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Leitung: Nina Ort, Oliver Jahraus

Ranulph Glanville
(The Relativity of Knowing)
Levels and Boundaries of Problems

Introductory Prelude

I believe it will be helpful if I recount a history of this text.

This piece was first written for, and presented at, the Conference on „Problems of Levels and Boundaries“ held in Amsterdam in the week after Easter, 1981. I had originally wanted to publish it in a form in which the comments of referees appeared in parallel alongside the text, in a sort of textual conversation, but this was not technically possible. The paper did not appear in the Proceedings. I put it away and it has languished ever since.

When I was approached to contribute to this volume, the editors and I decided this was a good place to allow the piece to emerge into the public gaze. So I reread the paper, and, by a piece of good fortune, also found the original notes, referees´ comments etc., which I could therefore also re-consider.

I discovered that, on occasion, the expression I used 20 years ago is somewhat abrupt (as the referees pointed out!). I can, I believe, now write of some of the issues with more subtlety and delicacy. Some of the vocabulary is not the (refined!) vocabulary I would use today. Nevertheless, I have chosen not to change the general feel of the text, hopefully clarifying and polishing it a bit while keeping its indiscretions and freshness, and retaining a certain irreverence, playfulness and hyperbole. So I hope I have retained the tone of the original. [1] Occasionally, I have made reference (even to work done since this was written) and have expanded on some of the points, arguments, concepts and terms.

The paper was written at a time when the „problem“ of self-reference was still an urgent concern amongst those involved in thinking about how we might think, and in wondering what and how we could know about knowing. (I have not written about self-reference, for long a central theme in my work, in many years.) It was also written within a particular context, i.e. for the Conference on Problems of levels and Boundaries, the anticipated audience, and the fact that most attendees were expected to have been at the first conference in the series. It was written in an intentionally sketchy form (which has not always made it easy to get to grips with 20 years later) so that it could respond to the comments of others. In effect it was a draft, and was written with overstatement, loud polemic, and (occasionally) heavy irony.

Clearly, then, it is no longer simply a text written for this publication: it is also a historical document (even if that history is only my history). It is in the peculiar position of being part of a body of work on which other pieces of work have been built, yet it has not previously been seen: so it may seem to succeed them. Such a reversal of the conventions of time is typical of the design process: think of the way architects talk of projects they hope to get built as if they already existed. It is part of a body of work which I, nevertheless, cannot see other than critically not only for what it says but for its place within that body. Yet it cannot really be seen that way by others. It is an invader, a Johnny-come-lately, a joker, a maverick.

Reading and working through the text after the lapsed time, I find myself entering into the paper and, inevitably, reflecting on it. The way I have worked at it is self-referential, reflecting what the paper is about. It also reflects what I had hoped to achieve in the original publication proposal of parallel texts, albeit transformed. I've read it, commented critically to myself and the text (as well as reading again the comments of the referees [2] from 20 years ago), and then modified it so that I feel relatively happy about

the text yet still retaining the identity of the original. This reflective and reflexive process is, of course, self-reference at work. I find that what started out as a somewhat iconoclastic academic argument has to be treated more in the context of art: perhaps some sort of latter-day cybernetic dadaist manifesto, dredged up out of a post-Beckettian slime.

Finally, in this prelude, I see this text as a sort of meditation of fragments rather than a formal argument. It is still often disjunct, a collage. It's not always coherent and cohesive. Insofar as it's an argument, the argument is not necessarily explicit. In some respects, it is, itself, more a source for an outpouring than an outpouring per se.

Over the last 20 years I have tried to find where I introduced various concepts and arguments. No matter what source I found, I always had the feeling that I was missing the real one. Now I understand why. This paper was the source. Looking after an interval of 20 years, I can see how central the thinking expressed in this paper has been in launching and developing my work since, even if it has taken me many years to try to express it in a form I consider coherent. So I am very glad this text is at last being published.

(See also the Appendix.)

Paper

"Then one day, suddenly, it ends, it changes, I don't understand, it dies, or it's me, I don't understand that either. I ask the words that remain-sleeping, waking, morning, evening. They have nothing to say. [Pause.] I open the door of the cell and go. I am so bowed I only see my feet, if I open my eyes, and between my legs a little trail of black dust. I say to myself that the earth is extinguished, though I never saw it lit. [Pause.] It's easy going. [Pause.] When I fall I'll weep for happiness." [3]

I stand accused of turning science into a circus. This I deny. In fact, quite the opposite. I take science seriously enough both to ask questions and to be interested in its range of application. This position is not unique amongst those interested in „serious“ knowledge, not is it remarkable in discussions of science (such as Popper's [4] which can be quite „unscientific“. I write as a cybernetician, a designer, an educator: that is, someone necessarily interested in ignorance, interaction, creation, the making of novelty, rather than the cold reporting of what is taken to be „fact“. I take a position that there are many things science cannot (and should not try to) account for, and that in the continuing and progressively less and less elegant modifications made to its schema in order to try to account for that which it cannot, it does no-one a favour.[5] I believe this position closely satisfies that most scientific of devices, Occam's Razor.

1 LEVELS and BOUNDARIES

1.0 What is a Problem

A problem is one of those things that something has to be done about, although we do not usually know what. The conference at which this paper was presented was focused on „Problems of levels and Boundaries“. This text is about those problems.

1.1 Boundaries and Content

We know, from our knowledge of systems, of identities, of relationships, that boundaries are edges (conceptual and/or physical) of things we are identifying. [6] We also have a notion of edges-not as things in themselves, but as containing and excluding. The coast line is seen as the beginning of something-Holland, say. [7] But is this really so? If some boundary (edge) defines some content, what defines the edge between this boundary and its content? And so on: the question regresses.[8] No, a boundary, an edge, is

itself, for itself and defining itself. Only itself. What it is, is what it is. It is not its content: in effect, what it contains irrelevant. As Gertrude Stein must have wished she had said: Eros is Eros is Eros. (R. Mutt, aka Marcel Duchamps, did say this, in his own abbreviated manner.)

1.2 Boundaries and Levels

If a boundary defines only itself, it has no content. To make content it must define more than itself, but the boundary only defines itself. If it has no content, it has no level, for level assumes some sort of nesting, some sort of dependency, some sort of if… then (such as the content within the space distinguished by the boundary). A boundary is itself, a whole: and this concept is completely detached from the concept of level (i.e. part). There is nothing with or from which hierarchy can be created. Yet we nest things: for instance, we generalise. So levels come about from our organising, or our cognising. There are no levels but those we make, which we make by assembling how we see whatever it is we see – i.e. the identities we perceive and construct in the boundaries that define themselves. [9] In a Humean sense, we are at the centre, and what we understand is of us. Therefore, I can assert, „There are no levels", only the levels I create!

1.3 Levels and Hierarchy

Nevertheless, we believe in levels and in hierarchy, and we believe they are to be found in The Great Out There. We experience life as constructed in hierarchies. Amongst the least sustainable of our ideas concerning the assembly of boundaries (and bounded things) into various levels is the idea that such assemblies are inherent in the things so assembled; and that these assemblies make uniform hierarchies. This is not so. They are not. Hierarchies and multi-peaked hierarchies – which I refer to as heterarchies – are made by us, observers. Not only do individuals construct heterarchies, we construct them ambiguously – in at least two ways

Firstly, we create them without consistency between events and our accounts of them (which is why Zadeh invented fuzzy sets).

Secondly, the assembly together of heterarchies developed by different individuals enriches this ambiguity, creating not only alternatives but also the variations and contradictions of inter-personal assemblies.

Thus, the levels we may have made as individuals are destroyed, for any bounded thing may, in principle, appear anywhere. [10], [11]

1.4 Ambiguity and Constancy

Thus, this ambiguity is not merely a social matter, it is also (and more profoundly) individual, i.e. lies in where we understand sameness to exist. A popularly supported fallacy is that different individuals understand the same when they utter what we take as being the same e.g. sound. What do we mean when we say „same", if not a cognitive entity?

Since understanding is not an external activity, each understanding of a supposedly commonly held thing will be different, formed tinted and tainted by the understander's understandings. Further, there is that other, equally pernicious fallacy: that each individual means the same every time he makes the same utterance. What same? Where is it situated? Whose is it? [12]

1.5 The Problem of Levels and Boundaries

The problem–of levels and boundaries–can be looked at so that it appears, at heart, very simple. It lies in our expectations. We assume this sameness: we do not question it: we dare not. Our problem may be (re)solved – or even dissolved – by transferring it: by invoking constancy over time (hence, memory), or the metaphysical identity of the two in one. [13] We assume a sameness as being in the thing(s) (our experience of such things?), but this sameness is a fiction. When we make boundaries, we are asserting difference. Sameness helps us cope, but it is not of the thing(s). It is of and in us. We believe in this sameness, and the problem comes about because the sameness does not lie where we believe it to lie, but rather in our individual perceptions of what we come to call „Thing(s)". It is in us. When we look at sameness in this somewhat Marxist and Hegelian way it is no longer a problem. The problem vanishes – as problems tend to do.

2 SELF-REFERENCE, PARADOX and HOW WE VIEW

2.0 Knowledge and Knowing

Let us be grateful: we are essentially ignorant. Whatever knowledge we have is an image of each of us, the knower, rather than of The Great Out There (aka external reality). Since there is no (known) thing, and no thing known, outwith (our) knowledge, [14] and since there is no (sensible) knowledge without a knower, our knowledge may not even be a reflection of the so-called thing. It is, rather, a bringing into being of what becomes that thing, a Kantian reversal in which existence is predicated on knowing, and not vice versa. As far as we sentient being are concerned, there is no thing without knowing. This is why we are obliged to bring things into being, and why the things we bring into being are personal. [15] But this means that – as far as we are concerned, and that is as far as we may be concerned – there are no things without us. Of whatever other things there may be, we know nothing. Not even whether there are, or may be, things we do not know about. We know, in this sense, nothing: of the world, The Great Out There, we know nothing but the distinctions we have drawn, which are ours, and which we call our knowledge. And, perhaps, not even this. [16]

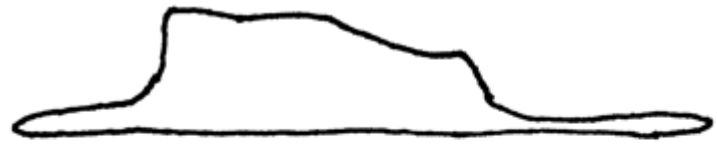
Let us be grateful we are not cursed with knowledge. We are free to learn!

2.1 The Little Prince's Digested Elephant

I will write using a metaphor. In so doing, I shall assume something I set out to demonstrate. This circularity maybe broken by remembering the levels of representatory construction in the metaphor. It could also be resolved by a very pedantic turn of phrase.

Saint Exupery's „Little Prince"[17] describes

as a snake that has just eaten an elephant.
The scientist says it is a hill.
I say it is George Melly's hat.
We watch, and whatever it is subsides.



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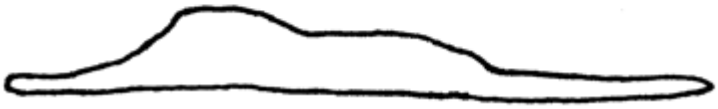

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The Little Prince says the elephant has been digested.
The scientist says erosion has occurred.
I don't know what explanation I give, but I'll think of something, if you insist!

But which is right? We don't know, because, in this way of saying things, our knowing depends on our knowing in the first place. We may talk of usefulness, of consistency, of whatever – the application of which may give rise to a notion of „betterness“. But these are forms of knowing, too, just as is the judging of comparison. And all this knowing depends on us being party to it. If we insist we can know through careful and proper investigation, all that does is peel away the a layer of the infinite onion. There is always another layer and we are always left depending on our understanding.

We might believe we could ask the thing itself. But it will reply by maintaining silence, to each question, because, in our knowing, there is no thing without our knowing. There is no thing itself to ask. It (also) depends on our knowing. We can only ask ourselves. There is only our knowing.

2.2 Science and Knowledge

Of all our (forms of) knowledge, the one that is, historically, most inclined to ignore or forget this – our involvement – is science. Science claims fact. But there are no facts, of the sort science would have us believe, because there is no Great Out There of which we can know without us to do the knowing. Yet the scientific observer remains untouched and unmoved, oblivious.

This scientific orthodoxy allows science to deny that there are alternative points of view, (not so much of detail: alternative to it). At least until it can no longer support its current orthodoxies and is overtaken by a Kuhnian revolution, [18] generating new visions and new orthodoxies. Like all good survivors, it clasps the new vision to its breast, claiming that it was its own, all along! Science, thus, has less to do with knowledge – of the essential ignorance from which we may develop knowledge – than we have become accustomed to think; except in a highly ritualised and particular way. Because of this, science operates, in effect, a form of prestigious and underhand censorship. What is amazing is not what we think we learn

from science. It is our willingness to continue believing in it, and to dignify this, our poor way of understanding, by the use of the term „Science“ to inflate it. Science is, or should be, better than this!

2.3 Self-Reference, Levels and Paradox

A significant current example of the inappropriate credibility of science lies in the so-called „Problem of self-reference“. Self-reference generates a problem of levels and boundaries. One way of presenting it is through Goedel's Theorem. Briefly put, Goedel's Theorem tells us that, within the confines of arithmetic, usually generalised to logic, a simultaneously complete and consistent description of a system may not be made within that system. Should we want to make such a description, the description must be on a higher level, i.e., on a metalevel above the system, rather than remaining within the level of the system. So we must bound these systems and arrange them in levels. An infinite regress of meta-meta-levels is set up. But complete and consistent description inwith the system is vitally necessary if a system is, for instance, to reproduce itself, as cells seem to – thus establishing their autonomous identity and (therefore) boundary. [19]

2.4 Handling Paradox

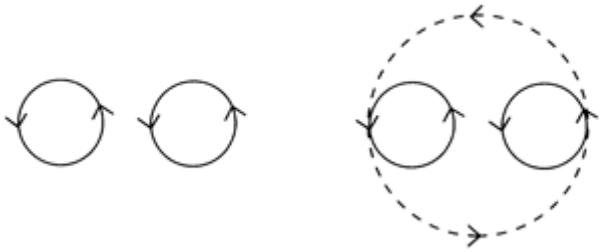
Thus, a contradiction, a paradox, can appear when some form of knowledge constituted as a description of our perceptions of The Real Out There is allowed to take over and become prescriptive. [20] But while we seem prepared to allow description to take over like this – especially when the description is constituted within that system we call science – we remain troubled by those phenomena, experiences and ideas we cannot account for when we do this. So we stretch and pull the artifice-knowledge – in an attempt to distort it to accommodate the troubling phenomena we wish to adumbrate, in a process of constant refinement and extension. We know this patching-up cannot work, because (as Goedel has shown us [21]) the descriptive system itself tells us it cannot: to do so it would have to accommodate a crippling paradox, denying the very qualities we most admire in it. But we live in hope! In spite of all the attempts to adjust logic so that it can account for aspects of self-reference, self-reference remains as remote as ever.

It is this desperately unattainable and doomed attempt to stretch and pull that is the true circus, and, of course, those who do it make up the circus acts. What we need instead is a change: the bars of the metaphorical cage must be broken. The forbidden self-reference looks tantalising and impossible to those clawing out towards it. However, the moment self-reference is accepted, this problem vanishes: the task of working out how to enrich old ideas becomes a possibility and we can look at logic in a new light. Thus, we may reconsider and enhance logic. I call this way of acting „Jumping“; and it is a vital creative skill. Self-reference is only a problem – and hence a concern worthy of the hours of discussion and the massive input of thinking that have been put into it – to those who, needing it, can't bring themselves to accept it. The levels we have constructed and boundaries we have drawn have been allowed to make, and then maintain, the problem!

2.5 Cutting the Circle: the Wheel and its Trace

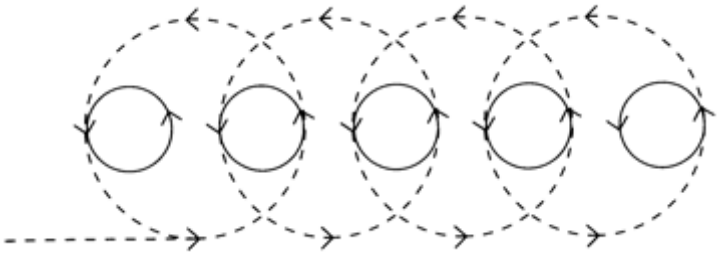
I would like to illustrate and explore this metaphor by using diagrams. It is as if the scientific (i.e. in this case, logical) response to self-reference were to follow a line, taking a linear form. [22] The logician pursues linear argument relentlessly, extending his arguments towards the unattainable goal of that autonomous and circular phenomenon, self-reference-without ever being able to reach it. Jumping is, as it were, transferring from a line (as a way of conceiving) to a circle. But what is the line? We can see it as the circle, cut and laid out.

An example may show this. It is of two autonomous systems forming another autonomous system constituted of the information exchange (conversation) between them.



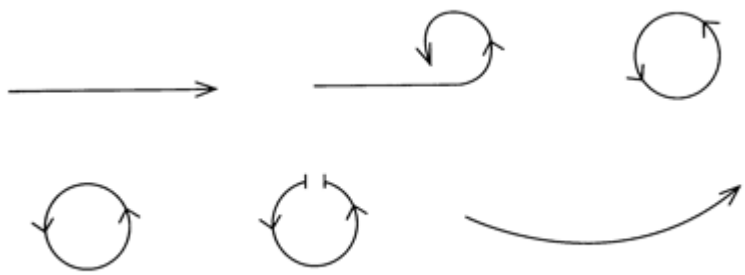
(two autonomous systems are forming another autonomous system: a conversation)

Here, two self-referential entities (participants) take part in a third entity (the conversation) which is a „living“ entity-that is, the conversation consists of the active interaction of these entities passing information. [23] So we depict such a system as a conversation



(the rolled trace constituted by conversation)

The conversation exists between these two. For an outsider, however, it is not the circle of their processes, but the trace left of such a circular process (akin to the track left by a wheel moving on damp sand). In order for the external observer to understand (and explain) the conversation, the circle is cut and laid out, [24] thus



(the trace (line) rolls up and becomes a circle - the circle: cut! - is laid out to a line)

Here is the difference. From inside, the system is a whole and living process, but from outside it's seen as linear. What happens with the logician and self-reference is the perpetual extension of the line failing to make a circle. In contrast, the jumper makes a new circle

The linear is an imprint, a trace, that is a special case of the circle, complete with necessary distortions.[25]

3 LEVELS and BOUNDARIES and BOUNDARIES and LEVELS

3.0 Science and Doing

The linearity of science (both as a pursuit and in the metaphor of the circle and its trace) is, of course, a gross caricature and well and truly over-stated. Science constantly and successfully absorbs new phenomena, giving new and valuable predictions and applications, extending its range. It also has its revolutionary phases. Yet the confusion persists. Science is, in truth, an activity, and not the trace (the imprint) of that activity-for all that science has traditionally taken the trace for the wheel. The confusion between these two leads to the problem, to the ability of the imprint to take over, becoming distortive and potentially prescriptive.

The activity that is clearly involved in doing, and in all those aspects of personal involvement and understanding, is what I typify (and explore elsewhere) as design. Knowledge, according to my view, is designed. [26] Design is not faced with either the levels or the boundaries of the problems I have indicated, for it continuously makes, remakes and plays with these levels and boundaries. [27]

3.1 Science and Design

Lakatos's characterisation of science taking the form of the Scientific Research Programme [28] is, in principle, another argument for design. The designer incorporates by doing, at many different levels, continuously creating new identities. The collective designer that is the body of scientists creating the (social) phenomenon of science is, according to Lakatos, doing the same. But, in himself, the scientist doesn't see this pattern, because he ignores his action as an agent. He is an actor, even when he forgets it is he who does, that the knowledge of his bounded identities and their assembly together into heterarchies of levels is his. What he is doing, as Scientific Research, is a form of (highly restricted) design. This does not mean the scientist and the designer are the same, however – just that they share something in common, their activities being related.

3.2 Where Problems Lie

From the preceding we can learn about aspects of problems. Problems exist not in those things which we postulate so we can tag our percepts onto them. Problems exist in us, as a response to those percepts, or to their description in the light of how we have come to think of and compose them. Our creation, and then our use of boundaries, give us problems: that we define this way or that, then finding the two definitions do not match while we look for constancy and consistency. That we become entrapped in one definition which is no longer appropriate. And our creation, and then our use of levels give us problems: that we restrict our view to one level at a time; that we forget the principle of inclusion rather than exclusion; that we disregard the difference between doing and describing (or, rather, we turn it into the meta problem) rather than remembering the distortion in cutting the circle and laying it out.

3.3 Levels and Boundaries

It follows from the argument that problems derive from (our use and way of thinking of) levels and boundaries. Levels and boundaries are our constructs, used to identify and relate the worlds we create. [29] Levels and boundaries have been examined for a long time and by many people, as has how they interact with the world view so created. They are not a problem, although they are open to disagreement.

This is exactly what I have been claiming about levels and boundaries-that they are individual constructions and, as such, open to disagreement when treated otherwise. When we forget this, we may create a problem. But, problems deriving from levels and boundaries-should there appear to be any problems of levels and boundaries-derive from the levels and boundaries of those levels and boundaries. Yet there are no levels and boundaries other than those we make. So the problem is ours. There can be, in the first instance, no levels and boundaries of levels and boundaries, since these imply that there are, in the first instance, (self-referential) levels (of levels) and self-referential boundaries (of boundaries). The logical and linear pursuit of the argument leads to this paradox. This is the so-called problem, and it is of a different kind: it is a problem of our making, not a problem of levels and boundaries! It is a problem of the confusion: are the levels and boundaries in us, or in the (purported) things?

Put another way: the problems we have been discussing are problems associated with levels. The presence of levels creates these problems: the problems lie in the levels (which we construct). So the problems of levels result from levels of levels. But there aren't any levels other than those we construct, so there are no levels of levels and therefore there are no problems of levels – indeed there are no problems!

3.4 Read My Lips: It's Self-Reference, Stupid!

The nature of the problem thus becomes clear. It is the problem of self-reference. I have already argued that this is only a problem, however (at least in any conventional sense), because we are determined to make it one. When we change our way of looking, it vanishes, it dissolves. By doing this, by no longer confusing (in the terms of the metaphor used here) the line for the circle it has been torn out of, the trace with the wheel that leaves it on the sand, we resolve the problem. Indeed, we do more. By defining levels and boundaries, by recognising them as a psychological and hence a world constructing, knowledge creating activity, we have at one stroke both a way of making problems and a way of solving them. [30]

The problem of levels and boundaries is that we think the problem lies in the levels and boundaries. So the problem is one of levels and boundaries vis a vis the levels and boundaries of problems.

Put another way: in this respect, the problems we have been discussing are problems associated with levels, which depend on boundaries. The presence of levels creates the problems: the problems lie in the levels (which we construct). So the problems of levels (and their defining boundaries) result from the levels of levels. But there aren't any levels other than those we construct, so there are no levels of levels and therefore there are no problems of levels-indeed, there are no problems! There are no problems of levels (and boundaries) since there are no levels and boundaries for there to be problems of.

3.5 The Circus

Maybe circus was the right word, after all.

I give Italo Calvino the ending. „Leave me like this. I have come full circle, and I understand. The world must be read backwards. All is clear.“ [31]

Appendix

I wrote, in a preface intended for the parallel text original, „In a sense, this is a paper about scientific ethics, and about responsibility. In examining what we currently understand of levels and boundaries, and then in considering the implications of such understandings in our conception of problems, the paper takes up the overt challenge of the considerable limits, not so much of science, but of a type of thinking and presentation of science that does science neither justice nor honour: what others sometimes refer to, scathingly, as scientism.“

Footnotes

1 I have not clarified the following potential ambiguity. I claim there is no knowledge, there are no levels and no boundaries: and then I talk about them. What I am getting at is this: we make them. When we make them, they exist. But they are not in what I here call The Great Out There. Hence the apparent contradiction whereby I say in one sentence that they do not exist, and in the next talk about them and their qualities etc..
I believe the context makes this clear, as long as the intent expressed in this footnote is kept in mind.

2 J Christopher Jones, Jim Ozinga, Karel Soudijn and John Zeisel

3 Samuel Beckett (1958) "Endgame" London, Faber and Faber

4 Karl Popper (1969) "Conjectures and Refutations" London, Routledge and Kegan Paul

5 I have written about this in Ranulph Glanville (1981) "Why Design Research?" in Jacques, R and Powell, J "Design/Method/Science" Guildford, Westbury House, "Researching Design and Designing Research" Design Issues vol. 15 no 2

6 The study in Cybernetics and Systems of boundaries, in particular in the manner of drawing distinctions, was inspired and driven by George Spencer Brown (1969), "The Laws of Form" London, George Allen and Unwin

7 Boundaries need not be of physical things.

8 I have criticised Spencer Brown's conception in several publications. See, for instance, Ranulph Glanville (1979) "Beyond the Boundaries" in Ericson, R (ed), "Proceedings Society for General Systems Research Silver Jubilee Conference, London" London, Springer Verlag, and Ranulph Glanville (1990) "The Self and the Other: the Purpose of Distinction" in Trappl, R "Cybernetics and Systems '90" the Proceedings of the European Meeting on Cybernetics and Systems Research, Singapore, World Scientific

9 So, if we insist it has to have content, it is its own content.

10 And all this without asking the questions of whether (and then how) we might know the same when we utter what seem to be the same sounds: see the next section.

11 This is the non-hierarchical character of Gordon Pask's entailment meshes. See, for instance, Gordon Pask (1976) "Conversation, Cognition and Learning" New York, Elsevier

12 See for instance, NNNN Polyani (DDDD) NNNN, one of many who have reminded us of personal differences in our knowing.

13 This is the central point of Heinz von Foerster (1973) "On Constructing a Reality", in Preiser, F "Environmental Design Research", Stroudberg, Dowden, Hutchinson and Ross (itself based on George Spencer Brown's dictum "Draw a Distinction!"), which comes from the work of Jean Piaget (1955) "The Child's Construction of Reality" New York, Basic Books. Recently, I have written about this in dealing with the question of how (in principle) a constructivist viewpoint can lead to an apparent objectivity: see Ranulph Glanville (forthcoming) "An Observing Science" Fundamentals of Science.

14 In agreement with Ernst von Glasersfeld (1990) "An Exposition of Constructivism: Why Some like it Radical", in Davis, R, Maher, C and Noddings N "Constructivist Views on the Teaching and Learning of Mathematics" Reston Va, National Council of Teachers of Mathematics, and in G Klir (1991) "Facets of Systems Science" New York, Plenum Press, I would not now use the word knowledge. It suggests an existence independent of a knower. But there can be no knowledge without a knower. Therefore, I prefer the word knowing. In my new lexicon I make virtually no use of the word knowledge. Gordon Pask and I had a long-running argument about this in the late 1970's and early 1980's, which I am glad to say resulted in eventual agreement.

15 Hence George Spencer Brown's command, "Draw a Distinction!" in his Laws of Form.

16 I am not asking how we could know there is a we to do the knowing! But it is a question that has to be faced.

17 Antoine de Saint Exupery (1945) "The Little Prince" London. Heinemann

18 Thomas Kuhn (1970) "The Nature of Scientific Revolutions" 2nd ed, Chicago, Chicago University Press

19 See Humberto Maturana, Francisco Varela and Ricardo Uribe (1972), "Autopoiesis", University of Chile, Santiago

20 See Ranulph Glanville (forthcoming) "An Observing Science" Fundamentals of Science.

21 Kurt Goedel (1931) "Uber formal Unentschiedbare Sätze der Principia Mathematica und Verwandter Systeme", Monatshefte für Mathematik und Physik vol. 38: this epoch making paper effectively demolished David Hilbert's meta-mathematics programme. It was followed by arguments by, for instance, Turing, Church and Quine, all to much the same effect.

22 The view of knowledge as a linear progression-although few who seriously study the history and philosophy of science would agree with such a simple linear model.

23 See, again, Gordon Pask (1976) "Conversation, Cognition and Learning" New York, Elsevier. Pask's work on conversation is based in circularities: that which can be studied is circular, concepts are circular, and those who do the studying (called p-individuals) are also circular.

24 The similarity with how biologists have dealt with the "problem" of life, killing it to study it, comes to mind. The work of Maturana, Varela and Uribe on "Autopoiesis" deals with this problem, talking of life rather as the process of continuing living.

25 This is sometimes (incorrectly, I believe) thought of as unfoldment.

26 I have argued that science is a specialised and highly restricted form of design.

27 See, for instance, Ranulph Glanville and Robin McKinnon-Wood "NOAH: the Ark of Knowing in a Learning Environment" in Trappl, R (ed) Procs 13 EMCSR, Vienna, University of Vienna and Austrian Society for Cybernetic Studies, 1996

28 Imre Lakatos (1970) "Falsification and the Methodology of Scientific Research Programmes" in Lakatos, I and Musgrove, A (Eds) (1970) "Criticism and the Growth of Knowledge" Cambridge, Cambridge University Press

29 This is part of what is so elegant in George Kelly (1955) "A Theory Of Personality", Norton, New York, one of the few brave accounts to allow our presence and participation in our thinking during the era of the behaviourist psychology we are still recovering from.

30 That this is an apparently two edged sword is a function of how we think of boundaries. But I have no room to elaborate that here.

31 Italo Calvino (1977) "The Castle of Crossed Destinies" London, Martin Secker and Warburg

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Ranulph Glanville
CybernEthics Research
52 Lawrence Road, Southsea, Hants, PO5 1NY, UK