Inefficient Feedbacks and Society

by **Eugene Durenard** *

Introduction

Cybernetic concepts crystallized 60 years ago thanks to the confluence of ideas coming from the theory of computation by Church, Turing and Von Neumann and by practical problems of control theory, electrical engineering and biology mostly led by Wiener and Rosenblueth. It was of course the highly creative atmosphere at MIT during World War II that provided the ideal environment for such a confluence. And it was Norbert Wiener, the leader of the MIT team, who coined the term Cybernetics (from *kybernetos* – the steersman) in his seminal book of 1948 and popularized it in a subsequent work "The Human Use of Human Beings" in 1950.

Since then Cybernetics has had an explosive growth under various guises. Of course its original thread is remaining in almost every engineering application thanks to the prevalence of fast digital signal processing. But the new dimensions that Wiener foresaw and encouraged are still very much work in progress worldwide – to name a few – intelligent artificial decision systems (self-adaptation), interplays between evolution and learning, efficient pattern-recognition techniques.

The exponential growth in computing power since WWII has also helped the development of the Theory of Complex Systems which was foreseen by Poincare in the early 1900. This theory, in part, tries to quantify and classify the emergence and disappearance of large-scale structures and long-range correlated behavior in systems composed of a multitude of simpler agents and subject to localized interaction between each other. The study of Societies of Organisms fits into this framework to the extent that the organisms are simple enough to model. For example excellent progress and practical applications to computing have been made by the study of ant colonies and their foraging behavior for food.

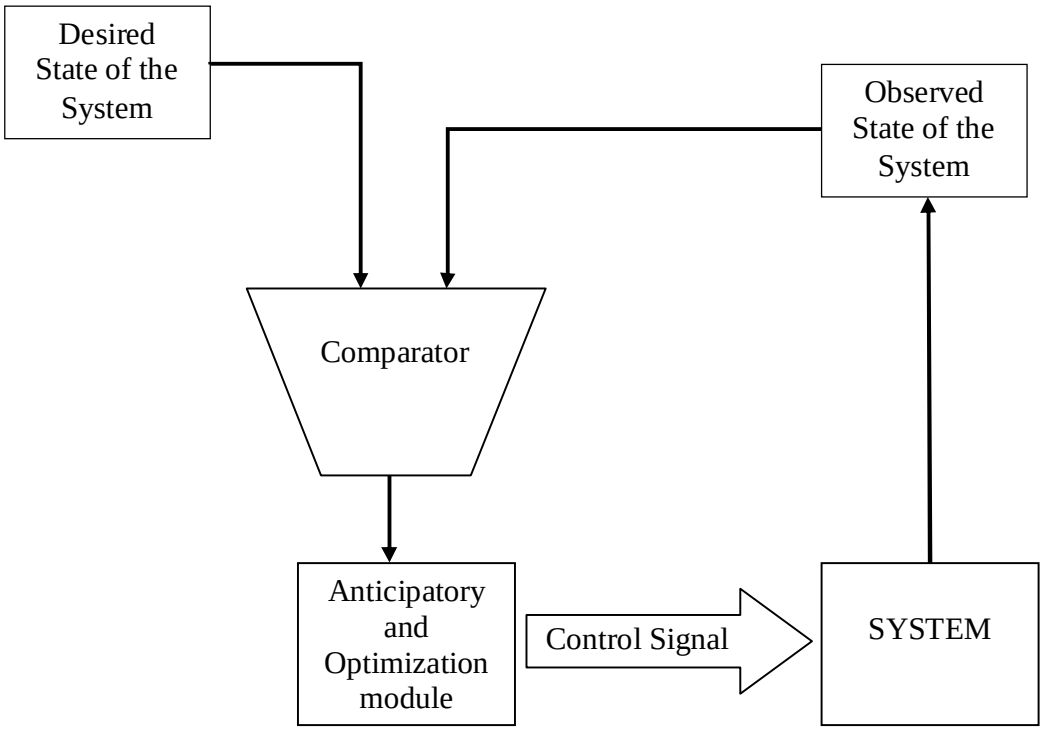
We are here today to discuss the applicability of Cybernetic principles to Human Societies. My goal is to point to the inherent complexity and possibly inefficiency

* Eugene Durenard has been working at various financial institutions and hedge funds as a proprietary trader in Foreign Exchange and Fixed Income products. A mathematician by training he is interested in applications of mathematics and computer science to problems of biology, cognition and robotics. Contact details: eugene.durenard@btginvest.com

of such an approach. Interestingly this has been foreseen and widely written by Wiener in both books. Even with a-posteriori knowledge of the progress that the Complex Systems theory and Artificial Intelligence had made since Wiener's death in 1964 we are still a very long shot from formalizing efficient cybernetic principles for such complex societies as ours.

General Principles of Cybernetics: Feedback and Control

The following diagram illustrates the flow of information for a controlled system.



Cybernetics formalizes the above feedback diagram into a finite algorithm: it is essentially a set of concrete rules on what to observe, what to compare to, what to anticipate and how to transmit the control signal to the system.

What type of Systems would Cybernetics apply the best to?

- Systems where a State can be defined efficiently and parsimoniously (2-way mapping (reality ←→ state) – a modeling relation need to exist in the sense of Rosen)

- Systems where Anticipation is possible (models of localized behavior of simple agents)
- Systems where Efficient Action is possible (low dimensionality and bounded complexity, efficient format of the control signal)

Basically if the (Control—System) pair cannot realize the above feedback diagram in a finite description (algorithmically and in time) then it is hard to distinguish a 'cybernetic' approach to its control from a set of random [Action→Reaction] pairs.

Why is it difficult to apply Cybernetic Principles to Human Society?

1: The Problem may be ill-posed due to Complexity.

A Society is formed of Organisms which are themselves highly complex systems and it is not obvious that cybernetic principles apply to them in any efficient way (see work by Robert Rosen "What Is Life?").

In a Human Society the concept of organism is also non-trivial – it may be an individual or a set of individuals subject to some attributes of similarity (e.g. gender, race, political affiliation or religious etc…).

Either in an Organism or a Society, the concept of state is usually hard to define, hard to observe and hard to measure. For example it is already hard to decompose a biological organism into functional parts as they do not correspond either to organs or to cells. It is also hard to decompose a Human Society into obvious components in order to simplify the problem of defining the concept of state.

Thus in most situations every organism of a society has a different subjective notion of state of the society based on his local observations and on centralized broadcasts (media or government) of which the informational value is not always obvious.

If states are hard to define the concept of distance between states is even harder, and this difficulty is passed on to the question of how to design efficiently a Comparator Module.

Societies like other highly complex systems have numerous feedbacks that are not understood either theoretically or practically. Therefore even if one tries to exercise control by hoping to reduce the distance between the observed and desired state the response of the system may be totally unpredictable and counter-intuitive. The Anticipatory and Optimization Module on a society level

needs to be of a much higher complexity order than the same module of an individual organism because one deals with a system of agents that interact and form their own anticipations as a function of their own goals and of the behavior of the society as a whole. Let us also mention that despite a good progress of Artificial Intelligence and Psychology the said decision-making module in most individual animals is not yet understood.

As an example, when Alain Devaquet the Minister of Education in France in 1986 tried to introduce measures to enhance the quality of the future for French university students by introducing one extra exam, the result was nationwide-wide riots and car burnings, lowered educational standards, followed by the lowering of the subsequent prospects for jobs for university graduates.

2: Feedback Inefficiencies due to Dissipation

To continue our investigation of inherent difficulties of applying Cybernetic principles to human societies let us assume that the practical problems of defining the desired state, the observed state, the distance in between them are known,-- and then the way to generate an appropriate control signal is also known. Basically we assume that the Cybernetic approach can be a well-posed problem in the context of a human society and now we are trying to run our algorithm.

There are still a few inherent problems with the control mechanism – i.e. the feedback arrow that goes from the Anticipatory and Optimization Module back to the Society.

That feedback arrow, i.e. our 'Control Signal' in the above diagram, is transmitted either by information or by law (change of society rules). The law is considered in its most abstract sense and may or may not be excluding part of the society in its operation, but nevertheless it is still represented by information to the individuals concerned and the rest of the society.

The question is whether there are some inherent difficulties in transmitting this information efficiently, i.e. without loss of content and in concise time. In general there are several inefficiencies operating at various timescales:

<u>Evolutionary</u>: the transmission of information from one generation to the next is very inefficient and slow. Without going into the Lamarkian-Darwinian debate one has to point out that this evolutionary inefficiency creates a large dissipation of energy in the society. People are not fast learners nor are they fast un-learners. In this context the speed of information transmission and its understanding may not be as fast as one needs for efficient feedbacks. (One needs probably a critical

mass of evolutionary time for this to improve or radically novel technologies allowing information downloads into brains). An example of this is a population explosion in certain parts of the Third World resulting from the drastic lowering of child mortality thanks to medicine but not being matched by increased usage of contraceptives.

Societal: societies can be locked into 'groupthink' and one needs to have the control signal be in tune with it to be efficient otherwise the response may not be adequate. Another element is that some societies cannot be considered as one as they are artificial concoctions of groups that have very different goals and aspirations. Some countries are amalgamations of tribes that cannot be efficiently governed as one unit

Individual: very often individuals prefer not to spend energy thinking for themselves or stand out from the crowd. If a society gives them a minimum amount of well-being individuals do not have incentive to take risk to change the situation even though a change may induce a better level of well-being. Examples of the combined effect of those two points is 'political lazyness' and low voter turnout even when confronted with important political decisions as well as 'political correctness' -- an inability to question minority-imposed dogmas that impose undue constraints on the majority.

Societies where Cybernetic Principles apply Perfectly

Some societies are much more amenable to an efficient application of the cybernetic principles for their control than others. As we discussed above the principal difficulty to apply the principles lies in the complexity of the system that is induced by the complexity of the organisms that compose it and interact within it. If one can reduce enough the complexity of either the individuals or their interactions then one can hope for a much more controllable system.

A series of societies have drastic similarities between them: efficient control is achieved by a rigid hierarchical structure of the society where rewards/punishment are determined by the angle between the structure vector and an individual's 'direction'. It is basically a one-dimensional structure where one has to be 'in line'. Militaristic societies, religious societies, communist societies and absolutist regimes all share the same features in this respect.

In each of those societies the individual's dimensionality is forcibly reduced either by dogma (cutting access to information), by fear, guilt or by combination thereof. It has also been observed at numerous occasions that the amount of time it takes to unwind such a society is a small fraction of the time it takes to build it

– a clear indication of non-linear phase transitions similar to ones observed in physical processes.

On the other side of the spectrum we find a completely different type of society prone to a good behavior vis-à-vis cybernetic control. Those are small homogeneous societies where there is a critical mass of coherence in views about themselves and the outside world. Almost like a club or a large family, a society of this type handles feedbacks efficiently because the control signal is not only well tuned to expectations but may already be anticipated positively by the system. The degree of self-organization induced by the coherence of views makes the system quite stable. Concrete, but not perfect, examples include the Swiss direct democracy, the now defunct Hanseatic League and other guild-like communities as well as certain city-states throughout the ages. (Such societies are rare and Plato already noticed that it is unlikely that direct democracies can exist with more than 4,000 people in them). A model of such a society, 'The Sovereign Society' has been proposed, and argued for, by Lord Rees-Mogg in his book "The Sovereign Individual". The idea is to transcend the inefficiencies created by bloated un-governable countries to create smaller merit-based societal structures where the common good of tax revenues is redistributed in a fair way.

References

Norbert Wiener. *Cybernetics*. MIT Press 1946, 1965
Norbert Wiener. *The Human Use of Human Beings*. Da Capo Press 1950, 1988
Robert Rosen. *What Is Life?* Columbia University Press, 1998
William Rees-Mogg, James Dale Davidson. *The Sovereign Individual*, TouchStone Books, 1999