On What Goes On: 
The Ontology of Processes and Events

Antony GALTON

School of Engineering, Computer Science, and Mathematics, 
University of Exeter, Exeter, UK

Abstract. The purpose of this talk is to advocate a particular way of thinking about processes and their relationship to objects and events. The point of view put forward is unorthodox in that it regards processes as being in some ways more closely akin to objects than to events, specifically with regard to their relationship to the directly experienced world and their capacity for undergoing change over time. A consequence of this is that the traditional distinction between continuants and occurrents becomes overshadowed by a more prominent distinction, that between the world of direct experience (made up of, inter alia, objects and processes) and the world of historical record (made up of events). In conclusion, a number of remarks are offered concerning the implications of this shift of viewpoint for formal ontology.

Keywords. Process, Event, Continuant, Occurrent, Experiential, Historical

Nowadays, we all acknowledge that ontology is not just about objects: the world we live in, and which we set ourselves to describe, is a world of constant change, and we will never do justice to that world unless we fashion our ontological tools in such a way as to accommodate the fact of this change. That much, perhaps, is uncontentious; the difficulties begin when we seriously confront the question of how this is to be done.

The changes that we see in the world include processes and events: in the course of this talk I shall try to put across a particular view as to how these two kinds of item are related. I do not advocate this as a uniquely correct view; doubtless different ways of describing these things are appropriate to different circumstances. But I do advocate it as a point of view which may be fruitful, particularly as a means to sorting out various confusions which talk of objects, processes and events is prone to.

An immediate question to confront is whether processes and events should be treated as entities in their own right, i.e., as ‘first-class citizens’ of the ontology, or whether they should be relegated to the status of attributes of physical objects, the latter being treated as the only first-class entities. Historically, attitudes to ontology have varied from extreme parsimony (e.g., the idea, most frequently associated with Bertrand Russell, that the only first-class entities are ‘sense data’) to extreme promiscuity (the term is due to Jerry Hobbs [4]) by which first-class status can be accorded even to such seemingly nebulous entities as the intensity of of a man’s belief that his wife might possibly have deceived him.

Processes and events are surely not that nebulous, but there is no doubt that a good case could be made for regarding them as somehow less fully-fledged members of the ontology than the material objects whose changes they comprise. This is an issue which I do not wish to become entangled with here: and indeed, I believe it is perfectly legitimate
to embark on a discussion of the ontology of these things prior to establishing their status in this sense. After all, a substantial part of the business of ontology is taxonomic — establishing classifications and hierarchies which encapsulate the relationships amongst the various concepts we employ, and if we have good reason to classify attributes of entities as well as the entities themselves then it seems that such attributes should also be grist to the ontologist’s mill. In short, we can embark on the ontological enterprise before establishing the precise logical status of what we are classifying.

I shall therefore have no qualms about at least according an honorary first-class status to processes and events, in order to discuss how they should be classified, and how they are related to each other and to other kinds of entities. Thus from now on I shall take it for granted that processes and events are legitimate objects of ontological enquiry, and indeed shall seek to argue that they are necessary objects of ontological enquiry, that an ontology that has no place for them is ipso facto incomplete.

At the present time, in the formal ontology community, a natural starting point from which to launch a discussion of processes and events is the philosophical distinction between continuants and occurrences. This has been encapsulated in the distinction between SNAP and SPAN ontologies that has been advocated by Barry Smith and his collaborators. In the words of Grenon and Smith [3], ‘a good ontology must be capable of accounting for spatial reality both synchronically (as it exists at a time) and diachronically (as it unfolds through time)’, these two tasks being assigned to SNAP and SPAN ontologies respectively — thus what is proposed is not a single ontology but rather a coordinated ensemble of ontologies of these two different kinds.

The inhabitants of a SNAP ontology are continuants, that is, ‘entities that have continuous existence and a capacity to endure . . . through time even while undergoing different sorts of changes’, while the inhabitants of the SPAN ontology are occurrences, that is, ‘processes, events, activities, changes’. The elements of a SNAP ontology include ‘all continuants existing at some given instant of time’, and of course the designation SNAP is suggested by the idea of a snapshot, a complete picture of the universe at an instant. A SPAN ontology, by contrast, of necessity spans a succession of instants, and specifically contains those entities whose nature encompasses such spans.

I want to consider more closely the invocation of ‘instants’ here. One generally conceives of an instant as a part of time that has no duration, and within which no change can occur. A superficially attractive picture of time has it that the ‘flow’ of time arises from the ‘stitching together’ of innumerable durationless instants. This is the picture implicit in the conventional mathematical representation of a time interval as a set of instants the form

\[ [t_1, t_2] = \{ t \in \mathbb{R} : t_1 \leq t \leq t_2 \} . \]

However useful this may be as an abstraction for certain technical purposes (and of course, in the mathematical context that gave rise to it, this picture is a beautiful and significant achievement), it seems to me that as an account of what time really is it is fundamentally incoherent. The essence of time is surely tightly bound up with change, but the mathematical picture contains no change, only a static ensemble of individually static snapshots.

Consider a man walking. What do we see if we observe him at an instant? (A real snapshot, i.e., a photograph, is a crude approximation to this, but of course the snapshots of the SNAP ontology are fully three-dimensional and encompass the whole universe at
the times they represent.) We might suppose that whereas we see the man, we do not see the walking: that is, while the man is wholly present in the snapshot, he is there motionless, and the best we can say is that his posture at that instant is characteristic of the sequence of postures assumed by a walking man — in other words, we may infer, with some plausibility, that he is walking, but cannot see the walking because it is not actually present in the snapshot. But, so the argument might go, if no single SNAP ontology contains walking, then a world which contains walking cannot solely comprise SNAP ontologies, and we are led to invoke the SPAN ontology to put the walking in.

While this may seem persuasive, we must not lose sight of the fact that the instantaneous snapshot is an idealisation. I believe that it arises as a conflation of two separate things: on the one hand, static representations such as photographs, and on the other hand, our idea of the present as the temporal location of our immediate experience. What the snapshot shows is precisely what was present at the time that it was taken.

But the present of our experience is nothing like a snapshot. What we experience is a dynamic world, not a static one. In the photograph we can only infer that the man is walking; in our actual present experience, looking at the man himself, we can see him walking. We perceive motion and change directly, just as we perceive shapes and colours. (Some change is admittedly either too slow or too fast for us to perceive directly — just as some shapes are too large or too small and some colours too bright or too dim.) Indeed, we perceive processes directly, for walking is not just motion, it is a particular structured kind of motion, a process: processes are present in the world right now.

Moreover, like objects, processes can change: the walking can get faster, or change direction, or become limping. All around us processes undergo changes: the rattling in the car becomes louder, or changes rhythm, or may stop, only to start again later. The flow of the river becomes turbulent; the wind veers to the north-west.

In all these respects, processes seem to contrast with events. There are, admittedly, many different ways of understanding the terms ‘process’ and ‘event’, and hence correspondingly different ways or portraying the relationship between them. Some authors regard processes as a subclass of events; other authors have it the other way round; others still treat them as two disjoint subclasses of some broader category such as ‘occurrences’, ‘situations’, or ‘eventualities’. Here I wish to advocate a particular understanding of the term ‘event’ by which the contrast between process and event is brought out with maximal clarity. I believe this is justified because in real language we hardly ever use the two terms interchangeably; indeed, in the dictionaries I have consulted, neither term figures at all in the definition of the other.

Some events are durative, that is, they take time to occur; such events are as it were made of processes. Durative events are to processes as physical objects are to matter: this has often been noted and was stated in very nearly this form by Emmon Bach [1]. Just as there is an obvious distinction between ‘table’ (a kind of physical object) and ‘wood’ (a type of matter, of which a table might be made), so there is an analogous distinction between ‘battle’ (a kind of event) and ‘fighting’ (a kind of process, of which a battle might consist). And just as some physical objects have complex constitution, being made of components of different kinds of stuff, so an event may involve a number of different processes (e.g., a journey might involve driving, flying, walking, and travelling by train).

A different kind of event is punctual. In idealisation, such an event takes no time at all to occur, it is instantaneous. In reality this is generally sensitive to granularity. The paradigmatic punctual event is the onset of motion, when a physical body starts moving.
If at each moment the body is either at rest or in motion, then the transition between rest and motion cannot be other than instantaneous, since there can be no time at which the body is neither at rest nor in motion. But in the case of an extended body, if the motion is initiated by an impact on one side of it, it will take some admittedly very brief time before the motion is communicated to the far side, so the transition from the body’s being wholly at rest to its being wholly in motion cannot be literally instantaneous. But these sorts of consideration are rather irrelevant to the point at issue, which is that if an event is defined as the initiation of some process then it is thereby being conceptualised as, in idealisation, instantaneous. As such it is a rather different kind of event from those which are conceptualised as durative, since it cannot be said to be made of process-stuff in the way that they are.

The world does not consist of objects and stuff: to describe a part of the world as an object is to describe a portion of stuff in a particular way. When I refer to a table (which happens to be, say, of wood), I am referring to a certain quantity of wood, but I am not referring to it as wood, but rather as an artefact constructed for the purpose of supporting smaller objects at a convenient height above floor level. This is an entirely familiar point (one might think of the four ‘causes’ of Aristotle here). Equally, if I refer to a journey from London to Paris I am describing an event in terms of what is accomplished by it, i.e., the transition between a situation in which someone, or something, is located in London, to a situation in which it is in Paris; but in referring to a particular journey of this type I am thereby implicitly referring to its constituent processes — which might involve various combinations of driving, flying, sailing, or travelling by train.

The relationship between processes and events is not all one-way: processes can also be defined in terms of events. This happens, for example, if I say, in answer to the question what I am doing right now, that I am going to the station. There is no such process as ‘going’: but if someone goes to the station, that is an event, and to say that I am now going to the station is to say that some process constitutive of an event of that type is currently going on. We can abbreviate this by saying that the event is going on, but strictly speaking the event is not something that can be said to exist from moment to moment in this way, rather it is something that, once it has happened, we can retrospectively ascribe to the time interval over which it occurred. Thus ‘I am going to the station’ describes a process in terms of the event that will have occurred if the process continues to the point at which my goal in initiating it is realised.

Another way in which processes can be defined in terms of events is through repetition. Many processes are of this kind: there is a process which we describe as ‘hammering’ which consists of repeated occurrences of the event of striking one hammer-blow. Many processes, on analysis, can be seen as being of this type, even if the way we describe them does not explicitly draw attention to this fact — e.g., walking consists of taking a succession of steps, each one of which is a discrete event (itself consisting of the process of swinging one of the legs forward while the other leg is in contact with the ground).

This draws attention to a key feature of processes which makes them clearly distinct from events: processes are open-ended, whereas events are closed. An event is a discrete chunk of history: it has a beginning and an end (or, in the case of truly instantaneous events, the ‘chunk’ becomes a ‘sliver’ and the end coincides with the beginning). A process is not like that: a process goes on from moment to moment, and in principle can continue going on. (Of course, there may be extraneous factors which prevent it from
doing so: a falling process necessarily terminates when the falling object hits the ground — and the closed chunk of falling which thereby has occurred is an event, i.e., a fall.) One way of expressing this is to say that processes and events occupy time differently: an event is a piece of history, a process can be experienced now.

This distinction is in turn related to another one which has often been noted, particularly in the linguistics literature: processes are homogeneous, but events are not. This is usually explained as follows: if a process goes on over some time interval, then it goes on over each subinterval of that interval, whereas if an event occurs over that interval, then it does not occur over any of the proper subintervals. To illustrate: if I bake a cake over the interval between 2 p.m. and 3 p.m., then it is not true that I bake a cake over any lesser subinterval; but if it rains (a process) throughout that interval then it rains from 2 p.m. to 2.10 p.m., and from 2.10 p.m. to 2.20 p.m., etc. If you believe in instants, then you could say that it rains at each instant within the interval from 2 p.m. to 3 p.m.; more concretely, we could say that at any time during that interval, you would have experienced rain. This is generally subject to a caveat about granularity, e.g., it is claimed that walking does not occur over any subinterval shorter than the time to take one step, but I am inclined to be sceptical about this — the process ‘smears’ out over the whole interval, so that I can say that right now, in the experiential present, there is a walking process.

The fact that a process is present at each moment that it goes on, whereas an event is rather associated in a unitary way with a whole interval, is intimately connected with the fact that processes, but not events, can be the direct objects of experience, present in the dynamic snapshots which we have conceived in contrast to the more conventional, but unrealistic, notion of a static snapshot. In this respect processes are almost more like continuants than occurrents: like ordinary physical objects, they are present from moment to moment, they can be experienced directly, they undergo change. Contrast this with events: an event occupies an interval — go to a subinterval and you only capture part of the event; events can usually not be experienced directly, rather you experience the constituent processes and when the event is over you can synthesise these experiences into a whole which by then is part of history, not direct experience (so there is nothing to stop you from remembering an event: memory, unlike experience, has room for extended intervals); and events cannot meaningfully be said to undergo change, they just happen (whenever we speak as if an event changes, in fact we are talking about a constituent process — e.g., if I say the battle is getting fiercer, I mean that the battling process, i.e., the fighting, is getting fiercer).

We can summarise the distinction between processes and events under two headings — how processes differ from events, and how they are related to events.

First, from the above discussion, processes differ from events in the following ways:

- Processes can be experienced directly.
- Processes can undergo change.
- Processes are open-ended.
- Processes are homogeneous.

Events lack all of these properties.

Second, events and processes are intimately related: each can be described in terms of some relationship it bears to the other. In particular:

- An event can be described in terms of its constituent processes (“He had a swim”).
• An event can be described in terms of a process that is initiated or terminated by it (“He began/stopped swimming”).
• A process can be described in terms of an event of which it is a constituent (“He is swimming a length”).
• A process can be described as the open-ended repetition of an event (“He is swimming lengths”)

These relationships suggest the possibility of an algebra of processes and events, in which constituency, initiation, termination, and repetition figure as operators for converting process terms to event terms and vice versa. This is close in spirit to work that has been done both in linguistics and in AI.

Perhaps none of this sufficiently emphasises the great difference in character between processes and events, and to bring this out we should return to the SNAP/SPAN dichotomy and re-examine it in the light of the above conclusions. The first two properties of processes — that they can be experienced directly, and that they can undergo change — are shared with objects (by which I mean, essentially, continuants) but not with events. While not going so far as to suggest that processes are continuants (though I have suggested this, in [2]), it does seem to me that these properties place them more on the side of SNAP than of SPAN. A snapshot of the world which is more akin to the experiential present — in other words, a dynamic snapshot rather than a static one — must contain processes as well as objects.

This seems to me to call into question the usefulness of the traditional distinction between continuants and occursents. A more apposite distinction is between the dynamic world that can be the object of immediate experience (the ‘now’), and the historical record that emerges as a static synthesis of a succession of such dynamic snapshots. Processes, with objects, belong in the former; events belong in the latter. Thus, in comparison with the SNAP/SPAN picture, processes have swapped sides: in the new picture that I am advocating, processes belong with objects amongst the changeable, dynamic contents of the world, rather than with events, which are essentially static faits accomplis belonging to the historical overview that spans the constantly changing succession of dynamic snapshots.

What are the implications of all this for formal ontology? There are implications for classification, and implications for logical representation and inference.

As regards classification, I would suggest that the contents of our ontology should be organised, at the top-level, as follows:

\[
\begin{align*}
\text{ENTITIES} & \\
\text{Experiential entities} & \quad \text{Historical entities} \\
\text{objects} & \quad \text{processes} \quad \text{events}
\end{align*}
\]

I have said nothing here about how processes are to be distinguished from objects, and it seems to me that one of the attractive features of this scheme is precisely that it makes much more plausible the notion, which many people find tempting, that ordinary
objects strictly speaking are processes. Potentially, this could lead to a view of the world that is process-oriented in a more than usually thoroughgoing way — to the world-views espoused by, for example, Bergson and Whitehead. Such views have enjoyed something of a revival in recent times, witness the papers collected in [6]. But even if we stop short of this, we are still in a much better position to approach a phenomenon such as a river, which seems to be delicately poised between being on the one hand an object and on the other hand a process. And of course, on closer examination many things we call objects become much more process-like; this is particularly true of living objects. On the view I am advocating, we can accommodate this quite easily without having to countenance bizarre notions such as the identification of objects with events. (Of course, if a human being is identified with a complex process then when the human dies, and the process terminates, an event has been completed which is made of that process. But this event is a human life, not a human being.)

The second set of implications for formal ontology concerns the logical representation of objects, processes, and events. In particular, since processes can undergo change, they must resemble objects in being the bearers of time-variable attributes. An obvious way to accomplish this formally is to allow both objects and processes to participate in predications of the form \( P(a, t) \), where \( a \) is a term denoting either an object or a process (in short, an experiential entity), and the formula ascribes property \( P \) to that entity at time \( t \). Another formula might withhold that same property from the same entity at some other time, as \( \neg P(a, t') \), thereby allowing us to express change in the object or process \( a \). Amongst the properties that can be expressed by different predicates \( P \) here, a particularly important one is \( \exists \), which can be used to specify the lifetime of an object or process:

\[
\forall t (\exists(a, t) \leftrightarrow \text{In}(t, \text{lifetime}(a))),
\]

where \( \text{In}(t, i) \) says that time \( t \) falls within interval \( i \).

Predications of this sort should be unavailable for events; as already noted, events occupy time in a quite different way from processes, and if \( e \) is a term representing an event (here I mean an event token rather than a type), all we can say about it, as far as time is concerned, is that it occurs over some particular interval \( i \), i.e., \( \text{time}(e) = i \).

These formal fragments are related to each other as follows. If a process \( a \) has lifetime \( i \), then there is an event, \( \text{life}(a) \) which is precisely the life of that process and which occurs on the interval \( i \), and hence we can put

\[
\text{time} (\text{life}(a)) = \text{lifetime}(a).
\]

What is the difference between the process \( a \) and the event \( \text{life}(a) \)? The process \( a \) is something that exists at certain times; it can be the direct object of experience for someone present at any of those times; its properties may be different at different times. At any time that the process exists (i.e., is in operation) it is in principle open for the process to continue existing at subsequent times. Only when it comes to an end (i.e., ceases to exist) can we then synthesise the entire history of \( a \) into the event \( \text{life}(a) \). Much of this can still be said in the case where \( a \) is not a process but an object, further reinforcing the alignment of processes with objects rather than events.

As stated at the outset, the view I have tried to put across in this talk is not claimed to be in any sense uniquely correct. It is a view that I found myself compelled to adopt
initially as a result of following through the consequences of the observation that occurre-
rents, as traditionally understood, while they can be changes, cannot themselves undergo change. With the observation that processes clearly can change, the view of processes as traditional occurrence is quickly undermined.

I offer the experiential/historical dichotomy to the ontological community as perhaps providing a more congenial setting in which to develop detailed taxonomies of the dynamic aspects of the world. Indeed, the dichotomy is hardly new: the terminology of ‘experiential’ vs ‘historical’ I have taken from the linguist John Lyons, who used it in the context of a discussion of verb aspect nearly thirty years ago [5]. Although I have made some initial attempts to work out some of the details of my proposal in a formal way, these are not yet ready for dissemination.

References