



System theory and cybernetics

A solid basis for transdisciplinarity in management education and research

Systems theory
and cybernetics

Markus Schwaninger

Institute of Management, University of St Gallen, Switzerland

1209

Keywords *Cybernetics, Management science, Modelling, Systems theory*

Abstract *Considers systems theory and cybernetics to be a solid basis for transdisciplinarity in management education and research. Introduces the “St Gallen Management Model” and discusses models grounded in systemic thinking. Outlines recent developments and assesses their impact.*

1. Introduction

It is widely accepted, now, that a transdisciplinary approach displays a substantially higher potential to contend with the challenges posed by complex issues than merely disciplinary or additive interdisciplinary modes of inquiry. As will be shown in this paper, this statement holds for education and research in the field of management and leadership.

In principle, any generalised, formal language could be used in order to provide a means of communication across different disciplines needed to deal with a complex issue at hand. To give some examples, logic, mathematics, statistics and philosophy provide such transdisciplinary languages. Much of the specific transdisciplinary apparatus that has emerged through the systems approach focuses on dynamic complexity. Therefore it is specially suited to enhance human and social actors' potential to deal with the complexities of our day.

The twentieth century not only has seen drastic developments in the complexity and dynamics of social systems at all levels. It also has bred a new evolutionary stage of science through the emergence of system theory (Rapoport, 1998). This is the science which deals with the structure and behaviour of all kinds of organised wholes (von Bertalanffy, 1968; Rapoport, 1986). Two different streams of systemic inquiry can be discerned, which are of special interest to organisations and other social systems[1].

On the one hand, a “cybernetics thread” of inquiry has bred cybernetics, the science of the (self-)control and communication in and of complex dynamical systems (Wiener, 1948). From this tradition, a new approach to dealing with the

The author is very grateful to Professor Roberto Moreno-Díaz for inviting him to stay, as a Visiting Professor, with the Instituto Universitario de Ciencias y Tecnologías Cibernéticas, Universidad de Las Palmas de Gran Canaria, Spain. Professor Moreno-Díaz and the Institute kindly provided an ideal environment for the writing of this paper. He is also indebted to Professor Stuart Umpleby, George Washington University, Washington, DC, USA, for encouraging him to write this paper, for reading a draft of it and providing valuable comments.

issues of structure, adaptation and learning of organisations, has emanated, which is subsumed under Management Cybernetics (cf. Beer, 1966, 1979, 1981, 1994) or Organisational Cybernetics (Espejo *et al.*, 1996; Schwaninger, 2000, 2001a).

On the other hand, a “servomechanism thread” of inquiry has led to the development of new methodologies for the modelling and simulation of complex dynamic systems. Of these, the theory and methodology of system dynamics have proven to be highly useful for triggering insights into the “counterintuitive behaviour” of social systems (Forrester, 1971). Given its generality, it has also triggered a broad range of applications (for an overview, see Richardson, 1996; Sterman, 2000).

Both of these “threads” not only have had a growing influence on management research and education in general. They also have been cornerstones for the development of the systems approach to management at the University of St Gallen (USG), Switzerland, the academic base of the author. This University is focused on the Social Sciences – Economics, Law, Business and Public Management. It has approximately 4,500 students, coming from about 55 countries.

This paper deals with the impact of the systems approach on management education and research. The evidence gained from the case of USG, where the systems approach has guided the research and education in general management for approximately three decades, will be documented in the following sections. The emphasis in this paper will be more on cybernetics than on system dynamics, for two reasons: first, experiences with the former have generally been documented to a lesser extent than those with the latter; second, cybernetics has been more influential in the specific case of USG[2].

2. Background: the “St Gallen Management Model”

Traditionally, business schools were organised along disciplinary lines (i.e. the chairs, research groups and institutes specialised in certain functions such as production, marketing, personnel, etc.) or methodological compounds (e.g. decision making, organising, accounting). By and large, the domain of general management tended to be underdeveloped in business schools. In the 1970s and 1980s, the emergence of departments, of organisational behaviour and strategy, as well as scientific journals to deal with pertinent issues, strengthened the general management orientation somewhat.

At the University of St Gallen, Professor Hans Ulrich, the former President of the Institute of Management (Institut für Betriebswirtschaft an der Universität St Gallen[3]), was convinced that a generalist outlook on management was extremely important. He established the integrative, generalist effort as a research and education issue in its own right and of high priority, therewith founding a tradition of transdisciplinary management education and research.

Ulrich put complex problems or issues at the centre of his perspective on management research and education. The consequence was that a management

science, conceived only as a discipline of micro-economics, had to be insufficient to deal with such issues. Also, and very much in line with Peter Drucker's argumentation, management was not seen as the task of a small élite of heads of large organisations, but as a role to be practised by many people across all levels of organisations. Management was also not limited to the domain of private business, but occurred in all kinds of organisations, big and small, private and public, profit-oriented and not-for-profit.

In the mid-1960s, a task force was established at the Institute of Management, which studied the works of early writers on systems theory and cybernetics (e.g. Wiener, von Bertalanffy, Beer, Pask, Churchman, Buckley, etc.). In 1968, the basics for a systems-oriented education in General Management were outlined in Ulrich's book *Die Unternehmung als produktives soziales System* (*The Corporation as a Productive Social System*, published in German), a manifesto for a systems-oriented approach to management. On the basis of this book, the "St Gallen Management-Modell" (Ulrich and Krieg, 1972) was elaborated, which was conceived as a framework for the description and the structuring of managerial issues. It conceived systems thinking as holistic, process-oriented, interdisciplinary, analytic and synthetic at the same time, as well as pragmatic (i.e. issue- or problem-focused, not discipline-focused). This publication contained some highly abstract and general schemes, namely a Corporate Model, a Leadership Model and an Organisation Design Model. Only one of them will be reproduced here – the diagram which is part of the Corporate Model and shows the inter-relationship between the firm and its environment (Figure 1).

This diagram visualises two aspects of the environment:

- (1) the stakeholder perspective, which today is generally known, but at the time was relatively new;
- (2) the dimensional structuring of the environment, highlighting not only the economic, the technological and the social spheres, but also the ecological domain.

To address the natural environment as part of managerial concern was at that time not only innovative but even revolutionary[4]. The model's incorporation of environmental concerns showed great foresight and far-reaching consequences emanated from it.

The St Gallen Management Model was required reading for generations of students at the University of St Gallen (USG)[5]. Not only were the categories of the model internalised by many firms in the German-speaking countries, but the University of St Gallen became the cradle of highly innovative initiatives, which revolutionised the attitude of businesses towards environmental concerns[6]. This example demonstrates the power of models in shaping reality. I maintain that these events would not have been possible without the underlying model based on the systems approach, which explicitly included the ecological dimension as a matter of concern. The scientific underpinnings of this claim will be formulated in section 3.

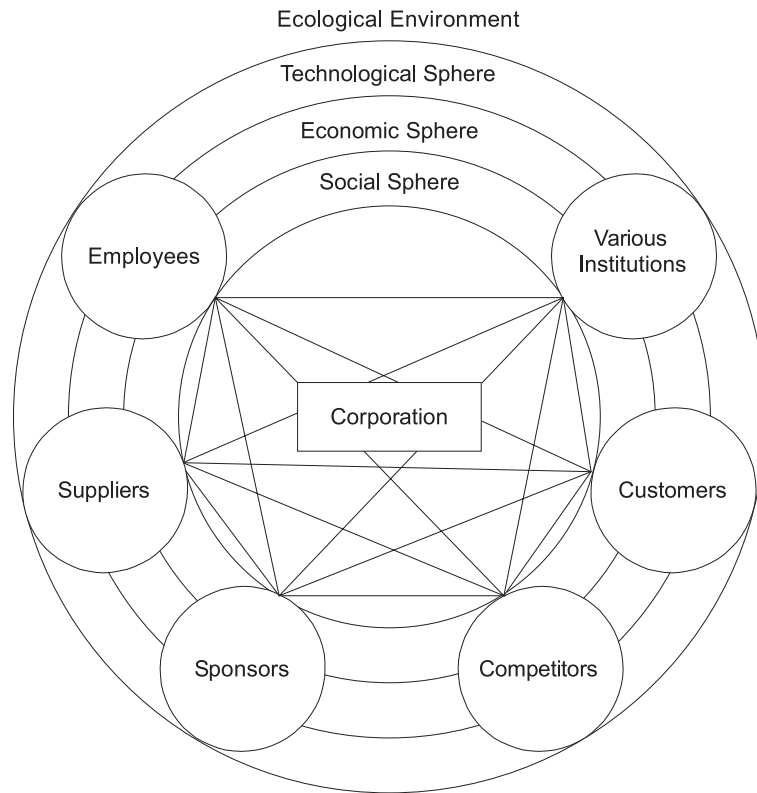


Figure 1.
The firm in its
environment

Source: Ulrich and Krieg (1972, p. 20)

The St Gallen Management Model was meant to be a shared framework and it also succeeded in fostering coherence in the activity of the Management Department of the University. It triggered many research and publication projects by a variety of faculty members of the University. In these projects, methodological aspects (e.g. decision making, planning) and specific adaptations to different contexts (e.g. public domain, tourism, etc.) moved ahead of the literature of the time. Also, a number of consulting and training firms have grown out of the Institute of Management, directly or indirectly. Several of these adhere to a systemic orientation (cf. Malik, 2000).

In the 1970s and 1980s, new issues emerged in management, for example, strategy, culture, and management philosophy, the latter spearheaded by Hans Ulrich himself (cf. Ulrich, 1981, 2001a, b). The original publication of the St Gallen Management Model (Ulrich and Krieg, 1972) did not contradict these developments, but some of them were not addressed by it explicitly. This led to a new research initiative. In 1988, under the direction of Professor Knut Bleicher – the successor in Hans Ulrich’s chair – a team was formed to develop the St Gallen Management Approach further (see below).

3. Better models, grounded in systemic thinking

Why is the quality of models, like the one referred to here, essential to the quality of management? The answer is given by the Conant-Ashby-theorem: “Every good regulator of a system must be a model of that system” (Conant and Ashby, 1981). In other words, the results of a management process cannot be better than the model on which it is based, except by chance. This theorem hinges on Ashby’s Law of Requisite Variety – the fundamental law of organisational cybernetics: “Only variety can absorb variety”[7] (Ashby, 1956). It implies, in a nutshell[8], that an effective management system must own a repertory of potential behaviours (~ “Variety”), which is equivalent to the repertory of behaviours (~ “Variety”) of the system to be managed.

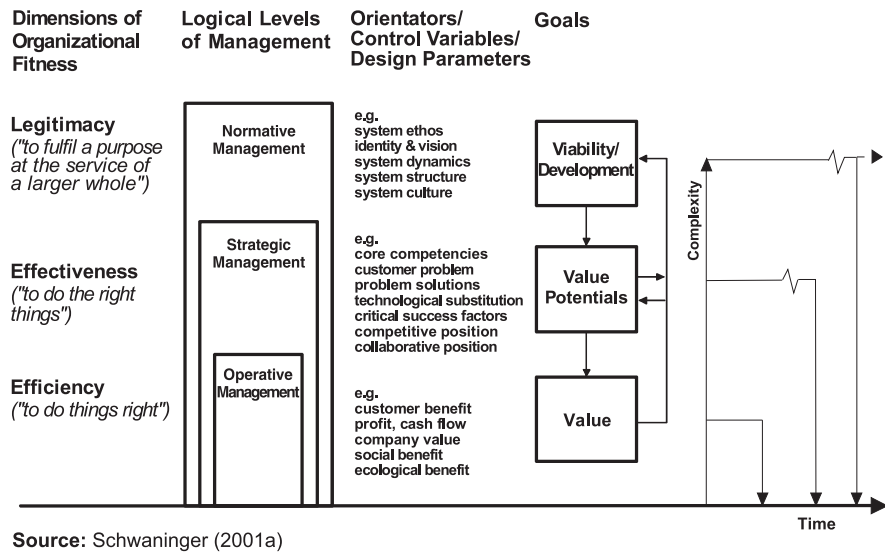
A good model for general management then must indeed display a high variety. If we consider the practice of management, we find that many organisations are managed on the basis of inadequate models. Typically those models are exclusively oriented towards profitability or shareholder value. Even if some models are mature (e.g. double-entry accounting, introduced by Fra Luca Pacioli in 1494), they are insufficient, because, in a context of rapid change, profit rates are inadequate to measure the performance of an organisation. In principle, they are not much more than short-term and partial indicators of the success of a business. Also, shareholder-value is an indicator which is biased towards one group of stakeholders. In other words, these models do not have requisite variety.

Indeed, several disciplines have taught us that further aspects have to be considered: marketing, strategy, innovation, knowledge generation, and human resources management have created new perspectives which lead to new indicators of performance[9]. However, the multiplicity of pertinent “theories” is high and the postulates of these “theories” (many of which do not qualify as theories in a rigorous sense) are often difficult to reconcile. Critics have even spoken of a “jungle of theories”, which reflects the immaturity of the field.

3.1. A general model of systemic control

Under this evolutionary pressure of increasing complexity and incomprehensibility, significant progress has been made on identifying criteria for competent management. Transdisciplinary models for management, which dispose of a much higher variety than the traditional ones, have emerged. This progress is based on the insight that a system must govern itself by means of control variables that may contradict one another, because they belong to different logical levels: the levels of operative, strategic and normative management. In Figure 2, a General Model of Systemic Control (MSC) is depicted, which was elaborated, in the tradition of the systemic approach to management at USG and on the grounds of organisational cybernetics (for earlier versions and more detailed accounts, see Schwaninger, 1984, 1989, 1993). As shown in the scheme, there are interrelationships between these levels; specifically the design parameters and control variables of the higher logical levels exert a pre-control influence on those of the lower ones[10].

Figure 2.
General model of
systemic control



These have been elaborated elsewhere in detail (Schwaninger, 1993, 2000, 2001a, b). It must be noted that the design parameters and control variables cannot be compared in every respect, since they belong to three different logical levels; ultimate consistency can be achieved within, but not between, these levels. The variables regulated at any one level are the pre-control parameters for the next level down.

At the three levels of management, different criteria of organisational fitness apply:

- (1) at the operative level, the criterion is that of efficiency, mainly in terms such as productivity, profitability and quality;
- (2) at the strategic level it is effectiveness in both the competitive and the co-operative sense; and
- (3) at the normative level it is legitimacy, defined as the ability to fulfil the claims of all relevant stakeholders.

The key duty of an integral or systemic management is to meet all three requirements in the long run. In order to achieve such a delicate task a corporation will require considerably higher developed mental models than the established ones, and more complex control systems than the simple feedback systems traditionally used.

The differentiation between the three logical levels of management, drawn in this model, was to become a lead distinction for the new management framework designed at USG in the 1990s ("St Gallen Management Concept"; see below), which built on the original "St Gallen Management Model" from the 1970s (see above).

3.2. A “methodology of network thinking”

Another development at USG was strongly influenced by System Dynamics (Forrester, 1968) and a mainly qualitative variant stemming from it, which became well-known in the German-speaking countries as *Sensitivitätsmodell* (Vester and von Hesler, 1988): combining the notions of feedback loops and earlier research on systemic problem solving (especially Gomez *et al.*, 1975), a methodology for dealing with complex problems was developed (Gomez and Probst, 1987, 1999; Probst and Gomez, 1992; Ulrich and Probst, 1991). This so-called “Methodology of Network Thinking” (MNT) is essentially a methodology which applies the qualitative principles of System Dynamics and embeds them in a set of heuristic principles and a logical sequence of steps to be followed. Some of these steps are:

- A “root definition” – very much as conceived by Checkland (1981), in which the different relevant perspectives with their goals are sorted out;
- A qualitative model in the form of a network of feedback loops;
- A thorough distinction between variables which can be controlled, by the actor-in-focus, and those which can not.

MNT has had a broad acceptance in private firms of all kinds, and it has been a compulsory component of their studies for all students of USG. The advantage of this methodology is that it is very easy to use, and it helps to gain an overview of a complex issue quickly. It also has the advantage that models can incorporate a more comprehensive set of variables than traditional tools, which are often confined to the perspective of operative management. However, it has barely addressed the question for model validity. Also, the software packages, which have been designed to support it, have very limited simulation capabilities. A more recent development under the denomination “Integrative Systems Methodology” has been designed to overcome these limitations (see below).

4. Recent developments

4.1. The “St Gallen Management Concept”

Based on the new insights sketched out in the last chapter, a management team led by Professor Knut Bleicher and co-ordinated by the author took on the task of developing the USG Management Framework further. This effort was aimed at creating a more concrete body of knowledge, based on the systems approach, as a basis for management education at the advanced levels of studies for students and practitioners. The task force came up with a three-dimensional scheme to complement the original St Gallen Management Model, reproduced in Figure 3, with some extensions. The label used to distinguish it was *St Galler Management-Konzept*.

The first dimension, made up of the aspects of activities, structures, behaviour, represents fundamental categories for describing organisational phenomena[11]. The second dimension comprises the three logical levels of management,

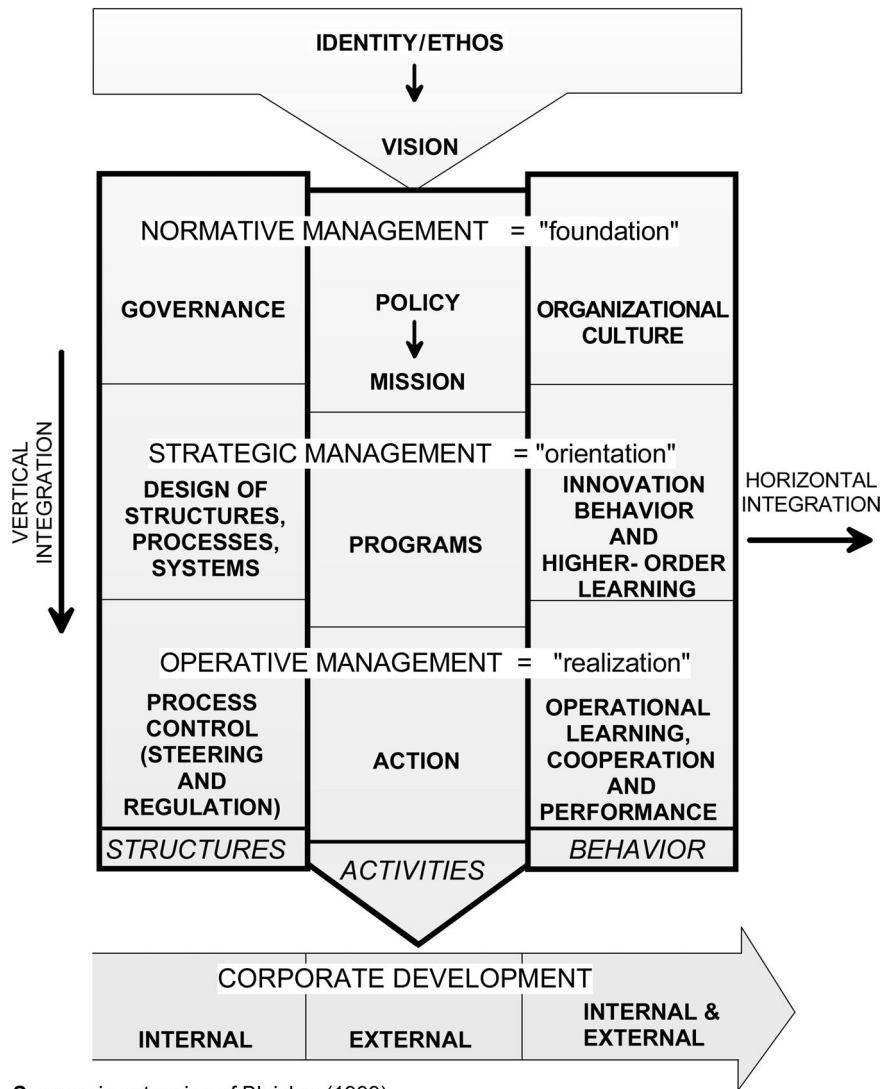


Figure 3.
The St Gallen
Management Concept –
overview

Source: in extension of Bleicher (1999)

elaborated in the last section, which are based on a crucial distinction for structuring managerial decisions. The third dimension is time.

On the basis of these powerful lead distinctions, a series of books which document and detail the St Gallen Management Concept (Bleicher, 1994, 1999; Pümpin and Prange, 1992; Gomez and Zimmermann, 1992; Schwaninger, 1994) have come out. These have been used as readings in the second half of studies (third and fourth years). Their purpose was to make the big bulk of management-relevant knowledge available, coming from many disciplines, more transparent and accessible, within a systemic framework. Therefore,

these publications have been appreciated in many schools and enterprises of the German-speaking countries. Bleicher's book, for example, has come out in five editions. The last book in this vein has just been published; it contains a "General Management Navigator" for strategic management (Mueller-Stewens and Lechner, 2001)[12].

4.2. A new "corporate model"

At the University of St Gallen, the quest for transdisciplinary models and frameworks goes on. In 1998, a task force of faculty members, of which the author is a member, was formed, which is aiming at creating an updated version of the St Gallen Management Framework. This will be directed to the needs of the first two years of studies at the University, and therefore will focus on a Corporate Model, which depicts the corporation in its environment and the value chain with its inputs, outputs and the components of the transformation processes (business, management and support processes).

This way, a new version of the integrative framework for management education will be made available to large numbers of students, early on in their studies. As a larger number of faculty members, also from outside the general management core, are collaborating in this venture, it can be expected that the systems approach will diffuse into the culture of the institution more broadly than before. The team membership of two professors, who were already on the task force for the *St Gallen Management-Konzept*, and are deeply committed to the systems approach to management, is a factor which may contribute to strengthening systemic thinking, also in the context of the new venture.

To give an accurate account, it must be added that in cases like the one at hand there are always countervailing forces as well, such as ignorance of and indifference towards the systems approach to management, on the part of faculty members and the managements of universities. It is also difficult to pass on the concepts underlying a rigorous systemic thinking. Furthermore, systems thinking has not always been highly regarded among mainstream researchers in schools of business and economics. For this and other reasons, staff turnover, which has its merits in terms of the evolution of organisational knowledge and adaptation, can, on the other hand, also be a factor likely to encumber the cultivation of a research tradition grounded in systems theory and cybernetics. Pertinent facts and signals[13] indicate that, even at the University in focus, the "systems movement" is potentially vulnerable and that the valuable tradition, outlined colourfully above, could also become unstable or dissipate over time. There are enough examples of other schools where this happened. On balance, however, this is unlikely, last but not least given the promising circumstance that the new president of the school has a thorough knowledge of systems theory and cybernetics and has shown commitment in conveying it in his publications[14] and teaching.

4.3. An “integrative systems methodology”

In the domain of methodology, an effort has been made to leverage the complementarities of System Dynamics and Organisational Cybernetics, while also overcoming the limitations of the Methodology of Network Thinking. A methodological framework called “Integrative Systems Methodology” (ISM) was elaborated for the purpose of helping actors in organisations to achieve requisite variety (cf. Schwaninger, 1997, 2001b). It is positioned in the tradition of systemic methodologies for dealing with complex issues. However, it explicitly addresses three aspects, which have individually been addressed by different authors or schools but have been integrated into a coherent heuristic:

- (1) The aspect of validation is a central component of the methodology.
- (2) The layout of ISM provides for taking also the organisational context into account explicitly, besides the content of the issue at hand. Therewith it builds on a combination of methods from both strands, System Dynamics and Cybernetics.
- (3) ISM leverages complementarities of different method(ologie)s, – quantitative and qualitative.

ISM has been taught at USG in courses and seminars with an emphasis on systems methodologies. These are courses at graduate and doctoral levels, one of them being an elective on systemic thinking comprising a package of three courses. Given its newness, and perhaps also due to the conceptual complexity of the tools which are needed to apply it properly (Viable System Model, System Dynamics methodology), ISM has not been a subject of the “mainstream” courses, i.e. those courses which are required for all students of management.

5. Conclusions

It is difficult to assess the impact of an endeavour as complex as the use of system theory and cybernetics as a scientific basis for the education and research in general management in a management school. In particular, speculations about the comparative outcomes which would have been reached, if the orientation had been different, can only be corroborated with difficulty. However, some specific indicators are available. The first one is that the tradition grounded in the systems approach has proven most valuable in accomplishing conceptual coherence and integration of a faculty jointly committed to building a strong management school. This is more than the author’s personal opinion. The view just expressed is also shared by a critical mass of the general management faculty at the University of St Gallen. Several cases are cited as evidence:

- Interviews held, during an earlier project, with several exponents of the general management faculty indicated their need for the Systems Approach (cf. Schwaninger, 1989).
- The red thread of the systems approach established by the St Gallen Management Model in the 1970s was picked up in the 1980s by a strong

faculty team, which thereupon created the St Gallen Management Concept (cf. Bleicher, 1999; see also above).

- Recently, on the *dies academicus 2000*, Stafford Beer, the founder of Management Cybernetics, has been awarded an honorary doctorate by the University of St Gallen (USG), honouring him for “his pioneering work in management cybernetics, which has stimulated management studies in many ways and had a formative influence on the St Gallen systems approach to management”[15]. This is a symbol of an ongoing commitment to the systems approach at USG.
- Towards the end of the 1990s, a faculty task force gathered to elaborate a new generation of the St Gallen Corporate Model (Dubs *et al.*, forthcoming). This group is committed to developing further the tradition of the systems approach to management (cf. above).

To these internal indicators, three additional and largely external ones have to be added:

- (1) In the 1990s, *Forbes* rated the Management School at USG as the number one among management and business schools in the German-speaking countries. It cannot be proved, but it is most likely, that this result would have been unachievable in a school which, during the 1980s, had to cope with a doubling of its number of students.
- (2) Over the last years, a strong interest in the systems approach as practised at USG has become manifest. Other management schools have taken it as a role model, and many inquiries for specific information have reached our Institute.
- (3) Last but not least, the frequent enquiries for Hans Ulrich’s publications, many of which were out of print, have led to a new publication project. The Foundation for the Promotion of Systems-Oriented Management Education[16], an institution founded by Hans Ulrich and presided over by him until his death in 1997, has decided to re-edit the bulk of his works. The author of this paper was in charge of preparing this edition (full edition in five volumes plus an abridged student version), which has just been published (Ulrich, 2001a, b).

At the public presentation of the new Ulrich edition[17], Professor Peter Gomez, the president of USG, emphasised the big impact of Ulrich’s work on the evolution of the University. He also outlined that the reform of studies, under way and to be implemented starting 2001, was in close alignment with a systems approach to management.

All of these indicators lead to a fairly positive outlook. Up to this point, the challenge of keeping the systems approach to management alive in the Management School of the University of St Gallen has been weathered successfully. There are enough clues that, despite all difficulties, this will also be the case in the future.

Notes

1. For a detailed, scholarly account of these traditions, see Richardson, 1999. Richardson's study concentrates on the traditions of "Feedback thought in social science and systems theory."
2. See *Proceedings of International System Dynamics Society Conferences* and *System Dynamics Review*, both available since the 1980s.
3. Former name: "Hochschule St Gallen".
4. Being a pupil of Hans Ulrich, it was natural for the author to put ecological issues on the agenda when discussing corporate strategies with client firms, as a consultant, as early as 1980. The author was aware that orthodox minds would have classified him as "red"; the complementary colour green had not been invented yet as a symbol of the environment.
5. Ulrich's work can be seen as the management-related complement to Hans-Christoph Binswanger's research and teaching in the macro-economic domain, which also was a required component of studies since the early 1970s (cf. Binswanger, 1972).
6. OIKOS, a students' initiative at USG, has developed several activities dedicated to uniting economy and ecology again. At one of the conferences, in 1988, the Swiss Association for Environment-Conscious Management was founded. This forum has triggered a stream of ecological renewal among Swiss firms; the organisation counts over 300 members today. Soon thereafter, a Foundation for Ecology was established, which became a major factor for the realisation of the Institute for Economy and Ecology at USG (Institut für Wirtschaft und Ökologie), the first institute of its kind at a European University.
7. Ashby's original version is "Only variety can destroy variety". Later, Stafford Beer substituted "absorb" for "destroy".
8. For a full account of Ashby's Law, cf. (Espejo *et al.*, 1996), where the aspects of self-control are taken into account: this implies that a control system has to take care of the "Residual Variety" (Espejo, 1989), i.e. only that variety of which the controlled system cannot take care by itself.
9. The Balanced Scorecard is a pragmatic approach to tracing performance indicators in a multidimensional space (i.e. along dimensions such as finance, customer, business process, learning and growth; Kaplan and Norton, 1996).
10. The notion of pre-control in this context goes back to earlier works by Gälweiler (1990).
11. These categories are based on Ralph Gerard's original scheme, with the dimensions of structure, function and behaviour as essential characteristics of all kinds of living systems (cf. Rapoport, 1992).
12. A publication of this book or a short version of it (Mueller-Stewens and Lechner, 1999) in English is planned.
13. Details will not be elaborated here.
14. See Gomez 1981, 1993; Gomez *et al.*, 1975; Gomez and Probst, 1999.
15. Original wording of the *laudatio* by the president of the University.
16. Stiftung zur Förderung der Systemorientierten Managementlehre, St Gallen.
17. 8 May 2001.

References and further reading

- Ashby, W.R. (1956), *An Introduction to Cybernetics*, Wiley, New York, NY.
- Beer, S. (1966), *Decision and Control*, Wiley, Chichester.
- Beer, S. (1979), *The Heart of Enterprise*, Wiley, Chichester.
- Beer, S. (1981), *Brain of the Firm*, 2nd ed., Wiley, Chichester.

-
- Beer, S. (1994), *Beyond Dispute. The Invention of Team Syntegrity*, Wiley, Chichester.
- Binswanger, H.-Ch. (1972), "Ökonomie und Ökologie – neue Dimensionen der Wirtschaftstheorie", *Schweizerische Zeitschrift für Volkswirtschaft und Statistik*, No. 3, pp. 251-81.
- Bleicher, K. (1994), *Normatives Management*, Campus, Frankfurt/ New York, NY.
- Bleicher, K. (1999), *Das Konzept. Integriertes Management*, 5th ed. (1st ed., 1991), Campus, Frankfurt/New York, NY.
- Checkland, P.B. (1981), *Systems Thinking, Systems Practice*, Wiley, Chichester.
- Conant, R.C. and Ashby, W.R. (1981), "Every good regulator of a system must be a model of that system", in Conant, R. (Ed.), *Mechanisms of Intelligence. Ashby's Writings on Cybernetics*, Intersystems Publications, Seaside, CA, pp. 205-14.
- Dubs, R. et al. (forthcoming), *Einführung in die Managementlehre* (working title).
- Espejo, R. (1989), "The VSM revisited", in Espejo, R. and Harnden, R. (Eds), *The Viable System Model. Interpretations and Applications of Stafford Beer's VSM*, Wiley, Chichester, pp. 77-100.
- Espejo, R., Schuhmann, W., Schwaninger, M. and Bilello, U. (1996), *Organizational Transformation and Learning. A Cybernetic Approach to Management*, Wiley, Chichester.
- Forrester, J.W. (1968), *Principles of Systems*, MIT Press, Cambridge, MA.
- Forrester, J.W. (1971), "Counter-intuitive behavior of social systems", *Technology Review*, Vol. 73 No. 3, January, pp. 52-68.
- Gälweiler, A. (1990), *Strategische Unternehmensführung*, 2nd ed., Campus, Frankfurt and New York, NY.
- Gomez, P. (1981), *Modelle und Methoden des systemorientierten Managements*, Haupt, Bern/ Stuttgart.
- Gomez, P. (1993), "Organising for autonomy", in Espejo, R. and Schwaninger, M. (Eds), *Organizational Fitness – Corporate Effectiveness through Management Cybernetics*, Campus, Frankfurt and New York, NY, pp. 165-82.
- Gomez, P. and Probst, G.J.B. (1987), "Vernetztes Denken im Management", *Die Orientierung*, No. 89, Schweizerische Volksbank, Bern.
- Gomez, P. and Probst, G.J.B. (1999), *Die Praxis des ganzheitlichen Problemlösens. Vernetzt Denken – Unternehmerisch handeln – Persönlich überzeugen*, 3rd ed., Haupt, Bern and Stuttgart.
- Gomez, P. and Zimmermann, T. (1992), *Unternehmensorganisation. Profile – Dynamik-Methodik*, Campus, Frankfurt and New York, NY.
- Gomez, P., Malik, F. and Oeller, K.-H. (1975), *Systemmethodik*, Haupt, Bern and Stuttgart.
- Kaplan, R.S. and Norton, D.P. (1996), *The Balanced Scorecard*, Harvard Business School Press, Boston, MA.
- Malik, F. (2000), *Strategie des Managements komplexer Systeme*, 6th ed., Haupt, Bern and Stuttgart (1st ed., 1984).
- Mueller-Stewens, G. and Lechner, Ch. (1999), "Die Gestaltung unternehmerischer Einheiten: Der General Management Navigator als Konzept zur integrierten Strategie- und Wandelarbeit", *Organisationsentwicklung*, Vol. 18 No. 2, pp. 24-43.
- Mueller-Stewens, G. and Lechner, Ch. (2001), *Strategisches Management. Wie strategische Initiativen zum Wandel führen*, Schäffer-Poeschel, Stuttgart.
- Probst, G.J.B. and Gomez, P. (1992), "Thinking in networks to avoid pitfalls of managerial thinking", in Maruyama, M. (Ed.), *Context and Complexity*, Springer, Berlin and Heidelberg, pp. 91-108.
- Pümpin, C. and Prange, J. (1992), *Management der Unternehmensentwicklung. Phasengerechte Führung und der Umgang mit Krisen*, Campus, Frankfurt and New York, NY.

-
- Rapoport, A. (1986), *General System Theory. Essential Concepts and Applications*, Abacus Press, Tunbridge Wells, Kent and Cambridge, MA.
- Rapoport, A. (1992), "Weltbilder – Wissen und Glauben: Die systemische Sicht", *Weltbilder – Wissen und Glauben, Aulavorträge*, No. 55, Hochschule St Gallen, St Gallen, pp. 3-27.
- Rapoport, A. (1998), "Reflection on the systems approach", unpublished lecture, delivered at Ecole Européenne de Systémique, University of Neuchâtel, Switzerland, September.
- Richardson, G.P. (Ed.) (1996), *Modelling for Management. Simulation in Support of Systems Thinking*, 2 volumes, Dartmouth and Aldershot.
- Richardson, G.P. (1999), *Feedback Thought in Social Science and Systems Theory*, Pegasus, Waltham, MA (Originally published in 1991 by University of Pennsylvania Press).
- Schwaninger, M. (1984), "Zur Architektur integraler Planungssysteme", *Harvard Manager*, I. Quartal, pp. 102-10.
- Schwaninger, M. (1989), *Integrale Unternehmensplanung*, Campus, Frankfurt and New York, NY.
- Schwaninger, M. (1993), "A concept of organizational fitness", in Espejo, R. and Schwaninger, M., (Eds), *Organizational Fitness – Corporate Effectiveness through Management Cybernetics*, Campus, Frankfurt and New York, NY, pp. 39-66.
- Schwaninger, M. (1994), *Managementsysteme*, Campus, Frankfurt and New York, NY.
- Schwaninger, M. (1997), "Integrative systems methodology: heuristic for requisite variety", *International Transactions in Operational Research*, Vol. 4 No. 4, pp. 109-23.
- Schwaninger, M. (2000), "Managing complexity: the path towards intelligent organizations", *Systemic Practice and Action Research*, Vol. 13 No. 2, pp. 207-41.
- Schwaninger, M. (2001a), "Intelligent organizations: an integrative framework", *Systems Research and Behavioral Science*, Vol. 18 No. 2, pp. 137-58.
- Schwaninger, M. (2001b), "Integrative systems methodology", in *EOLSS-Encyclopedia of Life Support Systems*, Unesco (www.eolss.com/).
- Sterman, J.D. (2000), *Business Dynamics*, Irwin/McGraw-Hill, Boston, MA.
- Ulrich, H. (1968), *Die Unternehmung als produktives soziales System*, Haupt, Bern and Stuttgart.
- Ulrich, H. (Ed.) (1981), *Management-Philosophie für die Zukunft*, Haupt, Bern and Stuttgart.
- Ulrich, H. (2001a), *Gesammelte Schriften*, 5 volumes, Haupt, Bern.
- Ulrich, H. (2001b), *Systemorientiertes Management*, Haupt, Bern.
- Ulrich, H. and Krieg, W. (1972), *St Gallen Management-Modell*, Haupt, Bern.
- Ulrich, H. and Probst, G.J.B. (1991), *Anleitung zum ganzheitlichen Denken und Handeln. Ein Brevier für Führungskräfte*, 3rd ed., Haupt, Bern and Stuttgart (first published 1988).
- Vester, F. and von Hesler, A. (1988), *Sensitivitätsmodell*, 2nd ed., Regionale Planungsgemeinschaft Untermain, Frankfurt am Main.
- von Bertalanffy, L. (1968), *General System Theory*, revised ed., Braziller, New York, NY.
- Wiener, N. (1948), *Cybernetics or Control and Communication in the Animal and the Machine*, MIT Press, Cambridge, MA.