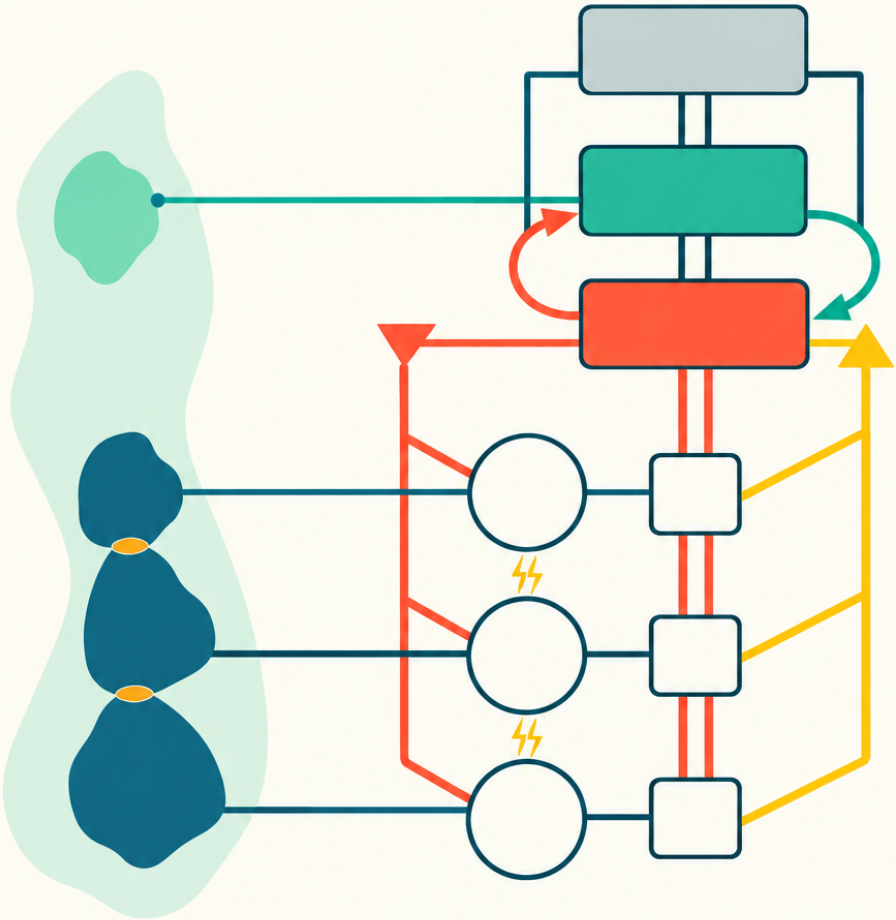
Pure VSM

Describing the VSM in Stafford Beer's own words



Krishan Mathis

Pure VSM

Describing the VSM in Stafford Beer's own words

Krishan Mathis

Tautai Press

Reader edition

Copyright © 2026 Krishan Mathis.
All rights reserved.

Tautai Press

Reader edition, built 2026-10-25

Set in Palatino. Typeset with XeLaTeX.

Contents

A note on quotations **1**

Part I — Foundations: Beer's cybernetics 3

Chapter 1 — What cybernetics is for Beer **7**
1.1 From Wiener's definition to "the science of effective organization" . . . 7
1.2 A system is an act of recognition . . . 9
1.3 Exceedingly complex, probabilistic systems . . . 10
1.4 Operational research and cybernetics . . . 10
1.5 Transdisciplinary, not interdisciplinary . . . 11
1.6 Not an analogy . . . 12
References . . . 13

Chapter 2 — Variety and regulation **15**
2.1 Variety as a measure of complexity . . . 15
2.2 Variety is the "stuff" of management and proliferates . . . 16
2.3 The Law of Requisite Variety . . . 16
2.4 Variety engineering: attenuation, amplification, transduction 17
2.5 The black box . . . 19
2.6 Heuristics rather than algorithms . . . 19
2.7 Feedback, ultrastability, self-organization . . . 20
2.8 The algedonic signal . . . 21
2.9 Every regulator needs a model: Conant–Ashby . . . 21
References . . . 22

Chapter 3 — The rules of the viable system **23**
3.1 Aphorisms . . . 23

3.2 Principles of Organization 24
3.3 Theorem 26
3.4 Axioms of Management 26
3.5 Law 27
3.6 Other key statements 28
References 29

Part II — The Viable System Model **31**

Chapter 4 — The origin of the model: the neurophysiological argument in *Brain of the Firm* **35**
4.1 Why the nervous system? 35
4.2 The five levels in the nervous system 37
4.3 What changes in the later books 39
4.4 Control physiology and the figures of the derivation 40
References 42

Chapter 5 — Viability, identity and autonomy **43**
5.1 Viability 43
5.2 Identity 44
5.3 Autonomy 45
References 47

Chapter 6 — Recursion **49**
6.1 The theorem 49
6.2 Recursion is a mathematical, not a metaphorical, term 50
6.3 Example: Chile 51
6.4 System-in-focus 52
References 53

Chapter 7 — System One: the operations and their embedment **55**
7.1 Definition 55
7.2 Primacy of System One 56
7.3 System One lacks the metalanguage 57
7.4 Horizontal variety 58
References 58

Chapter 8 — System Two: anti-oscillation **59**
8.1 Function 59
8.2 Neglected in practice 60
8.3 System Two in BOTF 62

8.4 System Two and the metasystem in HOE and DTS 63
References 64

Chapter 9 — System Three and Three*: inside-and-now, the resource bargain, audit 67
9.1 Function 67
9.2 The six vertical components of cohesion 68
9.3 The resource bargain 70
9.4 Audit (System Three*) 70
9.5 Three–Four 71
References 72

Chapter 10 — System Four: outside-and-then, the model of the self, the operations room 73
10.1 Why System Four is needed 73
10.2 System Four must contain a model of the whole 74
10.3 System Four in practice: disseminated, not integrated . . . 75
10.4 Focus and the operations room 76
10.5 System Four is not senior to System Three 77
10.6 System Four in BOTF: "Environments of decision" 78
References 79

Chapter 11 — System Five: closure, identity, the Three–Four homeostat 81
11.1 The Three–Four homeostat 81
11.2 Closure 82
11.3 The role of System Five 83
11.4 Who is System Five? 84
11.5 The multinode and the monitoring of decisions in BOTF . . 86
11.6 The higher management 87
References 88

Chapter 12 — Channels, transduction and the algedonic signal 89
12.1 Channels and transducers 89
12.2 Why an algedonic signal is needed 90
12.3 Algedonic signals cross recursions 91
12.4 Calm and alarm 93
12.5 The algedonic meter 94
12.6 The model of calm, alarm and response 94
References 97

Chapter 13 — Cohesion across recursions: the Law of Cohesion 99

13.1 Planning as the "glue" . . . 99
13.2 The law . . . 100
13.3 Cohesion and autonomy . . . 102
13.4 The mechanism and the limit . . . 103
References . . . 103

Chapter 14 — Diagnosis: the method of *Diagnosing the System for Organizations* 105
14.1 Purpose of DTS . . . 105
14.2 The sequence of the diagnosis . . . 106
14.3 Speed of diagnosis . . . 109
References . . . 110

Chapter 15 — Pathologies of viable systems 111
15.1 Why "pathology"? . . . 111
15.2 Four diagnostic points . . . 112
15.3 System Four missing . . . 113
15.4 Pathological autopoiesis . . . 114
15.5 The Test of Identity . . . 116
References . . . 118

Part III — Applications and politics 119

Chapter 16 — Chile 1971–73: Cybersyn, Cyberstride, the operations room 123
16.1 Beer's account and its standpoint . . . 123
16.2 The starting point: regulation in real time . . . 124
16.3 The four tools . . . 125
16.4 Recursion and autonomy in Cybersyn . . . 127
16.5 The indices of achievement . . . 128
16.6 The People Project and the five principles . . . 129
16.7 October 1972 . . . 131
16.8 The public dimension and the end . . . 132
16.9 Prospectus: crisis and entelechy . . . 133
References . . . 135

Chapter 17 — Freedom as a design problem 137
17.1 The Massey Lectures (*Designing Freedom*) . . . 137
17.2 The argument in HOE: freedom as a computable function . 140
References . . . 143

Chapter 18 — Institutions, metasystems and change (*Platform for Change*) 145
18.1 The form of the book . . . 145
18.2 The eight Thesis statements . . . 146
18.3 Metasystem . . . 148
18.4 Eudemony . . . 149
18.5 Data and information . . . 150
18.6 The Arguments of Change: dates and occasions . . . 150
References . . . 156

Chapter 19 — Planning that has to abort 157
19.1 Against planning as a product . . . 157
19.2 Plans must abort . . . 158
19.3 Planning as the "glue" of cohesion . . . 159
19.4 The same argument for society . . . 161
References . . . 162

Part IV — Team Syntegrity 163

Chapter 20 — The problem: non-hierarchical democracy in groups 167
20.1 Starting point: hierarchy does not suffice . . . 167
20.2 The requirement: a perfect democracy . . . 169
20.3 Infoset and Problem Jostle: the provenance . . . 169
20.4 Reverberation, tensegrity, syntegrity . . . 170
References . . . 172

Chapter 21 — The icosahedron as organisational form 173
21.1 Why a regular polyhedron . . . 173
21.2 Consequences of the geometry . . . 174
21.3 Why this form . . . 176
21.4 The mathematics of Part Three . . . 177
References . . . 179

Chapter 22 — Protocol, infoset, reverberation 181
22.1 The original protocol . . . 181
22.2 The revised protocol: episodes . . . 182
22.3 Outcome Resolve . . . 183
22.4 Facilitation . . . 184
22.5 Reverberation as the mechanism . . . 184
22.6 Beyond one group: hyperinfosets . . . 185
22.7 The Topic Auction . . . 186

References 188

Chapter 23 — Syntegrity and the VSM **189**
23.1 Syntegrity as a tool for System Four and the Three–Four homeostat 189
23.2 Recursion and consciousness 191
23.3 Governance or government 193
References 195

Part V — Method and epistemology **197**

Chapter 24 — Operational research, models and homomorphism (*Decision and Control*) **201**
24.1 Everyone has models 201
24.2 Mapping, isomorphism, homomorphism 203
24.3 The scientific model 204
24.4 The neurophysiological model of a company (1960s) 205
24.5 Models, laws and conventions 207
24.6 The formal languages 208
24.7 Models in the control of operations 209
24.8 Models of the enterprise 210
References 212

Chapter 25 — Systems as an act of recognition: observer, variety, control **213**
25.1 Coherence, pattern, purpose 213
25.2 The observer and the relatively isolated system 215
25.3 Variety depends on the observer 217
25.4 The Law of Requisite Variety and the variety sponge in DC 218
25.5 Black box and variety generator 219
References 220

Chapter 26 — Knowledge of knowing: the essays in *Think Before You Think* **221**
26.1 Against reductionism 221
26.2 Autopoiesis and identity 223
26.3 Paradigms and change 224
26.4 Learning an outlook 225
26.5 Holism through communication and control 226
26.6 Models of reality in the shorter pieces 227
References 229

Chapter 27 — *Management Science* (1967): models, control and the viable governor **231**
27.1 Management, science and the underlying system 232
27.2 Chance and variety 233
27.3 Conceptual model, scientific model, simulation 235
27.4 An alphabet of models and the cones of resolution 236
27.5 A worked case: interactions, self-organization, identity . . . 238
27.6 Control as the continuous function 239
27.7 Implicit control 240
27.8 Ecology: viable governors 241
27.9 Homeostasis and ultrastability 241
27.10 A new model: company and market 242
27.11 The education of systems 243
27.12 Automation, structure and purpose 244
27.13 Place in the development of the VSM 245
References 246

Appendix **247**

A. Chronology of Beer's books **251**

B. Textual notes: where Beer's formulations differ **253**

C. Terms Beer attributes to others **259**

A note on quotations

This book reports Beer's model in Beer's words. Quotations are cited as (abbreviation year: page), for example (HOE 1979: 355): the abbreviation names the book, the year is that of first publication, and the page is the printed page of the edition listed in each chapter's references. "ibid." refers to the citation immediately before it.

Quotations reproduce Beer's wording, spelling and emphasis as printed in those editions: italic as italic, bold as bold, capitals as capitals. Omissions are marked […]; words in square brackets are mine; misprints are kept and marked [sic]. When a quotation runs into a sentence of mine, the case of its first letter is adjusted to the sentence. Where a whole passage is set in italic as a typographic convention (a summary, a display, a verse), it is quoted in roman, and any word Beer sets in roman within it for emphasis is given in italic. Passages Beer sets wholly in bold, such as the Thesis statements of *Platform for Change*, are quoted in bold.

Two sources cannot show Beer's typography here. *Designing Freedom* (DF 1974) is quoted from a transcript of the radio lectures that has neither the page numbers nor the typography of the printed book; DF quotations are cited by lecture. *Management Science* (MS 1967) is quoted from reading notes made from the page images of a library copy; its emphasis has not yet been checked.

Where a sentence gives my reading rather than Beer's statement, it says so.

Part I — Foundations: Beer's cybernetics

Part I establishes the scientific ground on which the Viable System Model stands. Its three chapters lay out what Beer meant by cybernetics, the set of concepts with which he worked, and the explicit rules he derived from them.

Chapter 1, "What cybernetics is for Beer," reconstructs Beer's definition of cybernetics and of management cybernetics, and defends the claim that the model is a consequence of invariant principles of control rather than an analogy from the nervous system.

Chapter 2, "Variety and regulation," introduces variety and the family of ideas built on it: the law of requisite variety, attenuation, amplification and transduction, the black box, heuristics, ultrastability, self-organization, the algedonic signal, and the requirement that a regulator model what it regulates.

Chapter 3, "The rules of the viable system," collects the rules Beer himself assembled in the Glossary of Rules of *The Heart of Enterprise*: the regulatory aphorisms, the principles of organization, the recursive system theorem, the axioms of management, the law of cohesion, and the key statements Beer used as rules that do not appear in the glossary.

Chapter 1 — What cybernetics is for Beer

1.1 From Wiener's definition to "the science of effective organization"

In the notes to his first Massey Lecture, Beer records that cybernetics was "originally defined by the late Norbert Wiener as the science of control and communication in the animal and the machine" (DF 1974, Notes to Lecture 1). Beer did not invent the word or its first definition; he took both from Wiener. What he did with Wiener's pair, the animal and the machine, is where any account of the Viable System Model has to start, because his books present the model throughout as an application of cybernetics rather than a free-standing management technique.

In *Decision and Control* Beer keeps Wiener's wording and widens its scope: cybernetics is "the science of control and communication wherever these occur in whatever kinds of system". A claim follows at once to justify the widening. The core of the discipline is "the discovery that there is a unity of natural law in the way control must operate, whether the system controlled is animate or inanimate, physical or biological, social or economic" (DC 1966: 239). Everything else in Beer's work depends on this sentence. If control does obey laws that hold across animals, machines, economies and firms, then control can legitimately be studied in one kind of system and the result applied to another. If it does not, the VSM would be no more than a metaphor.

The connection to management comes next. In the connective summary that opens Part III of *Decision and Control* Beer writes: "Now if cybernetics is the science of control, management is the profession of control in a

certain type of system" (DC 1966: 239). Fifteen pages later the thought returns in shorter form: "For cybernetics is the science of control; and management is the profession of control" (DC 1966: 254). Beer draws a methodological consequence from the pairing. Models taken from other sciences reach management only "at one remove", by way of analogy, whereas "models drawn by the OR scientist from cybernetics have a direct bearing, an immediacy, which models drawn from other sciences lack" (DC 1966: 254). His reason is that the processes cybernetics studies "are to be found among brains, colonies of animals, and economic, social and managerial systems too" (ibid.). In 1967 *Management Science* repeats the argument and names the resulting field: "if cybernetics is the science of control, and if management might be described as the profession of control, there ought to be a topic called *management cybernetics*—and indeed there is" (MS 1967: 144; see chapter 27.6).

The later books shorten the long definition to a formula. *The Heart of Enterprise* describes itself as concerned with "management *cybernetics*: the science of effective organization" (HOE 1979: 4). Twenty pages on, Beer says what such a science contains: "What truly is given in nature is a collection of principles that systems cannot violate if they are to maintain their identity. These principles are the content of the science of cybernetics, which may conveniently be defined as the science of effective organization" (HOE 1979: 24). The formula also appears in the Chile chapters and the prospectus of *Brain of the Firm* (BOTF 1981: 259, 351, 394).

In its context, the HOE passage is aimed at the habit of accepting "the system" as if it were given in nature. Beer concludes: "We cannot successfully handle any system that we are disposed to manage unless we obtain an insight into its nature" (HOE 1979: 24). Read this way, the science of effective organization is the knowledge of what a system must satisfy in order to go on existing.

In an essay collected in *Think Before You Think*, Beer uses the same definition and at once qualifies the word "effective": "I define cybernetics as the science of effective organization. The adjective 'effective' at once entails a definition of purpose. But organizations do not have purposes. It is the perception and the purpose of the people who sponsor, operate, use and serve the organization that determine how it shall be deemed effective" (TBYT 2009: 24). He also says in what sense he speaks of laws: there are "fundamental facts about the way that large, complicated, probabilistic systems actually work, regulate themselves, organize themselves, learn, adapt and evolve, which seem to be invariant to the fabric of the system

concerned" (ibid.).

Three points follow from these passages for this book:

- For Beer, cybernetics is a **science of invariant principles** that a system cannot violate if it is to keep its identity, and the VSM is presented as a consequence of such principles rather than as one technique among others.
- "Effective organization" is **not an efficiency criterion**. The criterion in HOE is keeping identity and viability; nothing in the definition refers to cost per unit of output.
- Effectiveness is **judged relative to purposes that people perceive**. Beer's statement that "organizations do not have purposes" (TBYT 2009: 24) anticipates the treatment of purpose as something imputed by an observer (see chapter 3.6).

1.2 A system is an act of recognition

"A system is not something given in nature, but something defined by intelligence" (DC 1966: 242). A science of systems might be expected to begin with an inventory of the systems that exist; *Decision and Control* begins with this sentence instead, and the argument that leads to it is short. Beer first describes talk about systems as speaking "of the coherence of a number of" entities (DC 1966: 241). He then asks what identifies a given collection of entities as coherent, and answers: "Surely this is an act of mental recognition" (DC 1966: 242).

His example is a machine in Wiener's sense, an internal combustion engine. It is "clearly" a system to us because we know it was designed to be one; someone without engineering knowledge might at first see only a random collection of objects (DC 1966: 242). To recognize a system is to recognize relations between its parts, and here Beer finds a difficulty: "In declaring that a collection ought to be called a system, that is to say, we acknowledge relatedness. But everything is related to everything else" (ibid.). If everything is related to everything else, the boundary of a system cannot be read off the world. Someone has to draw it, for some purpose.

For the VSM the consequence is practical. Every VSM analysis begins with the observer's decision about which system is "in focus". *Diagnosing the System for Organizations* makes this the first step of the diagnosis: it is "important first of all to determine precisely what is the organization to

be modelled, and to specify its boundaries" (DTS 1985: 2), and the last exercise of the first section begins "Choose and clearly define the System-in-focus that you intend to model" (DTS 1985: 16); chapter 6 relates that choice to the levels of recursion. The same observer-dependence returns in the measurement of variety, where the states that count depend on the purpose of the system (see chapter 2.1).

1.3 Exceedingly complex, probabilistic systems

The engine of section 1.2 is a system someone designed. Beer's cybernetics is aimed at a different class: systems that cannot be fully described by analytical methods. In *Decision and Control* he writes that the kind of science "which is preoccupied with analytic method is not altogether adequate to the task of dealing with large and exceedingly complex systems and situations" (DC 1966: 219), and he draws a warning from this for his own profession: "Operational research is an empirical science; it is concerned with actual situations and not with idealizations of them" (ibid.).

His principal example is the economy, which is "*par excellence* an exceedingly complex ramified system, too unspecified, too deeply interactive, and for that matter too undecidable" to be mapped onto a linear-programming matrix (DC 1966: 225). The number of variables is only part of the difficulty. In systems with "literally billions of variables" there is "no *rigorous* means of knowing which 'matter' "; the importance of a particular variable "is a question of degree, a question of judgment, a question of convention", and it changes from moment to moment (DC 1966: 98). Beer insists that this goes beyond the ordinary fact that the values of variables change: "the *structural relevance* of the variable inside the system is changing with time" (ibid.).

The rest of the book responds to this problem. A system that cannot be specified completely cannot be controlled by a complete specification. Chapter 2 shows how Beer answers with the concept of variety, with the black box and with heuristic rather than algorithmic control.

1.4 Operational research and cybernetics

Beer came to cybernetics through operational research (OR), and *Decision and Control* is organized around the relation between the two. He defines OR as "the attack of modern science on complex problems arising in the

direction and management" of enterprises (DC 1966: 89). The distinction he then draws is sharp. OR "means doing science in the management sphere: the subject is not itself a science, it is a scientific profession", whereas in cybernetics "we encounter a science in its own right" (DC 1966: 239). In the same passage management cybernetics is described as "a rich provider of models for doing OR" (ibid.).

The division of labor follows from this. OR is the practice of applying scientific method to managerial problems. Cybernetics is one of the sciences from which that practice can draw its models, and the one whose subject matter, control, coincides with the subject matter of management. That is why Beer's later books, although written for managers, keep returning to laws, theorems and axioms (see chapter 3): he is presenting what he regards as the findings of a science to the profession that has to apply them.

1.5 Transdisciplinary, not interdisciplinary

In the essay "Laws of Anarchy", collected in *Think Before You Think*, Beer first describes the partial pictures that different people have of cybernetics, among them its work on biological systems and especially on the brain. He then states: "The fact is that cybernetics is all of these things. I mean that it is all of these things put together and at the same time. It is not so much an interdisciplinary science as a transdisciplinary science" (TBYT 2009: 24). A science that claims to find the same laws in brains, machines and economies could easily be taken for a meeting place where several disciplines exchange ideas. Beer rejects that description.

The difference matters for the argument of this book. An interdisciplinary science borrows results from one field and transfers them to another, and every such transfer raises the question of whether the analogy holds. A transdisciplinary science claims that its results belong to none of the fields in particular, because they describe regularities that hold in all of them. In the same essay Beer warns that taking cybernetics to pieces, and pointing to the cybernetic work done by engineers, neurophysiologists or social scientists, means "misleading ourselves" (TBYT 2009: 24). From this position he answers the charge of analogy.

1.6 Not an analogy

The jacket text of the second edition of *Brain of the Firm*, which names no author and refers to Beer in the third person, says that the comparison of brain and management structures "should not be thought of as 'analogy', but as the pursuit of fundamental principles whereby self-regulatory systems are necessarily constructed" (BOTF 1981, jacket text). The sentence answers a recurring misreading, that the VSM transfers the nervous system to the firm "by analogy".

Inside the book, in a passage that looks ahead to Part Two, Beer writes: "Models are more than analogies: they are meant to disclose the key structure of the system under study" (BOTF 1981: 75). The same passage explains why he chose the human nervous system. The firm is "something organic, which intends to survive", and that is why Beer calls it a viable system (ibid.). To understand viability, one should use "a known-to-be-viable system as a model". Another viable system, such as the amoeba, could have been used, and "The results are the same, as they must be if viability as such has its own laws and enshrines its own principles (as cyberneticians contend)" (BOTF 1981: 75). The body was chosen because it is rich, flexible and familiar to every reader, not because the firm resembles a body.

Beer concedes that the firm has something like a head, a trunk and limbs, and that the comparison "could be extended in a literary way at great length"; but "we are not interested in comparisons but in models, and we ought to be scientific rather than literary" (BOTF 1981: 86). A page later: "There can be no interest in analogy at this point" (BOTF 1981: 87). *Management Science* draws the same line in more general terms: an analogy that is not made rigorous is "a literary trick—not very scientific" (MS 1967: 68).

Wiener's definition put the animal and the machine side by side. Beer's claim goes further and says nothing about resemblance: there are invariant principles of control, these principles are the subject of cybernetics, and any system that stays viable must satisfy them, whether it is an animal, a machine or a firm. The brain is used because it is a well-studied instance of such a system. Whether the claim is justified is a separate question, taken up in chapters 4.1, 24.3 and 27.3. What sections 1.1 to 1.6 establish is that it is the claim Beer actually makes.

References

- **DC** — Beer, Stafford (1966). *Decision and Control: The Meaning of Operational Research and Management Cybernetics*. Chichester: John Wiley & Sons. Cited from the Stafford Beer Classic Library reprint, 1994.
- **MS** — Beer, Stafford (1967). *Management Science: The Business Use of Operations Research*. Garden City, NY: Doubleday, in association with Aldus Books, London.
- **DF** — Beer, Stafford (1974). *Designing Freedom*. London: John Wiley. Cited by lecture from a transcript edition.
- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.
- **TBYT** — Beer, Stafford (2009). *Think Before You Think: Social Complexity and Knowledge of Knowing*. Edited by David Whittaker. Charlbury: Wavestone Press.
- Wiener, Norbert. 1948. *Cybernetics: or Control and Communication in the Animal and the Machine*. New York: Wiley.

Chapter 2 — Variety and regulation

How can anyone control a system that is too complex to be specified completely? Chapter 1 ended with that problem. Beer's answer runs through one concept, variety, and through the ways of working with variety when it cannot be counted in detail. One case from the Chile chapters of *Brain of the Firm* recurs below: an economy whose only acknowledged regulator is the money supply.

2.1 Variety as a measure of complexity

Beer took the concept of variety from W. Ross Ashby, and his definition of it differs only slightly from book to book (see the textual note in chapter 27.2 and appendix B). In *Management Science* variety is "roughly defined as the possible number of distinguishable states in a situation" (MS 1967: 37). In the Massey Lectures: "The number of possible states of a system is called its variety. […] variety means the number of possible states" (DF 1974, Lecture 1). In *The Heart of Enterprise* variety is "the measure of complexity" (HOE 1979: 45). In *Diagnosing the System*: "Variety is the number of possible states of the system" (DTS 1985: 98). In substance the formulations agree: variety counts possible states, not actual ones, and it serves as a measure of how complex something is.

Directly after the definition, DTS asks which states are to count at all (DTS 1985: 98). Beer's example is deliberately trivial: "Today, Fred Bloggs has changed his shirt" (ibid.). This is a change of state, yet no one would count it in assessing the variety of a firm. Beer sets aside the obvious answer, that one should count all relevant variables, and gives a more

basic criterion: "What matters in discriminating one 'state of the system' from other states is whether the resulting **change of state** serves, or has no bearing on, the **purposes** of the system" (DTS 1985: 98). The count of variety therefore depends on the purpose attributed to the system, and always on an observer. This ties the concept to the observer-dependence of the system in chapter 1.2 and to the treatment of purpose in chapter 3.6.

2.2 Variety is the "stuff" of management and proliferates

In *Brain of the Firm* Beer writes that "variety is the very stuff and substance of modern management in a newly complicated milieu, just as physical matter was the stuff and substance with which our forefathers had to wrestle" (BOTF 1981: 229). Variety, on this account, plays the part in management that physical matter played for earlier generations. The major thread that management cybernetics unravels is accordingly "the thread of variety — its generation and proliferation, its reduction and amplification, its filtering and control" (ibid.). The list in that sentence could serve as a table of contents for what follows.

Beer means "proliferation" literally. When elements interact, the number of possible states of the whole grows much faster than the number of elements. *The Heart of Enterprise* sets the point out as a display: "*Variety* / the measure of complexity, / itself the STUFF of modern management — / *proliferates*." (typeset as a display in the original). Beer continues: "This is the natural law of interactive systems; and the task of the manager is to handle the proliferating variety of his muddy box" (HOE 1979: 57). The "muddy box" is his term for the partly opaque systems that managers deal with; the black box of section 2.5 is, in his words, its "limiting state" (HOE 1979: 40).

2.3 The Law of Requisite Variety

If variety measures complexity, how much variety does a controller need? Beer answers with Ashby's law, which he treats as the basic law of control. In *Brain of the Firm*: "Ashby's Law of Requisite Variety […] says that control can be obtained only if the variety of the controller (and in this case of all the parts of the controller) is at least as great as the variety

of the situation to be controlled" (BOTF 1981: 41). *Management Science* states the same requirement without Ashby's name: "the control must be capable of generating as much "variety" as the situation to be controlled" (MS 1967: 37; similarly 149).

In *The Heart of Enterprise* Beer builds the law up in two steps, and he begins from an objection to his own earlier calculations of proliferating variety: "who could possibly USE this variety measure in a real-life situation? Could we ever say: *this* is the variety of the chemical industry, say? Of course we could not" (HOE 1979: 86). The first step is an observation drawn from many kinds of system. In ecological food webs, "enormously potent variety generators have outputs regulated to criteria which relate to the STABILITY of the system"; in team games, "pairs of players contain variety by 'marking' each other" (ibid.). From these examples he draws a conclusion: "Thus the first stage of our perception about variety regulation says that VARIETY ABSORBS VARIETY" (ibid.). As the passage presents it, regulation depends on one source of variety being matched against another, and not on knowing the absolute number of states.

In the Chile chapters of *Brain of the Firm* Beer states the law more sharply and draws out its two possible readings: "*Only variety can absorb variety*: Ashby's Law can be met **either** by expanding regulatory variety to absorb evolutionary variety, **or** by curbing evolutionary learning until variety in the economy matches the regulatory variety" (BOTF 1981: 308). The second reading is his critique of monetarism in that passage. The full sentence goes on to name the regulatory variety in question as the one "disposed by the only regulator — the money supply — that the ideology of the status quo is prepared to acknowledge" (ibid.). Beer's objection is that "the regulatory tool embodies a model of what must be regulated that denies variety proliferation in pursuit of adaptation and evolution" (ibid.). The example shows that requisite variety is a condition to be met, and that the law itself does not say how to meet it. It can be satisfied by raising the variety of the regulator or by lowering the variety of what is regulated, and the choice between the two is a matter of design and of values.

2.4 Variety engineering: attenuation, amplification, transduction

The variety of the environment always exceeds that of the operation, and the variety of the operation exceeds that of its management. If control re-

quires matching variety, management must either reduce the variety that reaches it or increase its own. Beer calls "the manipulation of varieties by design" **variety engineering** (DTS 1985: 26). It has three components.

- **Attenuation:** High variety "is necessarily cut down, or attenuated, to the number of possible states that the receiving entity can actually handle" (DTS 1985: 23). Attenuation happens whenever information passes to a system of lower variety, and it becomes a failure only when it goes too far. In the exercises of DTS two quite different examples lead to the same finding: "each attenuator has reduced variety **below the threshold** of the required response. We say that the responding system does not exhibit **REQUISITE VARIETY**" (DTS 1985: 26).
- **Amplification:** Management has to raise its own variety towards the operation and the environment. Beer warns against assuming that information-gathering amplifies automatically, and takes market research as his example: "Many people suppose (without much thought) that because market research 'finds things out' it must be an *amplifier* of *managerial* variety" (DTS 1985: 25). In his example it does the opposite. It reduces an impractical range of customer demand to a range the works can handle, and so acts as an attenuator (ibid.). Whether a device amplifies or attenuates depends on the direction of the flow and on the system from whose point of view it is described.
- **Transduction:** Where a channel crosses a boundary, the message has to be translated. *The Heart of Enterprise* gives the reason: "Because the 'language' of each subsystem is unique to it, messages have to be 'translated' when a boundary is crossed" (HOE 1979: 101). The mechanism that does this "is called a *transducer*, because it 'leads across' " (ibid.).

For Beer, the balancing of varieties is both a natural tendency and a task. Over time the varieties of management, operation and environment come to equal one another. The way in which they do so may be damaging, and that is where the task arises: "if this is not to occur by happenstance, because a natural law is operating, then it is management's job to DESIGN the necessary amplifiers and attenuators" (HOE 1979: 97). The monetarism of section 2.3 is one way of reaching the balance: curbing evolutionary learning in the economy attenuates what is regulated until its variety matches that of the regulator. At this point in HOE Beer formulates the First Principle of Organization, discussed with the other rules in chapter 3.

2.5 The black box

Anyone who has had a new baby, Beer writes in *The Heart of Enterprise*, knows "what it is like to be in charge of a black box": one sees its outputs and controls some of its inputs. "So the solution is to manipulate the inputs in order to regulate the outputs. This can be done without much knowledge of what is happening inside the baby" (HOE 1979: 40). The systems of chapter 1.3 cannot be specified completely, and Beer treats them in the same way, as black boxes that cannot be fully entered.

Two "regulatory aphorisms" follow from this (HOE 1979: 40, 47; wording in chapter 3). The first concerns the function of the box, which can be understood from input and output alone. The second concerns its variety. With a series of combinatorial examples Beer shows that the variety of even simple boxes reaches very large numbers, and concludes that "we can measure the intrinsic variety of a black box, or even of a cascade of black boxes, by studying the mathematical implications of the interactions of their input and output schemata" (HOE 1979: 47). Together the aphorisms release the manager from having to understand the inside of a system before regulating it. The inside still matters. Regulation simply does not have to wait for it.

2.6 Heuristics rather than algorithms

In *Brain of the Firm* Beer contrasts algorithms, which specify every step towards a fully specified goal, with heuristics, which specify only a direction: "in dealing with unthinkable systems it is normally impossible to give a full specification of a goal, and therefore impossible to prescribe an algorithm. But it is not usually too difficult to prescribe a class of goals" (BOTF 1981: 53). Hence: "To think in terms of heuristics rather than algorithms is at once a way of coping with proliferating variety. Instead of trying to organize it in full detail, you organize it only somewhat; you then ride on the dynamics of the system in the direction you want to go" (ibid.). Proliferating variety that cannot be specified completely cannot be controlled by a complete set of instructions either.

Beer observes that people already live this way, and that institutions tend to reverse it: "The strange thing is that we tend to live our lives by heuristics, and to try and control them by algorithms" (BOTF 1981: 53). Heuristic control is therefore no relaxation of rigor, since it follows from the law of requisite variety. A controller that tries to prescribe everything would

have to match the full variety of what it controls, while a controller that sets a direction and relies on the system's own dynamics needs far less.

2.7 Feedback, ultrastability, self-organization

Riding on the dynamics of a system presupposes that the system has dynamics that tend towards stability. Beer's account starts from negative feedback, which "corrects output in relation to fluctuating inputs from any cause"; with it "we are now well on to the track of that normally desirable systemic property, ultrastability" (BOTF 1981: 36). His own glossary defines ultrastability as "the capacity of a system to return to an equilibrial state after perturbation by unknown or unanalysed forces (against the intervention of which the system was therefore not explicitly designed)" (BOTF 1981: 403). *The Heart of Enterprise* puts it more briefly: "An ultrastable system, that is, will operate in the face of perturbations that have not been envisaged in advance — at the design stage" (HOE 1979: 62).

The weight falls on unforeseen perturbations. A system that can cope only with the disturbances its designers anticipated has, in effect, the variety of its designers' foresight. An ultrastable system can absorb disturbances nobody predicted.

Self-organization has, in Beer's account, a structural precondition: "the redundancy of potential command turns out to be the prerequisite capability of any self-organizing system, and […] given this prerequisite the system will indeed organize itself" (BOTF 1981: 233). Redundancy of potential command means that the capacity to take control is distributed rather than reserved to a single center.

Control built into the operation of the system itself is a constant theme: "Control is integral and control is intrinsic" (BOTF 1981: 86). In HOE the engine governor serves as the example: it is designed so "that *in the very process* of going out of control, it is brought back onto control. This regulatory process of INTRINSIC CONTROL sees to it that Ashby's Law is automatically obeyed" (HOE 1979: 91). *Management Science* calls the same principle implicit control (MS 1967: 145–147; see chapter 27.7) and defines ultrastability in its own words (MS 1967: 155; see chapter 27.9). The connection to section 2.4 is direct: intrinsic control absorbs variety where it arises, so that it does not have to be transmitted to a manager at all.

2.8 The algedonic signal

In *Brain of the Firm* Beer introduces the algedonic signal with a trainer and a dog. The trainer tries to extinguish responses he dislikes by a rebuke and to reinforce those he approves by a reward, and so creates a mode of communication "between two systems which do not speak each other's language" (BOTF 1981: 59). Beer takes the term "algedonic" from the Greek *algos* (pain) and *hedos* (pleasure). The trainer does not need to know how the dog's brain works; pain and pleasure change the dog's behavior without a shared language.

Not every signal can wait for the normal channels. In the VSM the algedonic signal is a special alarm signal that bypasses the normal filters on the way to System Five (DTS 1985: 133). Its function is to make sure that the attenuation described in section 2.4 does not filter out the message that matters most. According to *Brain of the Firm*, the algedonic controller is "the biggest variety reducer of them all", both in the brain and in the firm (BOTF 1981: 233). Its place in the model is discussed in the chapters on System Five and the algedonic channel.

2.9 Every regulator needs a model: Conant–Ashby

The monetarism passage of section 2.3 already relies on a further theorem. There Beer recalls "the cybernetic theorem that declares a regulator to be effective only insofar as its model of what is regulated is adequate" (BOTF 1981: 308). This is the theorem of Conant and Ashby, which says in substance that every good regulator must be a model of the system it regulates, and it links variety to knowledge. For Beer it is also the formal basis for saying that self-regulation needs a model of the self: "Because of the Conant/Ashby theorem, any other approach is doomed: we should find ourselves or our social units moving blindly and incontinently in unknown territory" (TBYT 2009: 111).

The step from requisite variety to the theorem can be stated briefly (this is an explanatory reconstruction, not Beer's wording). A regulator must match the variety of the system it regulates; to do so selectively, it must represent the relevant states of that system; a representation of the relevant states is a model. A system that regulates itself must therefore contain a model of itself. In the VSM the model of the self later becomes the task of System Four (chapter 10).

References

- **MS** — Beer, Stafford (1967). *Management Science: The Business Use of Operations Research*. Garden City, NY: Doubleday, in association with Aldus Books, London.
- **DF** — Beer, Stafford (1974). *Designing Freedom*. London: John Wiley. Cited by lecture from a transcript edition.
- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.
- **TBYT** — Beer, Stafford (2009). *Think Before You Think: Social Complexity and Knowledge of Knowing*. Edited by David Whittaker. Charlbury: Wavestone Press.
- Ashby, W. Ross. 1956. *An Introduction to Cybernetics*. London: Chapman & Hall.
- Conant, Roger C., and W. Ross Ashby. 1970. "Every Good Regulator of a System Must Be a Model of That System." *International Journal of Systems Science* 1, no. 2: 89-97.

Chapter 3 — The rules of the viable system

In Appendix One of *The Heart of Enterprise* Beer brings together all the rules developed in the book in a "Glossary of Rules for the Viable System" (HOE 1979: 565–567). Those three pages are the most compact authorized summary of his theory, and they collect the rules he derives from the concepts of chapters 1 and 2. The wording below follows that appendix. The page references in brackets are Beer's own references to the place in the text where each rule is developed, and where the wording in the body of the book differs from the appendix, this is noted.

In the synopsis at the start of HOE Beer says that a science is expected to deliver "precepts" as well as concepts, "the rules that apply to the exercise of any art" (HOE 1979: 4). The glossary sorts its precepts into kinds: aphorisms, principles, a theorem, axioms and a law. The labels mark different degrees of generality and different ways in which Beer claims to have arrived at each rule, and they reflect his view (chapter 1.1) that cybernetics is a science that delivers invariant principles.

3.1 Aphorisms

- **First Regulatory Aphorism:** "It is not necessary to enter the black box to understand the nature of the function it performs." (HOE 1979: 565; developed on p. 40)
- **Second Regulatory Aphorism:** "It is not necessary to enter the black box to calculate the variety that it potentially may generate." (HOE 1979: 565; p. 47)

The two aphorisms follow from the treatment of complex systems as black boxes (chapter 2.5). The first rests on the observation that "The nature of the function can be deduced from those relationships between input and output schemata that turn out to be *invariant*" (HOE 1979: 40). Beer's example is a box observed in four operations (his Figure 4): the missing output, 26, can be supplied without difficulty because the box demonstrates an invariant transformation, which he names "times two" (ibid.). The box never has to be opened.

Two pages later Beer gives the first aphorism a practical edge. Managers, he writes, tend to disregard it in action: "They are prone to enter the box, hunting down 'causes' with the jawbone of an ass" (HOE 1979: 42). His example is industrial relations. A manager who explains his staff's behavior with a theory such as "All that interests them is the pay packet" has reduced the variety of a human being to the few states his theory allows, and is blinded to the input-output regularities he might otherwise observe (ibid.).

The second aphorism extends the argument from function to variety: the variety of a system can be estimated from the combinatorics of its inputs and outputs (HOE 1979: 47). Both are called aphorisms, not laws: they are rules of method for the observer rather than statements about the system.

3.2 Principles of Organization

- **First Principle:** "Managerial, operational and environmental varieties, diffusing through an institutional system, tend to equate; they should be **designed** to do so with minimum damage to people and to cost." (HOE 1979: 565; p. 97)
- **Second Principle:** "The four directional channels carrying information between the management unit, the operation, and the environment must each have a higher capacity to transmit a given amount of information relevant to variety selection in a given time than the originating subsystem has to generate it in that time." (HOE 1979: 565; p. 99)
- **Third Principle:** "Wherever the information carried on a channel capable of distinguishing a given variety crosses a boundary, it undergoes transduction; the variety of the transducer must be at least equivalent to the variety of the channel." (HOE 1979: 566; p. 101)
- **Fourth Principle:** "The operation of the first three principles must

> be cyclically maintained through time without hiatus or lags." (HOE 1979: 566; p. 258)

Textual note: In the body of the book the principles are worded slightly differently. The First reads "with minimal damage" (HOE 1979: 97); the Second reads "the management unit, the operation and the environment" and "originating sub-system" (HOE 1979: 99); the Third reads "it undergoes transduction; and the variety of the transducer" (HOE 1979: 101); the Fourth reads "cyclically maintained through time, and without hiatus or lags" (HOE 1979: 258). None of these differences changes the meaning.

The four principles form a sequence. They apply the variety concepts of chapter 2 to Beer's elementary model of three boxes: environment, operation and management unit, connected by channels.

The **First Principle** has two halves. The first is descriptive: the three varieties "tend to equate", which is a statement about what happens anyway. The second is normative: they "should be **designed**" to do so, with minimum damage to people and to cost. The passage discussed in chapter 2.4 links the two halves: if the equalization is not to happen by chance, "it is management's job to DESIGN the necessary amplifiers and attenuators" (HOE 1979: 97). The criterion of design is not efficiency alone; damage to people is named first.

The **Second Principle** concerns the channels. Requisite variety at each box is not enough if the channels between the boxes cannot carry it. The principle is formulated in terms of rates, and Beer explains why: variety "counts the number of possible states of the system. Clearly, in a dynamic system, there is a minimal time in which all possible states could be exhibited, and therefore there is a *rate* of variety generation possible per unit time" (HOE 1979: 99). A channel must be able to carry information faster than the originating subsystem generates the variety it has to report.

The **Third Principle** concerns the boundaries. Each subsystem has its own "language", so every channel that crosses a boundary needs a transducer (chapter 2.4). The principle adds that the transducer itself must have at least the variety of the channel. A channel of high capacity is useless if the translation at its end reduces what it carries.

The **Fourth Principle** comes much later in the book, in the discussion of the relation between Systems Three and Four. Beer says that it "was there all the time" and was entailed in the first three, but that it took the analysis of the Three-Four loops to show it "with sufficient force" (HOE 1979: 258). His reason for stating it separately is practical: "Breaks in flow, and

especially time lags, are dangerous to the entire management process", and yet "orthodox managerial procedures appear to rely, almost wholly, on 'snapshot' accounts of the situation" (ibid.). The first three principles describe a balance. The fourth requires that the balance be maintained continuously rather than checked at intervals.

3.3 Theorem

- **Recursive System Theorem:** "In a recursive organizational structure, any viable system contains, and is contained in, a viable system." (HOE 1979: 566; p. 118). Beer notes that this is "an alternative version of the Theorem as stated in *Brain of the Firm*, which expressed the same point from the opposite angle" (HOE 1979: 118).

Beer quotes the earlier version in the same place: "if a viable system contains a viable system, then the organizational structure must be recursive" (HOE 1979: 118). The two versions run in opposite directions. The BOTF version starts from the fact of containment and infers recursion; the HOE version starts from a recursive structure and states what it contains.

Beer calls this rule a theorem because he intends to prove it: "Theorems, no doubt, ought to be proved. The proof offered later will be a topological proof" (HOE 1979: 118). The claim to be proved is that all viable systems, drawn as systems diagrams, look alike, and that the way they are connected between levels of recursion is invariant as well (ibid.). The theorem is the basis of the recursive structure discussed in chapter 6.

3.4 Axioms of Management

- **First Axiom:** "The sum of horizontal variety disposed by *n* operational elements equals the sum of vertical variety disposed on the six vertical components of corporate cohesion." (HOE 1979: 566; p. 217)
- **Second Axiom:** "The variety disposed by System Three resulting from the operation of the First Axiom equals the variety disposed by System Four." (HOE 1979: 566; p. 298)
- **Third Axiom:** "The variety disposed by System Five equals the residual variety generated by the operation of the Second Axiom." (HOE 1979: 567; p. 298)

Textual note: In the body of the book the First Axiom is set with an equals

sign ("= the sum of vertical variety", HOE 1979: 217), and the Second and Third Axioms say "equivalent" rather than "equals": "The variety disposed by System Three, resulting from the operation of the First Axiom, and the variety disposed by System Four, are equivalent"; "The variety disposed by System Five is equivalent to the residual variety generated by the operation of the Second Axiom" (HOE 1979: 298).

The three axioms are balance equations. Each states that one variety must match another, which is the Law of Requisite Variety applied to a specific pair of components in the model.

The **First Axiom** balances the variety generated by the operational elements (System One) on the horizontal plane against the variety absorbed by the vertical channels of the model. Beer summarizes the reasoning in HOE: there are six vertical loops, "three determined by the *nature* of the enterprise, and three designed for metasystemic, managerial reasons", and "These six vertical loops (of which only one, the command loop, is customarily acknowledged in management theory) must absorb the total variety generated by the horizontal loops of the elemental units, according to Ashby's Law. This requirement leads to the designation of *The First Axiom of Management*" (HOE 1979: 143). The remark in parentheses states one of Beer's main criticisms of conventional organization: it recognizes only the line of command, and so provides one channel where the balance requires six.

The **Second Axiom** concerns the metasystem. Systems Three and Four must balance each other, and Beer explains why no one else can do it for them: "it is necessary for Systems Three and Four to absorb each other's variety: System Five cannot do it" (HOE 1979: 298). The **Third Axiom** assigns to System Five the variety left over from that interaction. Beer admits that the two axioms are hard to elucidate further, "because everything has already *been* said in the exposition of the viable system", and that a great deal of thought is needed before their full meaning is understood (ibid.). The axioms are therefore summaries of the preceding analysis, not independent starting points. The systems they refer to are described in Part II.

3.5 Law

- **Law of Cohesion for Multiple Recursions of the Viable System:** "The System One variety accessible to System Three of Recursion x

> equals the variety disposed by the sum of the metasystems of Recursion *y* for every recursive pair." (HOE 1979: 567; p. 355)

Textual note: In the body of the book the law is set with an equals sign and ends earlier: "The System One variety accessible to System Three of Recursion *x* = the variety disposed by the sum of the metasystems of Recursion *y*" (HOE 1979: 355). The words "for every recursive pair" are added in the appendix.

The law connects two levels of recursion. "Recursion x" is the level on which the analysis is focused and "Recursion y" the viable system contained in it (HOE 1979: 320). What System Three at the upper level can see of System One must match the variety managed by the metasystems at the lower level. The law is a balance equation like the axioms, applied across levels rather than within one.

Beer's overview of the argument of HOE places the law in the context of planning. The planning process is "perceived as the cohesive 'glue' that holds the embedments of viable systems in place", and the examination of that process "leads to the ennunciation [sic] of the Law of Cohesion for multiple recursions of the viable system" (HOE 1979: 276). Of all the rules in the glossary, this is the only one Beer calls a law.

3.6 Other key statements

The glossary ends there, but Beer uses three further statements as rules:

- **"The purpose of a system is what it does."** In HOE it first appears in the bar dialogue (HOE 1979: 25). In DTS it is introduced as the "key aphorism": a good observer imputes the purpose of a system from its actions, because "there is, after all, no point in claiming that the purpose of a system is to do what it consistently fails to do" (DTS 1985: 99).
- ***"Information is what changes us."*** (PFC 1975: 223; quoted again in HOE 1979: 337). In PFC it goes with the distinction between data and information: "Data are the very latest kind of pollution" (PFC 1975: 223).
- **Freedom as a computable function:** "*Freedom is in principle a computable function of systemic purpose as perceived*" (HOE 1979: 158). Beer calls this "the explosive conclusion", "explosive precisely because it sounds heartless" (ibid.).

The first statement is often quoted on its own, but in DTS it is part of an

argument about how purpose is established. The purpose of a system is stated for it by the higher recursion; the system acts and reaches a new state; and "A GOOD OBSERVER will **impute** the purpose of the system from its actions and thus from the resultant state" (DTS 1985: 99). The declared purpose and the imputed purpose can differ. Beer describes a comparator that "continuously compares the declared purpose with the purpose imputed from the results that the system delivers", with the result that "THIS SYSTEM WILL CONVERGE ON A COMPROMISE PURPOSE" (ibid.). Like the regulatory aphorisms of section 3.1, the statement is a rule for the observer: judge purpose by outputs, not by declarations.

The second statement belongs to Beer's argument about regulation. In PFC the sentence stands in a sequence: "The purpose is regulation. And that means translating data into information. *Information is what changes us*" (PFC 1975: 223). Data that change nothing have, in Beer's words, no value "of themselves" (ibid.). In the terms of chapter 2, information is what alters the state of a receiving system, whereas data that change nothing add to the variety to be handled without contributing to regulation.

The third statement concludes a numbered argument in HOE about the autonomy of the operational elements. Two steps of that argument explain why Beer calls the result explosive. First, "*The metasystem must make some intervention, and should make only that degree of intervention that is required to maintain cohesiveness in a viable system*" (HOE 1979: 158). Second, cohesiveness depends on purpose, "But systemic purpose (as we saw) is a subjective phenomenon, rather than a property of the system independent of its instigators, participants, and observers" (ibid.). Freedom is computable because the necessary degree of intervention can in principle be calculated; it is relative to purpose "as perceived" because the purpose is not given. Beer restates the result later as "freedom for the operational unit is a computable function of the purposes of the system as perceived" (HOE 1979: 200). The phrase connects the rules of the glossary to the discussion of autonomy and cohesion in Part II, and back to the observer-dependence of the system concept in chapter 1.2.

References

- **PFC** — Beer, Stafford (1975). *Platform for Change*. Chichester: John Wiley & Sons. Cited from the Stafford Beer Classic Library reprint, 1994.

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.

Part II — The Viable System Model

- Chapter 4 — The origin of the model: the neurophysiological argument in *Brain of the Firm*
- Chapter 5 — Viability, identity and autonomy
- Chapter 6 — Recursion
- Chapter 7 — System One: the operations and their embedment
- Chapter 8 — System Two: anti-oscillation
- Chapter 9 — System Three and Three*: inside-and-now, the resource bargain, audit
- Chapter 10 — System Four: outside-and-then, the model of the self, the operations room
- Chapter 11 — System Five: closure, identity, the Three–Four homeostat
- Chapter 12 — Channels, transduction and the algedonic signal
- Chapter 13 — Cohesion across recursions: the Law of Cohesion
- Chapter 14 — Diagnosis: the method of *Diagnosing the System for Organizations*
- Chapter 15 — Pathologies of viable systems

Chapter 4 — The origin of the model: the neurophysiological argument in *Brain of the Firm*

4.1 Why the nervous system?

In the summary of Part Two of *Brain of the Firm* (1972; 2nd ed. 1981) Beer states what the whole exercise is for: "The object is to construct a model of the organization of any viable system. The firm is something organic, which intends to survive — and that is why I call it a viable system" (BOTF 1981: 75). The book develops the model by comparing the firm with the human nervous system. Readers who know the model only from diagrams tend to take that comparison as a teaching aid, a vivid picture that could be removed without loss. Beer's own account of the choice gives a different reason, and his steps are best followed in order.

The sentence just quoted is the first step, and two points in it carry the later argument. The model is meant to apply to *any* viable system, not only to the firm. And the firm qualifies as a viable system because it intends to survive; viability is defined through survival, not through a particular form of organization (see chapter 5).

The second step is a criticism of the usual way of describing organizations. Instead of taking a system known to be viable as the model, management

uses organization charts, "that are really devices for apportioning blame when something goes wrong" (ibid.). The criticism recurs in the other books (MS 1967: 98–99; DTS 1985: i; BD 1994: 3). In *Diagnosing the System for Organizations* Beer gives the reason in one sentence: "the organization chart makes no attempt to model VIABILITY" (DTS 1985: 2). The chart shows who reports to whom. It says nothing about how the organization keeps itself going.

The third step follows directly. To understand the principles of viability, study a system already known to survive: "So if we want to understand the principles of viability, we had better use a known-to-be-viable system as a model, and that is why Part Two embarks on an account of the way the human body is organized and controlled by its nervous system" (BOTF 1981: 75).

On the same page Beer insists that the model is not an analogy: "Models are more than analogies: they are meant to disclose the key structure of the system under study" (BOTF 1981: 75). An analogy would say that the firm is in some respects *like* a body. A model in Beer's sense claims that the firm and the body share a structure, and that this structure is what makes both of them viable. The claim rests on a thesis of cybernetics that Beer states in the same passage. Any other viable system would have served, "such as the amoeba, or a whole animal species". The results would be the same, "as they must be if viability as such has its own laws and enshrines its own principles (as cyberneticians contend)" (ibid.).

So the choice of the human body is, on Beer's account, a practical one. He gives two reasons. The body is "perhaps the richest and most flexible viable system of all", and every reader has some insight into it (ibid.). The second reason is didactic. The first, on my reading, is more than that: a rich and flexible system displays more of the structure that any viable system must have.

At the transition to the anatomy chapters Beer repeats the point: "There can be no interest in analogy at this point: a useful model (as already discussed) must be able to handle differences in scale, transference, workability, and appropriateness in convincing style" (BOTF 1981: 87). Scale, transference, workability and appropriateness are criteria for a model that can be put to work. A figure of speech needs none of them.

A later remark in DTS, from a different book and a different context, belongs to the same line of thought: "a model is neither true nor false: it is more or less useful" (DTS 1985: 2). Read together with BOTF, it sets

the standard by which Beer wants the neurophysiological model judged. Whether the firm "really is" a body is beside the question; what counts is whether the model discloses the structure that matters for viability and can be used.

Beer reports how the comparison held up as he worked it out: "The more the neurophysiological model is studied in detail, the more astonishingly accurate does it seem to be in reflecting what happens in the firm" (BOTF 1981: 109). He follows this with an example at a finer grain. When an engineered control system replaces a local management centre, the unofficial connections between local management offices risk being cut; Beer sets this beside what surgeons observe when sympathetic ganglia are removed (BOTF 1981: 109–110). This is his own assessment of the fit and proves nothing by itself, but it shows how seriously he took the correspondence.

Textual note: This answers the open question from chapter 1.6. The rejection of the analogy reading is in Beer's own text (BOTF 1981: 75, 87), not only in the jacket text.

4.2 The five levels in the nervous system

Beer's summary of Part Two lays out the argument (BOTF 1981: 75–76). It proceeds by necessity: each new level is introduced because the levels before it leave a task unsolved.

- **Systems One, Two and Three** are "concerned, automatically, with the regulation of internal stability" (BOTF 1981: 76). Their model is the autonomic nervous system, which the summary calls "the autonomous nervous system" (ibid.): "Three vital systems are identified as prerequisites of all autonomous control" (ibid.).
- **System Four** is needed because the organism "needs also to maintain dynamic equilibrium with the external world", and because there "must be systems for arousal and adaptation" (ibid.).
- **System Five** is "the level of *conscious* direction (attributable to the board of the firm and to the cerebral cortex in the brain)" (ibid.).

The first three systems keep the organism stable from the inside, without conscious attention. Early in Chapter Eight, on autonomy, Beer says what such a level is: "Both systems operate autonomic control, which is to say a level of management which does not involve conscious direction by the organism as a whole" (BOTF 1981: 103). Its function, "from the point

of view of the whole organism, whether body or firm", is "essentially to maintain a stable internal environment" (ibid.). Chapter 5 takes up the argument about autonomy that Beer builds on this.

Internal stability is not enough, because the organism lives in an environment that changes. System Four is therefore introduced as the part that faces outward and prepares adaptation. System Five is the level at which the whole organism directs itself. Beer places it in "the 'thinking chamber' of System Five", from which a "vertical command structure" originates "intentions (as distinct from reflex responses)" (BOTF 1981: 135).

In the body of the text Beer assigns the systems to anatomical structures. The assignments below are Beer's own statements; the connecting remarks between them are mine.

- **Sympathetic and parasympathetic system:** The autonomic control of the organs sits in the thoracolumbar outflow of the spinal cord, "the sympathetic nervous system" (BOTF 1981: 104). The sympathetic trunks link the peripheral ganglia; "these paravertebral ganglionic chains […] really govern the stability of the internal environment" (BOTF 1981: 108). In the same passage Beer names their function: they are "the feedback regulators and integrators" (ibid.). "If the sympathetic system is, as it were, a middle management function, then the parasympathetic system is a senior management function" (BOTF 1981: 110).
- **System Two as spinal cord:** In the managerial application Beer calls System Two "the analogue of the spinal cord" (BOTF 1981: 124). The sympathetic trunk "links together the vertebral nodes of System Two" (BOTF 1981: 129). Each division's control centre is a "vertebra" of System Two: "it is the System One command centre itself" (BOTF 1981: 125).
- **System Three and the brain stem:** System Three is "a naturally sleepy or inattentive controller. It is wholly alert *downwards* […]. But its own major controllers of corporate, that is *upward*, awareness are essentially inhibitors" (BOTF 1981: 140). Beer links this to the sleep centres in the pons and medulla (ibid.).
- **Transition to System Four:** "The hypothalamus is the floor of the third ventricle, and very much the link between the third and fourth systems of the model under discussion. It is the highest element in System Three, or the lowest element in System Four" (BOTF 1981: 141). The arousal mechanism is the ascending reticular formation (BOTF 1981: 95, 141).

- **System Four as "the biggest switch":** System Four is "the great linking mechanism between volitional and autonomic control. It is the biggest switch of the whole organization" (BOTF 1981: 135).
- **System Five as cortex:** The direction of the enterprise, with its foresight, "is the thinking part of the whole organization. This, for the body, is the cortex itself — and for the firm it is the senior management" (BOTF 1981: 201).

Two features of this list deserve comment. Beer's wording in the managerial chapters is not always free of the language of analogy. He calls System Two "the analogue of the spinal cord", and he introduces the sympathetic system "as it were" as middle management. The rejection of analogy in 4.1 concerns the status of the model as a whole; it does not stop him from using comparative language when he maps single parts. And the boundaries between the systems are not sharp in the anatomy. The hypothalamus is "the highest element in System Three, or the lowest element in System Four". Beer does not hide this. He uses it to show where one system hands over to the next.

The bibliography of BOTF follows the same assignment. Literature on the autonomic nervous system is listed "On Autonomics (Systems One-Two-Three)", on the reticular formation "On 'arousal' mechanisms (System Four)", and on the cortex "On the Cortex (System Five)" (BOTF 1981: 407).

4.3 What changes in the later books

Only BOTF derives the model from the nervous system. *The Heart of Enterprise* (1979) develops the same model again from variety analysis, without the neurophysiology (see chapter 3). *Diagnosing the System for Organizations* (1985) presents it as a working method. That the same five systems can be reached by a second route, without reference to the body, fits Beer's claim in BOTF that the results "are the same" whichever viable system serves as the model (BOTF 1981: 75). On my reading, it also means that the model does not stand or fall with every neurophysiological detail: the neurophysiology is one of two derivations.

Two differences between the books matter for this text:

- **Status of System Two.** In BOTF: "System Two is the metasystem subsuming all Systems One. Throughout this book its existence has been diagrammatically indicated by the tall thin rectangular box

drawn round the column of boxes which are themselves the System One" (BOTF 1981: 172). In HOE, by contrast, System Two is "a **service** to System One" with "the highly specific function of damping oscillations, and nothing else" (HOE 1979: 177). DTS calls it "the viable system's anti-oscillatory device for System One" (DTS 1985: 66). The function, anti-oscillation, stays the same; its placing in relation to the metasystem shifts. In BOTF, where System Two is modelled on the spinal cord and its sympathetic trunks, it is a structure that runs through the whole column of divisions. In HOE, where the derivation starts from variety and oscillation, it is defined by the single task it performs.

- **Wording of the Recursive System Theorem.** BOTF: "If a viable system contains a viable system, then the organizational structure must be recursive" (BOTF 1981: 228). HOE: "In a recursive organizational structure, any viable system contains, and is contained in, a viable system" (HOE 1979: 118). Beer himself calls the HOE version "an alternative version […] from the opposite angle" (ibid.).

The practical consequence for the reader of this book: when a question concerns the *derivation* of the five systems from biology, BOTF is the source, with its spinal cord, brain stem and cortex. When it concerns the *definition* of a system's function, HOE and DTS give the later and in some cases narrower formulation, and the differences should be stated rather than smoothed over. The Recursive System Theorem, in both its wordings, is the subject of chapter 6.

4.4 Control physiology and the figures of the derivation

Chapter Seven of BOTF, "Control physiology" (BOTF 1981: 89–102), comes before the autonomic chapters on which 4.2 draws. It describes the somatic nervous system and supplies the vocabulary the later chapters use.

The first element is a pair of axes. A slice across the spinal cord shows an afferent–efferent mechanism: "Inputs come in at the back of the tube, and outputs leave from the front" (BOTF 1981: 90). Reflexes work *across* the cord at each level, so Beer speaks "of a lateral command axis"; bundles of nerves also run up and down "the central command axis" (ibid.). "Therefore we have an essentially two-dimensional system. This is one organizational secret of the body's ability to run affairs — a particular organ for

example — autonomously (working laterally), and also to integrate that local activity into an organic balance (working vertically)" (ibid.).

The second element is the work of the "specialized computers" that lie on the vertical axis: a slice through the cord, a swelling on the brain stem, a lobe of the cortex (BOTF 1981: 93). Each has three tasks, which Beer lists "in the form of instructions" (BOTF 1981: 95). The first is to recognize data on which command action should be taken, take that action, "and send on the original information, suitably modified". The second is to filter at that level, "compressing, facilitating, inhibiting the ascending path". The third is to "Store a record of these transactions, in case details have to be retrieved" (ibid.). A filter, in Beer's definition, is "a many-one variety reducer" (BOTF 1981: 93). The arousal mechanism is such a filter. Its anatomical name is the *ascending reticular formation*, and "this filter is one-way" (BOTF 1981: 94–95).

The third element is the number five. "We are confronting what seems to be a five-level hierarchy of systems contained within a major computer configuration. I say 'seems to be' because the choice of five (rather than some other number) is somewhat arbitrary" (BOTF 1981: 98). Five levels are distinguished "because of the major functional differences involved, and we do not want to differentiate any further than we must"; all five lie on the vertical command axis, "and they model the somatic nervous system of the body" (ibid.). Figure 14, captioned "Exploded diagram of the brain (compare Figure 13) showing classification as five-tier hierarchy", labels them Control Echelons I to V: the spinal vertebral level; the spinal cord; mesencephalon, pons, medulla and cerebellum; diencephalon, basal ganglia and third ventricle; the cerebral cortex (BOTF 1981: 99). Figure 13 shows the general layout of the brain (BOTF 1981: 91).

From the fourth echelon Beer draws a lesson for management. Everything the cortex receives is sorted and switched through the diencephalon and basal ganglia. "In orthodox management talk this level has nothing to do with command. In our model it has everything to do with command: it lies smack on the vertical axis itself" (BOTF 1981: 98). He rejects the line/staff dichotomy as "chimerical" and wants staff advisers to accept "their role as commanders-one-down overtly" (ibid.).

Chapter Seven speaks of control echelons and levels; it does not use the names System One to System Five. The names appear in the summary of Part Two (BOTF 1981: 76) and, in the managerial application, from Chapter Nine onward (e.g. BOTF 1981: 124). On my reading, the echelons of Figure 14 are the first, somatic version of the five-tier hierarchy, and the

model's Systems One to Three take their form only when the autonomic system is added in Chapters Eight and Nine.

Beer's figures trace that step. Figure 22, "The automatic system of a firm having subsidiaries A, B, C, and D" (the caption reads "automatic"), shows the boxes 5, 4 and 3, the column of controllers 1A to 1D, and the outside world (BOTF 1981: 130). Figure 23 shows the "Two dimensions of neurophysiological control: the main vertical command system (somatic) and the sympathetic and para-sympathetic systems (automatic)", and Beer asks the reader to compare it with Figure 22 (BOTF 1981: 131). Figure 27, printed without a caption, is the model itself (BOTF 1981: 157). Its labels name the corporate management (Board Level, Development Directorate, Operations Directorate), the Corporate Regulatory Centre, the Divisions with their Divisional Directorates, and the Divisional Regulatory Centres (ibid.). Beer ties it back to the derivation: "It may be compared at once with its neurophysiological counterpart in Figure 23, and with the idealized (content-less) chart at which we arrived in Figure 22" (BOTF 1981: 156). Figure 27 is the figure chapter 6 refers to when Beer reproduces the model within its own units (BOTF 1981: 228).

References

- **MS** — Beer, Stafford (1967). *Management Science: The Business Use of Operations Research*. Garden City, NY: Doubleday, in association with Aldus Books, London.
- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.
- **BD** — Beer, Stafford (1994). *Beyond Dispute: The Invention of Team Syntegrity*. Chichester: John Wiley & Sons.

Chapter 5 — Viability, identity and autonomy

5.1 Viability

Diagnosing the System for Organizations (1985) opens with a dictionary entry: "**VIABLE:** able to maintain a separate existence — *The Oxford English Dictionary*". The word that gives the model its name is used so often that it is easy to overlook how Beer himself defines it. He does so in three places, with slightly different emphases, and they are best read together.

In DTS an organization is viable "if it can survive in a particular sort of environment" (DTS 1985: 1). The phrase "a particular sort of environment" matters. Viability is no property that an organization has in itself, apart from its surroundings; it is the ability to survive in a given kind of environment.

Beer immediately guards against a misreading of "separate existence". He continues: "For although its existence is *separate*, so that it enjoys some kind of autonomy, it cannot survive in a vacuum" (ibid.). His example is the foetus, which is called viable when it can "maintain a separate existence", long before it is born, and which afterwards remains tied to mother, family, locality and culture. Separate existence does not mean isolation: "existence is never independent of other existences, even though the individual has a separate **identity**" (ibid.). He applies the same reasoning to organizations: "A village is a recognizable and viable organization, with its church and its school, its butcher's and its baker's: but it is embedded in a rural society that nourishes it" (ibid.). A firm may be the subsidiary of a larger corporation: "it is a viable entity in itself, but in a specially

defined way it 'belongs' to (what is often called) the 'parent' company" (ibid.).

That subsidiary will come back in each section below. On this first page of DTS it already holds three ideas that the later chapters of this book treat separately: separate existence (viability), autonomy, and embedding in a larger system. The embedding is the starting point of recursion (see chapter 6); the subsidiary that "belongs" to a parent company is the case of System One (see chapter 7).

In an essay of 1982/83 Beer adds identity to the definition: "A viable system is one sustaining the capability for independent existence as a recognizable identity" (TBYT 2009, "The Will of the People": 107). He goes on: "Thus a person is a viable system, and so is a firm" (ibid.). The formulation is more compact than the one in DTS, and it makes explicit what DTS leaves implicit: what survives is a recognizable identity. An organization that continues to exist in name, but has become something unrecognizably different, has not in this sense remained viable. In the same essay Beer notes that institutions devised to express the will of the people "are supposedly viable systems. They do not work at all well, and so their future viability is in question" (ibid.). On this reading, an institution's continued existence does not guarantee its viability.

In *Brain of the Firm* Beer defines viability through the intention to survive: the firm "is something organic, which intends to survive — and that is why I call it a viable system" (BOTF 1981: 75). This is the earliest of the three formulations and the least technical. It links viability to purpose: the firm is viable not merely because it survives but because it intends to. Chapter 4 showed how this definition motivates the choice of a known viable system, the human body, as the model.

The three passages give a consistent picture. Viability is the capacity to maintain a separate existence (DTS), as a recognizable identity (TBYT), in a particular kind of environment (DTS), by a system that intends to survive (BOTF). The connection of these elements is my summary; each element is Beer's.

5.2 Identity

The Heart of Enterprise (1979) gives the clearest statement of why identity is the reference point of viability. People, Beer observes, accept " 'the system' as if it were given in nature, or handed to them on an institutional

plate". He replies: "What truly is given in nature is a collection of principles that systems cannot violate if they are to maintain their identity" (HOE 1979: 24). These principles, he continues, "are the content of the science of cybernetics, which may conveniently be defined as the science of effective organization" (ibid.).

The sentence does two things. It defines cybernetics by reference to identity: its principles are those a system must respect if it is to remain itself. And it sets these principles against arrangements that people take as given but which are in fact conventions, such as the boundaries of a system and their legal definition, which Beer discusses on the same page. The conventions can be changed. The principles cannot be violated without loss of identity.

In DTS Beer relates identity to the structure of the viable system. Commenting on his first sketch of the model, he notes that viable systems "are **self-referential**. Their logic closes-in on itself", and that in this characteristic lies the explanation for "the maintenance of identity", "self-awareness", "the facility of self-repair" and "recursivity itself" (DTS 1985: 4). Identity, on this account, follows from the way the system refers to itself, rather than being a label attached from outside.

Identity returns later in HOE, where Beer discusses cohesion between levels of recursion. Understanding cohesion is important, he writes, "because it governs the question of **identity** in the viable system" (HOE 1979: 351). His illustration comes from his own work as director of System Four in an international corporation, when he discovered that the chairman of a large division was secretly moving to sell it: "Autonomy is one thing, but…" (ibid.). Here the subsidiary of DTS page 1 turns up in practice, a viable entity in itself that still "belongs" to its parent. The unfinished sentence names the tension that 5.3 examines. How identity is carried by System Five is the subject of chapter 11.

5.3 Autonomy

Beer derives autonomy from the Greek: "The word 'autonomy' is pure Greek; it might be freely translated as meaning 'a law unto itself'. So when we speak of autonomy, either in the body or in the firm, we mean that the branch or function indicated is responsible for its own regulation" (BOTF 1981: 103). The definition is functional. Autonomy means responsibility for one's own regulation; it does not mean independence from the whole.

Autonomy is also a necessity: "If every aspect of the business, every smallest decision, had to be thought about consciously at the senior management level, then the firm would grind to a halt rather quickly" (ibid.). Beer adds: "It is the same in the body and the same reasons apply" (ibid.). The argument is one of capacity. No central management can attend to everything, so large parts of any complex organization must regulate themselves. For the variety-theoretic background see chapter 3.

In the summary of Part Two Beer states the dilemma: "If a division of the firm were really and truly autonomous it would not be part of the firm at all. […] On the other hand if the heart and liver were not more or less autonomous, we would have to remember to tell them what to do all the time — and we would be dead in ten minutes" (BOTF 1981: 75–76). He applies the second horn to the firm as well: "if a division of the firm is not more or less autonomous, the main board has to run it directly — which is equally impossible. Besides, the divisional staff would resign" (BOTF 1981: 76). Both extremes are ruled out. Complete autonomy dissolves the whole, and no autonomy overloads it.

Beer names the body's solution "the autonomous nervous system" (BOTF 1981: 76). Beer's text continues: "The body has understood this dilemma for several hundred thousand years, and we can learn from it" (ibid.). Here the neurophysiological model of chapter 4 becomes an argument about organization. The body shows that the dilemma can be resolved, and the structure by which it resolves it, Systems One, Two and Three, is what the model takes over.

The rule for the metasystem is that it has "the authority to delimit the autonomy of any […] System One", but it "should do so according to the cybernetic rules, […] which are intended to preserve the maximum autonomy for […] System One consistent with preserving the coherence of [the whole] as a viable system itself" (BOTF 1981: 275). The passage comes from Beer's discussion of a firm that is itself a System One of a larger system, the subsidiary once more, and he adds that the firm's autonomy "preserves it from nosey-parkerdom" in the System Three above it (ibid.). The rule has two parts: autonomy is maximal, and its limit is the coherence of the whole. Neither part alone is the rule.

In HOE this becomes the question of freedom: "*Freedom is in principle a computable function of systemic purpose as perceived*" (HOE 1979: 158; see chapter 17). Among the steps leading to this conclusion is a statement about cohesion and purpose: "Viable systems of concentrated purpose will be closely-knit, highly cohesive. Viable systems of general purpose

will be more loosely coherent" (ibid.). Beer knows how the conclusion sounds. He calls it "explosive precisely because it sounds heartless, whereas the dear question of freedom is full of heart" (ibid.). Later in HOE he summarizes: "a strong case was developed to say that metasystemic intervention in System One activity should be minimized" (HOE 1979: 200).

BOTF and HOE thus state one principle in two languages. In BOTF it is a rule of management: preserve maximum autonomy consistent with coherence. In HOE it is a claim about measurement: how much freedom an operational unit can have is, in principle, calculable from the purpose of the system as perceived. Chapter 7 describes the operational units to which this freedom applies.

References

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.
- **TBYT** — Beer, Stafford (2009). *Think Before You Think: Social Complexity and Knowledge of Knowing*. Edited by David Whittaker. Charlbury: Wavestone Press.

Chapter 6 — Recursion

6.1 The theorem

On page 228 of *Brain of the Firm*, after the model of the firm (Figure 27) has been reproduced inside its own units, Beer writes: "Hence: Recursive System Theorem. If a viable system contains a viable system, then the organizational structure must be recursive" (BOTF 1981: 228). Recursion is what allows one model with five systems to describe organizations of any size. Beer states it as a theorem, and he states it in two versions.

The paragraph that leads up to the theorem explains why Beer thinks it is needed. As I read the passage, the problem is this: a metasystem regulates a system, but then something must regulate the metasystem, and so on without end. Beer's answer is that nature has already solved it: "there is an ecological answer, given in nature, to the abstract logical problem presented by an infinite regress of metasystems. It is the identification of the viable system, its determination to be itself and to survive" (ibid.). On this reading, the regress stops at the viable system because a viable system regulates itself. If viable systems are then organized into a larger viable whole, "we must expect that an organization of viable systems into some large viable whole will be organizationally recursive" (ibid.). The link to chapter 5 is direct. The regress stops at the same identity and intention to survive by which Beer defines viability.

The theorem "finally validates the five-tier hierarchic model we have been using all along. If the viable firm is organized like this, so is its major viable unit" (ibid.). Beer then follows the chain downward: "If the unit is organized like this, so is its viable sub-unit — the individual factory, for example. If the factory is organized like this, so is the individual viable shop of which the basic unit is the section of which the basic unit is the man" (ibid.). The chain ends where the model began: "The shop,

the section and the man then are each organized like this, and we know that the man is so organized, since that is where the model came from in the first place" (ibid.). Here the neurophysiological derivation of chapter 4 meets the recursive structure of the firm. The human being is both the source of the model and its lowest level of recursion in the firm.

This chain, from firm through factory, shop and section to the man, serves as the reference case in the sections below.

In *The Heart of Enterprise* the theorem reads: "In a recursive organizational structure, any viable system contains, and is contained in, a viable system" (HOE 1979: 118). Beer calls this "an alternative version of the Theorem as stated in *Brain of the Firm*, which expressed the same point from the opposite angle" (ibid.). The BOTF version goes from containment to recursion: if viable systems contain viable systems, the structure must be recursive. The HOE version starts from recursion and states what it implies: every viable system is both container and contained. In HOE Beer also announces how the theorem is to be established: "Theorems, no doubt, ought to be proved. The proof offered later will be a topological proof" (ibid.). Behind the proof lies the idea that all viable systems "when drawn out as systems diagrams […] will all look alike (they display the topological invariance discussed earlier)" (ibid.). Beer does not later label any passage of HOE as that proof. The nearest candidate is Chapter Twelve, where he states the task: to make the model 'stick', "it is necessary to show that each level of recursion exhibits the viable system as an *isomorphic* mapping of that same viable system at the levels of recursion above and below it" (HOE 1979: 307). That this chapter is the proof announced on p. 118 is my reading, not Beer's statement. Chapter 4.3 already set the two versions side by side.

6.2 Recursion is a mathematical, not a metaphorical, term

In *Diagnosing the System for Organizations* Beer explains why he uses the term: the embedded systems "are themselves viable systems. They are RECURSIONS OF THE VIABLE SYSTEM. We shall make use of this mathematical term because, while its meaning in context is evident, it reminds us that we are not talking loosely" (DTS 1985: 2). The sentence ends: we are not talking loosely "about **any** kind of system contained inside another — but about an absolutely precise definition of viability" (ibid.). Recursion in Beer's sense therefore means more than "being part of some-

thing larger". A unit that could not maintain a separate existence of its own may well be contained in a firm without being a recursion of the viable system.

In HOE Beer stresses that the levels of recursion "answer to mathematical criteria" and that a precise definition of the viable system provides "a vast attenuator of the variety" of organizational description (HOE 1979: 308). In the same passage he warns against the loose use: "If the term *recursion* is allowed to become a meaningless appendage to the term *organizational level*, then we do not have a valid model of a viable system" (ibid.).

The same page says why recursion attenuates variety. Beer contrasts it with the conventional organization chart, with its "arbitrary scattering of managerial boxes". The alternative "has been to treat a viable system as consisting of two levels alone: the level of the operational elements of the system, and the level of metasystem that organizes those elements" (HOE 1979: 308). Every viable system, at every level, is described with the same two-level scheme. In place of one enormous chart the observer needs one model, applied repeatedly: firm, factory, shop and section each get the same two levels. This is what Beer means by an attenuator of variety in organizational description (on variety see chapter 2).

DTS adds that the recursions can be followed very far in both directions: they "can be extended upward to the terrestrial globe (within the Universe) and downward to the cell" (DTS 1985: 4). DTS also connects recursion with self-reference. Viable systems "are **self-referential**", and in this characteristic lies the explanation, among other things, of "recursivity itself" (ibid.; see chapter 5.2).

6.3 Example: Chile

The longest example of recursion in Beer's books is the Chilean state, in the chapters of BOTF on his work in Chile. There Beer applies recursion to the state: "the government is embedded in the nation […]. The government should be concieved [sic] as a viable system (System Five being the President of the Republic) in which System One consists of the Headquarters of each major function — health, education, finance, industry". Industry in turn is a viable system (System Five: the Minister of Economics), whose System One consists of the industrial sectors (BOTF 1981: 249).

Beer continues the chain further down. Each sector (with "the Undersecretary for Economics with his appropriate committee" as System Five)

contains, as System One, a set of enterprises. Then: "Embedded in the enterprise is the plant; within that the department; within that the social unit of a working group; and within that the individual worker — viable systems all" (BOTF 1981: 249). Above the government, too, the chain continues: "Recursively speaking, the Chilean nation is embedded in the world of nations" (ibid.).

The Chilean chain has the same shape as the one on page 228, from firm to man, on a larger scale. At each level a System Five is named, and the System One of that level consists of the viable systems of the next level down. It ends, like the first chain, with the individual: there the man, here the individual worker.

6.4 System-in-focus

Every analysis chooses a level of recursion. DTS calls the system chosen the "System-in-focus"; its embedded units together "will be known as SYSTEM ONE of the System-in-focus" (DTS 1985: 19). Beer's rule of thumb concerns the number of these units: you "might have up to seven or eight: not many more, I hope, or else you may be missing a whole level of recursion" (ibid.). A long list of operational units is thus a diagnostic sign. It suggests that an intermediate level of viable systems has been overlooked.

DTS also advises how many levels to consider at once: "In practice, the best plan is to consider a trio of viable systems at any one time: the organization we wish to study, that within which it is contained, and the set of organizations contained by it — **one level of recursion down**" (DTS 1985: 4). The recursions further down are not ignored. They are treated as viable systems in their own right, but not analysed in detail at the same time.

The choice of the System-in-focus is the practical side of the theorem. Because every viable system contains and is contained in a viable system, the same organization can be System One at one level and the System-in-focus at another. The subsidiary firm of chapter 5.3 is an instance: a System One of its parent corporation and at the same time a viable system with its own Systems One to Five (BOTF 1981: 275). Chapter 7 describes System One of the System-in-focus in detail.

References

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.

Chapter 7 — System One: the operations and their embedment

7.1 Definition

"We shall start here because it is this part of the viable system that **produces** it" (DTS 1985: 19). With this sentence Beer begins the diagnosis in *Diagnosing the System for Organizations* with System One: the set of operational units of the System-in-focus, each of which is itself a viable system (DTS 1985: 19). The definition follows from the choice of a level of recursion described in chapter 6.4. Once the System-in-focus is fixed, its embedded viable systems together form its System One. Later in DTS Beer summarizes the result of his diagrams in these terms: the figure gives "a complete structural account of System One: the total collection of embedded viable systems that comprises the next lower recursion of the System-in-focus" (DTS 1985: 56).

On my reading, the opening sentence means that the operational units cannot be taken as one component among five, to be treated in any order. They are what the rest of the system exists to serve and to hold together.

The overview at the start of *The Heart of Enterprise* uses the same starting point. It describes the examination of "a collection which exhausts the operational elements of the enterprise" and of their interconnectedness, which "results in a completed description of System One, the term that shall be used to name the operational component of the viable system" (HOE 1979: 5).

What one such unit looks like is shown in *Brain of the Firm*, in the caption to Figure 20: "A firm's subsidiary has its own relations with the outside world, its own management problems within the corporation and its own control system embedded in the large one" (BOTF 1981: 125, caption to Figure 20). The caption names three things the subsidiary has of its own: relations with the outside world, management problems within the corporation, and a control system embedded in the larger one. The control system links the unit to the metasystem. In BOTF the control centre of each division is a "vertebra" of System Two, "the System One command centre itself" (BOTF 1981: 125; see chapter 4.2).

Beer is explicit that the order in which the units appear in the diagram means nothing. In DTS he reminds the reader: "There is no significance in the fact that they make a kind of list, in which one system appears to have 'higher rank' than another" (DTS 1985: 56). HOE makes a related point about the vertical placement of the metasystem: "It was inconvenient to depict the metasystem *above* System One, since this carries connotations of seniority and autocracy" (HOE 1979: 200). The vertical dimension of the page, he adds, "has logical but not organizational implications" (ibid.).

7.2 Primacy of System One

Beer gives System One a special status, because it alone produces what the system does: "And if any has a special primacy, it is System One — because it consists itself of viable systems. This is not organization-chart talk at all. But it is real-life talk. REMEMBER? **'The purpose of a system is what it does'**. And what the viable system *does* is *done* by System One" (DTS 1985: 128).

The passage comes in Beer's discussion of System Five, where the reader might expect him to announce the primacy of the board. He asks why he did not do so, "as by implication does the Organization Chart, with System Five sitting on top of the dunghill and crowing" (ibid.). His answer: "The fact is that in a viable system all five subsystems are dependent on each other" (ibid.). The primacy of System One is thus not a ranking that turns the organization chart upside down. It is a statement about where the activity of the system takes place. System Five, Beer writes in the next sentence, "is 'only' thinking about it" (ibid.).

The phrase "The purpose of a system is what it does" connects this passage with Beer's general account of purpose. HOE states it in its open-

ing chapter as "the definition of the purpose of a System as being *what it does*" (HOE 1979: 9), and DTS introduces it earlier in the book as "the key aphorism" (DTS 1985: 99). For System One the consequence is straightforward. If the purpose of a system is what it does, and what it does is done by System One, then System One is where the purpose of the viable system becomes visible: in the subsidiaries and divisions, with their own dealings in the outside world.

7.3 System One lacks the metalanguage

The same division that does the work cannot express the objectives of the whole. Beer's warning in BOTF reads: "never forget that the division is short of a metalanguage. Thus corporate objectives *cannot even be expressed* in the language of System One. It follows that divisional people must first identify themselves with the corporate enterprise, and learn to speak the metalanguage, before they can understand the issues" (BOTF 1981: 159).

The passage stands in a list of managerial constraints on the divisions. The first is to "Operate within the Intention of the Whole Organism" (ibid.). Beer distinguishes two aspects of it. The objectives of the whole "must, at the very least, be explained carefully to the divisions; preferably the divisions should participate in their formulation"; this, he says, is "to talk about the psychology of the system (and not its logic)" (ibid.). The logic is the point about the metalanguage quoted above. Explanation and participation can help. They cannot change the fact that the objectives of the whole are formulated at a logically higher level than the language of any single division.

Beer does not assume that the difficulty will resolve itself: "Contrary to the blithe assumptions of some optimists, they are often unwilling to do this" (ibid.). If divisional people do not learn the metalanguage, they still influence the whole, but only through the way they carry out instructions and through what they experience in doing so (ibid.).

This limitation is the other side of the autonomy discussed in chapter 5.3. The subsidiary of Figure 20 has its own management problems and its own control system, and regulates itself. From its own language, though, it cannot see the whole of which it is part. That is why a metasystem is needed at all.

7.4 Horizontal variety

In DTS the units of System One generate variety "on the horizontal axis of the diagram"; vertical constraints limit this (DTS 1985: 81). Beer lists five such constraints on the same page: "the Corporate Intervention", "the Resource Bargain", "operational (squiggly-line) linkages", "environmental intersects", and "System Two: anti-oscillation" (ibid.). The first four were listed in Section Four, as the constraints on a single element B of System One (DTS 1985: 64); System Two is added on p. 81 as the fifth, and Beer then speaks of "the five vertical linkages" (DTS 1985: 81). Of the corporate management that imposes them he writes that it "involves vertical constraint BECAUSE it too must have REQUISITE VARIETY" (ibid.).

The horizontal axis is also where the autonomy of the units is located. Each elemental viable system, Beer writes, "has its own dynamic on the horizontal axis (wherein its local management enjoys autonomy)", while the general dynamics of the System-in-focus derive from the vertical axis (DTS 1985: 55).

How much of this variety the metasystem has to absorb is set by the First Axiom of Management (HOE 1979: 217; see chapter 3.4 and chapter 9.2). Beer's formulation is: "The sum of horizontal variety disposed by *n* operational elements = the sum of vertical variety disposed on the six vertical components of corporate cohesion" (HOE 1979: 217). The axiom connects the two axes. Whatever variety the operational units generate horizontally has to be matched by the vertical channels of the metasystem. The components of the metasystem that do this work are the subject of the following chapters.

References

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.

Chapter 8 — System Two: anti-oscillation

8.1 Function

"System Two is logically necessary to any viable system, since without it System One would be unstable — it would go into an uncontrollable oscillation" (HOE 1979: 177). With this sentence Beer introduces the least familiar of the five subsystems, and he gives it a narrow job. The operational elements of System One are autonomous, but they are not independent. They share customers, suppliers, stocks, facilities and people. When one element changes what it is doing, the others feel the change and adjust, and their adjustments come back to the first element. If each element corrects for the others without any common reference, the corrections can amplify each other, and the system swings back and forth instead of settling.

Why not let the metasystem do the damping? Beer asks the question himself and answers it: "Could not the metasystem itself regulate the potential instability of System One, by damping its oscillations? Yes, it could; but in doing so it would necessarily be an autocratic controller, because it would have to deploy high variety on the channel that intervenes in the freedom of System One to manipulate its own horizontal variety" (HOE 1979: 177). The objection rests on variety (see chapter 2.3 on Ashby's Law). To damp through the command channel, the centre would have to track every interaction between the operational elements. That would flood the command channel and take away the autonomy the model is meant to protect.

System Two also intervenes in the freedom of System One, and Beer

grants as much. He answers with a limitation: System Two has "the highly specific function of damping oscillations, and nothing else. In fact, then, System Two is a **service** to System One" (HOE 1979: 177). A barber shows what he means by a service. A haircut removes several possible styles, "I do not however consider that I am being oppressed by my barber, because I gladly *expected* that he would reduce my hair's variety in this way. Equally, the viable system engages the services of System Two to cut down the variety of its operational interactions insofar as they are inherently oscillatory — and *only* to that extent" (HOE 1979: 177). Everything hangs on "*only* to that extent". System Two may reduce variety, but only the variety that shows up as oscillation.

Beer also keeps System Two apart from power. On the diagram, he concedes, the heavily drawn System Two "looks *dominant* in the entire model. The cybernetic fact is that it is not dominant; but it is necessary" (HOE 1979: 177). People readily confuse logical necessity with a claim to power, "and that is a mistake. The game of power, if there has to be one, is played on the direct vertical linkages between System One and the metasystem" (ibid.).

His standard example is the school timetable. A school with specialist rooms and specialist teachers generates clashes: several classes want the language laboratory in the same period, several forms want the only Russian teacher on the same afternoon. Swaps are requested in a circle, "and so on. The result is: uncontrollable oscillation. Yet somehow or other, schools operate. They have an anti-oscillation device, a System Two. It is called *the school timetable*" (HOE 1979: 178). Anyone can propose a change against the timetable without setting off a chain of clashes, and if one starts, "the keeper of the school timetable will shortly damp it" (ibid.). Nobody mistakes the timetable keeper for the Head Teacher or the Board of Governors. Those in the System Two role, Beer concludes, are often accused of destroying horizontal variety, "whereas their proper function is merely anti-oscillatory, as the school timetable example makes clear" (HOE 1979: 178).

8.2 Neglected in practice

The timetable is a clean case because its keeper does nothing else: "there is no other function than to be a System Two" (HOE 1979: 179). In most enterprises the function is mixed up with others, and Beer takes this to be the reason it is overlooked. In DTS he puts it bluntly: "The fact is that

System Two — the viable system's anti-oscillatory device for System One is almost totally misunderstood and under-represented in contemporary management technique. It is always present, or the organization would shake itself to pieces" (DTS 1985: 66). He lists cases in which balance is threatened, from East-West détente to "the capital locked into inter-process stocks", and adds: "All these demand the maintenance of balance in System One" (DTS 1985: 66). Senior Management, he says, does not command the requisite variety to resolve such oscillation "by dictat on the central axis (although many such managements try this impossible trick)" (ibid.).

HOE finds the function, unrecognized, in two further places. The first is the personal secretaries of executives. Taken together, "these people *between them* (which is to say, vertically) constitute an anti-oscillatory device across the horizontal elements of a very powerful kind" (HOE 1979: 179). Unlike the timetable keeper, a secretary may favor her own executive's engagements. Beer does not claim that executives are run by their secretaries. His claim is that "the *firm* is employing a damping device, a System Two, of which it is not truly aware — since it has never thought about the necessity for a System Two" (HOE 1979: 179).

The second is management accounting. Accountants are resented "down the line" because their constraints look like metasystemic authority. Beer reads them differently: "The fact is that no-one recognizes that a large part of their activity, perhaps eighty percent of it, is *purely anti-oscillatory*" (HOE 1979: 180). That part gets confused with the small share of their work that imposes mandatory constraint. So Beer divides management accounting into three components that belong to different channels of the model: interventions that constrain variety for legal reasons, interventions for the sake of institutional cohesion (the handling of resources, see chapter 9 on the resource bargain) (HOE 1979: 180), and "(iii) System Two activities, which are purely anti-oscillatory" (HOE 1979: 181). Agreed conventions for the format of information belong in the third group, "Simply because without a large number of agreed conventions, the system would oscillate" (ibid.). So do salary and company-car rules: "Were they not instituted in the name of *fair play* — that is, precisely to prevent inter-unit oscillations?" (ibid.). His practical proposal is to print the mandatory items on red paper and the System Two items on green, so that everyone can see "that a tiny proportion of the total paperwork machinery is red: and that is the only aspect of the system that genuinely reduces freedom" (HOE 1979: 181). The secretaries and the accountants do what the timetable keeper does, without the title. Their System Two work

has to be identified inside existing functions before anyone can design it.

8.3 System Two in BOTF

Brain of the Firm draws System Two more widely (see chapter 4.3): it is "the metasystem subsuming all Systems One" (BOTF 1981: 172). Beer describes its mechanics as "the interlinking of the divisional regulatory centres, and in the corporate regulatory centre", and adds: "So it would be correct, and even helpful, to think of System Two as an elaborate interface between Systems One and Three. It partakes of both" (BOTF 1981: 172). The neurophysiological analogue is the sympathetic nervous system; BOTF speaks of "the sympathetic (System Two) circuits" (BOTF 1981: 176). The earlier neurophysiological chapters of BOTF draw the line differently. There System Two is "the analogue of the spinal cord" (BOTF 1981: 124), the sympathetic trunk "links together the vertebral nodes of System Two" (BOTF 1981: 129), and in Beer's example of catching a bus: "The autonomic system, number Three, sits in the middle of the procedure monitoring the effects. The right-hand loop, the sympathetic, supervises the interaction of the organs and the flow of adrenalin" (BOTF 1981: 132). On my reading, the sympathetic system there belongs to System Three and runs alongside System Two, whereas p. 176 identifies it with System Two. Beer does not comment on the difference.

BOTF works through an example. Productivity changes in one division, and the divisions that depend on its output are affected. Without a shared, fast signal, they protect themselves. They build up stocks, the financial authorities intervene, and informal rules are adopted locally, until "trust is lost […] and oscillation has set in" (BOTF 1981: 174). System Two is meant to prevent this. The change is relayed "automatically" to the other divisions, and it is "neither fuzzy nor emotive: it is a statistical statement couched in achievement numbers" (BOTF 1981: 174). The corporate regulatory centre receives the same information and reports to System Three where managerial action is needed (BOTF 1981: 175).

Here Beer stresses time: "Perhaps the main point of this whole arrangement is its automatic simplicity, and therefore its speed" (BOTF 1981: 175). Under orthodox procedures the matter reaches the corporate level only after the oscillation has set in, and by then the technical control problem has been joined by suspicion and defensiveness. His verdict is sharp. Such oscillatory mechanisms "are a curse of our age — because our age has produced so many large-scale organizations without a System Two.

Most of the successful ones I have observed have been entirely unofficial and largely unrecognized" (BOTF 1981: 175).

Speed returns in the Chilean work. Beer formulated five principles there, one per subsystem, and the second reads: "The speed of response in an essentially lagged servomechanism is critical: note especially the anti-oscillatory Systems Two" (BOTF 1981: 288).

Two versions therefore have to be kept apart. In HOE and DTS, System Two is strictly the anti-oscillatory service to System One, and DTS insists that "System Two is concerned only with the regulation of oscillatory behaviour" (DTS 1985: 144). In BOTF the same term also covers the regulatory centres and the corporate regulatory centre, which filter information upwards to System Three. Both versions share the core function the timetable keeper performs: damping oscillation between the operational elements without turning the damping device into a second command channel. Chapter 9 places System Two alongside the other vertical channels.

8.4 System Two and the metasystem in HOE and DTS

BOTF calls System Two "the metasystem subsuming all Systems One" (BOTF 1981: 172). Neither HOE nor DTS refers to that sentence, to the tall thin box that illustrates it, or to the spinal-cord picture behind it. What both later books do is state for themselves where System Two sits.

HOE argues the point in two steps. The first excludes System One: "It is not possible to conceive of System Two as a subsystem of System One" (HOE 1979: 200). A committee in the managerial domain would meet sporadically, while the interactions it would have to damp are continuous; "System Two must be continuously in being" (ibid.). Its criteria, moreover, can be formulated "only by *this* viable system conceived as an operational unit (part of System One) of the viable system at the next level of recursion" (ibid.). The second step places it: "Thus we have to regard System Two, which is a service to System One, as a subsystem of the metasystem in which System One is embedded" (HOE 1979: 201). Once System Three is named, System Two becomes its subsystem. System Three "is also aware of the anti-oscillatory activity of System Two, since System Two is its own subsystem" (HOE 1979: 202). The recapitulation at the start of Chapter Ten repeats the placement: "We discovered

the logical necessity for System Two, *outside* System One, to damp oscillations internal to System One, and said that it must be a subsystem of the metasystem" (HOE 1979: 251). The same page lists System Two as the first of the complementary channels between System Three and System One (ibid.).

Two later passages draw the line more narrowly. "System Two cannot reach into the metasystem: it is dedicated to damping oscillations in System One" (HOE 1979: 259). A few lines on, Beer closes the argument for System Five: "Three-Two-One *plus* Three-Four-Five is a viable system — where the second group is metasystemic to the first" (ibid.). Discussing two levels of recursion, he writes: "the metasystemic systems Three-Four-Five belong to the management box depicted as a System One at the first level of recursion (and System Two is an appendage to System Three)" (HOE 1979: 316).

DTS does not use the word metasystem for System Two at all. It keeps System Two off the command line: "System Two does not lie on the central command axis. Its function is not to command, but to damp oscillations" (DTS 1985: 68). System Three differs from System Two "because it exerts authority on the central command channel", and it "is responsible for, although it does not conduct, the anti-oscillatory functions of System Two" (DTS 1985: 86). The metasystem, in DTS, is "a metasystem called 3-4-5" (DTS 1985: 132).

On my reading, the later books do not take System Two out of the metasystem that BOTF puts it in. HOE says in so many words that it is a subsystem of the metasystem and places it under System Three. What changes is the emphasis. BOTF's System Two "subsumes" all Systems One; HOE's is "a service to System One" in the same sentence that makes it metasystemic. HOE is also not uniform: System Two is a subsystem of the metasystem (HOE 1979: 201, 251), yet it "cannot reach into the metasystem" and falls in the group Three-Two-One rather than the metasystemic Three-Four-Five (HOE 1979: 259). A reader can reconcile the two by taking "metasystem" on p. 259 as Systems Three to Five. Beer does not do so himself, and he does not comment on the BOTF formula.

References

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.

- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.

Chapter 9 — System Three and Three*: inside-and-now, the resource bargain, audit

9.1 Function

In HOE System Three is "the component of the metasystem that is synoptically and synergistically concerned with the optimal operation of System One — the *inside* and *now* of the enterprise" (HOE 1979: 142). By this point the model has autonomous operational elements and, in System Two, a device that stops their interactions from oscillating (see chapter 8). Nobody yet looks at System One as a whole. Beer's definition fills that place, and it is compact, stated in terms of place and time. DTS gives it together with its counterpart: "If System Three has been discriminated within Senior Management as responsible for *inside-and-now*, then we shall also need to discriminate a System Four — to deal with (let's call it) the *outside-and-then*" (DTS 1985: 111).

The two adverbs in the HOE definition carry the argument. "Synoptically" means that System Three sees all the operational elements together, which none of them can do for itself. "Synergistically" means that it looks for what the elements can achieve together and would not achieve separately. The preceding sentences of the same summary give the reason. Much of the vertical variety of System One is absorbed "by happenstance", but "this containment of variety is not enough. It is only when System One is synoptically reviewed as a whole that its potential

synergy can be understood, and the need to contain residual vertical variety (left over from happenstance) can be perceived" (HOE 1979: 142). System Three exists to deal with that residue. HOE also gives it a managerial name: Beer "nominated it an Operations Directorate" (HOE 1979: 241).

Brain of the Firm places the same subsystem on the boundary between two kinds of management: "Here is the highest level of autonomic management, and the lowest level of corporate management. Its function is primarily to govern the stability of the internal environment of the organization" (BOTF 1981: 175–176). Three kinds of information converge on it. (1) The vertical command axis: System Three is part of corporate management and receives information about the internal environment, which it handles "as a metasystemic controller *downwards*", "as the most senior filter of somatic news *upwards*", and "as an algedonode". (2) System Three is "the only recipient of information filtered upwards from System Two". (3) It handles the parasympathetic information circuits (BOTF 1981: 176), which Beer describes as "antithetic to those of the sympathetic (System Two) circuits" (ibid.).

Why can System Three not simply rely on the regulators below it? BOTF answers. Systems One and Two are error-controlled regulators that measure deviations against paradigms of standard behavior. Such paradigms, Beer writes, "take no account of the external environment of the organism as a whole — only of the external environment of their own divisions. They may be regulators of *local* homeostasis, then, but System Three is the only competent regulator of *organic* homeostasis, since it alone has a System Four input" (BOTF 1981: 176). The sentence already points to section 9.5: System Three's competence depends on its link to System Four.

9.2 The six vertical components of cohesion

Beer builds System Three out of channels, and he organizes them around a variety balance. The operational elements generate variety on the horizontal plane, in dealing with their own environments and operations. If the enterprise is to hold together, that variety has to be absorbed on the vertical plane. The First Axiom of Management states the requirement. In HOE: "The sum of horizontal variety disposed by n operational elements = the sum of vertical variety disposed on the six vertical components of corporate cohesion" (HOE 1979: 217). DTS gives the same axiom in words: "The sum of horizontal variety disposed by all the operational elements EQUALS The sum of vertical variety disposed on the

six vertical components of corporate cohesion" (DTS 1985: 84). Beer lists the six components twice, with different emphases.

In HOE (1979: 142–143): three components arise "by happenstance", from the nature of the enterprise: the environments of the elemental units constrain each other; the operations constrain each other; and "the stamp of the manager's personality on his own elemental unit, coupled with the attempt of all System One managers to act as a team" (HOE 1979: 142). Three more "must needs be designed": the command channel, System Two, and auditing (HOE 1979: 142–143). Beer derives the third designed channel from the limits of the first two: "The first is obvious: it is the command channel. But we have already learned to minimize its variety attenuation. The second is System Two: but (as we know) its absorption of variety is by definition limited to oscillatory behaviour. Thus the necessity for a third metasystemic linkage is established: it may be called *auditing*" (HOE 1979: 142–143). The summary follows: "These six vertical loops (of which only one, the command loop, is customarily acknowledged in management theory) must absorb the total variety generated by the horizontal loops of the elemental units" (HOE 1979: 143).

In DTS (1985: 81–82): "(i) the Corporate Intervention, (ii) the Resource Bargain, (iii) operational (squiggly-line) linkages, (iv) environmental intersects […] (v) System Two: anti-oscillation" (DTS 1985: 81), and as the sixth the audits (DTS 1985: 82). DTS adds an observation that matters for the sixth channel: "NOTE that all five linkages refer to relationships that are **routine**" (DTS 1985: 81).

Textual note: The two lists are not identical. DTS splits the command channel into "Corporate Intervention" and "Resource Bargain" and does not list the interaction of the System One managers separately. Channels (iii) and (iv) "absorb whatever variety the circumstances of the enterprise dictate", channels (i), (ii) and (v) "whatever variety we have *designed* them to absorb" (DTS 1985: 84).

The residue from 9.1 comes back here as arithmetic. Because the First Axiom must hold, "it NECESSARILY FOLLOWS that Variety of Audit Channel (vi) = Total horizontal variety generated by System One *minus* Varieties (i) + (ii) + (iii) + (iv) + (v). The Audit Channel CLOSES THE GAP" (DTS 1985: 84). The audit is therefore no optional extra added out of distrust. In Beer's argument it is the channel that absorbs whatever variety the other five leave over. He anticipates the objection that such varieties cannot be measured precisely with the example of bricks in a

wall: nobody counts them, and yet the wall shows no gaps (DTS 1985: 84; the example is developed at length in HOE 1979: 85).

9.3 The resource bargain

"*The Resource Bargain* is the 'deal' by which some degree of autonomy is agreed between the Senior Management and its junior counterparts. The bargain declares: out of all the activities that System One elements might undertake, THESE will be tackled (and not *those*), and the resources negotiated to these ends will be provided" (DTS 1985: 38–39). Most of the everyday dealings between senior and junior management take place on this second DTS channel. Its counterpart is accountability (labelled "ACCOUNT-ABILITY" in Figure 9 of DTS, DTS 1985: 39).

Beer draws the bargain as a loop that keeps running after the deal is struck: "The homeostatic loop sketched into the diagram properly indicates that a **dynamic process** is involved. It is essentially attenuative, because it excludes a huge range of alternatives" (DTS 1985: 39). The attenuation is the price of autonomy, since System One is free within what has been agreed. The loop can also amplify. Senior management "may, by superior knowledge or through unexpected financing, open up opportunities not conceived by System One on its own initiative" (ibid.).

The bargain is Beer's alternative to indiscriminate intervention. He calls the question a "nettle to grasp", "because the senior management often assumes — and likes to exercise — the power to poke around in the intimate managerial detail of its subsidiaries in System One. But THINK: the so-called prerogative to intervene indiscriminately **does not have Requisite Variety**. It cannot be competently done" (DTS 1985: 38). Once the bargain is struck, the upward message can in principle be very short. DTS describes poor managements that ignore their filters: "they disregard the resource bargain (where in principle the homeostatic message upward needs to be only 'OK'), and invigilate the horizontal activities with all the zeal of an Inquisition" (DTS 1985: 82).

9.4 Audit (System Three*)

Routine channels filter by design, through totals, averages and agreed reports. Beer asks in DTS: "what happens if what the management most needs to know is FILTERED OUT (by the use of totals, averages, and so

on)?" (DTS 1985: 82). The Inquisition just described is one answer, and the wrong one. Beer's answer is a different kind of channel: "there is a whole set of acceptable management practices that do not involve this centralization of manifest power, which — properly designed — are capable of generating enormous variety" (DTS 1985: 82).

The audit channel works "**sporadically** (not as a perpetual routine […])", and "by agreement with System One management" goes "straight to the operations themselves. These procedures, which may generically be called 'audits', are indicated as the sixth vertical channel" (DTS 1985: 82). Three features define it. It is sporadic, so it does not become a second routine reporting line. It is agreed with System One management, so it does not undermine the autonomy granted by the resource bargain. And it reaches the operations directly, so it carries high variety where the routine channels carry low variety. That is how it can close the gap the other five channels leave.

In the later chapters of DTS the audit is "a typical 3* function"; the channel represents "sporadic — high-variety intervention in actual operations" (DTS 1985: 144). In the same passage Beer warns that the model can be misread: "There is no 'correct' interpretation of the VSM", but there may be incorrect ones, and "this is nowhere more likely to occur than in Systems Two and Three Star" (DTS 1985: 144). He asks the reader to design these channels deliberately: "They really do need to be designed, in relation to the two command channels that are central to regulation" (ibid.).

Terminological note: The label "3" *for the audit channel belongs to DTS. In HOE the same sign is used differently: in the discussion of System Five, "mini-boxes marked 3* and 4*" denote the models of Systems Three and Four that System Five contains (HOE 1979: 352). HOE calls the sixth channel simply "auditing" (HOE 1979: 143); later it is "the new System Three channel that runs directly to the operations" (HOE 1979: 215). In the text of HOE "3*" occurs only in the System Five sense (HOE 1979: 352, 354).

9.5 Three–Four

Dedicated to the internal environment, System Three cannot also take on the external environment and the future. They need a system of their own: "System Three is debarred, because it is dedicated to the internal environment, and System Four is born" (HOE 1979: 143). BOTF has already given the reason why the two must be connected: System Three is the only competent regulator of the whole organism's internal stability "since

it alone has a System Four input" (BOTF 1981: 176). Later in HOE Beer summarizes the resulting structure: "The Inside-and-Now was found to depend on Systems Three-Two-One. The Outside-and-Then was found to require Systems Three-Four-Five. System THREE is the common element: it is the managerial fulcrum of viable organization" (HOE 1979: 263). Chapters 10 and 11 take up how Three and Four are balanced.

References

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.

Chapter 10 — System Four: outside-and-then, the model of the self, the operations room

10.1 Why System Four is needed

The external environment of a viable system, Beer writes in HOE, "includes all the environments of the elements of System One, but much more. In particular, it includes the problematic environment that the future represents: the playground of opportunity. Then it becomes a necessary condition of viability that there should be a system within the metasystem that can deal with this. System Three is debarred, because it is dedicated to the internal environment, and System Four is born" (HOE 1979: 143). Up to this point the metasystem (Systems Three, Two and the command channel) stabilizes the internal environment (see chapters 8 and 9). Everything it knows about the outside world reaches it through System One, where the environment appears as a disturbance to be absorbed. For the future, that is not enough.

The reasoning follows the pattern of the other subsystems. Beer identifies a function the viable system cannot do without, and assigns a subsystem to it because none of the existing ones can take it on. System Three cannot, because it is "dedicated" to the inside-and-now. DTS adds a second task: "SYSTEM FOUR is not only concerned to *manage* the *outside-and-then*, but to provide self-awareness for the System-in-focus" (DTS 1985: 115). The second task becomes central in 10.2.

Beer distinguishes two environments of System Four: the accepted environment ("the total envelope") and the problematic environment, "special to System Four, and marked with the interrogation sign" (HOE 1979: 228). DTS draws the same distinction as two loops, Alpha and Beta. The Alpha loop watches what is going on in the environment of the outside-and-then; the Beta loop "is anchored in THE UNKNOWN FUTURE. Hence the '?' " (DTS 1985: 119). They face different problems: "Monitoring what is actually happening in the big wide world, and correctly assessing the *trends*, is different from being alert to NOVELTY. Folk too often assume that the future will be an extrapolation of the past — and then someone invents the transistor" (DTS 1985: 120).

System Four also sends. It is "involved in containing environmental variety […]; it is also concerned in generating that variety" (HOE 1979: 237). Beer calls this "the issue of *initiative*" (ibid.). Forecasting is only part of the task: "most people appear to believe that 'The Future' is something that *will happen to us*, whereas it is certainly open to humankind to take charge of these events" (HOE 1979: 237). The problematic environment, Beer writes, was defined as special to the viable system in question: "how will it invent the future?" (ibid.).

10.2 System Four must contain a model of the whole

In HOE Beer recapitulates the Conant–Ashby theorem (chapter 2.9): "that any would-be regulator must contain a model of that which needs to be regulated, and that if this model has a given level of variety, it will handle only that equivalent variety in the outside world" (HOE 1979: 235). Then he applies it: "although the theorem is completely general […], it has a very special application in System Four. This is because System Four houses the viable system's whole apparatus for adaptation. It follows that System Four must contain a model of the viable system of which it is the System Four. In current managerial practice, System Four is hardly recognized: still less does it contain this model" (HOE 1979: 235).

He guards at once against a misreading. By a model he does not mean a corporate model in the usual sense of "a set of simultaneous equations fed into a computer". "Instead, we are discussing a cybernetic model of the necessary and sufficient conditions of any viable system, as illuminating the managerial structure and behaviour of that organization" (HOE 1979: 235). The model System Four needs is the VSM itself, applied to its own

enterprise.

In practice this model "is held in the heads of the senior people: it is not made explicit, and cannot be interrogated or tested" (HOE 1979: 237). Beer draws a concrete consequence. The enterprise does generate creative ideas, "usually at junior levels, and these conflict with the paradigm held at the senior levels. They are usually squashed" (HOE 1979: 237). An implicit model cannot be checked against new ideas; it can only accept or reject them. The operations room of 10.4 is where Beer proposes to display the model.

DTS draws the recursive consequence. System Four's model of the whole includes System Four itself: "What we have to do is to constitute our Figure 30 as a **model of its own (that is, System Four) self**" (DTS 1985: 115). So System Four also contains a model of itself, and this model contains a model of itself, "indefinitely". "As hinted earlier, it is just this infinite regression of self-images that seems to hold the key to the characteristic **self-awareness** of viable systems" (DTS 1985: 116). Beer marks this as a step towards closure: the self-reference in System Four "is the operational basis for the final self-referencing, system-closing, System Five to which everything is now leading" (DTS 1985: 115; see chapter 11).

10.3 System Four in practice: disseminated, not integrated

"This is the weakest component of the viable system in existing management orthodoxy. System Four exists — it has to: but it is disseminated, and lacks integration" (HOE 1979: 143). Beer's diagnosis of existing enterprises holds across the books. The activities that belong to System Four are real, and he lists them: "Market Research counts. Corporate Planning counts. Economic Forecasting counts. Management Development counts" (HOE 1979: 231). Ask how they are integrated, and "The truth is: THERE IS NO SUCH INTEGRATION" (ibid.). They "are disparate, are disseminated, are active all over the organization in the cause of special pleading" (HOE 1979: 231); "It is quite normal, in a large enterprise, for the elements of System Four to have virtually no knowledge of each other's activity" (HOE 1979: 232). DTS makes the same point about corporate planning, which may proceed "as if the R & D and market research were simply inputs to a computer programme", so that the links between them may amount to "a total disjunction" (DTS 1985: 115). The verdict in DTS: "VERY FEW ENTERPRISES have a well-functioning System Four"

(DTS 1985: 117).

It matters more now than it used to, Beer explains. Before the Second World War the boss was primarily concerned with the internal environment: "He could deal with the problems of System Four in the bath-tub: such as once a month" (HOE 1979: 231). The expansion of technology "has meant that System Four is in continuous action" (ibid.). Disseminated System Four activity was tolerable when the rate of change was low. It is not tolerable when change is continuous.

Under stress, enterprises show a characteristic reaction. One of their early responses to a threat is to cut back System Four, "this being (supposedly) the organ of adaptation. On the face of it, this reaction is suicidal" (DTS 1985: 121). Beer adds a qualification that places responsibility on both sides: "if it is not, then System Four was either unprofessional or its Senior Management was not in good faith" (ibid.).

10.4 Focus and the operations room

If System Four is disseminated, the obvious remedy would seem to be to put it all in one place. Beer rejects this: "That solution would be to amalgamate all the elements of System Four in one integral department. I think it is mistaken, because it would involve a colossal proliferation of variety that no management could handle" (HOE 1979: 233). His answer is "Focus": "all elements of System Four (as it were, optically) 'project' their activities, in full variety, onto the same screen." He sees at once that the optical metaphor breaks down, because detailed pictures on one screen would blur each other, and concludes: "Then I propose that the 'screen' on which the elements all focus is none other than the model of the viable system whose System Four they comprise" (HOE 1979: 233). The model that System Four must contain (10.2) is also the instrument that integrates its parts.

The operations room gives that screen a physical form: "An Operations Room, considered as the physical manifestation of our focus — in which in particular the kernel of the System Four model of itself is displayed — might take on any form" (HOE 1979: 243). The Operations Room outlined in BOTF, Beer notes, "was subsequently built for President Allende in Santiago, Chile" (HOE 1979: 242), and the experience of using it did not outlast 11 September 1973 (ibid.). Such a room must satisfy three conditions, because its users are "human beings constrained by their own neurophysiological limitations": "it is absurd to overload them with data

that they cannot ingest, absurd to present those data in ways that actually suppress their inherent patterns, and especially absurd to maintain data that are out of date" (HOE 1979: 243). Every operations room he had visited, he reports, showed at least one of these faults, which is why the concept had fallen into disrepute (ibid.).

DTS keeps the idea: "At best, we need some kind of **management centre** (I have also called it an **operations room**)" (DTS 1985: 117). It also warns against the usual substitute: "do not simply constitute those red dotted lines as a bunch of committees. **They will not have Requisite Variety**" (DTS 1985: 117). In chapter 11 the operations room returns as the place where System Three and System Four meet.

BOTF calls System Four "the development directorate of the firm" (BOTF 1981: 181); HOE likewise calls an integrated System Four a "Development Directorate" (HOE 1979: 236, 242). Beer knows the proposal meets resistance. A Development Director in his sense "is not a 'Chief Boffin', a tame intellectual. He is a full member of the senior management" (HOE 1979: 241). He also records a common failure in appointments: "the man who usually gets the job (under whatever title) is the one who — his colleagues think — has the least chance of accomplishing change" (HOE 1979: 242).

10.5 System Four is not senior to System Three

System Four deals with the future and holds the model of the whole, so it is tempting to place it above System Three. Beer rejects this: "Let us also remember that System Four is in no sense senior to System Three: they are accountable *to each other* for the huge variety that each disposes in carrying through its own activity" (HOE 1979: 252). He continues: "But they are not in business to attenuate each other's inputs, nor to inhibit each other's disposable variety" (ibid.). HOE also places System Four "in the corporate *management* (and not the merely advisory) domain" (HOE 1979: 241), which is why the Development Director must be "a full member of the senior management".

With Systems Three and Four side by side, each handling high variety in its own domain, Beer describes the metasystem as "schizoid — torn between present and future preoccupations" (HOE 1979: 252). The channels between them cannot carry requisite variety without locking them "together in a solid embrace" (ibid.). Chapter 11 takes up how that tension is resolved, through the Three–Four homeostat, the operations room turned into a meeting place for both, and System Five.

10.6 System Four in BOTF: "Environments of decision"

The earliest full treatment of System Four is Chapter Thirteen of BOTF, "Environments of decision — system four" (BOTF 1981: 181–199). It opens with the two inputs to decisions at the top. The autonomic condition and the filtered information on the central axis reach System Five "mediated by System Three but, as we have seen, they are switched by System Four" (BOTF 1981: 181). The second input is information about the outside world: "All indications of relevance here are collected by System Four as direct input from the outside world, and they too are switched into System Five" (ibid.). Figure 33 enlarges the box of System Four, "which is the development directorate of the firm" (ibid.); System Five appears as a sensorium and a motor cortex (BOTF 1981: 182). Both the sensory and the motor representations of the world in System Five "are generated by the activities of System Four", and they must match the world outside: "Were it not so, the organism would be in a state of hallucination" (ibid.). With this loop between sensation and action, "At last the story of the central command axis is complete" (BOTF 1981: 183). Beer draws a consequence for planning: "a corporate plan must continuously abort, for unless that plan is continuously aborting, how shall sanity (the match between the world and the firm's notion of it) be preserved?" (ibid.).

The second part of the chapter states the model requirement that 10.2 follows through HOE and DTS. "Remember that there is always a System Four, even if it is not identified in quite the form specified here. […] We may then say that System Four *must* contain a model — some model — of the corporation" (BOTF 1981: 183). Beer then builds such a model in stages. Figure 34 shows the cash flow of a new subsidiary for one epoch; Figure 35 closes the reinvestment loop, with a feedback box *F(s)*: "It is precisely the corporate planning function of the enterprise" (BOTF 1981: 184–185). Figure 36, derived from work by R. H. Anderton, adds a second regulator, the match between product attributes and market demand, and five control parameters: capability to improve products (A), to innovate products (B), to improve efficiency (C), product market inertia (X) and money market inertia (Y) (BOTF 1981: 187–188). Figure 38 maps an extension of the model onto the corporate structure, and Beer warns against a misreading: "The diagram at Figure 38 is not an *alternative* to, nor even an *elucidation* of, Figure 27. It is explicitly the diagram of a model of System Four. The reason why it looks like the total figure is that System Four

must in some sense mirror or map the totality it serves" (BOTF 1981: 192).

The development director controls the functions that acquire and evaluate information and implement the adaptive planning agreed with System Five (BOTF 1981: 192). Beer's primary concern, though, is "the physiological role of System Four as 'the biggest switch' ", at "the conflux of information between the central command axis and the outside world" (ibid.). The existing fragments of System Four have no means of communication with the board or the operations directorate beyond formal committee work, and Beer takes his remedy from the wartime "war room" (BOTF 1981: 193). "I propose a control centre for the corporation which is in continuous activity. This would be the physical embodiment of any System Four. All senior formal meetings would be held there […]. PAPER WOULD BE BANNED FROM THIS PLACE" (BOTF 1981: 194). Its four walls display an animated, quantified Figure 27; information recalled in graphic form; prognoses; and an analogue version of the Figure 38 model whose knobs set the five parameters (BOTF 1981: 194–197). This is the Operations Room that HOE reports was later built in Santiago (HOE 1979: 242; see 10.4).

The chapter ends on the purpose of the whole arrangement. Most System Four work serves "stating what has happened in the past"; the System Four envisaged here builds a model to be used "as a tool for *inventing* the future (in Gabor's phrase), rather than fearfully predicting what it may hold" (BOTF 1981: 198). "Most enterprises are directed with the driver's eyes fixed on the rear-view mirror" (BOTF 1981: 199). A note to the second edition says that the chapter "has been left in its original form for strong historical reasons, which will become manifest in Part IV" (ibid.).

References

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.

Chapter 11 — System Five: closure, identity, the Three–Four homeostat

11.1 The Three–Four homeostat

In HOE Beer calls the metasystem at the end of chapter 10 "schizoid — torn between present and future preoccupations" (HOE 1979: 252). System Three handles the inside-and-now, System Four the outside-and-then, and neither is senior to the other. They must absorb each other's variety, and this is hard: "they do not share the same managerial nor technological languages, and their criteria of success necessarily consider different spans of time" (HOE 1979: 143).

Beer states the requirement as an axiom. The Second Axiom of Management demands equal variety between the two (HOE 1979: 298; DTS 1985: 118). In DTS it reads: "The variety disposed by System Three resulting from the operation of the First Axiom equals the variety disposed by System Four" (DTS 1985: 118). The First Axiom (see chapter 9) balanced System One against the six vertical channels; the Second balances System Three against System Four. DTS translates it into management terms: the investment "of (yes) **money**, (but also of) **time, care, talent, attention, reward** must be properly balanced, homeostatically" (DTS 1985: 118). Imbalance in either direction is dangerous: "Too much of this investment in Four, and the *inside-and-now* of the enterprise may collapse beneath your feet. Too much of this investment in Three, and you may be making the world's best buggy-whips, in which (notoriously) there is no future" (ibid.).

Hence the word homeostat. "The Three-Four homeostat is the organ of ADAPTATION for the enterprise" (DTS 1985: 120). As with all homeostats in the model, the principles of organization apply to it: "The Three-Four Homeostat […] MUST OBEY THE FOUR PRINCIPLES OF ORGANIZATION" (DTS 1985: 117). Among the practical rules DTS lists for it is a dynamic one: "The *rate* at which they operate to restore equilibrium must match the mean rate of perturbation" (DTS 1985: 120).

In HOE the same dynamic requirement leads Beer to the Fourth Principle of Organization. A steady familiarity with what is going on in System Three and System Four seems to be essential, and he formulates: "The operation of the first three principles must be cyclically maintained through time, and without hiatus or lags" (HOE 1979: 258). Orthodox practice, by contrast, relies "almost wholly, on 'snapshot' accounts of the situation" (ibid.). His means is to extend the operations room of chapter 10: "Let it become the Three-Four clubhouse, and not merely a development-oriented place" (HOE 1979: 258). The resulting management centre "would replace the Boardroom, the Executive Suite, and all of those committee rooms. Here System Three and System Four would exhibit themselves to each other, in a continuous mode, and absorb each other's variety" (ibid.).

Without such machinery Beer expects a power struggle where there should be a balance: "It will be a matter of Three *versus* Four and Four *versus* Three — and one of them will WIN, as a matter of power. It usually happens. It is a signpost to disaster" (HOE 1979: 258). In practice, the requisite variety between Three and Four is achieved "by a massive variety attenuation between the two subsystems — so that for each of them the rich reality of the relative investment problem is attenuated to the rule: 'it's *them* against *us*' " (HOE 1979: 259).

11.2 Closure

A well-designed Three–Four homeostat still leaves a gap. Beer asks what happens if the Three–Four loops "(in their turn) result in uncontrolled oscillation? System Two cannot reach into the metasystem: it is dedicated to damping oscillations in System One" (HOE 1979: 259). The answer follows directly: "There has to be a System Five. That will do it. System Five will monitor the operation of the balancing operation between Three and Four" (ibid.).

System Five arises from the concept of closure, "whereby the viable sys-

tem 'turns in on itself' to become an identity" (HOE 1979: 144). Beer introduces closure as a mathematical notion and describes it in a run of images: "Closure is the snake that is eating its own tail. Closure is what makes the language complete, self-sufficient. […] Closure turns the system back into itself, to satisfy the criteria of viability at its own level of recursion. Closure is the talisman of *identity*" (HOE 1979: 260). In a parenthesis he refers to Leibniz's monadology and rejects the division of systems into "open" and "closed" used in General Systems Theory, because he cannot identify any system that is either completely open or totally closed (HOE 1979: 260). He specifies: "by 'closure' I mean a *self-referential process*, and not the isolation of the system within an adiabatic shell" (HOE 1979: 260).

DTS puts it this way: "Logical closure means above all • self-reference: the assertion of **identity**" (DTS 1985: 130). Closure also means "there is **no more**", and DTS draws the same line as HOE between logical and physical closure: "There could not be a 'System Six' — because the five-fold system is a *closed* system, in logic. (It is obviously *open* to both energy and information.)" (DTS 1985: 130). HOE gives the recursive version: "What is beyond System Five is the next level of recursion, of which *this* fivefold viable system is an operational element" (HOE 1979: 259). DTS makes the link to chapter 10 explicit: the self-reference of System Four's model of itself is "the operational basis for the final self-referencing, system-closing, System Five" (DTS 1985: 115).

11.3 The role of System Five

Closure has a familiar face, "the boss". However "the boss" is conceived, "this boss *supplies the closure*" (HOE 1979: 261). The autocrat does it by decree: "'that's enough; I have heard all the arguments; THIS is how it will be'. Then high variety generated between Systems Three and Four, and not absorbed between them, is CLOSED by System Five" (ibid.). Beer judges this version on cybernetic grounds as well as ethical ones: it is "extremely vulnerable, unless the boss (Five) is God Himself. Sooner or later, Five will make a destabilizing mistake" (HOE 1979: 261). The reason is variety. The autocrat can administer closure only on a heavily attenuated input, because he cannot absorb the combined variety of Three and Four.

The alternative Beer prefers leaves variety absorption to Three and Four themselves. In a working Three–Four homeostat, "All that remains for System Five is to monitor the regulatory machinery — to ensure that it does not embark on an uncontrolled oscillation" (HOE 1979: 262). This

boss still supplies closure, but "He is not applying it by massive variety inhibition: he is leaving variety absorption where it belongs, between Three and Four" (ibid.). His intervention on the command axis therefore has low variety. He listens to the routine signals that all is well, and "It is only the interruption of those messages by a cry denoting imbalance and incipient oscillation that will lead to intervention" (ibid.).

Beer sums up: "cybernetically, its key role turns out to be as monitor of the variety sponge between Systems Three and Four: the administrator, as it were, of Ashby's Law in the metasystem" (HOE 1979: 144); "Within any one viable system, System Five is the metasystemic administrator of Ashby's Law" (HOE 1979: 263). The next sentence gives the variety formulation: "It necessarily absorbs the residual variety of the Three-Four interaction" (ibid.).

DTS gives the two functions in one sentence: System Five is "to supply logical closure to the viable system; and […] to monitor […] the Three-Four Homeostat" (DTS 1985: 129). The Third Axiom follows: "The variety disposed by System Five equals the residual variety generated by the operation of the Second Axiom" (DTS 1985: 130; HOE 1979: 567; where HOE first states the axiom, it reads "is equivalent to", HOE 1979: 298). Beer warns against assuming that the residue is small: "We often think of what is 'left over', residual, as being very small. There is nothing to stop it from being very large indeed. System Five may be absorbing more variety than anyone has realized" (DTS 1985: 130).

DTS also says how System Five sets rules. Discussing how System Four can acquire criteria of relevance for scanning the future, Beer writes: "I think that the rules come from System Five: not so much by stating them firmly, as by creating a corporate ethos — an atmosphere" (DTS 1985: 124). Published formal "objectives", he adds from experience, are "not recommended" (ibid.).

11.4 Who is System Five?

The boss of the organization chart is not the whole answer. The Inside-and-Now depends on Systems Three-Two-One, the Outside-and-Then on Systems Three-Four-Five, and "System THREE is the common element: it is the managerial fulcrum of viable organization" (HOE 1979: 263). Hence: "With great respect to System Five (for there sits 'the boss'), System Three in practice really runs the enterprise" (HOE 1979: 263). DTS says the same more drily: the fulcrum at System Three, "which, for this

reason, usually thinks it is running the whole enterprise" (DTS 1985: 129).

Who, then, makes up System Five? "Under more democratic conventions, System Five consists of many people" (HOE 1979: 263); "except for genuine autocracies" it "includes many people — which is contrary to popular belief" (HOE 1979: 264). Beer lists possible members: heads of System One and of System Three, shareholders, a consumers' council in a nationalized industry, perhaps, in the future, trade unionists "or better still, simply workers" (HOE 1979: 263–264). He also notes a limit on its power: "Probably System Five's main problem is its belief that it is *not* the puppet of some other system, whether subsystem or metasystem. But it always is" (HOE 1979: 264). In the neurophysiological version, "The cortex has no direct connexion with either the external or the internal environment: all its input is mediated by Systems Three and Four" (ibid.).

In BOTF System Five is "the thinking part of the whole organization", which "for the body, is the cortex itself — and for the firm it is the senior management" (BOTF 1981: 201). Beer then revises the orthodox picture of top management as a tidy set of nodes. System Five is modeled as the "multinode": "System Five is not the collection of nodes, logically organized to be precise and well mannered, that our first model suggested. It is instead, whether made of neurons or managers, an elaborately interactive assemblage of elements. I call it 'the multinode' " (BOTF 1981: 205).

Chile gave Beer the political version. Explaining the model to Allende, Beer drew System Five, and before he could say that this was the President, Allende answered "*el pueblo*" (BOTF 1981: 258; HOE 1979: 264). Whatever Allende's pride in his office, Beer comments, "when it came down to cybernetic science, he — System Five — was 'the people' " (BOTF 1981: 258). HOE retells the scene and closes it with a formula that gathers up the argument of 11.2 and 11.3: "As I said, the understanding of System Five is difficult, and its nature is mysterious. Its *role* is not mysterious at all. That role is closure" (HOE 1979: 264). The first of Beer's five principles for the Chilean project reads: "System Five within a people's government cannot be an élite ruling class: it is somehow the embodiment of the mass of the people themselves" (BOTF 1981: 288).

11.5 The multinode and the monitoring of decisions in BOTF

Chapter Fourteen of BOTF, "The multinode—system five" (BOTF 1981: 201–223), starts from the organization chart of a top team: a chief executive MM, three directors, each with three subordinates, thirteen people in all (Figure 39; BOTF 1981: 201). Beer lets them follow the chart's protocol. Each manager consults his subordinates separately and says "yes" only if all of them do. With advisers right seven, eight and nine times out of ten, "the boss will make less than two correct decisions out of every hundred" (BOTF 1981: 203). Neurons are far less reliable than managers, yet the brain works, because neurons "reinforce each other" (BOTF 1981: 205). Figure 40, "How organizations really work", connects the same thirteen people with repeated and crossing channels, and Beer notes that, save for the letters, it could illustrate the cortex (BOTF 1981: 204–205). Recalculated on the same assumptions, the chance that the group gives the wrong answer falls to 0.0033: "It is the way to get reliable results out of unreliable components" (BOTF 1981: 207). Beer draws three admissions from this: the boss is a colleague, "*primus inter pares*", of a group that includes his subordinates; protocol "must not forbid rich interactions throughout a group"; and there is far more communication at the same level than between seniors and juniors (ibid.).

The multinode works, but "it takes far too long to work successfully" (BOTF 1981: 208). Rigorous protocol is excluded as a remedy, because "it denatures the system itself" (ibid.). The remedy Beer offers is a way of monitoring the decision in terms of information. A decision has the form "do *this*" (rather than anything else), and the aim is to "measure the variety of the complex decision at the start, measure the reduction of variety brought about by each conclusion reached in the process of thinking things out, and in general monitor the entire operation of the multinode as the variety comes down to a value of one — the decision itself" (BOTF 1981: 209). Two tools are needed. The first is a search paradigm that is "priority-free", so as not to tell the multinode in what order to decide (ibid.): the problem is described in n logical dimensions, as a map is searched by coordinates rather than by numbering every square (BOTF 1981: 209–211). The second is a metric, variety measured in bits (logarithms to base two), which Beer relates to entropy (BOTF 1981: 211–213).

A fabricated example follows. A new product decision has six dimensions (production, marketing, finance, staffing, research and

development, distribution) with a total variety of 131,072 alternatives, or 17 bits (BOTF 1981: 215). A "decision algebra" records which variables bear on which (BOTF 1981: 216–219). When one selling plan is dropped, the ostensible reduction is 0.2 bits; followed through the dependences, "we have in fact reduced uncertainty in a single stroke by 5.84 bits" (BOTF 1981: 222). "This is the power of the multinode and its multidimensional search paradigm. It is a power which the multinode itself already has, but of which it is not quite self-conscious. That is why it needs a monitoring technique" (ibid.). The technique also shows when uncertainty rises again, because a decision has been unmade or the problem has changed (Figure 41; BOTF 1981: 222–223). One chart Beer kept had six peaks, the last as high as the first, which "can mean only that the multinode as constituted is unable to rise to the complexity of the problem it faces" (BOTF 1981: 223).

11.6 The higher management

BOTF closes Part Three with Chapter Fifteen, "The higher management" (BOTF 1981: 225–239). It asks why the hierarchy stops at System Five when logic points to an infinite regress of metasystems. Beer's answer is ecological, not logical: the ultimate criterion of viability is "the capability to survive. This is both a physiological and ecological criterion — and certainly not a logical one" (BOTF 1981: 226). Setting the cut-off at viability "solves the problem of identity, although it does not solve the problem of the undecidable" (ibid.). Elaborating the model yields subsystems and "trans-systems", not "a new metasystem, a System Six" (ibid.). Beer notes the relation to the later book himself: the criteria in BOTF are "neurocybernetic criteria; a set of logical criteria is developed in the companion volume, *The Heart of Enterprise*" (ibid.; compare the logical closure of 11.2).

What remains is "one trick": to stand outside ourselves and survey what we are, a faculty Beer calls "*the higher management*" (BOTF 1981: 227). The term does not refer to seniority, and it is not "meta-management", "because we are bound to include everything we know and understand about the control of the viable system in System Five. This is not then a metasystemic activity, but almost *extra*systemic" (ibid.). Its subject is identity, which Beer finds reasserted in participation, accountable cost and profit centres, decentralization and corporate planning (ibid.). The chapter then states the Recursive System Theorem (BOTF 1981: 228; see chapter 6).

The last part of the chapter returns to the algedonic mechanism modelled on the reticular formation, now as a variety reducer. With redundancy of potential command, a notion Beer takes from McCulloch, any group that holds the relevant information may become the centre of decision (BOTF 1981: 232). "Thus it comes about that the algedonic controller, for both the brain and the firm, is the biggest variety reducer of them all. It determines the *mode* of behaviour" (BOTF 1981: 233). For firms Beer describes mutually exclusive modes: sustained activity, growth and retrenchment on one scale, then crisis, the moribund, self-destruction, and "unfeigned aggression", which he calls "The sixth mode" (BOTF 1981: 234–235). He then speaks of "these six" (BOTF 1981: 236), although seven are named. The controller "is indeed a trans-system. Essentially, it connects System Three with System Four, but in so doing it creates a new dimension of decision, geared to survival" (BOTF 1981: 237). Once the mode is fixed across Three and Four, "System Five can act (albeit in a most superior capacity) only within the context of this conclusion" (BOTF 1981: 238). Beer italicizes the consequence: "*The senior controllers inevitably work within the framework set by their juniors*" (ibid.).

References

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.

Chapter 12 — Channels, transduction and the algedonic signal

12.1 Channels and transducers

On the diagrams of *Diagnosing the System for Organizations*, every line that crosses a boundary carries a red diamond: "**TRANSDUCTION** is the word we need: 'leading across'. Each red blob is a *transducer*" (DTS 1985: 47). Beer explains why he draws channels and transducers as separate things: "The point is to draw a clear distinction between channel capacity and transduction capacity: they are not at all the same thing. People think too loosely about 'communicating the message', as if any sort of connexion must be able to do the job" (DTS 1985: 47). The preceding chapters described the viable system as subsystems joined by lines. Here the lines themselves are the subject, and Beer gives them requirements of their own in the Principles of Organization of *The Heart of Enterprise*. The First Principle, on requisite variety between management, operation and environment, is listed with the others in chapter 3, and the underlying Law of Requisite Variety is the subject of chapter 2. The Second and Third concern the channels.

The Second Principle requires that the channels between management unit, operation and environment "must each have a higher capacity to transmit a given amount of information relevant to variety selection in a given time than the originating sub-system has to generate it in that time" (HOE 1979: 99). This follows from the variety measure. If variety counts the possible states of a system, a channel that carries fewer distinctions

per unit of time than the sending subsystem generates will lose some of those states in transit. The receiver then regulates a simplified image of the sender, and the requisite-variety balance fails even though the two subsystems are formally linked.

The Third Principle adds a separate condition. Every connection crosses a boundary, and "because the 'language' of each subsystem is unique to it, messages have to be 'translated' when a boundary is crossed" (HOE 1979: 101). Beer calls the mechanism at the boundary a transducer, "because it 'leads across' ", and formulates the principle: "Wherever the information carried on a channel capable of distinguishing a given variety crosses a boundary, it undergoes transduction; and the variety of the transducer must be at least equivalent to the variety of the channel" (HOE 1979: 101). A channel of ample capacity does not help if the translation at its ends is poorer than the channel. The red diamond in DTS marks the place where that second failure can happen.

Beer applies the principles well beyond the horizontal loops where he first introduced them. The Three–Four homeostat (chapter 11), like every other loop, "MUST OBEY THE FOUR PRINCIPLES OF ORGANIZATION" (DTS 1985: 117). He continues: "Nor can it be over-emphasized that they operate on all **vertical** homeostats (such as Resource Bargaining), as well as on the horizontal ones where they first became familiar" (DTS 1985: 117). In the same passage he warns against a common institutional answer for the Three–Four link: "But, oh please, do not simply constitute those red dotted lines as a bunch of committees. **They will not have Requisite Variety**" (DTS 1985: 117). The Fourth Principle requires that the first three be "cyclically maintained through time, and without hiatus or lags" (HOE 1979: 258). It applies to channels as well, so a channel that meets the capacity requirement only in periodic snapshots does not meet it.

12.2 Why an algedonic signal is needed

Every channel on the vertical axis carries filtered information. System Two damps oscillation, System Three aggregates and bargains, and the metasystem receives condensed reports. Without that attenuation System Five would be flooded. Yet the filtering that protects the metasystem from overload can also hide from it what it most needs to know, and Beer takes up this difficulty directly.

In DTS he describes it as a problem of staying awake. Somnolence is

"an occupational hazard of System Five", because with all the filters on the main axis the metasystem might hear "the whole organism droning on, and simply 'fall asleep'. For this reason, a special signal (I call it **algedonic**, for pain and pleasure) is always identifiable in viable systems. It *divides* the ascending signal […] coming from System One, and uses its own algedonic filter to decide whether or not TO ALERT SYSTEM FIVE" (DTS 1985: 133). He then gives the range of forms such a signal can take: "The cry is 'wake up — danger!' Informal extreme: the roof has collapsed — phone the boss. Formal extreme: the four-minute missile warning" (DTS 1985: 133). As elsewhere in the workbook, the reader gets a task: to list the organization's algedonic signals and to consider whether informal ones should be formalized (DTS 1985: 133).

The passage fixes two features of the structure. The algedonic signal has no separate source; it is split off from the same ascending stream that feeds the ordinary filters. And it has its own filter with its own criterion: not whether a report should be summarized, but whether it should wake the top.

Brain of the Firm places this mechanism in the neurophysiological model. System Three contains an "arousal filter which models the reticular formation of the brain stem"; the collateral fibres feeding the algedonic system are shown in Figure 32 (BOTF 1981: 178). Beer is specific about what this filter must achieve: "Statistical criteria must be established to ensure that ascending algedonic information on the vertical axis, of whatever kind, is not simply absorbed by the P-Q-R-S homeostat in the performance of its own function, for it would then be lost in the upward reports from point P — which, after all, will be about the effective functioning of the homeostat and not about discrete internal events. Those are the ones we seek, algedonically, to monitor" (BOTF 1981: 178–179). Reports on how well the regulator is working are one thing. Signals about particular events the regulator may be failing to handle are another, and they must not be averaged into the first. BOTF adds a second arousal filter in System Four, which "incorporates the new external information in the ascending stream" (BOTF 1981: 183).

12.3 Algedonic signals cross recursions

In the final chapter of *The Heart of Enterprise* Beer returns to the algedonic signal and adds the feature that sets it apart from all other channels. He starts from the alarm system of the book's chapter 14 ("Calm and alarm",

see 12.4 below) and first separates it from ordinary reporting: the alarm signals "do not belong to the family of management information systems at all. These systems are maintaining calm; but they do so by every kind of aggregation — thereby supressing [sic] the signals that point to instability. The alerting system is orthogonal to the calming system, in fact" (HOE 1979: 406). He then names them: "it will be useful to borrow nomenclature from *Brain*, to call these alerting signals **algedonic**" (HOE 1979: 406).

The two systems work on the same data and differ in their filters. "The data are the same; the information is different. It is because the two types of filter act in different ways. The traditional set of (MIS) filters says: 'take no notice, it will all come out right in the end'. […] The algedonic signal screams: 'ouch; it hurts!' No wonder that the enterprise awakes" (HOE 1979: 407).

From one recursion Beer moves to the nest of recursions. Because the lower recursion is autonomous, the higher sees it as a "muddy box, into whose management information system it will not enter" (HOE 1979: 407). If every level reported only its own calm, the whole would appear calm whatever happened below. Beer calls such a "spurious 'metacalm' " an "extremely lethal risk" (HOE 1979: 407), and his answer is the special property of the algedonic channel: "The postulate is that algedonic signals, alone of all the signals in the enterprise, are organized to *break through* recursivity" (HOE 1979: 407). All other channels respect the boundaries of recursion that the model otherwise insists on (chapter 6). The algedonic channel is the one designed exception.

The exception works in both directions. If signals from lower recursions are not dealt with at their own level, "they cause mayhem at the senior management level"; Beer's example is board meetings that discuss tea-breaks (HOE 1979: 407). If, on the other hand, the top did not respond to unblocked algedonic signals, "the viable system would *lose its cohesiveness*" (ibid.). Here Beer ties the algedonic channel to the Law of Cohesion discussed in chapter 13: "In the Law of Cohesiveness we found the variety equation that stops the enterprise from blowing apart. Now we have its mechanism" (HOE 1979: 407). The Law states a variety balance between recursions, and the algedonic signal is the route by which a failure of that balance becomes known at the level that can act on it. Beer at once adds a caution: "just because the mechanism is there, it does not mean that its cybernetic design can be disregarded" (HOE 1979: 407). Chapter 15 returns to the link, because Beer calls the failure of "inter-

recursive algedonics" the ultimate pathology of the viable system (HOE 1979: 408).

12.4 Calm and alarm

Beer lets the manager sleep. "If the job is being well done by the operation of cybernetic laws, […] the manager may go to sleep. […] What, then, is his job? It is to be alert to incipient instability — and to take action about *that*" (HOE 1979: 276). Calm is the intended state, and the algedonic signal presupposes it. Beer also describes how calm turns dangerous. When aggregates are taken "one *year* with another", at System Five "nothing much will ever appear to happen. Therefore sleep supervenes. If we are not very careful, sleep turns into coma; and coma becomes death. It was to deal with this lethal calm that the measurement of instability was introduced. Calm we must have, but not lethal calm" (HOE 1979: 406).

The usual measures do not detect incipient instability. In the summary of the book's argument Beer writes that most managerial measures are "projections of good health intended for public consumption", whereas the manager "needs to be alerted, instantly alerted, to any evidence of incipient instability in any of the loops that are supposed to display equilibrium. But nobody is measuring stability. It can however be done. The key to the problem is statistical filtration" (HOE 1979: 275). The same summary notes that the manager "must choose both a response and a style of response", which "jointly succeed in suppressing incipient instability within an appropriate time-scale" (HOE 1979: 276).

Statistical filtration goes back to Beer's earlier work. *Management Science* describes it in the context of cost control: "Perfectly ordinary accounting machinery (not to say computers) can be organized not to print the results they compute that lie within the expected variation about the mean" (MS 1967: 47). Only the variances outside statistically set limits are reported, so that "the manager gets one page of cost returns for every twenty he used to get, and the only information that has been suppressed is statistically guaranteed to be of no interest" (MS 1967: 48). In 1967 this is a reporting technique. In HOE the same principle becomes the basis of a signal that interrupts the calm of the metasystem, and in BOTF it defines the criterion of the arousal filter (see 12.2). The indices on which such filtering operated in Chile are described in chapter 16.5.

12.5 The algedonic meter

In Chile Beer carried the algedonic principle into a different setting: feedback from citizens to government. In *Brain of the Firm* he describes an "algedonic meter", a simple analogue device with which people could signal their satisfaction without having to rationalise it. He gives the reasoning: "An algedonic loop works on a non-analytic, non-articulated scale of 'pleasure and pain'. It uses the brain as its computer, structured and programmed by individuality and life experience, to produce an output indicating a degree of satisfaction that does not have to be 'rationalized'. This is at last an attempt to provide a metric for Aristotle's eudemony, or 'state of general well being'" (BOTF 1981: 283; figure 45 on p. 281). The device had a knob that changed the proportion of a "happy/unhappy" display, and the person holding it "does not have to explain anything — only to respond algedonically, which people may be observed to do all the time" (BOTF 1981: 283).

Beer reports that a prototype of ten meters, "linked by a single wire in a loop through a large summation meter", was built in England and taken to Chile for experiments. The summation meter "had to be very heavily damped" because each station could move at any time (BOTF 1981: 284).

The meter shows what algedonic means for Beer outside the enterprise. It is a channel with a low-variety signal, a position between satisfaction and disquiet, that bypasses the reporting structure and can reach the top directly. In that respect it does the same work as the algedonic signal in the firm: it keeps the metasystem from mistaking the absence of reports for the absence of trouble, and so from falling asleep over a calm that is only on paper. The Chilean context of the proposal is treated in chapter 16.6; the term algedonic itself is introduced in chapter 2.8.

12.6 The model of calm, alarm and response

Chapter 14 of *The Heart of Enterprise*, "Calm and alarm" (HOE 1979: 367–401), gives the full model behind the signal discussed in 12.3 and 12.4. Beer builds it in four figures, all titled "Handling incipient instability" (HOE 1979: 383, 389, 391, 393). He starts from two properties of instability: "The first is that instability may set in anywhere in the behaviour of the organization, and at any time. The second is that there are always presymptoms of the fact" (HOE 1979: 374). The ordinary reporting rhythm of a business therefore does not settle the question. What matters is "the

interval between a warning and a disaster" (HOE 1979: 375), and Beer calls the task breaking "the time barrier" (HOE 1979: 376). His conclusion: "calm is a function of alertness. It comes from being *poised* to read the signs of incipient instability, in the quiet confidence that instability can be averted" (HOE 1979: 376).

Figure 63 shows stage 1 (HOE 1979: 383). The metasystem sets the criterion for a meter that watches one "point of stability" in the system, a feature judged important to viability. The point may move within a circle of "physiological limits"; if it leaves the circle, the system is incipiently unstable (HOE 1979: 381). The manager sits in his "psychological space" at a "point of calm" (ibid.). The massive variety of the system reaches him through three filters. The *resolution filter* is designed by the metasystem and set for one level of recursion; it "does not know whether John or Mary is operating that machine today" (HOE 1979: 382). The *perceptual filter* is designed, "perhaps from a lack of self-knowledge, by the manager himself", and may attenuate or amplify (ibid.). The *variety filter* is "the formal way of attenuating variety: it houses the bureaucracy" (ibid.). The manager's "general approval" flows back to the system through arrow A (HOE 1979: 384). Each pass through this loop makes him calmer and reinforces the filters, which as learning systems "may easily learn the precisely wrong thing"; calm reached by not being told "is spurious because the viable system is robbed of its metasystemic component — which is a coma" (HOE 1979: 386). A "*special mechanism*" is therefore required, because otherwise "the triple-filtration will take out the vital signal along with all the others that are trivial" (HOE 1979: 384). In practice, Beer observes, that mechanism is the personal network ("I say, Harry, have you heard what's going on down at . . ."), and he lists its costs (HOE 1979: 384–385).

Figure 64, stage 2, replaces the network with "a device, operating in real-time, that monitors chosen points of stability by statistical methods" (HOE 1979: 386; figure on p. 389). When the meter detects instability, ideally "*before* the point actually leaves its circle", it generates "the *alarm signal*, which impinges on the manager's calm" (HOE 1979: 386). The manager then follows a three-phase trajectory. "The trajectory T1 is the trajectory of judgment": he chooses between a range of responses (ibid.). "The trajectory T2 is the manager's *choice of style* as to the projection of his judgment into the system" (HOE 1979: 387). The "effectiveness trajectory is a product of T1 and T2"; if it returns the point to its circle, the alarm stops and he returns on T3 "to his (newly defined) point of calm" (ibid.). An outer loop adds learning: a comparator records the deviation and

"*how long it took*" to restore stability, and a feedback modifier uses this to redesign the variety filter, so that the bureaucracy could become "more and more, instead of less and less, effective to its supposed purpose of informing management" (ibid.).

Beer then qualifies the separation of T1 and T2. Judgment and style are not independent: a draconian measure attenuates the variety of available style, and a benign style chosen only for its own sake makes draconian measures ineffective (HOE 1979: 387–388). Figure 65, stage 3, draws these mutual inhibitions as a web between choice of response and choice of style, and adds a second comparator whose readings should reveal the inadequacies of the perceptual filter (HOE 1979: 388; figure on p. 391). From the whole picture Beer draws two parameters for classifying managerial situations: variety and relaxation time (HOE 1979: 390). On the second: "if the system has not returned to stability before another shock drives it once more towards instability, then regulation is impossible. So is learning impossible, so adaptation, so evolution" (ibid.).

Figure 66, the final stage, is a procedure given in words (HOE 1979: 393). Its criterion of effectiveness is that a point becoming incipiently unstable "must be returned to stability (within acknowledged physiological limits) within a time-scale that does not allow immanent disaster to become actual", recognized by the return of the manager to his "POINT OF CALM" (ibid.). The procedure eliminates actions that cannot meet the criterion in time, estimates the relaxation time of the rest, matches each to a style, drops those whose effective style is unavailable or implausible, and weighs the stress of an unnatural style against the speed of response. If that fails, the situation is recast; if that fails too, the last line reads "RESIGN. (And do not fail to do so.)" (ibid.). Beer names the parameters of effectiveness as "judgment, style, and relaxation time" and says they derive from the model of any viable system (HOE 1979: 392). He ties the model to closure: a senior manager who legislates for "his own ambiance of calm and alarm" and classifies his decisions by "the tripartite model here set out" may "operate closure in the sense defined" (HOE 1979: 394). The chapter ends with a bar dialogue (HOE 1979: 395–401).

On my reading, this model is the source of the algedonic signal in 12.3: the alarm signal of Figure 64 is what the final chapter of HOE renames algedonic (HOE 1979: 406), and the feedback modifier is Beer's answer to the calming bias of the filters described in 12.2.

References

- **MS** — Beer, Stafford (1967). *Management Science: The Business Use of Operations Research*. Garden City, NY: Doubleday, in association with Aldus Books, London.
- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.

Chapter 13 — Cohesion across recursions: the Law of Cohesion

13.1 Planning as the "glue"

Chapter Thirteen of *The Heart of Enterprise* opens with a general statement: "*Cohesiveness* is the primary characteristic of organization" (HOE 1979: 335). The Law of Cohesion, which Beer derives in the same chapter, is the last of what Beer calls "all eight propositions that I have enunciated in this book" (HOE 1979: 356). The count fits the four principles of organization, the three axioms and the law; that grouping is my reading, since Beer does not list the eight there (see the list in chapter 3). He does not reach it from the variety equations alone. He reaches it through an analysis of planning, and that route shows what the law is about.

Beer justifies the opening statement from the purpose of organization as he developed it earlier in the book. Organization exists to contain the proliferation of variety that would arise from the unrestricted interaction of the elements of a system. But in breaking that interaction down, "the process of organizing itself creates a problem of fragmentation which only its capacity to provide cohesion can offset" (HOE 1979: 335). Any model of organization must therefore show how its parts hold together; it must be possible "to identify the 'glue' whereby the parts that the model postulates hang together" (ibid.).

In the conventional model, Beer answers, the glue is dependency. The hierarchical paradigm, "by its delegation of authority and demand for an antithetic accountability, uses the resulting chain of dependencies as

its 'glue' " (HOE 1979: 335). Even horizontal links between units at the same level rest on a common cross-over point higher up, so that in the long run there is "no other 'glue' than dependency" (ibid.).

The viable system model cannot use this glue, because its logic is recursive rather than hierarchical (chapter 6). A recursive logic is a process, so "its managerial embodiment must be a process too, rather than any such static bonding as dependency. It seems that this process is none other than PLANNING" (HOE 1979: 336). Beer knows the claim is unusual: "Many a treatise has been written about planning; but I do not know of any that contends that it is actually the 'glue' of organizational cohesion" (HOE 1979: 336).

The claim depends on Beer's own concept of planning. In the overview of the book he writes that planning "needs to be seen as a continuous, managerial, process of decision, whereby allocations of investment are made now, so that the future may be different"; and since more information is available at every moment, "it is necessary that plans should always abort before their time is due. In cybernetic terms, plans should be *continuously* adaptive to fresh information" (HOE 1979: 276). Chapter 19 follows this concept in detail. Here it is enough that planning in this sense is a continuous traffic of intentions between the levels of the system, and that this traffic is the glue that holds the recursions together.

13.2 The law

Beer derives the law from the complete model of the planning process (HOE Figure 61, "The definitive model of the planning process that provides closure (and therefore cohesive 'glue') between two recursions of the viable system", HOE 1979: 353). The figure's caption already names the glue. Before stating the law Beer prepares it with an observation about System Five, which must detect instability in the Three–Four loop but cannot absorb the full variety of that interaction. The resolution lies in the Conant–Ashby theorem: "Every regulator contains a model of whatever is regulated. This *model* must have requisite variety" (HOE 1979: 352). System Five therefore holds models of Systems Three and Four, and from its stored experience of their balance it develops a "policy ethos" that returns to the whole system through feedback loops. Beer stresses that "these feedbacks are not instructions" (HOE 1979: 354).

The derivation itself takes five numbered steps (HOE 1979: 354). In summary: (i) the variety of the metasystem of Recursion x is also the variety

of the System One management box that it constitutes in the next higher Recursion w; (ii) by the First Principle of Organization, the variety of a System One management box tends to equal that of its operation and environment; (iii) by the First Axiom of Management, vertical and horizontal variety balance at System Three; (iv) hence the variety disposed by all the metasystems of Recursion x equals the System One variety accessible to System Three of Recursion w; (v) because the mapping is isomorphic, the same relation holds for any other recursive pair, such as x and y.

The result follows on the next page: "Thus, using Recursion *x* as focus, we may state **The Law of Cohesion for Multiple Recursions of the Viable System:** The System One variety accessible to System Three of Recursion *x* = the variety disposed by the sum of the metasystems of Recursion *y*" (HOE 1979: 355). The appendix version adds "for every recursive pair" (HOE 1979: 567).

Put plainly, what the management of one level can see and influence of its operational units must match what the managements of those units themselves dispose of. If the higher System Three has access to less variety than the lower metasystems generate, it loses the ability to hold them within the whole. If it takes more, it absorbs variety that belongs to the lower level. The law specifies the balance point between the two recursions, not a direction of control.

Beer adds a qualification that applies to the law and to all the axioms. The equalities are written as equalities "to make clear the notion of balance", but in practice they "require some *extra* variety, which is called redundancy, to deal with noise in the system" (HOE 1979: 355). He then supposes that cohesiveness, as the law defines it, could be measured by an index C, and states that "we should find that" $dC/dt > 0$, the index rising over time: "It is this fact that makes the viable system not only cohesive, but *self-organizing*" (HOE 1979: 355). He does not develop the point, and attributes the underlying idea to Heinz von Foerster, explained to him by Gordon Pask (ibid.).

Beer calls the law "perhaps the most significant" of the discoveries in the book (HOE 1979: 275), and he explains the name. The three Axioms of Management belong to Recursion x, the four Principles of Organization were developed on its horizontal axis, but "when we come to the embedment of Recursion *z* in *w*, of *w* in *v*, and so on indefinitely, the concept of cohesion becomes outstandingly important. That is why it is dignified as a Law" (HOE 1979: 356). The choice of three terms, axiom, principle and

law, "was decided upon as a matter of expository convenience" (ibid.).

13.3 Cohesion and autonomy

The law formalizes a balance that Beer had set out much earlier in the book, described in chapter 5.3 of this text: "the contention was that autonomy should be passed to System One, and the command axis minimally used, consistently with maintaining *cohesion* of the viable system: it must not fly apart" (HOE 1979: 351). At that point the variety equation for cohesion between recursions "was not obviously in sight", because the recursive logic had not yet been developed (ibid.). Beer also says why cohesion deserves this attention: "To understand cohesion well in cybernetic terms is most important, because it governs the question of **identity** in the viable system, and because its practical application is potentially valuable" (HOE 1979: 351).

The search began in his own practice. As director of System Four in an international corporation Beer discovered that the chairman of a large division "was secretly moving to *sell* his division. Autonomy is one thing, but…" (HOE 1979: 351). Behind the law stands the question this episode raised: how much independence a subsidiary can have before it ceases to belong to the whole.

Beer states the relation to the First Axiom explicitly. The law "is an implicit consequence of the First Axiom" (HOE 1979: 355). The First Axiom "is explicitly concerned with cohesion inside any one viable system. That is to say, it is addressed to the inexorable operation of Ashby's Law within a single level of recursion" (ibid.). The Law of Cohesion extends the same balance to the relation between levels. Beer says that it "was logically entailed all along", but that it would have been awkward to state before the full recursive model had been given (ibid.).

In a later paper Beer applies the law to takeovers. Subsidiaries that are taken over are always assured that their autonomy will be respected. Beer calls this "poppycock", because a study of the embedment of the new System One "in terms of the Law of Cohesion […] will reveal how the interconnectivity between the subsystems of the two recursions inevitably takes up variety from the new subsidiary. In the VSM, 'autonomy' is a precisely defined term, and it does *not* mean zero interference" (TBYT 2009, "The Viable System Model": 149). The law also cuts the other way: "if the taking-over company makes the mistake of leaving intact all the new subsidiary's variety (or of handing over too much variety to an old

subsidiary), this company is very likely to be the subject of a reverse takeover bid" (ibid.). Both failures depart from the same balance, one by taking too much variety, the other by taking too little.

13.4 The mechanism and the limit

Two later passages in HOE connect the law with other parts of the model. The first concerns the algedonic signal (chapter 12). After postulating that algedonic signals alone break through the levels of recursion, Beer writes: "In the Law of Cohesiveness we found the variety equation that stops the enterprise from blowing apart. Now we have its mechanism" (HOE 1979: 407). The law states the required balance, and the inter-recursive algedonic channel is how an imbalance becomes known where it can be corrected.

The second concerns autopoiesis (chapter 15). Asking how much of a system's effort may properly go into maintaining itself, Beer rejects a numerical constant and proposes a structural one: "The proportion of total time that needs to be devoted to maintaining necessary autopoiesis is exactly the time required to maintain System One — which is the viable system at the next level of recursion — whatever that may be. Numerically, the proportionality will vary, because purposes vary; and therefore the law of cohesion will generate different relative varieties in different cases" (HOE 1979: 411). Here the Law of Cohesion sets the limit of legitimate self-maintenance. Effort beyond what cohesion across the recursions requires is, in Beer's terms, pathological, and he uses this criterion to define "The Establishment" (HOE 1979: 412; see chapter 15.4).

With these two passages the law takes its place in Beer's argument as the variety condition that keeps a nest of viable systems together without reducing it to a hierarchy of dependencies. Planning supplies the glue as a process, the algedonic signal raises the alarm when the balance fails, and the autopoiesis argument measures how much metasystemic effort the balance justifies. Chapter 15 takes up what happens when that measure is exceeded.

References

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.

- **TBYT** — Beer, Stafford (2009). *Think Before You Think: Social Complexity and Knowledge of Knowing*. Edited by David Whittaker. Charlbury: Wavestone Press.

Chapter 14 — Diagnosis: the method of *Diagnosing the System for Organizations*

14.1 Purpose of DTS

Beer opens *Diagnosing the System for Organizations* with the organization chart. He calls it "geological genealogy": a structure frozen out of history and "rationalized — *after* the event", which has "little to offer [the manager] beyond a procedural method for **blaming somebody** for whatever has gone wrong" (DTS 1985: i). The same criticism appears in his other books (see chapter 4.1). Against it he sets the claim of cybernetics to be the science of organizing effectively, and he states the aim of the book: it should guide any manager through the questions of his own organizational structure "without requiring of him or her any prior knowledge at all of this difficult interdisciplinary subject" (DTS 1985: i).

DTS (1985) is the third of Beer's books on the viable system model, after *Brain of the Firm* and *The Heart of Enterprise*, and it is a different kind of book. It is a workbook, and Beer presents it as one: the reader is meant to work through it with a particular organization in mind, drawing and redrawing the model. Where the organization chart records a structure after the event, the charts of DTS are drawn in order to find out what is wrong.

Beer compares the book with the handbook of a technical appliance. Such

a handbook reduces the electronics to diagrams; "This book reduces cybernetics to diagrams" (DTS 1985: ii). Like a handbook it introduces a few technical terms, and "it gets by with *less than twenty* technical terms" (ibid.). A handbook shows how to use a system but not how to design it, and here DTS claims more: "This book *will* tell you how to design an organizational structure — *and* HOW TO DIAGNOSE a faulty one" (ibid.).

On the same page Beer states the book's limits. It deliberately leaves out psychology, social anthropology and industrial relations, although "a lot is implicit in this book that derives from these fields", and also "the problems of *measurement* and *filtration*", which are treated in BOTF and HOE (DTS 1985: ii). The aim is to consider organizational structure "in the shortest posisble [sic] compass" (ibid.). DTS is therefore the most compact statement of the structure of the model. The reasons behind many of its requirements (the variety calculus, the neurophysiological model, the measurement of instability) have to be sought in the two earlier books.

14.2 The sequence of the diagnosis

The book leads through the model in eight sections and a "Completion of the Model" (DTS 1985: contents). The order is itself a statement about how a diagnosis should proceed. The sections carry no titles: each opens with a hand-lettered "§ ONE", "§ TWO" and so on, and the contents page lists them only as "Section One" to "Section Eight" (DTS 1985: contents, 1, 19, 37, 55, 73, 91, 107, 123). The section topics below are therefore summarized from the text and from the "special terms" Beer lists at the end of each section; the quotations show how Beer frames each step.

1. **Choose the System-in-focus and its recursions** (Section One, from p. 1). The first task is to decide which system is being diagnosed and where it sits among the systems that contain it and that it contains: "**NOW DO THIS:** Choose and clearly define the System-in-focus that you intend to model. Survey the sets of recursions of viable systems that constitute its organizational 'ecology', both vertically and horizontally" (DTS 1985: 16). The operational units are to be those "that between them PRODUCE THE COMPANY" (DTS 1985: 8). Chapter 6 discusses the recursion principle that this step applies.
2. **Start with System One; variety and the First Principle** (Section Two, from p. 19). "The best place to start work is the embedded viable system of the System-in-focus […] because it is this part of the viable system that **produces** it" (DTS 1985: 19). Beer adds a practical

check on the choice of recursion: a list of embedded units might contain "up to seven or eight: not many more, I hope, or else you may be missing a whole level of recursion" (ibid.). Beginning with System One rather than with senior management reverses the usual order of an organizational review. It follows the argument of chapter 7: the operational units produce the system, and the metasystem exists to serve them. The same section introduces variety, the Law of Requisite Variety, attenuators and amplifiers, and states the First Principle of Organization (DTS 1985: 30, 35).

3. **The command axis, the resource bargain, and channels and transducers** (Section Three, from p. 37). The section starts from the fact that the Senior Management "is IN PRINCIPLE unable to entertain the variety generated by any one (never mind all) of its subsidiary viable systems that constitute System One" (DTS 1985: 37). It then takes the threads of the command axis in turn: legal and corporate requirements, the Resource Bargain, accountability, and the Regulatory Centre (DTS 1985: 38–41). Its second half treats channel capacity and transducers and states the Second and Third Principles of Organization (DTS 1985: 47, 53). Chapter 12 discusses the channel and transduction principles introduced here.
4. **The Fourth Principle, System One as a whole, and oscillation** (Section Four, from p. 55). The section adds time to the three spatial principles with the Fourth Principle (DTS 1985: 55), assembles the "complete structural account of System One" with its environments (DTS 1985: 56–63), and ends with oscillation between the elements of System One and the introduction of System Two as the anti-oscillatory device (DTS 1985: 64–71).
5. **System Two, the six vertical channels including audit, and System Three** (Section Five, from p. 73). The section continues System Two, collects the vertical channels, adds audit as the sixth, states the First Axiom of Management (DTS 1985: 81–84), and names System Three and Three-Star (DTS 1985: 86).
6. **System Three, managerial style and the convergence of purpose** (Section Six, from p. 91). The section asks for a list of the System Three components of the System-in-focus (DTS 1985: 92–94) and turns to managerial style (DTS 1985: 95). Here the reader checks the First Axiom from two sides: how it "appears to be met • as System Three sees it; • as System One sees it. Be honest. Talk informally with those concerned. There are ALWAYS surprises in this exercise" (DTS 1985: 95). It goes on to purpose ("**The purpose of a system is what it does.**", DTS 1985: 99), to the convergence of

purpose between recursions, and to autonomy (DTS 1985: 98–105).

7. **System Four, the Three–Four homeostat and the Second Axiom** (Section Seven, from p. 107; the Second Axiom of Management is listed at DTS 1985: 121). The transition is marked by a reminder that the environment of the System-in-focus is larger than the sum of its parts' environments: "The fact is that the sum of all the System One environments is **less than** the total environment of the System-in-focus" (DTS 1985: 107). Beer is blunt about what the reader will find here: "VERY FEW ENTERPRISES have a well-functioning System Four. EVEN FEWER conform to the Principles that govern homeostasis" (DTS 1985: 117).
8. **System Five, closure, the Law of Cohesion and the algedonic signal** (Section Eight, from p. 123). The section approaches System Five obliquely, through variety attenuation in chess (DTS 1985: 123–124), and then states closure and the Third Axiom of Management (DTS 1985: 130) and the Law of Cohesion (DTS 1985: 132). The algedonic signal (chapter 12) comes at the end, with the task to "**MAKE A LIST**" of the organization's algedonic signals and to consider whether informal ones should be formalized (DTS 1985: 133).
9. **Cross-recursion linkages** ("Completion of the Model" in the contents; the page itself is headed "Completion of the Viable System Model"): "System Two and Three-Star require cross-recursion coordination of a delicate kind — if autonomy is to be preserved" (DTS 1985: 135). The final task asks for "a detailed analysis, with lists, of the linkages across the *three* recursions shown in Figure 37, for *each* subsystem of the viable system. If they do not severally exhibit Requisite Variety, what shall you (in each such case) propose?" (ibid.). This step applies the Law of Cohesion (chapter 13). The Law is stated two pages earlier, where Beer says that Figure 37 "puts the whole VSM together" and "leads straight to" the Law (DTS 1985: 132); the Completion page does not repeat its name.

The sequence moves from the operations upward to the metasystem and then outward across recursions. A diagnosis in this order builds the model of the organization from what it produces, and only then asks whether the management structure has requisite variety for it.

Throughout, the reader is given tasks ("**NOW DO THIS:**"). They range from placing oneself in the recursions ("You are a viable system. In which viable system are you embedded?", DTS 1985: 6) to listing the regulatory actions between System One managements and their operations (DTS 1985: 41). The book is meant to be worked, and reading it without doing

the tasks misses its purpose.

The appendix holds diagnostic charts that may be copied. Beer expects that most readers will turn to it early "and will proceed to rob themselves of a learning experience" (DTS 1985: 137). He grants explicit permission to reproduce the charts (though not the text or the figures) and recommends making pads of each chart, "so that rough analyses can be made, torn up, and improved upon without fuss" (ibid.). He also recommends enlarging them: "on a VSM chart 'blown up' to several feet high, it is often possible to give a succinct account of an organization, and its diagnosis, that would take a report several hundred pages long to 'explain' " (DTS 1985: 137). The remark makes a claim about the model as a language. A diagram in its notation carries a diagnosis in compressed form. This is the chart Beer sets against the "geological genealogy" of 14.1.

14.3 Speed of diagnosis

In a paper of 1984, reprinted in *Think Before You Think*, Beer returns to diagnosis. Confidence in the VSM, he reports, derives "not so much from the fact that the pathology of the viable system can be investigated with ease, as from the *speed* with which the diagnosis can be made. The knowledgeable user may expect to 'home in' on (say) half-a-dozen causes of concern within a day or so of exposure to the real-life system" (TBYT 2009, "The Viable System Model": 148). He continues that it is "a frequent experience to find such danger points when they have been deliberately concealed out of embarrassment or self-serving: they tend to signal themselves" (ibid.). Such incidents, he adds, "tend to enhance the confidence not only of the VSM-er, but of the client management itself" (ibid.).

The claim is empirical, and Beer offers it as a report from practice, introduced with "Subjectively speaking" (TBYT 2009: 148). He does not spell out in this passage why diagnosis can be so fast. What follows is an interpretation, not Beer's statement: a likely reason lies in the structure of the model: because every viable system must have the same five subsystems and the same kinds of connection, the diagnostician knows in advance what to look for and can recognize quickly where something is missing or malfunctioning. The same paper uses the vocabulary of medicine for this: "the etiology of the disorder may be traced, a prognosis may be prepared, and antidotes (even surgery) may be prescribed" (TBYT 2009: 148). Chapter 15 takes up the pathologies that such a diagnosis typically finds.

References

- **DTS** — Beer, Stafford (1985). *Diagnosing the System for Organizations*. Chichester: John Wiley & Sons.
- **TBYT** — Beer, Stafford (2009). *Think Before You Think: Social Complexity and Knowledge of Knowing*. Edited by David Whittaker. Charlbury: Wavestone Press.

Chapter 15 — Pathologies of viable systems

15.1 Why "pathology"?

In the 1984 paper "The Viable System Model", reprinted in *Think Before You Think*, Beer defends his medical vocabulary with a single alternative: "either we have a theory of viability, meaning 'capable of independent existence', or we have not" (TBYT 2009, "The Viable System Model": 147). He describes the failures of organizations as pathology and speaks of diagnosis, etiology and prognosis, knowing that many readers object to such terms when they are applied to social institutions or to technical networks. If there is a theory of viability, it applies to any system that meets its conditions, and so do the terms that describe the failure of those conditions. Beer adds that the method is more than analogy: "an heuristic such as the yo-yo technique is in search of a mathematical invariance that transcends analogy" (ibid.). Earlier in the paper he describes that technique: once a VSM has been constructed by mapping, say, a brain onto a firm, each further viable system is tested against the model by running "down the chain of similes, analogies and homomorphs" with it "until the isomorph is reached", then back up the chain with another fresh system, and so on, "hence the yo-yo metaphor (rather than model, note)" (TBYT 2009: 138).

On this basis he describes breakdown in the terms of his own model. Viable systems of all kinds are subject to breakdown, and such breakdowns "may be diagnosed, simply in the fact that some inadequacy in the system can be traced to malfunction in one of the five subsystems, where in turn one of the cybernetic features that compose the rules […] will be found not to be functioning" (TBYT 2009: 148). The "rules" are those of the glossary in HOE (chapter 3). A diagnosis therefore has two stages:

locate the subsystem that fails, then identify which rule it fails to meet. Beer continues "unabashed with medical-sounding talk": "the etiology of the disorder may be traced, a prognosis may be prepared, and antidotes (even surgery) may be prescribed" (ibid.).

The vocabulary also answers a common objection, that any organization which exists is by definition viable. Existence, Beer replies, proves little. The fact that a system is there does not guarantee that it will stay there, and "The fact that it is there does not prove that it is effectively there, witness universities, nor efficiently there, witness hospitals" (TBYT 2009: 148). Monopolistic systems in particular "often operate at the margins of viability" (ibid.). He names one frequent cause, especially in the social services: people looking for cheaper ways of doing things "attempt to repeal the Law of Requisite Variety itself", and policing of every kind "often fails to recognize that only variety can absorb variety" (ibid.). The last phrase restates Ashby's Law in the form Beer uses throughout (chapter 2.3). The hospital that is there but not efficiently there returns in 15.4, where Beer gives it a test.

15.2 Four diagnostic points

In the same paper Beer quotes four diagnostic points "made in a learned journal" (TBYT 2009: 148). The wording is someone else's. Beer says that all four "have been expounded in my own writings, but not I think with such pith", and reproduces them as direct quotations (ibid.). In summary, they ask whether management presides over a viable system at all, whether System Five represents the whole system to larger systems, whether managers understand the need for Systems Two and Four, and whether Three, Four and Five form a "Three-Four-Five" subsystem (TBYT 2009: 148–149). Beer judges them "extremely cogent and penetrating" and notes that they show how the language of the model allows subtle comments "in very few words" (TBYT 2009: 149). His own comments on the four points follow (TBYT 2009: 149–150):

- **Takeovers.** Acquired companies are always assured that their individuality and autonomy will be respected. Beer calls this "poppycock", because a study of the embedment of the new System One in terms of the Law of Cohesion (chapter 13) shows that the connections between the two recursions inevitably take up variety from the new subsidiary (TBYT 2009: 149). "In the VSM, 'autonomy' is a precisely defined term, and it does *not* mean zero interference"

(ibid.).

- **Identity.** Adaptation to a changing environment can involve so many adjustments that identity itself becomes the issue: "Will the system still be able to recognize itself? More particularly, will others be able to recognize it?" (ibid.). Beer refers to the Test of Identity in HOE (TBYT 2009: 150; see 15.5); identity as a condition of viability is discussed in chapter 5.2.
- **Collapse of Five into Three.** This is likely "insofar as Five people have usually been promoted from Three". They are uncomfortable in their new role, and when something goes wrong "they are likely to dive down into the problem that they understand so well—never to emerge again" (TBYT 2009: 150). "But the collapsed metasystem is a special pathology. It is a decerebrate cat […]. It responds *reactively*, from the autonomic command centres at Three, and is incapable of planning and foresight (Four) and will and judgment (Five)" (ibid.). *The Heart of Enterprise* describes the same pattern: when a crisis occurs, a member of System Five "dives down from System Five straight into System Three, or (worse) straight into a muddy bog in System One. He is never seen again" (HOE 1979: 266). HOE draws the conclusion in the same image: "Thereby do our institutions become decerebrate cats. Management is noticeably failing the world, in the absence of metasystem. It can just manage to say *miaow*" (ibid.).
- **Three–Four–Five.** The fourth point makes the case for a management center (chapter 11), where "the Three-Four-Five metasystem has a chance to find its own cohesion" (TBYT 2009: 150).

Beer ends the paper with a proposal that follows from the medical vocabulary. Since much has been learned about viable systems from those that are "viable no more", a small team of "organizational pathologists" should be formed, organized "more like a lifeboat crew", whose first task would be to resuscitate a dying organization and, failing that, to perform a post-mortem "before rigor mortis had set in" (TBYT 2009: 150). He observes that "history is rewritten in these circumstances with breathtaking speed" (ibid.).

15.3 System Four missing

The collapse of Five into Three has a precondition that HOE states directly. In the preceding chapter of that book Beer had argued that System Four is "often, indeed usually, virtually empty", because its components are

scattered, not in communication with one another, and labeled "staff" or "merely advisory" (HOE 1979: 265). The consequence follows from the structure of the metasystem: "Without a System Four clearly in place, and with a System Five whose very nature is ambiguous, there is no Three-Four interaction, and no Five monitoring of that interaction. Then the whole metasystem collapses into System Three" (HOE 1979: 265).

Beer calls this a practical point, "Everywhere one turns, the reality is the same", and adds the theoretical one: in terms of the neurophysiological model, "the institution is a decerebrate cat" (HOE 1979: 265). He works the image out with some care. A decerebrate cat lives on, but "its viability is ensured by a bogus environment, and is sustained by artificial sustenance. If you prod its leg, it kicks back. And this is called 'living' " (ibid.). Thought through in institutional terms, "we diagnose a major pathology of our times" (ibid.). The pathology links two parts of the model. The absent System Four (chapter 10) removes the Three–Four homeostat (chapter 11), and without it System Five has nothing to monitor and no function of its own, so it is drawn into the day-to-day management of System Three.

15.4 Pathological autopoiesis

In the last chapter of HOE Beer goes a step further. The pathologies discussed so far concern one level of recursion, and he summarizes them: "it should be very clear by now why Systems Two and Four are normally vulnerable subsystems, why the monitoring devices of the Three-Four balance often fail, why System Five often collapses into System Three, and why the metasystem often lacks a capabilty [sic] to speak the metalanguage" (HOE 1979: 408). Then he names a deeper failure: "The ultimate pathology of the viable system concerns the failure of its cohesiveness, and of its inter-recursive algedonics. This turns out to be an aberration of its autopoietic function" (HOE 1979: 408). To explain it he takes up Maturana and Varela's concept of autopoiesis.

The concept enters HOE as a statement about identity. In the overview Beer writes: "The primary characteristic of a viable system is not the power of self-reproduction, but of self-production. It is continuously in business to produce itself, to be what it is, to preserve identity" (HOE 1979: 277). Institutions such as a hospital or a university replace all their members over time and yet remain recognizably themselves: "There is, as in our bodies, every kind of change. But there is no alteration. In the

concept of autopoiesis we have the final testimonial to viability" (HOE 1979: 405). Already in the overview, however, Beer points to the danger: "Too much organizational effort may go into maintaining the status quo as an end in itself, so that the job that the enterprise is supposed to do becomes almost a by-product. This is the last of our diagnoses" (HOE 1979: 277).

He states the pathology with a biological comparison: "We need a thyroid gland; its pathology is to become a goitre. Enterprises need to be autopoietic; their pathology is to turn self-production into an end-in-itself" (HOE 1979: 410). For the hospital he proposes a simple test: "what proportion of everybody's time is spent on healing, and what proportion on the autopoiesis of the medical profession?" (ibid.).

Where, then, does the healthy proportion lie? Beer first considers a numerical constant, a fixed percentage of effort for necessary self-maintenance, and rejects it: purposes vary between systems, and "to seek a numerical constant of the *x*-percent kind for the maintenance of necessary autopoiesis, is to pursue a chimera" (HOE 1979: 411). The invariant is structural: "The proportion of total time that needs to be devoted to maintaining necessary autopoiesis is exactly the time required to maintain System One — which is the viable system at the next level of recursion — whatever that may be" (HOE 1979: 411). The Law of Cohesion (chapter 13) determines this proportion in each case.

The criterion follows. Only a viable system is autopoietic, and "Systems Two, Three, Four, and Five are not in themselves viable systems at any level of recursion" (HOE 1979: 411). Healthy autopoiesis is therefore only that of System One. Systems Two to Five are "services to the autopoiesis of System One" and should "exhibit no internal autopoietic behaviour whatever" (HOE 1979: 412). "It is precisely when these subsystems of the viable system exhibit internally autopietic [sic] behaviour (whereupon the total viable system becomes pathologically autopoietic), that people start to talk […] about 'The Establishment' " (ibid.). Beer gives two biological illustrations: a tree brought down by ivy, which he recognized as "a System Two failure", and "a cancerous tumour" as an example of pathological autopoiesis beyond failed symbiosis (HOE 1979: 412).

His definition reads: " 'The Establishment' in any social system comes into being at the point when the vital principal [sic] of autopoiesis consumes energy greater than that needed to maintain cohesiveness through the appropriate number of viable recursions that mark its claim to organizational identity as a set of embedments of System One" (ibid.). He adds:

" 'The Establishment' presents autopoietic activity on the part of Systems Two, Three, Four, or Five; and this constitutes a pathological symptom of the viable system" (HOE 1979: 412).

Here several threads of the book meet. The Law of Cohesion defines how much metasystemic effort is needed to hold the recursions together. The algedonic channel (chapter 12) is the mechanism that keeps the recursions in contact. On my reading (an interpretation, not Beer's statement), when the metasystem begins to produce itself instead of serving System One, it consumes more than cohesion requires and at the same time loses its responsiveness to the signals from below. That is why Beer can call the failure of cohesion and of inter-recursive algedonics a single pathology, and why he locates it in the autopoietic function (HOE 1979: 408).

15.5 The Test of Identity

In the 1984 paper Beer writes that "*The Heart of Enterprise* includes a highly sophisticated Test of Identity" (TBYT 2009: 150). HOE does not use that name. It contains one text that tests identity: "Identity: an exercise", placed after the last chapter and its bar dialogue, at the end of Part Three (HOE 1979: 415–433; listed in the contents at p. 417). That this is the text Beer means is my identification, not his statement; the exercise matches the point the paper raises, whether a system and others can still recognize it.

The exercise asks a single question: "Does the organization have the *power* to do what it says that it will do — given that it has done its best to define its terms, state its goals, and set up regulatory systems to these ends?" (HOE 1979: 417). Power here is neither legal nor financial capability. It is "the ability of the organization to gather itself together into an **effective identity**, to act as a unified whole" (HOE 1979: 417–418). Beer uses the image of a jigsaw: "The problem of **identity** is this: have we seen the picture on the lid?" (HOE 1979: 418). The puzzle came without a lid, and in a large organization it is too big to be seen whole from a distance, so the identity has to be understood from within. Consensus therefore has to begin with "a common view of the identity itself" (ibid.). The exercise is written without jargon, for managers (HOE 1979: 417).

The organization is divided into its main blocks, the Elements, which cohere in the Whole; service activities are left out (HOE 1979: 419). Fifteen questions follow. Each is answered by marking a card on a scale from low to high, without numbers or weights, and laying it face down to

avoid halo effects (ibid.). Questions 1 to 4 ask how far the senior team shares a picture of what it manages, how far the Elements agree with each other about the identity of the Whole, how far their view matches the Whole's own picture, and whether the Whole correctly assesses the gaps. Of the fourth Beer says "we could call it a meta-question": it concerns "the ability and honesty of the Whole to observe its own behaviour correctly and in context" (HOE 1979: 423; questions 1–4 on pp. 420–423). Question 5 asks how well the Whole's identity is transmitted to the Elements (HOE 1979: 424). Questions 6 and 7 turn to autonomy. The "Degree of Autonomy is a crucial factor in Identity", and Whole and Elements rarely agree on it (ibid.). The principle Beer proposes is "that the amount of intervention necessary in Elemental operations is only that required to support the **coherence** of the Whole", and question 7 asks whether the information passing between them is judged correctly for volume and level (HOE 1979: 425). Questions 8 to 11 concern the network of committees, task forces and judgments that decides matters bearing on identity, which Beer calls "Identity Regulation": is it adequate, do the Elements understand it and use it, and is it self-organizing, "LEARNING", "ADAPTING", "EVOLVING" (HOE 1979: 426–428)? Questions 12 to 14 ask how much of the effort of management, of the work force and of the respondent is "honestly addressed to the intended job (as distinct from ritual in all its forms)" (HOE 1979: 429). Question 15 asks whether the enterprise is aware of these issues at all (ibid.). Beer adds: "Perhaps we should think of institutional failure less in terms of an unsupportable balance sheet, or industrial unrest, and so on, and more in terms of the collapse of its identity" (HOE 1979: 430).

For the evaluation the fifteen marks are transferred to one chart, Figure 70, "An impression of the power of the enterprise to act as an effective integral whole" (HOE 1979: 430). What counts is the uniformity of the marks more than their position; "an almost random scatter" suggests that "the integrative system is quite probably out of control" (HOE 1979: 431). For a group of managers Beer proposes digitizing the cards and clustering them by computer, both by manager and by question. Clusters of managers show differences in perception between parts of the enterprise. Clusters of questions have a structural meaning, since the questions are based on the viable system model: "So it ought to be possible to discover through this exercise and its evaluation just how successfully the law of cohesiveness is working in a given enterprise; and maybe (one day) thresholds will be established, to exceed which will predict collapse" (HOE 1979: 432). In the first trial, managers who "cheerfully asserted that

they shared a corporate identity" fell into clusters that separated their two divisions (HOE 1979: 433).

On my reading, questions 12 to 14 are the working form of the pathology in 15.4: the ritual that preserves "accepted structures in the organization" (HOE 1979: 428) is what Beer, in the last chapter, calls self-production turned into an end in itself.

References

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **TBYT** — Beer, Stafford (2009). *Think Before You Think: Social Complexity and Knowledge of Knowing*. Edited by David Whittaker. Charlbury: Wavestone Press.

Part III — Applications and politics

- Chapter 16 — Chile 1971–73: Cybersyn, Cyberstride, the operations room
- Chapter 17 — Freedom as a design problem
- Chapter 18 — Institutions, metasystems and change (*Platform for Change*)
- Chapter 19 — Planning that has to abort

Chapter 16 — Chile 1971–73: Cybersyn, Cyberstride, the operations room

16.1 Beer's account and its standpoint

In 1981 Beer added five chapters to *Brain of the Firm* (chs. 16–20, pp. 241–397), and in them he told the story of Chile himself. The first edition had appeared in 1972, before most of those events, and its chapter 13 contained a design for an operations room. The second edition reports what happened when that design, and the model around it, was built at the scale of a national economy. The Chilean project is the episode of Beer's working life that most readers have heard of, and the one most often told by others. What follows stays with Beer's telling.

Beer opens by declaring where he stands. He rejects the role of detached expert: "the posture of a 'neutral scientific advisor' became untenable after the experiences of World War II" (BOTF 1981: 245). That sentence explains the form of what follows: "I can tell this story only in the first person, and in an autobiographical vein". He says he has "ruthlessly expunged from the story mere gossip and my own opinions", but he does not claim "a pretence of objective omniscience" (BOTF 1981: 245–246). The reader knows from the start what kind of document this is: a participant's account, disciplined and openly partisan. Beer adds a statement of responsibility: "I could have pulled out of Chile at any time, and often considered doing so; but I did not, and therefore I hold myself accountable for the part that I played" (BOTF 1981: 246).

This standpoint matters for the present book in two ways. What Beer

reports about Chile is his own reconstruction, and it is reported here as such; the book's method excludes secondary literature, so his account is not checked against others. And Beer treats the Chilean chapters as part of the argument of *Brain of the Firm*. The model of the earlier chapters is applied, and the application is reported in the model's own vocabulary: recursion, Systems One to Five, algedonic signals, variety.

Part Four sets out its own chronology (BOTF 1981: 243). Chapter 16 covers the start in late 1971. Chapters 17 and 18 cover the development up to "the extraordinry [sic] events of October 1972", which "appeared to mark a watershed". Chapter 19 covers the end, and chapter 20 is a "prospectus". The sections below keep that order.

16.2 The starting point: regulation in real time

The project began with a letter dated 13 July 1971. It came from Fernando Flores, Technical General Manager of CORFO (Corporación de Fomento de la Producción), the state agency through which Allende's nationalization program was being carried out (BOTF 1981: 246–247). The letter spoke of "the complete reorganization of the public sector of the economy" (BOTF 1981: 247). From the outset, then, the object was the growing nationalized sector of a whole country.

The preparatory work went quickly. By 12 November 1971 the Chilean team and Beer "had all agreed on a plan for the cybernetic regulation of the social economy of Chile"; the members of the team had read the draft manuscript of the first edition of *Brain of the Firm* (BOTF 1981: 248). The people who were to build the system had the viable system model in front of them in the form Beer had just written down, operations room included.

One idea, Beer says, took the most arguing: "The primary point of which I had to convince my friends was that we should firmly take the wholly innovatory step of seeking to regulate the social economy in real time" (BOTF 1981: 248). His reasoning starts from how economies are normally steered. "Even the most advanced countries in the world suffer from a vast lag in the receipt of economic data, and they suffer too from the bureaucratic time it takes to process these data towards any kind of conclusion" (ibid.). He puts a number on it: "In the world's most advanced countries, economic data arrive very late, perhaps the average delay is nine months […]. This means that most economic decisions are taken out of phase with economic reality" (ibid.).

Because the data are late, governments spend their effort estimating where they are, and have little left for where they are going: "they engage in econometric studies aimed at projecting data — not indeed into the future — but only into the present" (ibid.). Against this Beer sets a plain technical claim: "It is perfectly possible, these days, to capture data at source in real time, and to process them instantly" (ibid.). In his account, what was missing was the machinery and the programs to handle such a flow; the technology itself existed.

In the terms of the model, this is a matter of the timing of feedback. A regulator that receives its information nine months late is controlling a system that no longer exists in the state reported. Oscillation and overcorrection are what a cybernetician would expect from such a lagged servomechanism. The concern returns in the second of Beer's five principles (16.6), and again in the argument that plans must continually abort (see chapter 19).

16.3 The four tools

Beer names the project himself: "The code-name Cybersyn is an abbreviation of 'cybernetic synergy' " (BOTF 1981: 252). In Chile it was also called "Synco" (BOTF 1981: 278). He speaks of "the whole *Cybersyn* package: the four tools, and a computer" (BOTF 1981: 275), and he lists the four tools when summarising the second phase: "By now we have seen how the four main tools were created: *Cybernet*, […] *Cyberstride*, […] *Checo*, […] and the *Opsroom*, a new environment for decision, and dependent for its existence on the existence of the other three" (BOTF 1981: 270). In the same passage he characterises Cyberstride as "the suite of computer programs needed to provide statistical filtration for all homeostatic loops at all levels of recursion", and he dates the operations room: it was taken over on 1 December 1972, and "everything was finished and in experimental working order on 10th January 1973" (ibid.).

The order of the list shows the logic of the design. The operations room comes last because it depends on the other three. Without a network there is no data; without filtering there is only an unmanageable volume of data; without simulation there is no view of the future. Each tool can be read against a part of the viable system model.

Cybernet was the communications network: "a system whereby every single factory in the country, contained within the nationalized social eco-

nomy, could be in communication with a computer" (BOTF 1981: 252). It used what already existed, the telex network and microwave links, and needed no new equipment (ibid.). Beer states its intended use in a sentence that bears on the later charge of technocracy: "Now the intention of Cybernet was to make computer power available to the workers' committees in every factory" (ibid.). On this statement the network was to serve the operational units as well as the center.

Cyberstride was the suite of programs for Systems One to Three. Its purpose "was to monitor information flows […] at all levels of recursion; to provide alerting signals" (BOTF 1981: 261). It measured with the "triple index, which measures productivity, latency, and their product — the overall measure of performance" (BOTF 1981: 253; see 16.5). Beer records a decision taken at speed during the programming. The consultants had just agreed on the mathematical techniques for the statistical filter when Alan Dunsmuir telephoned late at night to ask whether Beer had read a paper by Harrison and Stevens, "'A Bayesian Approach to Short Term Forecasting'", in the *Operational Research Quarterly* for December 1971. Beer writes: "I stayed up all night with this paper, and next day we determined to scrap the agreed mathematical approach in favour of theirs. It was a bold step" (BOTF 1981: 262–263). He also notes that "nothing was known about the performance of the Harrison-Stevens techniques in advance" (BOTF 1981: 263). As the permanent suite developed, "changes were made to deal with the need to generate algedonic signals" (BOTF 1981: 264).

Beer places Cyberstride in the longer history of his own work. The underlying technique "was first developed in the years 1949 - 53 for the control of steelworks production" (BOTF 1981: 264). He had no electronic computers then, and "the whole system was operated by hand using nomographs to compute standards, desk calculating machines to compute indices, and visual control charts to provide the probability filters" (ibid.). Cyberstride was thus a computerized version of a method already tried in the steel industry, some twenty years before Chile.

Checo was the set of simulation programs, a "prolegomenon to a full-bodied System Four" (BOTF 1981: 267). The word "prolegomenon" marks its status as a first step toward the function that looks outward and forward. Beer's aim for it was ambitious: Checo "would be updated every day by the output from Systems 1-2-3, and would promptly re-run a ten-year simulation; and this has never been done" (BOTF 1981: 268). The sentence joins the two halves of the metasystem that the model

keeps apart and connects: the current state reported from inside (Three) and the long-range model of the future (Four).

The Operations Room was where the other three came together. Beer insists that it followed the published design: "In Chapter 13 a basic design was given for an operations room: we built it in Santiago, according to that specification — with the exception of the use of a hybrid computer there advocated for economic simulation" (BOTF 1981: 268). In *The Heart of Enterprise* he describes the idea in more general terms. The room was a way of discharging System Four through "a mode of integration described as a focus", in which "the whole model of the viable system, at all levels of recursion, would be displayed. It was to be a club-house" (HOE 1979: 242). He then refers back: "In *Brain of the Firm* I outlined the design for an Operations Room. This was subsequently built for President Allende in Santiago, Chile" (ibid.).

How far did the system reach? Beer reports that by the end of the second phase "something like seventy percent of the socio-industrial economy was operating this system, involving about four hundred enterprises, through Cybernet" (BOTF 1981: 264). *Textual note:* in the chapter on October 1972 he gives "Roughly 60% of all enterprises" as included in the Cybersyn system (BOTF 1981: 311). The two figures refer to different things (a share of the economy on the one hand, a share of enterprises on the other). They describe roughly the same moment: the first figure the end of Beer's second epoch, the second figure "the situation as it was at the start of the new epoch" (ibid.), his third. Beer does not reconcile them. They are not necessarily contradictory, but they should not be merged into a single figure.

16.4 Recursion and autonomy in Cybersyn

A system that connects every factory to a central computer invites the suspicion that it is an instrument of central control. Beer answers in the terms of recursion. Take a unit Beta that is one of the System One elements of a larger unit Alpha. Beta does more than report upward; it receives "the whole *Cybersyn* package: the four tools, and a computer". The consequence, in Beer's words: "Its autonomy preserves it from nosey-parkerdom in Alpha System Three" (BOTF 1981: 275).

Each level of recursion is itself a viable system with its own metasystem, and so needs its own instruments. Beer states the result: "Moreover, the schema represents maximum decentralization, since any given level of

recursion receives directly only its own Cyberstride reports" (ibid.). The higher level does not see the detailed indices of every plant below it. It sees what the lower level's filtering passes on as exceptional. That is the variety attenuation the model requires on the vertical channels, and it is the structural guarantee of autonomy that the Third of the five principles will state (16.6). In formal terms the same argument reappears as the claim that the metasystem should make "*minimal use of variety attenuators*" downward (see chapter 17). On this design, an operations room at one level would display only what that level's own filters had let through.

Beer does not claim that practice matched the design. The analysis of each factory was meant to be carried out with the people who worked there: the teams were to explain the flowchart model of a plant, to enlist help in building it from those who worked in it, and to obtain agreement on the performance measures. Beer writes that "this was not always being done in the intended spirit; and it seemed likely that this fact aided detractors who later wished to call Cybersyn 'technocratic' " (BOTF 1981: 271). Describing the shift in priorities after October 1972, he distinguishes two groups among those who reacted to the changed situation. Some regarded Cybersyn as a political instrument; and "The gratification was experienced by the technocratically minded, who wanted effective management regardless of the political framework" (BOTF 1981: 322). Beer thus separates the design from the attitudes of some who operated it, and he names the technocratic reading as a real tendency inside the project as well as an accusation from outside.

He also records proposals made at the end of 1972 to push autonomy further: a worker as "Director of Total Industry", the formal handing over of the tools, and "a replacement of technocratically oriented OR groups by workers' groups". He adds a reservation of his own: "And yet there was something manifestly starry-eyed about this set of 'expectations' " (BOTF 1981: 328).

16.5 The indices of achievement

The triple index that Cyberstride computed was not invented for Chile. It comes from chapter 11 of *Brain of the Firm*, where Beer defines three levels of achievement (BOTF 1981: 163):

- **actuality:** "what we *are* managing to do now, with existing resources, under existing constraints."

- **capability:** "what we *could* be doing (still right now) with existing resources, under existing constraints, if we really worked at it."
- **potentiality:** "what we *ought* to be doing by developing our resources and removing constraints, although still operating within the bounds of what is already known to be feasible."

The three are ordered: actuality does not exceed capability, and capability does not exceed potentiality. From them Beer derives three ratios: "*productivity:* is the ratio of actuality and capability; *latency:* is the ratio of capability and potentiality; *performance:* is both the ratio of actuality and potentiality, and also the product of latency and productivity" (ibid.).

Every index built this way is a dimensionless number between zero and one, whatever is being measured. A copper mine and a textile mill can then be watched with the same statistical machinery, because what is filtered is the movement of a ratio, whether the underlying quantity is tons or meters. That is what allowed a single program suite to monitor hundreds of different enterprises and to raise an alert when an index moved in a statistically unusual way.

Beer links each level to a form of planning: "Planning on the basis of actuality I call *programming*. Planning on the basis of capability I call *planning by objectives*. Planning on the basis of potentiality I call *normative planning*" (ibid.). The distinction foreshadows the fuller treatment of planning in *The Heart of Enterprise* (see chapter 19). The further a plan reaches beyond what is currently being done, the more it involves decisions about removing constraints, and the more it belongs to the metasystem rather than to the operations.

16.6 The People Project and the five principles

Beer describes one wall of the operations room as empty on purpose: "there remained a blank wall in the Operations Room: it was intended to house an algedonic meter" (BOTF 1981: 284). Cybersyn was concerned with the regulation of the industrial economy. In parallel Beer worked on a second project, on "the systems dynamics of the interaction between government and people" (BOTF 1981: 278). Part of it was the algedonic meter (see chapter 12.5), a device by which people could signal satisfaction or dissatisfaction directly. The blank wall shows where it was meant to go: in the same room as the economic displays, as the channel through which the people's own signals would reach the metasystem.

Another part was "The Manual". Beer formulated five principles, one for each subsystem, "each expressed in a single cybernetic sentence", and arranged in the order 5, 2, 1, 3, 4 (BOTF 1981: 288–289):

- **First:** "System Five within a people's government cannot be an élite ruling class: it is somehow the embodiment of the mass of the people themselves."
- **Second:** "The speed of response in an essentially lagged servomechanism is critical: note especially the anti-oscillatory Systems Two."
- **Third:** "Variety engineering enables us to design homeostatic subsystems that obey the Law of Requisite Variety, and determine a recursion of metasystems: this preserves System One autonomy."
- **Fourth:** "Command is neither a matter of wielding authority nor of overloading the central axis with variety-attenuating regulations: System Three delegates authority and accountability to the elemental level, and looks for synergistic advantage in taking a synoptic view of Systems One."
- **Fifth:** "Special attention is necessary to System Four: otherwise System Five identifies with System Three, and the whole cerebral metastructure collapses; instead of adaptation and self-determination, we are left with crisis management."

The order follows an argument. It starts with identity and legitimacy (Five), moves to the damping of oscillation (Two) and the autonomy of the operating units (One), then to the character of command (Three), and ends with the warning about neglecting the future (Four). Read together, the principles restate the model as political guidance. The first denies that the top of the model is an elite. The fourth denies that System Three is a command center in the ordinary sense. The fifth names the failure in which a government absorbed by day-to-day control loses its capacity to adapt, and its phrase "crisis management" anticipates what actually happened in October 1972 (16.7).

Beer meant to translate this "cybernetic substance of 'the manual' " into simple statements for the population, in booklets, leaflets, posters and, as he hoped, songs (BOTF 1981: 289). The popular version, the booklet "Five Principles for the People, towards Good Government" (early September 1972), was to open with the statement: "The revolution of ownership is two years old. IT IS TIME for the revolution of government to begin" (BOTF 1981: 289). Nationalization had changed who owned the economy; the model, as Beer saw it, was meant to change how it was governed.

16.7 October 1972

In October 1972 the "gremios" went on strike. This is the event Beer calls a watershed, and he insists that the gremios were not trade unions. The operations room was not yet finished, but the communications center and Cybernet were working, and the infrastructure was used for crisis management. Beer describes what was done: "Two of the senior cyberneticians organized a filtration system: some signals were algedonic, requiring instant decisions, while others could be attenuated into elements of the pattern that established the factual situation *in real time*" (BOTF 1981: 312–313).

Two ideas from the model are applied here at once. Algedonic signals bypass normal filtering because they demand immediate action; the rest are attenuated and aggregated into a picture of the situation. In a crisis the distinction lets a small group handle a large flow of messages without ignoring the urgent ones or drowning in the routine ones. Beer draws a general conclusion from the episode: "it had at last been made dramatically clear that properly organized information deployed in real time is a major national resource" (BOTF 1981: 314). This is the claim of 16.2, confirmed in his view by events, and confirmed before the room built to display such information was ready.

The success had a cost for the project as first conceived. After October the priorities changed, and Beer spent "only a fraction of my time" on Cybersyn (BOTF 1981: 320). The network grew in a different direction: Cybernet was extended to ministries, the Central Bank and government agencies (BOTF 1981: 327). Beer argues that the changed circumstances obscured a structural problem "in the recursive mapping of the economy" (BOTF 1981: 322). The original modeling of November 1971 had defined the economy "in terms of its assets — the land, minerals, industry — and the ownership of those assets" (ibid.). But, he continues, "the preoccupation with ownership makes sense only insofar as it betokens ruling power", and other factors supervene: "there seems to be a resurgence in the self-organizing capability of communities to promote themselves as viable systems" (BOTF 1981: 323). The recursions drawn along lines of ownership were therefore not the only ones that mattered. Beer carries the argument through to a redesign. The ownership model "nominated only owned assets (whether public or private) as viable systems, which between them constituted and exhausted System One", and events "powerfully suggested that two levels of recursion were mixed together in that preliminary model" (BOTF 1981: 323). The economic community

and the distributive function had each grown a management independent of ownership, so the social economy and public industry "were not after all co-exstensive [sic]: *the latter was a System One of the former*" (BOTF 1981: 324). He therefore proposed a new level of recursion in the Ministry of Economics, "with (initally) three Systems One" (ibid.): the industrial recursions regulated through Project Cybersyn and presided over by the workers' committees; the economic communities, with the People Project, presided over by the neighbourhood councils (JAPs); and a new "commerce" linking them, over which the Comandos de Abastecimiento presided and for which an "Allocation Project" became possible (ibid.; Figure 47, BOTF 1981: 325). The original Cybernet was not adequate at this ministerial level, but Cyberstride could handle its filtration needs, since Beer "could think of no regulatory indicator appropriate to the two new components of System One at the higher level of recursion that could not readily be expressed as a triple index" (BOTF 1981: 326). The fifth principle had warned against a metasystem reduced to crisis management, and the most visible use of the tools came in a crisis.

16.8 The public dimension and the end

Beer also judged the project's fate in public opinion, and he did so in cybernetic terms: "the battle of Ashby's Law for the reputation of Project Cybersyn had […] been lost *in advance*" (BOTF 1981: 336). He applies the Law of Requisite Variety to the public debate itself. The variety of the stories that could be told about the project, in Chile and abroad, exceeded anything the project's members could generate in reply.

On 11 September 1973 Beer was in London (BOTF 1981: 347). In the final chapter of *Brain of the Firm* he returns to that date in the context of entelechy, the realization of a system's own potential: "It is not conceivable that 'Progress' for the Chilean people could have veered through a hundred and eighty degrees during the morning of September 11th, 1973" (BOTF 1981: 382). The remark is aimed at the idea that progress is a fixed direction. What changed that morning was the regime; the needs of the people stayed what they had been.

In *The Heart of Enterprise* he writes, more briefly, that the experience of using the operations room "did not outlast the date of 11th September, 1973, which saw the overthrow of democracy in Chile, and the death of the President" (HOE 1979: 242). The sentence stands in a chapter about System Four. Beer uses Chile there as the one realized example of the

operations room, and reports its end in a single clause.

The Chilean experience shapes much of what Beer wrote in the following years. The Massey Lectures of autumn 1973 open the question of freedom as a design problem (see chapter 17). *Platform for Change* (1975) collects arguments on institutions and metasystems from 1969 to 1973, most of them written before the Chilean work began; its narrative pages refer back to Chile (PFC 1975: 417; see chapters 18 and 18.6). And the critique of planning as a product, developed in *The Heart of Enterprise*, takes up the lagged information with which the project began (see chapter 19).

16.9 Prospectus: crisis and entelechy

Chapter 20 of *Brain of the Firm* is where Beer stops narrating. He draws "a veil over subsequent events" and wants "to turn if that is possible to positive conclusions" (BOTF 1981: 349). What he found common to the governments and firms that later invited him was "*the perception of impending crisis*" (ibid.). He defines the term: "What counts as a crisis is the expectation of *loss of control:* in other words cybernetic breakdown in the institution" (ibid.). The first lesson of Chile follows from that definition: "ACT FAST" (BOTF 1981: 350). Beer reports that he made speed the essence of his proposals in four other countries, which he does not name, and that in each case the crisis exploded before work could begin (ibid.).

The cybernetics of crisis. Beer models three parties, A, B and C, whose interests intersect in a developing crisis (Figure 48, BOTF 1981: 354), and sets out "four major cybernetic requirements" of stability (ibid.). He recapitulates them himself (BOTF 1981: 376):

- "(i) The system is obedient to Ashby's Law of Requisite Variety;"
- "(ii) Information channels maintain variety entrusted to them;"
- "(iii) Transducers neither attenuate nor amplify variety;"
- "(iv) The time cycle is synchronous for all subsystems."

These, he writes, "were drawn respectively from the four Principles of Organization enunciated in this book's companion volume, *The Heart of Enterprise*" (BOTF 1981: 377). The core of the argument is that a party's regulatory model loses variety at each step: in the group onto which the model "condenses" (BOTF 1981: 356), in transmission, and in transduction into the conceptual model. "It follows therefore for Party A that the variety of its own model *decides* the variety of the crisis" (BOTF 1981: 364). The loss is then made good only in appearance: variety is "ostensibly but

not actually restored — essentially by *shouting*" (BOTF 1981: 365). The feedback loop that ought to damp the system is, on Beer's analysis, supplied by the mass media, and it works against stability (BOTF 1981: 366). His verdict: "The outlook, by these tokens, for crisis regulation must be adjudged bleak" (BOTF 1981: 376).

He applies the model to his own conduct. Before the coup he had set up three coded channels of communication with three groups in Chile (BOTF 1981: 358). To protect the people involved, he made each code specific to one channel and told none of the three that the others existed. He calls this "a mistake of metasystemic proportions", and one that he "would repeat for the reason given" (BOTF 1981: 362).

The cybernetics of progress. The second section starts from the behavioural modes of chapter 15 and argues that the crisis mode has become the normal condition (BOTF 1981: 378). Beer then argues that "the notion of Progress is politically relative" (BOTF 1981: 381). Beyond the intentions that Progress measures lie meta-intentions, "something to be achieved which is *politically invariant*" (ibid.). For this he revives Aristotle's word **entelechy**, defined with the help of the Oxford English Dictionary: the meta-intention "expresses *the realization or complete expression of some function*; it manifests *a condition in which a potentiality has become an actuality*" (ibid.). The remark about 11 September 1973 quoted in 16.8 is his illustration (BOTF 1981: 381–382).

The measure of progress in this sense is the triple index of 16.5. Beer's "Tentative and Final Methodology towards Entelechy" requires that the methodology "be able to measure performance — quantitatively defined in Chapter 11 as the ratio of the two estimates", and it "becomes thereby (Chapter 11, Figures 28 and 29) the tool of normative planning that brings the entelechy into focus" (BOTF 1981: 386). On my reading, this closes a circle in Part Four: the index that Cyberstride computed for each factory returns at the end as the measure of what a system could become.

Under "On Technological Method" Beer asks whether the computers and the operations room were "merely frills", since "the basic success was due more to **organizing structural variety** than to anything else" (BOTF 1981: 394). He grants the case weight and rejects it: "on balance I disbelieve its humanistic promise", because "The **requirement for speed** in the operation of the problem-solution homeostat makes this outstandingly a technological issue" (ibid.).

The cybernetics of prospectus. The last section explains why the chapter

gives no list of lessons for next time. Not a single question "can even be clearly formulated (much less answered) without specifying an attendant set of circumstances in great detail" (BOTF 1981: 395). The viable system is instead to be interpreted "in terms of the potentiality dormant in its actuality" (ibid.). The chapter ends: "This is the Prospectus of the Entelechy. The futurological prospectus does not have requisite variety" (ibid.).

References

- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)

Chapter 17 — Freedom as a design problem

17.1 The Massey Lectures (*Designing Freedom*)

"Individual freedom has been lost, momentarily at least, in Chile" (DF 1974, Lecture 3). Beer said this on the radio in autumn 1973, in the third of six lectures broadcast as the thirteenth series of the Massey Lectures and printed as *Designing Freedom* (DF 1974; cited by lecture, since the transcript has no print pagination, see `sources.md`). The lectures are one of two places where he treats freedom explicitly. The other is chapter 6 of *The Heart of Enterprise*. The lectures state the problem for a general audience; the later book gives the argument its most precise form, so they are taken here in that order.

The lectures avoid the notation of the viable system model, but the argument is the one developed in *Brain of the Firm* (see chapter 16 for the Chilean background). It proceeds in six steps, one per lecture.

Lecture 1 — institutions as dynamic systems. Beer begins by changing how an institution is to be seen. Institutions "are not just things, entities we recognize and label. They are instead dynamic and surviving systems" (DF 1974, Lecture 1). To make this concrete he uses a physical model, a tennis trainer: a ball hangs from a piece of elastic strung between two poles, and two men sitting on top of the poles pull on the elastic. When the ball is disturbed it bobs about and eventually comes to rest. "The time it takes to stop is called the relaxation time of the system" (ibid.). **Relaxation time**, the time a system needs to return to stability after a perturbation, is the key concept of the lecture.

Then Beer complicates the model. He adds some forty poles in a circle,

each with a person and a piece of elastic of different strength, and notes a counter-intuitive result: "the harder all the men try conscientiously to manipulate the system so that it settles, the more unstable it is likely to become" (ibid.). He also lets the world intervene, in the form of a cat that swipes at the ball. The general statement follows: "All our major societary institutions are high-variety systems; all of them need to have a finite relaxation time; but all of them are subject to constant perturbation" (ibid.).

How do institutions cope? They reduce variety, Beer answers, and all of them do it in one form or another. He summarizes the vocabulary he has built: "A dynamic system is in constant flux; and the higher its variety, the greater the flux. Its stability depends upon its net state reaching equilibrium following a perturbation. The time this process takes is the relaxation time. The mode of organization adopted for the system is its variety controller" (ibid.). Hierarchy is one way of reducing variety, for example a boss who constrains the freedom of subordinates. Beer names the cost and offers no easy escape: "It is in this way that freedom starts to be subordinated to efficiency; but the only alternative—which we must face—is total anarchy" (ibid.).

The lecture ends in a hypothesis, stated in its accompanying notes: "The relaxation time of the institutional system is now on the average longer than the average interval between perturbations, with the result that the institutional system is permanently unstable" (ibid., notes). This is the core diagnosis of the series. In terms of the ball: if the cat strikes again before the ball has come to rest, the ball never comes to rest. The system is permanently in transit, and the variety-reducing measures it adopts to cope are applied more and more heavily.

Lecture 2 — the disregarded tools. The second lecture explains why this happens and what could be done. "Our institutions are failing because they are disobeying laws of effective organization which their administrators do not know about" (DF 1974, Lecture 2). Beer means the laws of variety set out in the earlier chapters of this book. He repeats the point of the first lecture in sharper form: "A social institution is not an entity, but a dynamic system" (ibid.). The tools that could help are available but misused. The computer in particular is treated as a data processor; yet it "is really their only hope" (ibid.). The distinction between processing data and producing information returns in *Platform for Change* (see chapter 18.5).

Lecture 3 — the liberty machine. The third lecture applies the argument

to government. Beer recalls his earlier claim that government "is a kind of machine meant to operate the country in the interests of individual freedom", but that it does not work well. He proposes a change of conception: "So, I declared, let us redesign this 'liberty machine' to be, not an entity characterized by more or less constraint, but a dynamic viable system that has liberty as its output" (DF 1974, Lecture 3). On this conception freedom results from how the system is organized, and is no longer a quantity that the state grants or withholds.

Beer immediately strips the state of its aura: "There is no need to be overawed by the pomp and circumstance of the state, once we have found the scientific way in to the problems of effective organization, and understood the basic laws of variety" (ibid.). He goes so far as to say that the state and a department store face the same problems, because "the pattern for handling variety, which last time I called the model, is the same" (ibid.). This is the invariance claim that underlies the viable system model generally: organizations of very different kinds map onto the same model.

Lecture 4 — science and the individual. The fourth lecture turns from institutions to the individual and asks how much of the individual's variety actually reaches the system. Beer describes a chain of attenuators applied by culture and media, and singles out one of them: "The editorial decision is the biggest variety attenuator that our culture knows" (DF 1974, Lecture 4). His verdict on the present state of affairs is blunt: "I reckon our existing liberty to be largely illusory: we are fooling ourselves" (ibid.). Formal rights may be intact; what Beer points to is that the variety of what people can see, say and choose is heavily filtered before it matters.

Lecture 5 — bureaucracy. The fifth lecture puts the central question of the series in one sentence: "How do we sustain individual liberty and societary cohesion at the same time?" (DF 1974, Lecture 5). *The Heart of Enterprise* will answer it formally (17.2). The obstacle, in Beer's diagnosis, is bureaucracy. Inside institutions there is a nucleus "that exists—narcissus-like—in self-regard" (ibid.), and institutions produce their social benefits "simply as by-products of their major bureaucratic undertaking, which is to produce themselves" (ibid.). This is the popular form of the argument about pathological autopoiesis (see chapter 15.4): a subsystem that becomes concerned with producing itself rather than serving the whole. The remedy Beer draws is structural: "If institutions really are to be changed, then their fundamental organization really must be altered; and a major component of that alteration will be to dismantle the

bureaucracy" (ibid.).

Lecture 6 — the free man in the cybernetic world. The last lecture gathers the conclusions. The first addresses the fear that efficient organization must mean loss of freedom. Beer argues that behavior which looks like individual choice is often "an output of a dynamic system having a particular organization" (DF 1974, Lecture 6), and concludes: "And so my first conclusion to these lectures is: efficiency does not entail tyranny—if we can get the system right" (ibid.). He adds why this matters: "To do so is a top priority, because some version of efficiency is required to save our dinosaur society" (ibid.). The same lecture contains his argument about adaptive planning, taken up in chapter 19.4.

The series closes by drawing the line from diagnosis to task: "Thus is freedom lost; not by accident, but as the output of a system designed to curb liberty. My message is that we must redesign that system, to produce freedom as an output" (ibid.). The phrase "freedom as an output" is the thesis of the whole series. It puts freedom in the same category as any other output of a system: something that results from structure and can therefore be designed for.

17.2 The argument in HOE: freedom as a computable function

Chapter 6 of *The Heart of Enterprise* is entitled "Freedom". Where the lectures used images, it gives the formal version in the vocabulary of the viable system model.

Beer locates freedom in the geometry of the model. The model has two dimensions: a horizontal one, in which the management units, their operations and their environments interact, and a vertical one, in which the metasystem relates to System One. Beer states that in the VSM "the dear question of freedom is locked into its orthogonality" — that is, in the relation between horizontal (operations) and vertical (metasystem) variety, an interaction "which DEFINES FREEDOM within the viable system" (HOE 1979: 145–146). Freedom, then, is a property of how the two dimensions interact, and belongs inside the model from the start.

From this Beer draws a conclusion that runs against a common assumption. The loss of freedom is usually blamed on the top. Beer argues that it often arises in the operations themselves, through the interaction of the operational elements with each other: "The loss of autonomy, the erosion

of liberty, is already implicit in the total system […] — but the fact goes unrecognized, and is blamed on autocratic corporate management" (HOE 1979: 152). He also moves the question from feeling to structure. The reality of freedom in an institution "lies, not in the subjective impressions of the people involved, but in what the institution DOES to them by way of variety constraint" (HOE 1979: 156). This matches the fourth lecture's claim that liberty can be illusory. Whether people feel free and whether they are free are different questions, and the second is answered by examining variety.

Beer then develops the argument in seven steps (HOE 1979: 157–158). In summary:

1. The management unit has less variety than its operation, and the operation less than its environment; the unit must therefore design amplifiers and attenuators to balance these horizontal variety equations.
2. The other elements of System One intervene in these horizontal equations, because the operations interact. This "is a mark of the total cohesion, but it tends to vitiate elemental autonomy."
3. If the metasystem intervenes as well, in the interests of fairness, it is likely, on the whole, further to reduce the variety available to the management unit. "**Therefore** *The metasystem should make minimal use of variety attenuators in its dealings with management units in a downward direction*." Beer comments: "This is the cybernetic argument for autonomy (or freedom), as distinct from the ethical, political, or psychological arguments. Unlike these others, it has no emotive content. It is basically mathematical."
4. The minimum of intervention is in principle zero.
5. But without any intervention the elements would act inconsistently, or even contradictorily. "**Therefore** *The metasystem must make some intervention, and should make only that degree of intervention that is required to maintain cohesiveness in a viable system*."
6. Cohesiveness depends on purpose: systems of concentrated purpose are closely knit, systems of general purpose more loosely coherent.
7. Systemic purpose, however, is "a subjective phenomenon, rather than a property of the system independent of its instigators, participants, and observers."

The argument squeezes from two sides. Steps 3 and 4 push the metasystem's intervention toward zero, because every intervention costs the op-

erational unit variety. Step 5 stops it from reaching zero, because a viable system must hold together. The permissible amount of intervention is therefore the minimum required for cohesion. Steps 6 and 7 say what fixes that minimum: the purpose of the system, as those involved perceive it. The ball of the first lecture shows the same shape in miniature: the harder the men pulled to make it settle, the less stable it became.

The conclusion follows: "**THEREFORE** *Freedom is in principle a computable function of systemic purpose as perceived*" (HOE 1979: 158). Beer anticipates the reaction: "That is the explosive conclusion. It is explosive precisely because it sounds heartless, whereas the dear question of freedom is full of heart" (ibid.). He does not retract it. Calling the argument "basically mathematical" in step 3 means that it holds whatever one's feelings about it. When he summarizes the model later in the book he restates the result in the same terms: "The important principle was deduced that freedom for the operational unit is a computable function of the purposes of the system as perceived" (HOE 1979: 200).

Two features of the conclusion need spelling out. "Computable" does not mean that anyone has computed it. It means that the degree of autonomy is not arbitrary: given a purpose, the minimum intervention needed for cohesion is in principle determinate. And the purpose is "as perceived". Because purpose is subjective in Beer's sense, the calculation cannot be fixed from outside. People who perceive a system's purpose differently will arrive at different permissible degrees of intervention. On my reading, freedom is therefore bound up with the question of who defines the purpose, which is the business of System Five. This link is an interpretation, not Beer's statement.

Beer extends the argument beyond the enterprise: this explication "can be extended to cover individual freedom within a society (since we are dealing with the identical cybernetics exhibited at a different level of recursion)" (HOE 1979: 160). With that sentence the two halves of the chapter meet. The "liberty machine" of the third Massey Lecture and the management unit of *The Heart of Enterprise* are the same problem at different levels of recursion. The fifth lecture's question, how to sustain individual liberty and societary cohesion at the same time, receives here its formal answer: hold metasystemic intervention to the minimum that cohesion requires, and measure cohesion against a purpose that the participants themselves perceive. The same logic governs Beer's rules for planning, where a uniform planning rubric imposed from above is ruled out because it would impair the autonomy of System One (see chapter 19.3).

References

- **DF** — Beer, Stafford (1974). *Designing Freedom*. London: John Wiley. Cited by lecture from a transcript edition.
- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.

Chapter 18 — Institutions, metasystems and change (*Platform for Change*)

18.1 The form of the book

"No, it isn't meant to be poetry" (PFC 1975: 2). Beer expects the reader of *Platform for Change* (1975) to be surprised by the layout, since he writes in grouped lines rather than continuous prose, and he explains the choice at the outset. He has already published books "in the approved style", and gives the reason for departing from it: "It is the business of words to communicate but the more is not the merrier" (ibid.). Poets and mathematicians, he observes, use devices other than words to convey meaning, and grouping is one of them: it cuts down "verbiage" and "pinpoints ideas" (ibid.). He admits that the form may be tiring at first, and ties the difficulty to his theme: "reading habits thinking habits running-the-world habits they are all hard to break" (ibid.).

The form belongs to the argument. A book about changing habits of thought, written in the habitual form, would contradict itself in a small way. The layout asks the reader to do what the content asks of society: to break a familiar pattern of processing.

The book is physically structured as well. Its pages are color-coded. Narrative pages comment on the "Arguments of Change", which are printed on white pages; each Argument is "an aspect of a wider case" (PFC 1975: 10). The Arguments are lectures and papers from 1969 to 1973, most of them from 1970 (see 18.6), so the book collects the period that includes the Chilean work described in chapter 16. The wider case is set out in

eight "Thesis" statements, presented "in a colour of its own" (PFC 1975: 10). They are short, and together they are the most compact statement of Beer's social cybernetics in that period. The sections below follow them and then take up three concepts that recur through the book: metasystem, eudemony, and the distinction between data and information.

18.2 The eight Thesis statements

The eight statements form a sequence. The first two diagnose the problem and name the means; the third says what to do; the fourth to seventh work through institutions, measurement, information and decision; the eighth names the ethical condition.

First (PFC 1975: 15): "**Man is a prisoner of his own way of thinking and of his own stereotypes of himself.** […] **The new world is characterized by the need to manage complexity. Complexity is the very stuff of today's world. The tool for handling complexity is ORGANIZATION. But our concepts of organization belong to the much less complex old world**".

The first thesis joins a claim about the world to a claim about its managers. Complexity has increased and must be managed; the managers' concepts of organization lag behind. The gap between the two is the problem of the whole book. The Massey Lectures describe the same gap as relaxation time exceeding the interval between perturbations (see chapter 17.1).

Second (PFC 1975: 49): "**We need to invoke SCIENCE**", with its means: mathematics, general systems theory, "**to devise viable organizations through cybernetics**", behavioural science, operational research. Instead society proceeds "**by *consensus***", which "**buys protection against megalomaniacs, fascists, charlatans and lunatics and which also protects us from novelty, unique ability, change and leadership**".

Beer does not dismiss consensus. He names what it protects against, and then what it costs. The mechanism that filters out the dangerous also filters out the new. In the vocabulary of variety, consensus is an attenuator that cannot tell one kind of variety from another.

Third (PFC 1975: 99): "**There are three things to do: FIRST do some thinking[,] reconstruct the language, and then operate metasystemically**" — and "**make provision this time for continuous metasystemic monitoring**".

The three steps move from thought to language to structure. The words "this time" imply that earlier attempts at reform lacked the last element: a metasystem that goes on watching after the change has been made.

Fourth (PFC 1975: 131): "**Institutions are self-contained cells** […]. **They are esoteric boxes difficult to penetrate**". The omitted part of the first sentence names what holds each cell together: "**the nucleus— the organizing principle called the cytoblast— is management itself**" (PFC 1975: 131). Institutions have characteristics "**that make them highly stable — in itself a good and therefore unadaptable —something highly dangerous**". Reforming separate institutions will not reform society, because "**there is not likely to be enough time left**" and because "**the major instabilities of society arise *between* the esoteric boxes**" (ibid.).

The esoteric boxes are the image the rest of the book keeps returning to, and the Fourth Thesis is where the concept of the metasystem starts. If the instabilities lie between the boxes, no single box's management can deal with them, however competent. Something has to operate at the level of the relations between them, and that is what Beer means by a metasystem in this book (18.3). The remark that stability is "**in itself a good and therefore unadaptable**" restates a point that runs through Beer's work: the mechanisms that make a system stable are the ones that resist change.

Fifth (PFC 1975: 159): To design metasystems for "**systems of esoteric boxes we must have a metric**". Money "**ought to be viewed essentially as the metric of *constraint***"; "**Call the new and hypothetical metric: eudemony.**"

A metasystem needs to measure what it regulates. Money measures one aspect of the relations between the boxes, and Beer reads it as a measure of constraint. Well-being needs a metric of its own, which is named here and, as "**hypothetical**" says, still undefined (18.4).

Sixth (PFC 1975: 243): Such a metric depends on the measurement of information flow; "**the way in which society handles the commodity of information *which is what changes us* and the commodity of data *which are the raw materials of information* will prove to be critical** […] **even to the preservation of human freedom**".

The sixth thesis ties measurement to freedom. For Beer, how a society treats information bears on liberty. The link to *Designing Freedom*, where liberty depends on the variety constraints a system imposes, is direct (see chapter 17).

Seventh (PFC 1975: 299): New institutions need "**dynamics of decision, fast-responding, self-regulating, self-organizing**". This "**does away with sterile models of institutions as being for instance centralized or decentralized since any viable system is both at once. Such tired old issues are easily resolved metalinguistically.**" "**The institution most needing reform under these cybernetic canons is government itself**".

The claim that "**any viable system is both at once**" centralized and decentralized compresses what the viable system model does with that old opposition. The operational units are autonomous, the metasystem provides cohesion, and both are present at every level of recursion. Beer's design for Chile, in which each level received "only its own Cyberstride reports", is an instance (see chapter 16.4). The thesis ends by naming government as the principal target, which is also the subject of the third Massey Lecture.

Eighth (PFC 1975: 370): "**Change cannot occur within the framework of the existing ethic: mankind needs to formulate a new ethic**". Its basis is "**a true and not spurious compassion**" and the recognition that technology makes mankind "**unimaginably wealthy**", but that the wealth "**is largely consumed by massive waste**".

The sequence ends outside cybernetics proper. Beer does not claim that the model supplies the ethic. He claims that without a change in ethic the structural changes of the earlier theses will not occur.

18.3 Metasystem

"Metasystem" appears throughout Beer's writing, and *Platform for Change* gives it its most economical definition, derived from the idea of a metalanguage: "If a system speaks a language appropriate to that system the deficiencies of which (its undecidable propositions) can be discussed only in a metalanguage— then the system that speaks the metalanguage is a metasystem. There is no more to it than that" (PFC 1975: 71).

The definition is logical rather than hierarchical. A metasystem is defined by what it can talk about: the questions that cannot be settled inside the system's own language. Beer at once takes up a misunderstanding that the prefix invites. People seem to think, he writes, that a metasystem "being 'over and beyond' the system to which it relates has some special kind of authority— that it secretly manipulates the system and is sinister" (ibid.). His answer: "The power of a metasystem lies only in its *logical*

capacity to explain" (ibid.).

This fits the treatment of autonomy elsewhere. In *The Heart of Enterprise* Beer argues that the metasystem should intervene only as far as cohesion requires (see chapter 17.2). *Platform for Change* makes the prior point: the metasystem's standing comes from its logical position, and command has nothing to do with it.

Why are metasystems needed? Because integration cannot be achieved from inside the parts. Integration requires models drawn at the level of integration: the answer, Beer writes, is "by drawing our models at the level of integration. *They will be metasystemic models*" (PFC 1975: 66). Beer's diagnosis of his time is that such models are lacking: "the macro-systems of our firms and social institutions do not hang together, while the interaction of micro-systems is self-defeating" (PFC 1975: 60). The two halves of that sentence match the Fourth Thesis. The boxes do not cohere as a whole, and the instabilities arise in the interactions between them.

18.4 Eudemony

The Fifth Thesis names its new metric "eudemony". Beer takes the term from Sir Charles Goodeve and explains how Goodeve arrived at it. Goodeve had noted that a population drift would be hard to measure in terms of the many reasons for which individuals decide to move home. "He proposed instead that we measure the rate of drift itself, and also its rate of change", and interpret the results in terms of potential difference (PFC 1975: 167). What, then, does the potential measure? Goodeve's answer, as Beer reports it, was "some complicated image of well-being", for which he chose "the entirely suitable Greek word 'eudemony' " (ibid.). Beer glosses the word: "This is one of the Greek words for happiness, though it comes nearer to meaning prosperity than ecstasy" (ibid.). He knows he is reviving an unfamiliar term: "I ask you to bear with me in my attempt to regain currency for this moribund term" (ibid.).

The method matters as much as the word. Goodeve's approach, as Beer presents it, leaves the micro-level decisions unmodeled and measures the macro-level flow in which preferences show themselves. Beer states the general point just before the example: we "seek useful answers instead at the macro-level where the social preferences actually emerge" (PFC 1975: 167). On my reading, the discussion of metasystems made the same move: measure at the level of integration, between the boxes. Eudemony is thus,

in my interpretation rather than in Beer's words, a measure that belongs to a metasystem.

The term returns in *Brain of the Firm* as the measure registered by the algedonic meter (BOTF 1981: 283; see chapter 16.6), and in the Eighth Thesis as "**the eudemony of man**". Across these uses it designates the same thing: a measure of well-being taken from the flows of a system rather than constructed from its parts.

18.5 Data and information

The Sixth Thesis calls information "***what changes us***" and data "***the raw materials of information***" (PFC 1975: 243). One of the Arguments of Change states the distinction polemically: "The purpose is regulation. And that means translating data into information. *Information is what changes us*. […] Data, I want to say to you, are an excrescence. Data are the very latest kind of pollution" (PFC 1975: 223).

Beer grants data a use while denying them value of their own: "data of themselves have no value. What has value is the machinery to transform data into information, and the machinery by which that information may be used to innervate society" (ibid.). The metaphor of innervation leads straight to the model: "Society has become a complex organism, and it needs a nervous system" (ibid.). The viable system model, originally derived from the nervous system, is proposed here as the structure of such a nervous system for society, one that would run between the esoteric boxes as well as inside them. Cybernet and Cyberstride in Chile were an attempt to build one part of it: a network that carried data, and a filter that turned them into signals worth acting on (see chapter 16.3).

The phrase "information is what changes us" returns in *The Heart of Enterprise* as the reason why plans must continually abort (see chapter 19.2).

18.6 The Arguments of Change: dates and occasions

Each Argument of Change opens with a title page, and a note at its foot states where and when the piece was given or published. The list below takes its occasions and dates from those notes, in the order of the book (all title pages checked on the scan). Where a note gives no day, no place,

or a date of publication rather than of delivery, the list says so in square brackets; the bracketed remarks are mine, not Beer's.

Page	Title	Occasion (as stated)	Date (as stated)
21	Homo Gubernator	Address to the Fifth Annual Conference of The Pierre Teilhard de Chardin Association of Great Britain and Ireland, Central Hall, Westminster, London, under the title *This Runaway World—Can Man Gain Control?*	16th and 17th October 1970 [the conference dates; the day of the address is not stated]
55	Operational Research as Revelation	Inaugural Address by the President of the Operational Research Society, London	14th January 1970
85	Health and Quiet Breathing	The Sixteenth Centre Lunch Talk, Hospital Centre, London	25th November 1970

Page	Title	Occasion (as stated)	Date (as stated)
103	Management in Cybernetic Terms	Dissertation prepared for UNESCO; published in *Scientific Thought* in English and French by UN-ESCO/Mouton, The Hague, 1972	"late 1969" [prepared; no day stated; not a talk]
133	The Cybernetic Cytoblast: Management Itself	Chairman's Address, International Cybernetics Congress, Imperial College, London	3rd September 1969
161	Questions of Metric	President's Address to the joint plenary meeting of the Annual Conference of the Operational Research Society and the XVIIth International Conference of the Institute of Management Science, Imperial College, London	1st July 1970

Page	Title	Occasion (as stated)	Date (as stated)
191	The Law and the Profits	The Sixth Frank Newsam Memorial Lecture, Police College, Bramshill	29th October 1970
219	Managing Modern Complexity	Presentation to the Committee on Science and Astronautics of the House of Representatives of the United States of America, in the Capitol, Washington, D.C.	27th January 1970
263	The Software Milieu	Article written for the journal *Management Today*, published "with minor excisions"	issue of August 1970 [date of publication; date of writing not stated]

Page	Title	Occasion (as stated)	Date (as stated)
277	Dynamics of Decision	"Edited compilation" of a talk recorded before dinner and an extempore post-prandial discourse, London Branch dinner of the British Institute of Management, Savoy Hotel, London	16th December 1970
307	The Liberty Machine	Keynote Address to the Conference on Ecological Systems, organized by the American Society for Cybernetics as their annual national conference, Washington D.C.	8th October 1970
329	Science and the Mass Media	Broadcast on BBC Radio Three from London	30th January 1971

Page	Title	Occasion (as stated)	Date (as stated)
345	Renascence [labelled "A Meta-Argument of Change"]	"The uninvited Five-Hundredth Lecture" [prepared during 1970 and, by design, never given; p. 344]	"not delivered anywhere between the 10th and the 18th September, 1970"
397	The Surrogate World We Manage	Presidential Address to the Society for General Systems Research, at the annual meeting of the American Association for the Advancement of Science, Philadelphia	29th December 1971
421	Fanfare for Effective Freedom: Cybernetic Praxis in Government [not labelled "An Argument of Change"; it stands under the heading "The Post-Thesis: Praxis", p. 419]	The Third Richard Goodman Memorial Lecture, Brighton Polytechnic, Moulsecoomb, Brighton	Wednesday, 14th February 1973

Beer's narrative pages give the chronology behind the list. "The ARGU-

MENTS OF CHANGE so far expressed here were all set out during 1970 the first year of the project PLATFORM FOR CHANGE" (PFC 1975: 393). The title pages show three exceptions to the letter of that sentence, and the narrative accounts for each. The Cytoblast address, the first of the four on institutions, "was presented during the run-up to the project" (PFC 1975: 128). The UNESCO invitation "came during the count-down to the project" (PFC 1975: 101). The BBC piece was "the last piece I wrote in the first year of the project", "recorded and broadcast in January" (PFC 1975: 327). The Surrogate World address follows that remark and belongs to the second year, 1971 (PFC 1975: 393). The Fanfare is "this last address written at the end of the third year of the project" (PFC 1975: 417). Beer also notes that "Every Argument of Change in this book except this one" (Dynamics of Decision) was a carefully prepared presentation, and that during the first year he advanced *extempore* Arguments of Change in nine towns and cities, with "half a dozen in London" (PFC 1975: 274); by his account these are not in the book.

Two dates in the narrative do not fit the rest and are left as printed. Beer calls the Washington presentation "the first of the actual year 1970" (PFC 1975: 213), but its title page gives 27 January 1970, and the Operational Research Society address is dated 14 January 1970 (PFC 1975: 219, 55). And the narrative dates the encounter with Chile: "It happened in the middle of 1972" (PFC 1975: 417), whereas *Brain of the Firm* dates Flores's first letter 13 July 1971 (see 16.2).

The Classic Library reprint used here adds a Reader's Guide by Jon Li with a "Table of platforms" listing the same fifteen pieces (PFC 1975: 463–464, reprint pagination). It is not Beer's text and is not used as a source for the list above.

References

- **PFC** — Beer, Stafford (1975). *Platform for Change*. Chichester: John Wiley & Sons. Cited from the Stafford Beer Classic Library reprint, 1994.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)

Chapter 19 — Planning that has to abort

19.1 Against planning as a product

In *The Heart of Enterprise* Beer asks what holds several levels of recursion together, and he knows his answer will surprise: the binding process "is none other than PLANNING. Many a treatise has been written about planning; but I do not know of any that contends that it is actually the 'glue' of organizational cohesion" (HOE 1979: 336). His treatment of planning is short, but a large part of his theory of organization rests on it.

To make the claim plausible Beer first has to clear away the ordinary picture of planning, and he states that picture precisely. Treatises on planning, he writes, usually assume "that planning is an activity carried out by professionals called planners, that this activity results in products called plans, and that these plans will then be either implemented or not by those in authority" (HOE 1979: 336). He asks the reader to check this against experience: "(Please reflect for a moment: is that not indeed the common belief?)" (ibid.). Between this common belief and the view he is about to defend there is, in his words, a cognitive gap: "It is not so much a gap, as a chasm" (ibid.).

The common picture has three parts: a group of people (planners), an object (the plan), and a later step (implementation by someone else). Beer takes each part apart. He starts from where planning actually happens: "What needs to be reiterated is that planning happens only when there is an act of decision. […] It follows that the only planners are managers, namely those people who are entitled to commit resources" (HOE 1979: 337). Between these two sentences he gives the reason: the act of decision

"commits resources now, so that the future may be different from what would otherwise have simply happened to us" (ibid.).

A document describing a desired future is therefore not yet planning. Planning occurs when someone with the authority to commit resources does so. Beer had already made the point in the summary at the start of Part Three of *The Heart of Enterprise*: planning "needs to be seen as a continuous, managerial, process of decision, whereby allocations of investment are made now, so that the future may be different" (HOE 1979: 276). The professional planner may help, but he or she does not plan.

Beer draws on two points that, he says, others made before him. The first "is that planning is a *continuous process*", which "conflicts violently with the stereotype of a plan based on the next month, the next year, the next five years, or 'the year 2000' " (HOE 1979: 336). He adds, briefly: "Nature does not have a calendar" (ibid.). The second is the one just stated, that planning is an act of decision.

19.2 Plans must abort

From these two points Beer derives a third, which is his own. Decisions have to be adjusted continuously, "because rational expectations and probable scenarios are both constantly changing, so that the decision taken yesterday is very probably and ostentatiously wrong today" (HOE 1979: 337). What drives the change is the arrival of information. Because information keeps arriving — " 'information is what changes us' " — "plans must continually abort. Produce a plan, dated so-and-so, which has today been implemented in every detail, and you will see a stupid action" (HOE 1979: 337). The quoted phrase is Beer's own, from *Platform for Change* (see chapter 18.5).

The structure of the argument is simple. A plan fixed on a given date embodies the information available on that date. By the time it has been fully carried out, more information has arrived. If none of it has altered the plan, it has been ignored. A plan implemented in every detail is therefore evidence that the organization did not learn while implementing it. Beer states the consequence without softening it: "There is nothing more hair-raising than to see an implemented plan — unless it is to see honours and awards heaped on the idiots who went through with it" (ibid.). The summary at the start of Part Three says the same in more measured terms: "since at any moment more information is available than at the previous moment, it is madness to implement plans — those considered

as professional products — at some date later than they were conceived. They will necessarily be mistaken" (HOE 1979: 276). And it adds the cybernetic formulation: "In cybernetic terms, plans should be *continuously* adaptive to fresh information" (ibid.).

Beer gives two examples. The dome of St. Paul's "would have collapsed without the last-minute emergency action that put a vast chain around its circumference to hold it together", and Concorde, whatever its technological and aesthetic merits, "loses a great deal of money for every mile" (HOE 1979: 338). He is careful about what they show: "The argument is not against St. Paul's or against Concorde" (ibid.). The dome stands because someone changed course at the last minute; realized projects come out of continual adjustment, and plans carried out as drawn are the exception: "planning is a continuous act of adaptive decision that continually aborts" (ibid.).

Beer then sets out three counter-theses, each answering one element of the common picture (HOE 1979: 338):

- "planning is *not* an activity carried out by professionals called planners; it is an act of decision carried out by managers empowered to commit resources to a different future."
- "Planning is *not* an activity resulting in products called plans: it is a continuous process, whereby the process itself — namely that of aborting the plans — is the pay-off."
- "The plans do *not* have to be implemented or not by those in authority: what the authority **does** constitutes the plan — and its realization."

The second counter-thesis goes furthest. It puts the value of planning in the repeated act of abandoning the plan. The third removes the separation between plan and implementation altogether: what is done is the plan.

19.3 Planning as the "glue" of cohesion

With this redefinition Beer returns to his opening question. "And in that planning process the manager dispenses the cohesive 'glue'. The institution hangs together because, and only because, plans are constantly aborting" (HOE 1979: 338). Planning is thereby tied to the Law of Cohesion (see chapter 13). The summary at the start of Part Three states the connection: the planning process "is perceived as the cohesive 'glue' that

holds the embedments of viable systems in place", and this examination "leads to the ennunciation of the Law of Cohesion for multiple recursions of the viable system" (HOE 1979: 276).

The following reasoning is my reconstruction, not Beer's own derivation. Each level of recursion is a viable system with its own intentions. What holds the levels together is a process in which intentions are continually adjusted to each other, rather than a fixed structure of dependency. Planning, understood as continuous decision, is that process. If plans did not abort, the levels would drift apart, each pursuing a plan fixed at a moment when the others were in different states. The chain around the dome of St. Paul's is a physical picture of the same thing: cohesion supplied by a late decision. Beer's own derivation of the Law of Cohesion runs through variety rather than through the timing of plans. He builds it on his diagram of the planning process between two levels of recursion (Figure 61, HOE 1979: 353) and states it as: "The System One variety accessible to System Three of Recursion x = the variety disposed by the sum of the metasystems of Recursion y" (HOE 1979: 355). Chapter 13 treats the law itself.

Several rules follow from recursion. The first concerns uniformity: "no uniform planning rubric can be imposed" (HOE 1979: 340). Beer gives the reason: a uniform rubric "would very seriously impair the autonomy of the System One management, whose own needs (horizontal) are quite different from the needs of the metasystem (vertical)" (ibid.). Chapter 6 of *The Heart of Enterprise* made the same argument about freedom: the metasystem should reduce the variety of the operational units only as far as cohesion requires (see chapter 17.2). Beer notes that imposing a planning rubric "in the supposed interests of homogeneous planning across the institution" is nonetheless "normal practice", and that in his observation this is where the troubles usually start (ibid.).

The second rule concerns the content of plans: "Plans are the embodiment of the intentions subscribed to at each level of recursion: since these intentions are constantly changing […], they must continually abort" (HOE 1979: 342). What, then, should be measured and reported? Beer's answer is narrow: "The only characteristic worth detecting, measuring, reporting, or doing anything about, is incipient instability in the system" (ibid.). It matches his description of the manager's job in a well-designed system: "It is to be alert to incipient instability — and to take action about *that*" (HOE 1979: 276). Cyberstride had been designed in Chile to do exactly this: filter the routine and raise an alert when an index moved unusually

(see chapter 16.3).

The third rule concerns System Two. Different levels and units will describe their intentions in different terms. System Two must not settle this by issuing "a book of rules", because "there is no need for a *uniform* language, but only a need for System Two to speak *all* the languages of System One" (HOE 1979: 344). Beer gives a second reason in the same sentence: any such manoeuvre "would be perceived as the introduction of a planning rubric on the command axis" (ibid.). System Two's role, as he restates it, is anti-oscillatory: it "exists to damp oscillation" (ibid.). The Second of the five principles written for Chile makes the same point (see chapter 16.6).

19.4 The same argument for society

Six years before *The Heart of Enterprise*, in the last Massey Lecture of 1973, Beer had already applied the argument to public planning. He observes that planning has acquired a bad name, and asks why: "The reason surely is that our plans are not adaptive, and the institutions charged with making them grind on with their implementation long after it has become obvious to everyone who will be affected that the plans are inappropriate" (DF 1974, Lecture 6). He ties this to the diagnosis of the whole series: "We are back to the unviability of the institution again" (ibid.; see chapter 17.1).

His remedy is the one the later book gives, stated more briefly: "Planning should be continuous and adaptive. Societary plans should continuously abort, and be recast, before they give birth to a monster" (ibid.). He then lifts from planners a burden usually thought to rest on them, the burden of prediction. If plans abort continually, "there is no need to base them on the predictions that no-one can correctly make in any case, but only on the analysis of an unfolding situation in which every decision constrains future variety" (ibid.). Earlier in the same lecture he had disclaimed any intention to forecast: "I do not believe that we can predict the future. I believe instead that we can describe the present with perspicuity, if we use the proper instruments, and that this same present constrains future variety" (ibid.).

Here the lecture series links back to its theme of freedom. The future "is something we use our freedom to determine, rather than something that is lurking out there, and will happen to us" (ibid.). Beer compresses this into one sentence: "We can make, rather than prophesy, the future" (ibid.).

On this view planning is one of the forms freedom takes, provided that the plans are allowed to abort.

The two texts, six years apart, state one position. Planning is decision; decision is continuous because information keeps arriving; plans therefore abort, and the aborting is the pay-off. For an enterprise this is the source of cohesion between levels of recursion. For a society it is the difference between a future that is made and one that is merely suffered.

References

- **DF** — Beer, Stafford (1974). *Designing Freedom*. London: John Wiley. Cited by lecture from a transcript edition.
- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.

Part IV — Team Syntegrity

Main source: Beer, Beyond Dispute: The Invention of Team Syntegrity (BD 1994). The text of BD was produced by OCR; all quotations have been checked against that text. The fifth part of BD ("Collaborators' Surplus") is by other authors and is not cited as Beer.

- Chapter 20 — The problem: non-hierarchical democracy in groups
- Chapter 21 — The icosahedron as organisational form
- Chapter 22 — Protocol, infoset, reverberation
- Chapter 23 — Syntegrity and the VSM

Chapter 20 — The problem: non-hierarchical democracy in groups

20.1 Starting point: hierarchy does not suffice

On the third page of *Beyond Dispute* (BD 1994), after a list of paired roles (master and slave, squire and servant, boss and employee), Beer states the problem that the rest of the book tries to solve: "the notion of hierarchy is endemic to the human experience of social system. And yet it seems never to suffice as an organizing principle" (BD 1994: 3). The list and the sentence open the book's first chapter, "A Long Gestation".

Beer does not claim that hierarchy can be abolished. His claim is narrower: hierarchy is everywhere, and it is everywhere supplemented, because on its own it does not do the work of organizing. He has little patience with the device through which hierarchy usually represents itself. The typical organization chart, the "family tree" in the words of the same page, is "a mere instrument for discovering who is to blame" (ibid.). The family tree records the chain of accountability. How the organization regulates itself does not appear on it.

People had already found practical ways round these limits, Beer acknowledges. There had been non-hierarchical solutions, "real, and effective, but perhaps fairly pragmatic in design. It might be advantageous to have a more rigorous theory" (ibid.). *Beyond Dispute* is framed as an attempt to supply that theory. Beer also names reasons why the question had become urgent by the early 1990s: "the international trend away from centralization; a growing repugnance towards the very concept of hierarchy

detectable in public debate" (BD 1994: 3), together with the thinning of middle management that he describes on the following page.

The problem itself is older. The same chapter traces it back to Beer's operational research in the steel industry around 1950, where he used Alex Bavelas's network measures (Group Dispersion, Relative Centrality and Peripherality) to study how communication protocols shape a group (BD 1994: 4–5). What he reports from that work is a dilemma: "The central paradox resides in this: morale is improved by diminishing Peripheral isolation, but adjustments to Relative Centrality to achieve this lack efficiency and inhibit the emergence of leadership" (BD 1994: 5). Team Syntegrity would later address this paradox in a new form. Beer also notes that this line of work "was the origin of the theory of autonomy eventually advanced in *The Heart of Enterprise*" (BD 1994: 6). Syntegrity and the VSM thus share a starting point, well before the comparison Beer draws in chapter 9 of BD (see chapter 23).

Beer puts the VSM itself on the non-hierarchical side of the question. Reviewing his earlier models, he says that they "are all based on interlocking homeostatic subsystems, and are non-hierarchic in character for that reason—contrary to the critiques of some rather casual readers" (BD 1994: 7). The reasoning is brief. A model built from homeostats is a model of mutual regulation: each subsystem holds the others in balance and is held in balance by them, and command running in one direction is not what holds it together. Later in BD he repeats the point in the context of developmental planning: "the VSM is not a hierarchical but a circular model, exhibiting closure, because it includes its own environment in its organizational loops. Its five subsystems are profoundly interactive, so that notions such as 'top-down' and bottom-up' [sic] are as inappropriate as they are in the icosahedron" (BD 1994: 148). The sentence introduces Allenna Leonard's example chapter in the "Collaborators' Surplus" ("Her example emphasizes that…"). The words are Beer's, but he offers them as a summary of what her example shows.

A reader coming from Part II of this book may find these statements hard to square with the familiar VSM diagram, which puts System Five at the top and System One at the bottom and so looks rather like a family tree. Beer's answer, here and in chapter 23, is that the diagram shows logical levels of regulation, embedded in each other and linked in loops. It does not rank who may give orders to whom (see chapters 6 and 11).

20.2 The requirement: a perfect democracy

Garry Davis, founder of the World Service Authority, supplied the occasion with an invitation. Beer states the design task in two parallel clauses, one about structure and one about procedure: "The rest of us would need structure, but it had to be non-hierarchical; and we would need a procedural protocol, but it had to be non-hieratic. In short, we needed a perfect democracy" (BD 1994: 12).

Each clause keeps what it qualifies. Beer asks for structure of a particular kind, and for rules of procedure that give no one priestly standing. "Non-hieratic" (not priestly) anticipates the distinction between "sacerdotal" hierarchy and autonomous embedment that Beer draws at the end of the book (see chapter 23). "Perfect democracy" is meant as a specification: structure and protocol are to give no participant a privileged position, which is what a family tree gives to whoever sits at its root. Chapter 21 shows how Beer turns this specification into a geometric criterion.

His first attempt went through holography, "in which the whole picture is reformulated in any broken piece of glass, but could not get a hold via Denis Gabor's mathematics" (BD 1994: 12). He then returned to Buckminster Fuller's geodesics. The detour shows what he was after: a structure in which every part carries the whole, and in which that property can be stated rigorously.

In the acknowledgements Beer credits Davis with "the initial stimulus and subsequent contract that metabolized theory into action" (BD 1994: xi). The World Service Authority also paid secretarial and commissarial expenses for the Toronto experiments, "because of their interest in the validation of the Team Syntegrity technique" (BD 1994: 87). The technique therefore grew out of a concrete political commission as well as out of management consulting: a world-citizenship organization was looking for a way to let people deliberate without a ruling centre. Its use in enterprises (chapter 23) came later.

20.3 Infoset and Problem Jostle: the provenance

Two of the central ideas of Team Syntegrity, Beer stresses, are much older than the 1990 experiments.

Infoset. The first concerns what holds a group together. "Data themselves do not supply this cohesion: it is the *interpretation* of data that

procures purpose, and it is the *shared* interpretation between individuals that procures group cohesion. Thus groups of this kind were nominated as infosets" (BD 1994: 10). Beer's answer is informational, then, though data as such do not suffice. An infoset (information set) is defined by what its members share in interpretation; formal membership of an organizational unit, the kind of membership a family tree records, is not the criterion. Beer dates the term to an unpublished text, *Status Quo*, "which I wrote in Chile, June–August 1973, while working for President Salvador Allende" (ibid.). The concept thus belongs to the same period as the Chilean project described in chapter 16. In BD's chapter on developmental planning Beer extends it. Command in the brain "is not prefigured, but is potential in any concatenation that shares the needful information. Well, this defines none other than an information set, an infoset" (BD 1994: 158). In organizations, "Potential command will be seized and made actual by fluid infosets of people who have the shared purpose and the shared information appropriate to the decisions involved" (ibid.). The syntegrity protocol did not invent the infoset. Beer's claim is that infosets already exist in every organization, formally recognized or not.

Problem Jostle. The second idea concerns meetings without a fixed agenda. "Meetings with no agenda must generate their own; and they must generate their own categories too" (BD 1994: 9). The second clause carries the weight: a group which only fills pre-set categories has not set its own agenda. Beer traces the technique to "Marlow Seventy", the 1970 council meeting of the Operational Research Society, and reports its use at the Silver Jubilee Meeting of the Society for General Systems Research in 1979 (BD 1994: 9). He adds that during these experiments "it became obvious that the size of the group was critical" (ibid.). That observation points ahead to the fixed number of 30 participants that the icosahedron imposes (chapter 21).

20.4 Reverberation, tensegrity, syntegrity

A small group of friends who often discuss politics among themselves gives Beer the last element of his account, the dynamic idea that links the infoset to a geometric model. The views they hear "consolidate, gain or lose adherents, subtly change … these views are REVERBERATING around the closed system" (BD 1994: 13). He then puts it more sharply: "some node within the system propagates an idea, which then bounces round other nodes—and returns (somewhat modified) to hit its progen-

itors on the back of the neck" (ibid.).

Two conditions are built into this description. The group must be closed, so that ideas come back instead of leaking away, and ideas must pass through several nodes, so that they return changed. Beer connects both to Buckminster Fuller's principle of structural integrity. In a tensegrity structure, "the wholeness, the INTEGRITY, of the structure is guaranteed not by the local compressive stresses where structural members are joined together, but by the overall tensile stresses of the entire system. Hence came the portmanteau term for Tensile Integrity: TENSEGRITY" (BD 1994: 13). He applies this to groups. An infoset tries to compress its shared idea into a cohesive statement, but it knows that "the popular term 'consensus' is likely to represent merely a lowest common denominator that robs the group of its whole *raison d'être*. It is also aware of *tension*: what else but tension generates discussion, never mind argument?" (ibid.). Closure here does not mean isolation: "Of course the Infoset is not closed to information: new outside developments are pumped in as the lifeblood of the group's body-politic" (ibid.). The closure Beer means is organizational. What circulates stays in circulation.

One sentence brings the two ideas together: "This concept of Reverberation came to mean to me the instrumentality of tensegrity within the Infoset: it generates *synergy*" (BD 1994: 14). Reverberation is the means by which tension produces an integrated result. The name of the technique followed. Because Fuller's term had been taken up commercially by architects, Boris Freesman "coined the word syntegrity, which draws together synergistic tensegrity, and Team Syntegrity has been the name for this technique ever since" (ibid.). Beer adds at once: "Of course, it depends on structural closure" (ibid.). How to close an infoset structurally, with no position privileged, is the question that leads to the polyhedra of chapter 21.

Textual note: Later in the book Beer explains a related word differently: "Syntegration is a portmanteau word for *synergistic* integrity, after all" (BD 1994: 197). "Syntegrity" (synergistic tensegrity, p. 14) and "syntegration" (synergistic integrity, p. 197) are thus derived differently. The two explanations do not contradict each other, since tensegrity is itself "tensile integrity". But the second omits the tensile element that the first put at the centre. Beer's text does not say whether the change is deliberate.

References

- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **BD** — Beer, Stafford (1994). *Beyond Dispute: The Invention of Team Syntegrity*. Chichester: John Wiley & Sons.

Chapter 21 — The icosahedron as organisational form

21.1 Why a regular polyhedron

Syntegrity, Beer wrote at the end of the passage discussed in chapter 20, "depends on structural closure" (BD 1994: 14). How can a group of people be closed structurally, so that ideas reverberate among them and no member is privileged? Beer's answer starts from a criterion taken from the idea of democracy and ends with one geometric form that meets it.

The criterion comes straight from the demand for "perfect democracy" (BD 1994: 12). Such a structure "surely means that no individual, and initially no cause, should have ascendance over any other. Then in looking for polyhedra on which to construct democratic tensegrity models, we must consider only *regular* polyhedra: figures which have no top, no bottom, no sides—indeed no feature by which they may be specially oriented at all" (BD 1994: 14). A political requirement becomes a geometric property. If no position in the structure differs from any other, no person placed in it can hold a privileged position. The words "initially no cause" matter as well: topics, too, are to be equal at the start, so that the structure does not settle in advance which issues count most.

Five regular convex polyhedra exist: tetrahedron, cube, octahedron, dodecahedron and icosahedron. Beer compares them by Euler's law, "the number of faces plus the number of vertices is equal to the number of edges plus two" (BD 1994: 14), and tabulates faces, vertices, edges and edges per vertex for each. The icosahedron has 20 faces, 12 vertices, 30

edges and 5 edges meeting at each vertex. "Without pursuing all the relevant arguments here, I decided to base my major experiments on the icosahedron, and to consider the edges as representing Infoset members (namely 30) and the vertices as representing topics" (BD 1994: 14). Each vertex is a topic, and the five edges that meet there are the five people who work on it.

The choice was not deduced, and Beer says so: "There are no proofs to offer, but there is accumulated knowledge about interpersonal systems" (BD 1994: 15). He gives three reasons from experience. First, "five discussants per topic is a 'good' number whereas three is certainly low" (ibid.). Second, thirty members "guarantees a reasonably high variety of viewpoints, without reproducing too many clones or look-alikes" (ibid.), and thirty is also, "roughly speaking (a personal observation), the key number of influential members of a management group" (ibid.). Third, he first treats the fixed number of twelve topics as a possible "straitjacket", but concludes from the 1990 experiments "that the number is arbitrary. Any number of topics may be contracted or expanded to 12 by sensible drafting" (ibid.).

Chapter 11 of BD, at the start of Part Three, restates the original criterion: the five regular convex polyhedra were chosen "because each edge (a person) has exactly the same status in the geometry as every other edge. There is no top, bottom or sideways in any of the five structures" (BD 1994: 181). Beer recalls that the icosahedron had been selected informally in chapter 1, " 'without pursuing all the relevant arguments here' " (ibid.). Part Three sets out to supply those arguments (see 21.3).

The idea predates BD. In the essay "On Suicidal Rabbits", reprinted in *Think Before You Think*, Beer sketches the same structure: "Let us typify an organization as an icosahedron. Its twenty sides are triangles. It has thirty edges. Let each edge represent a person" (TBYT 2009, "On Suicidal Rabbits": 217). The same passage draws the key combinatorial consequence: "Since each edge (equals a person) has two ends, each of thirty people belongs to two teams, and no two people belong to the same two teams" (ibid.).

21.2 Consequences of the geometry

With people as edges and topics as vertices, a series of properties follow from the figure itself. Beer draws them out one by one.

- **Roles.** Each person (edge) connects two vertices and is therefore a member of two teams (topics); each team has five members. Beer notes that "one third of the Infoset has direct responsibility in topic formulation and development for any two topics", which he calls "a high Centrality ratio, whilst not being stressful for the member concerned" (BD 1994: 15). Critics are assigned between teams as well. In the Syntegrity diagram of ch. 2 of BD, "Each team appoints one member as a critic of another team" (BD 1994: 29). In chapter 1 of BD the critic is appointed "to the next-but-one neighbour team", with the consequence "that not only is s/he a *member* of two teams, but also a *critic* of two near-neighbour teams. There are now 120 roles being played out in the Infoset" (BD 1994: 16). Later chapters revise the allocation of critic roles (e.g. for the tetrahedral variant, BD 1994: 74; for the icosahedron, BD 1994: 125–129). In the tetrahedral case, with only six players, "each player is a critic of the two topic groups of which s/he is not a member" (BD 1994: 74), which Beer finds has "a certain incestuous quality about it" (ibid.). For the icosahedron, chapter 8 of BD adds two exclusion rules. The Freesman Exclusion reads: "A person may choose to play a critic role in only one of a pair of teams that are themselves polar opposites" (BD 1994: 125). The Adjacency Exclusion rules out criticizing a team that shares a member with the person's other team (BD 1994: 126–127). Together they leave nothing to choose: "Now it is clear that the critical roles are fully determined by the dual team membership" (BD 1994: 129).
- **Polar opposites.** Pairs of vertices that are furthest apart (BD 1994: 16, 29). The icosahedron has six axes, "which can be made to spin serenely between each pair of poles" (BD 1994: 16). The twelve topics therefore form six pairs of opposites, and that pairing becomes the basis of the Hexadic Reduction in the revised protocol (see chapter 22).
- **Tension.** Beyond the 30 edges there are internal relations: from each vertex five vertices "that are neither neighbours nor polar opposites. That makes 60 internal *tensile* relationships, represented by 30 internal struts" (BD 1994: 16). Beer asks what these struts could represent in human terms, and answers that the teams at the vertices provide compression and the critics provide tension. When each team appoints critics to next-but-one neighbours, "the whole icosahedral space is interlaced with tensile componentry" (ibid.). The critic role is thus the social counterpart of the struts. It holds the structure together by pulling across it; nothing is added as a

further layer above.

- **Limited variety.** A group of 30 has 870 directional relationships, Beer notes, and "An Infoset meeting that tried to accommodate this number of direct personal interactions would take forever. But if each person has only four roles, we reduce proliferating variety to 120—and this, it seems, can be handled" (BD 1994: 17). In the terms of chapter 2 of this book, the geometry works as a variety attenuator that everyone shares equally.
- **No marginalisation.** Beer applies the Bavelas measures from his early work (see chapter 20). A player who is a member of two teams and a critic of two others "may contact 20 people (including his *nodal* self) in ONE step", while the ten members of the two polar-opposite teams are reached in three steps (BD 1994: 17). Since every player is in the same position, all centralities are equal: "Peripherality is 30 – 30 = zero. This is exactly what our presuppositions about democracy and symmetry led us to expect from adopting such a model as this: zero marginalization of any one person" (BD 1994: 17). A friend, Donald Burrill, arrived at different numbers, and Beer notes that the invariant matters more than the count. He quotes Burrill that syntegrity requires identical values for every member, "so that Peripherality for each member is identically zero whatever the value of Relative Centrality" (ibid.). In one respect this resolves the old Bavelas paradox (chapter 20): symmetry removes peripheral isolation without making anyone central.

21.3 Why this form

Experience with the protocol led Beer to reconsider how teams at opposite poles of the icosahedron should relate. He restates the purpose of the whole design: "To replace hierarchic and authoritarian notions of management with a polyhedral envelope that maintains its equilibrium through the geodesic principles of tensegrity was the very basis for adopting this model" (BD 1994: 114). From this he concludes that "strong internal connexions, pole to pole, were barred. Such arrangements would inevitably lead to centralization (see Chapter One, and compare the Star Net), and destroy the 'holographic' equality of perception and potency at the periphery that was sought" (ibid.). The geometry constrains the design as well as picturing it. A direct channel through the centre would bring back a hub and, with it, hierarchy.

In Part Three (chs. 11–13) Beer examines the mathematics of "icosahedral

space". Much of the formal work is presented by collaborators in Part Five of BD and is not attributed to Beer here; Beer reports its outcome in his own chapters (for the matrix algebra he sends the reader to "Part Five, Surplus One", BD 1994: 222). One result concerns which structures meet the conditions for a "syntegral graph". His conclusion: "The syntegral graph conditions evinced by the icosahedral model are not met by most of the Platonic Solids with which we started in Chapter One. The tetrahedron, octahedron, and dodecahedron are out" (BD 1994: 220). The other result concerns the icosahedron's inner geometry, including its relation to the golden rectangle. He summarizes: the model, first chosen "for its convenience in describing a 'democratic' societary structure, using numbers for infosets and teams that looked appropriate, turns out to be a fundamental structure, with a potency derived from a minimalist logic of relations" (BD 1994: 187).

The sequence matters for reading that sentence. Beer chose the icosahedron first, on grounds of symmetry and practical experience (BD 1994: 14–15). Its mathematical distinction was found afterwards, and Beer himself calls the finding "a surprise" (BD 1994: 187). He does not claim that the mathematics proves the social claims. He claims that the form chosen for democratic reasons turned out to have well-defined formal properties that account for how information spreads in it. Chapter 22 takes up that spreading as reverberation.

21.4 The mathematics of Part Three

Beer's own part of the mathematics fills three chapters: "The Structure of Icosahedral Space" (ch. 11), "The Dynamics of Icosahedral Space" (ch. 12) and "Self-Reference in Icosahedral Space" (ch. 13) (BD 1994: 179). He sets the level himself: "The discussion works at the high-school level of difficulty" (BD 1994: 182). Each chapter adds one layer: a constant, a closed pathway, and a graph with its eigenvalues.

Structure: the golden section. Chapter 11 derives phi from the only proportion that can be written with two terms, $a/b = b/(a + b)$, whose positive solution is 1.618034 (BD 1994: 182–184). It passes through the Fibonacci series to the golden rectangle, which divides into a square and a smaller golden rectangle without end (BD 1994: 184–185). Three equal golden rectangles set orthogonally have twelve corners; joined by thirty edges, they give the icosahedron (BD 1994: 187; the "surprise" of 21.3). In the pentagon under each vertex the diagonal measures phi when the edges

measure one, and that diagonal "is an internal brace—a 'critic' trajectory in the dynamic structure" (BD 1994: 188–190). Of the icosahedron's three lengths (edge, polar axis, brace), the axis has no structural role, so "in a unit icosahedron, the *only* significant measure is phi" (ibid.). Each of the fifteen pairs of parallel edges, with the braces joining their ends, forms a golden rectangle, and the whole space is "an interpenetration of phiness" (BD 1994: 191). The crossing braces enclose a regular dodecahedron at the centre. Beer kept this space free of polar axes because "strength comes from elastic tension, and not from brittle rigidity" (BD 1994: 192); from his meditation practice he calls it the "sacred space" (ibid.). The chapter ends with a practical correction. The "clocks" of BD ch. 2 "are really entailment charts rather than projections" (BD 1994: 193), which is why they served badly for allocating topics. Don Burrill supplied proper projections centred on an edge, a vertex or a face (BD 1994: 193–195).

Dynamics: the enneagram. Chapter 12 asks whether reverberation has a basis in the model itself. Beer thinks "that there is a dynamic implicit in the icosahedral model that pre-exists the hum-and-buzz activity" of the protocol (BD 1994: 197). He stands the model on a vertex, sights along a polar axis and removes three teams: the two at the poles and the one at the vertex it stands on. Nine vertices and 16 of the 30 players remain (BD 1994: 198–199). On these nine points a closed triangle 3–6–9 appears, and a second closed path is traced by the digits of one seventh, 0.142857: "It is only the fraction of sevenths that generates a closed path" (BD 1994: 200). The figure is the enneagram (BD 1994: 202). Joe Truss found it in the model. Because it can be found along any axis, the icosahedron "enfolds *30* three-dimensional, four-planar, enneagrams" (BD 1994: 207). Beer marks the status of the history that follows: "This book is a story and an illumination rather than a text book, and the account of the enneagram that follows is a personal account" (BD 1994: 202). The chapter ends with the hypothesis of an "infosettic" consciousness (BD 1994: 208), taken up in chapter 23 (23.2).

Self-reference: graph and eigenvalues. Chapter 13 starts from closure and recursion. After von Foerster's recursive operators, Beer shows a "recursive square-rooting machine" that takes 93 down to 1.00 and stays there; 1.00 is "the eigenvalue of *the operation of a square root*", and the starting value disappears (BD 1994: 214–216). He then turns to graph theory, following Assad Jalali. A graph that conforms to "the syntegral logic" satisfies $kn = 2e$, $n(n-2) = 4e$ and $n = 2(k+1)$, with k the valency, n the vertices and e the edges (BD 1994: 218–219). "Summing up: the syntegral graph is symmetric, connected, of diameter 3, and exhibits involutive

isomorphism around all six polar axes" (BD 1994: 219). Jalali's list by valency gives the hexagon (k = 2), the cube (k = 3), an unfamiliar figure with twenty edges and ten vertices (k = 4) and the icosahedron (k = 5); the other Platonic solids fail (BD 1994: 220; see 21.3). The octahedron's diameter is two, which makes it "trivial", and Beer connects this with the atypical course of the California experiment (ibid.). Paley graphs continue the series to 90, 182 and 306 members; whether protocols could work at that size "is a matter for conjecture" (BD 1994: 221). Last, the syntegral graph has, besides the eigenvalue 1.00, the eigenvalues plus and minus one over the square root of five. The positive one sets how fast information evens out over the iterations (BD 1994: 222–223). What Beer draws from it for the number of iterations is reported in chapter 22 (22.5).

On my reading, the three chapters carry different weight in Beer's own presentation. The golden-section geometry and the graph conditions are stated as mathematics. The enneagram's history is a personal account, in his words. The group mind is a hypothesis "for which there is so far no scientific support" (BD 1994: 208).

References

- **BD** — Beer, Stafford (1994). *Beyond Dispute: The Invention of Team Syntegrity*. Chichester: John Wiley & Sons.
- **TBYT** — Beer, Stafford (2009). *Think Before You Think: Social Complexity and Knowledge of Knowing*. Edited by David Whittaker. Charlbury: Wavestone Press.

Chapter 22 — Protocol, infoset, reverberation

22.1 The original protocol

"If it sounds restrictive, that is because it must make clear how it needs to work. The Rules of the Game do not inhibit players once they agree to go on to the field" (BD 1994: 21). Beer wrote this in advance of an objection he expected: that a detailed protocol looks like the opposite of freedom. The icosahedron of chapter 21 had placed thirty people on its edges and twelve topics on its vertices, but a structure alone does not make a meeting. Beer's second requirement, from the "perfect democracy" passage, was "a procedural protocol" that is "non-hieratic" (BD 1994: 12; see chapter 20), and BD sets one out in detail.

The first version, from the 1990 experiments, has three parts: "There are three parts to the Protocol: the Problem Jostle, which is the initial phase, the Topic Auction, which allocates roles, and the syntegrity iterations, called the Outcome Resolve, which follow" (BD 1994: 21). In the Problem Jostle the infoset produces its own agenda, the idea whose origins were traced in chapter 20. The Topic Auction distributes the thirty participants over the twelve topics and the critic roles. The Outcome Resolve is the repeated round of team meetings in which the topics are worked out.

Beer states the scale of the undertaking twice. The minimum programme "uses four periods of four hours each, and takes three syntegrity iterations to reach its conclusions, with all players in one location" (BD 1994: 21). The full form is much larger: a "full-scale icosahedral team syntegrity is a big undertaking: it is clear […] that it should last for 5 days, and

ideally it needs four facilitators and four support staff" (BD 1994: 88). His comment: "That adds up to a considerable investment: the benefits are, however, overwhelming" (ibid.). The first figure is a minimum for a condensed meeting; the second is what Beer, after the experiments, regards as the proper scale.

22.2 The revised protocol: episodes

Records, participants' responses and facilitators' advice led Beer to revisit the protocol in Part Two of BD ("Enhancing Procedures", ch. 7). There he introduces a new unit: "the eight episodes of a 'meeting under syntegrity,' or (as it is now called) a SYNTEGRATION" (BD 1994: 111). Named in the text are:

1. **Importance Filter:** collecting Statements of Importance (SIs), in which participants "let their imaginations soar" (BD 1994: 111). Beer explains the name: "The Importance Filter is the device Syntegration uses to capture raw data of high quality. Thus it is intended to filter out only the low-quality material put forward, and tentatively to begin the process of shaping a variety so high as to be inchoate" (BD 1994: 113).
2. **Problem Jostle:** grouping and polishing the SIs into Aggregated Statements of Importance (ASIs), "the output of the Problem Jostle" (BD 1994: 115).
3. **Hexadic Reduction:** reducing the ASIs to six polar axes, i.e. twelve topics, adapted from George Kelly's theory of personal constructs (BD 1994: 115–116).
4. **Topic Auction:** allocating the 30 participants to the teams (BD 1994: ch. 8, from p. 137).

After the Topic Auction come the Outcome Resolve iterations (BD 1994: 21, 32). Beer does not give episodes five to eight headings of the "Episode One" kind, but he states their content: "Nothing more needs to be said at this stage about the fifth to eighth episodes of a Syntegration: these consist of the three episodes that between them constitute the Outcome Resolve, and the Conclusion session" (BD 1994: 144). Episodes five to seven are therefore the three iterations of the Outcome Resolve, and episode eight is the Conclusion session. The same numbering appears in the timetable, which lists "Outcome Resolve, Episodes One and Two" and "Outcome Resolve Episode Three" (BD 1994: 146).

The experiments had shown "two major flaws", Beer explains. The rules

used in the Topic Auction "did not result in an optimal allocation of tasks", and "the origins of the difficulty lay within the Problem Jostle itself—which was supposed to discover the Consolidated Statements of Importance (CSIs) in one fell swoop. That is to say, exactly 12 items had to emerge from the process" (BD 1994: 113). The revision splits that one step into two. First the Problem Jostle produces an open-ended list of ASIs, whose number "is not predictable" (BD 1994: 115). Then the Hexadic Reduction condenses it to twelve topics "in locations of polar opposition—as determined by the insights of the Infoset itself" (ibid.). The six axes and twelve poles of the icosahedron now enter the procedure directly, and the group itself decides which of its concerns stand opposite each other.

22.3 Outcome Resolve

In the Outcome Resolve the structure does its work. Beer describes it first for the minimum programme: "A Total Session, in this case of 4 hours, consists of six 40 minute Meetings on the part of two teams each time" (BD 1994: 32). With two teams meeting at once, ten players and ten critics are occupied, and so "there will always be ten other players 'on the move,' looking at new draft CSIs which they may sign, and noting in particular the activities of their two 'polar opposite' teams" (ibid.). No one is idle, and everyone keeps watch on the opposite pole.

The critics work under a discipline. "The team works for 30 minutes, in which time the critics must be silent. They then have 10 minutes in which to say something helpful and germane" (BD 1994: 32). Each team aims at a one-page draft Final Statement of Importance (FSI) (ibid.). In the revised timetable Beer tightens this further: 25 minutes of work, 10 minutes of critique and 5 minutes to "metabolize this critique within the draft FSI" (BD 1994: 145).

The iterations, Beer insists, must be close together in time. "If the reverberative effect is crucial, then meetings ought not to be spread out in linear fashion like so many episodes of a weekly TV series wherein one cannot remember what is going on. The closure must be evident: a three-dimensional ouroboros (the snake that eats its own tail) in action" (BD 1994: 40). The revised procedure says the same: "The Episodes, as we have come to call them in this chapter, are integral wholes. If an iteration were to be broken in half by a night's sleep, it would lose its dynamics and therefore also its syntegrity" (BD 1994: 145). The ouroboros is the

procedural form of the closure argued for in chapter 20: a night's sleep would cut the snake in half.

22.4 Facilitation

A protocol this detailed needs facilitators, and facilitators can steer. Beer warns against steering: "If facilitation is to be exerted *against* a self-organizing Infoset with open-ended mandate, instead of easing it towards acceptable conclusions, then the facilitators are effectively determining agenda, and the Syntegration is spurious thereafter" (BD 1994: 146). The boundary is sharp. Facilitators serve the protocol and leave the outcome alone. If they decide what the group should conclude, the process loses the property that justified it, namely that the agenda and its categories come from the group itself (chapter 20). Beer makes the same point about the Topic Auction in the original protocol. Organizers "are urged to allow the self-organizing propensities of this whole approach to determine the allocation of roles. If not, they might as well sit in their offices and appoint task forces, inter-departmental committees, and so forth, as they have always done—and with the same turgid results" (BD 1994: 32).

22.5 Reverberation as the mechanism

Why should this procedure produce better results than an ordinary conference? Reporting back to one of the experimental groups, Beer wrote: "There seemed to be a lack of appreciation of two key notions in this approach. Symmetric closure is one; reverberation round the system under repeated iterations is the other" (BD 1994: 45). His answer rests on these two properties.

Part Three gives the argument a more exact form. Starting from any vertex, "After only one iteration, that information is divided between ten of the remaining vertices via members and critics, and something will immediately be known at the polar opposite vertex, because Aggregated Statements of Importance are then published" (BD 1994: 222). Since the structure is symmetric, "the information will be evenly distributed everywhere—precisely by the process that we have been calling reverberation" (ibid.). Beer calls this an ergodic process: over time, and wherever it starts, it tends to the same limiting distribution (ibid.). The matrix algebra behind this is referred to the collaborators' Part Five ("see Part Five,

Surplus One"); otherwise, Beer writes, "take the value on trust" (BD 1994: 222). Beer reports the result.

From it he draws a practical rule: "the scheduling protocol for a syntegration is of vital importance: the capacity of the syntegral graph to resolve the outcome through homogeneous insight must not be compromised by shortages of time or facilitation" (BD 1994: 224). He also asks how many times the snake must go round. His calculation rests on the eigenvalue $1/\sqrt{5}$ raised to the power of the number of iterations, which falls from 0.45 after the first iteration to 0.20 after the second (BD 1994: 223; Figure 13.1 there marks 55, 80 and 90 % for one, two and three iterations). In his words, "One episode has only 55% resolving power; two episodes takes us to 80% of the ideal, which is not too bad. With three episodes, the Outcome Resolve is 90% effective" (BD 1994: 224). He adds a reason that lies outside the mathematics: "There is no allowance within the equations for sheer empathy among participants" (ibid.). The experiments suggested "that syntegration is more efficient than the model predicts. Three iterations are enough" (ibid.). The number three thus appears twice, in the first minimum programme (BD 1994: 21) and in the later calculation, which arrives where the earlier practical choice had already stood.

22.6 Beyond one group: hyperinfosets

A single syntegration involves thirty people. The large-scale experiment planned for the World Service Authority (see below) concerned much larger numbers, and for such scales Beer proposes linking infosets. When local groups with a shared purpose recognize each other, he calls the collective "a hyperset of neighbourhood infosets, or simply a hyperinfoset", whose architecture "is obviously based on a syntegral hypericosahedron" (BD 1994: 173). The rule is recursive: thirty infosets send one member each, and that member is again an edge in a new icosahedron. Each member brings two of the propositions produced by the primary infoset, so the hyperinfoset "begins operations, then, with 60 SIs" (BD 1994: 174). Beer calls this "a second level of recursive embedment" (BD 1994: 173), a term that connects directly with the VSM's principle of recursion (see chapters 6 and 23).

He rules out reading this as a hierarchy: "The purpose of forming hyperinfosets is not to create a hierarchy of warriors or of logical propositions that have advanced status because they have 'risen to higher levels.' It is to make consolidated statements available that have been worked over

by 900 people, 27 000 people, and so on" (BD 1994: 174). The higher level adds breadth of participation. It does not add authority. A large-scale experiment on this basis was planned for 1993 for the World Service Authority (BD 1994: 175), including "a syntegration manual that could be used by a highly motivated organizer to run a 3-day version of the technique, without prior knowledge, and without professional facilitators" (ibid.). Beer reports that the results were then "being evaluated by the World Service Authority" (BD 1994: 176). BD does not report the outcome.

22.7 The Topic Auction

The Topic Auction, episode four of the revised protocol (22.2), gave facilitators more trouble than any other step, and BD ch. 8, "Vexed Questions of Allocation", is given over to it. Beer starts from a failure. In the experiments people chose a first team colour and then, once that was settled, a second. This "was unsatisfactory for most people"; since an edge means membership of two teams, "the 30 options should be considered (for the majority) as colour pairs" (BD 1994: 126).

The critic roles then follow from the pair. Chapter 21 (21.2) states the Freesman and Adjacency Exclusions (BD 1994: 125–129); Beer's worked example shows them at work. The Green team's critical options are Dark Blue, Purple, Red, Black and Orange. For the person Green–Gold, Dark Blue is barred because it is the pole opposite Gold (Freesman Exclusion). Orange and Red are barred because each already shares a member with Green–Gold's other team, Gold, through Gold–Orange and Gold–Red (Adjacency Exclusion). So "the critical roles of Green–Gold are fully determined as Purple and Black" (BD 1994: 127). The same result follows from the Gold side (BD 1994: 128–129; Tables 8.1 and 8.2). Beer adds a piece of history. His first published rules (written in 1984, published in 1990; BD 1994: 127), with their "handedness" and the return of a critic to the other hand, already implied the Adjacency Exclusion. The insight was lost in the decade before the experiments, which produced scrambles for roles and "anomalous appointments to critical duties". "And no-one involved perceived what was wrong!" (BD 1994: 127–128). For the auction this means: "What is on offer, 30 times over, is a discrete entity: it is a quadripartite indivisible role" (BD 1994: 129), two memberships and two critic roles bought together.

A second constraint concerns who meets whom. Jo Hancock's simulation

of the meeting schedule showed that any player meets four people three times, eight twice, eight once and nine never; five of the nine can still be met in other sessions (BD 1994: 130–131). Joe Truss found that one person is "totally inaccessible": the player "who holds the edge role that is parallel to a given role, on the other side of the icosahedron", which Truss called the "polar edge" (BD 1994: 131). Table 8.4 lists the fifteen pairs under the heading "POLAR EDGES EXCLUSION"; for Silver–Green the polar edge is Yellow–Purple (BD 1994: 136). The remedy is informal. Each person should arrange a private meeting with the opposite polar edge, and this is explained at the auction (BD 1994: 131, 137).

The auction itself uses two documents (BD 1994: 137–141). The Topic Auction Data Sheet lists, for each of the twelve topics, its five member pairs and the two critic roles each pair entails (Table 8.5, BD 1994: 138–139). Participants are reminded that the pole opposite their own topic "is the topic of their antithetic management" (BD 1994: 137). The questionnaire "Topic Auction of Thirty Quadripartite Lots" asks for up to seven colour pairs in order of preference. Under "PRICING OF BIDS" each colour is ringed from 1 to 7 "to denote degree of enthusiasm to discuss"; anyone who initiated or strongly influenced a topic rings the number twice; topics to avoid are marked M, C or MC, for member, critic or both (BD 1994: 140). Beer frames the form with an ideal. In a "perfect" Infoset "all the questionnaires would be returned blank, and the roles allocated at random" (ibid.). In practice the room is set out as a clock of twelve stations. Holders of a double-ringed 7 go first, then the facilitator works down the price list, and people may change their minds as they watch teams form. Each person allocated receives a badge with two member colours and two critic colours. Facilitators must not force the issue. If the process stalls, they allocate the remaining places from the forms, and "We are left with something akin to a preferential voting system" (BD 1994: 141). Where someone is likely to be disgruntled, a facilitator explains why the decision ought to be acceptable: "This is frankly a sales pitch" (ibid.).

Beer treats allocation as an open research problem. Hancock's algorithm doubled mean satisfaction with the auction compared with a use of Kelly's approach, yet only up to the median of the scale. David Sutton's spreadsheet heuristic reached a fit of 71% against 48% for Hancock's algorithm, and Alan Pearson argues that assigning topics to vertices matters more than the auction (BD 1994: 142). Beer's verdict on the state of the art: "Meanwhile, it is still perfectly possible to run syntegrations!" (BD 1994: 143).

References

- **BD** — Beer, Stafford (1994). *Beyond Dispute: The Invention of Team Syntegrity*. Chichester: John Wiley & Sons.

Chapter 23 — Syntegrity and the VSM

23.1 Syntegrity as a tool for System Four and the Three–Four homeostat

Besides the common origin traced in chapter 20, *Beyond Dispute* relates Team Syntegrity to the VSM explicitly in two places. BD ch. 9 is practical and concerns developmental planning in the enterprise. BD ch. 14 is theoretical and concerns recursion (see 23.2).

Chapter 9 opens with a brief account of the five subsystems for readers who do not know the model, and it is through developmental planning that Beer places syntegration in the VSM. One sentence in that account is central for what follows: System Five "determines purposes for the enterprise, and in so doing cultivates its ethos" (BD 1994: 149). Beer adds that System Five is more than a label for top management: "recognizable bosses do not exhaust the role. All stakeholders are represented in System Five" (ibid.).

From there Beer moves to what he treats as the typical weakness of enterprises, the relationship between System Three and System Four, and he presents it as a common diagnosis. The people of System Three, responsible for running current operations, see those of System Four (planners, market researchers, R&D) as "organizational luxuries who frivol away the money that they, in System Three, are labouring to make", while System Four sees itself as custodian of the company's future (BD 1994: 149). Both functions are indispensable, and yet, Beer writes, "there is a total lack of synergy between the two vital forces" (BD 1994: 150). The VSM diagram marks this relationship with heavy arrows: "The heavy arrows

are saying: Systems Four and Three must massively interact; the main job of System Five (any included bosses notwithstanding) is to see that this interaction happens—all the time" (BD 1994: 150). He names this the "Three–Four homeostat: its function is to maintain a balance between investment for the future and the maintenance required to keep the business going" (ibid.). Chapter 11 of this book described the same homeostat; here Beer restates it in BD's own terms.

The consequence for planning follows. Developmental planning "cannot be isolated in System Four, although the VSM proposes that System Four be the concept of its focus" (BD 1994: 151). Planning is a process that "permeates the enterprise" (ibid.), and no single department produces it. This matches the view of planning as a continuous process set out in chapter 19.

Only after this groundwork does Beer bring in syntegration, and he warns against treating it as one more planning technique. It is "all too easy to say that this is a technique that is clearly relevant to planning. After which it is even easier to say that we cannot commit 30 people for 5 days to this nice idea" (BD 1994: 157). The concept of the infoset joins the two lines of thought. In the section "The Redundancy of Potential Command" Beer argues from the brain, drawing on McCulloch, that command "is not prefigured, but is potential in any concatenation that shares the needful information. Well, this defines none other than an information set, an infoset" (BD 1994: 158). In enterprises, too, "Potential command will be seized and made actual by fluid infosets of people who have the shared purpose and the shared information appropriate to the decisions involved" (ibid.).

His proposal puts the parts together: "if, as has been argued, the primary problem is the proper functioning of the Three–Four homeostat, then that would be a good place to start. We need to metabolize the creative and the synergetic resources of the enterprise. The directive management team of an enterprise is perhaps the most virile example of an infoset with which society is familiar" (BD 1994: 159). His example is a group of thirty such people meeting for five days under the Team Syntegrity protocol (BD 1994: 159–160). He also considers a variant in which any self-organizing group of thirty staff could apply for a week to hold a syntegration and report twelve findings to management. Such a scheme "should not be attempted unless the management makes an undertaking to respond in some way that is not merely cosmetic" (BD 1994: 161). The comparison he draws is with the suggestion box: "Voluntary syntegration raises the

possible benefit by orders of magnitude" (ibid.).

Read this way, syntegration is a procedure for making the Three–Four homeostat work, and it replaces no VSM subsystem. It gives the heavy arrows something to carry: it brings the people responsible for the inside-and-now and the outside-and-then (see chapters 9 and 10) into sustained interaction that is not ranked. The icosahedron's "no top, no bottom" (chapter 21) matches the requirement that the homeostat be a balance and not a chain of command.

An earlier application shows a second, smaller link. In the Hureston group, which had already used the VSM in a reorganization, Beer and the participants spent two days "discussing the relevance of the syntegrity model in the context of the VSM" (BD 1994: 76). They came away uncertain about the model's status: "we did not know whether syntegrity should be used structurally, as it had been misapprehended, or procedurally, as it had been intended" (ibid.). Beer's intention was a procedure; an organization chart was the misreading. One structural variant was nevertheless discussed. Each participant would belong to one wealth-producing project team and one quality-assurance team, which, Beer says, anyone familiar with the VSM "may think of […] as creating a characteristic repetitive loop: Three–One–Three Star–Three" (BD 1994: 77). Beer adds: "The meeting found the suggestion interesting, but it has not been tried" (ibid.). The loop is thus a suggestion from one meeting, not an established use of syntegrity within the VSM.

23.2 Recursion and consciousness

BD's last chapter, ch. 14, "The Concept of Recursive Consciousness", stands in Part Four ("Epilogue"), and it links the syntegrity model back to the VSM through recursion: "As embodied in the Viable System Model, the principle of recursion asserts that all viable systems contain, and are contained in, viable systems. This is by no means loosely expressed: it is rigorously determined by the Law of Cohesion in VSM theory" (BD 1994: 229). The formulation repeats the one discussed in chapters 6 and 13 of this book, joined here to Beer's image of Russian dolls. Embedment does not mean hierarchy in the sense of command: "they do not necessarily imply hierarchical dependence in the command–obedience sense, nor compromise the integrity of the included identity" (ibid.).

Beer draws the key distinction with care. On one side stands "sacerdotal" hierarchy: "Hierarchy means government by priests: it is a central fact

of sacerdotal organization that every level of authority commands all of the levels lower down" (BD 1994: 241). His examples are pope and parishioner, general and enlisted soldier. On the other side stands embedment with autonomy: "hierarchies do not have to be based on the sacerdotal model, but may involve autonomous embedments" (BD 1994: 242). He places the VSM firmly on the second side: "According to the Viable System Model, which is also organized as a set of embedments, social systems should not be conceived of hierarchically either" (BD 1994: 241). The passage completes the "non-hieratic" demand of chapter 20 and supplies the conceptual ground for Beer's earlier statement that the VSM is circular rather than hierarchical (BD 1994: 7, 148). The heavy arrows of the Three–Four homeostat run between embedded systems, with no priest at either end. The hyperinfoset of chapter 22 is built on the same principle: a "second level of recursive embedment" (BD 1994: 173) that adds breadth, not authority.

On this basis Beer develops a theory of "recursive consciousness" with eight "embedments", from the neuron to "consciousness at the level of global governance" (BD 1994: 244–250). The first embedment is the neuron, "as modelled here by the algedonode" (BD 1994: 244). The fifth is the group mind of the neighbourhood infoset, which Beer puts forward "simply because the neighbourhood infoset displays the usual tokens of consciousness" (BD 1994: 248). The sixth is the hyperset and the seventh the "technospheric infoset" (BD 1994: 249). Of the eighth he writes that "the brain-like capacities which would make the eighth embedment comparable to the fourth embedment in the individual are therefore missing. We are stuck with the woeful inadequacy of the United Nations" (BD 1994: 250).

The starting definition is: "awareness is best described as self-awareness; that consciousness is a reflection of its own activity" (BD 1994: 213). Beer proposes the hypothesis of an "infosettic consciousness" of a syntegrating group and notes that it is "at least in principle, falsifiable" (BD 1994: 208). The same passage states the limits of the claim: "If it exists it should make the infoset more competent than its component member consciousness, or even the group consciousness defined. Experiments have yet to be designed, and will be difficult to conduct; all there is so far is empirically based suspicion which suggests the formulation of an hypothesis for which there is so far no scientific support" (BD 1994: 208). Beer also marks the change of register himself when he moves from Part Three to the Epilogue: "The ideas advanced in Part Three tentatively, out of scientific rectitude, are embraced freely in this essay" (BD 1994: 248).

Note: In this chapter Beer also draws on his own yogic experience ("as I attest from yogic experience myself", BD 1994: 247). The chapter is reported here, not evaluated.

BD thus connects syntegrity and the VSM at two levels. At the practical level, syntegration is a procedure for the Three–Four homeostat and for developmental planning, and Beer argues for it with managerial reasons. At the speculative level, the infoset and its recursions are placed in a series of embedments that runs from the neuron to global governance. The VSM's principle of recursion is the thread through both, and Beer himself labels the second level an essay in which ideas are "embraced freely" (BD 1994: 248).

23.3 Governance or government

BD ch. 10, "Governance or Government?", closes Part Two. It does not mention the VSM. It belongs here because it states the political purpose for which the 1990 experiments were designed, gives Beer's sense of "governance", and contains, as a political proposal, the recursion of infosets to which 23.2 refers.

Beer opens with planetary threat, nuclear and ecological, and concludes that world governance "will be high on humanity's agenda from now on. The trouble will predictably be that no-one knows *how* to achieve it" (BD 1994: 163). The League of Nations and the United Nations "both failed dismally to do anything at all about world *governance*" (ibid.). The briefings for three of the five 1990 experiments gave three reasons: One World organizations are built from power blocs of nation states; some nations are " 'more equal than others' "; and resolutions must "climb up hierarchical ladders" within each state before they reach global negotiation (ibid.).

The title names the distinction: "governance is a concept that admits of many possible interpretations and instrumentalities, whereas a government is an entity, and one would expect it to have juridical status" (BD 1994: 164). The occasion is Garry Davis, the self-proclaimed World Citizen, who heads a World Government and had asked Beer to work on his concepts (BD 1994: 164–165). Beer is "cautious of any *entity* called world government" (BD 1994: 165). If governance could be achieved only by "law and order", no-one would remain outside that government to question its laws. "Fortunately to a cybernetician, governance is a quality of self-organizing systems, and is not an imposition from outside" (ibid.). He adds that the book "is not a political philosophy" (ibid.).

Davis wanted a protocol for a World Convention and saw it, at least at first, as a meeting. Beer "saw it instead as a *process*, a continuum of activity, in which *anyone* could take part" (ibid.). The briefing he wrote for the organizing committee "evolved into the 1990 Syntegrity experiments" (ibid.). It argues in a SINCE–THEN form: since the individual is a child of the cosmos and an inhabitant of this planet, a World Convention cannot acknowledge a nation-state format, cannot deal in any hierarchical formulation of the human condition, and cannot accept delegations of negotiators. "In a word, the World Convention could not 'happen'—it could only 'be.' " (BD 1994: 166).

Two further steps lead to the protocol. Cultural diversity, in Harlan Cleveland's account, "does not refer to a bunch of nation-states. It refers to a bunch of Infosets" (BD 1994: 167). The usual list of world problems (health, shelter, food, education and so on) is a taxonomy made by academia and power brokers, whereas the World Citizen lives these conditions as one integrated person (BD 1994: 168). The Problem Jostle is therefore asked to isolate twelve issues crucial to survival while avoiding existing taxonomies (BD 1994: 170). Beer defines the unit: "An Infoset is an information set of people who are focused on a common interest, however it is defined" (ibid.).

Under the heading "Structure as Process" Beer contrasts architecture, in which relations are fixed in stone, with architectonics, the principles that underlie building (BD 1994: 171–172). "The principles that underlie the practice of management are cybernetic principles", and "the appropriate cybernetic architectonic for the global problem discussed is the syntegral icosahedron" (BD 1994: 172). He limits the claim at once: syntegration has been shown to work "only in face-to-face situations" (ibid.). The political unit is the neighbourhood infoset of thirty, justified by the redundancy of potential command from BD ch. 9 (BD 1994: 172–173; see 23.1). Linked neighbourhood infosets form the hyperinfoset, "a second level of recursive embedment" (BD 1994: 173; see 22.6). Electronic infosets pose no technical problem, Beer thinks, but the human side of syntegration without physical presence has not been researched (BD 1994: 175).

The chapter ends on its title question. The people who could form infosets do not seek world government, "with all its overtones of duress and exploitation at the worst—or of patriarchy and submission at the best" (BD 1994: 176). "What is sought is not an architecture for world government, but the architectonics of world governance. And governance in its multifarious forms is the ultimate topic of this book" (BD 1994: 177).

On my reading, the chapter connects with the VSM through two ideas Beer states elsewhere, not through anything he says here: governance as a property of a self-organizing system, and recursion. Chapter 10 itself names neither the VSM nor its subsystems.

References

- **BD** — Beer, Stafford (1994). *Beyond Dispute: The Invention of Team Syntegrity*. Chichester: John Wiley & Sons.

Part V — Method and epistemology

- Chapter 24 — Operational research, models and homomorphism (*Decision and Control*)
- Chapter 25 — Systems as an act of recognition: observer, variety, control
- Chapter 26 — Knowledge of knowing: the essays in *Think Before You Think*
- Chapter 27 — *Management Science* (1967): models, control and the viable governor

Chapter 24 — Operational research, models and homomorphism (*Decision and Control*)

In chapter 7 of *Decision and Control* (1966) Beer reports an electroencephalogram of an industrial company, worked out by hand. The experiment only makes sense against the theory of the model that he builds in chapter 6 ("About Models") and chapter 7 ("Models in Aspic"). *Decision and Control* is Beer's account of what operational research (OR) is and why it works, and much of this long book deals with techniques and cases. The theory of the model is the strand his later work rests on. When Beer insists in *Brain of the Firm* that the comparison between the firm and the nervous system is not an analogy (see chapter 4.1), he is relying on the argument reconstructed here.

24.1 Everyone has models

Chapter 6 opens with a quotation from the Persian physician Rhazes, and Beer paraphrases his point: "before we do something, we contemplate doing it" (DC 1966: 100). He starts, then, from an ordinary faculty of the human mind, the ability to anticipate, and leaves science for later. Rational conduct therefore depends "not only upon knowing what is really happening and being able to interpret it, but on having present in our minds a *representation* of what is going to happen next" (DC 1966: 100). This representation, Beer adds, "is not an account of what *is* the case, but

a continuous prognosis of what is about to be reported to us as being the case. It is a prognosis continuously corrected by feedback" (ibid.).

From this he takes his definition: "Let us call this mental representation of the world that is not direct perception of the world a *model* of the world" (DC 1966: 100). He then separates the model from two neighboring concepts. It is not a hypothesis, because "the model does not postulate the causal mechanisms that underlie events"; nor is it a theory, because "it has no explanatory content" (DC 1966: 101). What remains is this: "A model is simply a reflection of whatever is the case, which is explicitly made available for experimentation" (DC 1966: 101). The possibility of experiment separates a model from perception. A healthy person, Beer writes, distinguishes between his sensations of reality, "with which he must not tinker", and the " 'spare copy' " of the perceptual pattern which he takes off for experiment (ibid.).

Science continues the same activity. "Now science is a carefully thought out, professional, version of this rigorously rational behaviour" (DC 1966: 101). The scientist differs from the ordinary citizen only in being "*professional* about its use. He is self-conscious about the model he uses" (ibid.). Beer is open that this is his own position: "this account of scientific methodology is my own, and must not be taken to be an agreed account of the matter" (DC 1966: 102).

The same passage takes a position on mathematics. In Beer's usage "a mathematical model is an algebraic statement of the representation already discussed" (DC 1966: 102). He rejects the narrow sense of "mathematical model" as "simply an equation purporting to relate one set of variables […] with another set", calling it "the very much debased sense in which the term 'mathematical model' seems often to be used" (DC 1966: 102). An equation linking a few variables is, on this view, not yet a model. A model represents the situation as a whole, and mathematics is one language in which that representation can be written down.

Beer then asks how the manager and the scientist handle their models. The manager compares his present model with remembered models of similar situations; this is "a way of saying formally that 'he brings his experience to bear' " (DC 1966: 102). The OR scientist cannot do this, because "he has by definition *no* historical models of the situation" (DC 1966: 103). He brings models from his own science instead. A thermodynamicist brings a model of systems characterized by changes in entropy. A neurophysiologist brings a model of the nervous system, and "there

are obvious resemblances between the controls used in an enterprise and those used in the human body. For example: both are hierarchical, both are redundant and both incorporate sub-systems of greater and lesser autonomy" (DC 1966: 104–105). No such transfer is ever wholly useless: "In the last resort, *any* physical system resembles any other to the extent that each endures" (DC 1966: 105). Here Beer finds his formal reason for the interdisciplinary OR team. Each scientist sheds light from a different direction, and Beer compares the whole process "by a simile, with the process of triangulation in a survey of terrain" (DC 1966: 105).

24.2 Mapping, isomorphism, homomorphism

The neurophysiologist's resemblances expose a weakness, and Beer names it himself. As described so far, the method "seems to depend on the examination of similes, which is well known to be dangerous and highly suspect" (DC 1966: 105). To say that a company's control system is "like" the central nervous system is, "At the worst, […] a glib literary metaphor" (ibid.). If nothing better can be done, he concedes, "the developing methodology is futile" (DC 1966: 106).

The remedy is a vocabulary taken from three branches of mathematics: "group theory, set theory and algebraic topology" (DC 1966: 106). Beer builds it up from the idea of a set, "no more than a properly specified collection of items, called *elements* of the set" (DC 1966: 106), and from partitions of sets, which he illustrates with the organization chart (DC 1966: 106–107). To make "correspondence" between models precise, he then introduces three terms (DC 1966: 107–108):

- **Mapping:** a correspondence in which each element of one set has an "image" in another (DC 1966: 107).
- **Isomorphism:** a mapping that "not only involves a one-one correspondence of elements, but which also preserves operational characteristics"; "isomorph means 'having the same form' " (DC 1966: 108).
- **Homomorphism:** a many-one mapping that is not isomorphic, but "the transformation can be arranged so that certain operational characteristics concerning the relationship of elements are preserved. When this is done, the result is a *homomorphism*" (DC 1966: 108).

Beer's examples show what is at stake. Two engines from the same assembly line map on to each other element for element and function for function: "if the first engine works, so will the second" (DC 1966: 108).

That is isomorphism. For homomorphism he uses arithmetic to the base five. The infinite set of natural numbers is mapped many-one on to the five digits 0–4, and the test is whether addition still gives consistent results after the transformation: adding 11 and 19 and then transforming the result must give the same answer as transforming 11 and 19 first and then adding them under the new rule (DC 1966: 109–110). Information is lost, since many numbers share one image, but a structure (here, addition) is preserved. Everything that follows depends on this combination of a mapping that loses detail with a structure that is kept.

24.3 The scientific model

Manager and scientist each have a conceptual model of their situation, and with the new terms Beer can say what OR does with the two. Compared directly, they yield at first an analogy, whose validity "must always be open to disputation" (DC 1966: 112). Beer distinguishes three levels at which such a comparison can be made. The first is metaphor, which "is a poetic device, and its validity is aesthetic; it can offer science no more help than its verbal facility" (DC 1966: 111–112). The second is analogy, whose validity is logical, but "the validity of a particular analogy must always be open to disputation, and its relevance in a particular instance cannot be formally demonstrated in a conclusive way" (DC 1966: 112). The third is identity; but between two things that are not in fact one and the same, identity has "a mystical validity" (ibid.). In practice, Beer notes, the scientist mixes all three, and the process is "self-defeating" (ibid.). In more modern terms, he is "attempting to establish a mapping between the two conceptual models, under some transformation which he would like to be isomorphic" (ibid.).

Beer's way out has two stages. The conceptual models are "literary things", and the scientist first translates each of them into "the languages of mathematics, statistics and logic" (DC 1966: 112). The translation has a price: "some of the conceptual richness must inevitably be lost" (ibid.). The transformations from contents of mind to formal propositions are many-one, and Beer glosses this: "This is what a loss of richness means". If the result is to represent its source it "should be homomorphic, too" (DC 1966: 113). The scientist therefore maps both conceptual models homomorphically into a formal language, and the two resulting models "*may well be isomorphic with each other*" (DC 1966: 113). "So he has achieved an identity between the managerial and the scientific situations which is shorn of mysticism and of poetry, and which is completely free

of the bedevilling disputation that attends analogy" (ibid.).

Then comes the definition: "A scientific model is a homomorphism on to which two different situations are mapped, and which actually defines the extent to which they are structurally identical" (DC 1966: 113). What is left out can damage usefulness but never validity: "If the transformation has ignored as irrelevant elements which are in fact relevant, then the model will lose in utility, but it *cannot* lose in validity" (ibid.). Utility is tested by prediction (ibid.). If the predictive value is low, "we had better start again"; if it is high, the model can be used "without further worry as to the appropriateness or otherwise of the analogy drawn at the conceptual level" (DC 1966: 113).

The definition has a critical edge. University teaching in OR, Beer observes, concentrates on mathematical techniques and treats modeling as the direct algebraic formulation of relationships believed to exist in the managerial situation. The scientific half of the procedure is ignored and the mappings are not studied. "Such activity should be referred to as applied mathematics, and not as operational research" (DC 1966: 114). He had made the same objection to the "debased" sense of "mathematical model" (section 24.1).

Beer's later insistence that the VSM is not an analogy (chapter 4.1) rests on this procedure. The brain–firm comparison is meant as a homomorphic mapping of structure. MS restates the argument for a general readership (MS 1967: 63–69; see chapter 27.3). The claim needs to be read precisely. Beer does not say that the firm *is* a brain. He says that there is a formal structure onto which both can be mapped, and that the structural identity extends exactly as far as that shared model. Anything outside it is simply not claimed.

24.4 The neurophysiological model of a company (1960s)

The electroencephalogram belongs to the case studies of DC's chapter 7, where the precursor of the VSM already appears. The company concerned was in unusual difficulty: production needed long, planned runs, while demand "proved impossible to forecast"; raw materials were scarce and labor relations tense (DC 1966: 134–135). Beer calls the approach chosen ecological: "The company is an organism which must adapt to its environment" (DC 1966: 135). Among possible organisms, only those

with highly developed nervous systems seemed able to cope with such an environment, and "If the entire management process of the company under discussion is conceived of as a brain-like activity, the possibility of a successful outcome is assured" (DC 1966: 135).

For an industrial company, "The conceptual model of this situation is inevitably taken from the science of neurophysiology" (DC 1966: 136). Beer anticipates objections from brain scientists and does not wave them away. Those who took part, "and certainly myself", were "neither underrating the task, nor laying an overweening claim to a knowledge they do not possess" (DC 1966: 136). The method protects the attempt: "The object is to construct a homomorphic mapping of the brain which is by definition a simplification", and, "by definition again, a simplification of which the limitations are understood" (ibid.). The danger lies elsewhere: "The really pejorative term here would be over-simplification; but that stage is not reached so long as a certain structure is preserved in the homomorph, and so long as we know exactly what that structure is" (ibid.).

The formal language was set theory, and the submodels were "homomorphic models, worked out in set theory, of the sensory cortex, the motor cortex, the thalamic level and the reticular formation" (DC 1966: 137). Beer gives no mathematical detail, since "the mathematics is extremely involved" (ibid.). He does describe the experiment, which he calls "surely the first attempt to record the brain rhythms of an industrial company" (ibid.). An electroencephalogram is a many-one transformation of neural activity, and "Yet what is inscribed is a homomorphic record" (ibid.). The pens preserve structure, such as the difference between sleep and waking, while discarding everything about individual neurons, just as base-five arithmetic keeps addition and drops the numbers. "Successful management decisions were taken using this model of the company's 'brain' " (DC 1966: 138).

Accounting offers the comparison. A financial expert also reads rhythms, from balance sheets and profit-and-loss accounts, but these are not generated by truly homomorphic mappings: "the attempt to map every feature of the business on to a unidimensional monetary scale does not succeed, and this is why wrong decisions are sometimes taken" (DC 1966: 139). The brain model, by contrast, has at least the right order of complexity (ibid.). Beer is careful about the status of what was done. The "electroencephalogram" of ten areas of company activity was "all worked out by hand"; "In short, it was an experiment" (ibid.). MS gives a non-technical version of the related reliability argument for redundant decision struc-

tures (MS 1967: 99–100; see chapter 27.4).

24.5 Models, laws and conventions

In chapter 7 ("Models in Aspic") Beer carries the argument over to natural laws. Language is a mapping of the world, but "in practice, the mapping will be *homomorphic*", able to preserve some structure "but committed to losing some information"; our account of nature is therefore "'true', but defective" (DC 1966: 121). From this he draws a strong conclusion: "a law of nature is derived from what is no more than a model of such general utility that it is never even recognized as such" (DC 1966: 121). Conversely, "What we usually call a natural law is a statement about a particular model of the universe; what we here call a model of a problem situation entails its own localized natural laws" (ibid.). OR, on this view, does nothing peculiar. Its inductions are no harder to justify than those of any other science; "they simply make a more agile use of models than is customarily necessary in science" (DC 1966: 122).

What counts as a valid model rests on "social conventions" (DC 1966: 122). Models can therefore harden and block discovery. "Progress in science might well be defined as the overthrow of a model, and its appurtenances, that has exhausted its usefulness" (ibid.). "The great scientist is one who sees the need and the moment to destroy a model", and Beer adds: "Perhaps the same is true of the businessman and his business" (ibid.). Science, however, has protections that management lacks. It is founded on observation and experiment, it intends to expose a reality beyond its own desires, and it knows that it deals in models (DC 1966: 122–123). Management has none of these: "Management is *not* founded on observation and experiment, but on a drive towards a set of outcomes" (DC 1966: 123), and it "is *not* normally aware of the conventional nature of its intellectual processes and control procedures" (ibid.).

The enterprise is therefore "accustomed to confuse […] its models of reality with reality itself" (DC 1966: 123). Yet it cannot do without models: "management operates *through a model* of the business, a model in which the organizational structure, the structure of costs and prices, the structure of labour relationships, the structure of production itself, are all homomorphic mappings of the real thing" (ibid.). No manager can handle a complete isomorph of his enterprise "unless he is the only employee"; he "can at best settle for a homomorph" (DC 1966: 124). Delegation is itself a mapping: "To delegate is to embark on a series of one-many trans-

formations" (ibid.).

The chapter closes on what the method is for. The systems of management "are not susceptible to total dissection, total analysis, total measurement" (DC 1966: 125), but their mechanisms can still be found. "The process of homomorphic modelling is at the least a heuristic method for inferring the existence and structure of systems of which the complexity defeats isomorphic modelling" (DC 1966: 125). Beer's first example is historical: Henry Cavendish's wooden model of the torpedo fish, published in 1776, of which Beer says "it might be fair to call what he did operational research" (DC 1966: 125–126). The company's electroencephalogram stands in the same line, a homomorphic record of a system too complex to be mapped whole.

Three results carry forward. A model is judged by utility and prediction. A homomorphism is a deliberate loss of information that keeps a specified structure. And what counts as a system, and which model is valid, involves the observer and the conventions he works within. Chapter 25 takes up the third result in DC's own treatment of systems and variety.

24.6 The formal languages

Chapter 8 of DC ("The Formal Languages") turns from the model to the languages in which it is made rigorous: mathematics, statistics and logic. Beer does not teach the techniques; his object is "to explain the meaning of these techniques" (DC 1966: 142). His first point ranks them below the model. A formal language "is a *deductive machine*: it investigates itself, rather than the sensual world", and its manipulations must be "properly embedded in its surrounding model" (DC 1966: 143). "Hence models take pride of place over the formal languages used to make them rigorous. For a good homomorphic model that is less than rigorously expressed may be very useful; but a rigorous demonstration that derives from a poor model, improperly mapped from the problem situation, is highly dangerous and may be irrelevant" (ibid.).

Mathematics earns its place because a pattern of decision can recur even when no single decision does. Equations can "adequately (by which is meant nothing more nor less than homomorphically) represent a wide variety of managerial situations" (DC 1966: 144). Beer's example is linear programming for a production shop (DC 1966: 144–149), and he then turns the example against the technique. Its conceptual model is thin: "In our nomenclature, the mapping from real life is not strongly

homomorphic" (DC 1966: 150). In one case the computed optimal mix of products could not be sold in exactly those proportions, and nobody had examined the stockholding that would have uncoupled production from the market (DC 1966: 150–151). Beer's verdict: "it was defective operational research. And the trouble lay in the failure to formulate a good model" (DC 1966: 151). For a retail distribution network, "The model is now all-important; the technique of linear programming is worthless until a homomorphic mapping of this retailing world is found" (DC 1966: 152).

Logic gets the same treatment. Its qualitative rigour is "methodologically prior" to the treatment of quantity (DC 1966: 161), and Beer asks for "a trained logician in the interdisciplinary team" (DC 1966: 162). His two cases, a military security problem and the flow of ingots in an alloy steelworks, each begin with an orthodox model, a map and a flow chart. The map is a good homomorph of the terrain, "the model is not homomorphic with the *operational facts*" (DC 1966: 162), and the same holds for the layout of the steelworks (DC 1966: 166). Enriched by an elastic geometry and by a model from acoustics, the two models produced new concepts that could be measured, "thresholds of coverage and reverberating ingots" (DC 1966: 171). Beer then reveals that "the logical structures of the military and civil arguments are identical with each other" (ibid.). On my reading, this is the procedure of section 24.3 shown on a small scale: two unlike situations mapped onto one formal structure.

24.7 Models in the control of operations

Chapter 13 of DC ("Controlling Operations") applies the theory of models to control. It opens with a critique of orthodox practice. Whoever would control a high-variety situation must first reduce its variety by making a model of it (DC 1966: 305). In orthodox practice the model is made by subdivision and classification, and writing it down is "a variety-killing exercise. It has to be" (DC 1966: 306). It can take years to build and is out of date when finished, its categories never fill with data, and forecasts drawn from it are amplified without new information, which amplifies the noise as well (DC 1966: 306–309). The arrangements "are typically so simple that they cannot go *right*" (DC 1966: 311). To the cybernetician, "the shop floor is a control system generating variety for the purpose of controlling the planning office, and not vice versa" (DC 1966: 310).

The cybernetic alternative also reduces variety, but "in a way which will allow at least some of the lost variety to be regenerated later on" (DC 1966: 313). Its first model has two parts. The structural model, *M1a*, records the relationships of the situation without numbers, in mathematics, statistics and logic; where even this is too large, "the ordinary operational research technique of homomorphic transformation must be used to keep it down" (DC 1966: 315). Beer's image is an account of every note on a piano replaced "by an account of the relationships obtaining for a single octave" (DC 1966: 316). The parametric model, *M1b*, records performance optima, not averages, because averaging can "kill variety so finally that it can never be regenerated" (DC 1966: 317). Applied through each other like the co-ordinates of a map (see chapter 25.5), the two parts generate predictions (DC 1966: 318–319).

Between prediction and event Beer places a black box that records their ratio. The ratios fall into statistical populations, and these supply a classification of events that "is quite unlike any conventional breakdown of the total system which people happen to think of" (DC 1966: 324). The ratio is not treated as an error. It is "an attempt to complete the incomplete language of the analytical model through the real world", which is "essentially a process of completion from without" (DC 1966: 323; on the principle see chapter 25.2). One conclusion concerns the models behind the specialist functions. Production control and cost control "are isomorphic systems" (DC 1966: 341), and "the notion that every specialist control function should be an isomorphic mapping of every other, and a homomorphic mapping of a basic control theory which expresses no particular specialist function but is modelled on the manager's own role, is seen as a valid and economical concept" (DC 1966: 341–342).

24.8 Models of the enterprise

Chapters 14 and 15 carry the argument from operations to the enterprise as a whole. Chapter 14 ("Self-Organizing Systems") holds, for a reason Beer calls "perhaps idiosyncratic", that "organization is an attribute of the observer of a system rather than of the system itself" (DC 1966: 350), and that for a system that already exists "The answer is not to design the control, but to constrain the system" (DC 1966: 354).

In chapter 15 ("Controlling Enterprises") the choice of model becomes the issue. The laissez-faire and the mandatory approaches to control rest on partial models: "the doctrinaire *laissez-faire* man is backing a model of

the ecological system, and the doctrinaire controller is adopting a model from the neurological system" (DC 1966: 375). Beer recalls the triangulation of section 24.1 and concludes: "If we are to adopt a useful model of an organic system, we must use a model taken from an organic system. Only a complex creature, such as a man himself, provides an adequate model, for he has problems of *both* internal and external adjustment to contend with" (ibid.). Asked within that model, the question of centralization versus decentralization shows itself to be absurd (DC 1966: 375–376). Partial models also explain why political opponents do not meet: "the conceptual models we adopt are far more potent than the propositional assumptions we put forward in the course of debate. The latter can be challenged and perhaps falsified; the former structure the universe for the speaker and make it impossible for him to know what the opposition is saying" (DC 1966: 377).

The model Beer then builds (DC 1966: 383–397) is a set of interlocking homeostats. Information about the enterprise enters the control system by a transduction that "is an isomorphic mapping" and then passes through black boxes that reduce its variety many-one (DC 1966: 384–385). At the centre, "*H2* is a homomorphic, homeostatic model of the moment-to-moment state of affairs" (DC 1966: 393), the "'still centre'" of the control system (ibid.). *H2* and *H4* corresponded in the original brain model to the sensory and the motor cortex (DC 1966: 394). *H5* amplifies variety again into day-to-day plans, *H7* balances the internal and external situations for years ahead and largely determines policy, and an algedonic loop, *H9*, lets policy and the world's reaction to it bypass the routine machinery (DC 1966: 394–396). Beer says the account is "based on the set-theoretic model of some parts of the brain referred to as far back as Chapter 7" (DC 1966: 391), the model of section 24.4, and he marks its status: "This is the only case, of the very large number of studies and models and approaches put forward in this book, in which what is no more and no less than a theory has been advanced" (DC 1966: 397). On my reading, several elements of the later VSM are present here in 1966 form: a homomorphic model of the present at the centre, a long-range model that produces policy, and an algedonic bypass. DC does not use the later terms, and the correspondence is my interpretation.

References

- **DC** — Beer, Stafford (1966). *Decision and Control: The Meaning of Operational Research and Management Cybernetics*. Chichester: John Wiley & Sons. Cited from the Stafford Beer Classic Library reprint, 1994.
- **MS** — Beer, Stafford (1967). *Management Science: The Business Use of Operations Research*. Garden City, NY: Doubleday, in association with Aldus Books, London.

Chapter 25 — Systems as an act of recognition: observer, variety, control

Seven objects in *Decision and Control* (1966) have a variety of 7, of 2, of 21, of 42 or of 2 to the power 42, depending on what the observer takes them to be (DC 1966: 247–252). The demonstration stands in Part III of the book, where Beer applies the view of models from chapter 24 (homomorphic mappings that keep a chosen structure and discard the rest) to the concept of system itself. Chapter 11 ("About Systems") and chapter 12 ("Coping With Complexity") contain his most careful statement of what a system is, of the role of the observer, and of variety as the measure of complexity. Several ideas that later carry the VSM are already fully present there, in the language of 1966: requisite variety, the variety sponge, and the black box as a source of variety.

25.1 Coherence, pattern, purpose

Chapter 11 of DC ("About Systems") begins with the system the manager faces: "It is exceedingly complex. It is highly probabilistic. It is, at least in certain ways, self-regulating (otherwise it would be chaotic)" (DC 1966: 241). Before these features can be discussed, Beer asks what a system is in the first place. "To speak of a system is to speak of the coherence of a number of entities called parts of that system" (DC 1966: 241). The objects themselves do not say what makes them coherent. "A system is not something given in nature, but something defined by intelligence" (DC 1966: 242).

Beer's argument goes through relations. Calling a collection a system means acknowledging that its parts are related; "But everything is related to everything else" (DC 1966: 242). He cites Hegel's Axiom of Internal Relations, by which things "would not be the things that they are if they were not related to everything else in the way that they are" (ibid.). Since everything is related, relatedness alone cannot pick out a system. The selection comes from the observer: "In practice, however, we acknowledge relatedness only when we are ready to declare its relevance" (ibid.).

A collection is recognized as a system in three steps, coherence, pattern and purpose, and it "is not dignified by the unitary notion of a system until some unifying purpose is devised for it" (ibid.). Beer spells the steps out. We acknowledge obtrusive relationships, and "this turns a mere collection into something that may be called an assemblage"; we detect a pattern, which gives "a systematically arranged assemblage"; and "Thirdly, we perceive a purpose served by this arrangement: and there is a system" (DC 1966: 242). "But coherence and pattern and purpose are, all three, acts of mental recognition rather than characteristics of physical things" (DC 1966: 243).

The consequences follow at once. "It follows that the detection of system in the world outside ourselves is a subjective matter. Two people will not necessarily agree on the existence, or nature, or boundaries of any system so detected" (DC 1966: 243). Consequently: "Nor is it possible to *prove* that a system exists, or is thus and thus; it is possible to say only that the treatment of a certain collection of things as a system is helpful" (ibid.). Beer ties this directly to the theory of models from chapter 24. The account of systems "is highly reminiscent of the account given earlier of models" (ibid.), and a recognized system is tested the way a model is tested, "by checking on the predictive capability of the insight" (ibid.).

The management example is market share. When two market research firms produce different estimates of a company's share, managers assume one of them is wrong. Beer's diagnosis is different: "the two organizations have not identified identical systems" (DC 1966: 244). What matters is the comparison within one system over time, and here he credits Locke: "The relation is more important than the things related" (DC 1966: 245). Classical science had handled large systems by isolating pairs of variables; "It dealt with this problem by making big systems little" (ibid.). It also claimed that its laws were independent of the observer, and "The discoveries of Einstein ruined that claim" (ibid.). The OR scientist should therefore "not gaily accept the system delineated by

the conventions of management structure" (DC 1966: 246).

One sentence links the section to the rest of the book: "This act of recognition is precisely the formulation of a conceptual model of system" (DC 1966: 246). Making such a model rigorous is the job of "the tool called *General Systems Theory*" (ibid.). A chemical analysis of a man is correct but "says nothing of any use to the observer concerned with man-the-system"; "Equally one might ask how much a balance sheet, which is correct and factual, tells about the *system* that is a firm" (ibid.).

Beer repeated the point in 1980, in his preface to Maturana and Varela: "A system is not something presented to the observer, it is something recognized by him" (TBYT 2009, "Preface to Autopoiesis": 68). In the same preface he draws the consequence for boundaries: "the labelling of connections between the system and its environment as either inputs or outputs is a process of arbitrary distinction" (ibid.). On purpose he goes further than DC: "I myself have for a long time been convinced that purpose is a mental construct imported by the observer to explain what is really an equilibrial phenomenon of polystable systems" (TBYT 2009, "Preface to Autopoiesis": 67–68). In DC purpose is the third act of recognition; in 1980 it is explicitly a construct of the observer. Chapter 26 follows the later texts further.

25.2 The observer and the relatively isolated system

Chapter 12 of DC begins with a difficulty: science needed the idea of an absolutely isolated system, and yet no real system is one. Beer's answer is the notion of the "relatively isolated system": "a set of entities […] that is separable from the rest of the world except for two specially chosen sets of relationships with things outside, called its inputs and outputs" (DC 1966: 273). He attributes the technical term to "the Polish cybernetician Henryk Greniewski" (ibid.). Only relations that matter are counted. A company's relation to the sun is real but unchanging and cannot be influenced, so "it will be disregarded" (DC 1966: 272).

Beer at once admits that the division into inputs and outputs is arbitrary, "just another of those dichotomies on which the author is fond of pouring scorn" (DC 1966: 273). Feedback already breaks it: in a feedback loop "an input is an output, and an output is an input" (ibid.). The deeper problem is that the direction of an interaction depends on how the system is drawn.

With a teacher and a class, either the pupils' questions are the input and the teacher's answers the output, or the teacher's words are the input and passed examinations the output. Which relations count as inputs and outputs depends on the observer: "Everything depends on how the system is defined, and this in turn depends on who is the observer: the dilemma of modern physics appears once again" (DC 1966: 274). The inputs and outputs of a relatively isolated system "may not be easy to nominate; moreover, which is which depends upon the observer's point of view and the conventions he unconsciously adopts" (ibid.).

Beer draws a practical conclusion for industrial relations. Management treats effort as input and wages as output; the workforce treats wages as input and effort as output. An incentive scheme that management sees as a reward is then seen by the workforce as a sanction. "The *systems* are formally the same, the one being a mirror image of the other, but the standpoint of each observer causes him to see the system in a totally different light" (DC 1966: 275). Beer advises assuming two-way interaction between subsystems, as a recognition that viable systems depend on richer interactions "than the analyst customarily assumes" (DC 1966: 275).

The systems management deals with are of a specific kind: "It is exceedingly complex (to the point where full definition becomes impossible); it is extremely probabilistic (to the point where causal relationships are discernible as no more than tendencies); and it is internally self-regulating to some extent" (DC 1966: 275).

Later in the chapter Beer returns to closure. When an environmental disturbance arrives that no one in the system can interpret, management brings in someone who can "speak the language" of that environment and in this way closes the system again, and the process can repeat indefinitely (DC 1966: 287–288). Beer links this to the Incompleteness Theorem and to his own earlier book: "In *Cybernetics and Management*, I tried to show that this theorem underlies the whole problem of organizing control in a large system such as an industrial company" (DC 1966: 288). To discuss control, the open system has to be closed "by an artificial convention"; "I have called this *the principle of completion from without*"; and "the closure of the system is *artificial*" (DC 1966: 288). Beer counts this as fortunate. He cites Bertalanffy's result that closed systems cannot behave equifinally: "Therefore viable systems are not closed" (ibid.).

25.3 Variety depends on the observer

To discuss the magnitude of the manager's problem, Beer needs a measure. "A clearly-formulated concept of complexity is needed, and its scientific name is variety" (DC 1966: 247). The first definition seems simple: "The *variety* of anything is its number of distinguishable elements" (ibid.). But its measurement depends on definition: "For if the intention is to measure the complexity of a system, to state its variety, everything will depend on how the system is defined", "in short, on who defines it" (ibid.). "In particular, it will be vital to know how deeply the observer's insight has penetrated into the nature of the system" (ibid.).

Here the seven objects come in, described successively at the levels of section 25.1 (DC 1966: 247–252). As a collection of dissimilar things, their variety is 7. If four of them are identical and the other three are identical, the variety is 2: "The seven-ness is illusory" (DC 1966: 248). As an assemblage in which every thing is related to every other, the variety is the number of connections, 21 (DC 1966: 249). If the relations are oriented, so that B→F differs from F→B, it is 42 (DC 1966: 249–250). If the seven things form a dynamic system in which each of the 42 connections can be on or off, the variety is 2 to the power 42, "well over 1,000,000,000,000" (DC 1966: 251–252). The objects stay the same throughout. Only the observer's account of them changes, and with it the variety.

Variety proliferates: "Every conceptual step which enriches the nature of a system under study increases the information about it, increases the uncertainty informing it, and proliferates its variety" (DC 1966: 252). Because interacting varieties multiply rather than add, Beer recommends the logarithmic measure to base 2 (DC 1966: 252–253). He then draws the conclusion for method that also closes chapter 24: "The erroneous idea that the problem could in principle be contained by nominating the most important variables in the system, and writing down some kind of equation to show how they are connected, has surely been demolished by now" (DC 1966: 253). "The reason is that what makes control difficult is precisely the proliferation of variety" (DC 1966: 253). The later definitions of variety in BOTF, HOE and DTS are compared in chapter 2.1 and in Appendix B.

25.4 The Law of Requisite Variety and the variety sponge in DC

Beer introduces the law with a rugby match. One can try to stop fifteen men in red jerseys with an elaborate computer and automata, but "the best way in which to control the system of fifteen men in red jerseys, is to put fifteen men in white jerseys on to the field" (DC 1966: 278). The plain onlooker knows this without theory, but the manager does not have his advantage: "He is playing a game of incomplete information, in which only a few of the rules are known" (DC 1966: 279).

DC gives Ashby's law in Ashby's words: "'picturesquely: *only variety can destroy variety*'" (DC 1966: 279). Beer does not dwell on the formal statement. He expects the reader to find it obvious and replies: "if the law of requisite variety is a truism, how is it that we try to disobey it all the time?" (DC 1966: 280). His example is a predator population controlling its prey. If there is one hawk for every hundred prey animals, each hawk must take a hundred. The general statement reads: "Requisite variety must be there; it does not have to exist on the basis of a raw count of items, but the purposive and systematic assemblage that is identified as a system must be capable of proliferating requisite variety" (DC 1966: 280). Communications matter too, but Beer considers the deeper point to be that "the capacity to proliferate variety within the control box must be as great or greater than the capacity of the situation box to proliferate variety" (DC 1966: 282).

An environmental disturbance that cannot be explained or foreseen increases the variety of the situation further. Neither the manager who looks for recurrent patterns nor the analyst who seeks a full explanation can deal with it. The cybernetician can, because he claimed neither (DC 1966: 284). From this Beer derives a different idea of control: "The orthodox notion of control is frankly fascist; it is mandatory; it is a bully. Orders are issued and it is expected that they will be carried out. But by now we have put on nature's spectacles" (DC 1966: 284). The image of the variety sponge, used later for the Three–Four homeostat (chapter 11), already appears here: "We see that the fundamental nature of the self-regulatory control implicit in a viable system is that it can *absorb* proliferating variety like a sponge" (DC 1966: 284).

The mechanism is the self-vetoing homeostat, in which each of two coupled subsystems rejects any state of the other that does not suit it, until both are in acceptable states (DC 1966: 292). It "has a plan

for ultrastability" (ibid.; on ultrastability see chapter 27.9). Even with disturbances nobody understands, control that has requisite variety can go on vetoing unacceptable states: "Requisite (control) variety absorbs proliferating (world) variety like a sponge" (DC 1966: 293). Beer names the limitation in the same passage: "the length of time taken to reach homeostatic equilibrium may be far too long" (ibid.). If control is slower than the arrival of disturbances, the system oscillates without end (ibid.).

25.5 Black box and variety generator

A practical question remains. Variety proliferates naturally in the situation, but the control system is artificial, "and we are simply not accustomed to the idea of a machine or an office which is meant to be a variety proliferator" (DC 1966: 293). Beer's answer is the black box, "a box to which inputs are observed to lead and from which outputs are observed to emerge", with nothing known about the connections inside (ibid.). A transparent box has constrained variety, because its internal arrangement is fixed. The black box "is assumed to be able to take on any internal arrangement of input–output connectivity at all; it can therefore proliferate maximal variety" (DC 1966: 293). For control, that makes it a resource.

Beer shows how quickly this variety grows. A box with two binary inputs and one binary output can be sixteen distinguishable machines (DC 1966: 294–295). In general the variety is 2 raised to 2 to the power n, where n is the number of inputs. With eight inputs the result is 2 to the power 256, a number with seventy-eight figures, close to Eddington's number of particles in the universe (DC 1966: 296). The seven objects of section 25.3 reached only 2 to the power 42. The conclusion is reassuring: "it is not necessary to be over-awed by the task of trying to supply requisite variety for its control" (ibid.).

"This immense variety is the raw material of a control mechanism competent to handle real-life situations" (DC 1966: 296). Against this, "The plain man, and especially the classical scientist, copes with complexity by suppressing the proliferation of variety, by killing off variety until almost none is left" (ibid.). The task is the reverse: "We have to learn how to fabricate systems from this raw material without de-naturing it" (ibid.). Beer distinguishes two verbs. In natural situations variety proliferates; in the control element of an artificial system it must be generated, which means that "deliberate 'black box engineering' can be undertaken in the design of managerial systems" (DC 1966: 296–297).

A "variety generator" is a device "deliberately organized to generate it for a purpose" (DC 1966: 297). Beer's example is two friends who want to find a place on the same map by telephone. The map has upwards of 20,000 grid squares. Numbering every square would meet the law of requisite variety but take about seventeen hours; the map's coordinates achieve the same by handling only $2 \times 144 = 288$ elements, which can generate 20,736 combinations (DC 1966: 297). "So, for the expense of recording and handling a variety equal to twice the square root of the requisite variety, the law has been met" (ibid.). The opposite case is a classification that destroys variety. Divide people into Scotsmen and Englishmen, kilts and bowler hats, and then meet an Englishman in a kilt and a trilby: "Before we know what has happened, *95* per cent of our records are in the miscellaneous file. The arrangements lack requisite variety" (DC 1966: 298).

The two chapters of DC give a consistent picture. A system is a conceptual model formed by an observer (25.1). Its boundary and the direction of its inputs and outputs are conventions (25.2). Its variety depends on how it is defined, as the seven objects show (25.3). Control means matching that variety, not suppressing it (25.4), and the variety needed for control can be generated by design (25.5). The VSM of the 1970s gives these points an organizational structure, and the observer-dependence of the concepts remains in it.

References

- **DC** — Beer, Stafford (1966). *Decision and Control: The Meaning of Operational Research and Management Cybernetics*. Chichester: John Wiley & Sons. Cited from the Stafford Beer Classic Library reprint, 1994.
- **TBYT** — Beer, Stafford (2009). *Think Before You Think: Social Complexity and Knowledge of Knowing*. Edited by David Whittaker. Charlbury: Wavestone Press.

Chapter 26 — Knowledge of knowing: the essays in *Think Before You Think*

"An evolving outlook is pieced together, like a patchwork quilt that has no prior design" (TBYT 2009: 272). Beer wrote the sentence in the unfinished title essay of *Think Before You Think* (2009), and the collection itself is built the same way. It is not a treatise. It brings together lectures, prefaces, papers and that autobiography, written over several decades, and its subtitle, *Social Complexity and Knowledge of Knowing*, was chosen by the editor, David Whittaker. The dates of first publication are in `sources.md`. Read for their epistemology, these texts show that the questions raised in *Decision and Control* (see chapters 24 and 25) stayed with Beer for the rest of his life: what a model is, who recognizes a system, how complexity is measured. In the later texts they are extended to identity, to self-reference and to the way a person comes to hold an outlook at all.

26.1 Against reductionism

In 1980 Beer wrote a preface for Maturana and Varela's *Autopoiesis and Cognition*, and it holds his clearest critique of a science that breaks things down and loses relations. It begins with an inheritance: "We are the inheritors of categorized knowledge; therefore we inherit also a worldview that consists of parts strung together, rather than wholes regarded through different sets of filters" (TBYT 2009, "Preface to Autopoiesis": 64). Beer traces this through the history of philosophy, from the scholastics through the rationalists and empiricists to Kant, and through the

history of science as classification, from Galen to Linnaeus. He then describes the dominant world-view as one "in which real systems are annihilated in trying to understand them, in which relations are lost because they are not categorized, in which synthesis is relegated to poetry and mysticism, in which identity is a political inference" (TBYT 2009, "Preface to Autopoiesis": 65).

The same passage makes a point about universities that Beer had already made about management in DC. Interdisciplinary work does not solve the problem, because it keeps the categories: "Thus it is that an 'interdisciplinary study' often consists of a group of disciplinarians holding hands in a ring for mutual comfort. The ostensible topic has slipped down the hole in the middle" (TBYT 2009: 65). What Beer praises in Maturana and Varela is the opposite: their book "does not inter-relate disciplines: it transcends them" (TBYT 2009: 66). The answer to the disciplinary deadlock "has got to be *metasystemic*, not merely interdisciplinary" (ibid.). Beer's description of cybernetics as a "transdisciplinary science" (chapter 1.5) belongs here.

Nine years later, in "The Identity of Organizations" (prologue to Jorge Etkin and Leonardo Schvarstein, *Identidad de las organizaciones, invariancia y cambio*, Buenos Aires: Paidós, 1989), Beer aims the critique at management literature. He opens with Bertrand Russell's reply to a reporter: "I define the practical man as the man who has no idea what to do in practice" (TBYT 2009: 186). He notes: "The evidence is that as the problems become worse and more complicated, the approach to management becomes more and more reductionist and simplistic" (TBYT 2009: 186). His argument against this "pop management" is cybernetic. He cites the Conant–Ashby theorem, which "states that a regulator is only as good as the model it contains of whatever it is that has to be regulated" (TBYT 2009: 187). A business managed through its balance sheet is managed through an inadequate model: "It does not have requisite variety" (ibid.). DC had made the same point about the "unidimensional monetary scale" (see chapter 24.4). Reductionist science and "bottom line" management fail in the same way, and of the former Beer writes that it "has understood the parts of man and of matter, in intricate detail, but has lost the holistic vision of both" (TBYT 2009: 190).

26.2 Autopoiesis and identity

Beer takes Maturana's concept and gives it a cybernetic formulation, most fully in "Laws of Anarchy". A homeostat, Beer explains there, "is a regulatory mechanism, that holds some critical variable within physiological limits" (TBYT 2009, "Laws of Anarchy": 32). Within this class there is a sub-class: "An autopoietic system is a homeostat for which the critical variable held within physiological limits is its own organization. Thus an autopoietic system produces itself" (TBYT 2009, "Laws of Anarchy": 32). Beer stresses a detail: "Maturana is explicitly NOT saying that it reproduces itself: he considers that a side issue"; the word is "simply the Greek for self-making" (ibid.). In the lecture he turns the idea into a polemic: "The proposal is that the main business of the government is to produce itself" (ibid.).

For Beer the concept "solves the problem of identity which 2,000 years of philosophy have succeeded only in further confounding. There is no need to postulate a mystical something, which ensures the preservation of identity *despite* appearances" (TBYT 2009, "Preface to Autopoiesis": 67). The preface explains why. Every philosophical school searched for the "it" that remains the same through change, and each ended with something unreal. Maturana and Varela's "it" is "notified precisely by its survival in a real world"; analysis cannot find it, "because its categories may all have changed since you last looked" (ibid.). Beer sums up: "The very continuation is 'it' " (ibid.). Against Berkeley he adds that autopoiesis "says that something that exists may turn out to be unrecognizable when you next observe it" (ibid.).

The preface also records a change of mind. Maturana and Varela held that coding and information are notions of the observer and not phenomena of the physical domain. Beer first found this "plainly wrong", then accepted it: "Nature is not about codes: we observers invent the codes in order to codify what nature is about" (TBYT 2009, "Preface to Autopoiesis": 69). The observer argument of DC (see chapter 25.1) is here applied to information itself.

Beer then extends the concept to social institutions, further than the authors themselves were agreed to go: "if a social institution is autopoietic […] then, on the author's own showing, it is necessarily alive. […] what does matter is that the social institution has *identity* in the biological sense" (TBYT 2009: 71). He notes that the two authors "do not fully agree between themselves" on this question (TBYT 2009: 70). He himself is not

in doubt: "For I am quite sure of the answer: yes, human societies *are* biological systems" (TBYT 2009: 70). His examples include "firms and industries, schools and universities, clinics and hospitals, professional bodies, departments of state, and whole countries" (ibid.). In practice such an institution "is not just the random assemblage of interested parties that it is thought to be" (TBYT 2009: 71). Reform therefore does not simply change it; legislation or even revolution "proposes a new challenge to their autopoietic adaptation" (ibid.). Beer adds a warning in the language of recursion (see chapters 3.3 and 6.1). The architects of change treat the system at their own level as autopoietic, "but they insist on treating the systems their system contains, and those within which their system is contained, as allopoietic" (TBYT 2009: 72).

In "The Identity of Organizations" the same argument runs through self-reference. Living systems "define themselves as they go along. They iterate their own identity" (TBYT 2009: 188). Beer acknowledges that many disagree about social organizations, and states his position: "Organizations do iterate their own identity: they are self-referential and self-organizing" (TBYT 2009: 188). Why do organizations survive poor management? "The answer says that the whole is greater than the sum of its parts, and that the system is primarily self-organizing" (TBYT 2009: 189). Beer refers back to his own earlier distinction, in *Cybernetics and Management*, between processes whose regulation can be circumvented and those "regulated *by the very act of going out of control*", the "intrinsic controller" (ibid.). He then gives a small formalization. If meaning is a function of structure and structure a function of meaning, substitution gives a structure that is "a self-referential recursion of itself, and the now isolated concept of meaning has altogether disappeared!" (TBYT 2009: 191). The prologue ends with a summary sentence of which the draft quotes the final clause: the organizational identity "is complex in itself because it feeds upon complexity, and […] is self-organizing because it computes itself instead of reacting to external stimuli" (TBYT 2009: 192). The link to self-reference and consciousness in BD is covered in chapter 23.2.

26.3 Paradigms and change

In the Concordia address "About Flat Earths" (1988) Beer asks for change at the level of paradigms. He first speaks of "models of Unreality" that graduates are responsible for updating, and then says that updating models is not enough: "It is a question of *paradigm*. I define a paradigm

as a model that exhibits a closed logic. It means that our attempts to break out of a fixed pattern of thinking are constantly defeated—by running headlong into our own premises" (TBYT 2009, "About Flat Earths": 183). From working in eighteen countries he names the most common such paradigm: "We cannot do as you propose because—you don't understand—*that's* not how we do it"; "It is the Noah's Ark Syndrome" (TBYT 2009: 184). The demand follows: "IF YOU WANT TO CREATE CHANGE, you must challenge not only the models of Unreality, but the *paradigms* that underwrite them" (TBYT 2009, "About Flat Earths": 184).

The definition fits the theory of models in DC. There, progress in science is "the overthrow of a model […] that has exhausted its usefulness" (DC 1966: 122; see chapter 24.5). A paradigm, in the 1988 sense, is a model whose logic prevents its own overthrow. Beer's BOTF glossary defines paradigm as "an exemplar or pattern; a basic way of doing something recognizable beneath many superficial variations" (BOTF 1981: 403). The two definitions do not contradict each other, but they stress different things: BOTF the recognizable pattern, the Concordia address its closure against change.

26.4 Learning an outlook

The title essay, "Think Before You Think: Learning an Outlook" (previously unpublished), is autobiographical. The editor describes it as "An experiment in autobiography, far from finished at the time of Beer's death" (TBYT 2009: 271). It is written with digressions and an interlocutor called Polycarp, who interrupts the author. Here the quilt appears in full. An outlook grows: "An evolving outlook is pieced together, like a patchwork quilt that has no prior design" (TBYT 2009: 272). The quilt-maker "works with whatever materials are available for much of the time" and sets patches aside until they are recognized as belonging (ibid.).

Beer decided early "never to regard the process of *learning an outlook* as completed, but actively to pursue that activity to my dying day" (TBYT 2009: 296). Most people, in his view, stop: they "seem to give up the process sooner or later, often as early as puberty, and that is a tragedy" (ibid.). He separates learning an outlook from learning in general: "*learning an outlook* means incorporating experience as it happens, formulating and refining it continuously" (ibid.). The next sentence ties it to the theory of models: "It means adjusting the model of life itself while it is being

lived" (ibid.). Beer applies to his own biography the "prognosis continuously corrected by feedback" of DC (DC 1966: 100; see chapter 24.1).

He sees his life's theme in a single distinction: "How could anyone have imagined that I would spend so much of my life trying to understand and to delineate the distinction autonomy / independence—whether in babies, or in communities, or in corporations, or in provinces, or in countries—all of which turn out to have formal identity" (TBYT 2009: 308). The occasion is his own birth: "I was now an autonomous unit, but by no means independent" (ibid.). He adds: "The issue is central to organizations of every kind, and of every political system, to this day. Also to this day, people do not understand it" (ibid.). On my reading, the distinction corresponds to the relation between System One autonomy and the cohesion of the whole in the VSM; Beer does not draw that link in this passage.

The essay also ties epistemology to the body. Discussing the senses, Beer notes that "Many self-organizing systems are similarly difficult to discuss, because they are subject to a form of what logicians call undecideability" (TBYT 2009: 300). His physical example is the smell of nitrous oxide, which cannot be investigated as such, because exposure to air changes the substance. And: "The fact is that the fiendish puzzles of epistemology, which sophisticated people imagine are founded in language, have profoundly physiological bases" (TBYT 2009: 300).

26.5 Holism through communication and control

The same essay names what science is missing. Reflecting on the complexity packed into a single fertilized cell, Beer writes that modern biochemistry has highlighted "the quantifiable complexity that has to be handled as a problem of communication and control" (TBYT 2009: 281–282). He then generalizes. Science, philosophy and logic have been reductive: "So anything that is said about *wholes* is at once analyzed into parts by the traditional tools of science or philosophy or logic, and loses whatever is important about its wholeness" (TBYT 2009: 282). Mathematics has nevertheless left "a trail of valuable clues"; in particular, "The field of set theory treats of wholes in preference to isolated parts" (ibid.). It is the same set theory in which the homomorphic brain models of DC were worked out (DC 1966: 137; see chapter 24.4). Then comes the sentence: "The time will eventually come when the dimension of communication-and-control is recognized as the missing clue to holistic thinking" (TBYT 2009: 282). Beer gives a working definition of "dimension" in the same passage: "A

working definition of a dimension is a condition of existence" (ibid.).

The sentence returns to the definition at the beginning of this text: cybernetics as the science of control and communication (chapter 1.1), and as a "transdisciplinary science" (chapter 1.5). The epistemological strand of *Think Before You Think* also closes the arc of Part V. In DC Beer argued that systems and models are acts of recognition by an observer (chapters 24 and 25). In the later texts he applied that argument to identity, to institutions and finally to himself, the quilt-maker whose outlook is a model continuously adjusted "while it is being lived".

26.6 Models of reality in the shorter pieces

Several shorter pieces in the collection return to the model as the observer's only access to the world. The occasions below are those given in the editor's source notes.

"Cybernetics of Humankind" (first published in *The Journal of Human Potential*, January 1976) argues from the physiology of perception. The senses and the brain filter variety from the moment signals arrive, and Beer concludes: "I want to establish that we do not 'just know' reality, but have a necessarily low-variety model of reality to work with" (TBYT 2009, "Cybernetics of Humankind": 39). The filtering supplies a shared classification and with it a way of talking "that gives expression to the model—and to nothing else" (ibid.). What remains is "the human potential to question the models, to doubt the programming" (ibid.).

"An Open Letter to Heinz von Foerster" (*ASC Forum*, January 1976) applies the Conant–Ashby theorem (chapter 2.9) to the regulation of large systems: "Since every regulator must be an effective model of the system regulated, it ought to consist of an isomorphic mapping of the system" (TBYT 2009, "An Open Letter to Heinz von Foerster": 52). Current approaches fail because "the mappings are contorted homomorphisms and not isomorphic at all", and "the guaranteed isomorphic mapping is the identity mapping" (ibid.). A large system innervated with an ultrastable network of microprocessors would approach that identity mapping (ibid.). On my reading, this asks more of a regulator's model than DC asks of a scientific model, which is a homomorphism whose omissions cost utility but not validity (chapter 24.3); Beer does not compare the two. The same letter diagnoses a bureaucracy that preserves its own organization instead of the nation's as "pathological autopoiesis" (TBYT 2009: 54). "Requisite Ross", written in the mid-1970s for *ASC Forum*

and previously unpublished, defends Ashby's Law against a friend who called it "a mere tautology": "Always suspect the word 'mere'", since "the entire corpus of mathematics is either tautologous—or wrong" (TBYT 2009, "Requisite Ross": 45).

In the Second Annual Teilhard Lecture, "I Said, You are Gods" (King's College, London, 2 December 1980), Beer insists "that these scientific accounts of reality are best called MODELS", whose "utility (as distinct from their truth or their inclusiveness) is judged by their *predictive capacity*" (TBYT 2009, "I Said, You are Gods": 75). This is the criterion of DC (chapter 24.3). From the Conant–Ashby theorem he derives a limit: "we cannot regulate our interaction with any aspect of reality that our model of reality does not include" (TBYT 2009: 77). He adds "that the distinction between what is real and what is unreal is determined not only by the *content* of the model, but by the kind of distinction that the model has the competence to draw" (TBYT 2009: 77–78). The same lecture cites "the cybernetic theorem of the recursiveness of viable systems" for the claim that the Earth is "an integral viable system" (TBYT 2009: 80).

"The Preposterous Inference" (first published in *So This Is 1984*, 1984) reads political simplification as a loss of variety: "The paring away of detail from multifaceted issues will soon pervert their fundamental nature: it represents a loss of variety" (TBYT 2009, "The Preposterous Inference": 120). "Recursions of Power", the keynote address to the 7th European Meeting of Cybernetics and Systems Research (University of Vienna, April 1984), places scientific progress in "the detection of invariants in systems" and proposes that identity "will be an invariant that we shall find at every level of recursion" (TBYT 2009, "Recursions of Power": 160–161). Beer uses "'recursion' in the mathematical sense of one system implying and being included in the next" (TBYT 2009: 161) and runs the Conant–Ashby theorem, "the regulator of a system must contain a model of what is regulated" (TBYT 2009: 163), through four levels: person, institution, nation and planet. For the institution the difficulty is one of recognition: "If your epistemology is such that fundamentally you do not recognize the system you've got, what is your hope of defining the regulatory system that will control it?" (TBYT 2009: 167). The address also states the maxim "The purpose of the system is what it *does*" (TBYT 2009: 169; see chapter 3). "On Suicidal Rabbits: a Relativity of Systems" (a Festschrift contribution for Russell Ackoff, first published in *Systems Practice*, 1990) puts the observer problem in the same terms: "To observe the observing system requires a new level of logical recursion" (TBYT 2009, "On Suicidal Rabbits": 212).

"The Culpabliss Error" (a "Memorandum marking his 70th birthday", Liverpool John Moores University, 25 September 1996, in the editor's note) begins with a story Beer had first published in DC (TBYT 2009, "The Culpabliss Error": 233). It then returns to his term "surrogate worlds" for the models by which we manage: they are not systemic, "they do not exhibit requisite variety", and "they are usually out-of-date" (TBYT 2009: 235). "But understanding is a product of modelling" (TBYT 2009: 239). The piece ends by asking for "a cybernetic insight into epistemology, with its emphasis on the role of models" (TBYT 2009: 247).

References

- **DC** — Beer, Stafford (1966). *Decision and Control: The Meaning of Operational Research and Management Cybernetics*. Chichester: John Wiley & Sons. Cited from the Stafford Beer Classic Library reprint, 1994.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)
- **TBYT** — Beer, Stafford (2009). *Think Before You Think: Social Complexity and Knowledge of Knowing*. Edited by David Whittaker. Charlbury: Wavestone Press.

Chapter 27 — *Management Science* (1967): models, control and the viable governor

Source: Stafford Beer, Management Science: The Business Use of Operations Research (MS 1967). Quotations from MS were checked against the page images of the Internet Archive lending copy and are taken from the reading notes in `_work/ms-1967-reading-notes.md`*; no searchable full text of MS is available. Quotations from other books by Beer were checked against the full texts.*

In 1967 Beer gave the sixth chapter of a short illustrated book the title "The Viable Governor". The governor in that chapter is first the Watt governor of the steam engine, which brings its variables back into control in the act of going out of control, and then a population of interacting animals, which governs itself without any governor at all. *Management Science* is the shortest and most openly popular of Beer's books from the 1960s. It appeared in a series for a general readership one year after *Decision and Control* (DC 1966) and covers much of the same ground without formulae: operational research (OR), models, probability and the cybernetics of control. Its seven chapters run from the manager's tasks, through chance and variety, models and simulation, and two worked cases, to the chapter on the governor and a closing chapter on automation.

The book shows in plain language how Beer joined OR and cybernetics before *Brain of the Firm* (1972). It also contains, scattered across its chapters, several ideas that the later books assemble into the Viable Sys-

tem Model: requisite variety, intrinsic control, homeostasis and ultrastability, coupled homeostats with preferred states, a hierarchy of models, identity, and the word *viable* itself. Whether and how MS relates to the VSM is a question for the last section, and there only as far as the texts allow.

27.1 Management, science and the underlying system

MS opens with the manager's tasks: "Policy-making, decision-taking, and control: These are the three functions of management that have intellectual content" (MS 1967: 10). The book is organised around these three functions. The last, control, becomes the subject of its chapter 6, where the steam governor serves as the model (27.6–27.11 below).

Beer grants the common view, "No wonder people say that management is an art. It is." (ibid.), and holds that the two descriptions do not compete: "To say that there can be a science of management is not to deny that management is an art" (MS 1967: 12). His working definition of science is broad: "systematic knowledge about the world" (MS 1967: 10). On this definition managers need not become scientists. What is required is that systematic knowledge be brought to bear on what managers do.

That knowledge offers a way of seeing the enterprise. OR gives management "a capacity to visualize the enterprise as an organic whole, to determine the structure of the underlying system that makes it what it is, and to compute in terms of the dynamics of that system" (MS 1967: 26). Understanding comes before technique: "The vital activity is the investigation of system: What makes things tick?" (ibid.). Applying a technique without that understanding is, in Beer's image, "like copying out the prescription that did Mrs. Smith so much good, and hopefully applying it to oneself" (ibid.).

Beer separates the science of a subject from skill in it: "The science of a subject is always about its very nature; it is not about virtuosity" (MS 1967: 13). Science begins with measurement but "is basically concerned with finding patterns of facts; and in particular with finding patterns that reproduce themselves", because the understanding of such patterns gives the capacity "to predict" (MS 1967: 18). Management science accordingly takes the manager's work as its object, and the shop floor only in passing: it "deploys a skill and methodology originally developed for the invest-

igation of nature at large to do research into the manager's own job. It is only trivially concerned with the processes being managed" (MS 1967: 19–20).

From the wartime origins of OR Beer draws three lessons. Management deals with situations "about which information is essentially incomplete"; an OR team "must represent as many scientific disciplines as possible"; and strategies must exploit "the entire system within the manager's command […] as a whole", in contrast to "the orthodox analytic approach, whereby the system is examined piecemeal" (MS 1967: 27). The same summary gives the reason for the third lesson: "Small advances made in particular localities of the system may actually turn out to be inimical to the health and success of the whole" (ibid.). The second lesson explains why OR "became at once, and remains to this day, an interdisciplinary activity" (MS 1967: 23); chapter 1, section 1.5 shows how Beer later preferred the word "transdisciplinary".

What OR investigates, then, is the system that produces a situation. OR "is trying to discover the nature of the underlying system that generates the particular situation under study. If we know what that system is […] then we acquire predictive power" (MS 1967: 24). The manager knows his "difficulties", but these are symptoms; "the problems that need solving […] are the underlying things of which difficulties are mere symptoms", and they "are locked up in the nature of the system that generates them" (MS 1967: 29). It follows that extrapolation fails whenever the proposed change alters the system. A policy for change based on "the extrapolation of the results into a future that will have been made different by that very change, is probably wrong" (MS 1967: 25).

27.2 Chance and variety

Chapter 2 of MS ("Chance, Risk, and Malice") introduces the quantities a calculus of decision has to handle. The first is chance. Beer attributes to managers, not to scientists, the view that science deals only with determined matters, and answers that modern science "is therefore especially designed to compute with probabilities rather than with certainties. And the scientist, like the businessman, sees his universe not so much as a collection of definite things but as a flux of uncertain interactions" (MS 1967: 32). The manager need not do the mathematics; "he ought to know what mathematics to ask for" (MS 1967: 33–34). Nor is the human element beyond such treatment: "the human being imports uncertainty into

a situation just as any other kind of natural variable imports uncertainty, and the effects are no different" (MS 1967: 48).

The second quantity is variety, and with it MS makes its first explicitly cybernetic statement. As controller the manager needs "a quantified understanding, of the number of alternative combinations of events with which he has to deal" (MS 1967: 37). Beer then states the law: "According to the science of cybernetics, which deals with the topic of control in every kind of system […], there is a natural law that governs the capacity of a control system to work. It says that the control must be capable of generating as much "variety" as the situation to be controlled. Now variety may be roughly defined as the possible number of distinguishable states in a situation" (MS 1967: 37). This is the Law of Requisite Variety, treated in its later formulations in chapter 2, sections 2.1–2.3, and in its DC form in chapter 25, section 25.4.

Variety grows fast. A production unit with ten processes already has "nearly ten million possibilities" (MS 1967: 38). That reverses the usual question about simple controls: against the belief that a simple control "cannot go wrong", Beer asks "whether it can go right" (MS 1967: 38). The same pair of phrases returns in chapter 6, where the governor sets the standard for a control that cannot go wrong (27.7). Seen from the other side, a situation is "just one choice out of millions of available choices", and "management becomes a task of chopping down possibilities to one actuality, rather than of building up small components to make an interacting whole" (MS 1967: 39). Management as selection among possible states, rather than assembly of parts, anticipates the later language of variety attenuation (chapter 2, section 2.4).

Textual note: MS defines variety "roughly" as "the possible number of distinguishable states in a situation" (MS 1967: 37); the BOTF glossary has "the total number of possible states of a system, or of an element of a system" (BOTF 1981: 403). MS adds the qualifier "distinguishable", which ties variety to what can be told apart and so to an observer — a dependence that DC makes explicit (chapter 25, section 25.3).

The chapter's examples are stocks and queues. "Stock is quite simply, and always, a shock absorber between two interacting sets of probabilities" (MS 1967: 50). Its size is a convolution of input and output distributions, and the manager's part is to state the risk he will accept (MS 1967: 52–53). Once that policy is set, a computer that reorders stock "is actually taking a decision". Beer calls this "a signpost to freedom. If we can offload rather low-level decisions of this kind to machinery by the use of

science, the manager is freed to attend to more important matters" (MS 1967: 53). A related example is a reporting scheme that prints only cost variances outside statistical limits, so that "the manager gets one page of cost returns for every twenty he used to get, and the only information that has been suppressed is statistically guaranteed to be of no interest" (MS 1967: 48). The later books call both cases filtering variety before it reaches management. Beer ends the chapter by recommending the word "stochastic" to every manager: "A stochastic process is about the results of convolving probabilities—which is just what management is about, as well" (MS 1967: 58).

27.3 Conceptual model, scientific model, simulation

Chapter 3 of MS ("Quantified Insight") gives the model theory of *Decision and Control* (see chapter 24) in non-technical form, and it starts from the manager. His understanding "may be thought of as some kind of model of the situation out there", a "conceptual model", and the stake is practical: "bad and unprofitable decisions are the outcome of a misconception about the way the system actually works" (MS 1967: 63–64). Such a model simplifies. It maps "many-to-one"; "A good model is a homomorph" (MS 1967: 64). Beer adds: "it may well be that all models are homomorphic rather than strictly isomorphic—except one. This is the model that reality constitutes of itself" (MS 1967: 66). The remark returns as the base of the cones of resolution (27.4).

The scientist does not know the particular firm. He brings experience of other systems: "What has the scientific experience in common with the managerial experience? The answer is quite simply: system" (MS 1967: 67). His conceptual model "is a scientific analogy" (ibid.), and an analogy alone is not enough: "Unless there is such a sense, the analogy is a literary trick—not very scientific. It is no use simply stating an analogy, and just hoping that it is valid" (MS 1967: 68). Rigour comes from formal languages, since "science commands several formal languages that destroy ambiguity and equivocation": mathematics, mathematical statistics and formal logic (ibid.). The scientific model (SM) is "a rigorous statement of the conceptual model (CM)" (ibid.), and it answers how far the analogy holds. A diagram links science (S), languages (L), scientific model (SM), techniques (T) and the real situation (R) (MS 1967: 69); the same scheme in DC is discussed in chapter 24, section 24.3.

Two clarifications follow. A scientific model written in mathematics is still not a mathematical model: "The basic nature of a scientific model is *systemic*, rather than mathematical" (MS 1967: 89). And models are judged by usefulness rather than truth, because "truth and falsity are attributes of statements about the world, and not attributes of the world itself"; models are "more or less useful" (MS 1967: 72). Chapter 24, section 24.5 discusses the related distinction between models, laws and conventions.

Models are needed because experiment on the real firm is impossible, and because a model has to be tested over time, not only fitted at one moment. "The situation the manager controls is essentially viable: It goes on living" (MS 1967: 81). This is the first of several places where MS uses the word *viable*. The scientist therefore "experiments on the model instead of on the firm. If the model of the company goes bankrupt, nobody cares" (MS 1967: 82); "This procedure is known as simulation" (ibid.). Simulation also tests robustness. The manager "does not necessarily want the *most* profitable policy, if this is really rather insecure. He would prefer to trade a little of the profit for a guarantee of stability" (MS 1967: 87). The preference for stability over maximum performance anticipates the governor of MS chapter 6. Finally, a validated model "is an asset that the firm has bought"; with "learning facilities" built in, "what is happening to the firm also happens to the model" (MS 1967: 87–88). A model that runs alongside the firm and is updated by it corresponds to what the later books require of System Four (chapter 10, section 10.2).

27.4 An alphabet of models and the cones of resolution

Beer runs through models from acoustics, biology, cybernetics, demography, engineering, fluid dynamics and genetics, all "within my own experience of actual cases" (MS 1967: 109–110). Chapter 4 of MS uses them to show that the scientist's analogies can come from any science. The premise: "Nature is an indivisible unit; but man's way of investigating nature is compartmentalized"; the unity of nature's systemic character is being realized "in terms of a body of knowledge called General Systems Theory" (MS 1967: 91). Hence: "There is some sense in which any system can be mapped onto any other" (MS 1967: 94). DC had put the same conviction in terms of viability: "what is robust, dynamic and viable about the real-life situations which the manager handles is mirrored

in the processes of nature which scientists study in all their forms" (DC 1966: 115).

Three entries bear on the later model. Under B for Biology, discussing the optimal size of a firm, Beer asks: "why should we not talk about the firm as a viable organism?" (MS 1967: 95). Under E for Engineering the market–factory loop is treated as a servomechanism. Without good control engineering "the whole system goes into oscillation"; "In engineering terms, the system is hunting" (MS 1967: 103–104). Beer presents this as a checkable prediction: "we ought to ask whether the prediction is borne out or falsified in practice" (ibid.).

Under C for Cybernetics he turns to the structure of management itself. A reliability calculation shows that a single unreliable decision cell is wrong more than half the time, while a redundant arrangement reduces the risk to about "one in a hundred million" (MS 1967: 99–100). "The new cybernetic model is a neurophysiological mapping of the way things really are. It gives a logic and a decision calculus for working out good management structures, too" (MS 1967: 100). The family-tree organisation chart, by contrast, "tells us nothing we may want to know about the way the system works" (MS 1967: 98–99). *Brain of the Firm* makes the same point: "brainlike systems are not organized into a pyramidal command structure looking like a family tree" (BOTF 1981: 232). Chapter 24, section 24.4 describes the neurophysiological model of the firm from the 1960s, and chapter 4 its later form.

The chapter ends with the question of detail. The models "preserve those structural facts that are important to the problem, but they make life easier by transforming the elements of the real-life system onto a many-to-one basis" (MS 1967: 110). How many-to-one is a choice: "We adjust the lens in order to see more or less detail as required" (MS 1967: 111). Beer calls the range of possible resolutions the *cones of resolution* (MS 1967: 113). At the apex is a model with no resolution. At the base lies "the uniquely isomorphic model: the company itself interacting with the market itself", which is of no use because "the only way to play the game at this ultimate level of modeling is to continue managing the situation as it is" (ibid.). The rule is economy: "Clearly, the most economic way to do management science is to stay as high up in the cone of resolution as one can" (ibid.). Where the scientist must go all the way down, "this is where the old-fashioned empirical research really begins" (MS 1967: 115). The result is "a hierarchy of models rather than one model. His first model is coarse, his second finer, and so on down. The finer models deal with

parts of systems, and lock into coarser and more complete models higher up the cone" (MS 1967: 115).

Models nested within models, each describing the whole at its own level of detail, bear a family resemblance to the later principle of recursion (chapter 6). The texts do not say that Beer derived one from the other, and the cones of resolution concern the scientist's models, not the structure of the firm.

27.5 A worked case: interactions, self-organization, identity

Chapter 5 of MS ("It Works") shows the hierarchy of models in two cases from practice. Beer first warns against techniques used alone. Mathematical programming "is best thought of as one of the techniques by which systemic models may be quantified", and the usefulness of an OR team "lies in its ability to make a model of the whole (relevant) enterprise" (MS 1967: 122).

In the first case the conceptual model "was drawn from ecology, because this is the science that considers an organism interacting with its environment" (MS 1967: 123). It had two boxes, company and environment, in a closed loop, with nothing yet specified inside them. Even so, conclusions about stability could be drawn, because they follow from the relationships: "Its general behavior is determined more by interactions than by the things that interact" (MS 1967: 126). The same priority of relations over components runs through Beer's later accounts of holism (chapter 26).

The next model had to locate the decisions, and Beer found that the system makes some of them itself: "sometimes the system itself effectively makes the choice"; "we are talking about the *self-organizing* properties of systems" (MS 1967: 128). "Management relies more heavily than it often realizes on the system's intrinsic ability to do the right thing" (ibid.). The general principle is a variety argument: "If the managerial systems we create were not basically self-regulating, we should never be able to manage them; they would generate too much complexity for us to cope with" (MS 1967: 130). Self-regulation makes the managed system manageable at all, and the same argument later grounds the primacy and autonomy of System One (chapter 7, section 7.2). The servo model showed "by default, what was *not* self-regulating: That is to say, where managerial decisions

had to be taken, on what evidence, and to what effect" (ibid.). Beer adds: "Few businesses know these truths about themselves" (ibid.). The chain ran from ecology through general systems theory and servomechanics to a mathematical program, so that the final computation "is actually *about* the real-life situation" (MS 1967: 131).

The second case, siting a factory, turns on identity. The distribution network is one of "those systems that have a total identity that means more than the sum of the parts"; "it is a *machine for distributing*" (MS 1967: 132). "Its integrity as a system depends upon these particularities. Therefore, if we seek arbitrarily to change the location of a major factory, we destroy that machine's identity and integrity" (MS 1967: 133). In the later books, identity as something a system has and can lose becomes part of the definition of viability (chapter 5, section 5.2).

27.6 Control as the continuous function

"Much more important, because it is continuous and sustained, is the manager's function of control" (MS 1967: 141). With this sentence chapter 6 of MS, "The Viable Governor", turns from policy and decision to the third function, and the book comes closest to cybernetics. Beer defines being in control by behaviour after a disturbance. A system in control returns to its pattern, and "The best word for "being in control" in this sense is *stability*" (MS 1967: 143). He warns against an indirect criterion. Systems in control usually look smooth, so people may take smoothness as the evidence; if so, "they may come to regard smoothness instead of in-control-ness as the object of the exercise, *and this will make them resistant to change*" (MS 1967: 144). The appearance of order can become a goal in itself and obstruct adaptation, a theme that returns in 27.11.

From this he introduces the discipline: "if cybernetics is the science of control, and if management might be described as the profession of control, there ought to be a topic called *management cybernetics*—and indeed there is" (MS 1967: 144; compare DC 1966: 254). The formula comes from DC, which states it twice. The introductory overview reads "Now if cybernetics is the science of control, management is the profession of control", adds that this holds in a certain type of system, and concludes that one may recognise "the subject of management cybernetics" (DC 1966: 239). The chapter on cybernetics draws the consequence for OR: "For cybernetics is the science of control; and management is the profession of control. It follows that models drawn by the OR scientist from cybernetics have a

direct bearing, an immediacy, which models drawn from other sciences lack" (DC 1966: 254). In MS the formula introduces a particular conception of control, set out in the next sections. Chapter 1, sections 1.1 and 1.4, follow the definition of cybernetics through the later books.

27.7 Implicit control

The model is the Watt governor, in which "Controllability is *implicit* in the operation of the machine" (MS 1967: 145). Beer sets it against a prison governor who controls by periodic inspection, where the lags between inspections defeat the control (MS 1967: 145–146). The steam governor "is an implicit controller: Variables are brought back into control *in the act of and by the act of* going out of control" (MS 1967: 147). There is no separate act of checking and correcting. Implicit controllers "depend for their success on two vital tricks": "continuous and automatic comparison of some behavioral characteristic of the system against a standard" and "a continuous and automatic feedback of corrective action" (ibid.).

The same principle appears as "intrinsic control" in BOTF (1981: 86) and HOE (1979: 91); see chapter 2, section 2.7. HOE ties it explicitly to requisite variety: "This regulatory process of INTRINSIC CONTROL sees to it that Ashby's Law is automatically obeyed" (HOE 1979: 91). BOTF applies it to the firm: "From the standpoint of senior management, that is to say, there are intrinsic controllers at work which do not, or do not normally, demand attention" (BOTF 1981: 86). It then complains that many senior managers "not only attend to these implicit controllers but interfere with them and stop them working" (ibid.), using the word that MS had used.

Beer applies the governor to management practice. "There is a difference between a self-regulating system that one confidently expects to go right, and a self-regulating system that cannot go wrong. Management, I fear, almost always uses the first. It ought to be the second" (MS 1967: 147). "Management by exception" is "a way of trying to express the need for implicit control", "But this is not enough" (ibid.); in practice "it becomes impossible to detect what really is an exception, until it is too late" (MS 1967: 149). The reason is requisite variety, invoked for the second time in the book: "the variety of the controller must be at least as great as the variety of the situation to be controlled, and this requirement is likely to be falsified" (MS 1967: 149). The remedy is to change what is measured. Beer proposes "an output of our system that we expect to remain

steady", such as the ratio of planned to actual time, which "reduces variety straight away" (MS 1967: 150). Choosing a measure that should be stable and controlling deviations in it is the move the later books make with their indices of performance (chapter 16, section 16.5).

27.8 Ecology: viable governors

The steam governor controls one variable in a designed and fully known machine. Most managerial systems are not like that. For systems whose variables cannot all be identified, Beer turns to ecology: "The fact is that living systems—interacting animal populations—are intrinsically controlled. They are *viable* governors" (MS 1967: 151). The chapter takes its title from this sentence.

Management usually controls high variety "by dividing them into subsystems" with "sufficient sub-controllers to absorb the variety"; this "is sound practice in cybernetic terms, but it is not the only nor the most economical approach to the job" (ibid.). An ecological system has no such apparatus. "There are no managers, no controllers, no sub-controllers, no bureaucracy, and no paper work"; there is "a vast network of interacting governors", and "no unique feedback, no unsupported control loop, on which the whole system depends" (MS 1967: 153). Beer concludes that "just because of this, the whole business is an excellent model of business itself" (ibid.). Stability from a network of mutually regulating parts, with no single loop on which everything depends, connects with the redundancy argument of 27.4. It also connects with the later treatment of System One, whose parts regulate one another before any metasystem intervenes (chapter 7, section 7.4, and chapter 8).

27.9 Homeostasis and ultrastability

Beer credits Ross Ashby with the discovery of these self-regulating properties and names the kind of self-control homeostasis (MS 1967: 153). A homeostat "holds the critical variables of the system stable within *physiological* limits", and these limits "are not arbitrarily imposed from outside, they are generated from within" (ibid.). Here the governor's standard has moved inside the system. The example is body temperature, held at 37°C "because the organism itself recognizes its own optimal working temperature" (MS 1967: 154). The management interest is immediate: "if it is possible to have a self-regulating system

that implicitly arranges its own stability, then this is of the keenest management interest" (ibid.).

The second property is ultrastability. A servomechanism copes with known and nominated inputs, but big managerial systems "are indeed shaken by all sorts of disturbances that we may not have thought about when we arranged the set of management controls" (MS 1967: 154). Ultrastability is "a capacity in a system to regain equilibrium after any kind of perturbation, including kinds the designer did not have in mind" (MS 1967: 155). BOTF also credits the concept to Ashby and places it in physiology: it "was devised by Ross Ashby specifically to explain, also in mathematical terms, the nature of physiological homeostasis" (BOTF 1981: 144).

Beer limits the claim: "There is, in short, a threshold of disturbances beyond which the system is denatured, if not actually annihilated" (MS 1967: 156). The mechanism draws its power from not needing to know the causes of disturbance. It "recognizes the results of disturbance rather than the nature of disturbance, and takes action to avoid unpleasant consequences without attempting to resist their unknown causes" (MS 1967: 158). In the later books this becomes the principle of the black box: regulation works on observed behaviour, without a full account of the mechanism (chapter 2, section 2.5).

Textual note: The definition of ultrastability in MS ("any kind of perturbation, including kinds the designer did not have in mind", MS 1967: 155) and in the BOTF glossary ("perturbation by unknown or unanalysed forces", BOTF 1981: 403) agree in substance but differ in wording.

27.10 A new model: company and market

Beer then draws company and market as two boxes of dots: "Each dot represents a possible state of the company or the market" (MS 1967: 157). The dots stand for each system's variety, and a circle encloses the preferred states. "Homeostatic equilibrium is reached when what is happening in each subsystem results in the representative point of the other system being chosen from its preferred set of states" (ibid.). Where the Watt governor held one machine to a standard, this model holds two coupled systems within each other's preferred states. Beer notes that the equilibrium is "precisely the criterion of "smoothness" that we noticed much earlier" (MS 1967: 158), the smoothness that, taken as an end, breeds resistance to change (27.6). If one subsystem is pushed out of its circle, the whole

oscillates "until both points, and not just one of them, have returned to safety"; Beer reports that "Ashby called this part of the mechanism "self-vetoing."" (MS 1967: 158).

BOTF uses the same construction and the same picture. When two homeostatically regulated systems are coupled, "a meta-control operation may be envisaged. It works as a self-vetoing system, and is depicted in Figure 26" (BOTF 1981: 145); the caption reads: "Each dot represents a total configuration of the system, dots contained in circles represent satisfactory states" (BOTF 1981: 146). HOE uses the circle for a system's stable range, "within physiological limits indicated by the circle surrounding the dot" (HOE 1979: 381). The model of coupled homeostats with preferred states is thus present in 1967 and recurs in both later books. Its best-known later use is the homeostat between Systems Three and Four (chapter 11, section 11.1).

The real case has more parts: "the cybernetic models we use are such multiple, polystable homeostats", with "little homeostatic subsystems in every one of the boxes drawn, and […] homeostatic supersystems that link the boxes together" (MS 1967: 158–159). This describes a layered arrangement of systems within systems; it is not yet the recursive five-system model.

Beer limits what the method claims: "the management scientist does not claim to make shattering new discoveries about the nature of business. He knows very well that the management understands its job" (MS 1967: 159). The aim is "to provide a rigorous account of what the manager knows" (ibid.). Such models investigate "stability, ultrastability, and the system's physiological limits", and they do not forecast in detail: "We have to face the fact that we cannot predict the future in detail. But our rigorous analysis can show that some loop of the control system is missing, that some of the laws known to govern systems of this kind are being disobeyed, or that some subsystems are placing undue stresses on others" (MS 1967: 162). Looking for missing loops, broken laws and overstressed subsystems is diagnosis. It resembles the procedure that *Diagnosing the System for Organizations* later sets out (chapters 14 and 15).

27.11 The education of systems

"We were surely right to think of viable governors as seeking, first and foremost, stability. An unstable organism, after all, is likely to go out of existence, or to go mad; our very first task, as men or as companies, is to

survive" (MS 1967: 162). Stability is the first requirement, and Beer does not leave it as the only one. A steam governor returns to its standard as often as it is disturbed; viable systems also learn. "Learning and adaptation, growth and evolution, are really implicit in the concept of survival, even though its precondition may be a static-seeming ultrastability" (MS 1967: 163). Learning is defined operationally: "the time taken to reach a stable response to a given stimulus shortens as the stimulus is repeated"; and "Individuals are certainly learning; much more importantly, the system as a whole is learning too" (ibid.). Adaptation to real change "is really a special kind of learning, which will involve some restructuring of the system itself" (ibid.). The later books assign adaptation through structural change to the metasystem, in particular to System Four (chapter 10).

Beer ends the chapter by separating management cybernetics from OR: "The cybernetician is seeking better control structures for the firm" (MS 1967: 166). In MS, OR compares alternative courses of action and management cybernetics looks for control structures. The later books are almost entirely about the second.

27.12 Automation, structure and purpose

Chapter 7 of MS ("Automation and Such") applies the argument to computers. Beer denies that management science is "really a question of making computer applications" and warns against "the mania which declares that science without computers is not science" (MS 1967: 169–170). He describes industrial development with a physiological model. Mechanization supplied energy; with advanced mechanization "the body acquired nervous control up to the level of reflex" (MS 1967: 170, 173). Automation "adds to mechanization the computational abilities of a brain", and "like a brain, automation can fulfill this task only if it is provided with criteria of success"; its mark is "automatic decision-taking capacity" (MS 1967: 173). A further phase, in which a company could formulate its own policy, "has already been called *cybernation*" (MS 1967: 174). Beer reports the term rather than coining it. On my reading, the sequence of body, reflex, brain and a level that sets the criteria of decision is related to the levels of the nervous system that BOTF maps onto the five systems (chapter 4, section 4.2). MS, however, uses it for historical phases of industry, not for the structure of a firm.

Why does this not happen? Beer's answer is structural. Departments exist because "the limitations of the human hand, eye, and brain commit us

to departmental activity"; the firm's anatomy "is a structure frozen out of time" (MS 1967: 175–176). "So we reach a point in understanding where we see that the way everything is structured really derives from a *human* incapacity to be structured differently" (MS 1967: 176). To automate the existing departments is to "enshrine in steel, glass, and semiconductors those very limitations of hand, eye, and brain that the computer was invented precisely to transcend" (MS 1967: 177). Automation of this kind even "reinforces the walls that separate one department from another" (MS 1967: 181).

The order of rethinking is purposes, policies, structures, problems and only then processes (MS 1967: 180, 182). For "anyone who has followed the general arguments of this book on the matter of the indivisibility of viable systems", automation offers the chance "to recreate the integral management that the firm enjoyed a century ago"; otherwise "we shall get what might be called rational but trivial automation" (MS 1967: 182). That information technology should serve a redesigned structure rather than freeze the old one is also central to Beer's account of Cybersyn (chapter 16). Beer applies the same criticism to banking and transport (MS 1967: 185–187) and to government, where "Examination of purposes is restricted to the elevated discussion of liberal principles; it is not undertaken in the practical context of affairs" (MS 1967: 187). He rejects the charge that he is substituting one faith for another: "Science is not a magic word, and scientists are not demigods" (MS 1967: 188). The book closes: "This book has argued that huge, not meager, savings and improvements are made possible by the integral control of integral systems" (MS 1967: 188).

27.13 Place in the development of the VSM

MS contains no five-system model: no Systems One to Five, no metasystem in the later sense, no algedonic channel, no recursive system theorem. In 1967 it does contain several elements that the later books build on:

- management cybernetics as the science of control applied to management (MS 1967: 144; DC 1966: 239, 254);
- the requisite-variety requirement and a definition of variety (MS 1967: 37, 149);
- control as a property of the system rather than an act of inspection (MS 1967: 145–147);
- homeostasis within internally generated limits (MS 1967: 153);

- ultrastability (MS 1967: 155);
- the company–environment interaction as coupled homeostats (MS 1967: 157–159);
- the hierarchy of models and the cones of resolution (MS 1967: 113–115);
- self-organizing decision elements (MS 1967: 128–130);
- identity and integrity of a system (MS 1967: 132–133);
- and the word *viable*: for the situation the manager controls (MS 1967: 81), for the firm as organism (MS 1967: 95), for self-regulating living systems (MS 1967: 151) and for "the indivisibility of viable systems" (MS 1967: 182).

Some of these reappear almost unchanged: the self-vetoing homeostat with dots and circles (BOTF 1981: 145–146; HOE 1979: 381) and intrinsic control (BOTF 1981: 86; HOE 1979: 91). Others change function. The cones of resolution describe the scientist's models, whereas recursion describes the organisation; the physiological sequence of MS chapter 7 describes the history of industry, whereas the nervous-system model of BOTF describes the firm.

The list records passages. It does not claim that Beer himself described MS as a stage of the VSM. What the texts support is narrower. In 1967 Beer already described the firm as a viable system held stable by a network of intrinsic, homeostatic controls. He had already separated what regulates itself from where management must decide, and he had already stated that "The cybernetician is seeking better control structures for the firm" (MS 1967: 166).

References

- **DC** — Beer, Stafford (1966). *Decision and Control: The Meaning of Operational Research and Management Cybernetics*. Chichester: John Wiley & Sons. Cited from the Stafford Beer Classic Library reprint, 1994.
- **MS** — Beer, Stafford (1967). *Management Science: The Business Use of Operations Research*. Garden City, NY: Doubleday, in association with Aldus Books, London.
- **HOE** — Beer, Stafford (1979). *The Heart of Enterprise*. Chichester: John Wiley & Sons.
- **BOTF** — Beer, Stafford (1981). *Brain of the Firm*. 2nd ed. Chichester: John Wiley & Sons. (1st ed. London: Allen Lane, 1972.)

Appendix

- A. Chronology of Beer's books
- B. Textual notes: where Beer's formulations differ
- C. Terms Beer attributes to others

A. Chronology of Beer's books

Source: the list "Books by Stafford Beer" (first publication dates) and the chronology "Threads From a Life" compiled by the editor David Whittaker (TBYT 2009: 352–361). The abbreviations mark the books used in this text.

- **1926** — Anthony Stafford Beer born in Fulham on 25 September (TBYT 2009: 352).
- **1959** — *Cybernetics and Management*. English Universities Press, London. [not yet used]
- **1966** — *Decision and Control: the Meaning of Operational Research and Management Cybernetics*. John Wiley, London. (DC; Lanchester Prize of the Operations Research Society of America, TBYT 2009: 356)
- **1967** — *Management Science: The Business Use of Operations Research*. Doubleday, Garden City, New York, in association with Aldus Books, London (listed in the chronology, not in the book list). (MS; chapter 27)
- **1972** — *Brain of the Firm*. Allen Lane, London. (1st ed.)
- **1973** — Massey Lectures delivered on radio in November (TBYT 2009: 357).
- **1974** — *Designing Freedom*. John Wiley, London. (DF)
- **1975** — *Platform for Change*. John Wiley, London. (PFC)
- **1977** — *Transit* (poems). Cwrw Press, Lampeter; 2nd ed. 1983.
- **1979** — *The Heart of Enterprise*. John Wiley, Chichester. (HOE)
- **1981** — *Brain of the Firm*, 2nd ed. John Wiley, Chichester. (BOTF)
- **1985** — *Diagnosing the System for Organizations*. John Wiley, Chichester. (DTS)

- **1986** — *Pebbles to Computers: The Thread* (with photographs by Hans Blohm). Oxford University Press, Canada.
- **1988** — *One Person Metagame*. Stafford Beer Foundation, Toronto.
- **1990** — Team Syntegrity launched at the Manchester Business School in January (TBYT 2009: 359).
- **1994** — *Beyond Dispute: The Invention of Team Syntegrity*. John Wiley, Chichester. (BD) — also *How Many Grapes Went into the Wine* (ed. R. Harnden and A. Leonard), John Wiley, Chichester. — DC and PFC reprinted in the Stafford Beer Classic Library.
- **2002** — Beer dies (TBYT 2009: 16, editor's introduction).
- **2009** — *Think Before You Think: Social Complexity and Knowledge of Knowing*, ed. David Whittaker. Wavestone Press. (TBYT; texts "from 1974 onwards" with one exception, TBYT 2009: 16)

B. Textual notes: where Beer's formulations differ

A collection of the textual notes from the chapters, for quick reference.

Topic	Formulation A	Formulation B	Chapter
First Principle of Organization	"with minimal damage to people and to cost" (HOE 1979: 97)	"with minimum damage to people and to cost" (HOE 1979: 565)	3.2
Recursive System Theorem	"If a viable system contains a viable system, then the organizational structure must be recursive" (BOTF 1981: 228)	"In a recursive organizational structure, any viable system contains, and is contained in, a viable system" (HOE 1979: 118); Beer: "from the opposite angle"	3.3, 6.1

Topic	Formulation A	Formulation B	Chapter
Law of Cohesion	"… the variety disposed by the sum of the metasystems of Recursion *y*" (HOE 1979: 355)	adds "for every recursive pair" (HOE 1979: 567)	13.2
System Two	"the metasystem subsuming all Systems One"; "the analogue of the spinal cord" (BOTF 1981: 172, 124)	"a **service** to System One", "damping oscillations, and nothing else" (HOE 1979: 177); "anti-oscillatory device for System One" (DTS 1985: 66)	4.3, 8
Six vertical channels	three by happenstance (environments, operations, S1 managers acting as a team) + three designed (command, System Two, audit) (HOE 1979: 142–143)	Corporate Intervention, Resource Bargain, operational linkages, environmental intersects, System Two, audit (DTS 1985: 81–82)	9.2

Topic	Formulation A	Formulation B	Chapter
Viability	the firm "intends to survive" (BOTF 1981: 75)	OED: "able to maintain a separate existence" (DTS 1985: 1); "capability for independent existence as a recognizable identity" (TBYT 2009: 107)	5.1
Variety	"roughly defined as the possible number of distinguishable states in a situation" (MS 1967: 37); "the total number of possible states of a system, or of an element of a system" (BOTF 1981: 403)	"the number of possible states of the system" (DTS 1985: 98); "the measure of complexity" (HOE 1979: 45)	2.1, 27.2
Variety sponge	control variety absorbs world variety "like a sponge" (DC 1966: 284, 293)	the Three–Four exchange, monitored by System Five (HOE 1979: 144)	11.3, 25.4

Topic	Formulation A	Formulation B	Chapter
Analogy	jacket text: "should not be thought of as 'analogy' " (BOTF 1981, jacket)	body text: "Models are more than analogies" (BOTF 1981: 75); scientific model as homomorphism (DC 1966: 113)	1.6, 4.1, 24.3
Cybersyn coverage	"seventy percent of the socio-industrial economy […] about four hundred enterprises" (BOTF 1981: 264)	"Roughly 60% of all enterprises" (BOTF 1981: 311)	16.3
Syntegrity / syntegration	"syntegrity" from "synergistic tensegrity" (BD 1994: 14)	"syntegration" as "synergistic integrity" (BD 1994: 197)	20.4
Syntegration protocol	three parts: Problem Jostle, Topic Auction, Outcome Resolve (BD 1994: 21)	eight episodes (BD 1994: 111)	22.1–22.2

Topic	Formulation A	Formulation B	Chapter
Ultrastability	"a capacity in a system to regain equilibrium after any kind of perturbation, including kinds the designer did not have in mind" (MS 1967: 155)	"the capacity of a system to return to an equilibrial state after perturbation by unknown or unanalysed forces" (BOTF 1981: 403)	27.9
Principles of Organization, Second to Fourth	body text: "the management unit, the operation and the environment", "originating sub-system" (HOE 1979: 99); "it undergoes transduction; and the variety of the transducer" (HOE 1979: 101); "cyclically maintained through time, and without hiatus or lags" (HOE 1979: 258)	Glossary of Rules, slightly different wording (HOE 1979: 565–566); the meaning is unchanged	3.2

Topic	Formulation A	Formulation B	Chapter
Axioms of Management	body text: First Axiom set with "=" (HOE 1979: 217); Second and Third "are equivalent" / "is equivalent to" (HOE 1979: 298)	"equals" in the Glossary of Rules (HOE 1979: 567) and in DTS (DTS 1985: 130)	3.4, 11

C. Terms Beer attributes to others

- *Algedonic* — Beer notes the word "dates from 1894"; he had thought for twenty years that he invented it (BOTF 1981: 401).
- *Autopoiesis* — Maturana and Varela (HOE 1979: 405; TBYT 2009: 64–72).
- *Eudemony* — Sir Charles Goodeve (PFC 1975: 167).
- *Law of Requisite Variety*, *ultrastability* — W. Ross Ashby (BOTF 1981: 41, 144; DC 1966: 279).
- *Syntegrity* (the word) — Boris Freesman (BD 1994: 14).
- *Tensegrity* — Buckminster Fuller (BD 1994: 13).
- *Inventing the future* — Denis Gabor (HOE 1979: 237).
- The self-regulating properties of homeostatic systems — "discovered by the cybernetician Ross Ashby" (MS 1967: 153); *self-vetoing* — Ashby's name for part of the homeostatic mechanism (MS 1967: 158).
- *Cybernation* — Beer: this phase "has already been called *cybernation*" (MS 1967: 174); the term is not presented as his own.
- The fluid-dynamics traffic model — "developed by Professor Lighthill" (MS 1967: 107).
- The four diagnostic points of the 1984 paper — quoted by Beer from a journal (TBYT 2009: 148).