INVITED PAPER

Cybernetics, the conscience of science

Studies of interactions between physical and sociopolitical feedbacks and the theory behind them

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Abstract *Cybernetics is considered in its fundamental aspect of a unique master science embracing the concepts of the causation and precipitation of consequences, and hence entraining values and history. In this context a deeper approach to feedback and socio-political realities becomes possible and is developed, in which practical problems are squarely addressed.*

To the first line of the title one may add: "and the science of consequences", thus adjoining a new dimension of meaning as we will see.

1. A word to the reader

Centuries ago, old Lao-tse said, "Those who talk too much do not know" – so we will keep what we say here as clear and brief as possible, not ruling out, however, the possibility of another session later. In harmony with this programme, technical expressions are minimized and underlying ideas and concepts maximized. Such an approach is also of substantially more helpful communicational benefit to interdisciplinary readers, especially for those who hold responsible managerial and executive positions requiring urgent solution of an increasingly emergent type of cybernetic problem whose parameters now arise for discussion. In the course of what follows we shall as occasion demands also draw upon our own prior findings to illustrate points that may arise.

2. The cybernetic idea

Kybernos, expressing the root image of a steersman-at-the-helm, is also the root of our word to *govern*. The shift between *k*/*g* and *b*/*v* ("gubernatorial" vs "governing") is etymologically common, even predictable from their kindred configurations of mouth, teeth and tongue in speaking. The inanimate "governor" in the engineering sense of a device for the control of motor speed was scientifically explained in *de facto* cybernetic terms by no less than James

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Clerk Maxwell of electromagnetic fame[1]. Of course, governors have progressed from the initial genius of James Watts' first flyball types in the 18th century to our more modern isochronous devices which hold the governor speed invariant with respect to variations in engine load, while also maintaining in, say, a motor/generator pair a constant period. The engine governor was one of the first examples of the key cybernetic process of negative feedback, as was the toilet cut-off float valve for water intake.

Even more anciently, man had used positive feedback. The harpoon – derived originally from nature (e.g. the finely barbed quills of the porcupine) – entailed the notion that the very process of penetration would increase the difficulty of withdrawal: an implement whose predictable nastiness is almost a necessary adjunct to an ecology dominated by predation, like those coils of sharp-pointed ivory bands in frozen fat that were left by Inuit hunters for polar bears to eat and … when the fat melts and the coiled knife explodes, die an agonizing death before being eaten in turn.

So in the food chain, a sanitized term for the Who-Eats-Whom scenario, *homo faber* had early reached the status of top predator.[1] But top predators can not overpopulate with impunity, as then ecological disaster will dog their footsteps in the form of a hydra-headed cybernetic monster: multiform positive feedback of habitat and species extinction, with increasingly unlivable conditions – both physical and psychosocial[2] – for all life forms, including the uncontrolled predator. All of which will lead us in the section after next to a defining concept for our subject. But first let us consider such a cybernetic monster, one of huge proportions and multipronged menace.

3. The man-caused bipolar ozone hole

It started to be noticed in the late 1980s, beginning as a small tear in the ozone layer of the earth's stratosphere in the vicinity of the South Pole. Not long afterward, its counterpart was observed in the skies above the North Pole. For a while the widening of the holes was well reported, but not too long afterward a blackout on ozone hole news began to be noticeable. Let us be more specific. First, for his having made inaccessible data available I am grateful to *Coastal Post* (Bolinas, California) science writer Jim Scanlon, who also wrote to me on December 31, 1998:

> No one is studying plant, human or animal health on the tip of South America, and, if there are any studies, they are not being published. If any are being published, no one is reporting them …This taboo on ozone and ultraviolet radiation continues [as well as] media denial, censorship and blackout of information on the Arctic Ozone Hole.

Continuing the story, in southern Argentina the observed ultraviolet radiation was 45 percent more than the predicted value for that latitude, this drastic shift being the equivalent of moving 20° toward the equator![2a].

Now some facts about the Hole as experienced in the extreme southern village of Punta Arenas in the Tierra del Fuego portion of Chile in the 1990s. The rate of ozone depletion was twice the global average, and the hole actually

passed over Punta Arenas annually from 1992-1994. And now (1999) Brazil has reduced allocations for this critically needed monitoring in order to attract huge loans from the International Monetary Fund to avoid national bankruptcy[2b].

Scientists from NASA's Goddard Institute for Space Studies and Columbia University's Climate Systems Research group reported on the increased North Polar ozone losses. The gist of their findings: the Arctic ozone losses will continue to grow through 2019, and are due to increase over the following decades because of the greenhouse effect's entrapping of warm air to cause the stratospheric cooling that activates ozone-destroying halogen compounds[2c].

The misreporting, more than once, that the holes are lessening is inexcusably just that. The plot thickens when we realize that it is not ladies' hair spray or even refrigerators and car-cooling systems that did the worst damage to the earth's protective ozone layer, but rather the megatons and megatons of halogen-containing solvents repeatedly used to wash down military planes, the chief offenders being in mid-North America.

The plot-thickening commences to take on a familiar pattern when we learn that there are huge and lucrative contracts farmed out for those solvents – so rewarding as to override even the desire to keep the earth safe for one's own children. Thus the ugly face of greed covers and then proceeds to rot the integrity of key individuals and spreads progressively throughout any society whose primary goal is maximizing short-term gain for the least expenditure of money, time and effort, and the devil take the hindmost. But this devil, if not stopped, will take all including the foremost.

A final ecological factor must be considered in this section – one that has as yet not been perceived; namely, the connection between the ozone holes, the trade winds, and the El Niño/La Niña phenomena. The great trade winds, it has been long known, are the prime movers of the world's weather. That they can be, and have been shifted by violent solar flares of great magnitude, however, has not been clearly grasped; and even less that such shifts directly cause typically El Niño effects and consequentially those of La Niña as well.

These effects began in the 1980s to be of mounting proportions and world-wide ecological disruption. In the usual explain-away mode of avoiding public panic, and a consequent possible disruption of public docility in general and of the workplace in particular, one was reassured by "recognized experts" that were trotted out by the established media. The gist of the reassurance was that El Niño phenomena had been experienced as long ago as Incan Peru and hence were not a matter for any particular concern. What was *not* told was that those former experiences were timed with periods of intense solar activity, causing temporary diminutions of stratospheric ozone concentrations. And what was also not told, but with much more excuse since it was not known, was that such thinnings and ruptures of the ozone layer cause shifts in the trade winds, whence the observed El Niño/La Niña effects.

The crux of this dénouement, however, is that, due to the depredations of technology in the service of short-term greed for profit and/or power already discussed, we now have a *permanent* and spreading bi-polar ozone hole of huge

proportions that is not going away, and that hence the Niño/Niña phenomenon, with all its implications for ecological change, has moved in on our planet as a permanent, even if unwanted guest – a cosmic gift of positive feedback to an impatiently ambitious species seeking to dominate the earth.

4. Feedback: a defining concept for cybernetics

Although positive feedback is not necessarily destructive and existed abundantly in experience, it came later than negative feedback as a clarified conception of cybernetic science. All practice-improved learning had long been observed to take exponential leaps from time to time, and alcohol and other addictive substances were long known to increase their hold on the victim with use: the more used, the more the desire to use. In all positive feedback, the process inherently reinforces itself; whereas with negative feedback, it is phased out by its own continued action.

Sometimes the situation is more complicated, as in the stalling of an aeroplane. Trying to counter the stall directly by pulling out of it (negative feedback) only increases it. To stop it one must go with it (positive feedback or reinforcement) and dive *more* until the falling speed is sufficient to generate enough air lift to be able finally to use negative feedback and pull out of the stall. Here, initial attempts at negative feedback will induce positive feedback. One must – seemingly paradoxically, but actually more logically – *first* use positive feedback and reinforce the dive, before negative feedback control can become effective. This means that for a stall to be non-catastrophic in the outcome, the pilot must have enough initial altitude. Put more mathematically, in this situation negative and positive feedback are anticommutative: reversing their sequence produces the opposite effect.

5. Feedback and resonance

Clearly there is a connection between positive (regenerative) feedback and *resonance*, which always tends to maximize the amplitude (height) of a wave, as anyone knows who has made a swing go higher by timing the applied force so that it is *in* phase with the oscillations. Another striking example of positive feedback as resonance is seen in the high tides of the Bay of Fundy, which can exceed the ebb-tide levels by an amazing 50 feet. The cause of this striking positive feedback effect is, in a word, *resonance*. The natural frequency (the lowest frequency at which a standing wave can form) for waves in the Bay of Fundy is in close synchrony with the frequency of the tidal waves there, thus generating strong positive feedback through rhythmic reinforcement. It will be appropriate now to have in mind a more formal definition of frequency. If a periodic quantity $x = f(t)$ where t is time and $f(t) = a_0 + a_1 \sin(wt + b_1) + a_2 \sin(2wt + b_2) + \ldots$, then $f = w/2\pi$, where w is the angular frequency in radians.

Just as positive feedback is associated closely with frequency resonance, as we now see, so similar relations exist between negative (degenerative) feedback and *anti-resonance*: the *damping* or attenuation of a wave by timing an applied force that is *out* of phase with the motion, i.e. with a 180° phase shift. Some

incidental mathematics are now needed, which will be kept as brief as possible. Consider the simple single-loop feedback circuit depicted in Figure 1.

The loop gain is the product ab of the two amplifier gains, the return ratio being $-ab$, and the return difference d is given by $d = 1 - ab$. If the absolute value of d is exceeded by unity, we have positive, regenerative (amplifying), or resonant feedback. And if unity is less than that value, there is negative, degenerative (attenuating and damping), or anti-resonant feedback, the benefits of which are stability, improved frequency response, and lowered distortion. For all benefits there is a price, which in this case is an overall reduced gain. In most situations benefiting by negative feedback control, the benefits outweigh this cost. In the case of positive feedback situations the question first arises, Do we want the kind of increased amplification that it gives, and second, if it goes runaway, how do we control it? Answering these searing questions has haunted the greater part of the 20th century.

In an undesirable and destructive positive feedback situation, such as the impact of an increasing scale of technology imposed on the existing (and previously balanced) natural environment, the problem of runaway control is more often than not one of trying futilely to put the genie back in the bottle. Positive feedback is associated with a magnified deviation from a prior state, whereas negative feedback diminishes such deviations. The first is thus a hallmark of *change*; the second, of conservation of a status quo. The first produces a state of flux, changing an amplifier into an oscillator. The second turns an amplifier into a control device and tends to produce a state of greater stability, and this discussion demonstrates their inherent connexion as we have seen. The notion of *systemic stability* is clearly at the heart of any negative feedback control, and it is time for us to define it more precisely. Stability is the ability of a system to remain in a given state despite perturbations external to the system; that is, the ability to generate restoring forces that equal or exceed the perturbing forces.

In a too little known passage Wiener adds some keen observations on this theme, occurring in one of his discussions during a conference[3] in which he speaks on the importance of phase and timing. Too many even among quantum physicists do not realise how imprecisely they talk when saying things like “accurate to within a phase”. But the phase may make all the difference in some situations! Now let Wiener speak (explanatory brackets ours):

> A system where you can easily get instability is a system of alternators [alternating current generators]. If you have switched in an alternator at a very different frequency [from the others] or an appreciably different frequency or which has been wrongly phased, the system will blow up. On the other hand, if they are all locked in [on the same or nearly the same frequency] nothing will happen. How is this engineering problem of phasing a system which

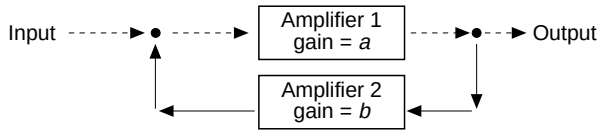

Figure 1. Single-loop negative feedback

may exist over the whole country, handled? In the old days human powers were used. A man watched two needles moving ahead and representing the rotation, run by synchronous motors, from different generators. When the needles were nearly at the same speed, the apparatus was switched in.

Today this is done automatically. An automatic mechanism switches the generator into the circuit only when the phase and frequency of the generator is correct[ly aligned in phase]. An unloaded generator wanders through the phases and when it comes to the right phase it is pulled in. If by some catastrophe one generator is overloaded a circuit breaker is actually blown out and the generator is again freewheeling.

In other words, in systems of the sort where instabilities are not only possible but very likely, the instabilities are limited by highly non-linear apparatus which will close or open a circuit at the right time. If you stay in a narrow [frequency] range, there is also a tendency, and this is most important, for the different generators to pull one another into frequency. In studying the nervous system it will be most useful to study analogies of this sort.

6. The connection with qualitative time and the unification of the sciences

Wiener's statements are noteworthy, not only for the light they shed on our thesis of the prime role of frequency and phase in feedback, but also for their almost prophetic application to what we term *chronotopology*[4], the study of the interconnectedness and qualitative nature of time itself through what may in effect be termed *time waves*. Note that here does not come into play the clock time of the Lorentz transformations and its inevitable optical illusions – physically effective though they may be in situations where electromagnetic signals of finite speed are used as the means and standard of measurement. Such phenomena do not deal with time itself, but only with effects arising out of the necessary limitations on our attempts to measure it; and even less do they penetrate into the qualitative nature of time, which ensures that no experiment is absolutely repeatable because the time configuration perforce differs on each occasion. In most situations such changes in configuration are, practically speaking, independent of what is being done. But sometimes they are not, and then we are playing a whole new kind of game, in which the chronotopology of the event plays a physically significant role in the outcome. There is, then, an exquisitely nuanced relationship between phase shift type of feedback, and the study of natural or man-made processes and their interactive reverberations throughout human society and the biosphere on which we along with all other life forms on this planet depend. Only cybernetics has provided a wide and deep enough perspective to be able to obtain those workable insights (which by the nature of things must always be the preludes to solutions) into the enormously challenging problems of the so-called post-modern world in an attempt at sophisticated verbal characterization that all too often approaches mere decadence. The singular characteristic of those problems is that they stretch across national boundaries as well as across the boundaries of arbitrarily demarcated fields that can today no longer be kept separate: physics, biology, psychology, sociology, politics and economics. Finally comes history itself which for the first time, with the advent of cybernetics as the study of consequences *par excellence*, can become a science.

An important paper in this regard – one of the last and most revealing he wrote – was Norbert Wiener's "The history and prehistory of cybernetics"[5]. It is not found in the collected works, nor in the proceedings of the Wiener Centenary volume, to which it was duly forwarded. The reason is that it was inadvertently overlooked by having fallen into a deep crack of miscommunication between the American Mathematical Society (to whom a copy of it was timely sent) and proceedings editor, our correspondent Professor Pesi R. Masani of the University of Pittsburgh's mathematics department. Our good colleague was thus unaware of it when I telephoned him about its existence, saying he was looking forward to reading it, which he did when it was finally brought to light in *Kybernetes* through the good offices of its editor Professor Brian Rudall[5a].

Although subsequently Professor Masani usefully called attention to an earlier (1958) paper by Wiener[6], the notion that because the two papers are similar is reason for the omission of the later one[8] from the collected works doesn't ride.[3] First of all, the omitted paper contains important points and nuances of thought not in its precursor; and second, "collected works" means just what it says, and the important omitted paper certainly should be included in a book (actually several volumes) that even boasts minutiae such as book reviews by Wiener, although even then it also does not contain that gem of a discussion almost lost by too obscure publication, but which we rescued in this section to show the integrated depth of Wiener's view of cybernetics.

It is at this juncture that one sees how devoid of meaning and hollow sound the attempts to denigrate cybernetics among some too backward-looking scientists and science writers, even among those who should (and do) know better, like Vladimir Arnold, whom we have not previously hesitated to credit on other grounds. Outside of a technical mathematical virtuosity, he seems to be really nothing so much as a nostalgic marxist who regards emotional concerns as "bourgeois romanticism".[4]

Paradoxically enough, for all his protestations, he is a *de facto* cyberneticist! As is apparent from his brilliant studies of catastrophe theory in which he speaks of the point of no return with respect to an approaching instability, he is well aware of a preceding pile-up of unstable components, and must be equally aware of the good sense of controlling them. But that would entail a cybernetic analysis of the feedback network involved, and to admit that would openly invalidate the prejudice he is understandably unwilling to admit.

Seeing that cybernetics would holistically involve science with affective components, he appears fearfully to shy away from such integration, deserting his customary rational posture and hiding fear under a cloak of snideness that ill becomes him.

Yet such topical errors in academe, unfortunate as they are, appear minuscule against the background of horrendous crimes against the health of all life-forms by twentieth century applied science and technology wedded to the greed-cum-power credos of multinational corporations. The result is a strangling network of exacerbating degenerative positive feedbacks

throughout the natural world, and then deceptively trying to ignore or explain them away in somewhat nauseating spectacles of transparent casuistry.

Of course, facts are not changed by such ploys, and cybernetics historically became and continues to be a fountainhead of multidisciplinary science – an emerging hope for the solution of the enormous problems that face the biosphere today.

7. The inherent politics of large-scale cybernetic problems

The Greek root of *kybernos* concerns not only helmsmanship but also directly refers to governing in the political sense. That is how Ampère understood it when he coined the word in 1832[7] that was used by Norbert Wiener over a century later in a more specific and scientifically pointed sense[8], as we pointed out years ago.

The "conquest of nature" – "Nature" personified as female – has been an underlying theme in male-dominated Western science and technology since about the 15th century. The prevalent conquest theme in scientistic/technological thinking is still alive and well, with all its overtones of rape, pillage and exploitation.

The finest alchemists knew that the domain of nature is vast and is *within* as well as external to us. So they taught that it was *human* nature that was in dire need of a healing transformation out of its quasi-*insane* (literally unhealthy) yet habitual and destructive states of mind. But alchemy then gave way to very profitable chemistry and chemical technology. The great philosophical alchemists, Zosimos and Maria of Egypt and Ostanes of Persia, are now replaced by DuPont, Dow and Monsanto (which is presently trying to control the biochemistry of food-plant seeds in order to sterilize and de-sterilize them at will, thus very gainfully controlling the world's food supply and exploiting hunger for profit). But the damaging human-triggered feedbacks of the latter twentieth century have made clear – despite short-term greed and profit – the increasing failure and instability of institutionalized science-cum-power (as opposed to older science as a benign and sacred search for truth). Also made clear has been the abject failure of the boasted "conquest of nature" as increasingly demonstrated in unprecedented, ultimately human-driven natural catastrophes.

With a mounting destructive attitude towards his own biosphere, man can only lose power over his own fate as nature recoils on him; and his anthropocentrism (logically culminating in anthropolatry) degenerates into a self-destruct command: an enterprise of nihilism and annihilation of the very biosphere that sustains him. This is Nature's final negative feedback control over her greatest predator/parasite in geological time. There is a hierarchical parasitism here. Humans following the "conquer-nature!" fanaticism simply parasitize all other life forms. The irony is that they in turn are parasitized by their own controlling cliques as "the revolution" tiresomely becomes just another and often more deadly tyranny.

8. Systemic feedbacks in biological contexts

Perhaps the very simplest case of a primordial kidney/bladder fluid-cleansing and rhythmic evacuation system is illustrated in the still not too understood contractile vacuoles in protozoa. One of the clearest biological examples of cybernetic control in the nervous system is to be found in the so-called "gamma system" of the neuron/muscle cell feedback control. There seem to be two general types of neurophysiological cybernetic control:

(1) morphogenetic and form-maintaining; and

(2) process-generating and function-maintaining.

The gamma system belongs to the latter of these two basic types. An example of the former is the control of embryonic development by the dorsal lip of the blastopore. This primal morphogenetic structure is the pre-somite stage isomorphic to the somite-stage pineal body, which hangs dorsally over the lamina quadrigemina. An identification not hitherto made is that the pineal body, like the fourth ventricle of the brain, can be considered as the final diverticulum of the spinal canal, which can be traced upward past the rhomboid fossa and calamus scriptorius, the tela chorioidea of the fourth ventricle to the region where the superior and inferior cerebellar vermis meet; then along the aqueduct of Sylvius, the fastigium, the anterior medullary velum and frenulum veli, past the quadrigeminal bodies and finally along the posterior commissure, past the habenular commissure and to the pineal itself. Fibres connected with the life-controlling efferent vagus nucleus in the ala cinerea are also connected by neurons along this entire path. The habenular commissure conducts to and from the columnar fornicis leading to the sub-thalamus of the hypothalamus, which master-controls even the pituitary body through neuropeptide transmission. All these structures are among the oldest portions of the brain.

In this complex psychosomatic feedback control system the role of the pineal is indicated as a subtle type of control, in the sense of a braking action by the pineal over the pituitary and gonads. Similar controls are exerted by human value systems, thus linking the neuronal/hormonal master system with higher functions, since ethics primarily exerts constraint on destructive behaviour.

Similarly, the conclusion is suggested that, though the EEG impulses originate, as we have found, in the pyramidal nuclei (and not in the apical dendrites) of upper brain stem, they are modified by the master control system. It need only be added here that more than a simple hormonal "start", "stop", "slow down" or "speed up" is required to convey chemically such comparatively complicated bio-information as a continued response of the organism to some feature of its environment. We are at the threshold of a process of organism/environment interaction that could serve to generate responsive, adaptive mutant RNA patterns biochemically coupled with "tagging" molecules directed to the gonads and slowing down their mitotic/meiotic processes enough to generate a higher probability for such custom-built, adaptive mutations to penetrate selective target areas in the formative genome.

9. The rôle of feedback in societal contexts

We have already seen something of such contexts in previous portions of the discussion. Cybernetic control is here exerted through a principle of "compound feedback" as each person reacts with reference to:

(1) what the behaviour of others suggests; and

(2) what the subject perceives others to think, whether in fact they do or not.

There is a constant communal interplay between these two factors – an interplay that is exponentially complicated as the number of persons increases.

But (1) and (2) are *governed* by what the majority *believes* is good or bad. These fundamental standards are in turn shaped by:

(a) past history and tradition;

(b) new discoveries and inventions; and

(c) by what the controlling core group considers good or bad.

As time goes on (c) always prevails, because the controlling group possesses the power to reward or punish and thus concretize its value system and make it very convincing for all others in society: "convincing" in a literal sense of *co-conquering*.

Hence societal control ultimately springs from the processes that create controlling groups, which normally become institutionalized. Among these processes there is a dominant one, definable as follows.

All human history in time can be broken down into ultimate units of person-to-person contact moment by moment. These are the quanta of social change. Whatever principle dominates the outcomes of those contracts will determine the type of value system and hence the type of person in the controlling group.

There is such a dominating principle. Namely, between two competitors or opponents (and *all* persons in active society are competing willy-nilly for portions of control) of equal intelligence, skill and strength, that one with the least ethical system of values will win, because that strategy is least constrained.

This randomly distributed but inevitably increasing type of person-over-person victory in society leads in time to the following corollary principle, which is crucial: There is a movement in human history of the least ethical representatives of the human race to the places of power in any and every culture, with appropriate changes in prevailing traditions, popular attitudes and what is called *normal* (i.e. prevailing) behaviour.

But there is a feedback-effect now. For a prime characteristic of the least ethical is also to be the most parasitic – to take most for least giving, with the "ideal" being to take all and give nothing. The history of taxes in national governments is only one case in point, the actual services rendered to the individual *qua* individual becoming less and less. The exception is made in regard to the individual in a role of supporter of those in power, e.g. soldiers, artists, scientists or other rôle models used for propaganda and to create a

façade of accomplishment around the core of parasitism. There is a historical abundance of examples.

The feedback at work here is such that the parasitism must eventually cut off its own lifeline for want of new victims, since human beings psychically require freedom from tyrannical surveillance and control for even, at last, physical survival. Thus there is an uneasy balance between the desires of parasitic rulers and the limits of the psychosomatic endurance of their subjects. And totalitarian rule, whether parading under a pretense of "democracy" and "representation" or not, is the most parasitic by definition.

By the societal game theorems enunciated at the beginning of this section, any overthrow of the ruling class is inevitably – by the psychological dynamics of person-person conflict – finally placed in the hands of the identical type, changed only in name or façade. The "revolution" is an illusion. Indeed there is a positive feedback here leading to a coarsening and increasing criminality of the ruling class; finally, the quasi-criminal gang, in the form of some tyrannical oligarchy, rules a totalitarian state. When the oligarchical reality is well-concealed and the people skillfully enough manipulated by controlled media, the totalitarianism is covered by a mask then touted as "democracy". This is the unfortunate situation of many *soi-disant* democracies, including those in North America. The structure of this apex of final power is that of a wolf pack *sans* its redeeming traits but with still the old leader being liquidated when he is no longer strong enough to liquidate others or the contenders for his place.

The net result, irrespective of the proclaimed ideology since the control-seeking types prevail, is that the human race is increasingly hag-ridden by its least ethical representatives in the places of power. This process will inevitably paralyze and poison society irretrievably – unless nature in some form we know, or do not yet know – interferes with the freedom of the unscrupulous. Too large an H-bomb, too much lethal pesticide, too few birds for the number of insects, or too many people competing for the same rewards of food, comfort and power …[5] Or perhaps as little as too much ultraviolet radiation – which leads us to look at a problem that just doesn't diminish and that bears on what we are talking about.

10. Back to the politics of the future

The key principle in cybernetically analyzing the higher integrated behaviour of human beings in sociopolitical contexts is one of paying attention to the dominant tendencies. For in a turbulent system of waves, the continued imposition of a certain frequency of sufficient amplitude will finally dwarf all the other frequencies into insignificance. Thus for long-term historical analysis the cybernetic approach uses the dominating frequencies of the societal wave-band as a basis for prediction.

The conclusion is straightforward. Unless the ethically benign and non-parasitic persons gain access to some power far greater than that to which the unethical and parasitic also have access, the process of social degeneration above described will prevail; and degeneration is basically unstable, for

parasitism is not self-sustaining. The escapism of a conjectured extra-terrestrial colonization would not solve this problem in the least but only postpone it. The power bait has set an effective trap. So much so that science itself tends to become openly dominated by politically motivated searches for power rather than for knowledge or improvement of welfare, as already noted in passing. In this sense, the entire process tends to degenerate cybernetics itself, for control over others is not an end in itself, but requires a value system embracing more than such control, and not placing it first. Axiology has the last word here.

In this connection the reader is referred to the crucial role played by the theory of linear permutations (and hence by the factorial function mathematically speaking) in any approach to the structure and operation of value systems and codes of behaviour. There is a further interesting aspect of the theorem of denial of absolute closure which has just been stated; namely, that in any cybernetically created system, however perfectly controlled otherwise, there is at least one unclosed place: the cyberneticist himself. This fact means that the problem of control in more cybernetically "advanced" systemic regions involves the question of how and whether the self-direction of the cyberneticists (or of the controlling group involving them, at the top of the power pyramid) can be achieved, together with the reverberations on stability. For all control proceeds ultimately according to some set of values, which also exerts control feedback-wise on the controller.

Beyond the place of power-exercise or release, the rules of power control, and the tactics or values employed in using those rules, lies the player himself, whose personality-structure ultimately determines whether a given value-system will be stable for him or not. But further analysis of this aspect of control would take us into reaches of psychology and sociology demanding more detail than now appropriate. Suffice it to say that the *scientist* is no small matter for the scientist to control.

Here is needed the philosopher in the classical sense of one who loves wisdom. And wisdom – not knowledge – is what will have to save our crumbling global society if it shall be saved from the headlong collision course directed by the too narrow conception of science to which it has been consigned. Wisdom by definition must address and provide for the future, whereas knowledge as such is not so capable. Now undesirable positive feedbacks do not go away if ignored. Rather, they increase to monstrously destructive proportions unless truly exorcised by a broader, deeper and more enlightened outlook that addresses and controls their causes via some therapeutic negative feedbacks that must begin with self-discipline and the control of that really silly macho-type of hubris that insists "we can and will conquer nature!" as though any healthy interaction with a biosphere were susceptible to the flawed metaphors of pillage and rapine.

A criminal government's tyrannical course of obliterating a part of reality already neglected, because one is no longer neglecting it, is of course compound of fallacy and blind desire heedless of the reality of others' wishes or welfare, and hence utterly pathological, with past deeds standing contrary to false

assertion. But intelligence can afford neither to be invalid nor, what is even more difficult to avoid, to be formally valid and yet untrue by reason of false or omissive premisses. Intelligent thinking, seeking ever to test the validities it has gained against further reality to determine their content of truth, thus must ever seek new clues of non-uniformity with its previous conclusions in order to better its premisses.

The food of intelligence is as much decreasing entropy, as increasing entropy is the nourishment of controlled performance. The two must remain in fruitful balance, which means that they shall operate within a value system that places the demands of intelligent thinking above those of mere performance for immediate results without the interposition of further thinking. Otherwise, the generalized entropy in the system or situation will increase to the point of purposeless, stagnant monotony, or to some other form of death, such as cessation, below any point of possible life or progress, of systemic action. We have thus arrived at the same conclusion we gained previously by the route of comparing the fate of Shannon information in a situation dominated by cybernetic control to a situation dominated by the decontrolling process of arriving at scientific discovery.

It is interesting that, like thinking, deep affection also pays careful attention to non-uniformities: to the least differentiation of behaviour or expressed wish on the part of the object of attachment. A mother watches her baby very observantly and a master watches a pet the more closely the more attachment is present, noticing at once the slightest indisposition which passes completely unnoticed by another. It finally appears that mass-treatment, lovelessness and valuing performance or results above the ways they are gained, all go together; while intelligence, individual treatment, affection, and the valuation of ways of behaviour above possible immediate gains also belong together.

Because of these deep interrelations both logical and ontological, we see that the mass-treatment of man by man, with its cognate value system of putting the results of performance above the ways of behaving, ultimately can but lead to degenerate stupidity and the actual inability any longer to distinguish individual difference or fine, vital nuances of thought and feeling.

Brutal and coarse cliques of leaders ruling brutish masses is the end result of placing what is gained, rather than how it is gained, first in the human value system. If control or "getting the results I want" (for control is never objective at its root, but always based on what is desired to be gained) is likewise placed first, then cybernetics likewise degenerates.

If, on the other hand, what I have called a theory of instruction is viably developed and deepened, then it is always seen that *if the instructions are less sensitive than the capacity of the system being informed by them, the sensitivity and capacity of the system are either wasted or degenerated by instructions that can in time destroy the unused capacity by either direct interference or by atrophy*. The reductively fallacious assertion that man is simply a "device" leads, for example, to such degenerate types of instruction. It behooves us, therefore, in dealing with humans, to frame our instruction theory in the

deepest sense, so that our instructions do full justice to the potentiality of a human being.

The applications of the theory of instruction go very far. Suffice it to say here that those applications importantly concern what are known as governments; for systems of law are nothing but instructions for behaviour. Hence for the first time an impartial evaluation of political systems and law codes, on the basis of the theory of instruction and the generalized theory of entropy already discussed in this paper becomes possible.

What poses as scientific "objectivity" is actually *indifference* to the impact on other life-forms of finally frivolous experimentation on the environment. Such "objectivity" is in reality the ruthless my-will-above-all mentality or my-interest-first-regardless-of-consequences. A true scientist, meaning "knower", however, must investigate all possibilities of feedback and carefully access the wave of results truly objectively on the environment. Such a scientist is utilitarian in his or her outlook in the historical sense of seeking maximum benefit for the maximum number of beings, and by beings we must include non-human forms of life without whom human life cannot be even sustained indefinitely, let alone under conditions of happiness and individual fulfilment. Benefit must realistically include long-term optimization. Temporary panaceas that create even worse long-term problems are not science but blind and irresponsible blundering or, in some instances, worse: criminal sociopathy. A knower worthy of the name "scientist" behaves so differently there is no comparison. Axiology again …

Interestingly enough, George Washington of American revolutionary fame was very near the truth that true government, the *kybernos*, must arise within each individual in a process founded on a shared basis of integrity, when he wrote that external government "is not reason and not eloquence. It is *force* and, like fire, is a dangerous servant and a fearful master".

The so-called "representative democracies" – actually oligarchically clique-controlled – at the end of the 20th century reached Washington's "fearful master" stage of psychological mass manipulation and fiscal control, with full-blown political tyranny not too far around the corner. And whenever the entrenched power groups are threatened by a too express or close-to-home dissent, then, sporadically but unmistakably, are shown the mailed fist and jackboot for all to see as a "salutary" example and warning. One cannot but think back to Waco, Texas or "The Square of Heavenly Peace" in Beijing … Sociocybernetics has its work of the next millennium cut out for it, and a winding and precipitous road before it. But the way forward is clear, and nothing less is the legacy and responsibility of cyberneticians today. *Pax vobiscum!*

Notes

1. In this connexion see also note 2 and surrounding text.
2. Including psychopathology and sociopathy, which repeatedly throughout human history are found inextricably intertwined with politics and sociology.

3. On the flip side of this mix-up, and directly germane to the principal concerns of the present paper, I cannot too highly commend the truly Zarathustrian integrity with which Professor Masani (himself from Parsi India) has in his various writings spiritedly excoriated bad faith and poor ethics in the sciences and fought the good fight against deceit (the *Druj* – "the big lie" – to use the Avestan word) and against self-deception as well. It is clear he has also seen, if not explicitly saying so, that if one tries to exclude values and their entrained affective components from science, one ends up with values anyway, but now with only destructive or despicable ones. There is not neutrality with respect to axiology, as we saw in Section 10.
4. Nine billion people are conservatively projected for 2050 of the current era on our shrinking planet – one too rapidly diminishing in terms of available life support of sufficient quantity and quality.
5. Actually little different from the attitude of some current zealot mechanists who noisily inhabit several scientific fields of biological flavour, but with 19th century notions of the nature of matter in their nonetheless resonating heads, and still naively unaware that their pet image "mechanism" is a human artefact and does not exist in the natural world. Nature does not use "mechanisms", but arranges her instrumentalities from within and does not construct them from without. Such zealots who identify their *amour propre* with their theories (and hence fight logic to the death) never tire of saying – as if repeating something makes it true – that natural objects like a leaf, or a fly, or even a brain all "arose" through randomness. One of the most recent (1997) goes like this: the great complexity of even the simplest organisms was developed randomly, like throwing dice.

   One first wonders how the word "simplest" could possibly have any meaning in a context of admittedly enormous complexity?! Next one must keep in mind that people who talk in such loose fashion also think unviably: they will most enthusiastically agree, when shown even the simplest human artefact, that a nail or a fork was made with intent and with purpose aforethought. But a practically infinitely more complicated and efficient object like a leaf or a peach or a moth is "of course" random in origin.

   Now the nub of the fallacy emerges: the incredibly foolish prejudice that only externally made objects can be purposive, but anything developing from within – even the zealot's own wondrous body – "arose randomly".

Annotated references

1. Maxwell, James Clerk, "On engine governors", *Proceedings of the Royal Society (London)*, Vol. 16, 1868, pp. 270-83.
2. (a) Booth, Diaz, Frederick, Lucas, Neuschuler, Smolenskaia, and Soulen, "Solar ultraviolet irradiance observed from Southern Argentina from September 1990 to March 1991", in the *Journal of Geophysical Research*, Vol. 98 Section D5, May 20, 1993, pp. 8891-7.

   (b) Kirchhoff, V. *et al.*, "The ozone hole over Punta Arenas in Chile", *Journal of Geophysical Research*, Vol. 102 Section D7, April 20, 1997, pp. 8945-53.

   (c) Lonergan, P. *et al.*, "Increased polar stratospheric ozone losses", *Nature*, Letters to the Editor, Vol. 392, 1998, p. 589.
3. Wiener, N. and Schade, J.P. (Eds), *Nerve, Brain and Memory Models*, Elsevier, Amsterdam and New York, 1963, pp. 241-2. The unique and insightful passage from Wiener's oral discussion given here both bears on and supplements his remarkable posthumously published paper of 1962 (reference 5b below).
4. Musès, C., *Destiny and Control in Human Systems: Studies in the Interactive Connectedness of Time (Chronotopology)*, Kluwer-Nijhoff, Boston (USA) and Dordrecht (Holland), 1985, especially chapters 1, 3 and 6. This work, now being readied for a paperback edition, appeared as the culminating title of the series "Frontiers in systems research". It was sponsored by two prominent systems theorists, Professors John L. Casti and George J. Klir, editor-in-chief of the series, both of whom are still active in the field, the

former now being an authority on complexity and chaos theory at Nobel Laureate Murray Gell-Mann's Santa Fe Institute and also one of the best known contemporary science writers.

5. (a) Musès, C., "A review of the proceedings of the Norbert Wiener Centenary Congress, including a paper not in the Collected Works", *Kybernetes*, Vol. 27 No. 1, 1998, pp. 26-28. A slight emendation in this paper should be noted. Professor Masani was quite correct in noting I referred to a different Watanabe [and not Professor Shinzo Watanabe, the mathematics contributor to the proceedings of the Wiener Centenary Congress]. It was the physicist S. Watanabe to whom I referred, whom I had met at a joint conference with my friend the late Warren McCulloch and his then protégé Heinz von Foerster, whose entry into and position in the United States Warren had aided with characteristic generosity – to the benefit of cybernetics, I may add. But I stand unrepentant anent my strictures (in my Kybernetes review of the proceedings) on the outdated quantum theory voiced on some pages of the Centenary volume, which was not supposed to be a period piece but an update.

   (b) Wiener, N., "The history and prehistory of cybernetics" (corrected final printing of the original written in 1962), *Kybernetes*, Vol. 27 No. 1, 1998, pp. 29-37. This key paper first appeared posthumously in 1965 in Rome as edited from audiotape by C. Musès at the request of the National Research Council of Italy, and has had a somewhat adventurous history. After having been inadvertently omitted from Wiener's collected works, the damage was repaired last year in Vol. 27, No. 1, of *Kybernetes* as per reference 5a above.

6. Wiener, N., "My connection with cybernetics. Its origins and its future", *Cybernetica* (Belgique), Vol. 1, 1958, pp. 1-14.

7. Ampère, André, *Essai sur la Philosophie des Sciences*, Bachelier, Paris, 1834, part 1, p. xxix (which shows Ampère already had used the word cybernetics in August 1832); also part 2, p. 141. Ampère defined his *cybernétique* as "la théorie du pouvoir" in the sense of the dynamics of societal power, and in this was not too far from one of the most sophisticated of its applications.

8. Wiener, Norbert, *Cybernetics*, Wiley, New York, 1948 and 2nd edition, MIT Press, 1961. The book that started it all, followed by *The Human Use of Human Beings*, Houghton Mifflin, 1950, and finally by Wiener's last book *God, Golem, Inc.*, MIT Press, 1964.