The Cybernetics of Crisis and the Challenge of Sustainability

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Stability, Identity and Circular Interactions

Good morning and thank you for the opportunity to share with you some thoughts about the topic of our meeting. I would also like to thank the organizers for having invited me here. This occasion is especially poignant for me. As some of you know, Stafford Beer was the examiner on my doctoral examination, which actually took place, over three memorable days, at Cwarel Isaf and at the bar of the Black Lion Inn, in Lampeter. I also had the good fortune to be a student and close collaborator of Buckminster Fuller and it is wonderful to see these two traditions converging here in this impressive facility. Much of the time since my own student days was devoted to an effort to integrate these two schools of thought, as well.

It is wonderful to see what Professor Malik and his colleagues have achieved here by assembling many of the familiar concepts, models, artifacts and memorabilia in one place, putting them all to excellent use. I would also add, in the same spirit expressed earlier by Professor Malik, that like him, I feel as if much of the time over these many years was spent in preparation for better understanding of how to approach major transformations of the kind we need to undertake now. My own comments, however, will refer to a crisis, not unrelated perhaps, but deeper than the current financial crisis. I shall refer to a "super," meta-crisis we seem to be rapidly approaching – the crisis of sustainability – a crisis that is rooted in the very relationship of humanity to the planet.

What I'd like to do in the short time that we have this morning is to try and integrate a number of concepts about crises, their meaning, anatomy and functioning. I would like to speak about the cybernetics of crisis and link this perspective to the broader notion of sustainability, to which I shall give a specific definition later on. There is a string of ideas involved here, each of which could absorb quite a bit of time. We shall only be able to briefly touch on key concepts, I hope, however, in a way that will help reorient our overall thinking, an important prerequisite in handling change.

The first thing I did when I accepted the invitation for this speaking engagement was to go to the dictionary and look up the term "crisis." The Random House Dictionary of the English Language defines crisis thus: "*A condition of instability, as in social, economic, political, or international affairs, leading to a decisive change.*" This is a wonderful definition for our purpose. I say wonderful, because it provides, at the outset, a couple of important framing concepts. First, it identifies, unambiguously, the general domain of concern – that of human affairs and social systems. This is the particular domain that involves what Stafford Beer used to refer to as "exceedingly complex systems," systems which do not yield to the conventional,

linear approach of the physical sciences. Second, it highlights two key words: instability and change, both pertaining to concepts that are at the heart of classical cybernetics, with its focus on the interrelated meaning of "stability" and "change" and the mechanisms which mediate them, blocking change or bringing it about.

The concept of stability is every-day-familiar and we tend to take it for granted, but it really isn't an easy concept because of its inherent relativity and because, more often than not, it actually involves dynamic processes rather than static conditions. We say "stable like the rock of Gibraltar," stable from what point of view? From the perspective of daily human life it may be. From the perspective of geological times it is obviously not. Whatever the case, the idea of stability has to do with some underlying invariant. Some "thing" that one can point to which remains in essence the same in spite of all kinds of perturbations and changes. This "something" pertains to Ashby's "essential variables" and much of a system's identity revolves around maintaining those essential variables in balance – maintaining them intact.

Cybernetics, of course, is particularly interested in the type of stability which is the consequence of complex processes of interaction of multiple entities, each of which may comprise a complex dynamic system in its own right. Here, stability is manifest as a condition of dynamic equilibrium in circular processes of co-creation. System entities interact and in the process, they are virtually defining and redefining one another. This is true, incidentally, even for the primitive cases of control familiar from early Cybernetics, where one can legitimately ask whether it is the temperature which controls the thermostat or the thermostat which controls the temperature. The emphasis on process-circularity is a popularly unfamiliar but enormously enriching way of looking at the idea of stability. Circularity is critical to the structural closure which is at the heart of defining identity, at any scale, and it can be found everywhere in the world of living systems and conscious participants. It is essential for discussing stability in complex, self-organizing systems: organisms, brains, societies, ecosystems, institutions, economies, and whole civilizations alike.

In all such systems, a similar dynamic concept of stability pertains to particular identities–to parts – as well as to wholes consisting of interacting parts. This question of the relationship between parts and wholes is an important question in mathematical logic, as it is in pragmatic instances of system design. Wholes, in our context, consist of myriad, interacting, semi-autonomous, viable identities. In the processes of interaction, they are actually continuously defining one other, making what we identify as individuals possible in the first place. Wholes are actually environments consisting of interacting, mutually adaptive parts and adaptation is the process of shaping identities under such interactions. The process is akin to true conversations of the kind investigated by Gordon Pask. Eco-systems of all kind – rain forests, coral reefs, financial systems, or systems of thought – consist of patterns of such interactive, multi-loop, mutual adaptations. Through the adaptive process, each identity is being shaped by all the other identities which constitute its environment. This idea is actually echoed by a profound, basic tenet in Buddhism, which stipulates that there is no independent existence. There is no identity in Universe which does not depend on other identities. For each identity in such patterns of

interaction, the rest constitute "the environment." For each, adaptation always involves change– specifically, change which produces a better adjustment to an "environment." The continuous trajectory of adjustments, if you will, comprises the gradual process of refinement in the essence of being. In conscious systems, this is the journey towards enlightenment, the ultimate in self-realization.

The Anatomy of Adaptation

For a closer look at the anatomy of adaptation we shall turn to Sommerhoff and Ashby, and a simple, potent and very elegant formulation, in which adaptation is addressed in the language of the cybernetic theory of regulation. This formulation highlights five key variables and the manner in which these variables interact. They include: a regulator R; a regulated system S; a source of disturbance D; the set of possible outcomes Z; and a set of desired outcomes G. For every given situation, there is a set Z of all possible outcomes that may occur whether regulation is applied or not. Of these, a subset G defines desired outcomes – those that correspond with a condition of stability for a system under consideration – its essential variables. In addition, there is a set R of events in the regulator – a nervous system perhaps; a set S of events in the system which is being regulated; and a set D of disturbances usually originating in the environment – the push and pull of all the other identities around you.

The basic concept is that events in D produce conditions in S that cause outcomes to be driven out of G. Effective regulation is achieved if, for a given value of D, events in R and S interact such that the outcome is bounded by a G. Key in this regard is the capacity, the requisite variety inherent to R. Significantly, in the management of human social systems the equivalent of all the five variables can be the subject of deliberate design. All can be configured and reconfigured with time. G, for example, can be expanded when you reassess expectations or redefine a mission. R, however, is always of central importance since its variety is ultimately critical in a systems ability to self-organize.

With this formulation in mind, there are fundamentally three effective strategies available for adaptation. The first involves adaptation under a fixed decision rule. An appropriate reaction, or capacity, is built into a system in anticipation of a likely pattern of "disturbances." This strategy is effective in environments where relevant conditions persist with high regularity and the rate of change is low. It can take a static form as in building a wall suitable for protection against prevailing winds, or producing a skeleton or shell to protect soft tissues, or it can manifest in more dynamic arrangements as in all homeostatic mechanisms, where a specific action is triggered to compensate for the impact of particular change. There is always a pre-specified decision involved which basically says "if this happens do that, if that happens do this." The limitation of this strategy is clear: it requires the ability to predict all possible contingencies.

The second strategy involves adaptation by Ashby's "ultrastability." When complete prediction is impossible you build sufficient redundancy into a system and this allows it to arrange and rearrange its internal configuration until it hits a state which matches well the requirement of a particular challenge. Brain like mechanisms, rain forests and societies, all high variety systems, function in this way. Precise prediction for all contingencies is not necessary but here too, there are ultimate limitations on the repertoire of tricks.

The third strategy, as I argued in earlier work, involves adaptation by evolution where, for a given

system, internal variety, or regulation capability is actually amplified. Typical is the case of "coalition formation" where previously unconnected identities are joined in order to gain some otherwise impossible advantage. In the process, a fundamental shift in adaptive variety is produced with the integration of a new, "larger" identity. This, incidentally, seems to be the case even in the elementary level of the formation of biological cells where, scientists now believe, originally separated nuclei, mitochondria and other elements joined under selective pressure for some overall survival gain. From this perspective, Evolution itself can be regarded as a process of amplifying regulation across series of stratified, interconnected regulators. These, as it turns out, form the complex environments of interacting identities that we spoke about earlier. It is these interactions which produce the requirement for new levels of integration that, in turn, define the conditions for the next necessary change.

Perspectives on Change

Change is involved in all the foregoing but the concept of "change" too, can prove to be evasive and full of contradictions and paradoxes. Constancy and change, which in our language designate contrasting conditions, are, in fact, entirely inseparable. Like many pairs of opposites they define one another and are revealed by comparison and contrast. Our perspective on change is significant in so far as it is central to our view of the world and thus to how we approach and deal with it. Different cultural attitudes to change are particularly interesting to observe in this regard. In the conventional Judeo-Christian tradition, for example, the world was created, to completion, in six days. No change thereafter. And even today evolutionary theory is frowned upon in some circles. This is true for some areas in the United States, as it is in other places. The other day I saw in a newspaper that the Turkish Parliament voted to abolish teaching evolution in schools. There are other cultures, of course, that are much more accepting of change. Ancient Chinese perspectives as expressed in the *I Ching, The Book of Changes*, portrays a more dynamic view of Universe that tries to interpret events in relation to constantly interacting, changing sets of constraints.

In order to gain a better understanding of the concept of change, we shall turn to Ashby again, and his theory of finite machines – systems which change states overtime. According to this formulation change involves three basic elements: an *operand*, which is acted on by an *operator*, to produce a *transform*. Change is basically defined here by a starting state, a decision rule, and an end result. Just contemplate this for a moment and you will realize how powerful this definition actually is. It has two immediate consequences. The first is that different kinds of transformations are produced by different type of relationships among the three basic elements. The second, perhaps even more significant, is that an important distinction can be made between two essentially different types of transformations: a transformation under a given decision rule and a transformation in the decision rule itself. You can begin to sense where all this is leading to – how it all relates to the notion of crisis and to the different situations we heard about in previous sessions concerning crisis in the financial system, crisis in organizations and crisis of management. All these situations demand a fundamental change in the decision rule itself, in the prevailing rules of the game, not just tinkering in the margins.

The important difference between the two types of transformation was investigated at length,

during the late sixties, by Paul Watzlawick and his therapist colleagues at the Mental Research Institute, in Palo Alto, California. These researches proposed a distinction between two types of change which they designated "first order" and "second order" change respectively. First order change involves change which occurs within a system, where the system itself remains invariant. Second order change, on the other hand, pertains to cases where change requires a fundamental discontinuity and a shift in logical level – where transformations occurs in the very nature of the system itself. Examples abound in all kind of management situations, for example, where some change situations call for corrective adjustments while others call for complete systemic change. These very practical distinctions, the research group pointed out, are borne out by two theories in mathematical logic, the Theory of Groups and the Theory of Logical Types. The first addresses the rules which govern membership in a class and transformations in such members which do not affect the class itself. The second deals with issues concerning the distinction between parts and wholes and with transformations from one class to the other, a transformation which requires a shift in logical level – a true paradigm shift. The reason why all this is hugely important is that all too often we tend to address situations requiring second order change with first order change strategies a practice which, of course, leads us nowhere. You can see this in numerous situations of attempts at personal, as well as institutional reform, and even in many of the policies advanced for dealing with the failures in the world's financial markets today.

Why Is Managing Change Difficult?

Change is obviously an essential ingredient in processes of adaptation. But change, in social systems is not always easy. Any one who tried to deal with real change, even on a personal level, but certainly in changing companies and other type of organizations, let alone in changing the world, would attest to the difficulty. But why is change, especially second order change, so persistently difficult? Why are the processes of managing change such a demanding challenge? I would like to offer you some thoughts about four key factors which make change in the kind of domains we are concerned with here, genuinely difficult. I shall refer to them as the Complexity Factor; the Epistemology Factor; the Structural Factor; and the Inertia, or Vested Interest Factor.

First is the ***complexity factor***. As we already established in the very beginning of this presentation, the unavoidable fact is that we are dealing in the domain of exceedingly complex systems where complete knowledge of all possible occurrences is inherently not possible. There are a number of compelling reasons for this. The most general has to do with the underlying systemic characteristic which means having to deal with a large number of variables and multiple dynamic interactions. The counter intuitive behaviors which often result make accurate prediction, even at a coarse level of major events, genuinely difficult. It was particularly instructive, in this regard, to hear Alan Greenspan, former Chairman of the Federal Reserve and for many years its master oracle, suddenly saying, while testifying before a Senate Committee when the financial crisis first broke, that nobody could anticipate events because the global financial system is too complex for complete

understanding. The fact is that we tend to treat complex systems as though they were simple clock-like mechanisms only to be taken by surprise by the results of our misguided concepts and actions.

There are other specific features which make for genuine complexity. One is the fundamental irreducibility of systems, a central tenet of Ludwig von Bertalanffy and General System Theory. All system components are interdependent and there are synergetic characteristics of wholes which cannot be deduced merely from analyzing the parts. Yet, our most common strategy for dealing with complexity is to simplify it to a point of complete trivialization often to disastrous effect. Yet another important feature relates to what Heinz von Foerster used to refer to as "historical dependency." The systems that we encounter in the living, social and conscious world learn from experience and therefore, behaviors observed in a particular moment may not reoccur, following a similar "stimulus," at a later time. Finally, there is the issue of the participant–observer already noted by Max Plank who is quoted to have observed that science can not solve the ultimate mystery of nature since at the end of the day we ourselves are part of the mystery we are trying to solve. This important theme was developed at length by von Foerster who made it a central tenet in cybernetics. Observers are actors in the very situation they try to understand and control. The financier George Soros, for example, recognized this particular feature, to which he refers as "reflexivity," in relation to the behavior of markets where participants' perceptions influence market behavior only to be influenced, in turn, by market events.

The central point I am trying to make in combining these arguments is that complexity is a genuine feature of our reality which produces a level of uncertainty that, in principle, cannot be entirely removed.

The second factor which makes addressing change a demanding task is the ***epistemological*** factor. It has to do with persistent mental models and limitations inherent in knowledge and language. The theoretical basis to this relates to Gödels Incompleteness Theorem which postulates that paradoxes produced by a given language cannot be resolved by that language itself. Beer, as many of you know, has written about this extensively, in *Platform for Change*, for example, pointing out the need for a meta-language, a meta-mental model in resolving essential paradoxes. This is exactly the case were a mismatch between experience and an assumption about reality, between a familiar way of doing things and a requirement for change, between an operating decision rule and changing demands of a new situation, call for a fundamental paradigm shift. The concept of paradigm shift, as introduced by Thomas Kuhn in his thinking about scientific revolutions, is enormously relevant to our discussion since it highlights the situation where a theory comes into difficulty with new observations and the only effective way out is for the theory to be radically overhauled. Lacking such complete transformation one is left with the prolonged agony of trying to refine obsolete models as was the case with Ptolemaic cosmology. For hundreds of years people tried to stubbornly hold to an earth centric assumption, in the face of mounting evidence to the contrary, by elaborating endlessly the existing model which simply did not work. Things were only cleared up by a true revolution in the view of the world introduced by Copernicus and Galileo.

Throughout history, the same syndrome has been evident in the political arenas as well. This was essentially the subject of Barbara Tuchman's wonderful book *The March of Folly*, where she

set out to show how so many regimes pursued, with complete conviction, policies which led to disastrous results. In all of Tuchman's examples a regime is essentially stuck with an obsolete mental model which it keeps pursuing, stubbornly, to a bitter end. Her examples include the case of the British monarch George III and his government, pursuing policies that lost them the American colonies; the US' defense establishment pursuing misguided policies with the Vietnam War; and many more. Some of you will recognize the same exact pattern in relation to management of enterprise.

In all the forgoing a similar scenario is being acted out. Invariably, the challenge is that of producing a second-order change in the context of a dominant but no longer relevant mind set. In all such cases, a system is trapped by a set of conventions, unable to produce an effective solution to new dilemmas from within its existing frame of reference. The system is trapped by an epistemological blind spot which is especially difficult to overcome since it does not only blind you to new, relevant data, it even blinds you to the fact that you are blind.

Next in the four factors is the ***structural factor***. Perhaps one of the most important contributions of early cybernetics was made in 1943 in a paper by Norbert Wiener, Rosenblueth and Bigelow, which for the first time established the connection between the output of systems and their internal structure. Every observed behavior is mediated by a particular structure. Think about this. Everywhere we see attempts at reform which call for change but insist, impossibly, on preserving the familiar, current structures. Many of you are involved in management consulting and I am sure that you have had opportunities to witness this particular syndrome. In many cases it is difficult enough to convince organizations that change is required. But even organizations that recognize such a need often attempt to accomplish change without really changing anything important, without really touching key aspects of their existing structures. There are so many examples of this but think for a moment of major reform attempts at the United Nations. Reform, yes, but do not touch the voting procedure, do not touch the structure of the Security Council, do not add more members with veto power, and so on. You simply cannot bring change this way. You have to redesign the underlying structure if you want a fundamentally different performance – a real different behavior.

Last is the ***inertia factor***, the factor of vested interest. All systems exhibit some form of resistance to change. Physical systems resist change in position or motion, as prescribed by Newton's laws. In physiological systems, homeostatic mechanism restore deviations from various fixed norms and similar mechanisms operate in social system where they operate to secure proven precedence. In the case of social systems of all kind, both structure and language, both organizational arrangements and epistemic communities, involve frameworks of benefits and special privileges. Any existing order benefits some particular individual or group. Someone will always benefit from preserving the status quo and will, therefore, resist change. Resistance to land reform by land owners, resistance of slave owners to the abolition of slavery, or resistance to various reform legislation by various interest groups are only a very few examples. Of particular interest here is the case where a manager, bureaucrat, government, or monarch, is placed in position to oversee reform, where it should be itself a prime target for change.

Understanding Crisis

Typically, in all change situations, especially those of second order change, elements of the four factors interact and combine to make the required transformation genuinely demanding. It is important to fully appreciate this impact on our ability to produce change in a smooth continuous fashion when change is required and, in fact, in this particular sense the very need for second order change can be interpreted as a crisis condition. The mere fact that we have gone so far as to require such a major transformational undertaking means that we have entered a crisis condition. The underlying characteristic, you will recall, is that a system "freezes" in a habitual mode while the context of its existence has changed. It keeps doing what it has always been doing, applying procedures which can no longer produce the intended results.

We are now in a position to define crisis in a way somewhat different from the dictionary. Crisis is basically a failure in adaptation. From the point of view of cybernetics the situation is that of insufficient variety in the decision rule, insufficient variety in the R that we talked about earlier. More specifically, from this perspective, crisis is a failure to produce second order change. A failure in transforming the decision rule itself.

So what characterizes crises situation in general? Three key things come to mind, three essential failures. First is a failure of identification. All the factors we talked about earlier: the genuine complexity of situations, the epistemological blindness, the structural issues, and the entrenched prerogatives of vested interests combine to ensure that serious threats are often ignored until it is quite late and you find yourself in major difficulty, you find yourself deep in a crisis situation. Next there is a failure in response. Again, the very same four factors are often responsible for the failure to produce a correct response, the right strategy, the required new decision rule. As already noted, it is not uncommon to witness attempts at second order change pursued with first order change strategies. The distinction is critical because confusing one approach for the other is bound to fail. Even now, for example, many of the policies involved in the "rescue package" about which we read daily in the press, are really first order kinds of strategies often produced by the same "experts" who were instrumental in producing the mess in the first place. Finally, there is the failure to prevent run-away, exponential amplification of deteriorating conditions. Under the pressure of crisis, motivated by fear and reflex, actions are taken, or held back, in a manner which fuels a downward spiral that may actually aggravate an already bad situation.

System thinking and cybernetics could be vital in helping avert such situations. These disciplines offer powerful tools which can help navigate a complex world. Unfortunately both are not yet universally familiar and they rarely impact on mainstream thinking. The central question we need to face, the management question of the highest priority, is whether it is possible to manage human affairs in a manner which would avoid these kinds of crisis conditions. This, after all, is the ultimate function of civilization – to ensure enduring well being, and reduce the threats to a wholesome existence, smooth out, if you will, the difficulties of life.

The Challenge of Sustainability

All this brings us to the question of sustainability and to what is arguably a looming crisis of unprecedented proportions which could engulf the

whole of humanity and many other forms of life. Let me start by clarifying some terms.

It often tends to happen that when a new term, bearing shift making connotations, is introduced into a language it loses some of it essence, some of its deeper meaning, as it gains popularity. This could be observed with the great abuse of the term "system" some years ago and it is happening with the increasingly common use of the term "sustainability" today. The word, which was introduced only relatively recently, has been stripped of its essential meaning as its very loose, broad-based, superficial use continues to spread even by those who should know better. In the world of multilateral institutions which finance development, for example, you can hear people talk about "sustainable financing," meaning whether development loans will be actually repaid. You can hear people refer to "sustainable projects" and this time your hope is excited that perhaps the reference is to projects that somehow reflect fundamental principles of sustainability; but no, the question is whether the project will carry itself, will be self supporting, after the subsidies expire. Similarly, you will find various commentator refer to "the sustainability of the stock market bubble," "the sustainability of the housing market," even "the sustainability of corporate brands." In all such cases, of course, the use is grammatically correct but it has very little to do with the deeper issues of sustainability of the kind we are facing today on the planet.

Precision in language can be very important especially when trying to identify, target and articulate effective direction for change. A loose terminology can obfuscate intentions and easily lead one astray. So let me invite you to sharpen our view and focus on what "sustainability" means. First and foremost, the concept pertains to a particular kind of balanced interaction between a population and the carrying capacity of its environment. It can be any population in any environment: amoeba in a Petri dish, algae in a lake, predators in a particular ecosystem, or humans on a planet. Ultimately, it must be this kind of balance which must be the focus of a meaningful definition of sustainability. The interaction itself is of the circular type that we talked about earlier where the two sides of the equations, continuously affect one another. An environment and its carrying capacity obviously define what kind of population is possible in the first place, but populations, in turn, alter environments defining in the process the nature and composition of the environment itself. The long history of the biosphere bears witness to this kind of process where basic conditions, chemical composition and temperatures for example, brought forth early forms of life which altered the original composition of gases in the atmosphere thus allowing new forms of life to evolve and so on.

The focus on populations and carrying capacity as I am suggesting here, takes a different approach from the one underlying the prevailing definition of sustainability, as coined by the Brundtland Commission of the United Nations. Taking a cross-generation equity approach, the commission defined sustainable development as a form of development which answers current development needs without jeopardizing the needs of future generations. Any society which is mindful about its future needs to be concerned, of course, with future generations. As it stands, however, this formulation is not adequate in defining sustainability for a number of reasons. It is not always easy to determine utility values for future generations and, perhaps even more importantly, from the view point of democratic ideals it may be a bit unfair to attempt to do so, since no representatives of the

future are with us around the decision making table to offer their views.

The definition that I would like to offer instead is as follows: **Sustainability pertains to a dynamic equilibrium in the process of interaction between a population and its environment such that the population develops to express its full potential without producing irreversible adverse effects on the carrying capacity of the environment upon which it depends**.

You will note that the approach, the departure point, is entirely different and the result is a clear, unambiguous concept which offers a better operational leverage. In fact, all the key variables involved are measurable. For example, population numbers, rate of consumption of resources, impacts of waste by-products, a defined basket of utilities per capita under a particular technology regime, even a measure of well being should be possible. Moreover, it should actually make possible computing a "global sustainability index" and indicating whether we are in or out of balance and specifically where.

Members of the Bruntland Commission were experienced, wise individuals. Why did they opt for a definition which offers very little actual guidance for action? I can only suggest a speculative answer to that. At the time of the commissions deliberations the two most critical variables for defining sustainability, population and carrying capacity, were two sacred cows which could not be touched. Developing countries did not want a discussion on population since that is where most of the exponential increase is taking place. In fact, serious reference to the issue of population would be accused of being a new form of imperialism with the industrial powers attempting to keep other peoples down. The developed countries, in turn, were not too eager for anyone to talk about carrying capacity, since that would require focusing on their relatively high consumption, with the related resources depletion and pollution. So as is often the case in the world of international diplomacy the focus turned to the lowest common denominator to which all could agree. No one would argue against the idea of caring for future generations, especially when it does not require specific commitments to actions and goals. Rhetoric can be passionate but action, real change need not follow.

The dynamic interaction of population and carrying capacity is quite complex. I will only point out here that a population impacts the carrying capacity by its activity, basically through two essential channels: the demand on resources, and the generation of byproducts which the environment has to be able to absorb. On these two accounts we are grossly out of balance. To put it in simple terms, we are currently over consuming and over polluting at rates which exceed the capacity of the biosphere to recover. You are all familiar with the exponential population growth trajectory which characterizes the last few hundred years. All major trends depicting critical aspects of human activity follow a similar trajectory. You will see it in the rate of increase in the world industrial production, the rate of increase of CO2 concentration in the atmosphere, the rate of discovery and isolation of the chemical elements, the rate of energy consumption, and many more. The later is particularly significant. World energy consumption has nearly quadrupled since the Second World War with people everywhere seeking a better life. Total demand is only likely to double again in the near future with India and China entering the equation, all this, while relaying almost entirely on depleting, non-renewable, highly polluting resource. We have no global energy strategy and the world continues

on a senseless path betraying the blind trap of the kind I tried to characterize earlier.

Charts depicting the dramatic acceleration in population growth since the industrial revolution are accentuated even more if the trend is viewed against a time base-line of some 18,000 years of history where human population basically hugged the base line, until very recently consistently under the one billion mark. When viewed from this perspective, the recent change looks like a sudden vertical spike on an electrocardiogram, which we are at peril to simply ignore since it represents an entirely new phenomenon. Most people who deal with the population issue tend to focus on the slope at the very end of the vertical spike arguing whether we shall end with 9 or 10 billion people on the planet. The actual slope, however, is actually marginal in relation to the bulk of the change that has already occurred. The point is that we have absolutely no experience with such numbers. There has been no precedent for managing 9, or 10 billion people on Earth. All our basic concepts, institutions, economic calculations, and governance modalities, all inherited from a fundamentally different past, are not likely to be adequate to the task.

Interestingly enough, incidentally, while we may be able to understand the underlying dynamics of population growth – the technical aspects of the trend – we really have no clue about the big why? Why, functionally, is it happening in the first place? Some would be quick to argue that it all represents a fundamental pathology, not unlike an out-of-control cancerous growth that is only bound to ultimately kill its host. Other interpretations are possible, however. Perhaps nature is attempting to amplify intelligence on our planet, producing an increasing stock of brain material, so that consciousness has a better chance of fulfilling its essential cosmic function in this part of Universe.

Looking at relevant trends concerning population and the impacts of human activity, it is legitimate to ask: what does all this mean? What is actually going on? It seems to me that there are three possible answers to such a question. The first puts the emphasis on the idea of "limits to growth" as perceived from current concepts of what is possible. The argument, which can be found among many environmental economists, and others, goes basically as follows: human activity used to be tiny in relation to the biosphere as a whole. The economy expanded to the point, that it now overshadows the planet in shear size. Consequently, we need to retract and shrink current levels of activity significantly, go back completely to a "small is beautiful" kind of existence or else, face a major calamity. The other view, perhaps best represented by the previous American administration, is still typical to many business leaders and to most of the public at large, seems to regard these trends as minor events, blips of secondary importance at best. Things will be fixed as we go along and it is basically "business as usual."

There seems to be yet another way of looking at things that is suggested by Fuller's design philosophy. From this perspective I would argue, that all the signs of stress we are witnessing, climate change, ozone depletion, alarming loss of biodiversity, water scarcity, loss of fertile soils, growing social and economic inequities and more, are all symptoms of blockages caused by yesterday's ways of doing things – blockages that are standing in the way of a new global integration of human affairs. A new reality is attempting to blossom and we are not facilitating the potential transformation by resisting the necessary change and holding on to our familiar ways of doing things. Entirely new possibilities are attempting to emerge but these are being constrained by all

the conventions of yesterday. In the context of our earlier discussion about change, we are constraining future possibilities by operating obsolete decision rules. We are not allowing new possibilities to take root by sticking to old assumptions about ways of doing things – assumptions about the purpose and structure of the economy, about how organizations work, about what leadership means and how it should be exercised, and more.

This third perspective is a proactive one. It calls for us to project a coherent image of a desired future for humanity and the planet then, collectively, marshal our resources and wisdom to ensure that our new goals are attained. I would hasten to add, however, that there are knowledgeable individuals who argue with conviction, armed with persuasive data and charts, that humanity has already missed the opportunity to bring about the necessary change in time and restore the kind of balance called for by the sustainability equation. But think about it, the overall efficiency of our whole industrial infrastructure is very low. Some suggest rates of well over 90% inefficiency. This means that over 90% of all industrial production activity is actually generated waste. So there is a vast room for improvement here. Even a mere doubling of overall efficiency, which may not require inconceivable technical breakthroughs, could make a huge difference. Timely change is of the essence and the opening session of our meeting, established "the great transformation" as a central theme. The context needs to be expanded however. Not just the transformation in management of this or that company, but a deep transformation in managing human affairs on the planet. The world's financial crisis is real enough, but it will pale in comparison to collapses that are inevitable if we do not change course in time. We are all passengers on a train that is rushing straight into a wall while a party goes on merrily onboard and little is done to avert an inevitable collision.

Transforming world society and its economy to a sustainable basis is the most urgent challenge of our time. The objective is to foster a well functioning alignment between individuals, society, the economy and the regenerative capacity of the planet's life supporting ecosystems. This challenge is completely unprecedented in its scope. It has all the characteristics of a second order change and it has to cover all key dimensions of the human experience. It has to involve a comprehensive, integrated transformation in our existing mental models, in the competence and focus of our technology, in the underlying assumptions and structure of our economy, in the way we behave in the biosphere in relation to all other species, in the way we interact with each other, and in the fundamental values that we hold sacred. The latter in particular, call it the necessary spiritual reorientation, is of great significance since ultimately, it anchors everything else. Everything that we do has to cohere and synchronize harmoniously with the great cycles of life and with the patterns of matter and energy conversions. Financial markets cannot be the singular most significant driver. Instead of abstractions upon abstractions of financial instruments increasingly divorced from real, enduring value, a new measure of wealth is required. We need to develop a new planetary currency which will reflect the essential relationship between available resources, our relative capacity to extract advantage from these, and some comprehensive measure of well being for all.

Temperamentally I tend toward proactive action, so "what," you may ask, "are you actually doing as a result of these thoughts?" Well, after many years of working on issues of sustainable development, in many parts of the world, I came to understand

the severe limitations placed upon leaders in the multilateral development agencies and private sector enterprises who wished to incorporate a commitment to sustainable development in the work of their organizations. In the international public sector arena, the requirement for decision by consensus tends to make it impossible to remain true to the actual nature of issues for long. In the private sector, the existing economic accounting framework, does not allow too much room for choice. As a result, much of the chatter we hear today about sustainability related intentions, corporate social responsibility, and the like, fall squarely under the category of first order change which is unlikely to bring about the necessary transformation. On my part, I decided that it would be interesting to establish an international Sustainability Laboratory that would have the mandate to act as a catalyst for change and produce, over time, a portfolio of breakthrough demonstrations, approaches and models, which could be inspiring and helpful to others.

There are four basic tenets behind the idea of the Lab. One is a fundamental vision of the future in which the concept of sustainability is established as the driving, organizing principle on the planet. Second is a cutting edge theory that is embodied in the five core principles of sustainability – a guiding framework for action that was developed by the Lab. The third is a comprehensive design strategy and a commitment to a design approach rather than to mere political activism, as advocated by Buckminster Fuller. And the fourth is to actually manifest all this through action in the world. The project we are currently doing with a Bedouin community in the Negev desert is an example of that.

I met Buckminster Fuller just as I was starting my first year's study of Architecture in London. At the time he was advocating a project whereby all architectural schools in the world would collaborate in a ten years program to redesign the world – "to make the world work," in his words – an impossibly naïve idea, perhaps, but one, the like of which is sorely needed now.

We are out of time, so allow me to close with an inspiring quote from Fuller which captures beautifully the essence of the challenge of sustainability, the challenge we need to urgently face creatively and collectively. It is the big design challenge of "how to make the world work for a 100% of humanity, in the shortest possible time, through spontaneous cooperation and without ecological offence or the disadvantage of any one."

Thank You.

Michael Ben-Eli is Founding Director of the Sustainability Laboratory.
This new initiative follows a distinguished career as an international consultant, pioneering application of system thinking and cybernetics in organization and management.
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