (syntax); in these three activities the agents are involved in a concurrent process, which gradually elaborates itself.

The method consists of a rough identification of primitive agents with their main characteristics, without any presumption on their human or artificial nature, by analysing the essential of their basic organisation, as well as the main tasks assigned to them. Then the first model is dynamically improved, by taking into account step by step, the situation of this community of agents which is searching for the rational solution of a generic problem, the manner used by this community for coordinating and optimising the solving process (this is sometimes called "limited rationality", which consists of implementing heuristics in order to limit the exhaustive exploration of potential solutions), and the manner used by the agents to express and communicate their contributions.



The method, named MADEINCOOP, is fully described in Zacklad (8) and Zacklad and Rousseaux (9). More details are not necessary here - a simple example, produced by a common situation of cooperative human activity, will suffice to illustrate our aim and our methodological approach. This example will serve to highlight the point of interest, i.e. the communication model, allowing us to reflect on the deep multimedia dimension of human interchanges.

The matter is mushrooming in the wood, decided by a small group of friends.

3. THE EXAMPLE OF COOPERATIVE MUSHROOMING

Our description of the mushrooming problem will be short - the matter is to “comb” a portion of wood searching for some kinds of mushrooms. Common knowledge, and sometimes expert knowledge is involved, but social interaction remains essential for optimizing some aspects of the action, e.g. the most renowned expert in the group can be consulted if a doubtful mushroom is detected, friends are informed that a rich glade has been discovered, or a warning about a given risk is shouted all around.

We just add a little more observations on coordination - there is a permanent, and well-known, danger of getting lost, either individually, or (a more amusing variant) by separate groups. Naturally, when several persons are involved in mushrooming, keeping in view constantly is impossible. Hopefully, in most cases, the lost person shouts "Where are you?" and receives after a short while the answer "I’m here!", supported by energetic gestures.

Getting lost in the wood is quite common, so that members of the group know that the best way to avoid it is the coordination of all human communication means (sight, hearing, …). However, in the context of walking in the wood, it seems reasonable to tolerate some exceptions (mutual view is lost), if the whole situation is well managed.

When a person sees no longer his companion, because of trees, colour changes, or relief variations, he decides to use the most efficient mode in this context, due to its reach, multidirectional aspect and independence of obstacles - his own voice. So, the question "Where are you?" has a semiotic meaning: it is both a question addressing a person whose place is unknown (but sound is omnidirectional), and a question whose text has only a pragmatic value (i.e. a coded onomatopoeia could play the same part). The answer "I’m here!" is similar: sound is used only to locate the speaker, then the lost hunter could use the sight to ascertain information he receives through the acoustic channel - a lost person moves about restlessly in order to appeal to his partner to engage visual contact. Once again, the text of the answer is in fact meaningless.

Following this way of thinking, we arrive at the conclusion that “ not to get lost ” is an implicit constraint in mushrooming - its success depends on a compromise between the best combing of a large portion of wood, using many independent persons, and strategies avoiding the group’s dissolution.

From the communication viewpoint, the previous scenario is a good example of successful multimedia communication. No single mode of human communication was able to support the coordination, but a judicious strategy of mixing several modes (which is quite common and implicit) led to a straightforward solution.

Thus, in the mushrooming model, it is necessary to consider first the multimedia characteristics of intersubjective communication, before trying to get a quantitative evaluation of the model, which depends much on very specific points (e.g. one of the hunters does not understand English, the group is accompanied by usual dogs or sniffers, etc.). It appears that "not getting lost" is a basic requirement, which was not obvious at first glance.

Now, we shall replace in our study mushrooming by more complex multiagent activities, including artificial agents and supporting unprogrammed strategic decision.

4. THE EXAMPLE OF MANAGING AN INTERNATIONAL CRISIS

In the scenario we shall consider now, inspired by an actual situation, the Republic of Chad is in a state of civil war, opposing a "legitimate" government to rebels supported by neighbouring Libya. The French army is engaged on the government’s side to protect itself from the Lybian threat - a local CP site is maintained permanently, under the command of a Military Attaché who evaluates the threat.

Several recent events have justified an increased level of alert at the local CP managing the crisis, which must send an argumented report with situation updates:

- troubles broke out in a military barracks in Biltine, situated near the northern border, but it is unclear whether the incident stems from a mutinous group of soldiers, poorly treated and badly paid, or from an attempted rebellion supported by traitors,

- street fighting was reported in the Chadian capital, around the parliament buildings and military forces stationed in the North were moved to the capital - once again the precise nature of these troubles in the capital is unknown,

- the airport of the capital, N'Djamena, has been bombed, but the identity of aggressor aircraft is yet uncertain. Experts are analysing the photographs of explosive impacts at the request of the Military Attaché (MA) responsible for the CP. Rebels own two old Soviet-made aircraft able to carry out this type of bombardment.

The main point of the report is to decide whether recent troubles are an essentially interior affair, or are caused by Libyans. In the latter case, a military invasion could be prepared, contractually justifying French military intervention. For strategic reasons, the French HQ, which is the addressee of the report, would prefer to avoid military actions.

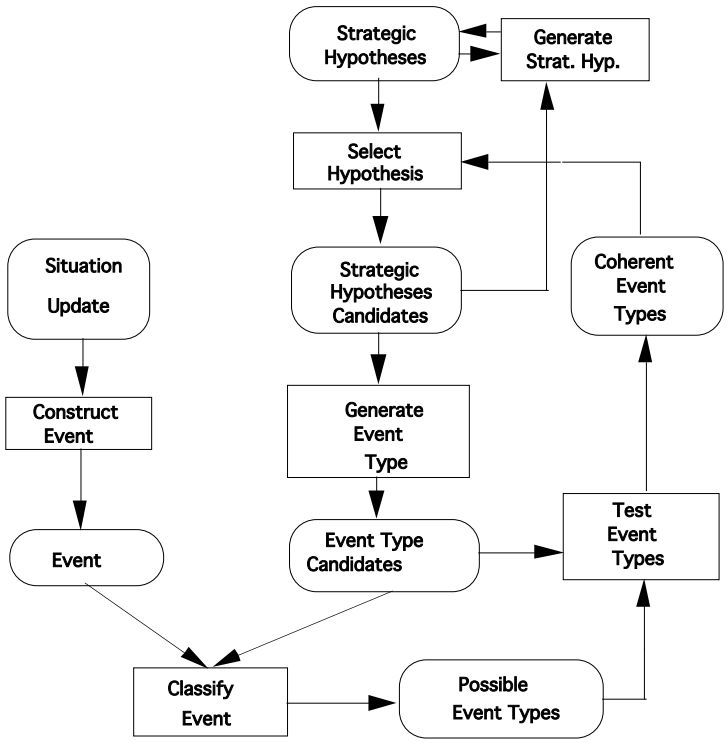
The Military Attaché then conducts a twofold action:

- on the one hand, he investigates the Biltine barracks life conditions, the fact that recent problems of pay or food could cause a mutiny, and the socio-ethnical history and political affinities of the M'Butul; in the same way, he tries to augment his understanding of the other events,

- on the other hand, he tries to orientate his reflection according to French government's objectives, in order to select the assumptions whose validation would favour the interests of his country.

Note that here the Military Attaché is in a position rather similar to that of the mushroom hunter in the previous example - his mission is to strike a compromise. From a certain viewpoint, he has to produce arguments allowing the French authority to demonstrate that the situation does not require the French military intervention, without any infringement of contractual defense agreements - he has to develop an interpretation of the situation, consistent with the position of his hierarchical authority. From another viewpoint, he must investigate in the field in order to evaluate the risk of this position, and determine the moment when it can be no longer defended.

But for the moment, the Military Attaché adopts the rigour, which will be changed only under constraint. Let's examine the cooperation engaged with artificial agents ARGU, SIMUL, MESSAG. This cooperation is based on a problem solving model, inspired by Simon and Lea (6), more complex than that of mushrooming - this is what Artificial Intelligence calls a "structure induction". Here an event is built from the situation update, before it matches some Event Type Candidate by classification. The nature of matching selects possible Event Types, whose compatibility with the context is selected in turn, by comparison with Event Types previously identified.



The following table presents an extract of an imaginary dialogue, analysed from the viewpoint of the Collective Problem Solving model. We neglect here the presentation of the coordination model which could control it. For more details, refer to Zacklad and Rousseaux (9).

	An interpretation according to the Problem Solving Process	
1	MA: Have you received the description of the events in N'Djamena? It seems that it is a protest manifestation organised by students close to the opposition. This confirms that the events in Biltine are probably only the consequence of problems related to the pay of soldiers, and so, a purely domestic affair …	Construct-Event Classify-Event Test-Event-Type Select-Hypothesis
2	ARGU: I don't agree. The real cause of Biltine events is unknown, moreover the M'Butul ethnic group (involved in the Biltine affair) is the closest to rebels.	Classify-Event
3	MA: Could you prove that rebels were involved in the recent events?	Test-Event-Type
4	ARGU: Yes, I shall prove it (the demonstration follows).	Classify-Event, Test-Event-Type
5	MA: What do you think the consequences are?	Generate-Strategic-Hypothesis
6	ARGU to SIMUL (the exchange can't be seen by MA): Could you estimate troop strength ratios in the southern region while taking into account recent events?	Generate-Strategic-Hypothesis
7	SIMUL to ARGU (the exchange can't be seen by MA): If rebel forces and	Generate-Strategic-Hypothesis

	Libyan regiments are involved, the strength ratio penalizes the troops of Chad.	
8	ARGU to MA: If rebel forces and Libyan regiments are involved, this means that an attack in the northern region is potentially imminent, while Chad's defence potential is reduced.	Generate-Strategic-Hypothesis
12	Intervention of MESSAG: I have just received the message we wait for; aircraft which bombed the N'Djamena airport could be Marchetti SF 260.	Construct-Event
13	MA to ARGU: You could be right.	Select-Candidate-Strategic-Hypothesis
14	ARGU: Why your opinion is changing?	Select-Candidate-Strategic-Hypothesis
15	MA: Because if Libyans did it, they surely own this Italian aircraft - a large scale invasion can be expected.	Construct-Event, Classify-Event Test-Event Select-Candidate-Strategic-Hypothesis

During this dialogue, the Military Attaché, engaged in a cooperation with artificial agents, is led to change completely the register of communication. Before the first speech, he obviously used the HQ dogmatic register, but this did not stop him from searching for cooperation with some artificial agents. However, as in the case of the lost mushroom hunter who calls for changing the register towards a form of cooperation, his first request looks like a rash provocation, which immediately causes the ARGU's retort. ARGU uses the same register, so that the Military Attaché is led to examine the deep causes of disagreement in interpretation, then their potential consequences.

Then the intervention of the MESSAG artificial agent causes a swing in the Military Attaché's arguments, who has to revise his initial doctrine. It is very likely that he will soon elaborate an alternative assumption and will try to promote it through cooperative and contradictory argumentation with HQ officials.

5. MULTIMEDIA AS A POWERFUL METAPHOR

How can we give artificial agents the capability of detecting the intention, so that they behave as cleverly as ARGU in the previous dialogue, just like a mushroom hunter who hears the call of a fellow and starts a productive dialogue without being told that "not to get lost" is a major stake in mushrooming?

In our example, which is idealized in natural language, ARGU could be able, by analysing the Military Attaché's speech, to note that its structure follows a mode that Austin, in his theory on speech acts, would call "statement mode", vs. "performative mode" (Austin (1), Bougnoux (2)). Really, according to Austin, statement utterances (e.g. "the window is open") characterize a thought which records a world's state and flows "from World to Word", while performative utterances (e.g. "I congratulate you") characterize a thought which adds a new state to the world and flows "from Word to World".

In a certain way, the statement utterance used by the Military Attaché in his first speech, due to its "self-important" character, calls for contradiction, i.e. a performative dialogue, which is reinforced by the first ARGU's speech (it is also a statement utterance). Tension is now brought to its climax, which can be solved only by using a performative utterance, to be replaced at the dialogue's end by a new statement utterance.

In this example, the Military Attaché's statement mode would clearly indicate a risk of being lost in the domain of abstract and dogmatic ideas, dangerously far from field's reality, and would incite cooperative artificial agents, represented here by ARGU, to challenge the Attaché to a concrete confrontation.

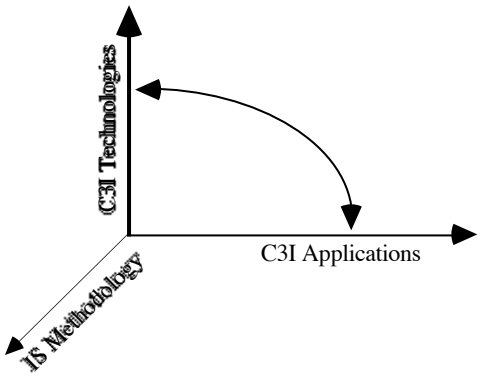
We have here a true metaphor of multimedia intersubjective communication which inspires both the artificial agent's action mode modelling and the representation and simulation modalities of its intention.

6. A PROPOSAL FOR INTEGRATING MULTIMEDIA INTO THE C3I DOMAIN

C3I designers often view multimedia only as a promising technology, liable to participate in the technical competition like any other technology.

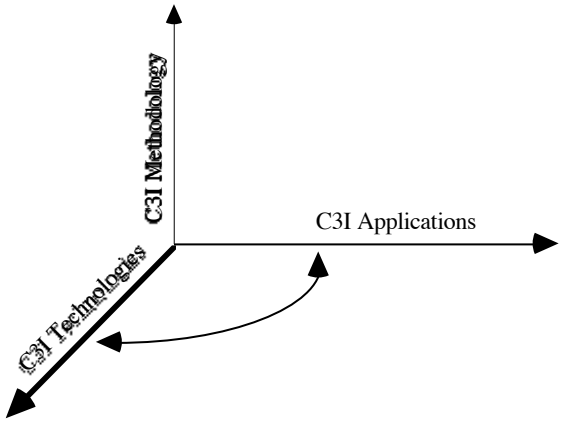
It is true that the current industrial approach of the C3I domain is often based upon a "C3I technologies" / " C3I applications" dialectics, supported by a general Information Systems (IS) methodology: some C3I technologies are preselected and implemented in C3I applications, whose evaluations modify the choice of adapted technologies and suggest further preselected technologies. This approach is strongly subject to technology market pressure and favours both uncreative technical managers and technology suppliers. Among other disadvantages, this approach hinders abstract conceptualization and tends to depreciate all form of culture other than technical.

From this viewpoint, general IS methodology does not play a significant part, because it is too general to be effective. It also ignores many specificities of the operational activity in the field treated by the C3I system. Thus, in Europe, a major part of present C3I R&D financing is reserved for studying the impact of emergent technologies on C3I technologies, while very few research activities aim at founding a true C3I methodology.



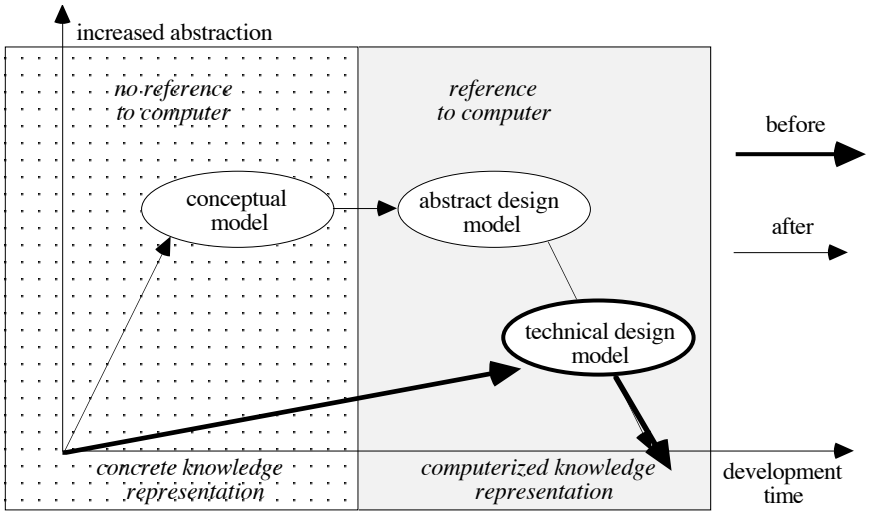
We propose a new industrial approach, more centred on a " C3I methodology" / " C3I applications" dialectics. This approach takes into account a strong trend of the C3I market towards discarding specific technologies in favour of technologies available on the IS market, named "IS technologies". Thus, the " C3I technologies" / " C3I applications" dialectics is weakened, or more precisely it becomes less specific and strategic: as a form of technological watch, its implementation can be entrusted to subcontractors.

This approach induces a very different organisation of C3I industrial designers: the technological watch is entrusted to subcontractors, and the core of the expertise moves towards the design of a C3I methodology (including ontologies, cooperation models and C3I architecture models), which has to harmonize incrementally with a sequence of applications. C3I design expertise depends less on technology and more on design techniques, enhancing the value of interdisciplinary competence.



Furthermore, it is essential that this approach aims at producing a true C3I methodology, that means an "operation-oriented information system methodology", which inherits the CIS methodologies, on the one hand, the "C3I human activity" methodologies, on the other hand, and finally installs a " C3I methodology" / " C3I applications" dialectics, which generates and puts into practice the C3I methodology. Such a C3I methodology is less general than CIS methodology, and since the C3I operational activity of real or potential users is assimilated, it is very likely to have an increased impact on design.

We thus state the following methodological principle: for structuring a C3I design activity destined to be inserted in a given operational area, it is necessary to implement "applications / methodology" concurrent engineering actions proper to this area.



In this new context, the study of the major intersubjective behaviour modes will provide powerful metaphors, supporting the design of the global man-machine system and allowing very high-level abstraction of artificial agents, which will be no more represented in terms of technical implementation.

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