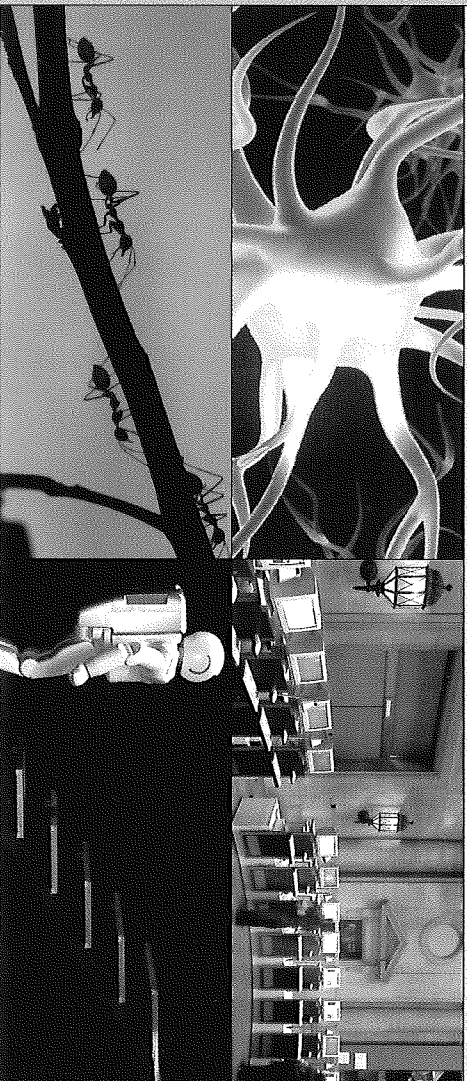


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**INTERDISCIPLINARY APPROACHES TO A  
NEW UNDERSTANDING OF COGNITION  
AND CONSCIOUSNESS**

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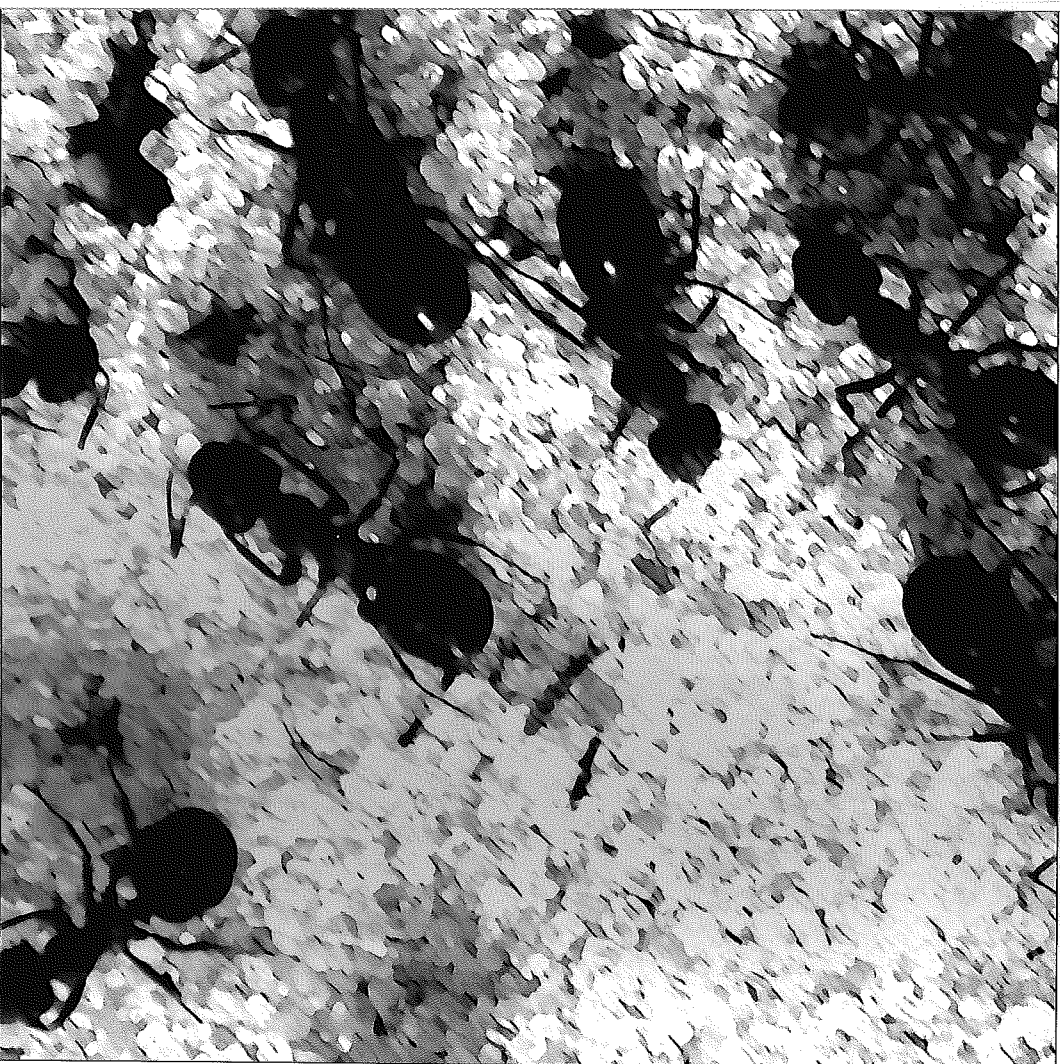
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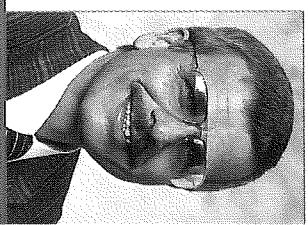
Markus Schwaninger  
**Self-Organisation and Self-Reference  
in the Cognition of Organisations**

## 1. INTRODUCTION

The aspects of cognition and consciousness are not a completely new subject for organisational research, but they have been underestimated, underdeveloped, and altogether under represented in the work of pertinent theoreticians and all the more of practitioners.

Management is, in principle, a transdisciplinary issue, and it has not only capitalised on economic theories, but also on sociology, psychology and socio-psychology. Micro economics is very much at the core of domains such as finance, operations research, and theories of the firm. Sociology has influenced the political perspective of organisation theory, dealing with the issues of power, conflict and cooperation. Psychology has entered the field of human resources management and leadership. And finally, social psychology maintains a great impact on the research about team building, group dynamics, and organisational culture.

There have been contributions about themes such as "The Mind of the Organization" (Heirs/Pehrson, 1982), "The Thinking Organization" (Sims/Gioia, 1986), "Organizational Knowledge" (Nonaka/Takeuchi, 1995), "Organizational Memory" and "Organizational Epistemology" (von Krogh/Roos, 1995). But altogether, the potential gain which cog-



nitive science could contribute to management — although it would be enormous — has been hardly recognised up to now by the mainstream of organisation science.

Yet, apart from the mainstream, there is one approach to the inquiry into and to issues of design in the organisational domain, which has built on cognitive science for a long time. It is cybernetics — the science of communication and control in complex systems (Wiener, 1948), and in particular management cybernetics, which is the application of cybernetic principles to organisations. The works of several originators of cybernetics, — namely Ross Ashby, Warren McCulloch, and Heinz von Foerster — have had great influence on our science. Stafford Beer, the father of management cybernetics, already built on their work as early as in the fifties and sixties (see for example Beer, 1959, 1966; see also the collection of early works of Beer, by Harnden/Leonard, 1994). Ever since, the few management cyberneticians who exist, have tried to learn from the inquiries into cognition and consciousness. Anyway, their community has recently started to grow: Given the growing turbulence of the socio-economic environments, the organisational world has started to look out for better theories to orientate actors at all levels (For an overview, see: Espejo/Schuhmann/Schwanninger, 1996).

## 2. TOWARDS THE INTELLIGENT ORGANISATION

Given the growing complexities faced by organisations of all kinds, the challenges are gigantic. Practitioners and researchers focus very much on

- speeding up action (time management)
- rationalising processes (e.g. "lean management")
- fostering quality (e.g. total quality management)
- enhancing capabilities (e.g. process organisation).

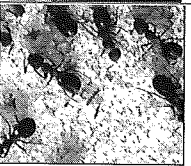
Recently, a famous firm presented herself as "strong, lean and fast". My immediate counter-question was "... and dumb?" Lean, fast and strong is not enough. The issue is becoming more intelligent. For example, a more intelligent way of time management, would be to start earlier, instead of trying to do things faster.

My personal research interest has been focused on the questions, "How can organisations become more intelligent?" and "How can they maintain a high level of intelligence?"

Among the basic faculties which distinguish intelligent organisations are the following

1. to adapt, i.e. to change as a function of external stimuli;
2. to actively change their environment;
3. to find a new milieu, if necessary, or to reconfigure themselves completely anew with their environment.

These faculties are associated with processes such as "adaptation", "learning", "development", and "(self-) transformation". Here, organisational cybernetics has a lot to contribute. While much of the original work in cybernetics was focused on external control, management cyberneticians have emphasised the issues of cognition, self-organisation and self-reference for two or three decades, by now. I strongly





believe, that the inquiry into these crucial aspects can have a tremendous impact on the well-being of organisations, in the future.

### 3. ON THE CONCEPTS OF ORGANISATIONAL COGNITION, SELF-ORGANISATION AND SELF-REFERENCE

The cognition of an organisation is the key to its intelligence. Derived from the latin term 'cognoscere', it denotes the generation and the use of knowledge. This involves activities such as observation, perception, memorisation, explanation and generalisation. Perhaps 'cognoscere' originated from the greek 'gnomon', — the shadow-casting pole of a sundial, which measures the heavens from shadows (Gregory, 1987: 149).

The concept of self-organisation and related phenomena has been around for a long time under different denotations:

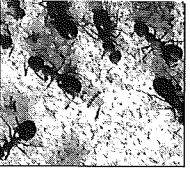
- The biologist Roux talked about "self-regulation" in 1914
- Friedrich von Hayek, nobel laureate of economics ascertained, about 35 years ago: "... the only possibility of transcending the capacity of individual minds is to rely on those super-personal 'self-organising' forces which create spontaneous order" (cited in von Foerster, 1984, 2).
- The French sociologist Touraine conceived societies as 'self-producing' systems (1973).

- The term 'autopoiesis', a greek version of 'self-production', coined by Maturana and Varela, in a context of biological research, has become very much used in sociology and management.

- Organisation scientists have talked about 'self-designing' (Weick, 1977), 'self-restructuring' (Gälweiler, 1987), and 'self-transforming' (Schwaninger, 1989) organisations.

The common denominator of these concepts is the notion of an emergence of order bred by interactions in complex dynamical systems which are operationally closed: It is a behavior displayed by autonomous units, that leads to increasing cohesiveness ("eigenbehavior") "by natural drift" (Varela, 1984: 25). Self-organisation has for example been observed as a fundamental property of the human brain, and therefore, is at the core of cognitive processes, as other contributors to this volume have emphasised.

Finally, the concept of self-reference is often mixed up with the concept of self-organisation, but it has a distinctive meaning, and it can be used under several aspects. The sociologist Niklas Luhmann (1984) distinguishes three levels, basal self-reference, reflexivity and reflexion. In the context of this paper, I shall concentrate on the latter. Reflexion is a process apt to cope with situations which self-organisation can not handle. It relies on the higher cognitive abilities entitled to observe the thinking process itself, — to reflect reflexion, the reflexion of reflexion, and so on, in a recursive mode. These cognitive processes lie at the heart of organisational capabilities such as awareness (and self-awareness, in particular, which is at the heart of consciousness), the generation of new knowledge, foresight, and creativity.



#### 4. MODELS TO ENABLE ORGANISATIONAL INTELLIGENCE

Management cybernetics has developed powerful theorems and models enabling for the design of intelligent organisations. Just to name a few, the Law of Requisite Variety<sup>2</sup> and the Conant/Ashby theorem<sup>3</sup> have an importance for all aspects of management, which is comparable to the role of the laws of thermodynamics as a basis for engineering. More specific frameworks for the design of organisations are the Viable System Model (Beer, 1979, 1981, 1985) and Team Syntegrity (Beer, 1994), both of which have been inspired by brain research. A growing empirical evidence as well as the personal experience of myself and my colleagues all over the world in using these models are testimonies of their validity and usefulness (cf. Espejo/Harden, 1989; Espejo/Schwanninger, 1993; Espejo/Schuhmann/Schwanninger, 1996).

Here, the Team Syntegrity Model will be examined more closely. This is an invention of Stafford Beer (Beer, 1994). I have helped him in elaborating certain aspects of the Model and over the last years I have realised several experiments as well as sociometric research to test it (Ibidem: 51; Schwanninger, 1994; Schwanninger/Hechenblaickner/Krafft/Steiner, 1995).

#### 5. OUTLINE OF THE TEAM SYNTTEGRITY MODEL

It is surprising again and again, how effective this model is. Even if it may seem quite complex, there is no other equally powerful model

which allows for deep involvement, self-organisation and the emergence of collective consciousness of large numbers of people. Therefore, I would like to ask you to "dive into" the structure and process with me, now.

*Team Syntegrity* is a future-oriented approach to the design of democratic management in the sense of the heterarchical-participative type of organisation (cf. Schwanninger, 1996). It is a holographic model for organising processes of communication, in particular for the (self-) management of social systems, in a non-hierarchical fashion. Based on the *structure of polyhedra* it is especially suitable for realising team-oriented structures as well as for supporting processes of planning, knowledge generation and innovation in turbulent environments. In the following, the architecture of the model will be illustrated by using the structure of an *icosahedron*, as an example.

The formation of networks by persons at different locations, who are connected by mutual interests, is a manifestation of the information society and a structural answer to challenges of our times. An *infoset* is a set of individuals who share a common concern and who are in possession of pertinent information or knowledge connected with the subject. The *Team Syntegrity Model*<sup>4</sup> supplies the structural framework for the synergetic interaction of an infoset that is intended to lead to an integration of multiple topics and perspectives. The term *Syntegrity* results from a combination of *synergy* and *tensile integrity*. Synergy is the condition of the properties of a whole being greater and distinct from the combined properties of its parts. Tensile integrity is the structural strength provided by tension, as opposed to compression (Leonard, 1995).

An infoset of 30 persons can organise itself using the structure of an icosahedron, the most complex of the regular, convex polyhedra (Figure 1). (For different numbers of people, solutions with the help of other polyhedra are possible.) Each member of the infoset is represented by one edge of the icosahedron. Each vertex corresponds to a team; with the icosahedron there are 12; they are marked by different colours. 5 edges lead to each vertex, therefore there are five members to each team (as players). Thus each participant as a player belongs to two different teams, — those connected by the edge that represents him or her. Mrs. *Red-Yellow*, for instance, belongs to the teams *Red* and *Yellow*. At the same time she is acting as a critic to two other teams

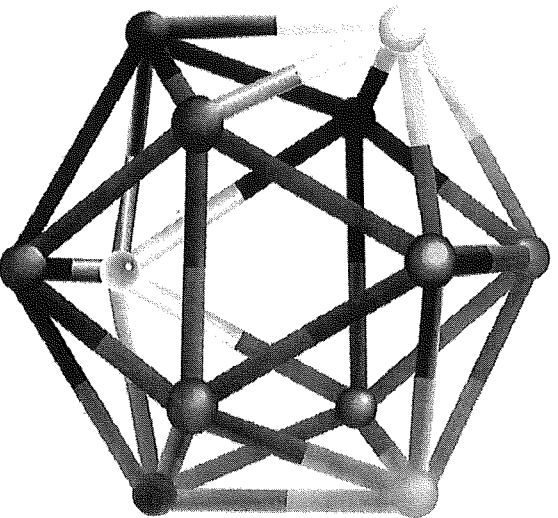


Fig. 1. The icosahedron reflects the structure of the Team Syntegrity Model

(for example *Black* and *Silver*, which are next neighbours). This means that each team consists of 5 players and 5 critics. Altogether, the thirty actors fulfil 120 roles.

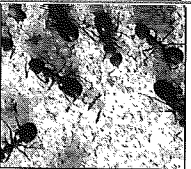
This structure dissolves the paradox of peripherality versus centrality of actors in an organisation (as formalised by Bavelas, 1952): While peripherality leads to communication pathologies, alienation and low morale, centrality is needed for effective action. However, as a group grows, centrality can only be "bought" at the cost of increasing peripherality (Leonard, 1995). Team Syntegrity enables an infoset to acquire "centrality" via a reverberative process, although the peripherality of each one of its members equals zero, i.e., there is no peripherality at all. A *process of a syntegration* has the following phases (This is a simplified representation):

### 1. Opening:

The syntegration stands under a general topic that focuses all mutual efforts and is explicated in an opening question. In syntegrations we realised with our students, the question was: "Which form should management training take in future?"

### 2. Generation of the agenda ("Problem Jostle"):

Each participant hands in contributions that seem important to him or her (Statements of Importance). In the following steps, these are discussed and combined (Aggregated Statements of Importance). Then, in a process of successive synthesis and prioritising, the agenda for the actual work on the general topic or problem is generated (Hexadic Reduction). It is finally worded in 12 topics (Consolidated Statements of Importance).





### 3. Assignment to groups ("Topic Auction"):

Each member of the infoset decides on the topics to whose processing he or she would prefer to contribute. A corresponding listing of the individual preferences forms the basis for the assignment to the various teams, with the help of an optimisation algorithm. An alternative would be random assignment to groups.

### 4. Working on the topic ("Outcome Resolve"):

The individual teams (consisting of 5 players and 5 critics each) discuss their respective topic. Each team meets several times (usually in three iterations). The fact that the same problem setting with its different but interconnected aspects is continually processed by the same set of people, who gather in alternating compositions (which leads to reversion), leads to a self-organising process with a high effect of integration. It can be shown mathematically, that this is a geometrically ergodic process<sup>5</sup>, in which the eigenvalue<sup>6</sup> of the process converges to a minimum: ninety percent of the information in the system will be shared after three iterations, and ninety-six after four iterations.

We have also realised sociometric studies, which ascertained significant increases of different measures of cohesion between the beginning and the end of the respective syntegegration events (Schwaninger, 1994; Schwaninger/Hechenblaikner/Krafft/Steiner, 1995; Espejo/Schwaninger, 1996).

### 5. Finalisation:

Final coordination if necessary, presentation of the results in plenary. By now there have been many applications, despite the young age of

the Model. Team Syntegegrity has been applied in the following cases, just to name a few:

- Planning processes in Universities, a polytechnical Institute, and a hospital
- Organisational Change in two Swiss banks
- Strategic Management in several industrial firms
- Governmental agencies in Canada
- Regional and Community Planning
- Non-profit Organisations
- Reorganisation of a political party in Great Britain
- Peace negotiations
- Seminars and workshops with students and researchers.

The case I am going to present now is about the collective creation of a knowledge product. This is new and not typical yet, but I have chosen this project for two reasons. Number one, it involved the first electronic syntegegration of an infoset distributed over the world. Number two, I have managed this difficult process myself, from beginning to end.

### 6. CASE STUDY: THE STAFFORD BEER FESTSCHRIFT PROJECT

On September 25, 1996 a research project, which I directed together with my colleague Professor Raúl Espejo, Lincoln Business School, University of Lincolnshire and Humberside, England, reached its culmination: In a special event at John Moores University, Liverpool, we presented a new CD-ROM and a book on cybernetics in organisation and

society (Espejo/Schwaninger, 1996). One of the distinctive features of these products lies in that they are the result of a collaborative global knowledge generation process, carried out mainly via electronic media, by 30 cyberneticians from sixteen countries and four continents.<sup>7</sup> The aim of this project was to create a substantial contribution to the body of knowledge of cybernetics, which we wanted to dedicate to Stafford Beer, as a festschrift<sup>8</sup> for his seventieth birthday.

In principle, at the core of such a collective writing effort is the generation of a knowledge product. However, the publications of this type often represent mere collections of articles that show little integration. Worldwide there was a reasonable number of people doing research in managerial cybernetics, and who probably would be willing to contribute. How was it possible to canalise this high potential into a coherent, integrated effort that would lead to a genuine knowledge product? In order to reach the demanding objective the project was aiming for, a new approach was required. We decided to apply the *Team Syntegrity Model* as a basis for organising the process of creating the opus. That model appeared to be especially suitable for carrying out the ambitious endeavour to work on the complex domain of knowledge embodied in managerial cybernetics, in a cooperative venture uniting co-authors from all over the world.

We went about to cope with the challenge confronting us, as follows:

**a) Winning the cooperation** of a circle ("infocet") of experts in cybernetics (among others from the Universities of Manchester, Toronto, Valladolid, Dublin, De Los Andes/Bogotá, Mannheim, Humberside,

John Moores/Liverpool, City University/London, St. Gallen, Bangor, Nanyang Institute of Technology/Singapore).

**b) Interaction on the basis of the *Team Syntegrity Model***, which has already been outlined.

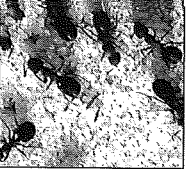
**c) Combination of distant and local communication** between the persons involved, making use of the most advanced technological means.

Up to then the *Syntegrity Model* had been applied in numerous strategy and organisation projects, but always in workshops, i.e. via local communication. In order to enable a genuine process of generating knowledge resulting in a tangible product, the envisioned CD-ROM and book, it was required to plan and control the project in an exceedingly circumspect fashion. To get a maximal result out of the project, the first electronic syntegration ever realised was among the planned technological innovations. Another innovation was the endeavour of thirty people writing a book together, mainly via the World Wide Web.

The project proceeded in the following phases:

#### **1. Preparation:**

We installed a worldwide web site as a communication platform (using a server at City University London, which also gave the necessary technical support).





## 2. First electronic synteegration:

By way of distant interaction, the agenda for a local synteintegration was generated that was to take place at the end of March, 1996, in Britain. In the course of five months an infoset of more than 40 cyberneticians from four continents and sixteen countries was interacting via electronic means.

At the beginning, a multitude of ideas was generated, all the participants handing in multifarious issues viewed from the most different perspectives. Later on, priorities were set successively. By means of election procedures (via Worldwide Web) and lateral discussions (that were partially also carried out by supplementary means of communication such as telephone, fax, e-mail, etc.) the infoset created, in self-organising fashion, an agenda, namely the twelve topics for the various chapters of the festschrift. In this phase 147 initial statements of importance were transformed, step by step, and following a complex protocol, into twelve consolidated statements of importance. This involved sophisticated techniques, such as underwriting and voting procedures via the Net.<sup>9</sup> Finally, each member of the infoset could decide to which topics he or she would prefer to contribute, i.e. which of the twelve teams he or she would join as a player.

## 3. Local synteintegration:

Towards the end of 1996, the definitive infoset — 30 cyberneticians — met for a three-and-half-day workshop at Mickleton near Stratford-upon-Avon, England. In an intensive and for all participants fascinating exchange of ideas, the twelve chapters of the volume were drawn up. The discussion was organised according to the geometry of

an icosahedron: Each of the thirty participants was a member of two teams as a player (represented by an edge connecting two corners of the icosahedron), as well as a critic of two further teams. Each team met in three iterations, first of all for a kind of brainstorming ("generating ideas"), at the second time for a conceptualisation ("modeling") and finally, at the third time for designing an action plan, i.e. how to proceed in order to produce the respective chapter within the team ("implementation"). All sessions were recorded on videotape. These recordings were then transcribed, to provide "raw material" for the writeup of our joint work.

## 4. Second electronic synteintegration:

Again through distant interaction, the twelve chapters were written up between March and beginning of August, 1996. For this purpose, a further platform with a special groupware ("First Class" Software) was installed on a server of the University of Bangor. An important input for this phase were the transcripts of the sessions in Mickleton. The consolidation of the chapters and the writing of one chapter reflecting on the process used, by the editors, took place at the University of St. Gallen.

## 5. Production of the CD-ROM:

In the months of August and September, a CD-ROM was produced at AMAZE, a multimedia company in Liverpool, under the direction of Roy Stringer and Dr. Roger Harnden, two multimedia experts. This CD-ROM is a technological and educational masterpiece. It documents more than merely the results of the project. The user can navigate through a hyperspace in an interactive manner, to discover the proc-

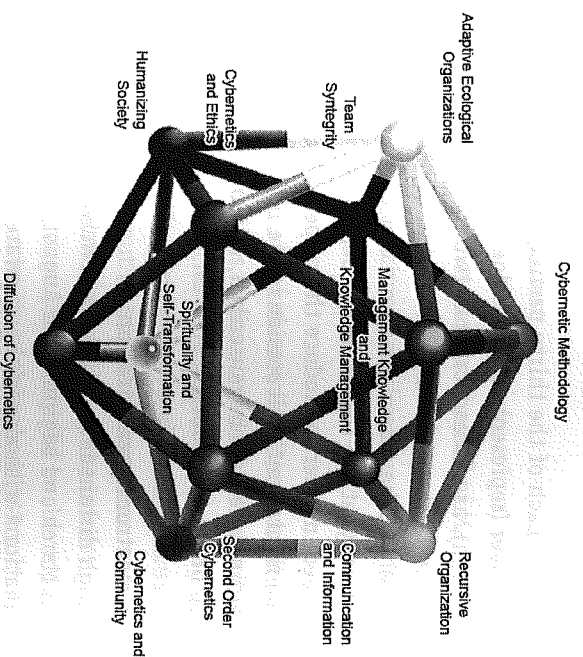


Fig.2. The twelve chapters of the CD and book — Overview

ess that led to this end product. The contents of the twelve chapters will disclose him or her state-of-the-art applications of cybernetics to organisation and society (see overview in figure 2).

The presentation at John Moores University, Liverpool showed that this work constitutes a world innovation. In a global, decentralised, cooperative research and publication project more than a book and CD with twelve highly integrated chapters had been created.

There was no central unit to coordinate the texts produced in the twelve teams. Coordination happend "automatically", via self-organisation in a reverberative process. At the end we realised that a most promising method had been found to organise distributed processes for

the elaboration of knowledge-intensive products, by a completely new approach whose full potential remains to be actualised in the future.

## 7. CONCLUSION

The aim of this case study was examining the Team Syntegrity Model as to its aptitude for the design of virtuous self-organising processes (not all of self-organisation is virtuous), in particular with regard to the creation of knowledge. Given the fundamental property of organisational knowledge that it is embodied in actors, Syntegrity has proven to be a framework for this purpose, which is more powerful than the traditional ones: It provides a process-oriented structure for these actors to become creative interactors. Interaction with a purpose is what breeds the emergence of new knowledge.

Team Syntegrity has a specific characteristic which distinguishes it from more conventional approaches to face-to-face teamwork. Not only is it focused primarily on the relationships rather than the elements in a system. It can even enable larger numbers of people (e.g. 30, as in our case) to interact purposefully, in a non-hierarchical mode. A huge spectrum of views and insights can be brought to an intricate mode of synergetic cooperation: The process of reverberation leads to knowledge gains at three levels, individual, team and infoset. As in the case outlined, entirely new levels of knowledge can be attained. Therefore, Team Syntegrity is a powerful means of implementing the Metasystem functions (Control-Intelligence-Policy), as conceived by the Viable System Model (cf. Beer, 1985, Espejo/Schulmann/Schwaininger, 1996).



But Team Syntegrity also provides powerful structural features which warrant self-reference in the sense of self-reflexion. These ensure self-awareness, and forcefully inhibit all kinds of process pathologies, which a lack of creativity and insight, but also hybrids, misguided mutual assurance or miscommunication can breed at any time. These self-referential features operate at three levels, team, cross-team, and infoset as a whole:

- a) At the **team level** there are three devices: Firstly, the interaction between players involves an error-correcting mechanism, known from group-dynamics. Secondly, the critics, who are permanently present in the sessions of the Outcome Resolve are explicitly in charge of bringing a meta-view into the discussion. They criticise, encourage, and embody the devil's advocate, from a content and a context as well as a process perspective. Thirdly, the groups are usually moderated by process facilitators who are the guarantors of adherence to the rules of the game (e.g. goal-orientation, equality of group members, adequate participation of critics, etc.).
- b) At the **cross-team level**, the fact that each one of the team members is also a member of three other teams (one more as a player and two as a critic), instils self-reference into the discussion, in a natural way.
- c) At the **level of the infoset** as a whole, plenaries at the beginning, between the iterations, and at the end of the process, foster the emergence of a collective consciousness.

Also, Team Syntegrity underpins, that consciousness is a recursive property, which in this case, is present, distinctively, at the levels of the individual, the group and the infoset as a whole.

We have an important social invention here, which is badly needed. Our world faces regulatory crisis at many levels. Much of this crisis can be derived from obsolete concepts of organisation and management, where hierarchy, autocracy and the abuse of power as an instrument of domination abound. There is an enormous potential for organisational innovation, to which this model can make a great contribution.

To finalise, it is worth mentioning, that the Team Syntegrity Model still leaves questions open for exploration. On the application side, there are methodological questions which have to be further investigated in different application contexts. On the theoretical side, many mathematical aspects (geometry, graph theory, topology) should be studied further. There are also promising interdisciplinary questions arising. Buckminster Fuller used to say: "All systems are polyhedra". And indeed, the icosahedron represents an invariant structure, which is most exciting from a system-theoretical standpoint: Great philosophers since Plato, leading artists and mathematicians — namely Leonardo da Vinci and Fra Luca Pacioli — were fascinated by the icosahedron.

Buckminster Fuller used it as a concept for his architectural invention of the geodesic domes. A few years ago chemists discovered the icos-



hedron as a structure for the most enduring molecule —  $C_{60}$  — which then was called the Buckminsterfullerene.

And, finally, brain researchers have identified — without being aware of it — that the structure of the activation processes in the human brain is icosahedral (Georgopoulos/Taira/Lukashin, 1993).

On the frontpage of the journal *Science*, No. 2, 1993, appeared a picture of a stellated icosahedron with a dodecahedron inside it, which represents the structure of a neural network model of the primate motor cortex. My friend Bill Perk, a pupil of Buckminster Fuller, was so excited when he saw it, that he called one of the authors, to discuss the issue with him. To his great surprise, he found out, that his interlocutor did not know what a stellated icosahedron with a dodecahedron inside is. Indeed, we do have a great need for cross-disciplinary communication!

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- 1 Beyond this, I have been interested in aspects of the "self-consciousness" of organisations, an issue in which research is still at the beginning. Cf. Schwabinger, 1989. See also Beer's concept of "recursive consciousness" (Beer, 1994).
- 2 "Only variety can absorb variety" after Ashby, 1956 (in the original: "Only variety can destroy variety").
- 3 "Every good regulator of a system must be a model of that system" (Conant/Ashby, 1970).
- 4 For details see: Beer, 1994.
- 5 Jalali, 1994: 277
- 6 The formula to calculate the eigenvalue is:  $y = (1/\text{sq} 5)^{n+1}$ , with n denoting the number of iterations.
- 7 A report and reflections on this project can be found in: Espejo/ Schwabinger, 1996 and 1997; see also: Schwabinger, 1997.
- 8 The term 'eigenschaft' stands for 'commemorative volume'.
- 9 The details of this procedure are documented in Espejo/Schwabinger, 1996.