Cognitive Science and Command Post Organization 1/2

military-Earth thinking notebook

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Cognitive sciences are often considered a fad or even a matter for a few specialists. However, they have already revolutionized many fields and are in full expansion. Could and would the army, which has been able to make the shift to digitalization, benefit from this new field of evolution? If so, what cognitive discoveries are likely to influence command structures in the future? It is to these questions, and to many others, that the authors of this article attempt to answer.

In Future Land Action, a forward-looking document for the optimum use of forces in the future, the Army identifies "command performance" as a fundamental factor in operational superiority. This is characterized as follows: "The performance of the command system must ensure the optimized direction of operations by taking into account four interdependent imperatives [...]: situational awareness, accelerated decision making, organisational plasticity and reduced vulnerabilities".

The first three imperatives refer to themes addressed by a discipline that was once discreet, but is now increasingly cited: cognitive sciences. Because they have the attraction of novelty, they carry an attention, an expectation, if not a hope, which is revealed in the multiplication of references made to them, particularly in the field of defence[1]. 1] A prospective study by the ANR[2] states in this respect that "cognition will be at the heart of the technological and societal revolutions".

However, like all scientists, cognitivists have developed a vocabulary, concepts and schools that often complement each other and sometimes clash, but which, once past the doctrinal postures of those who quote them, do not always say more to those who listen to them. Recognizing that these researches, in today's era of hyper-information, are fashionable and rich in potential does not make them any less hermetic or fantasized. Indeed, there is also friction on the scientific battlefield: at the crossroads of the life sciences, the humanities, social sciences and the logical sciences, cognitivists sometimes try to discover a theory of the whole that is rooted in the objectivity of the exact sciences.

While the richness (and sometimes conflicting diversity) of cognitive theories is real, they are not directly transposable to military realities. An effort of critical analysis, without fascination, is therefore necessary to exploit this wealth and draw useful doctrinal and strategic lessons from it.

Command posts (CPs), driven by intention and nourished by information, are ontologically cognitive and can be seen as decision systems [3]. 3] What cognitive discoveries, then, are likely to influence command structures in the future? Will the cognitive sciences remain only a fashionable effect that can be neglected, or should we on the contrary avoid the peremptory judgment of Foch that theShould we on the contrary avoid the peremptory judgment of a Foch judging aviation before 1914 and imperatively rethink the organisations of the CPs before a rupture occurs, offering to whomever anticipates it an undeniable superiority?

It is likely that, like all sciences, cognitive sciences will continue to approach objectivity without ever achieving it; they will probably not bring about the revolution that will lead to military domination through the mere reorganization of command systems. In fact, who would still believe that it would take only a few technological leaps to lift the fog of war? On the other hand, as with all scientific advances, it will be useful to determine what significant improvements cognitive discoveries will bring to what is, regardless of the flood of information, the raison d'être of military command: transforming intent into action.

Therefore, a definition of cognitive science will be proposed as a first step, so that the opportunities and limitations for command systems can be deduced, leading to the proposal of some applications for the future.

Cognitive sciences: what are they?

Cognitive sciences, or cognitive sciences, have their origin in the "cogito" ("I think") made famous by René Descartes. They are eminently linked to the use of thought, and their etymology is rooted in the noun "cognitio", which in Latin means "faculty of knowing". Thus, their "purpose is to describe, explain and, where appropriate, simulate the main dispositions and capacities of the human mind - language, perception, motor coordination, planning..." [4].

- Origin of cognitive sciences

Explaining and **formalizing the spirit** was one of the original ambitions of philosophy. Considered as peculiar to man since the Presocratics, thought appeared as the key to a conscious and wise use of human freedom. In the wake of the Renaissance, the "rationalist" philosophers, led by Descartes, Spinoza, Newton and Leibniz, laid the scientific foundations of the modern era by interpreting thought as a logical and decomposable phenomenon. The etymology answers: the Latin "ratio"corresponds to the ability to count, organize and order. The Greek "logos" refers to speech, particularly its explanatory and demonstrative nature. These almost synonymous notions have been used from Kant to Count, nourishing the desire to dissociate complexity into more elementary, clear, distinct and assured concepts, which in turn break down into simple ideas, "atoms" in short. According to this approach, reason then consists in the way of associating these "atoms" according to sequential rules, thus producing the matter that is thought.

In the 19th century, George Boole continued this mechanization of **thought by inventing the "** symbolic **calculus** ". This attempts to translate logical operations (or, and, if... then..., etc.) into simple algebraic actions composed of 0 or 1. In 1936, Alan Turing, a British mathematician, invented the famous machine of the same name, an abstract model of the computer, which breaks down any mathematical problem calculable by man into a series of simple operations. John von Neumann laid the foundation for the design of modern computers by differentiating between the program and the computational data.

At the same time, important discoveries in neurology **contributed to** the advancement of our understanding of the brain. Alcmeon de Crotone had laid the foundations for a consensus that had rarely been challenged since antiquity, identifying the brain as the seat of reason: modern scientific advances had, unsurprisingly, proved him right. Among other things, Paul Broca located the language centre in the left temporal lobe, and the neuron was discovered by a Spanish researcher, Santiago Ramón y Cajal. The German Korbinian Brodmann published the first brain map in 1909, which is still in use today.

The post-war period saw the birth of cybernetics **.** At the instigation of the mathematician N. Wiener and the neurophysiologist W. McCulloch, mathematicians, psychologists, sociologists, linguists and anthropologists participated in interdisciplinary sessions[5] to identify the principles governing systems, whether living or non-living. Very much in the spirit of Descartes, who "knew no difference between the machines made by craftsmen and the various bodies that nature alone composes"[6], the aim was then not only to develop an analogy between machines and living organisms[7], but also to bring together specialists from different disciplines. Three main ideas emerged: the possibility of associating calculation and electrical signals, the notion of system - which processes data and produces an effect - and finally feedback control[8], which makes it possible to regulate systems.

But it was in 1956 that cognitive sciences were brought to the forefront, when a first conference on artificial intelligence was held in Dartmouth, Canada, with the aim of copying and simulating human intelligence. It was given the name "cognition**"**. Various disciplines then tried to give it specific contents and orientations: linguistics, anthropology, psychology, neuroscience, philosophy, artificial intelligence, etc., among others.

Cognitive sciences have since made significant advances, thanks in part to the progress of computer science (neural capacities and networks), robotics, and finally brain imaging. Different currents today complement each other, and sometimes diverge. For proponents of **cognitivism**, the brain is comparable to an information processing system that sequentially manipulates symbols according to precise rules. From this point of view, as long as we know the mental processes, it is possible to deduce what a system is capable of and why. **Connexionnism** considers that the human mind can be modelled by a system made up of a set of interconnected units operating in parallel, which functionally - and roughly - correspond to neurons. The performance of the network is continuously evaluated by feedback loops. Finally, a more recent current, enactivism, **which** challenges the purely rationalist logic of cognitivism, is the defender of embodied dynamism, otherwise known as enaction. This school believes in particular that cognition is a temporal phenomenon that does not allow us to distinguish the mind from the organism (there can be no separation between the body and the brain, because emotions are embodied) and from its interaction with the environment.

- Cognitive science definition: modeling thought?

Cognitive sciences are not a unitary science, as they bring together several disciplines around a common goal. They can be defined as the **body of knowledge and studies dedicated to modelling the processes by which a system[9] (living or not) leads, based on real information** and **experience, to a decision that induces behaviour** . The major fields dealt with by cognitive sciences therefore relate to functions such as perception, behaviour, memory, language, reasoning, emotions, attention, learning, consciousness, communication, interactions, in other words everything that accounts for mental activity. More concretely, their purpose is to model, i.e. to understand and describe the functioning of information processing systems. They can be divided into several types.

Understanding the mechanisms of the human brain[10] comes first chronologically. The brain, at the centre of the nervous system (the body's command), is made up of a network of more than 85 billion neurons and as many glial cells, which communicate by means of electrical and chemical stimuli. Every millisecond they make millions of mini-decisions that outline a thought. The memorization of information, for which there are varied and complex cognitive structures (diagrams, plans, scripts...), plays an important role in the reasoning process. A simple distinction is made between short-term memory[11], where information is available quickly, and long-term memory, where all the rest of the information resides. Cognitive load, the amount of information that the brain can process and support, is limited, and learning is required to master complex tasks. The brain's mechanisms are also affected by the length of time it takes to think, its history, its interaction with the body and its environment (emotions, culture), and numerous cognitive biases. Advances in neurology have been significant in recent decades, as described in a recent parliamentary report [12]. 12] For example, the mapping of the brain is becoming increasingly accurate; a group of researchers recently identified 180 distinct regions of the cortex, 97 of which have never been described before.

13] Interactions between individuals and between societies are then studied. At the birth of organization theory, organizations were equated with machines, notably by Adam Smith. They are now considered as sets of interpersonal relations structured in networks: individuals represent nodes, and the information exchanged is flows. In order to make organizations more efficient, management tries to improve group work by relying on cognitive approaches such as the behavioural approaches of the British Meredith Belbin [14], or the communication processes of Taibi Kahler [15] and, finally, neuro-linguistic programming [16].

Finally, there is the question of machines. Computers can process large amounts of digital information and have computing, processing and storage capacities far superior to those of humans. Artificial intelligence is nowadays trying to reach and surpass the reasoning capacities of the brain. Thus the learning machine can predict values from data (too large in quantity to be evaluated by the brain) which serve as examples. Initially conceived with a computational, cognitivist vision, artificial intelligence today uses structures of the "neural network" type: deep learning. The functioning of the latter is modelled on that of the human brain, capable of learning from raw data. It can be found, among other things, in the field of voice or facial recognition and in word processing. This artificial intelligence, connected to the capabilities of robotics, now makes it possible to carry out tasks that were once the preserve of humans thanks to expert systems. For example, a robot, Vital, now sits on the board of directors of the Hong Kong company Deep Knowledge Venture since 2014 [17]. Advances in "strong", conscious artificial intelligence, capable of representing itself in its environment, feed the fantasies of a humanoid robot taking its autonomy. On another level, the relationship between man and machine (man-machine interface, "the HMI") also deserves to be studied: learning to work and using the machine requires a cognitive load from the brain that is often not negligible, sometimes greater than that which would be required for the task without the machine.

- From modelling[18] PCs as cognitive systems

PCs can be considered as decision systems[19]. Armies have always sought, in order to prevail over the enemy, to decide faster and better. Staffs were born at the end of the XVIIIth century, initially to organize the details of the execution of the decision of the leaders; then they evolved to allow the leaders to perceive and synthesize more quickly.

an exponential mass of information, from which the appropriate manoeuvres had to be deduced. Thus, modern command posts have become more formalized, allowing the analysis of advisors to be combined with that of the chief in order to reach a decision. In order to enable efficient and rapid decision-making by the CP, modelling the reasoning leading to a choice provides an analogical insight. Thus, if we are interested in the cognition of command systems, we can distinguish three layers corresponding to the three main currents of cognitive science: cognitivism, connexionnism and enactivism.

The functioning of a PC can be considered as that of a system sequentially manipulating symbols (tactical diagrams, tactical symbols, terms from glossaries, acronyms, etc.), following precise rules: doctrine, regulations, principles. The decision-making process consists of a logical succession of steps, which can themselves be broken down into sub-steps. The environment, the situation and the mission received are perceived and analysed by different sensors, human or not. The staff carries out an actual reasoning, and proposes options to the chief. This process is cyclical, and is renewed according to the evolution of the situation. The armed forces formalise this process in doctrine, according to conceptual principles and historical teachings. The simple OODA loop(observe - orient - decide - act, a model described by Colonel John R. Boyd of the US Air Force forair duel) and the complex NATO planning method, COPD[20], developed as part of a global approach with advanced technological means, are examples of this. This cognitivist vision of the CP has set a precedent, as it makes it possible to determine rational and therefore reassuring options for decision-makers. Nevertheless, it makes the CP predictable: if one knows the doctrine of the adversary, one can estimate its modes of action.

The CPs have adapted their structure according to needs, to the point of adopting a matrix organisation crossing hierarchies and functional branches, and integrating new technologies, in particular digitalisation. The networking of all levels of command through communication systems allows ad hoc coordination: working meetings bring together participants from different cells, it is essential to clearly define the modalities of these meetings ("comitology"), and mainly the responsibilities of each participant, as in the case of the RACI matrices [21]. 21] Information management within the framework of a global approach thus becomes the keystone of the functioning of the staff: how to access data, select relevant information, and disseminate it, despite the constraints of confidentiality. NATO has thus conceptualized Knowledge development, taken up by the CICDE in a joint doctrinal reflection (RDIA-004 of 18 June 2010), and developed the TOPFAS tool[22] to facilitate planning. Feedback is also present with control (performance of actions), feedback and steering, which allow the CP to be aware and adapt. This connexionnist vision of the functioning of the PC makes it possible to apprehend the simultaneity of the work of the various cells, as well as the problems of storage, flow and access to information.

The staffs are composed of human beings: the aspects related to enaction are therefore inherent to them. The perception of the environment, made difficult by the friction and complexity of conflicts, influences the evaluation of situations. Human and group heuristics are loaded with subjectivity and bias reasoning. It is then possible to model them in part, but all the cognitive processes linked to emotions (stress, fatigue, empathy, fear, etc.) are still unknown. Decision-making mechanisms are also influenced by the experience of the staff, their culture and shared values. The personality of the chief, finally, obviously influences the decision: he or she guides the planning, defines the criteria for comparison and chooses the option that seems best to him or her in the end, which does not imply that it is the most objective.

Staff processes can therefore be partly modelled: the cognitive and connective approaches describe the theoretical organisation and functioning of the staff. The enactivist approach, on the other hand, allows to take into account the human being: in practice, because it is composed of human beings, no staff fully applies the methods. This modeling - albeit partial - seems to make it possible, thanks to new technologies resulting from advances in cognitive science, to make staffs faster and more efficient. The essential condition for improving efficiency is staff awareness, i.e. their ability to represent and describe themselves.

1] For the CICDE, "cognitive sciences, which focus on major mental functions such as perception, memory, reasoning, communication, etc., should be able to contribute to increasing the amount of information that can be used by soldiers and their management. This capacity could have an impact on the organisation of command, on decision-making capacity and on the autonomy of teams in the field". (Joint prospective reflection "Future Operating Environment 2035" of 23 May 2016, p.15).

2] (PIRSTEC, Networked Interdisciplinary Prospective for Cognitive Science and Technology, 2010).

3] The command post is made up of two entities: the Chief and his staff. It is up to the former to decide and decide on the basis of the analyses and recommendations developed by the latter.

4] Andler, 1989

5] These are the Macy Conferences, named after the foundation that organized them. There were 10 of them, and they took place in the United States from 1942 to 1953.

[6] In Descartes, "Principles of Philosophy"Part 4, § 203

7] In a post-World War II context, some people hope to influence societies by "programming" individuals.

8] Anglicized nowadays under the term "feedback", understood as the effect that acts on its cause.

9] Jean-Louis Le Moigne (French systems specialist) defines a system as "an object, which, in an environment, endowed with purposes, carries out an activity and sees its internal structure evolve over time, without however losing its unique identity".

10] On this subject, see the website www.lecerveau.mcgill.ca.

11] The retention capacity of this short-term memory is described by G.A. Miller in 1956 (The magical number seven plusor minus two: some limits on our capacity for processing information. Psychological Review - 63, pp. 79-81): it contains about seven "pieces" of information at the same time and can use two of them directly.

12] Claeys & Vialatte, 2012

[13] Glasser, Coalson, & Robinson, 2016.

14] Some 20 years ago, psycho-sociologist Meredith Belbin described nine key roles necessary for the proper functioning of a team.

15] The American psychologist Taibi Kahler worked with NASA on the recruitment of astronauts in the early 1970s and derived a classification of personality types and a method for reducing communication problems between people.

16] A method of influencing behaviour through language, developed in the early 1970s.

17]http://www.latribune.fr/technos-medias/20140516trib000830445/un-entreprise-nomme-un-robot-a-son-conseil-dadministration.html

18] Modelling is defined by the National Centre for Textual and Lexical Resources of the CNRS as "an operation by which the model of a system is established.The modeling is defined by the CNRS's national centre for textual and lexical resources as "an operation by which the model of a complex system is established in order to study more conveniently and measure the effects on this system of variations in one or another of its component elements" (Giraud-Pamart Nouv. 1974). The model is defined as "a physical, mathematical or logical system representing the essential structures of a reality and capable at its level of dynamically explaining or reproducing its functioning" (Birou 1966).

19] See definition above.

[20] Comprehensive operations planning directive

21] The acronym RACI (responsible, accountable, consulted, informed) is used in management; it is a matrix of responsibilities for a project, whose entries are the division into sub-projects and the organisational structure.

22] TOPFAS(Tool for Operational Planning, Force Activation and Simulation) is a NATO software package for operational planning and force projection, consisting of a database and analysis tools.

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