THREE PHASES OF SCIENCE: A METHODOLOGICAL EXPLORATION[1]

Gerard de Zeeuw[2]

University of Amsterdam
University of Lincolnshire and Humberside
London School of Economics

Abstract

Science has responded to new questions by developing new theories as well as new methods. Some have said, therefore, that ‘reality’ has been teaching science by posing relatively simple questions before the more complex ones.

At present science is challenged by an increase in people’s ability to express themselves inside science, both as individuals and as collectives. It is not clear what the effective answer is.

The chapter describes how science has responded to a number of similar challenges. Some general trends can be recognised that suggest a response to the present challenge.

Key-words: organisation, observation, action, object, knowledge

---

1 In 1997 this paper appeared as a research memorandum of the Nijmegen Business School, University of Nijm egen, edited by J. Achterbergh, R. Espejo, H. Regtering, M. Schwaninger under the title of Organizational Cybernetics. It also appeared as working paper nr. 7 of the Centre for Systems and Information Sciences, University of Humberside, 1996, ISBN 1 86050 025 0.

2 E-mail address: gerard@educ.uva.nl

1. Introduction

At the turn of this century a change took place which was considered a revolution, with hindsight—the 'Second Industrial Revolution' (1880-1920). Industry set up large scale laboratories to harness and systematise existing scientific creativity, for example in the chemical industry. Science had to deliver what industry wanted and thus became part of a mass development. The new demands boosted old and new disciplines, inside and outside academe (Blauwhof, 1995).

Changes of a similar (mass) nature took place after the second world war. There was a growing need for contributions like those of operational research (Rosenhead, 1989). Companies increasingly wanted to know what people could contribute to the economic process (Dehue, 1990). An intense interest developed in helping people to become better qualified as citizens, to which end new academic fields developed (Ten Have, 1973; Reason and Rowan, 1981).

Next to such similarities there also is an important difference. In the 'Second Industrial Revolution' industry had taken command over what was to be studied, replacing science as a decision maker concerning what to deliver and what to study. However, it had not changed the nature of science, which thus could maintain its characteristic *disinterest* in the users of its results. After the second world war this attitude was challenged.

Users started to acquire an interest in *how* science studied, not only in *what* it studied. It was noticed, for example, that the act of observation could influence what was observed, and that the methods of research could determine what was found. This appeared difficult to accept, both to users and scientists—even though in some areas, like physics, scientists had been facing the same difficulty for decades.

It came as a shock, for example, when Kuhn (1962) demonstrated that science is not an a-historic process, something above and outside of history, but that it generates what its context allows it to generate—in terms of area as well as of content[3]. What people outside of science are interested in may influence what is studied, but also change the questions science can answer.

Something happened, therefore, that had not happened before: the *user* acquired a voice *inside* science[4]. Some of the difficulties this created have

---

3 The successes of science often have obscured the fact that it has been possible to build pyramids, establish empires, initiate voyages of discovery and even develop science without the help of science. These exploits have been based on processes of collective learning that could be expressed in many ways, for example, in early Christian monasteries, in medieval guilds, and, eventually, in organised science.

4 The notion of a voice inside science is not meant to mean that science is increasingly commissioned (and at the beck and call of who pays). The notion refers to empirical testability. Usually one tests

become canonised. Examples are notions such as self-fulfilling and self-destructing prophesies (Henshel, 1990), ill-defined problems (Rittel and Webber, 1973), the prisoners' dilemma (Howard, 1971), the commons problem (Hardin, 1972), the Braess paradox (Nienhuis, 1993), experimenter effects (De Zeeuw, 1974; Löfgren, 1991). Science itself proved to be part of the 'grand narratives' of its time (Lyotard, 1988).

It is not quite clear yet how science can respond to the change. Should it confess itself incompetent, or should it accept the user as a partner, and thus lose some of its identity? Responses differ. Some have banded together to respond to the challenge, as in the systems movement (Von Bertalanffy, 1968; West Churchman, 1971; De Zeeuw, 1974; Von Foerster, 1982; Henderson, 1995). Others respond directly to the canonised difficulties (Thom, 1975; Odum, 1983; Axelrod, 1984; Prigogine and Stengers, 1990; Lewin, 1992; Kellert, 1993).

Whatever the response, science no longer seems to be what for many years it was. Moreover, there does not seem any possibility of going back to the time when science could restrict itself to the *discovery* of what contributed to improved observation. It faces the challenge of having to deal with a much wider class of exchanges between people than just observations, and of having to *invent* the frames that help to improve on such exchanges.

This chapter attempts to identify how science responded to similar challenges—for example, how it proved able, about three centuries ago, to discipline the Cartesian 'out there'. Such responses may be related to how science will respond to the *challenge of the user*—that is, to the user having a voice inside science. Keeping this voice outside, as science has been wont to, does not appear to be effective—that is, at least not when one tries to discipline an 'in there' that is not Cartesian.

The main character in the story of this chapter is the observational device that was developed in the 15th and 16th century in Western Europe, and that strongly influences present-day culture. Unfortunately, the chapter can not do full justice to the variety in the way the device changed over time, and to the many effects of its use—which include, for example, the ousting, in the second half of the 19th century, of religious organisations from most positions of control in societal life (Foucault, 1974; Bowlby, 1990).

In other words, what is presented is schematised. The schema was chosen for reasons of space, but additionally to realise a second aim. The presentation is meant to provide insight in how to do research as a practical and useful contribution to activities, particularly the management and change

---

(repeatability over time and place). Some statements defy such testing: in such cases use remains of organisations. This insight summarises what has proved to be valuable as a response to the challenge of the user.

The chapter is structured as follows. It starts with a preliminary clarification of the role of observations, of the observer and of the use of observations (section 2). In section 3 a history is presented of the device that allows one to improve on observations. Over time it changed in how it works as well as in what it deals with. In section 4 these changes are discussed more generally, and related to people's need to act fairly and productively in various collectives. Section 5 concludes the paper.

2. Preliminaries

2.1 On collective learning

Although science often is associated with a search for explanation and for theory, it seems best characterised as a form of collective learning that concentrates on *observation* as its main vehicle. It stresses frames of reference that separate observations from their context to provide a possibility for comparison. It was this kind of emphasis which made science so important in the development of Western Europe.

There are forms of collective learning that emphasise forms of exchange that differ from direct observation. One is the *oral* tradition, which involves *listening* to what is being *told*. By telling and retelling it is possible to create and maintain individual and collective identities. Events in myths and stories identify and link similar events in the life of everyone, and thus help to reduce individual differences that detract from such identities.

As examples of this tradition one may think of the Homeric epos , the biblical stories (Armstrong, 1995), the stories of King Arthur, the Kalefala (Kuusi e.a., 1977), and myths of origin such as the Popol Vuh (Nelson, 1976)—each of which influenced the fate of some tribe, group or nation.

Stories and myths have become part also of a different tradition (including those mentioned), with a different kind of emphasis: the *reading* of *texts*. This tradition allows myths and stories to be compared by different people, at different times and places—in a process of scholarly learning. Texts may allow for more variety than stories[5]: individuals may develop their own texts, to *resist* what is presented by a narrator. A textual collective memory is more easy to extend and update than an oral one.

---

5 After the crusades large numbers of texts became available that up till then had been preserved in

The textual tradition faces a danger similar to that of the oral tradition, however. Ownership of a text can be defended as effectively as ownership of myths, or even better (Eco, 1989). Those who own and control texts thus can bend and constrain collective learning. To resist this a new form of collective learning developed: the *optical* tradition derives from the insight that *observations* can be transferred as myths and texts can—but unlike either of these, they can be *checked*, in principle at any time, by any observer. They are thus extremely difficult to own.

This insight, in combination with the invention of the printing press, laid down the basis for what now, traditionally, is called science. It could add to learning in the textual tradition, in the same way the latter had added to learning in the oral tradition. It made it possible to criticise observations on the basis of individual observations. The individual thus became empowered to determine the collective, and to control the contexts it supports. Such an individual influence had proved to be difficult to achieve in the oral tradition, and only a little bit more easy in the textual tradition.

2.2 On seeing 'better'

It is possible to adduce many reasons to explain the introduction of observation as a way of supporting collective learning—apart from the need to resist texts or stories. A different, practical reason is suggested by the increasingly long sea voyages of the time. Small deviations at some point in space or time can lead to differences of thousands of miles. Sailors needed to be able, therefore, to compare observations and ascertain precisely what they saw—independent from where they were, at what time (Dijksterhuis, 1950).

What seems to have contributed most was, first, a better kind of clock. It used the balance wheel, as invented by Huygens (1675). It allowed for precise comparisons of time. Second, the work of people like Galileo and Copernicus, but especially the work of Newton, made clear how to compare individual observations in general—although it took some time for this to become useful in practice.

It was clear then as it is today that individual observations can differ substantially. They show an unexpectedly large variety: they are 'value-laden', 'action-' and 'context-dependent', and, by definition, 'human-laden' (Hanson, 1958). Some of this variety had been constrained by texts and stories in earlier times. For example, people could be told, and be made to agree, that at some occasions the stars can 'stand still'. For practical purposes such an event would be undesirable, of course: if it happened repeatedly, clocks would not be much use to pinpoint positions on the ocean. A framework was needed that would allow for *local* collective learning, more than earlier traditions did.

The choice of a framework depends, of course, on what one wants to compare. What are considered observations may be interpreted differently, requiring different frameworks for comparison. One may assume, for example, that the *observed* acts as an agent, developing an image of itself, to send to the observer. Here the observed ‘controls’ the observer. Observations may also consist of *statements* from observers to identify changes in their senses. In this case the observed is ‘defined’ by the observer. A third possibility is that the observed is *reflected* in some medium, like sound or light, that affects the observer. Now observations ‘depend’ on what is observed, but not vice versa.

To choose between these and similar possibilities one may try and study the physiology of human observation. This would beg the question, however, as one needs the results of such a study to identify what kind of observations to make. Another possibility would be to delegate the choice to those with powerful societal positions: the church, the nobility, the learned. There would not be much to gain from this either, as such groups seem to try to influence the choice anyway, to prevent resistance to their position.

Eventually a convention was decided upon (Popper, 1959). What is accepted as observations, and as a framework to compare observations, has to satisfy two criteria (as formalised later by Descartes (1637; 1966). First, one should be able to identify whether an observation is part of the observed or not. Second, it should be possible to identify ‘levels of sameness’ among a set of observations that make it possible to identify and compare differences among the observations in the set.

A relatively simple interpretation of this, unfortunately unwieldy, formulation would be, of course, to identify ‘levels of sameness’ as the ‘things’ that appear in daily life. Instances of such ‘things’ may be compared, and observed to be different in a number of ways. An example would be ‘things’ like stones. They define a ‘level of sameness’ that allows for differences in terms of properties such as weight, speed, place and shape.

The identification of ‘levels of sameness’ as ‘things’ creates a reason for confusion, unfortunately. It proves possible, for example, to compare observations given some ‘level of sameness’, without a corresponding ‘thing’. Conversely, some ‘things’ in daily life do not allow for a comparison of observations, even though it is possible to recognise a ‘level of sameness’. An example would be a ‘thing’ like the moon of the earth, as conceived by the church of the time, and made part of daily life. It did not define a ‘level of sameness’ with the moons of Jupiter, so one could not compare the properties of both (Schwarz, 1992)

Much time and intellectual effort has been spent to distinguish between ‘things’ and ‘levels of sameness’ (pre-cursors can be found already among the pre-Socratics, for example Democritus: about 400 BC). Both continue to be easily confused. Nowadays the distinction is facilitated through a stepwise procedure. Starting with some observations, one compares them using a number of ‘hypothesised things’, and eventually chooses that ‘thing’ that allows for the selection or construction of observations that are ‘better’ than the ones one started from. This kind of ‘thing’ usually is called a(n) (scientific) ‘object’[6].

The notion of ‘better’ as regards observations refers to the possibility that some observations may lead to fewer ‘unintended effects’, ‘mistakes’ or ‘mishaps’ in action than others[7]. One is less easily burnt, the better one can observe the heat of a fire. A number of procedures has been developed to construct observations that are ‘better’ in this sense. Most of them depend on recognising what observations are *repetitions* of each other. Repeated observations can be combined through some form of averaging (see also section 3.1).

‘Improved observations’ need not have other properties than having been constructed as such. There may be properties, however, that arise through and in the process of improvement (De Zeeuw, 1986). For example, improved observations may allow for *predictions*, in case they were constructed to be invariant under changes in place and time. It also is possible that ‘objects’ *become* ‘things’ in daily life[8]. An example is ‘iron’, which, in pure form, became visible as a ‘thing’ only in the 19th century—although improved observations on the basis of the ‘object’ iron had been achieved much earlier.

2.3 On forms of repetition

Some of the difficulties that arose as part of the ‘challenge of the user’ can be recognised in work by Taket and White (1994). The authors describe a project in which they claim to have succeeded in improving on a social service: it aimed to help underprivileged groups in a community. They initiated discussions on what to do, using a veto procedure. This helped the members of the service to realise ‘consent’, and build ‘commitment’. The discussions ‘enabled’ and improved ‘co-operation’.

---

6 The identification of an 'object' with the aim of improving on observation implies the notion of a device. It is used to reduce some of the 'human-ladenness' of observations, in the same way one can say that a telescope reduces some of the 'distance-ladenness' of observations.

7 It is assumed that, for example, effects that damage others, and thus, in principle, may lead to reprisals, constitute unintended mistakes.

8 This device fulfils the same role as, for example, a telescope. It makes it possible to 'construct' observations that one prefers, for example to reduce the 'distance-ladenness' of observations. The

The authors use these results to identify where science failed to contribute. They note that 'different people see the same things differently', and suggest that these differences should not be reduced (p. 580): a reduction as required by traditional science would have had a detrimental effect. It would not have respected the differences, although important to the life of the group—something Taket and White claim their own device (discussions using a veto rule) did.

The argument faces some difficulties. First, if all people see things differently, they obviously can not recognise 'things' to be 'the same'—unless by extra-sensory perception. The notion of observation seems misplaced, therefore. Second, the authors do not explore the two conditions mentioned earlier, but appear to *assume* that the exchanges in the project constitute observations—in stead of, for example, *reports* on opinions and changes in opinions and other emotive states[9]. Third, it is not clear how *not* reducing the assumed observations can be expected to help prevent unintended effects of actions, for example conflicts.

The authors' claim that science could not contribute to their project does not seem supported, therefore. Science may not even have been involved. Science usually does not deal with *reports*, for example, nor does the device of science necessarily help to *improve on reports*. Moreover, even if discussions are what is needed to improve on organisations, one can not conclude that this makes science incompetent. It may still contribute as an activity that uses its special device.

Challenges to science such as these, to become involved in non-traditional situations, need not imply that it *must* be involved. There may be other sources to support communities, services, organisations or groups. These include the earlier traditions, as Taket and White actually seem to demonstrate. Their discussions focus on exchanges that in the main seem to be treated as *texts*, rather than as observations. Similarly, the authors point out that organisations are in need of a shared story or narrative—precisely what one would advise in the *oral* tradition.

Alternatively, the authors' work *can* be interpreted as a response from the optical tradition to the 'challenge of the user', and need not represent a case where science *must* fail. One may assume, for example, that *reports* and what is *reported on* are determined by, and react to each other: what is 'reported on' can include the effects of 'being reported on'. This kind of dependence could be the reason that reports can not be treated as observations: the two conditions mentioned in section 2.2 are not satisfied.

---

9 In section 3.2 and 3.3 a model for observations will be discussed in which the act of observation is distinguished from the observation. This kind of observation has been formalised by Spencer

The work of the authors might thus be interpreted as an effort to *re-create* the desired independence between the 'observations' and 'the observed', or rather between the 'reports' and the 'reported on'. To do so one would have to request the collective (the social service) itself to be one of the agents involved. It would thus be able to create the context in which its members can behave like the sailors of yore, and become skilled in using the device of science.

Science now would have to compare *sequences* of reports, and look for 'levels of sameness' in terms of such sequences—to learn what sequence to implement so reports can be treated as observations in the traditional sense. This implies that the collective should try to improve on what subsequently can be treated as observations (and thus behaves as a scientist), in order to allow its members to improve on their exchanges as if these are observations (and thus, similarly, behave as scientists), and vice versa.

This interpretation suggests that the users of the results of science (the members of the collective) do acquire a voice inside science (as implemented through the group or collective), and also that science (as implemented through the collective) gets a voice inside science (as member of the collective). It also implies that one recognises *second order repetition*, that is repetition among sequences of observations rather than *first order repetition* among observations.

The rule of veto may have been the device that helped to re-create the independence that allowed the members of the service to realise improved observations, or rather improved reports. Such reports can be interpreted as referring to 'objects' such as 'shared opinions' and 'consent'. As improved reports these may have been what helped the group to improve on 'co-operation'.

Whether this interpretation holds, and whether the rule of veto did fulfil this role, is not clear. Taket and White do not discuss the way the rule of veto functioned. That need not be of concern here, however. The interpretation *may* hold: the rule of veto may have forced the reports to be interpreted as observations on previous observations, that is as repetitions in the traditional sense, differently interpreted (see Von Foerster, 1982; Pask, 1975). The interpretation suggests that one reconsider the role of the device of science.

Such a reconsideration does take place in the work on canonised difficulties, such as the Prisoners' dilemma (Axelrod, 1984). It is also exemplified in the solution of the paradox of the therapist and the client (1989). Two therapists are instructed that the other is a client, hallucinating that he is a therapist. By 'helping' each other the two therapists get into serious conflict—from which they can escape only by making their collective come to life as a therapist as well.

In the next section it is tried to identify at least some of the patterns that arise when science tries to use its device in situations where the notion of observation is no longer obvious. Alternative devices have been explored—making the notion of 'object' into a historical entity. The section describes three forms of this notion. The first form is said to involve *non-constructed* 'objects', the second *constructed* 'objects' and the third *self-constructed* 'objects'. These 'objects', in this sequence, increasingly make it possible to effectively deal with what is non-Cartesian.

3. Variations on a device

To sketch the history of the device of science, that is of the notion of 'object' as a framework to compare observations, three *phases* will be distinguished. The advantage of this distinction is that it allows one to focus on the major changes in the development of science, and link each change to the difficulties that arose when using the device. The disadvantage is that one may think that the changes appeared in as abrupt a way as they are described.

Each phase will be presented under two headings: a short description, including suggestions on how to use the device (1), and a summary of fundamental difficulties that the methods of that phase may run into (2). The description of the next phase is then related to these difficulties. A more general discussion of the phases is attempted in section 4.

3.1 First phase: non-constructed objects

3.1.1 Description

Early developments in science were greatly influenced by Arabic and Greek texts that increasingly flowed into Western Europe after the fall of Constantinople in 1453. These texts fortified the notion that 'differences' between observations, languages and even people must be seen as deviations from, or corruptions of the original or pure (Eco, 1995). Its identification, through a reduction of the differences, became a major project in Western thinking.

'First phase' science can be interpreted as part of this project. The accepted procedure is as follows. First, one selects some observations as relevant for further study (in standard notation: a collection $\mathbf{X}$). Second, the elements of the collection are compared and ordered into groups ($\mathbf{X_i}$, the index $\mathbf{i}$ usually is allowed run up only to a finite $\mathbf{I}$), while the number of elements in each $\mathbf{X_i}$ is unlimited, and often larger than $\mathbf{I}$), by putting together those observations that can be recognised as repeated observations. Third, it is tried to construct an observation $\mathbf{T_i}$, that is a *high(er) quality observation*, by combining the elements of $\mathbf{X_i}$.

Ordering the observations **X** requires the use of the device that was described in the previous section: the notion of an 'object'. It needs to be emphasised, again, that the use of this device does not imply that one will find any 'real thing', as a material instance of the 'object'—although this may be possible. What the device does is to decompose **X** into two parts: on the one hand observations that help one recognise whether or not an observation is a repetition of an other observation, on the other hand observations that are ordered by this kind of observation (which thus acts as a framework for comparison).

It must be emphasised that this decomposition is not a trivial matter—although it sometimes may seem to be so in daily life. In science it is the most difficult thing, and may constitute its most crucial achievement. Without it, science would not have been able to make the impact it has made. The non-triviality resides in the fact that the ordering has to be based on observations that result from a decomposition of **X**, and are *part* of **X**. The ordering is *internal* to **X**, therefore—and not *external* as when imposed, for example, by a(n elite or religious) organisation.

That the device is defined only as a way of ordering observations, does not imply that there may not be some 'thing' that one can consider the 'real thing', or rather, some 'thing' in 'reality'. If one can find such a 'thing', it is considered a discovery. Later in this chapter cases will be considered where there can be an 'object', but no corresponding 'thing' (and, in a sense, no discovery, therefore, but only an invention).

The *first phase* notion of an 'object' defines that high quality observations can be constructed if two conditions are met. Labelling the construction of **T** (or $\mathbf{T_i}$, the index is irrelevant here) as the use of an estimator $\mathcal{E}$, applied to the elements X of **X**, these conditions can be formulated as follows. It should be possible a) to add $\mathcal{E}(X)$[10] to the collection **X** without changing the definition of this collection, and b) to do the same for the set that is constructed by adding **T** to the collection (if that were possible). If the two conditions are satisfied, then $\mathcal{E}(X) = \mathbf{T}$[11].

As an example one may think of the (well-known) estimator that is defined as taking the average of (numerically represented) observations. It usually is assumed for this estimator that $X = \mathbf{T} + e$, and that $\mathcal{E}(e) = 0$ 'in the long run', when the two conditions are met. In this case $0 = \mathcal{E}(e) = \mathcal{E}(X - \mathbf{T}) = \mathcal{E}(X) - \mathcal{E}(\mathbf{T}) = \mathcal{E}(X) - \mathbf{T}$, that is $\mathcal{E}(X) - \mathbf{T} = 0$, and, hence, indeed: $\mathcal{E}(X) = \mathbf{T}$.

---

10 The notation indicates that an operator operates on an operand.

11 Technically this is expressed by saying that the set of repeated observations is closed under the

As indicated above, the elements of the collection **X** may be ordered into a number of collections, each using the same 'object'. This implies that one can construct more than one high quality observation $\mathbf{T_i}$. Together these observations constitute another observation on the same 'object': R($\mathbf{T_1}$, …, $\mathbf{T_I}$), to be summarised as R(**T**). It may turn out that it is possible not only to recognise repetitions $\mathbf{X_i}$, but also observations R(**T**) as repetitions of other R(**T**)'s. Under the same two conditions mentioned above, one may again aim for the construction of a 'high(er) quality observation', that is **R**(**T**), related to R(**T**) through e_R, where e_R indicates an element of the collection $\mathbf{e_R}$, and where e_R = R(**T**) **-** **R**(**T**).

Objects should be such that they allow for the recognition of repetition, as indicated above. In the case of 'first phase' objects, repetition includes repetition in terms of different places, different times and different observers. These forms of repetition imply characteristic aspects of science. It should be possible, for example, to *predict* observations, that is identify repetitions of the high quality observations $\mathbf{T_i}$ and **R**(**T**) over time.

A major consequence is that it is possible to *transfer* observations $\mathbf{T_i}$ and **R**(**T**) to other people. This implies that high quality observations assume a linguistic form. Observations $\mathbf{T_i}$ usually are called *statements*, observations **R**(**T**) statements about statements, or *sentences*. The set of sentences **R**(**T**) represents a collection of rules, that is a grammar, which is part of the 'language of variables'[12]. Transfer takes the form both of teaching and learning. It leads to the ability to use statements and sentences. Sentences **R**(**T**) are said to constitute knowledge. Some sentences are called 'laws', an example is the law of gravity.

Another consequence concerns the way one defines science. Usually it is stated that (first phase) science aims for the acquisition of knowledge, that is for the acquisition of statements that allow for prediction. Such formulations are consequences of the notion that science aims for the improvement of observation—one interpretation of which is that science aims to overcome the 'human-ladenness' of observation, to reduce the mistakes in action that it may generate. As Rosen (1993) points out, one may also say that science aims to increase the ease of recognising 'objects' as 'things'. Or in other words: to reduce the efforts and cost of discovery at the time of action.

Science has been very successful on these terms. We no longer have any difficulty, for example, in recognising lights in the sky as stars, the earth as a massive ball, the arteries in our body as a circuit, or in 'seeing' heat through a thermometer—even though these feats at some time took laborious

---

12 In what is called 'logical positivism' the two kinds of observations (T, and R(T)) are strictly separated, unlike the approach in the text. There is a Wittgensteinian contribution in the emphasis

arguments, or were not possible at all. One may say that science has made such forms of recognition less expensive, more ‘free’: one recognises without having to do much work, and without much deviation ($\mathbf{e}$ and $\mathbf{e_R}$ small or strictly bounded).

The fact that observations can be improved through the use of sentences $\mathbf{R}(\mathbf{T})$ constitutes a great advantage. This is due to the fact that such sentences do not depend on the future: they help to predict the future, and, hence, will be part of that future themselves. This implies that such sentences are independent of future use. One may thus expect the quality of action to increase (a reduction of mistakes) through the use of sentences $\mathbf{R}(\mathbf{T})$, whenever such quality depends on the precision or speed of one’s observations.

The search for a ‘first phase’ object (and for the resulting knowledge) lends itself to the formulation of some guidelines or instructions. They indicate how one may proceed to find the desired high quality observations, and to test whether one has realised one’s aim. The set of such instructions describes what is called the ‘empirical cycle’ (De Groot, 1961[13]). It identifies subsequent steps, as well as their possible repetition when the intended level of observability has not been reached.

Usually five steps are distinguished:

1. Identify a collection of observations $\mathbf{X}$ that appear of interest (to the researcher, or to some commissioner[14]). The collection may be adapted in re-iterations of the cycle.
2. Separate out some of these observations as repeated observations on some object.
3. Construct high quality observations of the object and check whether conditions hold such that $\mathbf{T} = \mathcal{E}(\mathbf{X})$.
4. Estimate relations between high quality observations: $\mathbf{R}(\mathbf{T})$.
5. Extend or reduce the set $\mathbf{X}$ to test whether deviations $\mathbf{e}$ and $\mathbf{e_R}$ remain sufficiently limited (step 1 and 2), and thus do not require increased efforts to estimate $\mathcal{E}$ and $\mathbf{R}$ (steps 3 and 4).

---

[13] De Groot (1961) distinguishes the following steps: Observation, Induction, Deduction, Testing, Evaluation—which are roughly analogous to the steps mentioned in the text. De Groot’s definition seems to lack precision, however, due to the fact that he emphasises the search for ‘theory’ (in the terms used here: $\mathbf{R}(\mathbf{T})$), rather the improvement of observation and its transfer.

[14] [illegible]

3.1.2 Difficulties

There is nothing in 'first phase' science to suggest that it guarantees success as desired in all situations—even though it often is criticised for this limitation (see, for example, section 2.3). It presents a method to improve on observations *if* the conditions for estimating **T** and **R**(**T**) are met (see section 2.1), or in an alternative formulation, *only if* one can separate observations from the observed. This limitation raises two questions.

The first question is how these conditions relate to the situation in which science developed. This situation apparently was such that it induced people to look for 'internal' decompositions of observations of objects, rather than accept the 'external' decompositions[15] (for example, as decided in the Council meetings of the Roman Catholic church in Constance, in 1417, and in Trent, 1564).

Several answers seem defensible. One is that what had been achieved in the textual and oral traditions helped to organise certain actions, but failed when new actions were needed—as in the case of navigating the ocean. This required more precise and 'free' observations, as made possible by the device described (see the previous section). Another answer is that, after the Crusades and the voyages of discovery, Western Europe was no longer a closed culture. New reports were coming in that could not be treated as stories, nor as texts—but proved treatable as observations.

One may summarise both answers as indicating a situation of 'overload'. There were too many reports that could not be combined by the 'old' device of 'external' decomposition (in the oral and textual traditions): the process of reaching consensus over texts or stories was too unreliable, generated too many conflicts, did not lead to efficient collective learning. All this changed when it became possible to construct 'internal' decompositions of observations, that is 'objects'. Results now could be transferred directly to others, in 'local' transfers, rather than having to be considered first for textual criticism.

The second question concerns the situation where traditional science itself proved to be insufficient, where the conditions observation no longer were met—notwithstanding a long record of successes. One of the situations where this was the case was when, at the end of the 18th and the beginning of the 19th century, it was tried to apply science's device to what had been left out in the first phase—when it was tried to deal with the *in there* as if it were the outside of the Cartesian 'out there'.

---

[15] Examples of 'external' decompositions are the 'things' of daily life (see section 2), the geocentric

Unfortunately, this did not prove easy. It implied that it was attempted to use the procedures of science on earlier traditions of collective learning, *as if* they dealt with observations rather than stories or texts. It was tried, for example, to find ‘objects’ that would allow one to improve on expressions of ‘will’, ‘emotions’, ‘values’, ‘intentions’, ‘problems’. Such concepts proved difficult to handle when treated as observations.

The ‘overload’ that results from this approach seems to be due to the fact that it allows the observed to *defect* from the act of observation. A person that is asked to report emotions may answer in many ways, depending on what he or she thinks is being asked, or even why. This implies that one can no longer identify what observations are repeated. It even implies that one can not expect a limited number of variables, to describe the properties of objects.

Studies of *work stress* exemplify this conclusion. The notion refers to a form of working, which not only depends on the task that has to be performed, but also on the effects of being observed in performing the task. If one tries to capture these effects in new variables, there may be some effect of these variables as well. And so on: one may expect an ‘unending’ series of newly discovered variables[16]. This kind of ‘overload’ is not restricted to social situations. It was noted also in physics[17].

3.2 Second phase: constructed objects

3.2.1 Description

That the basic device in science needed to be adapted was recognised at an early stage (Kant, 1960). A number of proposals were made to fulfil this need. One of the most effective can be traced back to the work of Quetelet (1835)—who did not aim to propose a new device, however, but rather to emulate the use of the ‘first phase’ scientific object in a new area. This is exemplified by the title of his paper which contains ‘physics’ as well as ‘man’ and ‘social’.

This ‘second phase’ device is used in many areas, but seems to have been appropriated especially by the social sciences. It consists of the following. First, one collects observations $\mathbf{X}$ that may be relevant for further study. Second, the elements of the collection $\mathbf{X}$ are compared and ordered into groups $\mathbf{X_i}$ (the index $\mathbf{i}$ runs up to some finite $\mathbf{I}$, while the number of elements in each $\mathbf{X_i}$ is undetermined and often larger than $\mathbf{I}$). The grouping should be

---

16 See, for example, Lazarus and Folkman (1984).

17 It has been noted, for example, that it is not possible in some situations to measure two properties of an (hypothesised) object at the same time. To measure (improve the observation of) one property it is necessary to use the other property as an external choice to determine the 'object' (see section 3.2). This may be sufficient to internalise the object, as in quantum physics, or not as in the case of

such that the selection of one group of observations can be recognised as a repetition of the selection of an other. Third, on the basis of this grouping one tries to construct **F**(**X**)[18].

To do so one must realise that it is not possible to construct observations **T** for each element $X_{\mathbf{i}}$ separately, as in 'first phase' science, but only observations F($\mathbf{X_i}$) for each *set* $\mathbf{X_i}$. F($\mathbf{X_i}$) has to be interpreted as a distribution, therefore[19]. It thus allows for a certain level of observational indeterminacy—which is needed, indeed, if one wishes to reduce the 'overload' of 'first phase' science. **F**(**X**), the *high(er) quality observation*, is the result of a combination or estimate of properties F($\mathbf{X_i}$) for all $\mathbf{X_i}$ in **X**.

There is an additional aspect to a 'second phase' object. As indicated, Quetelet intended the ordering of **X** to constitute only a special case of a 'first phase' object (see section 2.1). This would require that selections $\mathbf{X_i}$ are recognised as repetitions on the basis of an internal decomposition of **X**. An example would be the recognition of a population, like the population of all 'cats', where the observation of cats (as a framework for comparison) can be improved in the way of a 'first phase' object. In contrast, 'second phase' science appears to characteristically base the recognition of repetition on an external decomposition.

The external source of such a decomposition may be the throw of some dice, the whim of a researcher, or more generally, some purpose G (the non-bold G stands for the purpose of an individual[20]). The interest of science is, of course, in purposes G that are transferable to other individuals (and thus become bold **G**), so the ability to recognise repeated selections of observations is not lost in transfer.

Purposes **G** may be those of a group, or the formally defined purposes that one can interpret as applying to local situations. This kind of purpose is noted as **G**(**F**) (in a notation analogous to **R**(**T**), the estimate of R(**T**)). One may also write **F**(**X**)   **G** for **G**(**F**), to emphasise the fact that **F** can only be constructed or estimated *given* a transferable purpose **G**.

The transfer of a purpose implies a linguistic medium, similar to what was required for the transfer of **R**(**T**)[21]. The medium used to transfer **G**(**F**) may differ from the medium in 'first phase' science, of course. The notion of a

---

18 Quetelet developed, for example, the notion of a 'normal distribution'.

19 Often, but not necessarily, a probability distribution. Alternatively, one may think of a (fuzzy) membership function.

20 Someone who decomposes using the throw of a die aims to 'destroy' the personal character of the purpose G.

21 The text emphasises the notion of transfer, for two reasons. One is that usually it is assumed that there are no constraints on transfer, if testing has been done properly—as identified in section 3.1 (but this may not be achievable). The other is that transfer implies the notion of copying (and of making mistakes in copying)—a notion that is necessary to the notion of innovation, especially in

decision maker provides an example (rather than the variables of ‘first phase’ science): it represents the purpose **G** of making decisions. Or more generally: the purpose **G** of actorship is to act (while G is the individual’s purpose as an actor). Another example is the notion of a problem solver, implying the purpose **G** of ‘problemsolvership’.

On the basis of the above one may define the aim of ‘second phase’ science as follows: to formulate (transferable) purposes **G**, and to estimate observations **F**(**X**), as an improvement over **X**, to facilitate the realisation of **G**. As examples one may think of efforts to improve observation of categories such as the ‘poor’, the ‘underprivileged’, or the ‘post-war generation’, none of which can not be recognised internally. Their identification serves a purpose **G**.

Making such ‘objects’ visible implies developing a *qualification*, a way of determining what to observe to improve the realisation of the purpose **G**—like giving people more privileges, making them less poor, identifying a cause for blame or praise. ‘Second phase’ science thus can be said to aim for the definition and implementation of qualifications—which are expected to produce or generate behaviour that can be transferred as **F**(**X**) **G**.

‘Second phase’ objects thus are *attached* to an actor. They are constructed to fit and realise the observer’s purposes as an actor, if he or she decides to act as such[22]. This would seem to suggest that their construction is relatively easy as the observer can choose an appropriate object, and does not need to ‘discover’ what may serve as such an object. Still, also the construction of ‘second phase’ objects does not appear to be an easy or trivial task.

This seems due to the fact that determining a ‘second phase’ object does not make transfer fully ‘free’ (section 2.1.2). One can only reduce the cost of improved observation. This is the price one has to pay. The ‘costs’ involved become visible as the possibility of *defection*, as described above. People may resist being considered a repetition of others, and thus refuse to help realise **G**. It takes effort to prevent defection, for example through negotiation, teaching, priming, training, or questioning people[23].

Again, paying this price may be acceptable if one can not discover a ‘first phase’ object: examples of ‘second phase’ objects thus abound in daily life. A ‘second phase’ object like the ‘elderly’ appears constructed to qualify for certain types of action: usually to be taken care of, but sometimes also to be put outside society. ‘Second phase’ objects thus *inform* others to behave such

22 ‘Second phase’ objects thus sometimes are said to constitute frameworks that represent some ‘point of view’, what someone can or should see given the need to reduce mistakes in some action.

23 Costs may run as high as having to repeat in full some study, the results of which one wants to

that a particular action is not impeded. They even help to *prophesy* that being ‘elderly’ anticipates certain treatments.

The effectiveness of sentences **G**(**F**) is determined by the ease with which they can be interpreted by those involved in particular situations. This means that the *form* of the sentences is important. Sentences function as narratives: they address people, inform them what object to construct, shape them. ‘Second phase’ science thus seems geared especially to improve on the oral tradition, by allowing individuals to become their own narrator (it does not suggest ‘the’ narrative). It thus may be possible even to improve on the ‘grand narratives’ of Western culture (Lyotard, 1988; Glanville and De Zeeuw, 1989).

As Van Strien (1986) points out, to find sentences **G**(**F**), the form of which facilitates the transfer of constructed objects, one needs something that is different from the ‘empirical cycle’ (De Groot, 1961). Van Strien proposes to instruct or inform by way of what he calls the ‘regulative cycle’. The steps regulate what to construct, how to transfer constructions, and how to maintain constructions by minimising defections[24].

1. Collect observations **X**, for example by according ‘authority’ to a way of selecting observations **X** (that is choose some **G**).
2. Construct high quality observations from the collection, that is estimates **F**(**X**)   **G**[25].
3. Identify the possibility of defection by transferring **F**(**X**)   **G**.
4. Look for methods to reduce defections (training, priming, etc.).
5. Increase the transferability of **F**(**X**)   **G**, by changing **G** (step 1 and 2), and by adapting **F**, given changes in **G** (steps 3 and 4).

3.2.2 Difficulties

‘Second phase’ science may seem to imply a ‘throw back’ to the time before ‘first phase’ science, and possibly to even to turn it into non-science, and a non-optical tradition. There are some redeeming features, however. It still tries to improve on observations—although now with the explicit aim of improving on the implementation of purposes, that is on actions if one accepts certain purposes. These are meant not to be ‘owned’ by a specific, well-established group. The notions of decision making, for example, should be transferable to anybody who wants to make a decision.

One of the difficulties ‘second phase’ science may have to face is that actors can be seduced into reducing the amount of effort needed more than is

---

24 The steps imply the rules that De Groot later formulated as the rules of the forum.

25 Note that one can not say anymore that the estimate **e**(**X**) reflects some ‘pure’ (error-free) observation **T** (as was possible in the ‘first phase’). It may be a statistical distribution, or some other

warranted by the observations. Although this can appear effective on the short term, it may lead to increased levels of defection in the long run. This means additional costs, as well as an 'overload': the stronger the tendency to defect, the more effort is needed to maintain the 'second phase' objects.

A number of special areas have developed to help overcome this kind of 'overload'. One is concerned with what is called *action research*. It aims to improve on observations that support actions on behalf of special underprivileged groups, like the unemancipated, the dominated (Coenen, 1987; Reason and Hawkins, 1988; Guba, 1990). Action researchers focus mainly on the difficulty of preventing defection when helping such groups.

Another example is provided by the efforts of the systems movement, that is of *systems science*. The research involved tends to subsume 'second phase' objects under the notion of *system* (Rosen, 1993). Unfortunately, a confusion seems to arise, as there also is a tendency to interpret systems as 'first phase' objects', to claim repeatability as well as respectability (Korn, 1994), or as 'things', to increase practical usefulness (Waelchli, 1992), or as constructed objects that do not require any effort to reduce defection, to facilitate modelling (Klir, 1985; Miller, 1978). This type of confusion exemplifies a disadvantage of 'second phase' science (see also section 4).

It similarly appears attractive to interpret 'second phase' objects as a license to let purposes **G** be realised only by researchers or facilitators—and not by the general public of users (Flood, 1995). This turns researchers into politicians—without the advantage of being accountable to an electorate. Such misuse may also be interpreted as due to the 'overload' of having to spend too much effort in maintaining the appropriate 'object'.

A recent study provides an example of how an 'overload' may come about (without intended misuse). High quality observations were sought so the commissioner of the study, the director of a social service, would become more effective as a decision maker (Vahl, 1993). The results satisfied the contract: the decision maker accepted the results as appropriate and useful. The 'improved observations' turned out to address some of the employees as well, however, inducing them to become decision makers themselves. This led to an interplay of decision makers, the collective of which needed results different from those of the commissioner (compare the canonised difficulties in section 1).

It needs to be emphasised that this kind of 'overload' may be spurious: it may be that 'second phase' science has not yet developed to the point where the 'overload' is not just due to inexperience, to an insufficient understanding of what 'second phase' science can do. It may still be possible, for example, to accommodate multiple-actor effects, like those in the study through 'constructed objects'. Alternative proposals can be found, however, which deal with the 'overload' by another adaptation of the device of science.

3.3 Third phase: self-constructing objects

3.3.1 Description

Results of 'second phase' science refer to the 'form' that make the transfer of results less costly, *more* 'free'—when it is not possible to make them *fully* 'free', as in 'first phase' science. Such results can be quite powerful. Cartesian science itself is an example. It uses a form of statements that selects observations concerning the 'out there' rather than those concerning the 'in there'. Results may be 'free' to the point where the costs of their transfer are negligible, and transfer itself is independent from their use (so the user has no voice inside science).

'Second phase' science aims to resolve the 'overload' that derives from using the Cartesian form to study the 'in there', *as if* it is the 'out there'. It is the *range* of forms of transfer which it studies. This implies an interest in 'transfers' that may be of help in increasing the quality of single actions only (not of all actions). As argued in the previous section, even such 'transfers' may run into an 'overload'.

'Third phase' science aims to consider alternative selections of forms of transfer. It may be interpreted as improving on collective learning through 'texts'[26]. It identifies as relevant for study collections of observations **X**, the elements of which 'belong together' in the sense that the collections are chosen for some purpose. The collections themselves also 'belong together', in the sense that they can be treated *as if* they are observations on non-constructed objects. The choice of the collection of collections of observations **X** can be repeated[27].

This type of approach should allow for the construction of 'objects', a high quality observation which helps to increase the quality of the actions that the approach supports. In other words, the use of this kind of 'object' is necessary to maintain it. By constructing the process of construction one may realise '*self-constructed* objects'. As the efforts invested in this way should be sufficient to maintain the object, its *further* use should be 'free'[28]. Its properties can be made visible, therefore, through estimators $\mathcal{E}$, as if one deals with a 'first phase' objects, usually as the distribution of estimates **G**(**X**) **S**.

---

26 The notion of 'texts', or of 'scripts', is used to indicate 'improved' texts, which are meant to lead beyond the textual tradition.

27 The definition of this type of object implies the notion of 're-entry of the form' (Spencer Brown, 1969).

28 Some authors consider such objects 'dimensionless': they can be maintained by an indefinite

Developing ‘self-constructed objects’ proves non-trivial, even though, again, such objects are not infrequent in daily life. In recent years the notion of a ‘post-war generation’, for example, seems to have changed from being a ‘constructed object’ to a ‘self-constructed object’. Membership can be used to make visible one’s identity, which itself increases each member’s power of claiming understanding and support.

While there is an advantage in the reduction of costs, a disadvantage is that ‘self-constructed objects’ make it difficult to defect—even when the objects are no longer acceptable. That is to say, it requires effort to change the process of self-construction (as it would to change ‘non-constructed objects’, for example iron into gold). This kind of difficulty is well-known. Many companies would like to change their ‘distribution of estimates’, that is change their ‘division of labour’—but are prevented to do so by their own self-constructing ability.

An example of the use of a ‘third phase’ object can be found in a(nother) study by Vahl (1994). She first ‘informed’ workers of a service that aims to deal with mental health problems, then asked the workers to ‘inform’ each other in the same way. This allowed them to adapt their distribution of tasks or qualifications such that it could be adapted to any change in the workers’ contributions or clients’ activities. In cases like these one does not aim for repetitions, therefore, but constructs objects on the basis of the order in which observations are made (second order repetition; see section 2.3). Additional studies are reported in Glanville and De Zeeuw (1995).

The aim of ‘third phase’ science can be summarised as making it possible to develop ‘self-constructed objects’ such that ‘defections’ are not avoided or prevented, but are used to reduce the cost of maintaining these objects. In other words, research will aim to support the self-construction of self-constructed objects—and, conversely, make it more easy to defect from (to avoid being trapped in one’s own object)[29].

In ‘third phase’ science the observer must be fully ‘attached’ as an actor[30]. He or she has to contribute actively: by stimulating observations **X**, and making sure that the observations lead to objects that help to construct high quality observations. The observer can be seen as a participant, therefore, with the special task of introducing new forms of transfer[31]—while participants become observers with similar tasks. In this way new activities (innovations) can be developed and tested.

---

29 This can be interpreted as saying that ‘freedom’ of action is gained by including individual ‘ought’s in the collective ‘is’.

30 Studies using ‘third phase’ objects do not aim to be observer-independent, but rather to be participant independent (cp. Axelrod, 1984).

31 These forms may be labelled ‘texts’ in that they prescribe a form on what is transferred: they

The method of ‘third phase’ science may thus be characterised as supporting the purpose of becoming a ‘good’ participant. A good participant should be able to help other participants develop as well as access what contributes to their actions. Making this possible may be compared to the original notion of *rhetoric*: to provide the tools that allow citizens to participate as citizens (Scholten, 1990). Such tools constitute a *language* (differing from the languages used in ‘first’ and ‘second phase’ science): a form of transfer that structures both the use and the being used.

Becoming a good participant in this sense requires steps that differ from the ‘empirical cycle’ (section 3.1) as well as from the ‘regulative’ cycle (section 3.2). The steps constitute what may be called a ‘self-referential’ cycle: they allow the researcher to engage in a discussion or debate in which observations stimulate new observations and help to construct high quality observations on the basis of sequences of observations. As the observations are transferred to the members of a group, they also may be labelled ‘reports’ (see section 2.2).

1. Select some form of transfer **S** and generate at least two collections of observations or reports **X**.
2. Construct high quality reports **F**(**X**)   **S** and **G**(**X**)   **S** and estimate their distributions.
3. Identify defections when transferring **F**(**X**)   **S** and **G**(**X**)   **S** and use these to change **X** and **S**.
4. Construct high quality reports **F**(**X**’)   **S**’ and **G**(**X**’)   **S**’, and estimate their distributions.
5. Repeat steps 1 to 4 until the distribution of **F**(**X**)   **G**(**X**) can be estimated as if it is a property of an ‘object’ in ‘first phase’ science; that is until the use of the estimator stabilises, and does not change with further reports.

3.3.2 Difficulties

Again one may ask whether ‘third phase’ science still is science. It does not aim to reduce differences between how people see ‘things’, but rather to increase differences in the collective in which people construct their exchanges (as Taket and White (1994) also advocate). The increase results from the fact that it is not tried to prevent or reduce defections but to use them as exchanges in new forms of transfer, to improve on collective learning.

An argument that would indicate that ‘third phase’ science still represents an acceptable adaptation is that it does seem to reduce the ‘overload’ of ‘second phase’ science. It leaves the construction of objects to those who need them, and thus distributes the effort of preventing defections over (multiple) users. ‘Third phase’ science also may be argued to be at least ‘near’ to science in another sense: it makes improved observation (using the self-constructed object) internal to the process of collective learning.

It can not be claimed that there is yet much experience with the systematic use of ‘third phase’ science. It is most frequently exemplified by situations where developments can be interpreted as having proceeded without systematic guidance from ‘third phase’ science. One may think of networks that people develop to reduce mistakes in what they do—by creating exchanges, by accepting ‘rules of interaction’, by developing ‘things’ in the interaction that act as ‘memories’ to the networks (Baecker, 1992). Characteristically such networks make defection easy, but suffer defection only infrequently.

There does not appear any indication yet that ‘third phase’ science itself is running into a ‘overload’. One difficulty one may have to face is that the three ‘phases’ of science and their underlying ‘objects’ seem to be confused relatively easily. In mental health work it appears to be agreed, for example, that ‘first phase’ science is not acceptable—that it has been impossible to find ‘objects’ that allow for treatment with minimal mistakes. Still, one often finds patients treated as non-constructed objects—whose needs can be diagnosed and assessed without any degree of self-construction.

Similar difficulties can be found in the study of management, and of organisational support. Checkland (1981) notes, for example, that constructed objects such as ‘problems’ may not help much to increase the quality of the actions of a company. This may change when the language of problems is allowed to help self-create ‘objects’. Tests of the quality of the problem language in this sense are still insufficient, however (Checkland and Scholes, 1990). Methods to perform such tests were presented in section 3.3.1.

4. Discussion

What is called science is extremely varied and also very well documented. This implies that it can be described in many ways. One may value the intellectual high points, or be more interested in the ways science is and has been organised. One may look at the effects of scientific endeavour on society, or concern oneself with mundane matters such as the daily competition among academic researchers (Bunge, 1969; Hacking, 1981; Latour, 1987; Brooke-Rose, 1991; Carvallo, 1992).

In the previous sections only one theme was explored, but even this involved many ramifications. It is as if one picks up a piece of paper: picking up one part, makes the other parts follow, picking up one of the other parts will let the one follow. Here the notion of ‘object’ was taken as central, a tool to improve observations. This made other parts follow: it was necessary to consider the relation between observation and action, and discuss ‘overload’, user involvement, ‘locality’ as a way of dealing with variety and of their relations.

Obviously many other topics would need to be discussed if more space were available, topics that appear at the other end, given that at this end the notion of the ‘object’ in science was chosen. Such topics might have been chosen first themselves. An example would be the study of values and of ethics. It has been dealt with implicitly in the discussion on reports. There are many studies that approach values more directly, however, and ask the question how to observe values, and improve on their observation (Doeser and Kraay, 1986).

Below some of the relations between these and similar topics on the one hand, and science on the other, are briefly discussed. It should be possible to derive the general nature of such topics from the story that was told in this chapter. Still, there are particularities that are interesting by themselves. The notions to be dealt with are those of system, of organisation, of intervention, and of value.

4. 1 Systems and agency

It has been noted that some organisations (not all) are such that defection is possible, but seems to be effectively prevented at the same time. There are companies that suffer from this difficulty, and are in need to become part of ‘third phase’ science, therefore. An other example is traditional science itself. It seems to resist systematic adaptations of its major device, in a number of ways. Sometimes it rejects such adaptations. Sometimes it accepts them, but changes them back to the original mould. Adaptations have to be frequently re-invented, therefore.

An example may be found in the notion of systems, the characteristic notion of the systems movement. Originally this notion was developed to deal with situations where the traditional device of science did not appear to work—where it proved difficult or impossible to find the kind of ‘object’ that would help to improve on observations. The notion of systems was meant to extend the notion of ‘object’ for use in such cases (Bateson, 1979).

Meanwhile, the notion of systems has begun to be confused with the notion of ‘object’. Some authors now define it as a ‘complex’ object (Klir, 1993)—which makes it difficult to distinguish the notion of system and ‘object’. Traditional science seems well able to identify complex ‘objects’, however, for example in physics. Others relate ‘systems’ to ‘things’ in daily life, for example the different levels most cultures tend to identify in nature

(Miller, 1978). There also are those who even *equate* ‘systems’ with ‘objects’ and even with ‘things’ in general (Korn, 1994; Waelchli, 1992).

The need to adapt or extend the device, that is the notion of ‘object’, continued to be recognised, however. One repeatedly finds efforts to re-introduce systems as a way to fulfil this need (Varela, 1979). A number of authors have emphasised that it is necessary to interpret observers as agents: the act of observation can influence or even define what is observed. One thus will have to consider the act of observation, in addition to or rather than what is observed (Checkland, 1995; Jackson, 1991).

The impossibility of dealing with certain phenomena as if one can use the original device has been emphasised by many authors. Some have concentrated on the need to give users in general a voice inside science (Ulrich, 1983), or on the need to give voice to at least some users (De Raadt, 1995; Van Haaster, 1991). Some have emphasised the need to distribute such a voice, that is allow for self-constructed ‘objects’ (Von Foerster, 1982; Maturana, 1988).

Similar changes seem to have been made outside the systems movement. It is emphasised repeatedly that one can not treat the clients of social services as ‘objects’ with certain properties: an ability to express the need for help, a disposition to be lazy or to profit from others, a lack of understanding of their own dependence on help of others (Vahl, 1994; Kersten e.a, 1980; Coenen, 1987; Guba, 1990). The same difficulty appears to hold for the study of business organisations: there does not seem to be any ‘object’ in science that is equivalent to the ‘thing’ one calls companies (Peters and Waterman, 1983).

One might despair of the (strange) attraction that the traditional device of science seems to have on all those who attempt to extend its area of use (Pask, 1991). There seems to be little reason for despair, however, as long as on concentrates on what one is looking for: a way of dealing with exchanges (observations, expressions) that can be improved to the point that they support one’s activities—on the basis of notions such as ‘first order’ or ‘second order’ repetition, respectively.

There may be reactions to the difficulties, of course, that are more dangerous than just despair, like looking for some form of magic. An example seems to be the notion of ‘point of view’ as an adaptation of the traditional device. The notion defines what one needs to observe to improve on an action, but leaves its definition to individual actors. One may interpret this as saying that sailors should look at the ocean as sailors (which they do anyway)—and thus need no further help.

4.2 Adaptation and organisation

The demands that were made on science differed in the 'Second Industrial Revolution', and in the period after the second world war. In the first period industry proved able to *organise* itself as a (very strong) *singular client*—which could order results, but did not change the production of results. In the second period an *adaptation* of the device of science appeared necessary to deal with situations with multiple and interacting clients.

The two approaches may interfere with as well as support each other. If one tries to organise clients to become a singular, 'good', client, as industry did, one risks *imposing*: one will *coerce* clients to formalise interactions such that they act as a single, well-defined organisation (Jackson, 1991). Such imposition can be prevented by the use of the adapted device.

The relation between organisation and adaptation seems to be one of differences in degree, rather than differences in kind. If the disinterest of science in users is maintained, the user must organise oneself. If the interest increases, one can add some of the elements of the oral tradition to the optical tradition ('second phase' science), that is allow for a 'narrative' to improve on observations. If the interest increases even more, one can devise a contribution from the textual to the optical tradition, that is consider reports rather than observations as what needs to be improved upon (on the basis of self-constructed objects; section 3.3).

It is possible to describe these differences in terms of the notion of 'point of view', as introduced in section 4.1. In 'second' and 'third phase' science it is accepted that there may be 'points of view', representing the interests of one or more users or actors, and that such 'points of view' must be respected and not be reduced using the traditional device.

'Third phase' science seems to aim for the most: to respect *all* points of view by allowing for *additional* points of view to develop whenever necessary. As an example of what 'third phase' science may lead to, one might think of the legal system (based on, for example, the 'narrative' of Roman law): it supports any act or actor as long as damage to others is avoided. It may be the use of this kind of adaptation that responds most to the 'challenge of the user'.

'Second phase' science also allows for some 'point of view', usually one that can be represented by a (repeatable) purpose **G**, like the purpose of a decision maker (section 3.2). This implies that one can accept a single 'point of view' as the source of the constructed object. The literature reports on many adaptations that appear to be in between 'second' and 'third phase' science, each accepting a (limited) number of 'points of view' (Brett, e.a., 1990).

An example is described by Van Haaster (1991), who distinguishes three points of view: of the professional, of the client and of the researcher. He creates exchanges between ex-psychiatric patients in which the three points of view become co-ordinated. Another example is the ‘soft systems methodology’ initiated by Checkland (1981): an indefinite (but limited) number of points of view is induced to emerge (so called ‘root definitions’).

The literature on management usually suggests of a mixture of *organisation*, accepting the device that science uses, and *adaptation* of that device, to meet the needs of the client. This may suffice as a way of helping organisations on the short term. Unfortunately, such mixtures also seems to prevent a clear distinction between organisation and adaptation.

When ‘organisation’ is emphasised, the possibility of traditional science is accepted—but the activity of finding a non-constructed ‘object’ often seems to turn into the imposition of a constructed object. When adaptation is emphasised, the notions of constructed and self-constructed objects appear to fuse with the notion of organisation. In this case ‘third phase’ science is taken to represent sentences **R**(**T**), rather than sentences **F**(**X**) **G**(**X**)—which constitutes a mistake of category.

4.3 Observation and intervention

A number of authors appears willing to replace the notion of ‘object’ as developed in science by (some form of) the notion of ‘point of view’ (VanderPlaat, 1995). Traditional science would consider this a major sin. It implies that one does not separate constructing a model or a theory from the use of that model or theory, that is from values (Doeser and Kraay, 1986). This allows for the possibility that the user or actor can impose the model that he or she wants.

In this chapter the need to avoid this sin, even when it is impossible to separate modelling and action, has been interpreted as a challenge that many people try to respond to: the challenge of the user. A number of adaptations of the major device of science has been proposed, and appear to make sense.

The major difficulty seems to be to not confuse the alternatives, and to proceed according to the ‘cycles’ identified in section 3. For example, what in the literature is called ‘objective’ or ‘experimental’ often proves not to be ‘objective’ or ‘experimental’ at all. It often is only claimed that the original device of science has been used, or can be used—without proper consideration of either ‘organisation’ or ‘adaptation’, or of their combination (see section 4.2). This seems to subvert science as a (relatively complex) voting procedure.

As examples of this latter possibility one may think of surveyed groups that have been selected for no other reason than some researcher’s interest (see section 3.2)—but then are used to support political action. This type of selection implies that one is not making visible distributions **F**(**X**), or looking for sentences $\mathbf{F}(\mathbf{X}) \quad \mathbf{G}(\mathbf{X})$, but rather that one is summing votes from an undefined electorate (see for an example, Shern e.a., 1995).

Further exploration of what helps to respond to the ‘challenge of the user’ is obviously needed (De Zeeuw, 1995). It should become possible to state *how* one may self-construct objects that allow for many alternative points of view, or uses; *what* the language is that fits what is needed in particular situations; *how* one may guarantee that the variety of supportable uses is sufficient; *what* steps to take to help develop the necessary objects.

5. Conclusion

This paper started out by describing the challenge that was posed to science after the second world war. It is still trying to meet this challenge, which derives from the fact that clients increasingly claim, and get, a voice inside science. What is needed is a device that does not function by reducing the variety in what clients say, but rather helps to increase this variety. Continuing to look for a reduction can lead to various kinds of ‘overload’, as described (section 3).

It appears possible to learn from the efforts to develop what is required. Firstly, there is not much to be gained from studying users as ‘objects’ in ‘first phase’ science—that is model actors as if they are objects, and impose on them to behave as such. Secondly, responding to the ‘challenge of the user’ appears most effective when one adapts the device that characterises science.

‘Third phase’ science seems to represent most readily what is needed as a response. It allows one to meet the demands of people that act as interactive users. It allows them to learn collectively, and to systematically develop the resources needed to improve on their own development. It makes it possible to increase differences between individuals, and to use these differences as a resource.

Notions like constructed and self-constructed objects may easily lead outside science, however. This can be avoided by following the injunction to make such objects as *internal* as possible: ‘objects’ should depend on the process of observation itself, or of reporting, if they are to allow for a minimum of mistakes in action. To include the user, and still arrive at internalisation, one has to look for ‘languages’ and ‘reports’, rather than for ‘laws’ and ‘facts’.

References

Armstrong, K., *A history of god: From Abraham to the present: the 4000 year quest for God*, Heinemann, London 1993

Axelrod, R., *The evolution of cooperation.* New York, Basic Books 1984

Baecker, D., The writing of accounting. *Stanford Literature Review* 9 / 2(1992)157-179

Bateson, G., *Mind and nature.* Dutton, New York 1979

Bertalanffy, L. von, *General System Theory*. Braziller, New York 1968

Blauwhof, G., The non-linear dynamics of technological developments: an exploration of telecommunications technology. Univ. of Amsterdam, Amsterdam 1995

Bowlby, J., *Charles Darwin: a biography*. London, Hutchinson 1990

Brett, J.M., Goldberg, S.B., & Ury, W.L. Designing systems for resolving disputes in organizations. *American Psychologist* 45 / 2(1990)162-171

Brooke-Rose, C., *Stories, theories and things.* Cambridge University Press, Cambridge 1991

Bunge, M.,The Metaphysics, Epistemology and Methodology of Levels. In Whyte, L.L., Wilson, A. G., Wilson, D. (Eds.), *Hierarchical Structures.* American Elsevier, New York 1969.

Carvallo, M.E. (ed.), *Nature, Cognition and system* II. Vol. 2: On complementarity and beyond. Kluwer, Dordrecht 1992

Checkland, P. & J. Scholes, *Soft systems methodology in action*. Wiley, Chichester 1990

Checkland, P., Model validation in soft systems practice. *Systems Research* 12 / 1(1995)47-55

Checkland, P., *Systems Thinking, Systems Practice.* Wiley, Chichester 1981

Churchman, C.W., *The design of inquiring systems.* Basic Books, New York 1971

Coenen, H.M.J., *Handelingsonderzoek als exemplarisch leren*. Konstapel, Groningen 1987

Dehue, T., *De regels van het vak.* Van Gennep, Amsterdam 1990

Descartes, R., *Discours de la méthode*. Paris (1966; 1637)

Dijksterhuis, E.J., *De mechanisering van het wereldbeeld.* Meulenhoff, Amsterdam 1950

Doeser, M.C. & J.N. Kraay (eds), *Facts and values: philosophical reflections from western and non-western perspectives*. Nijhoff, Dordrecht 1986

Eco, U., *De slinger van Foucault*. Bakker, Amsterdam1989

Eco, U., *Europa en de volmaakte taal.* Agon, Amsterdam 1995

Flood, R.L., *Solving Problem Solving*. Wiley, Chichester 1995

Foerster, H. von, *Observing Systems. A Collection of Papers by Heinz von Foerster.* Intersystems Publications, Seaside 1982

Foucault, M., *The Archaeology of Knowledge*. Tavistock, London 1974

Glanville, R. and G. de Zeeuw (eds.), Problems of Impossible Worlds. *Systemica, 7,* 1 / 6(1989)1-220

Glanville, R. and G. de Zeeuw (eds.), Problems of values and (in)variants. Special Issue. *Systemica* 10(1995)1-250

Groot, A.D. de, *Methodologie; grondslagen van onderzoek en denken in de gedragswetenschappen.* Mouton, Gravenhage 1961

Guba, E.G., The alternative paradigm dialogue. In: E.G. Guba (ed.), *The paradigm dialogue*. Sage, Newbury Park 1990, p. 17-30

Haaster, H. van, *Wartaal. Een onderzoek naar methoden van competentieverhoging in de geestelijke gezondheidszorg*. Thesis Publishers, Amsterdam 1991

Hacking, I. (ed.), *Scientific revolutions*. Oxford University Press, New York 1981

Hanson, N.R., *Patterns of discovery*. Cambridge University Press, Cambridge 1958

Hardin, G., *Exploring New Ethics for Survival*. Viking, New York 1972

Have, T.T. ten, *Andragologie in blauwdruk*. Tjeenk Willink, Groningen 1973

Henderson, H., An appreciation of Kenneth Boulding. *Systems Research* 12/4(1995)273-281

Henshel, R.L., Creditbility and confidence loops in social prediction. In: R.F. Geyer en J. van der Zouwen (eds.), *Self-referencing in social systems*. Intersystems Publications, Salinas, CA 1990, 31-58

Howard, N., *Paradoxes of rationality: theory of metagames and political behavior.* MIT Press, Cambridge 1971

Jackson, M.C., Five commitments of critical systems thinking. In Jackson, M.C., Mansell, G.J., Flood, R.L., Blackham, R.B., Probert, S.V.E. (eds.), *Systems thinking in Europe*. Plenum Press, New York 1991, 61-73

Kant, I., *Kritik der reinen Vernunft*. Meiner, Hamburg 1960

Kellert, S.H., *In the Wake of Chaos: Unpredictable Order in Dynamical Systems*, University of Chicago Press, Chicago 1993

Kersten, A., P. Groen, G. de Zeeuw. *Beter sociaal veranderen*. Coutinho, Muiderberg 1980

Klir, G., *Architecture of Systems Problem Solving.* Plenum, New York 1985

Klir, G.J., Systems science: a guided tour. *J. Biological Systems* 1/1(1993)27-59

Korn, J., A new direction in systems research. *Systemist*, 16(1994)158-168

Kuhn, T.S., *The structure of scientific revolutions.* University of Chicago Press, Chicago 1962

Kuusi, M. & Bosley, K. & Branch, M. (Es and translators), *Finnish Folk Poetry Epic. An anthology in Finnish and English*. Finnish Literature Society, Helsinki 1977

Latour, B., *Science in action*. Open University Press, Milton Keynes 1987

Lazarus, R.S., and Folkman, S., *Stress, appraisal and coping*. Springer, New York 1984

Lewin, R., *Complexity. Life at the Edge of Chaos*. MacMillan, New York 1992

Löfgren, L., The nondetachability of language and linguistic realism. In: C. van Dijkum, F. Wallner (eds.), *Constructive realism in discussion.* Sokrates Science Publisher, Utrecht 1991

Lyotard, J.-F., *Het postmoderne weten*. Kok Agora, Kampen 1988

Maturana, H., Reality: the search for objectivity or the quest for a compelling argument. *Irish Journal of Pyshcology* 9 / 1(1988)25-82

Miller, J.G., *Living systems.* McGraw-Hill, New York, 1978

Nelson, R., Popol Vuh. *The Great Mythological Book of the Ancient Maya.* Houghton Miffin Co., Boston 1976

Nienhuis, G., Geremd en gedreven. *Natuur en Techniek* 61(1993)880-896

Odum, H.T., *Systems Ecology*, Wiley, New York 1983

Pask, G., *Conversation, cognition and learning.* Elsevier, Amsterdam 1975

Pask, G., The respectability of predictability and repeatability in the social and organisational sciences. *Proceedings of ASC conference*. Old Dominion University, Norfolk, Virginia 1991

Peters, T., Waterman, R., *In Search of Exellence. Lessons from America's Best-Run Companies.* Harper and Row, New York 1983.

Popper, K.R., *The logic of scientific discovery*. Harper & Row, New York 1959

Prigogine, I. en I. Stengers, *Orde uit chaos.* Bert Bakker, Amsterdam 1990

Quetelet, L.A., On Man and the development of his faculties; an essay in social physics, 1835

Raadt, J.D.R. de, Expanding the horizon of information systems design. *Systems Research* 12 / 3(1995)185-201

Reason, P. & P. Hawkins, Storytelling as Inquiry. In: Reason, P. (ed), *Human Inquiry in Action. Developments in New Paradigm Research.* Sage, London 1988, 79-101

Reason, P. and Rowan, P., *Human inquiry*. Wiley, Chichester 1981

Rittel, H. W. J., Webber, M. M., Dilemmas in a General Theory of Planning. *Policy Sciences* 4 (1973)155-169

Rosen, R., Some random thoughts about chaos and some chaotic thoughts about randomness. *J. Biol. Syst.* 1 / 1(1993)19-27

Rosenhead, J. (ed.), *Rational Analysis for a problematic world.* Wiley, Chicester 1989

Scholten, J., Retoren en demokratie: funkties en disfunkties van de retorika in klassiek Athene. Groningen, 1990

Schwarz, J., *Het creatieve moment*. Prometheus, Amsterdam 1993

Shern, D.L., Trochim, W.M.K., LaComb, Chr. A., The use of concept mapping for assessing fidelity of model transfer: an example from psychiatric rehabilitation. *Evaluation and Program Planning* 18 / 2(1995)143-153

Spencer-Brown, G., *Laws of Form*. Published by G. Spencer Brown, London 1969

Strien, P.J. van, *Praktijk als wetenschap. Methodologie van het sociaal-wetenschappelijk handelen*. Van Gorcum, Assen 1986

Taket., A. and White, L., Doing Community Operational Research with Multicultural Groups. *Omega, Intl. J. Mgmt. Sci.* 22/6(1994)579-588

Thom, R., *Structural Stability and Morphogenesis*. Addison-Wesley, Reading 1975

Ulrich, W., *Critical heuristics of social planning: a new approach to practical philosophy*. Haupt, Berne 1983

Vahl, M., *Improving mental health services in Calderdale.* Centre for Systems Studies, University of Hull, Hull 1994

Vahl, M., The Community Resource Teams for people with physical disabilities 1990-1993. An evaluation commissioned by the North Humberside Joint Planning Team (Physically Disabled). The University of Hull, Centre for Systems Studies, Hull 1993

VanderPlaat, M., Beyond technique: issues in evaluating for empowerment', *Evaluation* 1(1995)81-96.

Varela, F.J., *Principles of Biological Autonomy*, North-Holland, New York 1979

Waelchli, F., Eleven Theses of General Systems Theory. *Systems Research* 9/4(1992)3-8

Watzlawick, P., *Münchhausens haren en Wittgensteins ladder. Uit de greep van de werkelijkheid*. Van Loghum Slaterus, Deventer 1989

Zeeuw, G. de (ed.), Knowledge (dis)appearance. *Systemica* 6(1986)

Zeeuw, G. de, *Model denken in de psychologie*. University of Amsterdam, Amsterdam 1974

Zeeuw, G. de, Values, Science and the Quest for Demarcation. *Systems Research* 12/1(1995)pp 15-25