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# Trivial, non-trivial and wise machines: higher-order transformation functions in the case of the Crow tribe and Plenty Coups[1]

by

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**Abstract:** This paper explores the possibility of extending Heinz von Foerster's concept of non-trivial machines to articulate the idea of second-order intelligence, that is, of adaptive change that consists in changing the mode of adaptation. It makes use of the transformations undergone by the Crow Tribe during the late $19^{th}$ and early $20^{th}$ centuries. We develop the concept of "second-order non-trivial machines", or "wise machines", that is, machines possessed of higher-order transforming functions that transform lower-order transforming functions (rather than working directly over given inputs); and of a discriminating function, which decides whether a given output must trigger first, second or third order transformations. We provide a framework to discuss wisdom in the language of cybernetics, and we discuss the particular case of the Crow tribe. This opens the possibility of further discussions on the mechanics of wisdom in individuals and societies.

**Keywords:** cybernetics, wisdom, Crow tribe, trivial and non-trivial machines, second order cognition

## 1. Introduction

"Although feedback and dialectics represent motion in similar ways, cybernetics is an integrated model, while dialectical materialism is an antagonistic one" (Texeira, 2015, 33). For Ana Texeira, cybernetics is a science of regulation,

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feedback loops and homeostasis, but not of fundamental change: "dialectics implies a fundamental tension, and an unresolved antagonism; while feedback knows no outside contradiction, only perpetual iteration" (Texeira, 2015, 33). Whereas dialectics (be it Hegelian or Marxist) attempts to account for fundamental transformations in a system's operation (through which a system can be said to be historical in a meaningful way), cybernetics, according to Texeira, is unable to account for all but homeostatic change. In this paper, we would like to explore this suggested limit to cybernetics, by attempting a cybernetic account of a historical process.

In his beautiful 2006 book, *Radical Hope*, Jonathan Lear describes the response to an ontological crisis, which the Crow Tribe of the Great Plains faced at the turn of the $19^{th}$ century, with the near-extinction of the buffalo and territorial encroachment by the US government: hunting and tribal warfare, the practices that constituted their world and identities could no longer be performed in any meaningful way. Lear describes the reasoning for the kinds of decisions to be taken at such times as "abysmal", in that there is no established framework of meaning from which to draw a guiding light in the decision-making process (cfr. Swiezynski, 2012; Connolly, 2011). Such problems are of a higher cognitive order than ordinary means-ends problems. In what follows, we explore the cybernetics of such decisions, using the vocabulary of trivial and non-trivial machines, proposed by Heinz von Foerster (2003), and introduce criteria for distinguishing the cognitive order of problems. We propose that higher-order problems require different cognitive resources than lower-order problems, so that proficiency in one kind of problem is not necessarily predictive of proficiency in the other.

Before we move on to an account of Jonathan Lear's book, we offer a brief illustration of the distinction between higher and lower order problems, to give an intuitive idea of the distinction we are after. A man works ten plus hour days at his job, Monday through Saturday, and drinks heavily on Saturday nights. On two occasions now, when arriving at his apartment where he lives alone, he has, in his drunkenness, broken the key to his front door from twisting it too heavily, and has had to pay for an all-night locksmith, and wait uncomfortably in the hall. What is the solution to his problem? A couple come to mind:

1. Change the lock and key system, to one that uses sturdier keys.
2. Take up a different form of relaxation for Saturday nights.
3. Switch to a less alienating job.
4. A complete change of life, e.g. by devoting it to monastic living, or cheating the welfare state.

Each successive possible solution contemplates a different level of observation: solution "a" leaves the entire system intact, except for the very particular problem it presents, whereas solution "d" is achieved by a complete change in the

larger system.[1] The kind of intelligence it takes to effectively produce a solution at the lower-order (e.g., adequately selecting a new lock and key system) differs with respect to that of the higher order (e.g., what kind of life, as a whole, should I lead?). The challenge of the Crow, at the turn of the century, is, in this sense, a problem of the highest order.

In Section 2, I will explain how the challenges, faced by the Crow in the second half of the nineteenth century, can be said to be ontological; that is, that the constituents of a meaningful world for the Crow were disappearing. The following two sections tackle the problem of the kind of intelligence it takes to face this kind of ontological crisis: Section three contrasts the reaction of Chief Plenty Coups to the crisis to that of the young man Wraps His Tail, and Section four derives some conclusions from this contrast: whereas the former leader tried to find new forms of adaptation, the latter tried to insist upon the old forms. This is further developed in section five, where a difference is fleshed out between first order and second order intelligence, the first being an adaptation to specific changes in the environment and the second a change in the mode of adaptation, which is necessary when there is a systematic change in the environment as a whole. The specificity of second order intelligence is fleshed out in the following two sections: Section 6, in discussing the case of Plenty Coups, explores the usefulness of the vague symbolism found in dreams for tackling problems of second order adaptation; Section 7, using the example of the Ghost Dance religious movement, explores the specific ways in which second order intelligence can fail. In Section 8, we discuss the idea of authenticity, remaining true to oneself, as a concern for second order adaptation, and in Section 9 we discuss some of the practical payoffs for the management of systems that can be gleaned from this discussion.

## 2. Loss of meanings

Until the second half of the nineteenth century, the Crow, being nomadic, lived within shifting and vaguely defined borders that they had to protect through tribal warfare; this implied not only the physical protection of their land from

[1] Incidentally, this distinction may be useful as a rough characterization of the divide between analytic and continental philosophy (e.g, Tieszen, 2011). The tendency, in the former is to focus on lower-order problems, to which clear logical procedures can be applied, whereas thinkers like Derrida or Levinas put the whole edifice of rationality into question. This assessment is in no way meant to suggest a superiority on the part of continental *or* analytic philosophy: indeed, when faced with a problem, it is *prima facie* reasonable to treat it as a lower-order problem *before* contemplating higher-order considerations. If I am continuously getting caught in the rain, buying an umbrella seems more reasonable than moving to the Sahara. However, to limit oneself to finding solutions for lower-order problems may be akin to the proverbial drunkard that, having dropped his keys while walking home at night, looks for them beneath a lamppost, although he has dropped them further up the road, because the light is better there.

incursion, but also the task of gaining recognition as a tribe with a claim to the land. It is in this way that the otherwise whimsical-seeming practice of *counting coup* can be accounted for: Crow warriors made sure they gained the attention of their enemies by hitting them with a coup-stick *before* doing them harm, in order to be recognized: "the reality of a boundary is established when people on both sides recognize it as such" (Lear, 2006: 17). Lear argues that counting coup was not only a way of gaining honor among the Crow, it served as a paradigm of intelligibility for Crow life; and that territorial tribal warfare was not merely a material basis for Crow life, it undergirded their value system by providing a framework to judge on what was worthy and good in life, and what was not (Lear, 2006, 40).

If this is so, the passage from traditional Crow life to the life within an Indian reservation (a process that started in 1851 with the first Fort Laramie Treaty), implied not only the loss of territory but the loss of a point of view (Lear, 2006, 32), of the way in which the Crow *disclosed* their world (that is, caused a lived world to be experienced, by performing roles, taking on activities, using objects according to the latter two, etc., see Spinosa, Flores and Dreyfus, 1999, for the concept of disclosing worlds). Not only did the Crow world had their own ontology, which became threatened by reservation life, they had their own recognizable style, both of which became threatened in terms of meaning. By counting coup, the Crow affirmed not only a claim to territory but an identity and a way of life: failure, of course, was a possibility, but,

> It is one thing for this form of insistence to fail, in the sense of being overrun by the enemy (...) It is quite another for the form of insistence to fail, in the sense of ceasing to be an intelligible act. What we have in this case is not an unfortunate occurrence, not even a devastating occurrence like a holocaust; it is a breakdown of the field in which occurrences occur. (Lear, 2006, 34).

In order to understand Crow loss of meaning, we may look at the loss of social roles. In any culture, people want to perform their roles according to the adopted culturally appropriate criteria of excellence. In pre-Reservation times, these criteria had been clear for the Crow: a good warrior steals many horses from rival tribes, is courageous in battle, etc.; a good leader organized successful raids and hunts. But when raids started to count as crimes according to the law of the United States and nomadic hunting became impossible within the confines of the reservation, what does it mean to be a good Crow warrior, or a good leader? (Lear, 2006, 44-45). Likewise, in any culture, people experience time through benchmarks, through significant occurrences, for the Crow, such benchmarks had to do with victories and defeats, with memorable hunts, etc., and which were no longer available (Lear, 2006, 41), and which is why perhaps, some of them felt that "nothing happened" after they entered the reservation (Lear,

2006, 1-5), that history, for them, had ended. Without projects or horizon, existence becomes provisional, time appears to have stopped (see Frankl, 1992, 78-81).

This is not to say that reality, for the Crow, became phantasmal or illusory. Things, of course, continued to happen; but the Crow lacked a framework in which to give meaning to the happenings. In other words, to say that the Crow underwent an ontological crisis is not tantamount to a naïve constructivist denial of external reality, but an affirmation of it: its persistence as a separate entity from the constructive activity of the mind; its obstinacy and cruelty, so to speak. The realization, on the part of second-order cybernetics, that the mind helps build the worlds that we inhabit, need not imply a negation of a world independent of our minds (see Laracy and Laracy, 2021).

In times of ontological crisis, people are faced with a challenge that requires an unusual skill: rather than performing well within well-constituted life-worlds, it has to do with navigating the breakdown and emergence of life-worlds. Rather than transforming the world according to my specifications, it has to do with transforming myself and my relationship to others. It is this skill that I would like to explore, both in the person of Crow Chief Plenty-Coups and in general, using the conceptual framework of trivial and non-trivial machines. This will be the topic of the following two sections.

## 3. Plenty Coups

Plenty Coups (that is, "many achievements"; notice that his very identity is inscribed within the paradigm of counting coups), 1848-1932, was chief of the Crows during a pivotal time in their history, when they decided to ally themselves with the whites. Rather than being remembered as a traitor or collaborator, Plenty Coups is largely seen as a great leader, who was able to give some kind of continuity to Crow life in a time of great danger, when their very existence was threatened by tribal warfare, loss of lands to the whites, and the scarcity of buffalo.

In 1921, at the dedication of the tomb of the unknown soldier, Plenty Coups (invited there as a respected leader), surprised the audience by placing his war-bonnet and coup stick in the tomb, thereby ritually burying them. For Lear, this is not an act of surrender, but rather a culturally appropriate way of acknowledging a new situation: "he symbolically expressed the thought that the traditional modes of fitting behavior themselves had to be laid to rest" (Lear, 2006, 60). Instead of simply abandoning Crow symbols, by respectfully burying them in an appropriate context, Plenty Coups was attempting to give continuity to Crow culture and frameworks of meaning: whatever new life the Crow would make for themselves, they would do so in a "Crow" kind of way. Bear in mind

that if such continuity were not achieved, we would not be speaking about a mutation in a system but rather of one system being replaced by another[2].

As an example, the Crow virtue of courage would need to mutate, in order to continue to exist in the world of the $20^{th}$ century, where, e.g., daring raids were no longer possible (see Lear, 2006, 65). Plenty Coups' kind of courage (negotiating with white men, encouraging the Crow to become farmers as opposed to hunters, stressing the value of education for the younger Crow generations) is best understood if we contrast it with a different response to the same basic situation: that of Wraps His Tail.

By 1887 (after the US government had reneged on the first Fort Laramie Treaty, neglecting stipulated payments and dramatically reducing the size of the Crow lands), life on Crow reservation was both materially dire and devoid of traditional sources of meaning: tribal warfare was forbidden by the US government and hunting was impossible, due to mass extinction. In this fraught context, some members of the Blackfeet tribe stole horses from the Crow, and a series of telling events unfolded:

> A group of young Crow, led by Wraps His Tail, set out to get revenge and count coup. On September 30 they returned exultant: they had captured Blackfeet horses and were parading them through the camp (...) There was, apparently, much shouting and shooting of guns into the air. At one point, Wraps His Tail, who was then twenty-five, rode up to the agency interpreter, Tom Stewart, and stuck a gun into his belly. He then pulled it away and fired into the air (...) (Lear, 2006, 27-28).

Reservation agent H. E. Williamson reacted by declaring that the acts of the young Crow amounted to horse stealing. Matters escalated, until, on November 4, the band of young rebels was defeated by the US Cavalry, and Wraps His Tail was shot by a fellow tribe member, Fire Bear, who acted as police for the Crow Agency (Lear, 2006, 28-29). The contrast between the triumphal entry into the reservation and the death of the leader at the hands of a fellow tribesman makes for a poignant contrast: the whole episode was, precisely, absurd. The action undertaken by Wraps His Tail was impossible to undertake in a meaningful way: it was more akin to *cosplay* (a portraying of fictional characters in costume, see Guo, 2022) than to the true-to-life *counting coup*. As we will discuss later, and however cleverly Wraps His Tail and his band acted in order to steal Blackfeet horses, their actions belied a certain triviality, a lack of a certain kind of intelligence. The difference between the ways Wraps His Tail

[2] A reader might notice that this amounts to an implicit definition of "system's identity", which is, therefore, understood in terms of preservation of cultural-behavioral continuity, even if this is, certainly, not a very precise and constructive definition (eds.).

and Plenty Coups acted or proposed to act can be articulated through Heinz von Foerster's concepts of Trivial and Non-Trivial Machines.

## 4. Trivial and non-trivial machines

The formulation of the notion of trivial and non-trivial machines emerged out of the idea of second-order cybernetics, which originated in the late 1960s (Glanville, 2002); but the distinction between different levels of feedback goes back to at least as early as 1950. Wiener (1989, 59) distinguishes between specific responses to feedback and knowing "whether a whole policy of conduct (. . . ) has proved successful or not"; the latter option, according to Wiener, is of a different logical type, which constitutes learning (Wiener, 1989, 61). The idea of higher order responses to feedback is useful for understanding that although human beings can be characterized as adaptive systems, they are of a quite different kind than animals or mere machines (see Laracy et al., 2019, 66).

Heinz von Foerster introduces the distinction between trivial and non-trivial machines in a discussion of memory, learning and behaviorism. Von Foerster distinguishes between two conceptions of learning: 1) "a change of ratios of the occurrence of an organism's actions" (Von Foerster, 2003: 137) in terms of hits and misses, so that proper behavioristic training can increase the former; and 2), "a process of evolving algorithms for solving categories of problems of ever-increasing complexity" (Von Foerster, 2003, 137). Roughly, learning as 1) constitutes an ability to be programmed (meaning that the direct experience from hits and misses gradually influences the later rate of success); and 2) an ability to self-program (meaning that the way of proceeding is redesigned).

The second kind of learning can be accomplished by non-trivial machines (henceforth NTMs), where inputs are turned into outputs by a transforming function, which is dependent upon a machine's internal state which (and this is crucial), can change because of outputs. In a trivial machine, by contrast, "internal states do not change" (Von Foerster, 2003: 139) (see Fig. 1). Therefore "a trivial machine is one which couples deterministically a particular input state or, in the language of reflexologists, a particular stimulus with a specific response" (Von Foerster, 2003, 140). Successful learning, as understood by behaviorists, would be tantamount to becoming a trivial machine.

A good way to think about the distinction between trivial and non-trivial machines is to consider the case of Adolf Eichmann, a prominent Nazi officer, having played an important role in the World War II genocide, particularly of Jews, as portrayed by Hannah Arendt. In her depiction, there was nothing particularly monstrous or demonic about the Nazi war criminal; rather, he was best characterized by his "quite authentic inability to think" (Arendt, 1971, 417). He simply followed orders, in an automatic, unthinking way (Paz, 2010).

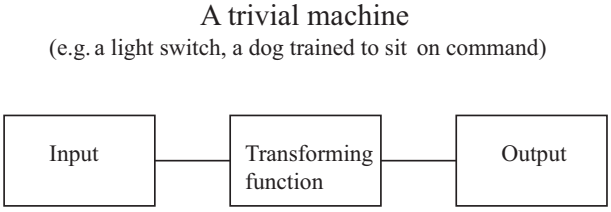


Figure 1. A trivial machine

Let us think of Eichmann as a trivial machine: input (order), invariant transforming function, output (compliance and execution). If this is an accurate account of the nature of Eichmann, then, under different circumstances (e.g., if he had received better orders), he might have been remembered as a respectable civil servant, or even as a hero: trivial machines are fine as long as the system, in which they operate, is working well, but they are a problem if this system requires rehauling (see Bula, 2017). In order to change the system, you need non-trivial machines.

Certainly, some desirable forms of learning correspond to trivialization: we want our dogs, for example, to sit on command. But what characterizes complex learning organisms is, precisely, their non-triviality. Imagine you are playing peek-a-boo with a baby, hiding your face behind your hands, and surprising her by suddenly revealing it; now imagine that you get the same delighted laughter after the twenty-fifth iteration. By this point you would be worried: a normal baby would be bored; this baby's continuing delight is a sign that the history of outputs has not altered her expectations[3]. Learning organisms change their transforming functions according to their *history* of interactions with an environment (Von Foerster, 2003, 141). That means that we can add a second-order transforming function to NTMs, the one that governs how the first order transforming function (henceforth 1TF and 2TF, the latter for the second order transforming function, respectively) changes according to a history of interactions (see Fig. 2).

Both Wraps His Tail and Plenty Coups fit into the general definition of non-trivial machines, but at different levels of observation: in order to cunningly steal horses from the Blackfeet, Wraps His Tail had to learn from past experiences, make adaptations to his tactics, etc. Plenty Coups saw that the Crow way of life needed to change, and undertook steps in this direction. But, if we make a

[3]This example, however, even if to the point, neglects one aspect, mentioned explicitly, anyway, in the narrative: *the delight*. If one is delighted by the situation, why move away from it? It is the misses that mostly teach us (lead to learning), not (so much) the successes (eds.).

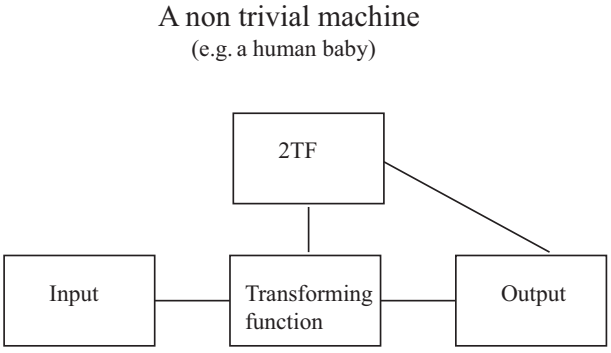


Figure 2. A non-trivial machine

comparison, Wraps His Tail operated as a comparatively a trivial machine: in a changed world, he continues to attempt to count coup, without re-imagining what this might mean in 1887. In order to understand this, we need to add a new layer of complexity to Von Foerster's model.

A given 2TF (which distinguishes non-trivial from trivial machines) guides adaptation *in a particular way*; that is, it operates upon the first order transforming function according to certain rules of operation. Organisms and institutions learn in different ways: adaptation to new situations may take the form of small, tentative, Burkean changes[4]; or of radical changes in behavior. They may amount to changes in a localized domain or across the board, etc. As a humorous example, when George Bush senior was weighing the possibility to go to war with Iraq in 1990, the question of whether the US had "learned the lessons of Vietnam" arose in the public sphere. But the Bush administration did not seem overly concerned with involving the country in a potentially long and disastrous regime-change war in a faraway country that had not attacked the US. In this context, George Bush parodist Dana Carvey of *Saturday Night Live* gave a mock speech impersonating the president:

> (...) And if we do go to war, I can assure you—it will not be another Vietnam. Because we learned well the simple lesson of Vietnam: "Stay out of Vietnam." They'll beat you bad, b-a-a-d. (SNL Transcripts Tonight, 2018).

One way to learn from the undesired output of the Vietnam war is to no longer engage in non-defensive regime-change wars; another is to avoid war with

[4]Edmund Burke (1729-1797), Irish thinker, philosopher, political writer, author of the famous *Reflections on the Revolution in France*, was an opponent of abrupt, "revolutionary" changes, and proponent of gradual, incremental ones, with preservation of existing institutions (eds.).

Vietnam specifically. Of course, one transforming function is more sophisticated and adaptive than the other. Can an NTM learn to pass from one kind of second order transforming function to the other (e.g., rather than learning to avoid this particular romantic partner – e.g. Todd or Jake – avoiding this *kind* of toxic relationship partner)?[5] One would hope so. But then, NMTs capable of doing so not only have a 2TF, but also a 3TF, that changes the way we adapt; that learns to adapt in different ways [6] (see Fig. 4). This 3TF would account for fundamental changes in systems, as opposed to mere homeostatic adaptation.

In order to avoid the clunky moniker "second-order non-trivial machines", we would like to call systems possessed of 3TF *wise machines*. Indeed, there is wisdom, for example, in Plenty Coups' actions, as opposed to those of Wraps His Tail: the former was capable of first-order adaptation, whereas the latter was capable also of second-order adaptation, that is, of adapting his form of adaptation (see Fig. 3); a kind of second order intelligence that goes beyond, say, knowing how and when to create a diversion so that the Blackfeet will not notice that some of their horses are being stolen.

Furthermore, this second-order intelligence requires a specific kind of wisdom in order to be used well: a history of unsatisfactory outputs does not necessarily require a second-order change; it may just be a matter of persistence and elbow grease. As Kuhn (1996) has explained, there is value to scientist's persisting in their adopted paradigm in the face of mounting anomalies, rather than adopting a revolutionary stance. For example, if Adams and Le Verrier had rejected Newtonianism because of the discrepancies between Uranus's predicted and observed orbits, they would have not discovered Neptune (whose presence accounted for the said discrepancies)[7]. There is an Aristotelian golden mean here: on one end, there is stubbornness; on the other there is flakiness[8]. Per-

[5]Going away from "just Vietnam" or "just Todd or Jake" can be done in an infinite number of ways – the space of second-order alternatives is a continuum (another *kind* of relationship partner, or perhaps – of relationship?). One of the alternative options, relative to the particular political example quoted, is: *do not engage in war with a country having a powerful, well-prepared, aggressive and inconsiderate neighbor, displaying obvious direct interest in the country you mean* (in this particular case: North Vietnam) (eds.).

[6]Why not a 4TF to trigger changes in 3TF, and so on *ad infinitum*? As much as I would like to furnish some kind of clever argument for logical closure at some point, a topping-off of self-reference, there is no logical reason why, *in principle*, you could not have an indefinite number of higher-order transforming functions. The reason we do not touch upon 4TFs and 5TFs is that there does not seem to be an empirical correlate to such highly complex machines, or real-world situations where discussions of such higher-order transforming functions is germane.

[7]Urbain Le Verrier was the first, and, independently, John Couch Adams was the second to establish the existence of Neptune as the source of discrepancies in the Uranus orbit, without direct observation (even though Neptune had been, in fact, observed before), just by calculation, in 1845 (eds.).

[8]It is perhaps significant that the rightwing stereotypes of the left, and vice-versa, include these opposites.

haps the virtue may be called *poise*[9]. One must know when to change radically and when to correct specific bugs in a system: therefore, wise machines need a *discriminating function* (DF), to decide whether output failures should activate 2TF or 3TF [10] (see Fig. 4).

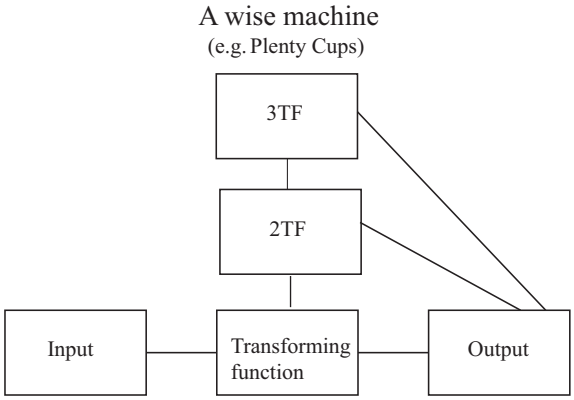


Figure 3. A wise machine

This second-order intelligence, *wisdom*, is not merely an iterative copy of the first; it has specific characteristics (see Clayton, 1983; Armitage, 2022, for the related distinction between wisdom and intelligence). We will explore this in the following section.

## 5. The specificity of second order intelligence

Let us recall our key-breaking drunkard from the introduction, and the possible solutions to his problem. Solution a), at the lowest level, was to change the lock and key system. The intelligence required to successfully execute it is rather straightforward: go online, search for sturdy lock and key systems, find one with a good price and good reviews; if you want to be thorough about it and search all options, you can get the task done in a couple of hours. If, however, you do

[9]This word has already been "taken", in cybernetics, by Stafford Beer (1978), in a beautiful personal communication, and with a somewhat different, if perhaps compatible meaning. In the context of mental health, Beer speaks of poise between *personal control* and *personal intensity* and invites readers to mind a comparator between the two, since a lack of balance may lead to either *aridity* or *showmansip*, depression or mania.

[10]By this point, readers familiar with Stafford Beer's *Viable System Model* (1995), for instance, will have spotted similarities: the 3TF overlaps with some of the functions of System 5, the discriminating function is similar to the VSM's *vertical axis*, etc. We believe that the comparative simplicity of Von Foerster's model helps highlight the specificity of second-order intelligence and is therefore more powerful in this context.

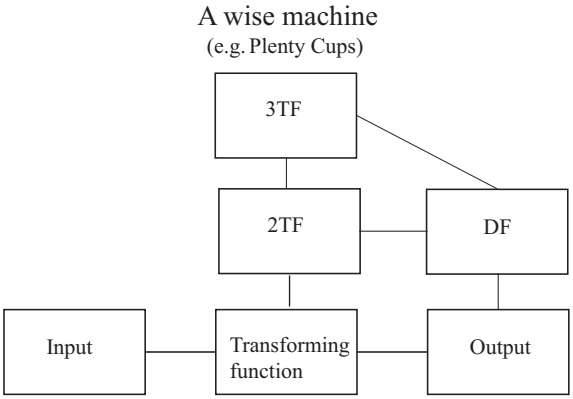


Figure 4. A wise machine, with discriminating function

not have a couple of hours to spare, you could decide on a heuristic (e.g. pick the cheapest lock and key system that still scores above four stars). Finally, evaluating whether your choice was good or not is a simple matter: e.g. a week later, the lock breaks, or you get an ad for the same system you bought but at half the price...

Now, compare it to solution d), that is: finding a more satisfactory way of life: where to start? The problem space is infinite, therefore a thorough search of it is impracticable. More importantly, the choice of a heuristic to explore the problem space is problematic because the choice of heuristic depends on priorities and values and these, in turn, depend on the choice of a way of life. Finally, after changing one's life, there is no clear-cut way of evaluating whether one's choice was good, because the criteria for such an evaluation are included in the choice of life (e.g. cult members will enthusiastically assert that they are better off than before joining). Schumacher's (2015) distinction between *convergent* and *divergent* problems seems useful here: the former are those where, after intelligent consideration, different people come to the same answers, whereas it does not happen with the latter: Sumerian and Aztec astronomy are necessarily similar, but their Gods are not. Higher-order problems are divergent, lack clear methods, present problems related to heuristic selection, and the evaluation of the performance of a given solution is problematic as well. Second-order intelligence can be characterized as *poetic*, in a very specific sense, suggested by Lear:

> (...) in claiming that planting a coup-stick lost intelligibility (...) I do not mean that nothing could ever count as doing such again. What would be required, though, would be a new Crow poet: one who could take up the Crow past and- rather than use it for nostalgia

> or ersatz mimesis- project it into vibrant new ways for the Crow to live and to be (Lear, 2006, 51).

Second-order intelligence produces meaning because, in second-order problems, the problem-solver is one of the elements of the problem. *Meaning* is not a semantic question, to be understood in terms of mere references (e.g. "the wine stands for the blood of Christ"), but rather in terms of *worlds*, where roles, actions, tools, symbols, and language hang together coherently (see Spinosa, Flores and Dreyfus, 1999): by transforming myself in such and such a way, the world transforms along with me: e.g. a coup-stick is no longer an indispensable tool in tribal warfare, but a symbolic link with the past to be ritually buried. These higher-order decisions are simply unavailable to simpler systems, whose adaptation and apparent purpose can be seen as a mere residual pattern, as the result of the evolutionary pruning of less successful alternatives (see Wiener, 1989, 37-38). Ontological decisions (that is, decisions that are poetic in the sense of world-constituting), produce a way of life in which lower-order decisions are taken and make sense (see Heidegger, 1997; Martínez-Castro, 2024). This capacity is specifically human; and, according to Heidegger (1977) the very essence of humankind.

Second-order intelligence, therefore, makes use of imagination: new forms of life must be conceived and tested imaginatively, before or in tandem with undertaking actions to instantiate them. In this context, imagination is exactly the opposite of reality-evasion: "At a time of cultural devastation, the reality a courageous person has to face up to is that one has to face up to reality in new ways" (Lear, 2006, 118-119) (Perhaps our own time (in which capitalism appears as no longer viable, but no alternatives seem to be imaginable, see Fisher, 2009), is also a time in which unimaginative "capitalist realism" is a form of evasion, and the exercise of political imagination is a brave and clear-eyed act.) In contrast, "(...) the rebellion of Wraps His Tail isn't just futile, it's nostalgic evasion" (Lear, 2006, 97).

Second order intelligence, then, has something of the artistic to it; this does not mean arbitrary fancy, but rather a willingness to try out new ways of being, and evaluate them reasonably. This artistic element is ever present in our daily experience; our current way of life is, among other things, the product of artistic decisions and artistic creation (Nordquest and Frezza, 2017, 62); but it comes to the fore in what may be termed "apocalyptic times", where political imagination is both in urgent demand and depressed by a sense of doom (see Castro, 2022).

To summarize, second-order intelligence can be modelled as a wise machine, provided with a 3TF and a discriminating function. The selection function works well when it suitably triggers a system-change, avoiding both flakiness and stubbornness. The 3TF works well when it can produce new ways of life that are adapted to new circumstances, preserve the identity of the system in

some way, and produce new ways of life that are rich, desirable and robust: these are all necessarily vague terms, because their detailed definition is dependent upon the choice of life itself.

Whereas precision is valuable for first order intelligence, the creative exploration of an infinite problem space can make good use of *vagueness*. Things such as narratives, symbols or dreams are useful in charting new ways to live: people make use of such aids as the *I-Ching*, cartomancy or other religious and shamanistic practices. This does not mean that such kind of thinking is outside the purview of rational analysis, and included within a systematic unity of human knowledge (see Laracy et al., 2019, 67). Following Lonergan (1992), we should approach cognitive phenomena empirically, in order to understand their immanent dynamics and the way they fit into the larger scheme of human cognition. As a first step in this direction, we will explore how things such as dreams can be useful for solving second-order problems in the next section, where we discuss a particular vision quest of Plenty Coups.

## 6. Dreams

At age 9 (in accordance with a curious division of labor among the Crow, where such dreams are sought by the young, and interpreted by the elderly) Plenty Coups went out into the wilderness in pursuit of a "medicine-dream", intended to guide the Crow tribe in decisions about their future. When the dream finally came, Plenty Coups, guided by a buffalo-person, saw many buffalo coming out of a hole, which then vanished and were entirely replaced by a strange kind of spotted buffalo. Then, a voice told Plenty Coups to look to the chickadee: of the many birds in the forest, only the chickadee remain after the storm, because they are willing to seek wisdom, to listen and learn from others when these speak about their successes and failures (Lear, 2006, 66-71).

A couple of things must be borne in mind: 1) what we have access to is a re-telling of the dream by Plenty Coups as an old man, once the dream had been discussed and interpreted by the tribe; 2) whereas a fairly straightforward interpretation of the dream seems available to us (the spotted-buffalo are cows; the buffalo disappear and a new world - the storm - wipes out most of the birds- the Indian tribes- but the chickadee - the Crow who have adopted the values of adaptability ascribed to the chickadee- remain after the storm); such an interpretation was not available to the crow in the 1850's. What to us are easily translatable symbols were, for the Crow at the time, vague oneiric hints (see Lear, 2006, 79).

Although chickadees were thought by the Crow to be wise and powerful animals, the call to be like the chickadee had no concrete meaning; the dream, as interpreted, called on them to pursue "life under the auspices and example

of the chickadee - *whatever that might come to mean*" (Lear, 2006, 113). A sceptic might say that the call to be like the chickadee was vague to the point of meaninglessness. However, in navigating an undefined problem space (the storm), it is useful to have a symbol function as a placeholder: not quite as an algebraic $X$ for which a definite value can be surmised, but rather as a receptacle of meaning: as a symbol that both has a certain pedigree in Crow tradition, and can receive new meaning as the Crow improvise a new way of life as changing times demand:

> (...) the dream-advice to become a chickadee is being given in full recognition that upcoming events will be extraordinary (...) nothing is said about what constitutes the wisdom of others, what their successes are, or how one should learn from them. In particular, there is no first-order advice that one should simply pick up the skills and values of the white man. Indeed, there is no first-order advice at all (...)" (Lear, 2006, 81).

Would first-order advise be more desirable (e.g. practical advice on becoming farmers, to adapt to reservation life)? The problem faced by the Crow was not of this practical nature; they were being called-upon to reimagine themselves. Would useful first-order advice to *this* end even be intelligible to the Crow of the 1850's? The problem faced by the Crow was not a convergent problem of finding adequate means to well-defined ends, but rather of weathering a material *and* ontological storm: in these situations, intelligibility is partial and emergent. The intelligence needed to navigate such a state of affairs is situated, improvisational, and at ease with incomplete data. It is not the intelligence of the engineer, but rather that of the shaman who interprets symbols seen in a dream or vision quest.

The difficulties inherent in defining second-order intelligence produce a temptation towards reductionism: perhaps there is no such thing as second-order intelligence, only ordinary intelligence operating in an unwieldly problem space with a large number of variables. I have already furnished some arguments against this: in second-order intelligence (as opposed to first-order intelligence) imagination is an inherent component, the problem solver is part of the problem, and the criteria for evaluation of performance are inherently unstable. Two further arguments can be furnished: 1) a particular kind of failure ensues from a lopsided development of first-order intelligence as opposed to second-order intelligence; and 2) the failures of second-order intelligence have distinct characteristics that distinguish them from the failures of first-order intelligence.

## 7. Failures

What is preferable, a lunatic with a gun or a lunatic with a stick? If our civilization's guiding principles are flawed and ultimately lead to suffering, is it preferable that we go where we (mistakenly) want to go quickly and efficiently? If there are second-order flaws in a system's operation, first-order intelligence can be undesirable: Adolf Eichmann's probity and efficiency were not positive goods. If problems arise from a wrong proportion between first and second-order intelligence, then these are different sorts of things.

Indeed, second-order intelligence failures look different from those of first-order intelligence. Some examples of the latter: the 1999 destruction of the Mars Climate Orbiter due to a mistaken use of the imperial system of measures, when they should have used the metric system; cooking too much or too little food for the number of guests you have for a dinner; the poor placement of the fuel tank in the Ford Pinto, which caused it to catch fire when rear-ended; invading Russia in winter time. Implicit in these failures is a behavior which mistakenly expects the environment to behave in a certain way, a failure of control.

Now let us look to what I posit to be a failure of second-order intelligence: the Ghost Dance Religious Movement of 1890, embraced by the Sioux, among other First Nation Tribes. It emerged among hopes of an Indian Messiah; a scarred and resurrected savior who had been killed by the whites and who would restore the Indians to their previous way of life, and the buffalo to the prairies (Lear, 2006, 149).

From an emotional point of view, this mysterious messiah promised precisely what American Indians desirous of their old lives and resentful of the whites would most long for. The change brought on by the messiah would mean that no profound change in the part of the First Nations would be necessary: they could keep their old 1TF intact, and make no use of 2TF; they could simply continue to strive to be better hunters and warriors, instead of adapting to a new world. What would it take? The relentless performance of the "Ghost Dance", which believers performed until they dropped from exhaustion, to the abandonment of all other activities (Lear, 2006, 149).

There is perhaps a romantic attraction to this tilting-at-windmills; but it certainly was not effective: the movement was violently suppressed by US authorities. Was it authentic? Not only was it an evasion from reality (Lear, 2006, 151), it cannot even be said to be a return to pre-conquest Indian traditions: whereas each tribe had its own particular religion, the ghost dance was pan-Indian; as well as messianic and apocalyptic (Lear, 2006, 151): in sum, suspiciously Christian[11]. We will explore the issue of authenticity further on.

[11] The movement had distinct tribal "liturgical" varieties and actually originated from a tradition, having existed long before among Païute Indians, and evolving through various

The Ghost Dance Movement was a response to the massive change brought on by European settlers on formerly Native American lands. It called its members to full and intense sacrifice, but it did not call on its members to change in any fundamental way: indeed, its lure was the promise that they would not have to do so. It was a "solution" to the problem posed by the radically changed world First Nations faced at the turn of the nineteenth century that did not involve 2TF, and can therefore be seen as either an absence of 2TF or a failure of the selection function. In this sense, it is perhaps comparable to some contemporary efforts to solve the problems of social instability, inequality, and especially environmental degradation caused by capitalism, by deepening and strengthening capitalist activities (see Klein, 2014; Bula, 2010).[12] Whereas failures of first-order intelligence fail to control a system's environment (and end up in events such as explosions or military defeats), failures of second-order intelligence are characterized by inflexibility and, therefore, by a kind of wishful-thinking that hangs on to obsolete ways of operating. They end up in absurdity, in the undertaking of actions that are irrelevant to the situation at hand. On the other hand, Plenty Coups found common cause with the white men that destroyed the Crow way of life; and perhaps paths such as the Ghost Dance or the rebellion of Wraps his Tail were the only authentic paths available. A discussion of the idea of authenticity seems pertinent.

## 8. Authenticity

In order to examine the issue of authenticity, a detailed example seems pertinent. Let us imagine a young man named Glenn. Punk rock probably saved Glenn's life: as a rudderless teen, he "found his tribe" among garage-concert goers who valued pluck and despised bullshit. In his teens, he played the bass for a couple of bands, and dealt in bootleg cassette tapes. Four of his six tattoos are band logos. Today, at 25, Glenn sells insurance for a mid-sized corporation, and is saving for him and his wife to get a small apartment of their own. He still listens to the Misfits and the Dead Kennedys on his headphones, when he is not talking to customers. An old photo posted on social media, in which a young Glenn sported a multi-colored mohawk, triggers a question: "have I remained authentic"?

For the purposes of this discussion, let us posit that "true to myself" is an adequate paraphrase of "authentic". 25 years old Glenn is different from 16 years old Glenn, of course, and pure identity seems too high a bar to clear for

stages over the second half of the $19^{th}$ century (eds.).

[12] Just by the way: the damage done to the environment was far more intensive under the so-called real socialism, suffice to recall two exemplary facts: the quite frequent river fires in the Soviet Union, and the leading (by far) position of the German Democratic Republic in the world in terms of energy used per unit of domestic product (eds.).

authenticity: if 25 years old Glenn were to live with his parents, receive meals and allowance from them, go to garage concerts all weekend, etc., he would hardly seem to be displaying authenticity as a virtue. The fact is that in a changing environment, it is impossible to remain the same. But it is possible to remain true to one's particular way of coping with changes in the environment: whereas 1TF must change (because merely trivial machines are not adaptive), one may remain true to one's own 2TF or 3TF. As a young punk rocker, Glenn learned to be forthright, to meet challenges head on, to seek independence, and to stand by his convictions: this is what has motivated him in the corporate world, and helped him to be a respected worker, and also what moved him to overcome his shyness and ask Courtney to marry him.

Authenticity cannot mean the preservation of once-successful practices in a world where keeping them is maladaptive: authenticity, then, has to do with preserving the values from which such practices emerged. As an example, US culture need not hold on to transport systems designed around personal vehicles to remain authentic; rather, now that such vehicles have proven to be environmentally unsustainable, it should find new solutions motivated by the spirit of innovation and independence that produced cars in the first place. Indeed, "[a]ny culture that jettisons the values that have given it competence, adaptability, and identity become weak and hollow. A culture can avoid that hazard only by tenaciously retaining the underlying values responsible for the culture's nature and success" (Jacobs, 2004, 176).

Was the Crow's decision to collaborate with the white man authentic? Was the Ghost Dance movement authentic? We have argued that the preservation of practices (in this case, religious dances) cannot be tantamount to authenticity. In times of change so profound that they upended the ontology of First Nation Worlds, authenticity would demand the preservation of something of a higher-order: the values, the motivating virtues of particular First Nations. I will not judge whether the Crow or the Sioux participants in the Ghost-Dance movement were authentic, but perhaps I have provided a useful framework for thinking about this question.

## 9. Practical payoff for system management

Discussions about adaptation are often fraught; take, as an example, the question of the virtuous medium between the opposing vices of stubbornness and flakiness, which I have dubbed *poise*: when is it time to change the strategy for adaptation? This issue is complicated by the fact that some participants may have a material (Kubińska, Adamczyk-Kowalczuk, Andrzejewski and Rozakis, 2022), ideological (Mulligan, 2013, 138), or even psychological (Mueller and Yin, 2021) stake against deep changes to the system. It is always possible to

argue, on the one hand, that existing strategies, no matter how long a history of failures, are being poorly applied, or not thoroughly enough; and on the other, that any small failure of adaptation can be seen as a sign that a complete overhaul is necessary. In general, when the identity of a system is being discussed, conversations become more complex, because they have to do not only with the system's relationship to the outside, but also with the history of structural couplings among the participants in the system, and can lead to emotional upheaval (Espejo, 2022, 64-65). This is exactly where the distinctions presented here are useful: not in solving arguments (which have to do with the particularities of a given system), but in clarifying the level of discussion.

In the context of discussing adaptation, it is useful to clarify whether the topic at hand is:

a) whether existing adaptation strategies are being applied correctly (the *locus* of this discussion would be 2TF in Fig. 4),

b) the criteria for changing the level of adaptation (DF in Fig. 4), or

c) whether new forms of adaptation are being discussed (3TF in Fig. 4).

Additionally, the types of sensible arguments differ at each level of discussion: arguments in the context of a) are of a technical sort, and have to do with sorting out bugs in a given adaptation strategy; arguments in the context of b) are epistemological, and have to do with determining a heuristic for when a strategy has ceased to work; and arguments at c) have to do with both strategies of adaptation (see Espejo, 2020) and normative horizons, and center around the kind of system a given system wants to be in response to profound changes in the environment (it is at this level that philosophical considerations, and even symbols and dreams, can be reasonably deployed).

Finally, the variables and constants, the "moving parts", differ at each level of discussion: at a), the environment in which the system operates is assumed to hold steady, and only changes to the operation of the system are contemplated; at b) the possibility that the world has changed and therefore adaption strategies must also change is contemplated; and then, at c) the possibility of changes to the normative horizons or even identity of the system are contemplated. In summary, the practical payoff of this contribution is that, through the distinctions it introduces, it can help clarify the depth at which reform to a system is being discussed, thus preventing participants from talking at cross-purposes and clarifying the sorts of arguments that are sensible at a given level of discussion,

## 10. Conclusion

In this text, I have expounded upon von Foerster's concept of non-trivial machines in order to distinguish between ordinary non-trivial machines and what I

have called *wise machines* which are able to i) transform the way in which they adapt and ii) discriminate when such a second-order adaptation is preferable to making specific adjustments. This entails a further distinction between first and second-order intelligence which, I have argued, has specific features, such as ways of succeeding and failing. Distinguishing between different kinds of cognitive tasks is useful both in understanding the nature of cognition and the ways in which different cognitive tasks can be better approached. In particular, given the multiple crises, faced by humanity (such as extreme inequality, global climate change, pandemics, etc.) it is important to understand what kind of understanding is required to adapt to vastly changing circumstances.

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## Editorial complement to the paper by German Bula

In view of the somewhat unusual character of the paper, not having any of the engineering, technical nor mathematical character, proper for the Journal, the Editors deemed it worthwhile to complement it with two short texts, one concerning the personality of Heinz von Foerster and the other one, presenting a view on the relation of the considerations, contained in the paper, to the subjects, more usually treated in the Journal.

## Heinz von Foerster[13]

Heinz von Foerster (1911, Vienna – 2002, California) was a leading information theorist of the twentieth century, who combined his knowledge of philosophy and physics to develop the study of cybernetics and artificial intelligence.

Von Foerster was born in Vienna in 1911 and grew up in the company of the leading intellectuals, performers, and artists of city's fin de siècle. Von Foerster recalled that when his parents and maternal grandmother, a prominent feminist, hosted them, he would sit under the piano and listen to their free-flowing debates—an approach that contributed to von Foerster's own distaste for disciplinary borders.

As a teenager, he was a poor student of Classical languages, and struggled to keep up with the Gymnasium curriculum. He excelled, however, in mathematics and physics and entered Vienna's Institute of Technology to study technical

[13]Largely after Heinz von Foerster – on the ETHW website, with some additions.

physics. Here, he soaked up the ideas of the Vienna Circle, a group of philosophers gathered at the University of Vienna who applied the logical positivism of Ludwig Wittgenstein. Von Foerster's devotion to Wittgenstein led him to memorize much of the philosopher's "*Tractatus Logico-Philosophicus*." He was also strongly influenced by philosopher Rudolf Carnap and mathematician Hans Hahn. He attributed his early understanding of second-order reasoning to the Vienna Circle. As he later told an interviewer, it opened up new ways of thinking for him: "how do we do it, how do we do things, how do we think about it, how can we describe our descriptions, how can we think about our thinking?"

During World War II, he hid his partial Jewish ancestry and was able to work in Berlin's radar laboratories. Meanwhile, he received a doctorate in 1944 from the University of Breslau. When the war was over, he returned to Vienna and found that the ruined city offered few opportunities for supporting his wife and three children. He was able to secure two jobs: rebuilding telephone relays and switching stations for an affiliate of the Swedish telephone company Ericsson and creating broadcasts for Red White Red, a radio station established by the American occupation forces.

Von Foerster and his family left Soviet-occupied Vienna in 1949 and immigrated to the United States. He brought a calling card with him to secure a place in American academic life: a manuscript entitled "*The Memory – a Quantum Mechanical Treatise*". In this short book, von Foerster proposed a molecular basis for memory, connecting the exponential rate of decay of biological molecules with a similar curve charting the speed at which people forgot a set of syllables. This research attracted attention among scientists at the University of Illinois who were developing a parallel theory of memory and feedback. Von Foerster was brought to speak in Chicago on memory and then was invited to the Josiah Macy Jr. Foundation's conferences in New York.

The Macy Conferences of the 1940s and 1950s brought together influential scientists and thinkers, including Norbert Wiener, Gregory Bateson, Margaret Mead, and Warren McCulloch, to discuss a variety of scientific concerns, from medical technology to computer programming. Von Foerster joined this interdisciplinary circle with gusto, volunteering to edit its proceedings and document what amounted to a blueprint for future research in many of these fields. Of the Macy Conferences, von Foerster wrote, "I met those people who laid the conceptual foundation for comprehending the behavior of the 'really' complex systems, the teleological systems, and the self-organizing systems". In particular, von Foerster was drawn to the conference on Circular Causality and Feedback Mechanisms in Biological and Social Systems, or Cybernetics, in which he identified a continuation of the logical positivism of his Vienna youth.

In the 1950s, Von Foerster headed the Electron Tube Laboratory at the University of Illinois' electrical engineering department. He researched high-speed

electronics and electro-optic switching devices, but transitioned the laboratory away from tubes and toward solid-state devices.

Between 1958 and 1975, he founded and supervised the university's Biological Computer Laboratory (BCL), which became a center for innovation in biophysics and the study of memory and knowledge. Among von Foerster's projects was parallel computing, which aimed to process data faster by breaking down tasks into multiple parts. His laboratory built the first parallel computer, the Numa-Rete. It was a square of four hundred photocells—a virtual retina—that could count multiple objects in its field of vision.

In 1960, W. Ross Ashby accepted an appointment as a Professor of Electrical Engineering and Biophysics at the University of Illinois at Urbana-Champaign (1960-1970) and also helped steer the direction of the BCL. Over the next two decades, the BCL "became a major centre of innovation for cybernetics and cognitive science" and the study of second-order cybernetics. Like the Macy Conferences, it fostered a transdisciplinary research space that drew a variety of scholars, including frequent visitors Margaret Mead, Francisco Varela, and Humberto Maturana. In addition, the BCL organized conferences, produced publications, and encouraged discussion around the ideas of McCulloch and Walter Pitts, the emerging concept of "bionics," linguistics, speech, and cognitive science, and Maturana's notion of autopoiesis.

As a polymath, Von Foerster pursued a variety of projects outside his specialty in biophysics. He sparked a lively debate in the 1960s after co-authoring a paper that proposed a population "doomsday" extrapolated from contemporary demographic data. His lifelong concern with epistemology led him to propose a set of theories that became known as constructivism.

He was a Guggenheim fellow and a fellow of the American Association for the Advancement of Science.

## Some notions from automatic control

The notions, which appear in the paper are very much in line with the categorization of essential problems, which are being solved in automatic control with the use of apparatus of control theory and optimum control.

If we stick to the notion of "trivial machine", then – putting aside simple devices, in which a finite set of reactions is deterministically and unambiguously assigned to the corresponding set of stimuli – we may speak of a standard control system, in which deviations from the established setpoint are compensated for by appropriate controls. This may also concern the realization of a certain trajectory or achievement of a terminal state, with, again, controls serving to ensure effective maintenance of the prescribed behavior.

The short characterization above remains valid even if the rules and the mathematical structure, serving to fulfil the task become really complex (e.g. in view of the mathematical complexity of the system model, which plays an important role in designing the control laws). Moreover, this description also applies, as indicated, to the situation, in which it is not just a single state that one wishes to maintain, but some kind of behavior ("trajectory"), or the fact of reaching some desired state, despite the disturbances.

In these terms, then, when one passes over to a non-trivial machine? One might propose the so-called "adaptive control systems", in which definite change is possible under the influence of shifting conditions of work. This way of functioning can certainly be called second-level machine, but is it really non-trivial? There exists a theory, and indeed, practice of multi-level control systems, where the passage from one level to another usually involves a change in the principle of control or the way optimization is performed (for instance: i. a simple PID controller; ii. optimization of parameters [mathematical programming]; iii. game theory; iv. agent-based search, etc.). At each consecutive level a broader set of possible instruments and ways of behaving is considered. Likewise, the objectives may also change, although their internal consistence has to be preserved (the objectives at successive levels cannot be truly contradictory).

Given such a kind of system, its behavior cannot be predicted, even if we know the principles of its functioning. This occurs, for instance, when we use the currently popular biologically-based (say, swarm-like) heuristics in optimization. On the other hand, one is reminded of the simple manner of generating chaotic behavior by applying quite straightforward mathematical constructs.

So, it is possible to propose that addition of successive levels of control, especially when based on different principles, and accounting for different objectives, constitutes the passage to another level away from triviality. If such a proposition is opposed, more concrete thresholds must be indicated for accepting such a passage. This issue appears to apply very much nowadays to artificial intelligence, its construction, applications and capacities.