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■ *Research Paper*

What Can Cybernetics Contribute to the Conscious Evolution of Organizations and Society?

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This contribution is based on the Ludwig von Bertalanffy Lecture delivered by the author at the 47th Conference of the International Society for the System Sciences (ISSS) in Crete, 7 July 2003. The conference was organized around the issue 'Conscious Evolution of Humanity: Using Systems Thinking to Construct Agoras of the Global Village'. This article explores the potential and actual contributions of cybernetics to organizational and societal evolution. The focus is on the models and conceptual tools of managerial cybernetics. When properly used these can become powerful pivots of an 'evolution by design', as opposed to an evolution at the mercy of mere chance. Copyright © 2004 John Wiley & Sons, Ltd.

Keywords management cybernetics; organizational cybernetics; viable system model; model of systemic control; team syntegrity

INTRODUCTION

The title of this contribution establishes a link between the motto of this conference and my personal work. My endeavour in research and education is to make the systems approach fertile for organizations and society. I am aware that this plenary comprises members of different strands of the systems movement. Therefore I have tried to structure my talk along a range of concepts probably shared by all of us:

- complexity;
- autonomy;
- recursion;
- control;
- communication.

COMPLEXITY

The world is in crisis. Problems everywhere: the yawning chasm between rich and poor, ecological catastrophes, economic instabilities, drugs, corruption and crime, terrorism and social decay, epidemics running amok—you name it. Everything is questioned, at risk, in danger, even the survival of humanity as a whole. We create a cornucopia of technologies and instruments, and we reap a Pandora's Box of problems.

Cybernetics, the science of communication and control (Wiener, 1948), has its own way of

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examining these crises. It understands them to be crises of regulation, and it offers powerful concepts and models for dealing with them—not only in the therapeutic mode, but also by prevention: how can we design robust, virtuous, viable systems?

We stand on the shoulders of giants like Wiener, Ashby, McCulloch, and others, who gave us the theoretical foundations. Stafford Beer endowed us with his pioneering works on managerial cybernetics. Finally Heinz von Foerster's cybernetics of cybernetics, i.e. the introduction of the observer, and Luhmann with his sociological systems theory, have rounded this out to a theory for the explanation and design of social systems, unequalled in maturity and potential.

Cybernetics is about how to cope with the challenge of ubiquitous complexity. Complexity is a multifaceted term; there are many ways of defining and capturing it. Let me start with Ross Ashby's work. It opens new horizons to anyone who studies it—if he or she grasps it. Complexity, in Ashby's sense, is essentially conceived as a system's potential to assume a large number of states, and we also have a measure for it: *variety*, the number of states a system can assume. This has been calculated by formulas to measure the number of

(a) configurations of relationships or
(b) constellations of elements or
(c) both.

As the respective numbers become exorbitant, Ashby (1957) suggested measuring variety in terms of bits, i.e. the logarithm to the base 2 of the respective number.

If we look at organizational regulation, the salient problem is one of a huge divergence of the varieties of an agent—be it an individual, an organization or a team—and the situation he or she faces (Figure 1). The challenge then is to bring the varieties of the two interacting systems into balance:

(a) by means of attenuating the variety of the specific environment; and

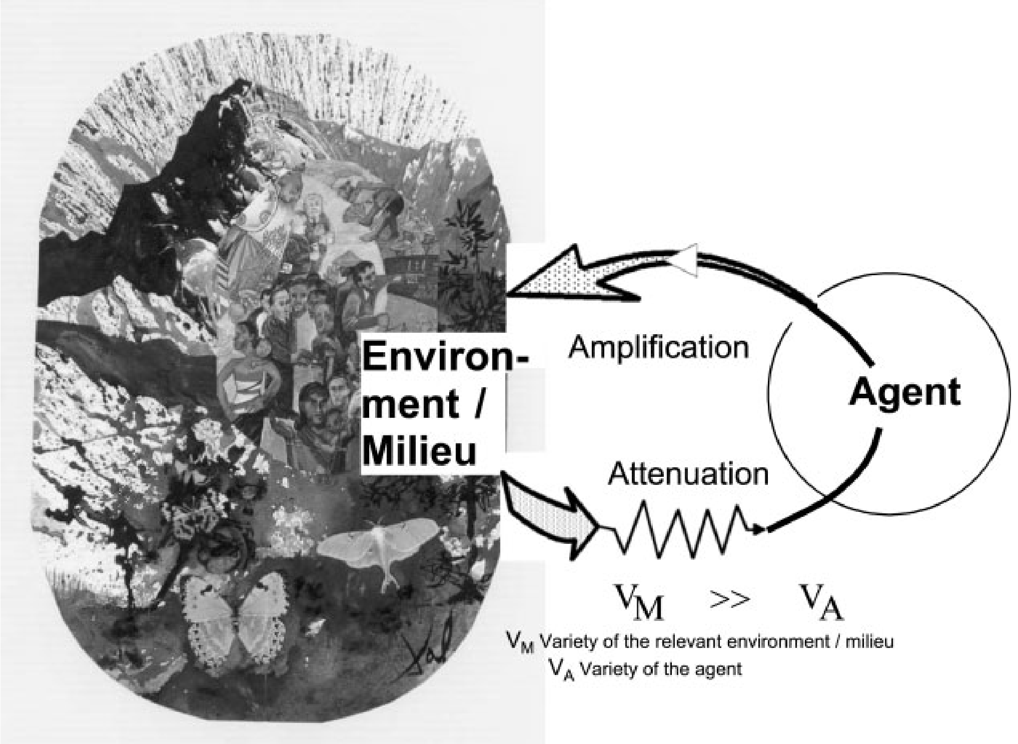

Figure 1. Coping with the complexity differential

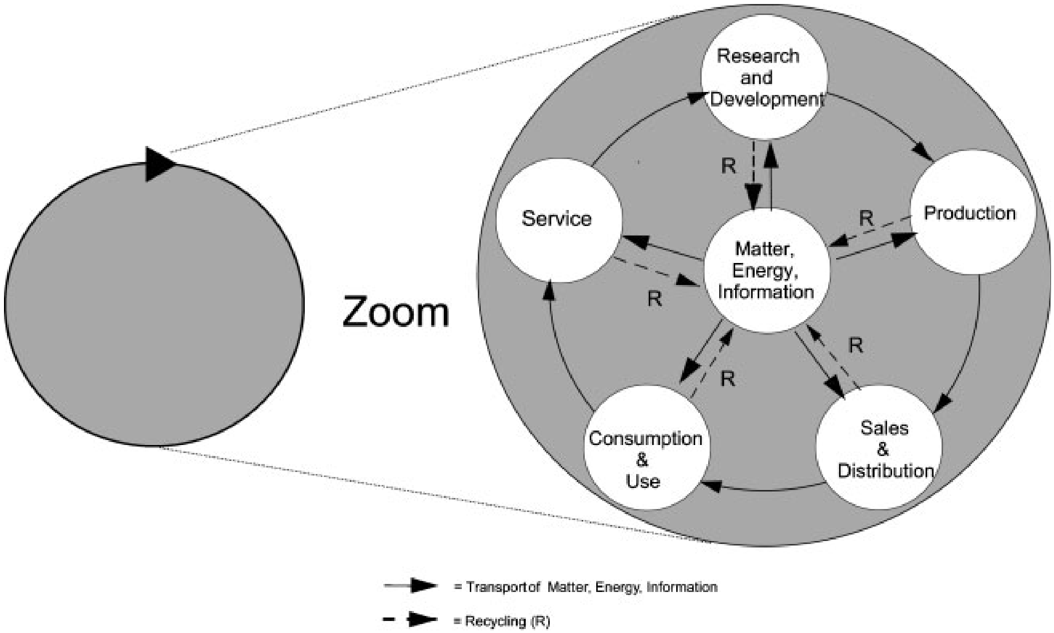

Figure 2. Autonomous units: basic building blocks of viable systems

(b) by amplification of its own variety ('eigen-variety') or repertory of behaviours.

This process of 'variety engineering'—as Stafford Beer (1979) called it—can only be effective if the actor chooses an environment with which he is able to coexist and co-evolve in the long run. Defining the purpose and the domain of activity of the organization from a complexity standpoint, therefore, is of crucial importance. The main trap here is adding eigen-variety without knowing one's own limitations, that is, losing focus.

The crucial concept here is 'requisite variety' from Ashby's law: 'Only variety can absorb variety' (Ashby, 1957).[1] This law is *the fundamental law of management*, which essentially has two tasks:

(1) Given the variety differential already addressed, bringing the varieties into balance.
(2) Ensuring that the system managed does *not* take on *any* possible state, but only the desirable ones.

[1]Stafford Beer inserted 'absorb' instead of the original 'destroy' (Beer, 1966).

So much for the 'What has to be done?' When we are asking the question for the 'How', things become more intricate.

AUTONOMY

A master strategy of higher living systems for coping with overwhelming complexity is integrity. 'Integrity' is another word for health, and denotes wholeness or absence of fragmentation. The epitome of integrity is the whole.

To survive and develop, wholes must have high levels of autonomy (from *autos* for self and *nomos* for law); in other words, self-governance. This is not to be confused with independence or isolation. Autonomy is rather the responsibility of a system 'for its own regulation' (Beer, 1981, p. 103).

It is this autonomic control which is essential for a system to maintain a stable internal milieu. But it is also essential for an efficient adaptation to changes in the external environment. The beauty of a living organism's adaptation hinges crucially on this autonomic function, which is also the basic building block in Stafford Beer's *Viable System Model* (Figure 2).

Stafford went beyond the aspect of autonomy; he asked for the organizational prerequisites for the viability of systems. In his model, a set of functions is distinguished providing the necessary and sufficient conditions for the viability of any human or social system. These functions and their interrelationships are specified in a comprehensive theory, the claim of which is stronger than that of any other theory of organization:

An organization is viable if and only if it has a set of management functions (named Systems 1 to 5), with a specific set of interrelationships identified and formalized in the model.

For details, see Beer (1979, 1981, 1985). The model was also presented in this journal in an earlier paper (Schwaninger, 2001a).

Systems 1–2–3 (including 3*) constitute operative management, System 4 (in interaction with System 3) strategic management, and System 5 the normative management of the organization.

In this structure, each primary unit (basic unit with the regulatory capacity supplied by System 1) must possess high autonomy in order to be able to adapt to their respective environment or milieu. The combined activities of Systems 1, 2, and 3 (including 3*) provide for management of the present and short term. System 4 is the fulcrum for long-term adaptation and System 5 the embodiment of the ethos, the governing principles and values. In a democracy, System 5 is 'the people'.

Any deficiencies in this system, such as missing functions, insufficient capacity of the functions, or faulty communications or interactions between them, impair or jeopardize the viability of the organization.

The strength of the VSM lies in three aspects:

(1) *Its generality*. The model is applicable to any kind of organization, large or small, but also to larger social systems, cities, regions, nations.
(2) *Its rigour*. Stafford was inspired by the structure of the human nervous system, but he went beyond mere analogy, identifying a mathematical invariance. The relationship is homomorphic, and the model embodies an isomorphism.
(3) *Its validity*. This theory has not been falsified.

Those of us who have applied it know about the extraordinary diagnostic power of the VSM. But there is more to it—*recursion*.

RECURSION

Ever since Benoit Mandelbrot published his 'Fractal geometry of Nature', we have become aware of the power of fractals to represent natural phenomena—plants, clouds and landscapes. Fractals are the product of recursive functions, i.e. formulas applied onto themselves in iterations, as anyone knows who ever programmed a loop around the formula of the type $t = t + 1$.

Fractals, like other figures from chaos theory, have become popular metaphors used in the discourse about organizations. Warnecke's book on the *Fractal Factory* is one of the best-sellers of management readings. His postulate on the use of invariant principles of organization on different levels of resolution is good but not implemented with the necessary rigour. A far more rigorous principle of design is provided by the VSM: the principle of recursion. Here is the second proposition of the VSM:

The viability, cohesion, and self-organization of an enterprise depend upon the specified functions being recursively operating at all levels of organization.

I illustrate this by the example of a leading media corporation in Brazil, where I applied the VSM in a consulting project. Figure 3 depicts the three divisions—Publications, Television Channels, Phone directories—with the metasystem, in which several structural issues had to be sorted out.

Next we see the recursive sequence of the same basic organization unfold over four levels (Figure 4).

The power of the recursive design lies in the architectural principle of building up eigenvariety along the fronts on which complexity unfolds. The concept of recursion is probably one of the most valuable contributions of the systems approach to the future of humanity. Let me illustrate this in relation to the issue of sustainability. I have heard so many disputes on whether sustainability lies under the responsibilities of

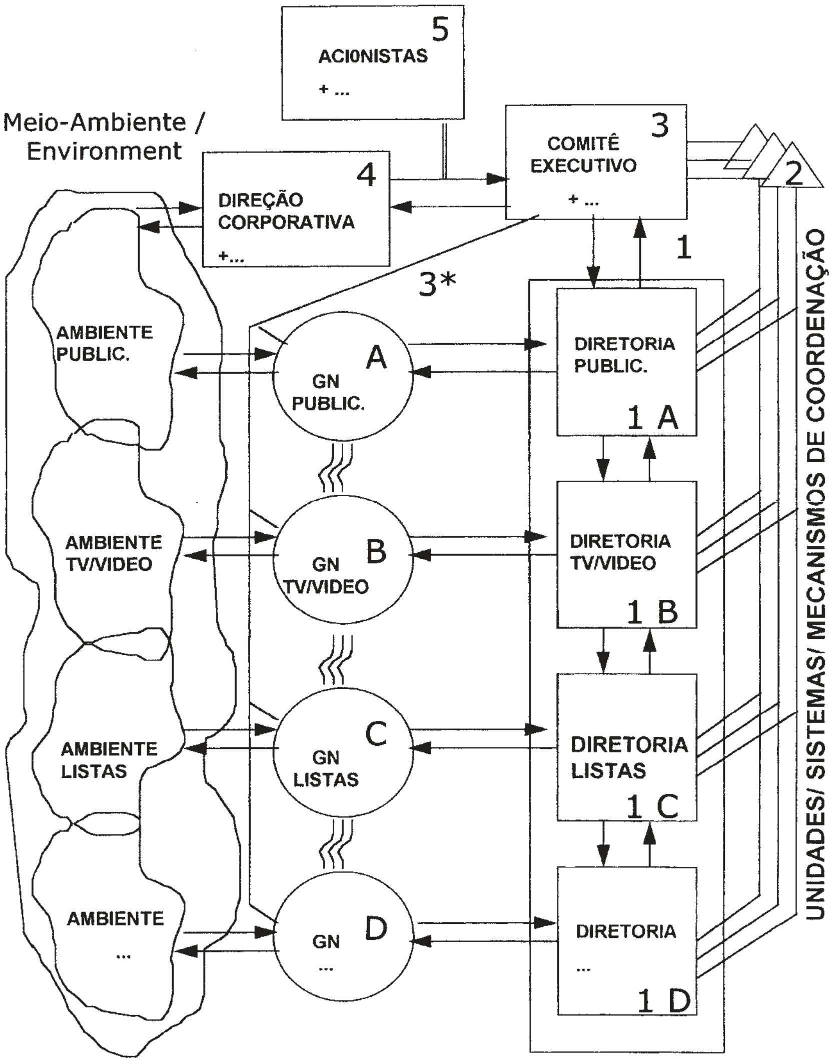

Figure 3. Viable system model—Brazilian Media Group

countries or continents or even the world, while others assert that it is only a matter of responsible citizens. I heard one of the world authorities on sustainability laugh at the endeavour to create a regional initiative for sustainability where he lives. Recursion gives us the key: sustainability can only be brought about via the recursive effort at all levels, from citizen to world. There are different, but equally important regulatory issues at each one of those levels. This is illustrated in Figure 5, a scheme I contributed to the foundation of the Plato Network, a joint initiative of politicians and scientiests in cooperation with the Club of Rome, UNESCO and the European Union.[2]

The recursion principle provides for a system design by which control, organizational fitness and intelligence become distributed across the system. The separation of thinking and doing is abolished.

According to the recursion principle, all three levels of management—operative, strategic, normative—are distributed functions; with aspects

[2]The Plato Network was founded at the Futuroscope World Symposium on Network Media, in Poitiers, France, March 1999.

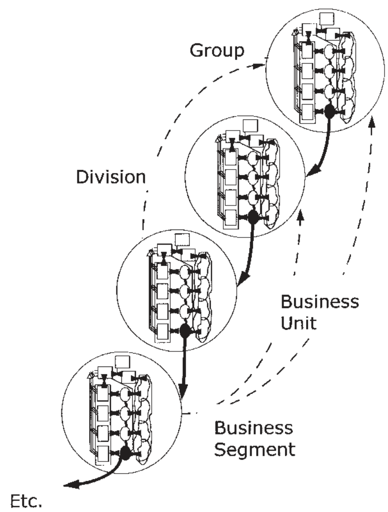

Figure 4. *Recursive structure—Brazilian Media Group*

such as control, intelligence and ethos being properties of the system as a whole, but also inherent in wholes of all further levels of recursion. This contradicts the oft-repeated comments that 'vision is the concern of the entrepreneur' or 'strategy is the duty of the board of directors'. Vision is a function of the metasystem: to be precise, it is one of the functions of the normative management of every viable unit. Equally, strategic thinking is necessary even in the smallest units, if those units are conceived as viable wholes.

CONTROL

Now let us get back into the individual primary units of the organization—i.e. the basic units with their regulatory capacity. We started with

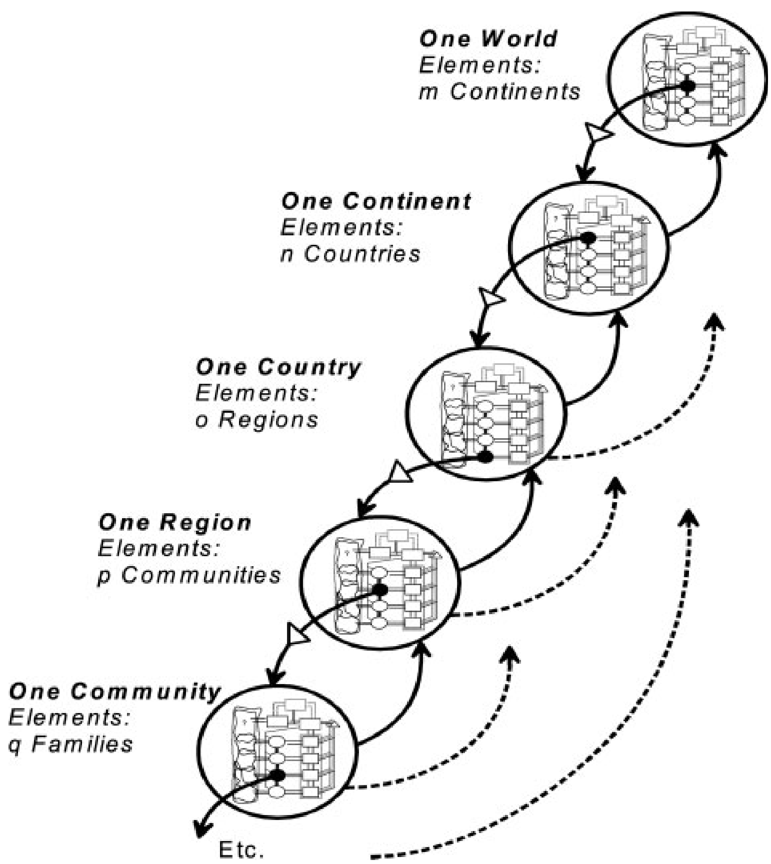

Figure 5. *Structural prerequisites for sustainability*

autonomy and we carry on with its complement—control.

The traditional feedback cycle is not sufficient for social systems, however. In opposition to lower organisms, e.g. the amoeba, the viability of organizations calls for multilevel control, not only in terms of recursion, but also in terms of logical hierarchy. We have seen this in structural categories, in the five VSM homeostats. But we also have to differentiate our control model accordingly.

If the Conant–Ashby theorem—'Every good regulator of a system must be a model of that system'—is true (Conant and Ashby, 1981), then the quality of the models we use is the primary critical factor of management: The results of an organizational process cannot be better than the model on which the management of that process is based—I must add, '... except by chance', because stochasticity can also favour the fool, at any time.

A serious problem is that many organizations are still managed on the basis of inadequate models. The prevailing models of management are almost exclusively oriented towards profitability. The return-on-investment-based system of indicators is well established, but it is insufficient. In a context of rapid change, profit rates are inadequate for measuring the performance of an organization. In principle they are not much more than short-term and partial indicators of the success of a business. In addition, we have seen that stock prices—which are based on profit expectations—tend to be grossly spurious. The pertinent models do not have requisite variety. Therefore, relying on them is likely to be misleading; they will probably point precisely in the wrong direction. The following analogy is useful: assessing the effectiveness of a business by the level of its profits is like measuring the temperature to decide what season it is; for this purpose, the calendar, not the thermometer, would be the appropriate source of information. Long-term-patterns are driven by different causal mechanisms which double-entry book-keeping is unable to ascertain. It is essential to make this point in the face of the frenzy of management by financial figures, where short-term thinking tends to drive out long-term orientation.

Under the evolutionary pressure of increasing complexity and turbulence, new control models have emerged, which allow for a much higher variety than do the traditional ones. The Model of Systemic Control (MSC), which I am presenting here, is based on the essential insight that a system must govern itself by means of control variables that may contradict each other because they belong to different logical levels.

In the following graph we recognize the three levels embodied in the Viable System Model: operative, strategic and normative management (Figure 6):

- Operative management is about delivering *value* to stakeholders.
- Strategic management is concerned with the creation of *potential* to enable the delivery of those benefits.
- Normative management provides the ethical foundations for a *viable* enterprise—the identity of the organization and the values governing it.

The essential control variables for a business at the operative level are the determinants of liquidity and profit. Ever since Luca Pacioli introduced double-entry book-keeping (in 1494), we know that these are two distinct objects of thought and action. Note that this had not been known until then! For anyone understanding 'modern' book-keeping, *the pre-control effect* which profit exerts on liquidity should be clear. If profit is strong, this will affect liquidity positively. This effect will usually occur with some time lag, because the time-related natures of profit and liquidity are distinct: *liquidity* materializes immediately as a consequence of income and expenditure; *profit* has a longer time horizon, because its components—revenue and cost—span longer periods (visualized on the horizontal axis). Consequently, the determinants of liquidity, and those of profit, have to be booked separately. The implication for control is that the level of profit is an early-warning indicator with respect to liquidity. If profit is negative once, this can be compensated for with accumulated reserves or via credits. However, with repetitive losses, the system converges toward illiquidity, until bankruptcy becomes inevitable. So much for the *operative level*.

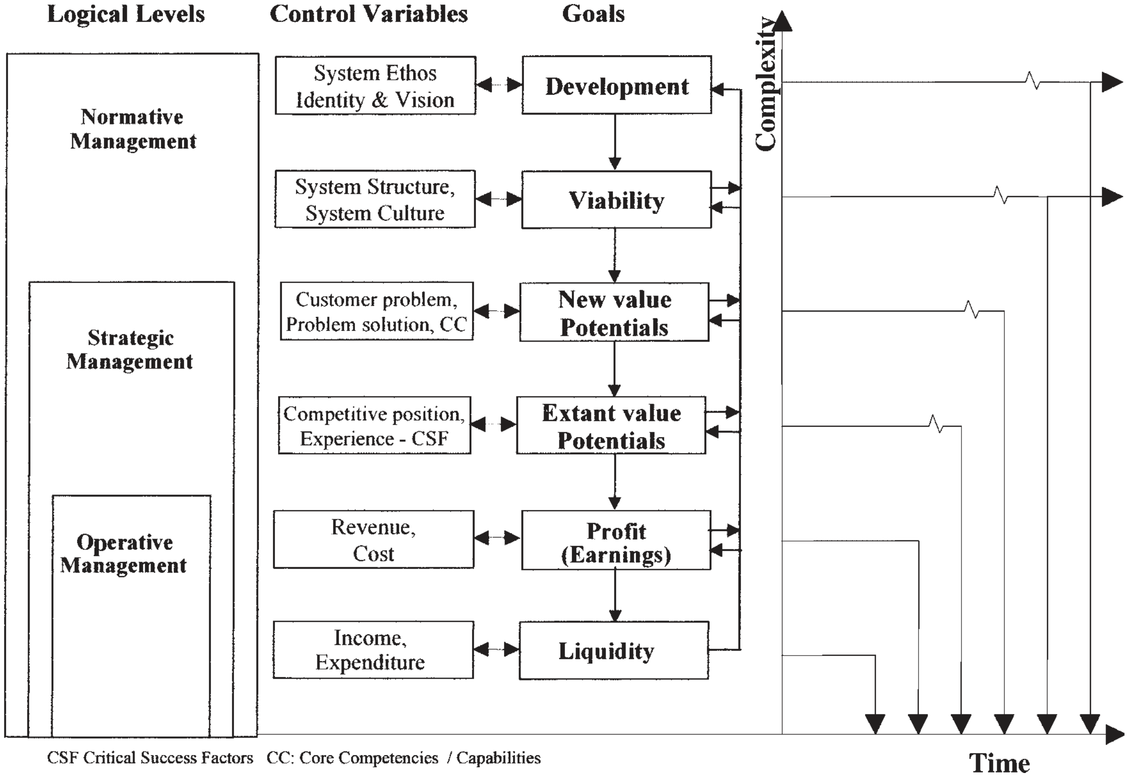

Figure 6. Model of Systemic Control—detailed version[3]

Beyond that, however, a comprehensive theory of the higher-order variables of control has emerged. It discloses the really powerful levers for influencing the destiny of an organization. Those exert a pre-control function in relation to the controls of the operative level just outlined.

Pre-control is about the anticipative creation of prerequisites at a higher logical level for effective control at lower logical levels of management, as shown in Figure 6. Why do high-performing firms achieve sustained profitability over the long run? The answer is a general one: apart from steering events efficiently on a day-to-day basis, they have an effective higher-level control mechanism in place.

On the *strategic level* the control is for value potentials, i.e. the preconditions that must be actualized whenever concrete value is to be delivered to stakeholders:

- customer benefits to clients (also 'patrons', from Latin *patronus*—lords, protectors, supporters!);
- remuneration and a high-quality working place for employees;
- profits to the sponsors, etc.

The determinants of value potentials are usually referred to as critical success factors and core competencies.

Finally, on the level of *normative management*, the control is for the *viability* of the organization—maintenance of a separate existence and identity—in the first place. The VSM is a reference model for diagnosing the viability of a firm, even without knowledge of the details of the operations or even of the strategy. I have made the point in my writings (e.g. Schwaninger, 1984, 1993, 2000a) that the ability to survive is not

[3]The goals and control variables referred to at the operative level, in this version of the Model of Systemic Control (MSC), for the sake of didactics, are limited to the economic dimension of value. The more general version—along the lines of Figure 6—refers to the different dimensions of value, i.e. the benefits generated for the different stakeholder groups. The general version of the MSC was published in this journal earlier (Schwaninger, 2001a, p. 141).

the ultimate goal of an organization.[4] From a systemic stance it is a viability beyond survival which is at stake. Therefore, in Figure 6, *development* has been distinguished as a higher goal in its own right. Development can imply a profound transformation which may even imply a dismantling of the current identity and transition to a new identity of the organization.

At each one of these three logical levels, a different criterion of organizational fitness applies:

(1) At the *operative level* this is efficiency, with aspects such as quality, productivity, profitability.
(2) At the *strategic level*, it is effectiveness, in terms of both the abilities to compete and to collaborate.
(3) At the *normative level*, it is legitimacy—the ability to fulfil the legitimate claims of the relevant stakeholders.

In other words, a different language is needed for dealing with the issues at the various logical level; each one of them obeys a distinct rationale.

Meeting all three criteria simultaneously is the key duty of what we call a 'systemic' or 'integrative management'. And indeed, the distinctive feature of the organizations which are intelligent and valuable in the long run is that they meet all of these three interdependent criteria to a high degree. They are steered in a way that the control variables at all three logical levels are kept under control despite the contradictions which occur between them. Only such a model of multilevel control can dissolve these contradictions. My experience since the creation of this Model of Systemic Control in the early 1980s has been that this conceptual scheme is very helpful in (a) supporting strategic discourse, (b) weathering conflicts of corporate management and (c) building better tools for decision-making (e.g. simulation models).

At this point we can tie the VSM and the Model of Systemic Control together: it is incumbent upon the management at each recursion level to define the level-appropriate orientors and to lead their units in a correspondingly 'integral' manner. Here are two examples.

First, from the media firm mentioned above: the control variables differentiated for the enterprise as a whole, on a divisional level, and at the level of the business unit (Figure 7).

Second, an example from project management in one of the large development organizations of this world: I have done research there, and found out that the same logic is also applicable to project management (Figure 8).

More of my research has shown that this cybernetic approach is also a powerful trigger for better management of the virtual firm, but elaborating on that would burst the framework of this lecture (cf. Schwaninger, 2000b; Schwaninger and Friedli, 2002).

If we have been talking about (organization design and) control, the priority now is to address the 'second leg' of cybernetics: *communication*.

COMMUNICATION

The new theory of sociology defines ongoing communications to be the building blocks of organizations. All the arrows in the graphs of cybernetic models concern communication. But there was a need for a substantive protocol to make real-life discourse about complex organizational issues more effective. Those matters are full of uncertainty. Often they are not problems, but dilemmas. Tackling issues of that kind requires multiple people with different backgrounds to interact in a knowledge-generating discourse. Under the title 'Large Group Concepts', a number of approaches have been designed to support those processes: Harrison Owen's *Open Space*, Marvin Weisbord's *Future Search*, Aleco Christakis' *Cogniscope*, Ken Bausch's *Agoras* Co-Laboratories, Kathleen Dannemiller's *Large Scale Change*, diverse approaches to *Interactive Management*, etc., to name just a few.[5]

I will refer more specifically to one 'model' which emerged directly from Management Cybernetics: *team syntegrity*. As a complement to his VSM, Stafford Beer (1994) invented a

[4]This point was made early on by Russell Ackoff (e.g. 1981).

[5]For an overview, see Bunker (1997).

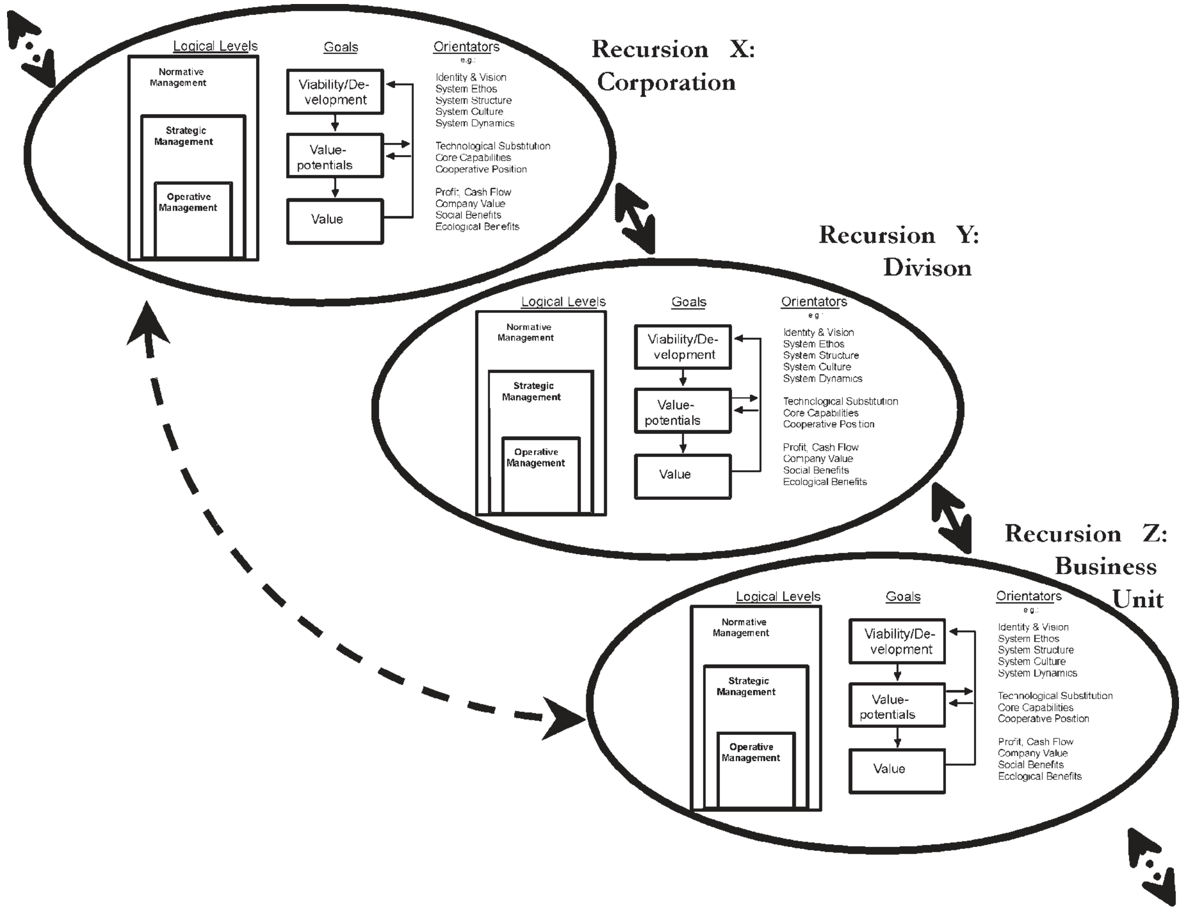

Figure 7. Operative, strategic and normative management are distributed functions

methodology for the design of democratic management in the sense of the heterarchical–participative type of organizations: this is very much in line with the title of this conference and I have been involved in the development of the respective methods.

Team syntegrity is a holographic model for designing non-hierarchical processes of communication, which are at the core of the (self-) management of social systems. Team syntegrity—much like the VSM—was inspired by brain research. Its futuristic design is based on the structures of polyhedra. Team syntegrity is especially powerful for the realization of team structures as well as for fostering organizational cognition and consciousness—processes of planning, knowledge generation, innovation and cultural growth in turbulent environments.

The formation of networks by persons in different locations who are connected by similar interests is a manifestation of the 'global village' and a structural answer to challenges of our times. An *infoset* is a set of individuals who:

- share a common concern;
- are in possession of pertinent knowledge connected with the subject; and
- are motivated to tackle the shared issue.

The term *syntegrity* comes from a combination of *synergy* and *tensile integrity*. Synergy (from the Greek *syn* and *ergon*) is joint work, to make the whole greater than the sum of its parts. Tensile integrity is the structural robustness provided by tension, as opposed to compression.

Such polyhedral construction has been used by nature for ages. It became famous through

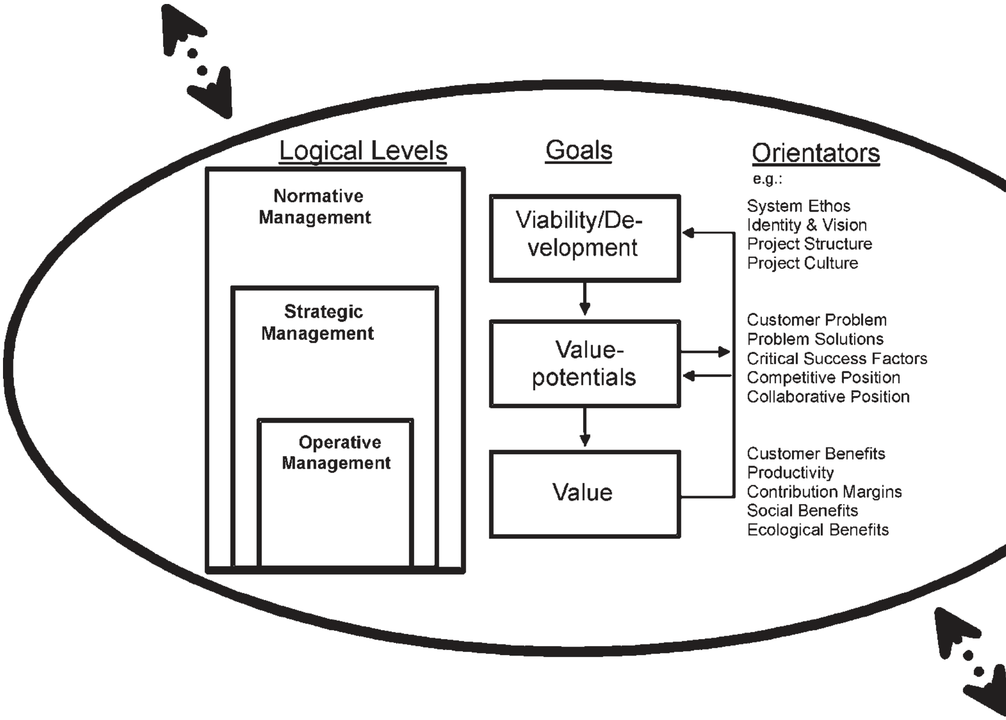

Figure 8. Orientors for a systemic project management

Buckminster Fuller's geodesic domes, and it has been discovered as the recipe for strength and elegance in organic chemistry in the C-60 molecule.

So why not design social processes along the geometry of polyhedra? As an example, I will outline the architecture of the model on the basis of the icosahedral structure.

The icosahedron—the most complex of the platonic solids (see Figure 9)—provides the structure commonly used to organize syntegration events—in this case with 30 participants. Variants for any other numbers are possible (cf. Ahmad, 1999; Truss *et al*., 2000).

Each member of a 30-person infoset is represented by one edge on the icosahedron. Each vertex stands for a team of five players (→ five edges) working on the topic. In an icosahedron there are 12 vertices—marked with different colours. As each edge connects two vertices, each individual is a member of two teams. *Ms. Red–Yellow*, for example, belongs to the teams *Red* and *Yellow*.

In addition, the individual is acting as a *critic* to two other teams (for example, Black and Silver, which are next neighbours). Altogether, the 30 persons fulfil a total of 120 roles (30 persons × 4 roles). Finally, there is the observer role, a connection to those teams of which one is not a member.

The process departs from an opening question, for example 'How can our state and society preserve and recuperate the environment?' in the Gorgona Syntegration in Colombia (Espinosa, 2003). The process is then organized in a number of phases, along which the Infoset:

- creates its own agenda;
- works on the topics in groups, usually in three rounds of group work; and then
- designs and initiates the process by which the generated ideas are put into practice.

To date about 200 syntegrations have taken place, in corporations, universities, state agencies etc. The subjects have ranged from regional planning to strategy and reorganization in firms and hospitals, from the preparation of peace negotiations to management education (cf. Schwaninger, 2003). And there was a first electronic syntegration, which Raúl Espejo and

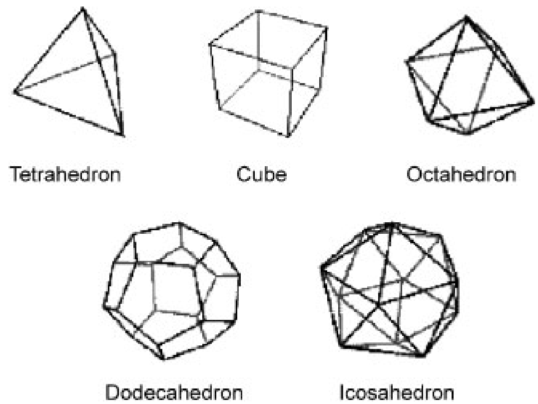

Figure 9. The platonic solids

I directed, where 30 cyberneticians from four continents and 16 countries produced the commemorative volume for Stafford Beer's seventieth birthday. The results are on a CD with the title 'to be and not to be, that is the system' (Espejo and Schwaninger, 1998).

One strength of team syntegrity is its strong theoretical foundation. For example, we have experienced many times how the self-organizing process in a syntegration leads to a high level of knowledge integration. There is no need for a centre to integrate the multiple efforts; integration just happens by itself.

It has been mathematically shown that this is a geometrically ergodic process, in which the eigen-value converges to a minimum: 90% of the information available in the system will be shared after three iterations (Figure 10). Consequently, sociometric studies by my doctoral students Hechenblaickner *et al*. (1995), *inter alia*, have ascertained significant increases of different measures of cohesion between the beginning and the end of syntegration events.

And finally, a theoretical study of mine (Schwaninger, 2001b) came out with a surprising result: the icosahedral syntegrity model shows a fractal dimensionality of 2.22. This number is identical to the value for higher organisms, considered optimal by biologists: a remarkable structural invariance!

OUTLOOK

I have outlined the potential of management cybernetics to contribute to the evolution of society and organizations, along three models which have emerged from the field. Multiple applications from all over the world and growing empirical evidence, documented in my

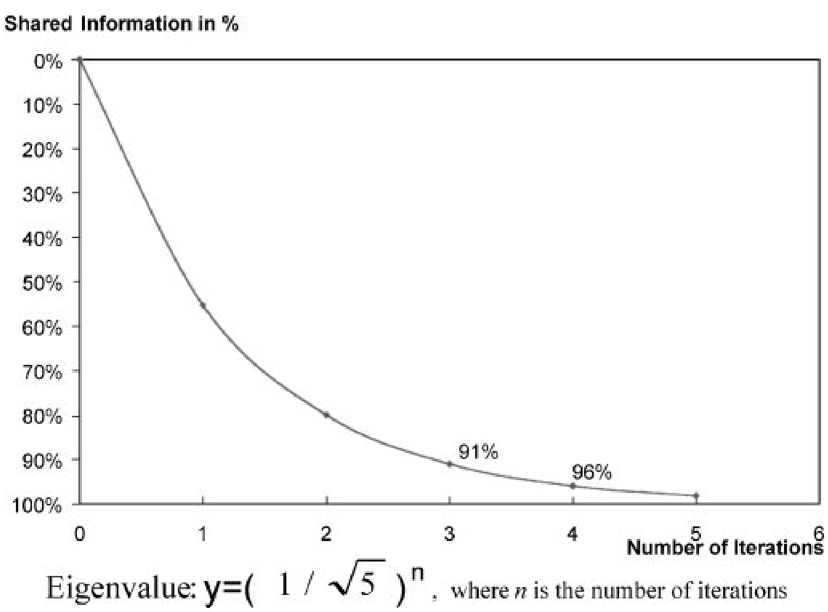

Figure 10. The growth of shared information as a function of the number of iterations of team meetings (after Jalali, 1994)

publications, testifies to the validity and usefulness of these models.

I have talked about the topics programmed by this lecture's title: evolution, society, organization. But what about the promise contained in the attribute 'conscious'? Was it lost along the way? The theory of evolution rests on the concept of randomness. With 'conscious evolution', I denote the path of social systems, which is not left to the mercy of chance. At this stage, an *evolution by design* is not only necessary, it is also possible. This kind of design is not one that anticipates what evolution will or has to produce. It has to be based on a discursive inquiry into what kind of society we envisage, and guided by ideals. It must be supported by careful study and simulations of paths into the future. And it has to focus on bringing about a context which fosters evolution within desirable bandwidths.

The evolutionary potential inherent in the models and conceptual tools of managerial cybernetics is huge. This gives us the courage to continue making it real, building bridges towards a sustainable future for humanity.

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