APOSTEL'S THEORY OF CAUSALITY. Critical discussion of Leo APOSTEL : *Matière et forme. Introduction à une épistémologie réaliste*. Vol. 1. Gent, Communication and Cognition, 1974, 454 pp.

1. This first volume is devoted entirely to problems in causality. In the second volume related topics are dealt with, but the contents of the first volume form a coherent whole. Whence we take it justified to review the two volumes separately.

Let us start by two general remarks. Negative remark : the proofreaders did a lousy job. There are quite a few misprints, some of which might disconcert a reader not familiar with the problems discussed. Positive remark : the book contains an overwhelming number of mostly fresh and suggestive ideas, both with respect to possible approaches to the problem and with respect to the problem itself. More than one chapter might easily be expanded into a whole book by working out the materials it contains. In a sense the author overreaches his aim, viz. to show that there is nothing in the way of a meaningful, exact and "material" theory of causality. He rather demonstrates that the ways in which such a theory might be approached are abounding, and that a large number of related such theories are in our reach, the choice between which should be postponed until at least some of them are worked out in detail and confronted with logical and empirical standards. It follows immediately that the theories presented in this book are not ready for falsification. This might seem to be a disadvantage, but we are not sure it is. In view of the present state of the study of causality a number of promising outlooks might be more valuable than a set of fully articulated theories, which might be misleading in suggesting the problem to be solved.

It goes without saying that we cannot comment on each topic dealt with in the book within a few pages. We shall mainly try (i) to make clear which notion of causality Apostel has in mind, (ii) to survey briefly the contents of each chapter, and (iii) to offer some objections and suggestions with respect to some ideas defended in the book.

2. Apostel considers causality a "real objective relation" which holds between objects, facts, processes, states, etc. This position is connected with the fact that he is a realist in the sense that he takes reality to exist independently of knowing subjects. Causality is an ontic category to him, not an epistemic one. Metaphorically a cause is described as that which *produces* the effect. It is presumably the concentration on the production relation which lead Apostel to consider almost exclusively what we shall label the "excellent cause relation". In order to clarify this notion we first contrast it with the "sufficient cause relation". Let p be a physically sufficient condition for q. In some cases, viz. if the relation between p and q has certain further characteristics, p will be the cause of q. In such cases -q (q's being false) will not be the cause of -p, although -q will obviously be a physically sufficient condition for -p. This kind of causal relation between p and q we shall label "sufficient cause relation". (By way of an example consider those facts which form at the same time a physically sufficient condition and the cause for the lighting of a bulb.) Apostel does not deal with this relation. He is interested in that privileged part of q which may be considered the excellent cause of q, viz. a privileged necessary condition to the effect q. Notice that 'a part of p' makes sense because we are not considering the name or sentence 'p' but the fact, process, etc. referred to by 'p'. Notice also that the excellent cause relation is much closer to the production relation than any sufficient cause relation. That what produces is certainly not sufficient in itself for the effect, but is so only together with the "transformed materials' and the "instruments' used. One should not wonder that Apostel deals almost exclusively with cases in which particular space-temporally located entities (objects, events, processes, ...) "produce" other such entities. As will be shown later, the excellent cause relation has odd properties if applied to generic events, processes, etc.

A further limitation on the subject matter of the first volume is that Apostel approaches causality from the semantic (ontic, if you prefer) point of view only, not from the pragmatic (epistemic) point of view. He wants to describe the characteristics of the aforementioned causal relation, not the grounds on which a knowing subject decides whether a given relation is causal or not. In Rescher's (1973) terminology, he is interested in the definition, not in the criteriology of causality. In the second volume Apostel articulates his epistemology with essential reference to his theory of causality, the knowledge relation being considered as a specific causal relation.

3 In the first chapter Apostel discusses several space-temporal logics. He shows that space-temporal conditionals are implied by the causal relation, but that they are not sufficient to define the latter. Some of the logics are shown inadequate to the intended aim, and emendations are proposed. A large chapter is devoted to the logic of conditionals in general. We later return on some connected problems, and also on the hierarchization of the environment of the effect and the cause and on the automaton model for the causal implication. Chapters 5 and 6 concern the relation between probability and causality and between statistics and causality respectively. As far as probability is concerned Apostel's argumentation relies partly on work by Suppes and Good. The upshot is that causality cannot be founded on probability because any attempt to do so presupposes an interpretation of probability in terms of causality. Apostel stresses that great use is made of the notion of causality in contemporary statistics. Here he refers especially to work by Simon, Wold, Blalock and Boudon. In chapter 7 the causal relation is implicitly defined by means of an axiomatic system. Apostel is aware of the tentativeness of his axiomatization (also, he presents several alternative axiom systems at the same time). Several of the following chapters are devoted to the search for models for the axiom systems; e.g. automata theory, algebra, topology. The book contains also a chapter on the causal relation and general systems theory and a chapter on the status of causality in physics. General systems theory is introduced because its language is apt to describe, in a general way, the interactions of systems is a universe. The chapter on mathematical physics deals mainly with changes in the notion of causality which occurred during the last twenty years. At the end of the first volume Apostel enumerates investigations which we shall have to elaborate in the future if we want to get a clearer view on causality.

4 Subjunctive conditionals ('if p had been the case, then q would have been the case') and "indeterminate" conditionals ('if p is the case, so is q') play an important role throughout the book. There is a serious problem as to the ontological status of such expressions. Indeed, by no means they describe "real facts'. The truth of such conditionals depends on the question whether reality is governed by certain mechanisms (laws). As we shall see soon, even these mechanisms have not a simple factual status.

Incidently, Apostel's argument to the effect that the introduction of such conditionals is necessary might mislead the reader. On p. 54 he argues that the ground for the assertion of a causal relation relies essentially on the assertion of subjunctive and indeterminate conditionals. The reader might derive that Apostel is talking here about the criteriological problem : in view of which beliefs does one conclude to the existence of a causal relation between two facts? This, however, is not what Apostel means. He is not thinking about criteria, but about the analysis of the causal relation. As becomes wholly clear from p. 144 and following, his claim is that one cannot define the causal relation unless by referring to subjunctive and indeterminate conditionals.

Let us now return to the problem of the ontological status of the aforementioned conditionals. Notice first of all that this problem should not be confused with the equally important but neatly different problem concerning the meaning of 'the situation that would

have obtained if p had been the case'. In our opinion, the latter problem should be approached and may be solved along the lines of Rescher's (1968). But even if we know exactly what we mean by this expression, then still a subjunctive or indeterminate conditional does not simply express a "real fact". Some comfort might be found in the knowledge that this problem is not at all specific for causality. The very notion of a law of nature cannot be made sense of, from a definitional or ontological point of view, unless by referring to "non-real facts". (And the distinction between mere truth and lawful truth is important, were it only because we need hypotheses about what we might hope to become able to change to the world, and what not.) As Apostel correctly states, the doctrine that the meaning of a term reduces to the verification procedures connected with it (i.e. to the pragmatic or criteriological approach) cannot be upheld. Hence, we cannot but applaud that Apostel devotes the whole third chapter of the book to the study of conditionals, with the aim of the formulation of a semantic and ontic theory of causality. He sketches the complexity of the problem, introduces several results, discusses large parts of the immense literature on the subject, does not underestimate the relative tentativeness of the proposals he offers, and deals extensively with the ontological problems involved in his position. The high degree of technicality of the material presented in this chapter prevents us from discussing them within this review. We shall confine our attention to one less technical point.

In a more general philosophical section Apostel offers an interesting defence of the need to take physical modalities seriously. However, some of the moves made in this connection seem on the wrong track. One of these concerns the assignment of an ontological status to physically possible worlds. Apostel claims that one cannot deal with causality unless by referring to subjunctive and indeterminate conditionals, and that one cannot deal with the latter (from a definitional point of view) unless in the frame of a possible-worlds semantics. As mentioned before, he takes causal relations to be parts of reality. For these reasons he believes to be committed to the assignment of an ontological status to physically possible worlds (not to all logically possible worlds). His proposal in this connection is to interpret physically possible worlds with respect to time as well as with respect to tendencies and forces. However, if this will work, and we believe it might, then the introduction of an ontological status to the aforementioned worlds becomes superfluous. We might as well interpret subjunctive and indeterminate conditionals in terms of tendencies or forces (and time) *directly*. It would be possible then to deal with the conditionals by other means than possible-worlds semantics, and the latter might be considered a mere technical device, not committing us to assign an ontological status to physically possible worlds.What we mean is this. It seems handy and fruitful, at present, to study causal relations as well as conditionals with respect to physically possible worlds. Yet, the latter are dubious animals, and not only for reasons of Ockham's razor. In this situation it seems a sound policy to use these animals to build a theory as strong as possible on causality, etc., postponing judgment on their ontological status, and at the same time to work on a less objectionable theory in terms of tendencies and forces. If the new approach succeeds, the results of the old one will be taken into account and may very well prove useful and important.

In connection with the interpretation of possible worlds, Apostel writes : "The notion of real indetermination of the future (devenir) is implied by the notion of the really or ontologically possible" (p. 146, our translation; in italics in the book). We cannot see how this statement might be upheld. Suppose first of all that it concerns *real* possibility, in the sense of a function of (i) physical possibility and (ii) the past history of the world. It would be true then that real possibility cannot be distinguished from real necessity unless in case the future is really indetermined. However, it appears from the context that the statement concerns *physical* possibility, and hence is even more objectionable. Complete and strict determinism presupposes the notion of physical necessity. And even if our actual world is

strictly determined, this does not rule out the physical possibility of other worlds which, starting from different initial conditions, are partly indetermined.

5. Several kinds of causal relations may be distinguished. We shall give a brief survey of some such notions in order to ease the further discussion. For simplicity's sake we shall use lower-case characters to refer to particular space-temporally determined facts, processes, etc., whereas we shall use capitals to refer to the "generic" counterparts. The latter are not space-temporally determined, but may contain relative time references (we now that this is sloppy, but everything we shall say may be rephrased in an exact, albeit more complicated way). By (p i P) we denote that p is an instance of P (we leave technical details aside). We shall restrict our attention to binary causal relations.

Let (p ec q) mean that p is the excellent cause of q, and (p sc q) that p is the sufficient cause of q (see higher). Notice that these have to be interpreted in such a way that :

(1) (p sc q) $\supset$ (p & q)
(2) (p ec q) $\supset$ (p & q)

We now define a combined causal notion :

(3) (r/p sec q) $=_{df}$ ((r&p sc q) & (p ec q))

Here r is a part of the circumstances in which p occurred (not necessarily all of them), viz. at least that part that is needed for making (r&p) sufficient to q. The following seems correct to us :

(4) (Er)((p ec q) $\equiv$ (r/p sec q))

In which (E...) is the existential quantifier. Notice that (4) does not intend to say that there is a sentence r belonging to a considered language such that the fact (etc.) described by this sentence forms, together with the excellent cause of q, a sufficient cause of q. We only state that there is a fact (process, etc.) r such that this relation obtains. Notice that p, r, and q might be themselves "conglomerates" of more primitive facts.

Let us now consider what we shall label "conditional causes", such as, e.g., that p, if it were (or is) the case, would cause (or causes) q. In other words, we introduce a kind of indeterminate causes. To denote these we introduce (p iec q), (p isc q) and (p isec q). We have :

(5) (r/p sec q) $\equiv$ ((r/p isec q) & p & r)

and analogously for ec and sc. Notice that these formulas might be used as definitions (weaker formulas will not do). However, it might be easier to construct a theory with ec and sc as primitive. With respect to the pragmatic (criteriological) approach the latter notions are certainly easier to tackle, because we might reduce the fact that p and q actually are the case, to empirical knowledge (which, obviously, is only the smaller part of the problem).

Let us now turn to the generic counterparts of the above expressions. It seems to us that the following is correct :

(6) (R/P sec Q) $\equiv$ (Ar)(Ap)(Aq)((r i R)&(p i P)&(q i Q)$\supset$(r/pisec q))

and analogously for sc and ec. The reference to isec is the latter part of (6) is essential; sec will not do. For generic facts (etc.) iec, isec and isc reduce to ec, sec and sc respectively. It is

doubtful whether any sentence of the form (P ec Q) is true; indeed

(7) (P ec Q) $\supset$ (P sc Q)

That, for *all* instances p and q of P and Q respectively, p is the excellent cause of q, cannot but entail, as far as we can see, that for all these p and q, p is the excellent cause of q in all circumstances in which p is the case. Whence we have, for all these p and q, that p is the sufficient cause of q. Notice also that

(8) (r/p sec q)$\supset$(ER)(EP)(EQ)((r i R)&(p i P)&(q i Q)&(R/P sec Q))

The analogue holds for sc. For ec, however, we have only the weaker :

(9) (p ec q)$\supset$(ER)(EP)(EQ)((p i P)&(q i Q)&(R/P sec Q))

It goes without saying that all this should be worked out. However, our only aim was to introduce some distinctions which might ease our present review.

Let us notice at once that Apostel is most of the time discussing causal relations of the kind (p ec q), or n-ary extensions of these, but that he sometimes seems misled by other kinds. So, e.g., he introduces the following axiom, where p, q, r, s, and t are all different :

(10) (p$\rightarrow$q v r)$\supset$(Es)(Et)((p&s$\rightarrow$q) & (p&t$\rightarrow$r)

It is quite unbelievable that Apostel is thinking here about ec-expressions. Indeed, if the arrow is replaced by 'ec', then we may derive

(11) (p ec q v r) $\supset$ (p & q & r)

which reduces the meaning of 'cause a disjunction to be true' to something awfully unnatural. We arrive at analogous problems by replacing all arrows in (10) by iec, sc or isc. On the other hand (10) sounds quite natural, given some restrictions on the relation between q and r, if we interpret it as an expression about *generic* sc- or ec-relations, of if we read it as

(12) (p ec q v r) $\supset$ (Es)(Et)((p&s iec q) & (p&t iec r))

in which case we might even add to the implicatum (and within the scope of the quantifiers) : &((p&s ec q) v (p&t ec r)).

6. In earlier work Apostel had introduced a clear separation of lawfulness (physical necessity) and causality, taking these as belonging to the realm of pure sciences and applied sciences respectively. In the present book he rejects both the separation of these two kinds of sciences and the separation of lawfulness and causality. Of course, he does not intend to reject the distinctions involved. What he rejects is the position that the philosophy (e.g., methodology) of the pure sciences and the philosophy of the applied sciences can be developed separately, or that the theory of lawfulness and the theory of causality can be developed separately. We agree with Apostel concerning the separation of the two kinds of sciences. One should not repeat the mistakes that became clear from, e.g., the Carnap-Popper discussion on "inductive logic"; Popper has concentrated all the time (at least until the late sixties) on the value of theories with respect to further testing, Carnap on the degree of rational credence that has to be assigned to hypotheses. (To say that they had

a different explicandum in mind is, in our opinion, an understatement; their concentrating on one explicandum, instead of on perhaps ten relevant ones, made their respective theories hopelessly incomplete.)

We are less convinced of the correctness of Apostel's view concerning the separation of the theory of causality and the theory of lawfulness. Apostel is clearly correct in claiming that the same kind of semantics is needed to analyse both causality and lawfulness. Yet his general position on the non-separation seems exaggerated to us. It seems possible indeed to develop a correct and informative theory of lawfulness, without at the same time including an analysis of causality. One might, e.g., articulate a modal logic that defines the notion of physical necessity implicitly. Although such a logic would not necessarily constitute a complete analysis of physical necessity or lawfulness, it would nevertheless be informative and important, irrespective of the fact that it would not involve an analysis of the notion of causality. Apostel might reply that physical necessity ultimately relies on causality, i.e. that the basic mechanisms which govern reality and which we are used to call laws of nature, are all of the causal type (notice in this connection that Apostel allows for probabilistic causes). Now, we obviously have it that (P sc Q) implies logically F(P $\supset$ Q), where F denotes physical necessity. What Apostel might want to add to this (disregarding probabilistic causes for a moment) is that, for any true relation of the form F(P $\supset$ Q), there is a set of relation of the form (S sc T) such that the former follows logically from the latter (in a suitably rich language). However true this might be, it does not follow that one cannot develop a theory of lawfulness without reference to causal relations, neither does it follow that we gain information on lawfulness as such by extending a theory of lawfulness into a theory which also deals with causal relations.

There is a further point which seems to undermine Apostel's position on the non-separation of causality and physical necessity. If Apostel *would* defend this thesis with the help of the argument that the basic mechanisms of reality (from which physical necessity derives) are causal, then it seems that he is committed to the position that these mechanisms derive from the only causal relations he discusses, viz. excellent-cause relations. This position, however, does not seem very defensible. First of all, it is clearly impossible to define physical necessity as a general relation between "generic" facts (events, etc.) from expressions of the form (p ec q). It might be true that any concrete case in which a law of nature "acts" is a case in which an effect is "produced" by some excellent cause. Yet, laws of nature cannot be defined by means of (even all possible) excellent-cause instances; we need at least sec relations (which involve sufficient-cause relations). We are even more sceptical than this. Apostel did not convince us that excellent causes have a genuine ontological status. We shall try to make clear subsequently what we mean by this and why we feel not convinced.

7. A very central chapter concerns what Apostel calls the hierarchisation of the environment of the effect and of the cause. The basic intuition of this chapter derives from the production relation. Somewhat simplified this may be rendered as follows : we have agents, materials and instruments; the agents are determined by none of the other elements, but determine the instruments and the materials; the instruments too determine the modifications of the materials; the materials are determined by the two other kinds of elements, but determine nothing. Apostel now defines first an abstract relation R which neither transitive nor connective. With the help of R an order O is defined. It is the R-O hierarchy which is considered to provide the abstract structure for causal relations. Apostel clearly points out three decisions that have to be made in order to apply this R-O hierarchy : considering the effect as given and looking for its cause (i) we have to decide which space-temporal part of reality we shall concentrate upon, (ii) we have to decide in which way we shall decompose reality, which entities we shall take as primitive, and (iii) we

have to decide the degree of the causal relation (dyadic, triadic, ...). As we mentioned earlier, it is an important advantage of this book that all such decisions are explicitly mentioned

The abstract R-O hierarchy is first somewhat generalized and next made more concrete with reference to subjunctive conditionals and space-temporal implication. Apostel mentions explicitly that he tries to construct a theory which rests on the objective counterparts of fundamentally criteriological (epistemic) ideas. The book would have been much less valuable, had this chapter been absent. It constitutes a far-reaching tentative to make sense of the central notion of an excellent cause as an ontological category. Apostel claims, quite correctly, that, e.g., Mackie's famous INUS conditions have to be interpreted along the lines of the aforementioned hierarchy, if one wants to make sense of them from an ontological point of view; and he indeed articulates the reinterpretation. This example shows in which way numerous contributions to the problem of excellent-cause relations may and should be reconsidered in view of the production relation analogy.

8. Apostel presents an interesting approach to the causal relation in terms of automata theory. As a starting point he expresses his conviction that an object can be viewed as an automaton (whether finite or infinite, deterministic or probabilistic). If this is right, one might take the sort of interaction which exists between automata as a model of the causal relation. It is important to stress that causality is compared to a relation between automata, and not to a relation between elements of a same automaton (a decision which would lead to a completely different outlook). Incidently, Apostel wants to define the causal asymmetry without reference to time, although he allows that time references are combined, for other reasons, with the formalism he uses.

Starting from the formal definition of an automaton as a quintuplet (a set of possible inputs, a set of possible outputs, set of internal states, a function from inputs and states to states, and a function from inputs and states to outputs). Apostel considers connections (with different kinds of strength) between automata. The inputs of a "receiving" automaton S2 may be determined, in several ways, by the outputs of an "emitting" automaton S1. Apostel describes this in terms of the "identification" of outputs of S1 with inputs of S2. Indirectly, states of S2 may also be determined partially by outputs of S1. A survey of different sorts and strengths of relations between automata is presented, but the criteria involved are not very clear. Next, the notion of a normal evolution of an automaton is introduced – roughly, that consecutive input, output and internal state positions are not too different. Apostel decides not to restrict caucal relations to abnormal evolutions of automata. He then proposes two possible "definitions" of 'cause' : (i) the identification of n outputs with n inputs, and (ii) the conjunction of this identification and of changes in states, inputs or functions of the emitting automaton. In the latter case the asymmetry between the cause automaton and the effect automaton is determined by the strength of change in the automata : the most intense change occurs in the effect automaton. We do not see very well why the author believes this decision to be the most "natural" one. Neither do we understand why he seems to consider "strength of change" an unproblematic notion; he does not offer clear criteria for determining it.

One of the reasons why Apostel introduces the automata approach is that he wants to provide a "real model" for his axiomatics of the causal relation (presented in an earlier chapter). More particularly he wants to show that certain somewhat perplexing theorems become quite natural in view of an automaton interpretation. Unfortunately, the discussion of some examples is almost inscrutable because of the huge number of misprints in the formulas of this section. On the other hand, the automaton analogy opens an interesting and promising approach to causality all by itself.

9. We saved a very philosophical and very difficult point to this last discussion section. We stated earlier that we are not completely convinced that excellent causes have a genuine ontological status. To avoid confusion, we first want to add that we do believe that the basic mechanisms that govern reality may be adequately expressed by statements of the form (P sc Q), and not by statements that contain physical necessities only. Next, let us take an example, in order to overcome charges of weird abstraction. Suppose that a closed but expansible vessel, e.g., a balloon, contains gas, that the gas is heated, that the vessel expands and that the pressure of the gas increases. Apostel requires that we find the excellent cause of the expansion of the vessel and of the increase in pressure. Suppose the increase in temperature does this job. On the other hand, the properties of the vessel and of the gas and the fact that heat is added to the system constitutes a sufficient cause for the combined change in expansion and pressure. Now it is possible that the increase in heat may be considered the excellent cause which produces the effect in the given circumstances (properties of the gas and the vessel). But what guarantee do we have that this is not an (antropomorphic) interpretation, and that the actual responsible mechanism is not simply the sufficient cause as a whole ? We do not want to deny that the increase in temperature may play a role which can be distinguished from the role played by the other parts of the sufficient cause. The problem is whether this role is sufficient to ascribe it a special ontological status.

Let us try to clarify what we have in mind by adapting an analogy used by one of us elsewhere (Batens, 1975). Consider a set of machines. Each machine has a number of possible inputs and outputs. For the sake of simplicity we shall say that an input or output is positive, respectively negative, when we mean that a possible input or output is realised, respectively not realized. Facts are now considered as (projected upon) inputs and outputs, events as changes in these, etc. Each primitive (non-compound) law of nature (basic mechanism) is considered as the function that holds between the inputs and outputs of a single machine (the machines are considered black boxes). For the sake of simplicity we take each machine to have a certain reaction time; some may have reaction time zero (outputs very immediately with inputs). To clarify our model, we mention that the basic law-statements of our theories about reality are hypotheses about combinations of machines, viz. about relations between facts (events, etc.) that obtain as a consequence of the specific input-output functions of several machines. To stimulate imagination : reality may be compared to a number of bulbs each of which is connected to exactly one output of one or more machines (they light up if such an output is positive), and which are furthermore connected to inputs of a number of machines (the inputs are positive if and only if the bulb lights up). The changing state of reality (of the lighting up of the bulbs) is completely determined by the reaction time of the machines and by their specific functions.

We now want to claim : excellent causes have no specific ontological status in this kind of reality. Even if our model would be too simple, we do not see that it needs complifications which do introduce a special ontological status to excellent causes. Let us now present the argument. Suppose we have a complete description of all specific functions of all machines. This comes to : we have a theory that describes adequately all physical necessities that obtain in reality. Do we than have a completely adequate description (in the broad sense) of reality ? The answer is obviously no. We indeed do not now the *direction* (the asymmetry) of the basic mechanisms. In other words, we are not able to discriminate between the inputs and outputs of a (primitive) machine. Even if we were in the privileged situation of knowing which facts are primitive (their negations are not primitive), we still would be unable to determine in general for each machine which ones are inputs and which ones outputs, since converses and partial converses of numerous functions might be functions themselves. What we need to know is the direction of the functions, viz. we need to have the functions in input-output order. This comes to saying that we need to know the *sufficient cause* relations

that hold in reality. This shows, it seems to us, that sufficient cause relations have a specific ontological status. Notice that sufficient cause relations will not only hold between combinations of inputs and outputs of a single machine. Numerous other sufficient cause relations will be derivable (and it is about these – who doubts ? – that we actually make hypotheses in the real world). Incidently, it has been demonstrated by Batens (1975) that it is possible to devise a *criteriology* (albeit a very complex one) for determining sufficient cause relations, starting from the aforementioned machine analogy.

Let us now turn to excellent causes. There is no doubt that we can devise a definition of 'excellent cause' in such a way that we are able to single out a specific input or a specific combination of inputs which differs from the rest of the concrete sufficient cause of a certain effect. Even a large number of ways for singling out inputs may be available. For the sake of simplicity we might take an oversimplified definition of excellent cause – one which Apostel rejects explicitly – viz, the last relevant input (set of inputs) that has been modified before the effect-producing mechanism started working. So, clearly, we do not claim that there is something wrong with introducing the notion of an excellent cause. But does this mean that excellent causes have a special ontological status ? By no means so, if this expression is taken seriously. Let us not quarrel about words. The man-with-the-longest-name-in-town and the hottest-day-of-the-century may be selected and may be ascribed a special ontological status in a trivial sense. The fact that an object has a given length (a temperature) has an ontological status in a clearly different and more basic sense. Analogously, excellent causes may be singled out and given a special ontological status in the trivial sense, but sufficient causes have a special ontological status in a clearly different and more basic way (*omnis comparatio claudicat* but we hope the point is clear). Remember indeed, that the knowledge of sufficient causes provide us with information that is not derivable from knowledge about physical necessities. But the *additional* knowledge about excellent causes *is* derivable, in view of the definition, from knowledge about sufficient causes and mere knowledge of facts. Whence our claim. Notice that our argument is not invalidated by the fact that Apostel's definition of the notion of an excellent cause is more complex than the one we used here as an example (last modified relevant fact). Quite to the contrary, Apostel states explicitly, in the context of the hierarchization (cf. section 7), that it depends on *the context choosen* which entity will be considered the excellent cause of an effect. This seems to strengthen our position and to undermine his claim that excellent causes have a genuine ontological status.

Our argument, need it be said, relies on the degree to which our multiple machine model of reality is adequate. So we need to add two words in this connection. First, we cannot imagine any complexification of our model which (i) would make it more realistic *and* (ii) would introduce a special ontological status for excellent causes. Secondly, it seems to us that reality has at least the kind of complexity we introduced in our model, viz. the complexity involved in the direction of sufficient causes. We know and need to know about this direction because we are acting beings, and the only criteria we may introduce again refer to the fact that we are acting beings (as was argued in Batens (1975, p. 252) the underlying anthropomorphism is not objectionable).

10. This review is very incomplete indeed. We were not able even to discuss all basic ideas of this first volume. Some of our comments may sound quite negative. We tried to show that certain ideas propagated and discussed in the book are on the wrong track. One should not let oneself be refrained from reading the book for this reason, and one should even not try to skip the objectionable passages; important falsehoods are more interesting than trivial truisms.

A general evaluation we gave already. The book should not be recommended to beginning

students in the field, but it opens numerous perspectives to all those who want to study the problems of causality in an exact way and on a level the subject deserves.

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