TOWARDS AN OBJECTIVELY COMPLETE LANGUAGE

An Essay in Objective Description as Applied to Scientific Procedure

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NOTE [by Anthony Blake]: The DuVersity makes this article available for several reasons. The first and foremost is that this is the only place in which Bennett attempted any kind of rigorous use of his concept of three modes of inner togetherness: compatibility, compresence, and coalescence. The distinguishing of modes of togetherness is crucial for any theory of Systematics. Secondly, he and his colleagues make the concept of *the present moment* as defined in terms of *will* the primary starting point for their investigation of the structure of what a scientist does. Bennett's understanding of will and the present moment is, as far as we know, quite exceptional and unique. It is still the case that people seek to understand questions of reality in terms of consciousness and function alone, which means that they *cannot* understand!

We have preserved the mathematics mostly for the sake of the record. It is exceedingly clumsy and wearisome to follow. However, it does emphasise the hard work required to focus attention in precise ways on *what it is we do,* instead of thinking in terms of our habitual representations. Those who can struggle with the symbolic terminology may find some ultimate benefits.

Ken Pledge brought to the work his considerable experience in teaching experimental method to students. His 'Structured Process in Scientific Experiment', which appeared in the next issue of *Systematics* and is also included in the collection *Enneagram Studies,* took up the themes introduced here to do with 'setting up' procedures in using scientific apparatus and showed how the inner lines of the enneagram precisely corresponded to such procedures. Pledge's paper remains perhaps the only one that gives evidence for the enneagram as a diagram of the present moment and applicable to concrete and precise combinations of actions.

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[1] Taken from http://www.toutley.demon.co.uk/objective%20language.htm on 2010-06-06 with typographical corrections and minor style edits by John Dale. The editor has appended some questions and comments as alphabetical endnotes. Footnotes in the original are indicated by a * symbol.

Henri Bortoft went on to struggle with the formalised system in his own way, as in 'The Resolution by a Rigorous Descriptive Method of Some Dilemmas in Modern Physics' (*Systematics,* Vol. 4, No. 2 (September 1966)), which he worked on while completing a PhD thesis under David Bohm. Eventually, however, he turned for his inspiration away from 'rigorous descriptive method' to Goethe. He has become known in recent years as a key expositor of Goethe's 'way of science' and has written an important book on *The Wholeness of Nature.*

ABSTRACT

A symbolic language is built up for the purpose of describing the structural features of operations such as characterise the procedure of scientific investigation. There are five sections. In Section I, two key notions of will and of the present moment[a] are introduced as the foundation of the descriptive scheme. Section II develops and elaborates, with special reference to the scientific activity, a comprehensive symbolic model whose elements derive from the structuring discovered within the content of the present moment. Certain elements of the model are then applied in Section III to distinguish and specify six types of complex situations significantly exemplified in scientific work. In Section IV, the descriptive symbolism and the complex situations thus defined are used to describe and clarify the operational procedure involved in the genesis and performance of a typical physical experiment. The description is carried only to the stage where the results of measurement are recorded. In the Conclusion, Section V, the scope and limitations of this description of an experiment are examined and possible extensions of the language, proposed for a later paper, are discussed.

I. INTRODUCTION

Our languages of verbal signs and sentences have grown out of the need to communicate experiences and instructions. In relatively simple situations, they are effective, but even so, they require a community of memories and behaviour patterns to supplement the inadequacy of words to express the complexity of experience. In scientific discourse, the community is that of specialists who can recognise one another's experiences and behaviour.

In modern times, two difficulties have arisen in the use of verbal language. One is connected with the increasing specialisation of the communities able to have shared experiences. The second is due to the changing requirements of communication in itself. In the present paper, we shall be concerned only with the second type of difficulty and with an attempt to remove it by constructing a new kind of language rather than by supplementing the existing forms.

The requirements of communication have changed because it is no longer possible, using ordinary languages, to have an effective community of knowledge and action. We know too much, and we do too much, to be able to convey what is required by means of words and sentences.[b] The present trend is to think in terms of structures and organisations rather than elementary objects and actions that can be expressed by single words and verbal sequences.

Moreover, there have been profound transformations in our way of looking at the processes of nature. The traditional concepts of space, time, and causality have been criticised and modified. Even the belief in universal "laws of nature" has given place to a tendency to regard successful description and action as more promising than the search for ultimate or certain truth.

In keeping with these tendencies, we have undertaken to construct a descriptive scheme, using a formalised notation of symbols and signs, for the purpose of describing various features of scientific procedure. The basic signs and symbols can be arranged in formal expressions to provide models for procedure. For this reason, we refer to the formal scheme as a "language."

Our everyday ("natural") languages already provide us with models, but they are not without disadvantages. They are vague and imprecise, containing many elements whose meaning is not readily discernible. They are rich and diffuse and so do not lend themselves easily to characterising the essential features of a situation. In using such languages, we often incorporate elements that we do not intend along with elements that are quite unnecessary and whose effect is to hide what we are seeking to show.

An accurate description that is also not misleading is attainable if we are prepared to limit and discipline ourselves. For this, we must agree to use only descriptive elements whose meanings are directly verifiable in experience and that are therefore unambiguous.[c]

As an example, references to "the past" are inherently ambiguous for the simple reason that all meanings must be *within the present moment*. We cannot directly perceive or recognise "the past," and so we do not know precisely what it could mean. That we can use 'the past' effectively, that is, in the construction of proper sentences, can hardly be taken as a guarantee that in doing so we know what we are talking about.

If a sign is to have meaning, then it must point to an element of experience.[d] When one sign is correlated with the recognition of a single recurrent element within experience, that is, with a meaning, then that sign is a model of the meaning.[e] Further, if the one-to-one correspondence of signs with meanings is rigorously adhered to, then the meanings of expressions built up from such signs will be evident and can be communicated without ambiguity. Thus, by imposing upon our scheme such limitations, we can justifiably hope to convey what is intended and no more. For our present purposes, many features of experience are irrelevant, and consequently only a few basic elements are required.

Our experience *for us* is the *present moment*.[f, g] We start, then, with the axiom that if anything can be described at all, it can be described in terms of the content of the present moment.[h]

The elements of the present moment are, however, distinguishable from elements not present. Collectively, the elements present form a whole enclosed within a boundary that is never well defined and usually not even recognisable. The boundary generates a paradox that consists in the contradiction between our *experience,* which is always and necessarily confined to the present moment, and our *conviction* that the present moment is not all that there is. We do not doubt, for example, that there are things that we do not experience and never shall experience that yet exist. We do not doubt that there are other selves or other minds, and that each of these has its own "present moment" that is different from ours. In short, we have the paradox that the present moment is always single, unique, and all that we can know at any specific moment; and that it is also multiple, indeterminate, and capable of being enlarged to include what is outside it.

The formal resolution of the paradox comes about through a notion of *will,* defined as that which determines a present moment.[i] Will is both unique and multiple, always the same in its nature and constantly changing in its power to act.[j] Will has the special properties of being non-numerical and non-extended,[k] so that it is not legitimate to say that it is either one or many. We shall therefore speak indifferently of "the" will, "a" will, and of varying degrees of conjunction and disjunction of will or wills.

When determining a present moment, will can appear as a "self" or a "person." It may also, however, be the initiating factor for an act too restricted to merit the description of "person." Each differentiated part, or sub-region, of the present moment can be regarded as the domain of "a" will.[l]

The will of the present moment experiences, decides, initiates, and terminates actions but is not itself otherwise[m] involved in action. This follows from the definition of will as non-extended and non-numerical. For our purposes here, however, it is not necessary to resolve the question whether "will" is a descriptive fiction, a substance, or an independent mode of reality. We are concerned with the problem of complete, adequate, and unambiguous description, not with metaphysical questions of being and knowing.[n]

Within the present moment, we can distinguish three main kinds of elements. These are:

1. *"Goings-on,"* which range from a general flux that has no immediate significance to meaningful transformations and purposive acts.

2. *Recurrent features,* which include material structures, both living and non-living, executives, observers, and agents.[o]

3. *Modes of togetherness,* which can vary from mutual tolerance or compatibility to a common presence and ultimately to a fusion of elements into a whole that can exist and be acted upon and cognized as such.

These descriptions are not definitions, nor are they intended to identify precisely differentiated parts or sub-regions of the present moment. If we can recognise what is referred to, that is all that is necessary.

In the present paper, we shall construct a descriptive model based upon the formalisation of these distinctions within the present moment. This artificial language will then be utilised to construct a model of experimental procedure that is less cumbersome than the models provided by our customary languages and that can, therefore, more evidently demonstrate the major structural features that characterise experimental procedure.

II. THE DESCRIPTIVE MODEL

1. That which uniquely exists is the present moment.[p] There is only one present moment, namely, that which is here-and-now.[q]

1.1. The present moment may be thought of as diverse in content yet present as a whole, as embracing separate elements in a whole that is the place of action and existence.

1.1.1. The present moment varies both in content and in range of embrace ("extent"). The power to focus or to extend attention determines factors of inclusion and exclusion. Thus, by the voluntary or involuntary focusing of attention, a subordinate present moment may be isolated.[r]

1.1.2. The range of embrace of the present moment is the limit of immediate experience.

1.1.3. A present moment is not a point. A point-like present moment would be without awareness, content, or action, and thus equivalent to zero experience.

1.2. The present moment cannot be conceived, let alone determined,[s] without reference to the centre of experience. There is such a center, S, for whom the present moment, Q, is immediate experience. Q, apart from S, does not exist. All that S is, or can be, aware of is the content of Q. We write:

$$P \square {}^{S}Q \quad \text{...(1).}$$

which reads, "P is within the present moment Q of S."[t] More simply, we can write:

$$P \square S \quad \text{...(2),}$$

which reads, "P is within the experience of S."

1.2.0.1 It follows from 1.1.2 and 1.2 that (2) implies (1), and the converse.[u]

1.2.1. The center of experience is not itself a part of experience but “that” for which experience is present.[v] Since “that” is active and effective, we shall also call it a “will.”

1.2.2. Every will determines the [a] [its] present moment.[w]

1.2.2.1. Will is monadic, excluding all other will but itself; this is why the present moment is unique.[x]

1.2.2.2. The present moment Q is unique from the standpoint of the will “for which” it is present, but it is not unique for another will.[y]

1.3. For every will, S, there is a present moment, Q.[z]

1.3.1. The present moment is different for different wills or centres of experience, such as selves or people.[aa]

1.4. The present moments of separate selves need not be isolated.[bb] They can be combined in different ways. For our purposes, we distinguish three different modes or degrees of togetherness.[cc]

1.4.1. The present moments ${}^{1}Q$, ${}^{2}Q$, ... , ${}^{n}Q$ can be *compatible*. We write this as

$$({}^{1}Q, {}^{2}Q, \ldots, {}^{n}Q) \quad \text{.. (3),}$$

where the parentheses indicate the compatibility concept. To form a statement, we write

$$({}^{1}Q, {}^{2}Q, \ldots, {}^{n}Q) \square (Q)^{n} \quad \text{... (4),}$$

which reads, " ${}^{1}Q$, ${}^{2}Q$, ... , ${}^{n}Q$ are compatible within the comprehensive present moment $(Q)^{n}$."[dd]

This statement cannot be doubted, for if there *are n* present moments, corresponding to *n* selves, ^{1}S, ^{2}S, ..., ^{n}S, then they must be compatible.[ee] If we can generalise to

$$(^{1}Q,\ ^{2}Q,\ \ldots,\ ^{n}Q,\ \ldots)\ \text{[illegible]}\ (Q) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5),$$ [ff]

then this is equivalent to the presupposition of some *universal order* (in the sense that it is not restricted to a universe of *n* selves). Consequently (5) is the basic presupposition of order. If there is some present moment that is not within the universal present moment (Q), then it cannot be compatible with any or all of those present moments that are within (Q). This implies that it is beyond order in the sense that order may not be predicated of it.

The introduction of $(Q)^{n}$ and (Q) is a formal device that ensures meaningful usage of 'compatibility'.[gg]

1.4.2. The present moments ^{1}Q, ^{2}Q, ... , ^{n}Q can be *compresent*. This is written

$$[^{1}Q,\ ^{2}Q,\ \ldots,\ ^{n}Q] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6),$$

where the brackets [ ] indicate a compresence unit. Such a compresence unit is equivalent to a communal present moment, for which we write $[Q]^{n}$. Thus

$$[^{1}Q,\ ^{2}Q,\ \ldots,\ ^{n}Q] \equiv [Q]^{n} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7).$$

That there is such a communal present moment, formed by the compresence of separate present moments ^{1}Q, ^{2}Q, ... , ^{n}Q, is the basic condition for communication. Two selves, ^{1}S and ^{2}S, can only communicate if their present moments, ^{1}Q and ^{2}Q, are compresent.[hh] If there is no compresence, then there is no "contact." Furthermore, within such a compresence there can be changes that are meaningful; that is, there can be transformations. Communication is an example of meaningful change. [iijj]

1.4.3. The present moments ^{1}Q, ^{2}Q, ... , ^{n}Q can *coalesce*, that is, they can fuse into one whole. We write this as:

$$\{^{1}Q,\ ^{2}Q,\ \ldots,\ ^{n}Q\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8),$$

where the braces { } indicate a coalescence unit.[kk] In the coalescence mode of togetherness, integrality predominates over separateness. Consequently, individual present moments can no longer be added or subtracted without detriment to the whole. Such a coalescence unit is equivalent to a super present moment $\{Q\}^{n}$ thus:

$$\{^{1}Q,\ ^{2}Q,\ \ldots,\ ^{n}Q\} \equiv \{Q\}^{n} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9).$$

1.4.3.1. Such a super present moment is the condition and basic presupposition of unification of will, that is, of a community of purpose.[ll]

1.4.3.2. A coalescence brace defines the sphere of operation of a single will.[mm]

2. The present moment is a perpetual flux. Although it always is the present moment, it is constantly changing.[nn]

2.1. The flux that is the present moment is not homogeneous, continuous, or closed.

2.2. Within the present moment, we can distinguish simple flux, meaningful flux, and origination.

2.3. Because of its "openness," the present moment can carry meaning and significance over and above the flux itself.[oo]

2.3.1. Simple flux is taken to be the more or less continuous background of the present moment without reference to meaning or significance. It is that which merely happens. Happening just goes on; it is without meaning or purpose.[pp] We refer to this simple flux as “change” and denote it by the symbol “$\longrightarrow$.” The change symbol is the most general way, in our model, of referring to motions, transitions, modifications of state and configuration, etc., that are not particularly meaningful. Rules for the use of this symbol will be introduced later (Props. 7.1 to 7.4.1).

2.3.2. We refer to meaningful flux, or meaningful change, as “transformation” and denote it by the symbol "$\rightleftharpoons$." Transformation, since it is meaningful, is always a reciprocal relationship. We indicate this reciprocity by doubling the arrow. There can be transformation only if the transforming subject has the capacity for it. As an example, one can consider a seed that transforms into a plant, thus preserving the order inherent in its genetic constitution. This can occur only if the seed is healthy and if the environment is favourable. If this is not so, the seed will decompose with resulting loss of order. Thus, in this example, if the seed decomposes, we write

$P \longrightarrow P^1$ ....(10),

where P stands for the seed and P^1 stands for a speck of humus. If the seed transforms into a plant, we write

$P \rightleftharpoons P^2$ ....(11),

where P^2 stands for the plant. Such formal expressions will be discussed later in greater detail (*cf.*, Props. 8.1 to 8.4.1).

2.4. Because of its discontinuity, the present moment permits “beginnings” and “endings,” that is, operations of the will.[qq]

2.4.1. A beginning is not a beginning *ex nihilo.* A beginning is a discontinuity within experience. It marks a change of direction, the injection of novelty, and the presence of purpose. Simple change, for our purposes here, is without beginning or end.[rr]

2.4.2. Beginnings are intentional acts of the will within its own present moment.

3. Transformation is originated. Simple change is not; it just happens as it may.

3.1. Origination is an act of will. The act that originates is a “decision.” An originative act is represented by the symbol "⟶."

3.1.1. A decision is a decision to do something and not to do something else. It is an act both of commitment and of sacrifice.

3.1.2. Decision is a necessary sacrifice. Without this act, nothing can be realised.

3.2. Decision without choice is impossible, and choice without decision is unreal. They supplement each other in one act that is the first step in the direction of realisation.

3.3. A decision is always willed, and it is more than a choice between a definite number of previously available and completely cognized alternative possibilities. Beyond such a choice, a decision is an opening out towards an indefinite number of possibilities, the majority of which are unsuspected by the will that decides. Nevertheless, the decision opens the will to them.

3.3.1. Mechanical "decision," or choice, after the fashion of switching-circuit and game theory models, would be a null act. It would make a change of direction but would contain no opening for novelty. Such models are not a full picture of the world of human purposes and endeavours.[ss]

4. An act of will results in the partitioning of a field of compatible possibilities.

4.1. The act of will (“executive act”) partitions what is possible from what is not possible and so brings into operation factors of inclusion and exclusion. It provides, at the same time, a criterion of relevance. All that is compatible with or relevant to the decision pertains to it; all that is not becomes irrelevant.

4.1.1. It would be too "strong" to say that when scientists make a decision, they "create" possibilities. It would be too "weak" to say that they "select." ‘Partition’ is intended to convey a notion intermediate between creation and selection. Nevertheless, either extreme may be approached asymptotically.

4.2. The paradox of action is that as long as everything remains possible, nothing is possible, and that for something to become possible, nearly everything else must become impossible.

4.2.1. Possibilities become "realistic" as possibilities only when they are limited. It follows that there must also be impossibilities. A decision is the act that effects the partition between possibility and impossibility.

4.3. When a decision is made, there is then a potential for realisation through further acts involving choice and hence commitment of the will. Without a decision, there is no such potential, and the situation contains only change.

4.3.1. Consider a traveller who has a choice of several towns to visit the following day. Initially, within the field of activity partitioned by the decision "to visit towns," he has several possibilities open to him. Until he has further decided which town to visit, however, he can do nothing. We could say that when all the possibilities are open to him, he is severed from these possibilities. He is able to do something only by an act of decision that links him with one possibility and that effectively removes the remaining possibilities out of reach. If he refuses to choose, there is no linkage, and nothing purposive can come about. By refusing to exercise his will as an executive power, the traveller sinks into the world of mere happenings and merges with the simple flux. In effect, he is refusing to be real, giving himself up instead to simple change. On the other hand, when he does make this further decision, he opens himself towards an indefinite number of further possibilities of action, cognition, etc., formed around his choice. Only a few of these will be realized, but if they are compatible with his decision, they will all be initially compatible.

5. The *act of decision* is represented as:

$E \longrightarrow (P^1, P^2, \ldots, P^n, \ldots)$ .... (12),[tt]

which reads, "The executive E makes a decision (an act) that results in the partitioning of an open-ended field of possibilities of action ($P^1, P^2, \ldots, P^n, \ldots$) that are compatible with respect to that decision."[uu]

5.0.1. The executive E is will in action. Without decision, will as action remains in abeyance, but as long as it determines a present moment, the will is there as its principle of unity and potential realisation.

5.0.2. The will cannot act in a vacuum, and the possibilities of action reside in the present moment and its contents.[vv]

5.1. An act of will cannot be separated from the actor or that which is acted upon. Expression (12) does not tell the whole story. It must be amplified to show how actors and the contents of their present moments are conjoined.

5.1.1. As it stands, Expression (12) seems to imply a definite separation and sequence. It looks as though the executive E "existed" prior to, and the compatibility unit after, the decision, while the act itself "exists" and is separable from its elements.

5.2. There is no reason, however, for supposing that any of these elements have the same meaning, or indeed any meaning, outside of an action situation. The compatibility unit and the executive are present, not after and before, but within the act. It is only within the reality of the act that these elements are separable, and if our scheme makes it look as though they may lead a separate existence of their own, then we must introduce a correction term.[ww]

5.2.1. For this purpose, we will use the coalescence brace and write;

$$\{E \longrightarrow (P^1, P^2, \ldots, P^n, \ldots)\} \quad \ldots\ldots (13),$$

where the braces { } represent a coalescence unit that is "present as a whole." The situation enclosed within a coalescence brace is wholly present as one and can be thought of as such.

5.2.2. Coalescence is *not* structural dissolution into sameness or uniformity.[xx]

5.3. There is an almost self-evident rule of interpretation to the effect that the coalescence brace is primary over its contents in that it signifies that the wholeness of the situation is primary over particulate features to which the attention may be directed by the will.

5.3.1. The particulate features are secondary, for they presuppose the whole in relation to which they are aspects.

5.3.2. “Aspects” refer to some total situation, and it is only inasmuch as they do so that they have meaning and so can be recognised and known.

5.3.3. Thus the very condition for particularisation is that a situation be primarily present together as a whole. Such a primary wholeness is always, and must always be, presupposed when reference is made to particulate aspects.

5.4. Referring to Expression (13), we see that it represents primarily a total action situation. Within this total situation, two linked poles emerge. The executive E is the "subject-pole"; the compatibility unit $(P^1, P^2, \ldots, P^n, \ldots)$ is the "object-pole"; the “act" ($\longrightarrow$) links the two poles.

5.4.1. These elements bear meaning individually only when they are taken together.[yy] To isolate any element and consider it without reference to the others collectively within the present moment is to abstract it and to misplace its concreteness.[zz] We can hardly avoid doing this for the purpose of explication, but we must not assume that the corresponding elements of actual experience are similarly separable. Therefore, for example, we must not suppose that the executive exists apart from an act. Its only reality is within an action situation.

5.4.2. Will is meaningless except in a present moment, and a present moment is unspecifiable except by reference to a will.

5.5. Expression (13) is an example of what we call in our scheme a "descriptive simplex." Such simplexes are the minimal descriptive expressions that can be said to refer to an element of experience having independent reality. Neither the executive element by itself nor the compatibility unit by itself can be said to have independent reality when taken in isolation. They require to be connected by the linkage act, and it is then the whole act itself, represented by $\{E \longrightarrow (P^1, P^2, \ldots, P^n, \ldots)\}$, that is the element of experience. This is not to say that the constitutive elements are no more than representational artifices. They stand in distinct relationships to the present moment within which they are contained.

5.5.1. Descriptive simplexes play the role of building blocks in the construction of more complex expressions representing self-realising situations.[aaa]

5.5.2. Any simplex has the following formal characteristics:

(i) A subject-pole.
(ii) An object-pole.
(iii) A linkage, and
(iv) A coalescence brace.

(i), (ii), and (iii) may be simple or compound. In Expression (13) above, the subject-pole is simple and the object-pole compound.

5.5.3. An expression is *well formed* if it contains only descriptive simplexes and, as a whole, has the form of a descriptive simplex. This will be illustrated when we come to build complex expressions out of simplexes.

5.5.4. An expression is *complete* if it contains direct reference to the will S, which is the centre of experience. Expression (13) is well formed but not complete. It is completed by writing

$$\{E \longrightarrow (P^1, P^2, \ldots, P^n, \ldots)\} ▯ S \text{ ....(14)},$$

where '▯ S' indicates "within the experience of the scientist," "within the present moment of the scientist S," or, best of all, "within the sphere of possible action of will S."

5.5.5. The full constitution of S will be given (Props. 12.4.1 to 12.4.6) when all the necessary elements of the scheme have been introduced. At this stage, all we need to say is that the executive element E is a property (but *not* a "part") of the scientist S, whereby he is able to act within his present moment.

5.5.6. When the descriptive simplex refers to an act, the subject-pole is the *executive*, since he, she, or it is the source of the act. The object-pole, in this case, is called the "aim" or the "objective."

5.6. In Expression (13), the object-pole is represented as open-ended. This is to indicate that the possibilities compatible with a decision cannot in principle be enumerated. This does not mean that they are infinite in number but that enumeration itself is not possible by the very nature of the situation. If the object-pole were closed, then decision would be no different from selection. It cannot be closed, however, for our very experience, with its characteristics of uncertainty and hazard, tells us immediately that we do not inhabit a closed universe. Only if we accept this can we entertain the possibility of a truly *creative* act, an act that results in something entirely new and unsuspected.

5.6.1. The entries in the compatibility unit, *i.e.,* P^1, P^2, ... , P^n, ... , etc., are referred to as "passive elements" or just "passives." This name is not meant to imply any distinction between animate and inanimate or inert, for it includes both of these categories. A passive is *any recurrent element taken without regard for the power to act or cognize*. Passives can transform, change, and participate in operations.

5.6.2. In Expression (14), the passive elements are the "objects of decision," *i.e.,* possibilities. Inasmuch as what is possible can be considered only with respect to what is impossible, possibilities must always be within a compatibility unit.

5.6.3. Let P_c be all possibilities compatible with (and relevant to) a decision; and let P_c^* be all possibilities not compatible with that decision and therefore effectively impossible. We may formally write this

$$N\,(P_c, P_c^*) \mid S \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (15),$$

where $P_c \equiv (P^1, P^2, \ldots, P^n, \ldots)$, and the sign "N" indicates the logical negation operator "not," *i.e.,* "it is not the case that ... ."[bbb] This expression is indicative of a beginning.

5.6.4. To illustrate how what is possible can only be considered against a background of what is not possible, we might suppose that we are tempted to ask, "Is the field of possibilities not compatible with a decision compatible with itself?" *i.e.,* can we write (P_c^*, P_c^*)? The answer is that this question cannot be asked. The expression (P_c^*, P_c^*) is meaningless, for there is no criterion of limitation by which the compatibility unit referred to could be defined.

5.6.5. The interpretation of the passives, in this case, as objects of decision, has the advantage of not implying that they can exist independently in isolation from an action situation. This is reinforced by, and reinforces, our use of the coalescence unit. The passives have meaning in this scheme only inasmuch as they are within the present moment of an active will.[ccc]

5.6.5.1. This is consistent with the definition of meaning as "the recognition of a recurrent element in experience."

5.6.5.2. For the purpose of a descriptive model, it is not necessary to "step outside of the present moment." Questions of isolated independent existence do not therefore arise.

6. Using words as symbols[ddd] treats them as invariants that can be transferred from one situation to another without change of content. This eliminates the dynamism inherent in the present moment as immediate presentation.

6.0.1. Conceptual thinking that uses words as symbols is by nature static. It freezes into immobility that which is by nature mobile.

6.0.2. In consequence, verbal description of change, transformation, and flux in general encounters difficulties that, being inherent in the linguistic form, cannot be removed by a linguistic device.

6.0.3. Nevertheless, such devices are employed without recognition of their artificiality, and they usually consist in introducing further concepts to link together the supposedly static elements. The latter are usually regarded as "states" and the former as "relations."

6.0.4. "States" are abstract or spurious present moments that are no more than conceptually instantaneous cross-sections of the situation. "Relations" are abstract or spurious acts of will that are not true acts because they neither begin nor end a process. Description by states and relations is, then, no more than a representational device that could be justified only if or to the extent that it worked.

6.1. The “state/relations” representational device tends to squeeze out the very features of actual experience that one is trying to point to. By directing attention to the static, it seems to deny the primacy of the dynamism that is so striking in the immediacy of experience. Indeed, in its crudest form, it amounts to an attempt to constitute the dynamic from the static and is often associated with the claim that we do not know change directly but only infer it from the cognition of different states. In our model, however, we take flux to be a primary feature of experience.

6.2. The state/relations representational device is also intimately connected with the view that sees time as a simple linear uni-directional progressive sequence of instants. This characterisation of time arises *of necessity,* however, from the way in which we try to grasp our experience by means of the customary state/relations conceptualisation. If we hypostatise the experienced flux into separate states, then we are *forced* to introduce a relational connecting link with linear characteristics. The "temporal sequence," with its distinctions of past, present, and future, fulfils the role.

6.3. The picture of time as a linear sequence of instants is a mental construct within the present moment. It is not an object of direct perception; within the *present moment,* there is direct awareness of content and change but not of time as a linear sequence of "instants."

6.4. The picture of the world as a series of instants in temporal succession breaks down when we seek to find a place in it for organised complexity. A structural process of self-organisation cannot be described by a uni-linear sequence of steps without loss of the very features that make it a structure. The features referred to are expressed by such words as "organisation," "complexity," "wholeness," "integration," "structure," etc., which refer to integral rather than to particulate features of experience.

6.5. The present moment is such an organised complexity. Its embrace is variable, as is its degree of organisation and structural articulation, but with all its variations of content and togetherness, it is totally present as a whole.

6.6. There is succession within the present moment. This is not succession in the temporal sense of "before and after." The elements that are successive are yet together within the present moment.[eee]

7. We have used 'change' by itself to refer to simple flux, that is, to flux taken without regard for its purposiveness or even significance (*cf.,* Prop. 2.3.1).

7.1. If a passive, P^1, changes into a passive, P^2, we write:

$$\{P^1 \longrightarrow P^2\} \quad \text{...(16),}$$

which is a descriptive simplex. To complete this expression, we must place it within the experience of some particular scientist, S. We write, therefore

$$\{P^1 \longrightarrow P^2\} \,\square\, S \quad \text{...(17).}$$

7.1.1. Since the coalescence brace is primary over its contents (*cf.*, Prop. 5.2), it stresses the wholeness of the change. This means that the change is present as one whole within which elements are distinguished. The sequential order that may be implied is within the present moment and so is not temporal in the sense of "before and after."

7.2. The subject-pole of (16) is referred to as the "initial state" and the object-pole as the "final state." If we call P^1 the “changing subject,” then P^2 is the “object of change.”

7.2.1. To speak of an object of change in this way, referring to the final state (and not the initial state as might be expected) is no different from speaking of "reaching an objective," implying the gain of an "object of purpose" or of an "object of endeavour.”

7.2.2. Nowhere in our scheme is "object" equivalent to "thing." An object is always an "object of … .”

7.3. The present moment is perpetually changing, but not all the elements change in the same way or at the same rate.[fff] Within a given moment, some elements change so little that they can be treated as non-varying. The same element when related to a more widely embracing will, *i.e.,* a greater present moment that contains the first, may vary or even disappear. All change is within the present moment, but what is change for one, may be invariance for another.

7.3.1. Expression (16) describes non-invariance, *i.e.,* the change of one passive into another that is different in identity. An example of this (*cf.,* Prop. 2.3.2) is the seed changing into humus.

7.3.2. The features of experience that we distinguish as relatively permanent or stable can be treated as if the particular passive is *invariant*, and we can write

$\{P^1 \longrightarrow P^1\}$ ....(18).

7.3.3. This expression appears to be tautologous and trivial. It is, however, the basic axiom of identity[ggg] put in a form that relates it directly to experience. It is significant and true only within the present moment defined by the coalescence brace. If we were to write

$[P^1, P^1]$ ....(19),

i.e., P^1 is *compresent* with P^1, then, indeed, it would be tautologous but still not trivial, for it tells us that there is an entity P^1 that remains itself within a present moment. It is only when we write

(P^1, P^1) ....(20),

i.e., P^1 is *compatible* with itself, that the statement degenerates into triviality.

7.3.4. The invariant Expression (18) is meaningful if P^1 is in the company of other passives that are changing non-invariantly. This, of course, is the assumption that is always tacitly made, for invariance has meaning only within the context of non-invariance. In the extreme case, the contrary would also be true, for if there were total flux with no invariant features, it would be impossible to entertain the concept of non-invariance except at a meta-level.

7.4. There is the intermediate case of semi-invariance. Identity is conserved, so that the same passive occupies both poles of the descriptive simplex, but there is a distinction of state. This is indicated by a subscript, thus:

$\{P^1{}_1 \longrightarrow P^1{}_2\}$ ....(21),

which reads, "The passive P^1 in state 1 changes into the same passive P^1 in state 2." An example would be the same liquid at two different temperatures.

7.4.1. In view of this, Expression (18) should more properly be written

$\{P^1{}_1 \longrightarrow P^1{}_1\}$ ....(22),

which appears to be an awkward way of saying that nothing has happened at all. Nevertheless, such a descriptive simplex finds frequent application in theoretical physics, particularly in the formulation of thermodynamics.

8. When change is *meaningful*, that is, when due regard is given to the significance of features of the flux, then it is called "transformation" (*cf.,* Prop. 2.3.2).

8.1. If a passive, P^1, transforms into a passive, P^2, we write

$\{P^1 \rightleftharpoons P^2\}$ ....(23),

which is a descriptive simplex. To complete this expression, we must place it within the present moment of some particular scientist, S. We write

$\{P^1 \rightleftharpoons P^2\} \between S$ ....(24).

8.1.1. When there is a transformation, the subject-pole of the descriptive simplex contributes significantly to the flux. We indicate this by doubling the arrow into $\rightleftharpoons$.

8.1.2. Since the coalescence brace is primary over its contents (*cf.,* Props. 5.2 and 7.1.1), it stresses the wholeness of the transformation. The transformation is present as one whole within which elements are distinguished. The sequential order that may be implied need not be temporal in the sense of "before and after."

8.2. Because the subject-pole in (23) contributes a significant element to the transformation, it is referred to as the *originator*. The object-pole is called the “outcome.”

8.2.1. Comparing "originator and outcome" with "initial and final state," it will be seen that the former carry implications of meaning and significance that are missing in the latter.

8.2.2. We can again take, as an example, the transformation of a seed into a plant. This is described by Expression (24). The originator is the seed, and the plant is the outcome. It is clear that the seed contributes a significant element to the transformation.

8.2.3. If we call P^1 the “transforming subject,” then P^2 is the “object of transformation.”

8.3. Within the present moment, a given passive may undergo meaningful change without loss of identity. This is transformation in the sense of development or degeneration by which a passive becomes more like or less like its own “natural pattern.”[hhh]

8.3.1. When we write

$$\{P^1 \leftharpoondown\!\!\rightharpoonup P^2\} \between S \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (25),$$

we are saying that the scientist S can observe a change in P^1 that is meaningful without diminution of the identity of P^1.

8.3.2. The propositions of Section 7 as applied to simple change can in most cases be transposed into propositions about transformation.

8.3.3. When a passive transforms according to (25), we describe the change as a "self-transformation" of P^1. We can also say that P^1 is “invariant for the transformation.”

8.4. The simplex $\{P^1 \longrightarrow P^2\}$ describes a “happening,” whereas the simplex $\{P^1 \leftharpoondown\!\!\rightharpoonup P^2\}$ describes an “event.”

8.4.1. Transformation, since it is meaningful, must be more closely bound to a centre of experience, S, than in the case of change. Two centres of experience, ${}^1S$ and ${}^2S$, may be in agreement that a change occurs, but for ${}^1S$ it may be meaningful and significant change, whereas it may not be so for ${}^2S$. Thus, we have

$$\{P^m \leftharpoondown\!\!\rightharpoonup P^n\} \between {}^1S \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (26),$$
$$\{P^m \longrightarrow P^n\} \between {}^2S$$

where both expressions make direct reference to the scientist for whom the change is or is not meaningful.

8.5. The notions of change and transformation that we have introduced are somewhat akin to the mathematical concept of transformation. For example, in a vector space, there are matrix transformations of a vector. If the vector represents a particular state of some system, the matrix will transform it into another vector representing a different state. This operation is analogous to the descriptive simplexes $\{P^1 \rightharpoonup P^2\}$ and $\{P^1 \leftharpoondown\!\rightharpoonup P^2\}$. The analogy is more appropriate if we imagine a transformation matrix whose components are not constant.

8.5.1. Flux may perhaps be visualized as being rather like a rising and falling, something giving way and something coming into place, which, when seen in a certain perspective, presents the appearance of a sequential order moving on.

9. A particularly important class of transformations is *cognitions*.

9.1. Since, by definition, the present moment, Q, is *for* a self, a centre of experience, S, the flux in Q is connected with S in a special way. This connection consists in S "cognising" what is going on. S does not necessarily cognise all the "content" of Q, for there is always the background flux that forms the context of the cognition. Part of this background may, in turn, become the foreground, *i.e.,* may become a cognition.

9.1.1. It is important to note that cognitions are contained within the present moment, not apart from it. There is no separation of knower and known, but there is a distinction between cognitive and non-cognitive flux.

9.2. Cognitions are *ipso facto* meaningful.

9.2.1. Cognition is reciprocal. Meaning depends as much on the cognitive element that is the subject as it does upon the object of cognition. These two poles of a cognitive situation depend each upon the other.

9.2.2. Looking down a microscope to observe Brownian movement, observing the oil drops in Millikan's experiment to determine the electronic charge, seeing the interference fringes in Michelson's interferometer, or visualizing a thought structure in theoretical physics — all of these examples demonstrate the point. More familiar examples are reading a thermometer, a galvanometer, a computer programme, etc. Even more directly, a chair would not be cognised as "chair" by a member of a society whose members always seat themselves upon the floor.

9.2.3. Propositions 9.2 and 9.2.1 demonstrate that a cognition is a transformation within the present moment.

9.3. The introduction of a special symbol for cognition is fortunately unnecessary. We represent cognition by associating the transformation arrow ⥋ with the sign "O," which stands for "cognitive element" or "Observer." Thus, we write

{O ⥋ P} ....(27),

which reads, "The cognitive element O cognises the passive P." Whenever we have the combination "O ⥋," then the transformation sign is referring to a cognition.

9.3.1. More completely, we have

{O ⥋ P} ⌶ S ....(28),

which stresses that the cognition is within the present moment of the scientist S.

9.3.1.1. The cognitive element O is a property or member (but not a "part") of the scientist S. (*cf.,* Props. 5.5.5 and 12 through 12.5.3).

9.3.2. The coalescence brace indicates the immediacy and wholeness of cognition. The distinction between the cognitive element O and the object of cognition P, is secondary to this wholeness.

9.3.3. The descriptive notation does not take the object of cognition and the cognitive element as being capable of existing in isolation. However, we do not say that the passives do not exist unless perceived. To do so would be to make the passives dependent upon the cognitive element that would then be prior to and independent of the objects of cognition. But to give independent individuality to the cognitive element apart from the objects of cognition would also be false, for it would imply that a continuously present consciousness remains even when not cognitive.

9.3.4. The cognitive element and the object of cognition each depend upon the other. Their only independent reality is as they occur together within a cognition situation.[iii]

9.4. In pointing to the wholeness of cognition, the traditional separation between "outside-world" and "inside-world" is seen to be secondary rather than primary. *Both* these worlds are contained within the present moment, which is one whole.

9.4.1. Our experience does not disclose to us any distinction in kind between "outer" cognition, or what is usually called "perception," and "inner" cognition such as thinking. Consequently, no notational distinction need be made, and

Expressions (25) and (26) each describe the two cases that are usually distinguished.

9.4.2. The difficulty with "perception" is that its referent is unclear. Does a scientist perceive "something" in an "outer" world that is then interpreted in his "inner" world and presented to him as, *e.g.,* "thermometer," or does he perceive "thermometer" directly? In other words, what is a percept, and when can it be said that we have “perceived”? For the purpose of description, all this is unnecessary and can be abolished if one is prepared to deny the distinction “inner/outer” as being primary.

9.5. It must be remembered that although cognitions are transformations, not all transformations are cognitions. Thus, if we introduce a cognitive element into Expressions (26), we have

$$\{O \longrightarrow \{P^{m} \longrightarrow P^{n}\}\} \between^{1} S \text{ .... (29A)}$$

and $$\{O \longrightarrow \{P^{m} \longrightarrow P^{n}\}\} \between^{2} S \text{ .... (29B).}$$

In (29A), the first transformation symbol refers to cognition, whereas the second belongs to the object of cognition that is the transformation of the passive.

9.5.1. It will be noted that, in (29A) and (29B), the object-pole itself is a descriptive simplex, and hence that the expression as a whole is formally correct, *i.e.,* it is itself a descriptive simplex, (*cf.,* Prop. 5.5.2).

9.5.2. If the passive, P^{m}, referred to in (29B) is invariant, then we have

$$\{O \longrightarrow \{P^{m} \longrightarrow P^{m}\}\} \between S \text{ .... (30).}$$

We take this to be equivalent to "no change" (*cf.,* Prop. 7.4.1), thus

$$\{O \longrightarrow P^{m}\} \between S \text{ .... (31).}$$

We write

$$\{O \longrightarrow \{P^{m} \longrightarrow P^{m}\}\} \equiv \{O \longrightarrow P^{m}\} \text{ .... (32),}$$

which reads, "The cognition of invariant change is equivalent to no change." The symbol "≡" reads: "describes the same situation as … ."

9.5.3. Since all transformations are meaningful, an invariant transformation is meaningful and is not equivalent to no transformation. Consequently, there is no expression for transformation of the same form as (32).

9.5.4. The present moment is an indivisible whole, and it is, therefore, never rigorously permissible to isolate a single act of cognition, change, or transformation. Nevertheless, owing to the property of quasi-invariance possessed by the perceptual apparatus of the will S and by the general physical environment, it is in practice possible to make statements as if there were single, isolable acts of cognition and decision within the totality. If this were not the case, there would be no order or organisation within the complexity of the present moment, and there would be nothing to be communicated in our symbolic language or any other.

10. The will that determines the present moment can be associated with any of the modes of togetherness[jjj] and can enter into any of the three types of linkage, namely, change, transformation, and decision. In non-degenerate states where there is effectual action, the will to know and the will to act are distinct but complementary. Will without cognition is blindness, whereas cognition without the power to act is velleity and impotence.

10.1. Recall Expression (14): $\{E \longrightarrow (P^1, P^2, \ldots, P^n, \ldots)\} \square S$. In any real action situation, however, we would not have Expression (14) only, but

$$\{\{O \leftrightharpoons N\,(P^1, P^2, \ldots, P^n)\} \leftrightharpoons \{E \longrightarrow (P^2, P^r, P^s, \ldots, P^w, \ldots)\}\} \square S \quad \ldots\ldots\ldots\ldots\ldots\ldots(33),$$

which reads, "O cognises that it is not the case that the possibilities $P^1, P^2, \ldots, P^n$ are compatible within the experience of the scientist S. This transforms into the act whereby the executive E decides upon one possibility P^2 that results in the partitioning of an open-ended field of possibilities $P^2, P^r, P^s, \ldots, P^w, \ldots$ that are compatible with respect to that decision within the experience of the scientist S."[kkk] When we add that the whole of this is within the present moment of S, it will be seen that Expression (33) is both more concise and more informative than its English language equivalent.

10.1.1. If decision were merely selection, we would have to write

$$\{\{O \leftrightharpoons N\,(P^1, P^2, \ldots, P^n)\} \leftrightharpoons \{E \longrightarrow P^2\}\} \square S \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(34)$$

and interpret the simplex $\{E \longrightarrow P^2\}$ as "the executive E selects P^2." If decision were only selection, then it would be a "closing" operation. In our scheme, however, decision is taken to be an "opening" operation, and consequently the simplex $\{E \longrightarrow P^2\}$ is not admissible as a decision.

10.1.2. The cognitive situation “transforms,” not only “changes,” into the executive situation. This is clearly the case inasmuch as the change is meaningful and the two situations are reciprocally related (*cf.,* Prop. 9.2).

10.2. The subject-pole of (33) and (34) requires further discussion. The possibilities $P^1, P^2, \ldots, P^n$ represent alternative courses of action. The brace is closed because here the scientist is cognising alternatives prior to decision, and clearly he can only definitely cognise a few such alternatives.* When a decision is taken, then, although only one of these alternatives is chosen (in this case P^2), nevertheless the act opens S to a non-denumerable totality of possibilities P^r, P^s, ... , P^w, ... focused around P^2.

10.2.1. In many cases, there will not be a finite number of alternatives that can be clearly cognised. Even so, the will that makes the decision will be able to cognise only a definite number from among which it will make its choice.

10.2.2. It has previously been maintained (Prop. 5.6.2) that possibilities are the objects of decision. Yet in (33) and (34), we have possibilities that appear to be objects of cognition. The contradiction is only apparent. Firstly, decision is connected with a set of compatible possibilities, whereas in (33) and (34) the cognition is connected with a set of incompatible possibilities. When such a set is cognised, we refer to the possibilities as "alternatives." Secondly, the cognition of alternatives is clearly connected with a prior decision, namely, the decision to consider alternatives. Thus, our usage is consistent.

10.3. In (33) and (34), both subject-pole and object-pole are compound, though each in itself is a descriptive simplex. Thus, we have coalescence braces within coalescence braces, giving the expression the overall coalescence form of

$\{\{\quad\} \leftharpoondown\!\!\rightharpoonup \{\quad\}\} \updownarrow S$ ....(35)

There are three coalescence braces, and we say that all that is within each of these is within the present moment of the scientist S. Thus the whole simplex, as well as each sub-simplex, is taken to be within the present moment.

10.3.1. This will appear strange, since we would certainly think of such a sequence as "occupying a stretch of time." We would then perhaps use a linear sequence for representation, such as:

$\{\ \} \leftharpoondown\!\!\rightharpoonup \{\ \}$ ....(36)

The difficulty with this arrangement is that when the referent of the first brace exists, the referent of the second brace is not yet, and when the second exists, the first is no longer. Yet, both exist as traces together in the representation that is within the present moment. Are we to infer from this that one present moment can be compared with another? Clearly, this cannot be so, for there is only the present moment — that is, not one that is past and another that is present.

10.3.2. The paradox of the present moment is that all present moments are within the unique present moment.[III] This suggests that any adequate

* [Footnote in original]: The temporal implications of "prior" belong, of course, to customary usage. There are no such implications in the formalised expression since the latter is constructed to avoid such usage.

representation scheme should try to imply a nested rather than a sequential order. This may be strange, but it is certainly not absurd. If one reaches the conclusions that all acts, cognitions, operations, transformations, etc., are within the present moment, then one may well be led to ask, "Why not strive to represent it so?"

11. Within the present moment of scientific activity, there are "higher" cognitions or insights.

11.1 An insight is a cognition, but it is more than just meaningful.

11.2. An insight has the character of a beginning. From an insight, new series of transformations originate. In this way, an insight is purposive.

11.2.1. An insight has the quality of an act. It is a creative act.

11.3. Since insight involves both cognition and purpose, or intention, we coalesce the executive and cognitive element into {E, 0}.

If P is the object of insight, we write:

$\{\{E,0\} \longrightarrow P\}$ ▯ S ....(37).

The arrow $\longrightarrow$ is intended to indicate that the link "insight" has the quality of transformation (and hence of cognition because there is a cognitive element O in the subject-pole) as well as the quality of an act.

11.3.1. As in the case of (ordinary) cognition (*cf.,* Props. 9.4 - 9.4.2), the traditional distinction between "outer" and "inner" is not implied. If P is "inner," we call it a "creative thought," whereas if P is "outer," we call it "invention."

11.4. Consider the case of a scientist S who has a set of scientific results, P^1, P^2, ..., P^n, that seem to be quite incompatible with the existing relevant theory T. He is troubled by this and ponders upon it. Suddenly, in a flash, he sees a new theory ,T^1, that would "explain" these results, *i.e., the results are compatible with* T^1. The cognition of T^1 is an insight that may be the origin of further experiments and theoretical enquiries. This can be written

$\{\{O \longrightarrow N\ (P^1, P^2, ..., P^n, T)\} \longrightarrow \{\{E, O\} \longrightarrow (P^1, P^2, ..., P^n, T^1)\}\}$ ▯ S ....(38).

(Note that the passives P^1, P^2, ..., P^n are scientific results and not “possibilities.” Here they are not “alternatives” as discussed previously (Prop. 10.2.2).)

11.4.1. If the scientist is not successful, that is, if he does not have an insight, we would write:

$$\{\{O \rightleftharpoons N\,(P^1, P^2, \ldots, P^n, T)\} \rightleftharpoons N\{\{E, O\} \longleftrightarrow (P^1, P^2, \ldots, P^n, T^1)\}\} \in S \quad \ldots\ldots\ldots(39).$$

12. Every real action situation must include decision, cognition, and operation.

12.0.1. There can be no successful outcome to action if any one of these linkages is either absent or too weak. Ideally, they are coeval.

12.0.2. Operation reconciles decision and cognition; cognition reconciles decision and operation; decision reconciles cognition and operation. All these relationships are necessary for realisation.

12.1. Scientists operate; they perform operations.

12.1.1. Operating is intentional. It has the quality of an act of will.

12.1.2. An operation, if successful, results in a transformation.

12.1.3. Because of the intention, the transformation is directed. Directed transformation implies purpose, progress, and refinement.

12.1.4. There is always hazard and uncertainty. If an operation fails, then transformation degenerates into change, and the action does not meaningfully proceed.

12.2. Every operation of the will requires an operative element that must combine intention and agency.

12.2.1. The scientist's agent is his body. The scientist's body is his way of combining change, meaningful operations of cognition, and action with the direct initiative and terminative power that resides in his will. His body fills the present moment by its acts and cognitions, actual and potential. We can say that by his body he is "at-the-world-from-within-it."*

12.2.2. The body is a passive among passives, but it is not inert. It can behave automatically, but it can also be directed.

12.3. An operation that results in the transformation of a passive P^a is written:

$$\{\{E, P\} \twoheadrightarrow \{P^a{}_1 \rightleftharpoons P^a{}_2\}\} \in S \quad \ldots\ldots\ldots(40).$$

---

* {Footnote in original]: This suggestive phrase is borrowed from M. Merleau-Ponty.

This expression would describe, for example, the operation of connecting the power supply into an electrical circuit. The passive P^{a} may refer to the whole circuit, to some part of the circuit, or even just to the switch. Which is intended could be indicated by specifying the referent of P^{a} explicitly.

12.3.1. The operative element is written {E, P} to indicate that it is a coalescence of the executive element E and the agent P. The latter does not require any distinguishing mark, for we take it that, whenever the element {E, P} occurs in the subject-pole of a descriptive simplex, then the passive referred to is the scientist's agent.

12.3.2. The symbol for operation, *i.e.,* $\twoheadrightarrow$, is in effect the symbol for decision, *i.e.,* $\longrightarrow$ repeated twice. This is to indicate that operation is intentional and has the quality of a decision, but that it is more than a decision alone. An operation is a decision that is *implemented.*

12.3.3. If the operation fails, and transformation degenerates into change, we could write:

$$\{\{E, P\} \twoheadrightarrow \{P^{a}_{1} \rightharpoonup P^{a}_{2}\}\} \between S \text{ ....}(41).$$

12.4. Expression (40) does not include the cognitive element that would be present in any real situation. This element is included by writing {E, O, P} and by adding an extra barb to the operation symbol so as to indicate cognition. (40) then becomes

$$\{\{E, O, P\} \twoheadrightarrow \{P^{a}_{1} \leftrightharpoons P^{a}_{2}\}\} \between S \text{ ....}(42),$$

and (41) becomes

$$\{\{E, O, P\} \twoheadrightarrow \{P^{a}_{1} \rightharpoonup P^{a}_{2}\}\} \between S \text{ ....}(43).$$

12.4.1. The element {E, O, P} is equivalent to the scientist S, *i.e.,*

$$S \equiv \{E, O, P\} \text{ ....}(44).$$

This defines S, and we refer to {E, O, P} as a “total element.”

12.4.2. Thus far, we have used {E, O, P}, {E, P}, {E, O}, E, O, and P.

Each of these elements must be "included" within the scientist S. But they are not components or constituents, for that would imply that S was in principle separable into isolable parts. They may be distinct elements, but they are not separable parts, since they are what they are only within the coalescence unit.

12.4.3. For descriptive purposes, we refer to non-separable though distinct parts as "members" and to separable parts as "components." This distinction is discussed further when compresence is introduced (Props. 13.1.4, 14.0.2 through 14.1.2).

12.4.4. The scientist S is a total element who is prior to his members. The use of the coalescence unit reflects this. Consequently, the terms {E, O, P}, {E, P}, {E, O}, etc., are each members of S.

12.4.5. We make the following rule, which is characteristic of the concept of coalescence:

> If the coalescence brace consists only of elements without linkages, then any element that is a member, or any coalescence subbrace with members numbering up to the total number of members involved, is considered to be capable of manifesting independently within the total brace.
>
> Thus (44) is equivalent to
>
> S = {{E, O, P}, {E, O}, {E, P}, {O, P}, E, O, P} ....(45).

The total brace is always implied though not necessarily explicitly stated. For example, if we write

> {O $\longrightarrow$ P} ▯ S ....(46),

then it is implied, by virtue of the symbol " ▯ S," that O is a member of Q, the present moment of S, and that S is primary over O.

12.4.6. We have not so far used the element {O, P}, which appears in the total element. This element serves to stress that "seeing" is "looking by means of instruments." Thus, if we wished to stress that seeing is looking through one's eyes, that it is instrumental, we would write:

> {{O, P} $\longrightarrow$ P^1} ▯ S ....(47),

rather than simply

> {O $\longrightarrow$ P} ▯ S ....(47a).

Thus, (47) more properly describes, for example, looking down a microscope to observe Brownian movement (*cf.,* Prop. 9.2.2) than does (47a). It is artificial to separate the "seeing eye" from any additional instruments that may be used. When a microscope is focused, it becomes an extension of the eye, with which it optically coalesces. Hence, the element P in {O, P} may represent the eye together with a focused optical arrangement. In the case of observing Brownian movement, it would be the eye together with the focused microscope, treated as optically one.

12.4.6.1. It will be noted that, since the element {O, P} is a coalescence unit and hence the wholeness is primary, the traditional Cartesian distinction between mind and body, thinking substance and extended substance, does not arise. To insist that the distinction is primary is to mistake {O, P} for [O, P]. The latter is inadmissible in our model since it would imply separability between O and P, and this cannot be the case.

12.5. The elements E, O, P, and their various combinations are, to some extent, present in any present moment Q. Consequently, it would appear that the scheme could be simplified by writing "S" in any expression. This is true, but it would descriptively weaken the scheme, for it would fail to show clearly what was involved in each individual simplex.

12.5.1. In any present moment Q, we find E, O, and P to some extent. If there is one element that is dominant while the others are in abeyance, then we use only the symbol for that one element. The symbol "S" is sometimes used in place of {E, O, P} when it is necessary to distinguish between different scientists.

12.5.2. We find in societies examples of other total elements that have the same type of members. For example,

(i) An insurance company that has executives, agents, and cognitive individuals. Yesterday, the cognitive individuals would be clerks with their records; today they are computers with programmers.

(ii) A government or industrial research unit, which has executives, scientists, and technical assistants.

(iii) An advertising agency, which has executives, "visualisers," and agents.

From the human point of view, the elements will be seen as quite separate in each of these three cases. however, from the point of view of the total element, the working system, the member elements are not isolable parts.

12.5.3. As the executive element E, say, is what it is only inasmuch as it is within a coalescence unit with others, so each total element, in turn will only be what it is inasmuch as it is within such a unit. We cannot imagine an insurance company that was not within a society. Nor could we imagine a scientist apart from a scientific community. However, a total element is such that we can recognise it as a whole capable of relatively independent existence within experience. The scientist S is, in this sense, the first total element we have come to in the descriptive scheme.

13.	All scientists are combined[mmm] in a totality that we call “the world of science” or simply "Science." There is in humankind a common will to know and to operate upon nature. This "will to naturalise" or to perform the operations performed by scientists determines a present moment ^{s}Q that is *the scientific activity of humankind within the greater totality of human history.*[nnn]

13.0.1.	All scientists, when "doing science," form part of ^{s}Q.

13.0.2.	All passives used by or investigated by scientists can be called “scientific objects” inasmuch as they are the object-pole of an intentional or directed activity. They have a “family resemblance”[*] by virtue of their common relevance for ^{s}Q.

13.1.	The individual scientist selects, assembles, arranges, and connects scientific objects that are relevant to his own purpose, *i.e.,* the will that determines the present moment of a specific piece of research or a particular experiment.

13.1.1.	The scientist establishes a group of mutually relevant objects by an act of will that is his initiating decision to do a particular piece of work and not another.

13.1.2.	The scientific objects, when assembled and arranged, are called "components.”

13.1.3.	The bringing together of scientific objects, the forming of components, introduces a degree of organisation characterised by a mode of togetherness that is more than simple compatibility. This further mode of togetherness is equivalent to our compresence.

13.1.4.	Within a compresence unit, the elements are distinct, and there is a degree of separability inasmuch as adding or removing one component will not reduce the mode of togetherness.

13.1.5.	The components of a compresence unit are not entirely separate; they are not distinct "things." They are related inasmuch as they are objects relevant to the particular purpose in hand. This relationship derives from the originating decision. Without that, how could one say, "This is relevant"? If one could not say, "This is relevant," how could one construct a compresence unit?

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[*] [Footnote in original]: The term "family resemblance" is borrowed from Ludwig Wittgenstein.

13.1.6. From 13.1.5, it follows that the objects that form the components of a compresence unit are connected by mutual relevance. Inasmuch as 13.1.4 is the case, the relevance is *extrinsic.*

13.2. The setting up of a compresence unit constitutes a transformation in the mode of togetherness. A set of elements that are compatible, $(P^1, P^2, \dots , P^n)$, is transformed by operation into a set of elements, $[P^1, P^2, \dots , P^k]$, that are compresent.[ooo] This operation is expressed as:

$$\{\{E, P\} \twoheadrightarrow \{(P^1, P^2, \dots , P^n) \longleftrightarrow [P^1, P^2, \dots , P^k]\}\} \text{[illegible]} S \text{ ....(48).}$$

13.2.1. The operation described by (48) could be expressed more concisely by writing

$$\{\{E, P\} \twoheadrightarrow [P^1, P^2, \dots , P^k]\} \text{[illegible]} S \text{ ....(49)}$$

and interpreting the symbol $\twoheadrightarrow$ as "constructs." Then (49) reads, "The operative element {E, P} constructs a compresence unit $[P^1, P^2, \dots , P^k]$."

13.2.2. In the case where an operation results in the transformation of a mode of togetherness, we can, if we choose, interpret the symbol $\twoheadrightarrow$ to be equivalent to "constructs" and omit any direct reference to the transformation involved.

13.3. Forming a compresence unit is constructing conditions for something to come about. Te acts of bringing together and arranging make it possible for something to happen.

13.3.1. The compresence mode of togetherness permits expectation. When all that can be said of a set of elements is that they are compatible, there can be hopefulness but not expectation. For the latter, there must be some degree of arrangement, configuration, or patterning. The more well defined the pattern is, the greater is the degree of confidence that can be placed in an expectation.

13.3.2. There may be patterns that are not wholly within the present moment of a single scientific will but that may be embraced by the compresence of the present moments of several such wills. Expectation may then be described as the confidence that some transformation more or less conforms to a pattern that embraces events outside present experience for the particular self in question.

13.3.3. Consider the compresence formed by numerous automobiles driving on a highway. Then, for any particular driver, there is a pattern or configuration that, if it holds together, permits anticipation and expectation. The driver can anticipate what gap "will occur" in the traffic ahead as if it were happening now, *i.e.,* within his present moment, and drive accordingly. This is only possible inasmuch as there is a compresence mode of togetherness with which the driver is cognitively in contact.

13.3.4. In a scientific present moment ^{s}Q, expectation can take the form of prediction based upon calculations that act as guides to successful outcomes. Calculations of this directly practical type become possible only when there is a compresence unit.

13.3.5. The arrangement that characterises a compresence unit also introduces the possibility of reproducibility.

14. A compresence unit, $[P^1, P^2, \ldots, P^k]$, can be transformed by operations into a coalescence unit, $\{P^1, P^2, \ldots, P^k\}$. This is a further transformation within the total coalescence.

14.0.1. This operation may be represented as:

$$\{\{E, P\} \twoheadrightarrow \{[P^1, P^2, \ldots, P^k] \leftrightharpoons \{P^1, P^2, \ldots, P^k\}\}\} \between S \quad \ldots\ldots (50).$$

From Prop. 13.2.2, it follows that (50) can be expressed more concisely by

$$\{\{E, P\} \twoheadrightarrow \{P^1, P^2, \ldots, P^k\}\} \between S \quad \ldots\ldots (50a).$$

14.0.2. The elements of a coalescence unit are called "members" (*cf.,* Prop. 12.4.3).

14.1. Upon transformation, what was a grouping, a constructed configuration of relatively distinct components, coalesces into a working whole. There is a vanishing of boundaries, a merging of distinctions. The components of the compresence unit unite further to result in a relatively autonomous structure.

14.1.1. The members of a coalescence unit do not have the same freedom of separability and distinctness that pertains to the components of a compresence unit. They are subordinated to the whole.

14.1.2. To be what it is within the coalescence unit, each member requires all the others within the unit. The relation of mutual relevance that the members bear to one another has become *intrinsic*. In the case of a compresence unit, it is *extrinsic* (Prop. 13.1.6).

14.2. The coalescence as a working whole is at the disposal of the scientist and can be regarded as an extension of his agent. Thus when the stage of coalescence is reached (in the performance of an experiment, for example), the scientist's agent can be regarded as the sum of his bodily skills coalesced with the apparatus that is itself coalescent. If we take this point of view, the agent must be considered as the sum of bodily skills and instrumentation, $\{{}^{s}P, P^1, P^2, \ldots, P^k\}$, where ${}^{s}P$ represents the bodily skills.

14.3. The transformation from compresence to coalescence constitutes a further step towards realisation.

14.4. The purpose of the symbols $[P^1, P^2, \ldots, P^k]$ and $\{P^1, P^2, \ldots, P^k\}$ is to distinguish descriptively two modes of togetherness that are clearly recognisable within experience. No essential relationship is implied between the two modes, so that there may be two structures that are different in all respects other than that they are coalescent. For example, a working mechanical contrivance is very different from a person and yet they both have the coalescence mode of togetherness. A mechanical contrivance can also be reduced to a compresence unit, whereas a person cannot. Thus, any value that this distinction may have resides in its use.

14.4.1. The numeration of the entries in $\{P^1, P^2, \ldots, P^k\}$ is purely formal. If such a unit arises, as we have introduced it, through the transformation of a compresence unit, then we adopt the convention of enumerating the members of the coalescence unit and the components of the compresence unit in the same way, *i.e.,* writing $P^1, P^2, \ldots, P^k$ in both cases.[ppp] This is adequate because we are only concerned with indicating a difference in the mode of togetherness. It must be remembered, however, that the members of the coalescence unit cannot be separated in the same way as can the components of the compresence unit. The separation implied by the formalism, *i.e.,* by writing the entries as $P^1, P^2, \ldots, P^k$ is again purely formal.

15. When we come to construct formal descriptions for operations performed in scientific procedure, making a set of measurements for example, we shall find that the descriptive simplexes will be composite. If we adhere to the rules strictly, this will result in a cumbersome number of coalescence braces as well as frequent repetition of "$\{E, O, P\} \twoheadrightarrow$." To avoid unnecessary ungainliness, we relax the rules and allow "improper" descriptive simplexes. We construct the following rule for improper expressions: Whenever there are several consecutive simplexes beginning with "$\{E, O, P\} \twoheadrightarrow$", take this symbol out, write it once only, and run the simplexes together into a transformation chain (or a change chain, depending on which is appropriate) that is ultimately contained within a coalescence brace. Formally, such an improper expression will appear as:

$$\{\{E, O, P\} \twoheadrightarrow \{X^1 \rightharpoonup X^2 \rightharpoonup \ldots \rightharpoonup X^k\}\} \mid S \quad \ldots\ldots\ldots (51),$$

where X stands for any entry, simple or compound. If we treat the improper simplex $\{X^1 \rightharpoonup X^2 \rightharpoonup \ldots \rightharpoonup X^n\}$ as though it were a simplex, then (50) as a whole does have the form of a descriptive simplex. However, it must be remembered that such an improper expression, which is introduced purely for representational convenience, does not show the topology of the present moment correctly.

16. The elements of the model are summarised in the following table:

Type	*Simple Elements*		*Compound Elements*	
	Element	*Name*	*Element*	*Name*
Fundamental Element ..	Q	The present moment	S $\equiv$ {E, O, P}	The scientist
	E	Executive element	{E, O}	Creative element
Basic Recurring Elements	O	Cognitive element	{E, P}	Operative element
	P	Passive element	{O, P}	Instrumental element
	$\longrightarrow$	Act, decision	$\leftharpoondown\!\!\rightarrow$	Insight
Flux Linkages	$\leftharpoondown\!\!\rightharpoondown$	Transformation	$\twoheadrightarrow$	Operation
	$\rightharpoondown$	Change	$\leftharpoondown\!\!\twoheadrightarrow$	Scientific action
Modes of Togetherness	( )	Compatibility		
	[ ]	Compresence		
	{ }	Coalescence		
Additional Symbols	[illegible]	Is included within		
	$\equiv$	Is equivalent to		
	N	Not, negation		

III. COMBINATIONS OF PASSIVES

Experimental procedure consists in producing, modifying, observing, and recording combinations of passives. We shall find it convenient, at this stage, to distinguish, with the help of our descriptive model, different types of combination. Any such combination is a whole that is both complex and organised. Organised complexity can be "internal," in which case we describe it as a coalescence; and it can be "external," when it is a compresence. There can be meaningful transformations between the two kinds of togetherness. We obtain six types by taking the three elements of (1) compresence, (2) meaningful transformation, and (3) coalescence in their six possible combinations. We shall refer to these as:

(1) *Assemblages* or simple compresences,
(2) *Irreversible Artifacts,*
(3) *Reversible Artifacts,*
(4) *Reversible Wholes,*
(5) *Irreversible Wholes,* and
(6) *Identities* or simple coalescences.

Each of these is distinguished from the rest by the kinds of operations that are permissible. Since all of them have a place in scientific description, we shall examine them briefly before going on to give an account of experimentation and measurement.

(1) An *assemblage* is a complex with the togetherness of compresence but lacking the conditions for transformation into a coalescence. We can write

$$N\{[P^l, \ldots, P^k] \rightleftharpoons \{P^l, \ldots, P^k\}\} ▯ Q \quad \ldots\ldots(52),$$

where Q stands for a present moment of indeterminate character. An example of an assemblage is a stock of scientific apparatus and material in storage in charge of a storeman who does not know its significance and therefore cannot construct a coalescence.

In scientific work, the system of interest* may have a characteristic disorder. In statistical mechanics, random assemblages play an important part just because they have to be studied without transforming into ordered systems. Thus (52) can be regarded as a descriptive type for statistical work.

(2) An *irreversible artefact* is a complex with the togetherness of compresence whose nature is to transform into a coalescence and remain so. It is formally defined by

$$\{\{[P^l, \ldots, P^k] \rightleftharpoons \{P^l, \ldots, P^k\}\} \rightleftharpoons N\{\{P^l, \ldots, P^k\} \rightleftharpoons [P^l, \ldots, P^k]\}\} ▯ S \quad \ldots\ldots(53).$$

In setting up an experiment, it is often necessary to produce irreversible artefacts, for example in glass-blowing, or in cutting and welding metal sheets or wires.

A type of experiment involving an irreversible artefact is thermal decomposition, exemplified in the conversion of coal into coke.

(3) A *reversible artefact* can transform from compresence to coalescence and back again without loss of identity. Thus, we have

$$\{\{[P^l, \ldots, P^k] \rightleftharpoons \{P^l, \ldots, P^k\}\} \rightleftharpoons \{\{P^l, \ldots, P^k\} \rightleftharpoons [P^l, \ldots, P^k]\}\} ▯ S \quad \ldots\ldots(54).$$

We introduce the notational device "Πn" to signify "repeat *n* times and connect with *n-1* transformation links." We can then write (54)

$$[illegible]\{[P^l, \ldots, P^k] \rightleftharpoons \{P^l, \ldots, P^k\}\} ▯ S \quad \ldots\ldots(55),$$

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* [Footnote in the original]: A common term in measurement theory, *see: e.g.,* D. Bohm, *Quantum Theory,* Chapter 22.

which means that the reversible transformation from compresence to coalescence and back again can be repeated indefinitely.

Comparing (53) with (54), it can be seen that an irreversible artefact corresponds to the case where *n* = 1/2. This means that the cycle can be realised only half way. Using this notation, we can now write (53) in the form.

$$\{[P^1, \ldots, P^k] \rightleftharpoons \{P^1, \ldots, P^k\}\}\ S \quad \text{...(56).}$$

The reversible artefact is exemplified in the apparatus required for a scientific experiment whenever the component parts can be disassembled and returned to storage.

It is also of special importance as a characteristic system of interest. Where a test piece is made to undergo reversible changes such as thermal expansion, elastic deformation, fluorescence, or electric charge, it behaves substantially as a reversible artefact.

No organised complexity can be perfectly reversible when changes of energy distribution take place upon transformation, for this would be inconsistent with the Second Law of Thermodynamics. Nevertheless, in many cases, both the experimental set-up and the system of interest can be treated as undergoing only reversible transformation.

A reversible artefact is an important type of organised complexity because, by its very nature, there is considerable freedom in what can be done to it before a limit is reached, and it is destroyed. When we come to the description of experimental procedure (Section IV), we shall see how, as a result of the operations it permits, this freedom is of value in experimentation. Nevertheless, this freedom is in another way a restriction, for there are certain types of operation that cannot be performed if a complex can be treated only as a reversible artefact. In particular, there are often measuring operations that must be made while the experiment is "running," *i.e.,* that must be made entirely in the coalescence phase and cannot be performed at all if the complex is reduced to the compresence phase. From the point of view of making these measurements, the complex must be considered as having the kind of organisation that characterises an irreversible whole (*cf.,* (4)). This demonstrates that, where to the eye there may appear to have been no change in the constitution of the apparatus, from the operational point of view there may have been a significant change in the organisation of the complex. This operational difference is common in physics and is the basic condition for the distinction between "static" and "dynamic" measurement developed below in Section IV.

(4) A *reversible whole* is a complex that has the togetherness of coalescence and that can be reversibly transformed into a compresence. The reversibility

means that the original coalescence can be restored and then reduced again, and so on. A single sequence of such transformations is described improperly by

$$\{\{P^{1}, \ldots , P^{k}\} \rightleftharpoons [P^{1}, \ldots , P^{k}] \rightleftharpoons \{P^{1}, \ldots , P^{k}\} \rightleftharpoons [P^{1}, \ldots , P^{k}]\} \subset S \quad \ldots\ldots(57),$$

which can be written

$$\Pi_{2}\{\{P^{1}, \ldots , P^{k}\} \rightleftharpoons [P^{1}, \ldots , P^{k}] \subset S \quad \ldots\ldots(58).$$

It follows from the definition that a completely reversible whole is one for which the cycle described by (58) can be repeated indefinitely. This condition is formally expressed by

[illegible] $\{\{P^{1}, \ldots , P^{k}\} \rightleftharpoons [P^{1}, \ldots , P^{k}] \subset S$ ......(59).

A reversible whole is particularly significant inasmuch as it is identical with the content of some present moment of experience. For example, the laboratory that the scientist enters to perform an experiment is already coalesced into an organised complexity. He has to produce disorder in order to create the conditions he requires and so breaks the coalescence down to a compresence. When the job is done, the original order is restored.

Reversible wholes appear as systems of interest whenever attention is directed to a partial disorder within a total order. Thus a pathological state in an organism can be studied without destruction of the organism as a whole, which, when "cured," reverts to its normal order. Determination of the elastic constants of materials is possible because the specimens behave as reversible wholes, while exhibiting phenomena that can be isolated and measured: elongation, stress-strain ratio, etc.

(5) The *irreversible whole* is the content of a present moment undergoing transformations that destroy part or all of its order. It starts as a coalescence but breaks down into a compresence that cannot be restored to the primitive coalescent state. Thus, we have

$$\{\{P^{1}, \ldots , P^{k}\} \rightleftharpoons [P^{1}, \ldots , P^{k}] \rightleftharpoons N\{[P^{1}, \ldots , P^{k}] \rightleftharpoons N\,\{P^{1}, \ldots , P^{k}\}\}\} \subset S \quad \ldots\ldots(60).$$

Comparing this expression with (53) and (56), it can be seen that it corresponds to the half-cycle $n = 1/2$ of (56). We can, therefore, also write

[illegible] $\{\{P^{1}, \ldots , P^{k}\} \rightleftharpoons [P^{1}, \ldots , P^{k}]\} \subset S$ ......(61).

The living organism subjected to pathological disorder beyond the limit of recovery dies and disintegrates. This is the classic case of an irreversible whole.

The organism is a reversible whole within the limits of pathological tolerance and an irreversible whole beyond these limits.

Similarly, a deformable body stressed beyond the elastic limit passes from reversible to irreversible wholeness.

(6) *Identity*. Finally, we come to the situation where coalescence is the only possible state. Transition to compresence is prohibited by the very nature of the complex under consideration. Hence, we have

$$N\ \{\{P^1, \ldots, P^k\} \leftrightharpoons [P^1, \ldots, P^k]\} \supset S \quad \ldots\ldots(62).$$

We describe this as identity. For example, the scientist S cannot be broken down into a compresence of his nature as a man and his role as a scientist. There can be no such thing as a scientist who is not also a living intelligent being.

The case of identity is not trivial, because we have to deal with properties of a complex that cannot be separated without ceasing to be what they are. We cannot study life separately from living beings. We cannot study electric charge separately from charged bodies.

These six types of organised complexity that we have distinguished by this method are summarised, with their operational definitions, in the following table:

Table 2

Type of Organised Complexity	*Operational Definition*
Assemblage	$N\ \{[P^1, \ldots, P^k] \leftrightharpoons \{P^1, \ldots, P^k\}\} \supset Q$
Irreversible Artefact	[illegible] $\{[P^1, \ldots, P^k] \leftrightharpoons \{P^1, \ldots, P^k\}\} \supset S$
Reversible Artefact	[illegible] $\{[P^1, \ldots, P^k] \leftrightharpoons \{P^1, \ldots, P^k\}\} \supset S$
Reversible Whole	[illegible] $\{\{P^1, \ldots, P^k\} \leftrightharpoons [P^1, \ldots, P^k]\} \supset S$
Irreversible Whole	[illegible] $\{\{P^1, \ldots, P^k\} \leftrightharpoons [P^1, \ldots, P^k]\} \supset S$
Identity	$N\ \{\{P^1, \ldots, P^k\} \leftrightharpoons [P^1, \ldots, P^k]\} \supset S$

IV. A DESCRIPTION OF EXPERIMENTAL PROCEDURE

We shall now illustrate the application of the model to an action situation by formally describing the operations that constitute a scientific experiment. There are, of course, many varieties of experiment involving many different techniques and methods. Nevertheless, most experiments exhibit features that are sufficiently common to allow the construction of a paradigm for a "typical" experiment. If restricted to a specific field, such as experimental physics—as exemplified, for example, in the study of the solid state or the structure of the nucleus—such a paradigm can be used with reasonable confidence. It can even be expected that a paradigm derived from specific cases would apply in other fields where some of the experiments performed are of the physics type, *e.g.,,* in biology and psychology.

It is taken in what follows that we are dealing with an experimental science of the physics type, and with an individual scientist, $S \equiv \{E, O, P\}$, who is concerned with carrying out experiments in that science. We shall now descriptively distinguish features that are characteristic of the development of the physics-type experiment. The first three phases in the development of such an experiment — namely, the initiating decision, construction of the compresence unit, and the transformation to coalescence — will be summarily treated since they have been discussed at length elsewhere in this paper (*cf.,* Props. 3-5.6.7, 13 through 13.3.4, and 14 through 14.4.1).

(A) The *originating decision* to do a particular experiment defines a scientific situation. The situation at this stage has the compatibility mode of togetherness represented by the partitioning of a set of compatible possibilities. This decision is represented

$\{E \longrightarrow (P^1, P^2, .. , P^n, ...)\}$ ▯ S ....(63).

Compatibility means that there are criteria of relevance for a purpose. Elements can be selected as scientific objects and arranged with the compresence mode of togetherness. This step is described by

$\{\{E, P\} \twoheadrightarrow \{(P^1, ... , P^k) \leftharpoondown [P^1, ... , P^k]\}\}$ ▯ S ....(64)

or alternatively by

$\{\{E, P\} \twoheadrightarrow [P^1, ... , P^k]\}$ ▯ S ....(65),

where the compresent passives $P^1, ... , P^k$ simply represent "apparatus elements." If specification that is more explicit is required, this may be indicated by a prefix. Thus ${}^aP^i$ will represent the *i*-th element of kind *a*, and so on.

There are "lining-up" operations. These are operations concerned with matching, balancing, focusing, etc. They mark the end of the compresence phase and the beginning of the transformation to coalescence, which is described by

$$\{\{E, P\} \twoheadrightarrow \{[P^{l}, \ldots , P^{k}] \leftharpoondown\!\!\rightharpoonup \{P^{l} , \ldots , P^{k}\}\}\} \,\square\, S \quad \text{.......................................(66)}$$

or alternatively by

$$\{\{E, P\} \twoheadrightarrow \{P^{l}, \ldots , P^{k}\}\} \,\square\, S \quad \text{...(67).}$$

Coalescence is the mode of togetherness characteristic of the apparatus in running condition.

The transformation from compresence to coalescence constitutes an important step towards realisation, for it is only when this step is made that certain specific kinds of operations can be performed. These are operations that are necessary for acquiring data, the transformation of which will ultimately yield that kind of scientific object that we call a “result.” The gain of a scientific result signifies the fulfillment of purpose and the realisation of intention.

(B) The *specific operations* referred to are preparatory; they prepare the conditions necessary for the relevant measurements to be obtained. Such preparatory operations are of two kinds. There are operations that produce the phenomenon and others that introduce a degree of quantitative control.

If we are concerned with an experiment where the phenomenon has been produced before setting operations are performed, then when a prepared set has been achieved, measuring operations can be performed immediately. If the experiment is not of this kind, then, before measurements can be obtained, the phenomenon must be produced. Often when this is the case, the phenomenon is introduced in the form of a sample.

(1) In discussions of experiment, and particularly of those features concerned with measurement, it is customary to treat the apparatus and the phenomenon (or, more specifically, for measurement purposes, the system of interest), as separate and distinct parts of an experiment. To do so is to insist upon a distinction that is artificial, as well as often unattainable in practice, and that consequently fails to describe adequately the conditions for an experiment. There are easily distinguishable cases.

(a) There are experiments where the phenomenon is produced by the introduction of the system of interest, perhaps as a sample of a material one property of which is of interest, when the apparatus is in running condition. Examples include experiments to determine the dielectric constant, the magnetic susceptibility, or the tensile strength of different materials.

When the phenomenon is produced in this way, the apparatus taken together with the system of interest constitutes a reversible artefact. The operation of introducing the sample into the apparatus and the transformation to a coalescence of the apparatus and the sample, which is the condition for the experiment to proceed, are described by

$$\{\{E, P\} \leftrightarrow \{[\{P^1, \ldots, P^k\}, {}^{I}P] \leftrightharpoons \{\{P^1, \ldots, P^k\}, {}^{I}P\}\}\} \text{ [illegible] } S \text{ ....(68),}$$

where ${}^{I}P$ represents the sample as the system of interest. Removing the sample would be described by the inverse of (68).

It is clearly in the nature of such an experiment that the cycle of transformations described by (68) and its inverse can be repeated as desired. Hence, the system of interest and the apparatus taken together constitute a reversible artefact, and, since they are separable, operations can be performed on either without involving the other.

Because of this separability, an important feature of this type of experiment often passes unnoticed. It is true that the apparatus and system of interest can be separated, which is to say that they can be compresent. However, when an experiment is in progress, they are coalescent from the point of view of the experiment. It is a condition for an experiment that the apparatus and the system of interest shall constitute one whole.

There is a more embracing condition for an experiment that describes the way in which the scientist himself is involved in the situation. This will be discussed below.

(b) There are many experiments where the phenomenon cannot be produced by the introduction of a sample as described above, but is, on the contrary, present only when the apparatus becomes coalescent. When this is the case the phenomenon, or system of interest, is "nowhere to be found" at the compresence phase, but makes its appearance at the coalescence phase. Consequently, since the phenomenon can never be separated from the apparatus, "taken together" they constitute an irreversible whole. Thus the mode of togetherness is always described by $\{\{P^1, \ldots, P^k\}, {}^{I}P\}$ with the condition that

$$\{\{E, O, P\} \leftrightarrow N \{\{\{P^1, \ldots, P^k\}, {}^{I}P\} \leftrightharpoons [\{P^1, \ldots, P^k\}, {}^{I}P]\}\} \text{ [illegible] } S \text{ ....(69).}$$

When the phenomenon is produced in this way, the separability of apparatus and system of interest, which is implied by the customary analysis of an experiment, becomes inapplicable except as a conceptual device. However, if one fails to notice the difference between the conceptual device and the situation as it obtains in practice, then the true nature of the phenomenon is not appreciated.

Examples include Callendar and Barnes' experiment for the determination of Joule's constant, determination of the acceleration due to gravity by a pendulum method, and optical experiments involving interference and diffraction patterns.

(c) There are experiments where the system of interest is introduced when the apparatus is coalescent, but in such a way that the apparatus and system constitute an irreversible artefact. Consequently, although initially separate and distinct, they cannot be reduced to a compresence again without destroying one or the other—usually the system. Thus, we have

$$\{\{E, O, P\} \twoheadrightarrow \{[\{P^{l}, \ldots , P^{k}\}, {}^{I}P] \rightharpoonup \{\{P^{l}, \ldots , P^{k}\}, {}^{I}P\}\}\} \between S \quad \ldots\ldots\ldots\ldots(70)$$

but then[qqq]

$$\{\{E, O, P\} \twoheadrightarrow N \, \{\{\{P^{l}, \ldots , P^{k}\}, {}^{I}P\} \rightharpoonup [\{P^{l}, \ldots , P^{k}\}, {}^{I}P]\}\} \between S \quad \ldots\ldots\ldots\ldots(71).$$

This situation is characteristic of many biological experiments. These will not be considered in this paper.

(d) Finally, there are experiments where the apparatus and the system of interest taken together must be considered to constitute a reversible whole. In this case, the system of interest will not be present at the initial compresence phase, described by (64), nor will it be introduced at the coalescence phase, but it will be formed at the coalescence phase in such a way that it can be separated from, and so made compresent with, the apparatus. This situation is described by

$$\{\{E, O, P\} \twoheadrightarrow \{[P^{l}, \ldots , P^{k}] \rightharpoonup \{\{P^{l}, \ldots , P^{k}\}, {}^{I}P\}\}\} \between S \quad \ldots\ldots\ldots\ldots(72)$$

and

$$\{\{E, O, P\} \twoheadrightarrow \{\{\{P^{l}, \ldots , P^{k}\} \; {}^{I}P] \rightharpoonup [\{P^{l}, \ldots , P^{k}\}, {}^{I}P]\}\} \between S \quad \ldots\ldots\ldots\ldots(73).$$

This situation is characteristic of many chemical experiments. These will not be considered in this paper.

We have now distinguished four situations in terms of the ways in which the phenomenon under investigation is brought within the present moment of S. The phenomenon can be regarded as the coalescence of the scientist S, the system of interest ${}^{I}P$, and the apparatus $P^{l}, \ldots , P^{k}$.

Although it is true that the three features of the situation can be distinguished and considered as separate but compresent, this is only how they appear from the point of view of the human observer who makes this distinction. When there is an experiment, then they are coalescent.

The system of interest can always be operated upon in isolation from the apparatus in case (a), never in case (b), only if it is not part of an experiment in case (c), and when it has been formed in case (d). In all cases where the system of interest can be isolated, then it may in itself be a reversible artefact, an irreversible artefact, a reversible whole, or an irreversible whole. Which case obtains in practice will depend upon the character of the experiment in question.

From the point of view of the operations involved in its construction, any laboratory apparatus will be either a reversible or an irreversible artefact.

(2) We have already indicated that there is a more embracing condition for an experiment than just the coalescence of the system ^{S}P with the apparatus. The full condition is described by the coalescence of these two features with the scientist's manipulative skills and cognitive powers. For case (a) above, this is described by

$$\{[\{P^{1}, \ldots , P^{k}\}, {}^{I}P, {}^{S}P] \longleftrightarrow \{\{P^{1}, \ldots , P^{k}\}, {}^{I}P, {}^{S}P\}\}\} \square S \ \ldots\ldots\ldots\ldots(74).$$

The element ^{S}P, representing the scientist's skills and powers, will be discussed below. For case (b) above, the coalescence is described by

$$\{[\{\{P^{1}, \ldots , P^{k}\}, {}^{\bar{I}}P\}, {}^{S}P] \longleftrightarrow \{\{\{P^{1}, \ldots , P^{k}\}, {}^{\bar{I}}P\}, {}^{S}P\}\}\} \square S \ \ldots\ldots\ldots\ldots(75).$$

Since, in this case, the system of interest can never be separated from the apparatus, we can conveniently include ^{S}P within the apparatus. If we do this (75) becomes

$$\{[\{P^{1}, \ldots , P^{k'}, {}^{I}P\}, {}^{S}P] \longleftrightarrow \{\{P^{1}, \ldots , P^{k'}, {}^{I}P\}, {}^{S}P\}\}\} \square S \ \ldots\ldots\ldots\ldots(76).$$

The cases (c) and (d) above will not be discussed since they can be treated similarly.

The necessary data for a scientific result can be acquired only when (74) or (76) obtains. Since an experiment is the means by which such necessary data are acquired, then (74) and (76) describe the *condition for an experiment* in each of the two cases respectively.

The scientist's skills and powers, represented by ^{S}P, are considered to be a property of the scientist's agent (*cf.,* Props. 12.2.1 and 12.2.2), *i.e.,* $^{S}P \square P$ where P is the scientist's agent. It is important to note that if there is to be an experiment, ^{S}P must become coalescent with the apparatus as described by (76). When this is the case the scientist's skills and powers fuse with the apparatus into a whole, and we may legitimately consider the apparatus as an extension of the scientist's agent, both manipulatively and cognitively.

Any apparatus will contain elements that are basically manipulative in the sense that their purpose is to extend the scientist's powers of manipulation.

Such an extension is described by the coalescence of the scientist's manipulative skills with the manipulative elements in the apparatus, ${}^{m}P^{1}, \ldots, {}^{m}P^{f}$ say. The effect of this is to extend the operative element {E, P}. Thus, if

$$\{{}^{m}P^{1}, \ldots, {}^{m}P^{f}\} \between \{P^{1}, \ldots , P^{k}\} \quad \text{...(77),}$$

then

$$\{E, P\} \longrightarrow \{E, P^{m}\} \quad \text{...(78),}$$

where

$$P^{m} \equiv \{ {}^{S}P, \{{}^{m}P^{1}, \ldots , {}^{m}P^{f}\}\} \quad \text{...(79).}$$

Similarly, any apparatus will contain elements that are relevant for cognition in the sense that their purpose is to extend the scientist's powers of cognition. Such an extension is described by the coalescence of the scientist's cognitive skills with the cognitive elements of the apparatus. These latter, which include detectors, meters, gauges, and other forms of instrumentation, we will represent by ${}^{c}P^{1}, \ldots , {}^{c}P^{q}$. The effect of this coalescence is to extend the cognitive instrumental element {O, P}.

Thus, if

$$\{{}^{c}P^{1}, \ldots , {}^{c}P^{q}\} \between \{P^{1}, \ldots , P^{k}\} \quad \text{...(80),}$$

then

$$\{O, P\} \longrightarrow \{O, P^{c}\} \quad \text{...(81),}$$

where

$$P^{m} \equiv \{ {}^{S}P, \{{}^{m}P^{1}, \ldots , {}^{m}P^{f}\}\} \quad \text{...(82).}$$

Thus, the total extension of the scientist in action is a transformation of {E, 0, P} described by

$$\{E, O, P\} \longrightarrow \{E, O, P^{*}\} \quad \text{...(83),}$$

where

$$P^{*} = \{P^{m}, P^{c}\} = \{ {}^{S}P, \{{}^{m}P^{1}, \ldots , {}^{m}P^{f}\},\{{}^{c}P^{1}, \ldots , {}^{c}P^{q}\}\} \quad \text{.................................(84).}$$

In practice, there can be no extension to E or O in isolation from P. Since the extension to the scientist's powers is achieved through the agency of special kinds of passives, they can only coalesce with those features of S that belong to the scientist's passive or agent. However, since the scientist as $S \equiv \{E, O, P\}$ is one whole, then any extension to P will also be an extension to S that provides an extended field of action for E together with an extended field of cognition for O.

(3) The second kind of preparatory operation consists of all those operations that introduce a definite "set" into the experiment. We shall refer to these as "setting operations." Such operations may be performed upon the system of interest, as for example in the preparation of a radioactive source of a specified intensity. More often, however, they are performed upon the apparatus, although they can be performed upon both the apparatus and the system of interest.

Setting operations introduce some degree of quantitative control by the planned adjustment of variable parameters. When those adjustments have been made that complete the coalescence, the apparatus, and hence the experiment, are said to have a "prepared state." This can also be referred to as the "initial state."

Each setting operation ultimately involves the comparison of a pair of marks, one of which is moveable and the other fixed as an element of a scale. Making such a comparison means forming the compresence of the two marks. Typical examples are, turning a control knob to set the pointer of an instrument in a desired position, adjusting the level of the mercury in a thermometer by the application of heat, etc. An apparatus element that consists of a scale of marks and an indicator will be called a "gauge."

We consider a gauge ${}^{G}P$ consisting of an indicator ${}^{r}P$ and *w* scale marks ${}^{g}P$, ^{1}..., ${}^{g}P^{w}$. The gauge is constructed so that

$${}^{G}P \equiv [({}^{r}P, {}^{g}P^{1}) , (({}^{r}P, {}^{g}P^{2}) , \dots , ({}^{r}P, {}^{g}P^{i}) , \dots , (({}^{r}P, {}^{g}P^{w})] \between S \quad \dots\dots\dots\dots\dots\dots (85).$$

The meaning of (85) is that the measuring element ${}^{G}P$ is *invariant in the present moment of S*. It amounts, therefore, to an axiom of mensuration, but treated as descriptive of an operation, *i.e.,* the construction of the gauge to serve the purpose of the experiment -- and not as a philosophical principle.

In general, a number of gauges, *m* say, will be used. They must be compatible, will be made compresent, and are then brought into a common adjustment, thus:

$$\{\{E, O, P\} \twoheadrightarrow ({}^{g}P^{1}, \dots , {}^{g}P^{m}) \longrightarrow [{}^{g}P^{1}, \dots , {}^{g}P^{m}] \longrightarrow \{{}^{g}P^{1}, \dots , {}^{g}P^{m}\}\} \between S \quad .(86).$$

The coalescence of the ${}^{g}P$'s is the *measuring system* used in the experiment. The ${}^{g}P$'s may, for example, be rulers, clocks, thermometers, pressure gauges, etc.

The operation of making a definite set selects one of the compatibilities of (85) and transforms it into a compresence, thus:

$$\{\{E, O, P\} \twoheadrightarrow \{[({}^{r}P, {}^{g}P^{1}), ({}^{r}P, {}^{g}P^{2}), \ldots, ({}^{r}P, {}^{g}P^{w})] \rightharpoonup [{}^{r}P, {}^{g}P^{i}]\}\} \in S \quad \ldots\ldots (87),$$

which, from (85) may be written

$$\{\{E, O, P\} \twoheadrightarrow \{{}^{G}P \rightharpoonup [{}^{r}P, {}^{g}P^{i}]\}\} \in S \quad \ldots\ldots (88).$$

A gauge is so constructed that when one of the compatibilities ('P, «P1) is chosen, all the others are excluded. Thus, if

$$\{\{E, O, P\} \twoheadrightarrow \{({}^{r}P, {}^{g}P^{i}) \rightharpoonup [{}^{r}P, {}^{g}P^{i}]\}\} \in S \quad \ldots\ldots (89),$$

then

$$N([{}^{r}P, {}^{g}P^{i}], [{}^{r}P, {}^{g}P^{j}]) \in S \quad \ldots\ldots (90)$$

for all $j \neq i$.

Once it has been made, the comparison compresence $[{}^{r}P, {}^{g}P^{1}]$ is cognised by the scientist as a number. This is possible because the scale of the gauge is so constructed that there is a single scale-number, ${}^{h}P^{i}$, corresponding to each scale mark ${}^{g}P^{1}$, *i.e.,* so that

$$({}^{g}P^{1}, {}^{h}P^{i}) \in S \quad \ldots\ldots (91)$$

but

$$N({}^{g}P^{1}, {}^{h}P^{i}) \in S \quad \text{for all } j \neq i \quad \ldots\ldots (92).$$

When a set, thus made, is cognised, the corresponding scale-number ${}^{h}P^{i}$ is called the “set-reading.”

The set-reading is a magnitude, ${}^{h}P^{i}$, consisting of a pure number, *h*, associated with an extensive or intensive property, P^{i}, of the system of interest. We can represent the operation by which ${}^{h}P^{i}$ is obtained as a transformation from compresence to coalescence in the experience of the observer O who makes the reading, thus:

$${}^{h}P^{i} = \{O \rightharpoonup \{[{}^{r}P, {}^{g}P^{i}] \rightharpoonup \{{}^{r}P, {}^{g}P^{i}\}\}\} \in S \quad \ldots\ldots (93).$$

Having described the specific operations performed upon a gauge, we have now to relate this to the apparatus as a whole. In what follows, we will consider setting operations performed upon the apparatus alone, and, for convenience, we will omit any reference to the system of interest.

So far as the apparatus as a whole is concerned, setting operations can be performed in one of two alternative ways depending on the kind of set required. We will discuss these alternatives separately.

(a) *Static states of the apparatus* are those in which the sets can be introduced without requiring the apparatus to be in operation. In this case, therefore, a set can be introduced while the apparatus is at the compresence phase. Consequently, when the transformation to coalescence is brought about, the required set is built-in.

The operation of introducing one set into an apparatus compresence is a partial preparatory operation. It will be described by making direct reference to the gauge concerned. No reference will be made to any other operations involved, since it is not necessary to do so for an unambiguous description.

It follows from Expression (88) that the operation is described by

$$\{\{E, O, P\} \twoheadrightarrow \{[P^{1}, \ldots , {}^{G}P^{1}, \ldots , P^{k}] \longrightarrow [P^{1}, \ldots , [{}^{r}P, {}^{g}P]^{1}, \ldots , P^{k}]\}\} \updownarrow S \quad ..(94).$$

Reference to the particular scale mark is omitted, hence the absence of the postscript on ${}^{g}P$.

The object-pole of the above expression shows the setting operations as performed within the apparatus compresence. This is reasonable since they involve operations performed upon the gauges, which are apparatus elements. The setting operations, since they are performed within the apparatus compresence, result in a definite state being introduced into the apparatus compresence taken as a single unit. Thus, we can write

$$[P^{1}, \ldots , [{}^{r}P, {}^{g}P]^{1}, \ldots , P^{k}] \equiv [P^{1}, \ldots , P^{k}]^{1} \quad \ldots\ldots(95),$$

where the superscript on the right-hand side indicates that the compresence has a definite state corresponding to the comparison compresence of the set on the left-hand side. Since only one set is involved, the state of the apparatus compresence is here referred to as a "one-set state." Expression (94) now becomes

$$\{\{E, O, P\} \twoheadrightarrow \{[P^{1}, \ldots , P^{k}] \longrightarrow [P^{1}, \ldots , P^{k}]^{1}\}\} \updownarrow S \quad \ldots\ldots(96),$$

where $[P^{1}, \ldots , P^{k}]$ describes the apparatus with no set.

When the mode of togetherness is transformed to coalescence, the apparatus becomes a working whole in running order, and the experiment can proceed. The state that has been introduced will be carried through the transformation so that the apparatus coalescence will also have a definite one-set state, *i.e.,*

$$\{\{E, O, P\} \twoheadrightarrow \{[P^1, \ldots , P^k]^1 \rightharpoonup \{P^1, \ldots , P^k\}^1\}\} \in S \quad \text{.................................(97).}$$

So far, we have considered only one setting operation. The description given above for the construction of a one-set state is formally extended to an *n*-set state, thus

$$[P^1, \ldots , [^rP, {^g}P]^1, \ldots , P^k] \equiv [P^1, \ldots , P^k]^1$$

$$[P^1, \ldots , [^rP, {^g}P]^1, [^rP, {^g}P]^2 , \ldots , P^k] \equiv [P^1, \ldots , [^rP, {^g}P]^2, \ldots , P^k]^1 \equiv [P^1, \ldots , P^k]^2$$

$$[P^1, \ldots , [^rP, {^g}P]^2, \ldots , [^rP, {^g}P]^n , \ldots , P^k] \equiv [P^1, \ldots , [^rP, {^g}P]^n, \ldots , P^k]^{n\ 1}$$

$$\equiv [P^1, \ldots , P^k]^n \quad \text{..(98)}$$

With this notation, the total operation of introducing an *n*-set state into the apparatus is described improperly by

$$\{\{E, O, P\} \twoheadrightarrow \{[P^1, \ldots , P^k] \rightharpoonup [P^1, \ldots , P^k]^1 \rightharpoonup \ldots \rightharpoonup [P^1, \ldots , P^k]^n\}\} \in S \quad \text{......(99),}$$

which can be condensed to

$$\{\{E, O, P\} \twoheadrightarrow \{[P^1, \ldots , P^k] \rightharpoonup \square[P^1, \ldots , P^k]^i\}\} \in S \quad \text{...........................(100),}$$

or, more simply,

$$\{\{E, O, P\} \twoheadrightarrow \square[P^1, \ldots , P^k]^i\} \in S \quad \text{..(101),}$$

where

$$[P^1, \ldots , P^k]^0 = [P^1, \ldots , P^k] \quad \text{...(102)}$$

describes the original state of the apparatus compresence, *i.e.,* with no sets.

When an apparatus compresence $[P^1, \ldots , P^k]^n$, with an *n*-set state, is transformed into a coalescence, the latter in turn will have an *n*-set state, thus

$$\{\{E, O, P\} \twoheadrightarrow \{[P^1, \ldots , P^k]^n \rightharpoonup \{P^1, \ldots , P^k\}^n\}\} \in S \quad \text{.............................(103).}$$

From the point of view of introducing static sets, as described above, the apparatus could constitute either a reversible or an irreversible artefact. There are experiments where static sets can be introduced after the apparatus has become coalescent. In this case, the mode of togetherness is reduced to compresence, the sets introduced and the resulting compresence in an *n*-set state transformed into a coalescence, which consequently has a *n*-set state. If static sets are to be introduced in this way, the artefact must be reversible.

(b) *Dynamic States*. So far, we have considered only static setting operations. A number of sets produce the *n*-set state in which measurements are made. There are also, in general, factors that influence the state apart from the setting operation. These are produced both by apparatus conditions, *e.g.,,* if there is a supply or loss of energy from the system as a whole, and also by the nature of the system of interest, *e.g.,* if it undergoes some spontaneous change in the course of the experiment.

As an example, we may take the experiment to investigate the characteristics of a triode valve. This is essentially a dynamic experiment in which setting operations are performed only when the apparatus is in running condition with voltages applied and currents flowing. Apparatus conditions depend upon the connection of batteries supplying electrical energy that transforms into and becomes dissipated as heat and radiation within the apparatus. The system of interest is really the space-charge set up by thermionic emission from the heated cathode. The space-charge phenomenon determines the shape of the curves finally obtained—in particular by saturation effects. Setting and measuring operations during the experiment are performed upon the apparatus governing the flow of current from space-charge to anode, which includes gauges and variable resistors registering and regulating voltages and currents. The grid is essentially a device that permits a special range of dynamic states of the apparatus as a whole to be set up and measured.

In the general case, each state of an experiment will thus involve *n* setting operations, *k* apparatus effects, and 1 system of interest effects. In general, a number *q* of distinct states will be subjected to measurement operations, each involving a number *m* of observations. We shall refer to those conditions as dynamic states where the sets can be introduced only when the apparatus is in operation.

A set must now be introduced when the apparatus has already reached the coalescence phase. If this is the case, the above method (a) cannot be used because, from the point of view of making dynamic sets, the total apparatus {P1, ...P"} constitutes an irreversible whole. However, it is the total apparatus that is an irreversible whole, and this totality may contain sub-units that, from the operational viewpoint, can be treated as reversible wholes and for reversible artefacts. By operation upon these subunits within the totality, dynamic sets can be introduced into the totality.

There is no difficulty here for a scientist who is operating with apparatus of the physics-type. The scientist who is concerned with biological experiments, on the other hand, may have to operate upon a system of interest that is an irreversible whole. The extent to which he can do so without irreparably destroying the system in question depends entirely upon the presence of reversible sub-wholes within the irreversible whole.

We will now consider a physics-type apparatus into which dynamic sets are introduced. The operation of introducing one dynamic set is described by

$$\{\{E, O, P\} \twoheadrightarrow \{\{P^{1}, \dots, {}^{s}P^{1}, \dots, P^{k}\} \longrightarrow \{P^{1}, \dots, [{}^{r}P, {}^{s}P]^{1}, \dots, P^{k}\}\}\} \text{ [illegible] } S \quad \text{..........(104).}$$

For reasons identical with those already given in the case of static states, we can write for a dynamic one-set state

$$\{P^{1}, \dots, [{}^{r}P, {}^{s}P]^{1}, \dots, P^{k}\} \equiv \{P^{1}, \dots, P^{k})^{1} \quad \text{..........(105),}$$

whereupon (104) becomes

$$\{\{E, O, P\} \twoheadrightarrow \{\{P^{1}, \dots, P^{k})^{1} \longrightarrow \{P^{1}, \dots, P^{k})^{1}\}\} \text{ [illegible] } S \quad \text{..........(106),}$$

in which $\{P^{1}, \dots, P^{k})$ describes the apparatus coalescence with no set.

This description can be extended, as before, to an *n*-set state, thus

$$\{P^{1}, \dots, [{}^{r}P, {}^{s}P]^{1}, \dots, P^{k}\} \equiv \{P^{1}, \dots, P^{k}\}^{1}$$
$$\{P^{1}, \dots, [{}^{r}P, {}^{s}P]^{1}, [{}^{r}P, {}^{s}P]^{2}, \dots, P^{k}\} \equiv \{P^{1}, \dots, [{}^{r}P, {}^{s}P]^{2}, \dots, P^{k}\}^{1} \equiv \{P^{1}, \dots, P^{k}\}^{2}$$
$$\{P^{1}, \dots, [{}^{r}P, {}^{s}P]^{1}, [{}^{r}P, {}^{s}P]^{2}, \dots, [{}^{r}P, {}^{s}P]^{n}, \dots, P^{k}\} = \{P^{1}, \dots, [{}^{r}P, {}^{s}P]^{n}, \dots, P^{k}\}^{n-1}$$
$$\equiv \{P^{1}, \dots, P^{k}\}^{n} \quad \text{..........(107).}$$

With this notation, the total operation of introducing an *n*-set dynamic state into the apparatus is described (*cf.,* 101) by

$$\{\{E, O, P\} \twoheadrightarrow \text{[illegible]}\{P^{1}, \dots, P^{k})^{i}\}\} \text{ [illegible] } S \quad \text{..........(108),}$$

where $\{P^{1}, \dots, P^{k}\}^{0} = \{P^{1}, \dots, P^{k}\}$ describes the apparatus coalescence with no dynamic sets.

In actual practice, there will often be both static and dynamic sets, and hence both methods will be utilized. Since the dynamic sets require a higher mode of togetherness than is necessary for static sets, they are specific features of the experiment as an integral whole. If an experiment does not have the coalescence mode of togetherness, then dynamic sets cannot be achieved. Whatever the method of procedure, the end result of preparation is that the apparatus, and hence the experiment as a whole, is in the prepared *n*-set state represented by $\{P^{1}, \dots, P^{k}\}^{n}$.

Each comparison compresence $[{}^{r}P, {}^{s}P]^{i}$ is ultimately cognized as a set-reading ${}^{h}P^{i}$ (*cf.,* (93)). There will be *n* set-readings ${}^{h}P^{1}, \dots, {}^{h}P^{n}$ that are compatible since they are relevant to the totality of setting operations, *i.e.,*

$$({}^{h}P^{1}, \dots, {}^{h}P^{n}) \text{ [illegible] } S \quad \text{..........(109).}$$

The construction of a record of these set-readings is described by the transformation of the mode of togetherness from compatibility to compresence, thus

$$\{\{E, O, P\} \twoheadleftarrow\!\!\twoheadrightarrow \{({}^{h}P^{1}, \ldots , {}^{h}P^{n}) \leftharpoondown\!\rightharpoonup [{}^{h}P^{1}, \ldots , {}^{h}P^{n}]\}\} \between S \quad \ldots\ldots\ldots\ldots(110).$$

(c) The difference between setting and measuring operations lies in the relative roles of the scientist and the phenomenon. Setting operations are *arbitrary*, *i.e.,* they are, to some extent at the discretion of the scientist. The scientist introduces arbitrary sets into the apparatus by means of his manipulative skills.

Making measurements is not arbitrary in the same way. A measurement is evidently arbitrary in that its numerical value will have some dependence on the chosen sets, so that choosing different sets will result in a different measurement value. However, there are also other factors that make the measurement value dependent upon the scientist. For example, the scientist will very often decide when to intervene in a particular process to make a measurement, and in this case, the numerical value may depend upon just when he operated. The value will be arbitrary but not capricious.

When everything that depends upon the scientist, and so is arbitrary, is accounted for, there nevertheless remains a residue that is determined by the nature of the phenomenon being investigated. If there is no non-arbitrary residue, then there has been no experiment. This dependence of the measurement upon the phenomenon is reflected in the operation of making a measurement, which quite often involves cognition without manipulation, as, for example, reading a gauge.

The phenomenon *relates* the set-readings and the measurement readings. Consequently, an investigation of the relationship between the sets and the measurements yields information about the phenomenon itself. In many experiments of the physics type, the non-arbitrary residue in the measurements is the only evidence for the presence of the phenomenon. If it should turn out, in a particular case, that ultimately there is no such non-arbitrary residue, then the phenomenon is "spurious," being *no more* than a consequence of the scientist's action. If this is the case, the relationship between the set-readings and measurement-readings is entirely arbitrary, and the information this relationship yields is spurious.

When the scientist speaks of an experiment as an "investigation of nature," then the "nature" he refers to shows itself in the non-arbitrary residue in the measurements. It is through this residue that the scientist is convinced that he has made a contact with "nature," that is, that he has made an experiment.

Making measurements can usually be identified with making observations. An observation is achieved by reading a gauge—which is taken to be any apparatus element consisting of a scale of marks and an indicator. For an observation, no further manipulation is required once an *n*-set state has been prepared. The scientist's cognitive powers alone are involved.

We shall consider an apparatus with an *n*-set state, described by $\{P^1, \ldots, P^k)^n$. In order to make more explicit the transformation involved in making a measurement observation, we shall include the measuring system $\{{}^{G}P^1, \ldots, {}^{G}P^m\}$ (*cf.,* Expression (86)) within the prepared apparatus coalescence thus, $\{P^1, \ldots, \{{}^{G}P^1, \ldots, {}^{G}P^m\}, \ldots, P^k\}^n$.

Making one measurement observation within such a prepared state requires one gauge ${}^{G}P^1$ and the cognition by the scientist of the relevant comparison compresence $[{}^{r}P, {}^{g}P^1]$. It follows from Expression (94) that this measurement observation is described by

$$\{O \longrightarrow \{\{P^1, \ldots, \{{}^{G}P^1, \ldots, {}^{G}P^m\}, \ldots, P^k)^n \longrightarrow \{P^1, \ldots, \{[{}^{r}P, {}^{g}P]^1, {}^{G}P^2, \ldots, {}^{G}P^m\}, \ldots, P^k\}^n\}\} \subset S \quad \ldots\ldots (111).$$

Making two measurement observations will require two gauges, ${}^{G}P^1$ and ${}^{G}P^2$. The first observation is described by (111) and the second by

$$\{O \longrightarrow \{\{P^1, \ldots, \{{}^{G}P^1, \ldots, {}^{G}P^m\}, \ldots, P^k)^n \longrightarrow \{P^1, \ldots, \{{}^{G}P^1, [{}^{r}P, {}^{g}P]^2, \ldots, {}^{G}P^m\}, \ldots, P^k\}^n\}\} \subset S \quad \ldots\ldots (112).$$

More generally, if there are *m* measurement observations, requiring *m* gauges, ${}^{G}P^1, \ldots, {}^{G}P^m$, the m^{th} is described by

$$\{O \longrightarrow \{\{P^1, \ldots, \{{}^{G}P^1, \ldots, {}^{G}P^m\}, \ldots, P^k)^n \longrightarrow \{P^1, \ldots, \{{}^{G}P^1, \ldots, {}^{G}P^{m-1}, [{}^{r}P, {}^{g}P]^m, \ldots, P^k\}^n\}\} \subset S \quad \ldots\ldots (113).$$

Thus one measuring sequence comprising *m* measurement observations within an *n*-set state is described by

$$\{O \longrightarrow \{\{P^1, \ldots, \{{}^{G}P^1, \ldots, {}^{G}P^m\}, \ldots, P^k)^n \longrightarrow \prod\{P^1, \ldots, \{{}^{G}P^1, [{}^{r}P, {}^{g}P]^i, \ldots, {}^{G}P^m\}, \ldots, P^k\}^n\}\} \subset S \quad \ldots\ldots (114).$$

If there are measurements that require manipulation, then these can be described by using the element "$\{E, O, P\} \twoheadrightarrow$", which is taken to include "$O \longrightarrow$." In this case, (114) becomes

$$\{\{E, O, P\} \twoheadrightarrow \{\{P^1, \ldots, \{{}^{G}P^1, \ldots, {}^{G}P^m\}, \ldots, P^k)^n \longrightarrow \prod\{P^1, \ldots, \{{}^{G}P^1, [{}^{r}P, {}^{g}P]^i, \ldots, {}^{G}P^m\}, \ldots, P^k\}^n\}\} \subset S \quad \ldots\ldots (115).$$

Each comparison compresence is ultimately cognized as a measurement-reading, or an observation. To distinguish set-readings from measurement-readings, we introduce subscripts. The *l*-th set-reading will be represented by ${}^hP^i{}_a$ and the *i*-th measurement-reading by ${}^hP^i{}_b$. There will be *m* compatible measurement-readings, *i.e.,*:

$({}^hP^i{}_b, {}^hP^2{}_b, \ldots, {}^hP^m{}_b)$ [illegible] S ....(116),

which can be recorded thus

$\{\{E, O, B\} \twoheadleftarrow\!\!\to \{({}^hP^l{}_b, \ldots, {}^hP^m{}_b) \leftharpoondown\!\!\rightharpoonup [{}^hP^l{}_b, \ldots, {}^hP^m{}_b]\}\}$ [illegible] S ....(117).

We introduce the notion of an experiment sequence. One experiment sequence will consist of *n* setting operations, resulting in an *n*-set state, upon which *m* measurements will be made. Making one experiment sequence is described by combining (108) with (114), thus

$\{\{\{E, O, P\} \twoheadleftarrow\!\!\to$ [illegible] $\{P^l, \ldots, P^k\}\} \leftharpoondown\!\!\rightharpoonup \{O \leftharpoondown\!\!\rightharpoonup \{\{P^l, \ldots, \{{}^GP^l, \ldots, {}^GP^m\}, \ldots, P^k\}^n$
$\leftharpoondown\!\!\rightharpoonup$ [illegible] $\{P^l, \ldots, \{{}^GP^l, \ldots, [{}^rP, {}^gP]^i, \ldots, {}^GP^m\}, \ldots, P^k\}^n\}\}\}\}$ [illegible] S ....(118).

Or, alternatively, using (115),

$\{\{E, O, P\} \twoheadleftarrow\!\!\to \{\{P^l, \ldots, P^k\}^j \leftharpoondown\!\!\rightharpoonup \{\{P^l, \ldots, \{{}^GP^l, \ldots, {}^GP^m\}, \ldots, P^k\}^n$
$\leftharpoondown\!\!\rightharpoonup$ [illegible] $\{P^l, \ldots, \{{}^GP^l, \ldots, [{}^rP, {}^gP]^i, \ldots, {}^GP^m\}, \ldots, P^k\}^n\}\}\}$ [illegible] S ....(119).

A typical experiment will contain *q* such experiment sequences, each of which will consist of *m* measurements performed upon an *n*-set state. Using (119), the entire experimental procedure is described by

$\{\{E, O, P\} \twoheadleftarrow\!\!\to$ [illegible] $\{\{P^l, \ldots, P^k\}^j \leftharpoondown\!\!\rightharpoonup \{\{P^l, \ldots, \{{}^GP^l, \ldots, {}^GP^m\}, \ldots, P^k\}^n$
$\leftharpoondown\!\!\rightharpoonup$ [illegible] $\{P^l, \ldots, \{{}^GP^l, \ldots, [{}^rP, {}^gP]^i, \ldots, {}^GP^m\}, \ldots, P^k\}^n\}\}^u\}$ [illegible] S (120).

The record of this procedure that is constructed will contain *n* set-readings for each of the *n*-set states, together with *m* measurement-readings for each of the *q* measuring sequences. It follows, from the descriptions of constructing a record given above, that the construction of a record for the entire procedure is described by

$\{\{E, O, P\} \twoheadleftarrow\!\!\to [[[{}^hP^l{}_a, \ldots, {}^hP^n{}_a]^l \leftharpoondown\!\!\rightharpoonup [{}^hP^l{}_a, \ldots, {}^hP^n{}_a]^q], [{}^hP^l{}_b, \ldots, {}^hP^m{}_b]^l, \ldots, [{}^hP^l{}_b, \ldots$
$, {}^hP^m{}_b]^q]]\}$ [illegible] S ....(121).

V. CONCLUSION

We have set ourselves to show that a typical scientific experiment can be fully described as the content of the present moment Q of the scientist S. The language used consists of symbols for recurrent elements, linkages, and modes of togetherness. We have tried to avoid assumptions as to the meaning of these concepts apart from their everyday, pragmatic significance in the cognitive and manipulative operations of S himself.

The examples we have considered are limited in several ways:

(1) They belong to the sub-class of metrical experiments in which the results are obtained as arrays of numbers associated with intensive or extensive magnitudes. We have scarcely considered qualitative experiments where the result takes the form of a new product or a state of affairs. These can be treated as transformations from compresence to coalescence. They usually involve comparisons that are formally similar to measurements: *e.g.*, one *recognises* a product by shape, colour, smell, and other data or one *observes* that a transformation has occurred. There is, thus, probably no loss of generality in our treatment of experimental procedure. This will require more careful investigation that may bring to light new uses of the symbolic language.

(2) We stop at measurement. Usually there are further operations of calculation, generalisation, interpretation, and verification. We have not considered calculations, which require that mathematical operations should be expressible in our symbolic language. It is probable that compatibility parentheses can define a class concept, that compresence brackets can define relationships, and that coalescence braces are equivalent to truth statements. If this can be demonstrated, all mathematical and logical operations form a sub-class of the operations of S within Q.

(3) We have not shown how to derive basic notions corresponding to those of mass, time, space, charge or to express their relationships in terms of the present moment Q. We have carried this investigation to the point at which we hope to show that conventional uses of time and space co-ordinates can be derived from our basic notions. It is, in our opinion, very important to eliminate the last vestiges of absolute space and time from scientific description. As this must be done rigorously, we reserve the demonstration for a later paper.

(4) We have not dealt with *representation.* The simplest case is, perhaps, the representation of the relationship between two arrays of numbers in a graph. This operation is far more significant than might appear from the way it is usually described. It suggests a principle of correspondence that can be regarded as the basis of practical activity. We can perform meaningful operations because situations have structural similarity yet differ in their content. The graph is similar to the experiment, and the generalisation is similar to the graph. The act of verification is similar to all the rest and the similarity is the instrument of the verification.

In a more general sense, *language should correspond to the content of the present moment*, and in this correspondence lies the possibility of communication. This notion is the foundation of the language we are endeavouring to construct. Ordinary speech makes no pretence of consistency or precision. The analytical languages proposed by modem schools of logic do not and cannot express the structural character of the present moment. They eliminate the organisation of experience and substitute a set of formal connections. In our new language, we are concerned to preserve structural complexity and show how it can be described in its simplest terms. We must not be misled by the apparent similarities of symbolical form. Our scheme lies as far to the right of common speech as analytical logic lies to the left. By this, we mean that it is more concrete and objective than ordinary language, which disregards the distinctions of compresence and coalescence that make human actions significant. These features also serve to distinguish our approach from that of Husserl's phenomenology that asserts that our experience of nature must be contingent and fragmentary. Our scientist S stands at the opposite pole from Husserl's transcendental self. We start from the scientist in action and treat as one indivisible whole the present moment with its varying content and transformations. The method of objective description does not analyse nor does it treat the "self" as a meaningful term apart from the situation in which it acts.

We are well aware that the present paper is no more than an essay and that the adequacy of the method for all possible scientific situations remains to be demonstrated. We intend in a further paper to show how the results of the experimental procedure are transformed into theoretical constructions. We have found that the symbolical language we have constructed can easily be learned and used for describing experiments and that, apart from its philosophical importance, it proves to be of practical value in distinguishing the various stages of a practical undertaking.

Questions and Comments

In editing this work, a number of questions and comments arose in my mind that might help spur thought and commentary. I have indicated these in the text by alphabetical letter endnotes. -- John Dale

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[a] In the original text, 'will' and 'present moment' are sometimes capitalized, sometimes not. Present trends in style tend toward decapitalizing.

[b] What is the precise difference between these two reasons for the changing requirements of communication? Is the first, as the authors state, or hint at, the factor of scientific specialization, while the second is simply the rising complexity and atomization of the general communicational environment regardless of specializations?

[c] Do we need to be worried here by Karl Popper's enunciation of the logical asymmetry between "verifiable" and "falsifiable" statements or observations? Secondly, can we, as sentient beings with "multiple I's," ever achieve complete unambiguity even as scientists using the authors' language, and particularly when words and signs in our everyday languages are themselves often ambiguous and when these ambiguities are themselves the objects of scientific inquiry?

[d] Logical operators such as 'and', 'or', 'if … then', 'if and only if', 'not', etc. have conventional visible linguistic signs, but in what sense do these operators or their signs point to elements of *experience*? This essay needs a much clearer laundry list of things that fall under the range of the term "experience." Should we call inference in general an element of experience even if our attention is not focused on noticing the inference process per se during an experience? Should we consider the unconscious inferential process as part of the fluxial background of experience? Certainly there can be debate on these points.

[e] It is not clear how a *sign* (*e.g.,* a word) pointing to X can be said to be a *model* of X. The word "model," to me, implies structure and structural correlation.

[f] The original text reads; "We start with the one certainty of our experience: that there is a region of experience which *for* us is the *present moment.*" On the contrary, the concept of certainty is itself philosophically and psychologically ambiguous and uncertain and cannot stand outside of, and in judgment of, the notion of a purely descriptive model. I have thus edited out the reference to certainty. In any case, the authors make no further use of the concept in this paper.

[g] Do the authors here intend to restrict the concepts of experience and of the present moment to the concept of *conscious experience* or the *subjective present moment, i.e.,* to elements that come into the subject's conscious attention? This would seem to make the notion of "unconscious experience" into an oxymoron, yet almost all schools of modern psychology affirm that the vast, vast majority of incoming sensory impressions and signals to which the organism reacts are handled below the level of consciousness. In addition, what is objectively present in a situation in terms of signals is clearly often different from what is subjectively present to somebody's mind. The term "experience" comes from a Latin root, *experiens,* whose original connotation was to put something to a

trial or test. This would tend to give 'experience' a connotation of consciousness being present. However, in physics, it is not uncommon to see statements such as, "Two particles experience a force of gravitational attraction proportional to their masses and inversely proportional to the square of their distance." Clearly, however, here 'experience' refers to functional behavior and means 'undergo' and has no connotations of consciousness. Thus there is some justification for a notion of unconscious experience. The authors later seem to argue for or postulate a kind of "neutral monism" *a la* James and Perry without using that term, or perhaps a Buddhist model of the skandas.

[h] The authors use the term "axiom" here but do not list this proposition as an axiom in their formal descriptive scheme. In fact, in their scheme, they do not distinguish between axioms and any other kind of statement, which gives this essay a feeling of incompleteness and lack of rigor at the beginning despite the formalities that the authors do attempt to carry out. A more rigorous axiomatic treatment of the subject upfront would give this essay a conceptual clarity that is currently lacking in certain areas and aspects.

[i] Is will, then, within the present moment, or outside it? If it actively determines (creates) a present moment, then it would seem to be "outside" that moment as its cause, with experience and the present moment being its effect. On the other hand, can we not "know our own will"? If so, then will would seem to be capable of being also inside the present moment, as being both knower and content of such knowing, and thus a present moment would seem to be capable of self-knowledge, self-determination, and self-origination, thus not requiring a will "outside" of itself to be its cause. In that case, however, what role does the concept of will actually validly play in this descriptive scheme?

[j] Thus will would seem to be something changeable and contingent in its own nature. On what, then, does it depend?

[k] What, literally, does this mean? To say that something is "non-numerical" means literally that it is something other than a number, which does not tell us very much. To say that it is "non-extended" (in some physical sense, apparently) would seem to mean literally that will is nowhere and nowhen. In what sense, then, can it be "linked" to or "associated" with brains , persons, experiences, "present moments," or other entities that we commonly conceive of as "existing in time and space"? Is there anything else that is *like* will that could serve as a model of it?

[l] How does this description comport with the previous notion of will as being non-numerical and non-extended? If we affirm both X and ~X of will at the same time and in the same aspect, does will not become a contradictory notion from which, in classical logic, anything can follow? Can some non-standard logic come to our rescue here?

[m] I have added the word "otherwise." To say that will initiates and terminates actions but is "not itself involved in action," as the original text read, seems inconsistent. Also, what about will as *sustaining* continuing actions? The authors do not seem to mention this possibility,

[n] Why, then, even mention the concept of will in the first place? Why do we need a concept of will as something that "determines" a present moment as if from the outside? Why not stick to what is *within* the present moment and treat will as something that co-determines the present moment along with other factors?

[o] What is the difference between an "executive" and an "agent"? Is an agent subordinate to an executive, as in jurisprudence? The authors answer this much later in the essay.

[p] How is the reader to interpret this statement? Is it intended as a cosmological statement, applicable to the universe as a whole in the eyes of some deity? Or is it to be interpreted subjectively as applicable among all human beings, as in "what uniquely exists *for us"*? Or is it deliberately left ambiguous?

[q] Why in a descriptive model of experience do the authors start off with an ontological existence-claim rather than an epistemological appearance-claim? What role does the word "uniquely" play here?

[r] I have added the word "involuntary" for the sake of completeness.

[s] The original text reads "defined," but this is ambiguous, and I think the authors' intent was to refer to the "determination" of an actual present moment, rather than the abstract definition of a present moment. More deeply, however, what is the authors' concept of determination? Are the Present Moment and Experience the universal concepts that are particularized and thus "determined" by a particular, individual will and "viewpoint"? Or is Will the universal concept synonymous with, or creative *ex nihilo* of Experience and the Present Moment, and is Will thus conceived as self-determination, as in Hegel? It is not clear to me from this paper what the correct relationships are. By the time of this writing, Bennett had already developed a large amount of elaboration on the notion of Will and considered as part of his "fundamental triad" of Being, Function, and Will in *The Dramatic Universe.* It would have been good to at least refer the reader to this material.

[t] It is not clear why the authors adopt this rather obscure notation. Could they not have easily used the standard set-membership symbol 'ϵ'?

[u] This seems like a separate proposition that needs a separate proposition number.

[v] How can something that is not part of experience or appear within it, namely this so-called center of experience, be the basis for a *descriptive model of experience*? Such a center needs to be postulated as a separate axiom, or it needs to be revised, and the center of experience needs to be made a descriptive part of experience. Here the authors, following perhaps the lead of Bertrand Russell and Alfred North Whitehead in *Principia Mathematica,* seemingly try to avoid the notion of self-reference, which had led to paradoxes in the foundations of mathematics and set theory. This concept of a center of experience recalls, of course, the notion of a transcendental self, which appears in many traditions and philosophies, including Kant. *See,* however, Sartre's critique of this notion in *The Transcendence of the Ego.* In addition, neurophysiologists critique "locationless" or "brainless" mental activities and, in order to try to get around the physiological problem posed by a "center of experience" (*i.e.,* the "problem of the homunculus"), resort to looping and decentralized perception processes. *See, e.g.,* Douglas Hofstadter's *I Am a*

Strange Loop. In addition, taking our cue from other schools of psychology, we could say that this "center of experience" is located *within* experience as *conscious attention.* Thus will may need to be reconceived not as transcendental but as emergent from and supervenient upon a sufficient complexity of interacting elements. *See, e.g.,* the work of Stuart Kauffman and Daniel Dennett's, *Freedom Evolves.*

[w] Again, the relation between will and the present moment is unclear. Is it the notion of the authors that the present moment is universal, eternal, unlimited, and ontologically prior to the will, and that will then limits ("determines") this present moment? Or is it the other way around, where will is universal and unlimited, and present moments arise based on the self-reference or self-constraint of the will? The authors try to eschew ontological questions, but then, again, the basic question arises as to why the authors seem to refer in the first place to will as something seemingly outside of experience and of the present moment. How does this contribute to a descriptive model?

[x] We recall here the *monads* of Leibniz' *Monadology,* for which a good description and analysis appears in Anna-Teresa Tymieniecka's *Leibniz' Cosmological Synthesis.* Tymieniecka's work in some ways seems to parallel Bennett's project in Systematics but draws on the phenomenological traditions of Husserl, Roman Imgarden, and others. In contrast, however, to Leibniz's monad, Bennett's version of the monad, elaborated in other places, has never impressed me as having the property of exclusivity. Furthermore, the authors have just stated in a previous paragraph of this article that the elements of the present moment "form a whole enclosed within boundaries that are never well defined and usually not even recognizable." We have, therefore, a paradox of "exclusive" wills that determine boundaries of experience that are "never well defined."

[y] I had the impression from previous statements that the present moment is unique for every will.

[z] How is this different from Prop. 1.2.2?

[aa] How does this harmonize with Prop. 1.2.2.2?

[bb] How does this harmonize with Prop. 1.2.2.1?

[cc] I have added the word "degrees." 'Modes' connotes exclusivity. Where would such exclusivity arise from? 'Degrees' connotes a spectrum of possibilities, which seems more at home in a description of experience.

[dd] What is the descriptive basis within ^{n}Q for the notion of a "comprehensive present moment $(Q)^{n}$"? Where does this concept come from? Is it a hidden axiom? What evidence is there for the existence of $(Q)^{n}$? Are we in conflict here with the notion of time and simultaneity as used in relativity physics? If so, this needs to be addressed at some point.

[ee] What does 'compatible' actually mean? Logically compatible? Physically compatible? Psychologically compatible with one another? (Is the present moment of the prey "compatible" with the present moment of the predator?) Communicationally compatible? Psychologically compatible with S's attitudes and knowledge?

[ff] Why do the authors add the three dots after ^{n}Q in this expression? What precisely does this denote? This is not standard notation and needs to be explained or eliminated. Secondly, why is (Q) a generalization of $(Q)^{n}$? What restriction is being lifted? Is it that n is used in the context of selves? What beyond selves are the authors postulating as capable of having a present moment? Is this a "back door" for a deity to sneak through down the road? And, again, what is the descriptive basis within experience for the notions of a "comprehensive present moment" of *n* selves or of a "universal present moment"?

[gg] How does it do so?

[hh] Do the authors mean here that communication can occur only within shared "light-cones"? It would be useful to tie the compresence concept down to actual physics.

[ii] The authors outline the mode of togetherness that they call "compresence" as the requirement for communication, but this is clearly simply the physical requirement. The psychological requirement for truly significant communication is te next mode, coalescence. It is this quality that is often lacking in our present overall, future-oriented public policy framework, and that, by its lack, for example, in the United States, is leading to the conservative "bubble" of distorted information that threatens the continuation of a progressive reform agenda in the upcoming 2010 mid-term election. The progressive reform agenda of the US in energy, climate disruption, economic reform, etc., is vital for reaching the global goal of transitioning from viral growth paradigms to sustainability. The failure of political forces in the US to achieve sufficient coalescence around rational, long-term goals puts all else in the Earth-human and human-human systems in deadly doubt and thus makes this article and its notion of communication of great theoretical interest.

[jj] Why is there no parallel between the treatment of Q in the compatibility context (Expressions 4 and 5) and Q in the context of compresence? Why do we not have the compresence equivalent of (5), *i.e.,* $[^{1}Q, {}^{2}Q, \ldots, {}^{n}Q, \ldots]$ [illegible] [Q]?

[kk] I have added this phrase for clarity and consistency. The authors later refer to "coalescence brackets," but the correct name for the {} characters is "braces," and I have accordingly corrected this throughout the text.

[ll] It may be of interest that McTaggart conceived the Absolute, not as a single individual but as a community of purpose.

[mm] Parallel to Expression (5), is there, therefore, a single universal coalescence or community of purpose, {Q}?

[nn] In content? In extent? In what other ways?

[oo] This would have been an excellent place to have made reference to information or signal theory.

[pp] The authors continually make these seemingly objective statements. Don't they always have to be taken subjectively, i.e., *for S*? Am I missing something here?

[qq] Does the concept of a discontinuity in the present moment imply that acts of will are "singularities" of some kind? Again, is it also not an operation of the will to *sustain*

something or to balance its existence with the existence of other forces or factors? The authors consistently seem to ignore this point, and yet they elsewhere have a fully developed doctrine of will connecting it in Systematics with the triad.

[rr] I have added "for our purposes here" to avoid the appearance of an uncritical assertion.
[ss] What motivates the authors to take such a harsh and deprecatory view of game theory and circuit-switching? Does their attitude really stand up to professional-level understandings of these fields? The work of Stuart Kauffman in complexity theory refutes this kind of criticism.

[tt] Again we have the mysterious use of the "P^n, …" notation. The only seeming explanation is that these dots represent some kind of additional open-endedness that is not represented by P^n by itself. What is this additional factor? Prop. 5.6 hints at a explanation in differentiating between denumerable and non-denumerable possibilities but gives no examples.

[uu] Why do the authors denote separate present moments as ^1Q, ^2Q, ... , ^nQ as in Expressions 3 through 9 but denote separate Ps by P^1, P^2, ... , P^n as in (10) and later? Does it relate to the mysterious ^SQ of Expression (1)? It seems inconsistent to index numerically distinct members of a class in two different ways. Moreover, the standard way to denote individual members of a class is Q_1, P_1, etc.

[vv] I have added the phrase "and its contents" for clarity.

[ww] It might be more precise to say that its only *actuality* is in an action situation. Its potentiality is also a part of its reality, and that potentiality is present outside the action situation.

[xx] I have added "into sameness or uniformity" for what I think to be clarity.

[yy] We have now fully entered the world of the Bennettian three-term system.

[zz] The original text uses the term "artificial," which is pejorative but does not isolate the precise error. The more precise error is Whitehead's notion of inappropriate abstraction and "misplaced concreteness."

[aaa] I have changed "realising situations" to "self-realising situations" for what I think to be greater clarity.

[bbb] The standard alternatives denoting the logical operator "not" are ~, -, and ¬ .

[ccc] Again, the authors seem to ignore the concept and mode of potentiality and reduce reality to actuality.

[ddd] I thought that using words as signs meant using them in a one-to-one correspondence with a recurring element of experience. Using them as symbols, I thought, would be to use them into a one-to-many correspondence with recurrent elements of experience.

[eee] The authors need to give examples. There are many ways to order or rank the elements in a present moment that are not temporal, for example, by complexity of shape, by edibility, by sexual attractiveness, by amount of danger posed to survival, etc. But what about by order of appearance (assume, *e.g.,* a movie, *i.e.,* a moving strip of static images that gives the illusion that the images themselves are in motion)?

[fff] I have added "at the same rate" for clarity.

[ggg] What is this "axiom"? Where is it defined in this paper?

[hhh] I have put this into quotes to indicate that it needs to be elaborated and not taken at some kind of normative face value.

[iii] Again, the authors fail to take the potentiality of these elements as a valid part of their reality. The act is what brings them out of potentiality into actuality. The knower and the known exist prior to the act in the mode of potentialities.

[jjj] I have previously mentioned the notion of modes of togetherness versus the notion of degrees on a spectrum of togetherness. The authors should elaborate on what they mean by modes and on where such modes arise from.

[kkk] The authors here seem to use the sign "N" to negate the whole of any subsequent formula.

[lll] I do not understand this concept. Is "the" unique present moment associated with an individual will, with some alleged universal will, or what?

[mmm] Compatible, compresent, coalescent? Which mode of togetherness, or combinations of modes, does 'combined' refer to?

[nnn] Is this some kind of "comprehensive present moment"? For whom or what does this present moment exist in its fullness? If this present moment akin to Karl Popper's notion of *World 3*?

[ooo] Why do the authors use P^n in the first set and then P^k in the second? I see no explanation given for this, but perhaps they wish to indicate that the first (of compatible objects) is larger than the second set of actually compresent objects.

[ppp] Apparently, however, this is not the case with a compatibility unit, which is presumably a set with potentially more members than a compresence or coalescence unit.

[qqq] The original reads "but that," which does not make sense to me, so I have changed it to "but then."