A processual account of social reality and its application to corporate change

Volume 2 of 2

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Appendix B

Process theory and research: Exploring the dialectic tension

De Cock, C., Sharp, R.J., (2007), Process theory and research: Exploring the dialectic tension, *Scandinavian Journal of Management*, Vol 23(3)

Appendix C

P is for Process

Sharp, R.J., De Cock, C., (2005), P is for Process *in* Jones, C., O'Doherty, D. (*eds*.), *Manifestos for the Business School of Tomorrow*, Åbo:Dvalin Books

Annex D

A Short Essay on Process Ontology

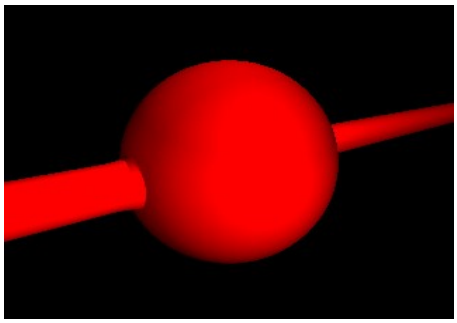
1 Preamble

This essay was written as a last attempt to integrate a coherent process ontology into the thesis. It is an attempt to define a fine-grained ontological position in keeping with the principles of localisation and grounded materiality that I have attempted to adhere to through-out. However, I have moved it to an annex because, on its own, it represents a truncation – a descriptive process that fails to deliver because it raises further issues that in turn require resolution to achieve the desired coherence. I have included it as an annex because I believe it may assist some readers in understanding the process "model" I have been struggling to work with myself, and because it represents an unfinished project on the way to a more comprehensive ontological position. The latter is the subject of Annex E.

2 Introduction

I have used a series of three-dimensional diagrams to try to illustrate this explanatory section as something that is necessarily distributed and dynamic. It would, perhaps, work better as a series of movie clips or animations but this is not feasible within the medium of this thesis.

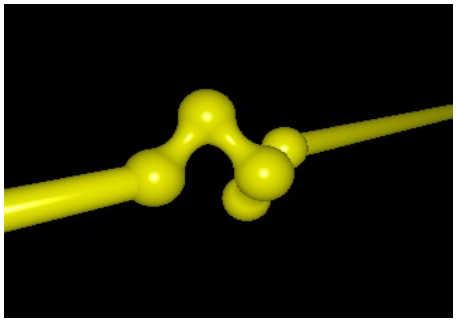
3 Events



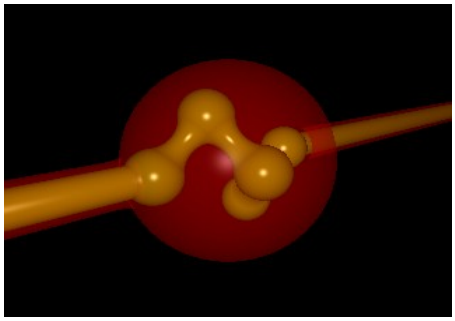
The basic unit of any process ontology has to be the Event, being a discrete (or perhaps better, a distinct) manipulation or transformation of materiality by some sort of force. I am, however, forced to conclude that events are tricky ontological devices for a number of reasons. Perhaps most importantly, if I try to consider the event as a distinct element of this ontology that merits detailed consideration then I run the risk of succumbing to process reductionism[1] (turning events into Things that can be separated and studied in isolation) and I fail to reflect that processism is always about the flow of events and never about events on their own.

[1]This is a phrase often used by Norbert Elias

Nonetheless, I still need to provide some level of description of events, especially given the somewhat vague description above. I want to make a distinction between what might be considered a formal definition and a much more informal but hopefully more useful definition. I am not going to dwell on the strict other than to acknowledge that such a definition could exist, has certainly been attempted by any number of authors[2], and tends towards something indivisibly unique, located at a single point in space-time.



My informal definition is, however, an immediate step towards process, accepting that what we commonsensically recognise to be events are in fact mini-processes where the underlying discrete events are almost bound to happen in quick succession once the first event is triggered. Switching on the kettle comprises a number of precise events involving the firing of neurons, movement of arm and fingers, mechanical tilting of the rocker, making of electrical contacts and the flow of electricity. However, from a commonsensical viewpoint all of these discrete events can be elided into one simple event.

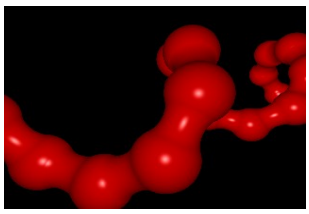


In a sense, this convenient elision can be continued, so that the process of boiling a kettle becomes an event within the process of making tea, which could itself be classified as an event within the daily lives of millions. But this introduces a new problem, because at each stage the subject of the event becomes more and more abstract until it has no real ontological claim any more. The solution to the problem is two-fold. First there is a question of granularity. If I am interested in the process of tea making then I will want to dissect this process into a number of detailed events so that I can understand the process and, hopefully, study how it varies from place to place or over time etc. If I am only interested in tea making as an activity undertaken by people at work, then I can probably get away with accepting it as an event in itself. That is why I think of it as a methodological choice. Second there has to be a principle of process applied to these elisions. It seems OK to elide a number of events where they are all part of a single process – all threaded together by that process. But this act of elision cannot break up or across the flow of the process or bound together events that are not within

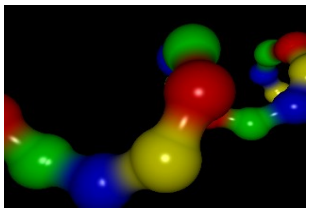
[2]AN Whitehead, for example, who is quoted severally in the OED definition of the noun *event*.

the same flow. This amounts to abstraction: reifying unconnected events into Things. Its another form of process reduction.

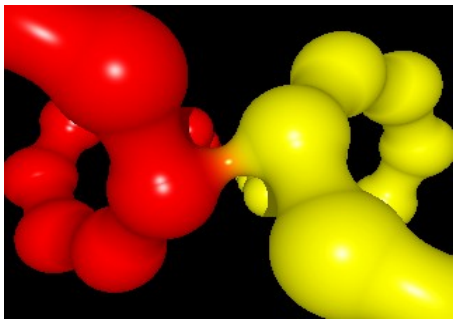
Processes



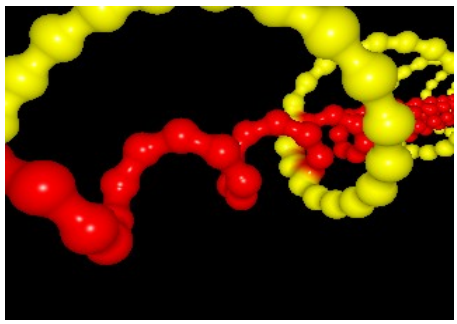
All of which leads us directly on to considering the nature of processes as opposed to events: the sense of a sequence; of being connected together through causal relations; of flow. Events cannot be considered in isolation but must be seen as part of sequences flowing together as processes.



But processes rarely consist of single events repeated over and over again. They are heterogeneous, being comprised of different events that form a sequence. They are also branching and merging, with one event depending on or triggering several others.

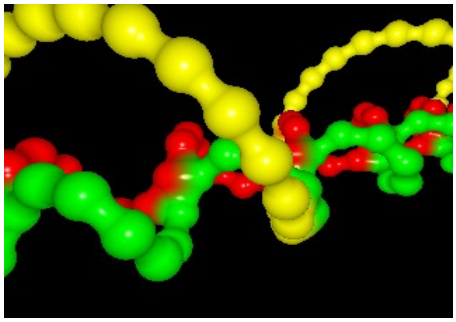


For example, the process of making tea consists of several events that can be repeated over and over again, except that this process depends upon a stock of tea that is gradually consumed by the process. Every now and then this process becomes dependent upon the process of growing, processing and supplying tea. At the moment I pick a box of tea bags from the supermarket shelf I become directly engaged in this process, reaching back to the tea being picked from the bush and well beyond that short moment. I am directly, causally connected to the first tea bush from which my bush was itself descended.

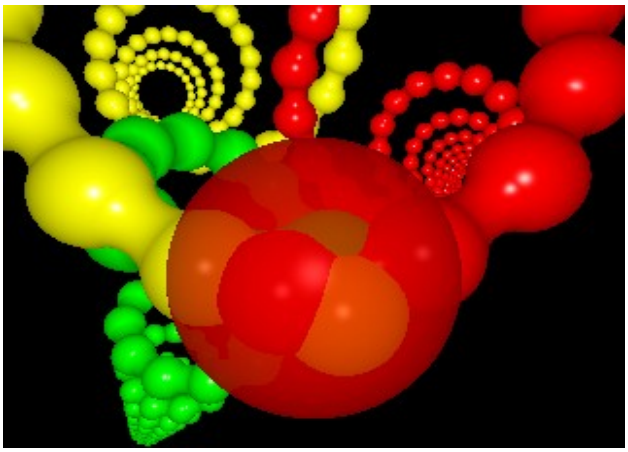


Imagine then the intertwining of native (illustrated in red) and descriptive (yellow). The descriptive draws upon the native every now through some form of act of perception and then continues on its own way. This could be an accurate description of these native perceptions or it could be their complete recombination into something fictional. Unfortunately this static picture is wholly inadequate for the purposes of representing the complexity of even this simple process. For example, any act of description necessarily draws upon pre-existing constructs with which the describer is familiar, linking in the processes through which the describer has developed this familiarity. Most often these

enabling processes have no relationship to the native processes to which they are now being applied.



Finally I have to introduce the performative, even though the resulting image is now a little busy. Hopefully this shows how the descriptive (yellow) interacts with the native (red), and how the performative (green) interacts with the descriptive and the native. Unfortunately this image shows all three processes from some third point lying outside of them all, and hence inferring the existence of another descriptive process connecting these with this observer. Where this scheme is perhaps best viewed from is right in the middle. Imagine, therefore, an event that is enabled by all three processes:



Now we can see how all of these processes have flowed down and into this one brief eventful moment. Of course, the diagram no longer illustrates the same set of processes as above given that each has arrived almost independently of the others, but this once more illustrates the limitations of these images and the complexity of the processes impinging on even the simplest of social events.

Perhaps this serves to highlight the need for the process researcher to occasionally abandon all forms of conventional representation and revert to the imagination. Standing in the aisle of a supermarket, you can sense the depth and breadth of the processes that are impinging upon you but you couldn't hope to set these down in any meaningful comprehensive form, at least not with out expending a lot of effort.

4 Conclusion

Events are the building blocks of process, but they are also inseparable from the flow that defined process, rendering any attempt to define events meaningless. Process is the flow of events – it is the causal connectivity of the present event to the previous events upon which the present depends. Process can only really be appreciated if you can capture this sense of flow; its trajectory.

Annex E

An Essay on Reality and Process

1 Preamble

This essay was written as an early attempt to develop a process ontology as part of this thesis. The intention had been to construct a reasonable foundation for understanding a "process world-view" that was sufficient to account for the localisation and material grounded implicit in that world-view. The essay became problematic for several reasons. First, its scope became too broad – moving too far into philosophy and sociology for a thesis on Organisational Studies. Second, it stretched the "jack-of-all-trades" approach beyond the limit, requiring much more specialist input than was available (given that this is a thesis on Organisational Studies). Finally, it raises more questions than it answers, requiring further work to resolve and moving deeper into this difficult territory.

Why, then, include it at all? One reason is because it is still relevant and does offer a suggested approach to a "proper" process ontology (if it can be called that). Another is that it represents an option for further work – a new project that could be explored on the back of the main part of the thesis. Its incompleteness is also a reminder that all projects are incomplete, in that their greatest contribution may be more what they enable than what they achieve? Finally, on a purely personal note I have included it because I believe it is an opportunity – a relatively novel ontological idea that could still be fruitfully developed.

A note of caution to the reader: this essay has not been edited but just "tidied up". It has not been re-worked to reflect some of the more recent "innovations" in the main text, such as the notion of native, descritive, and performative. Apologies in advance.

2 Introduction

This essay is about Reality, or more precisely it is about ideas concerning the nature of Reality. However, it is not a review of these ideas but rather the development of a single idea about reality, one that is intended to address the ontological problems surfaced in considering the notions of Ideas and Process. It is my intention to establish an ontological perspective or set of perspectives that I believe could resolve these problems.

What are these problems with ontology?

In Chapter 5 I discerned a significant problem with the idea of ideas. They were either mentally situated, in which case it was difficult to identifying how ideas were able to spread through time and space and develop across groups of people rather than just being in individual minds, or socially situated, which give the opportunity to overcome these problems but highlights their ontological uncertainty: if ideas are able to exist outside the mind, just exactly what are they? At the end of this chapter I described how, troubled by this latter problem, I had alighted on the idea that the solution might lie not in thinking of ideas as Things but instead regarding them as Processes. This led me on to Chapter 6 and the idea of process.

Unfortunately, the ontological status of process seems to be no less problematic than ideas themselves. There are ontologically explicit process theories, most notably Whitehead's Actual Entities and Bergson's Duration. Otherwise most other developments of the idea of process are either insensitive to the process:substance issue or deliberately sidestep it, e.g. ANT.

Whitehead's process ontology could be thought of as comparable to quantum physics. He wants to create a process ontology that is a direct parallel to quantum physics so that process *replaces* substance. But his ontology is not very usable in research contexts, and its theological foundations are unsatisfactory.

Bergson, on the other hand does not set out to replace substance, but instead sub-ordinates it under duration. Space, and therefore materiality, are the objects of the intellect and can be seen to be fallible. Duration is the common thread that links the social together and through Creative Evolution accounts for its development. Bergson's rejection of space as ontologically significant is, however, difficult to understand and accept. For example, his following acknowledgement of the importance of movement can only make sense if we admit space into the equation:

> *there are underneath the change no things which change: change has no need of a support. There are* movements*, but there is no inert or invariable object which moves: movement does not imply a mobile".*[3]

How can we conceive of movement without providing it with at least 1 dimension in space and 1 dimension in time for it to take place in? Furthermore, Bergson's separation of time from space cannot be reconciled with the post-Einsteinian conceptions of the Spacetime continuum. Since Einstein and Minkowski elided space and time into a 4 dimensional continuum[4] there is no sense in which space can be separated from time. Furthermore, there is a convincing

[3]From Chia and Tsoukas 2003, p.204, reference to Bergson's Creative Mind pp95-96

[4]See Wikipedia Spacetime 2006 and Space-time 2006

argument made by Tegmark[5] that the only dimensionality from which it is possible to observe the universe is (3+1). Movement is always only observable within this 4 dimensional space.

Whatever Bergson's intention was, the effect was to de-centre space and therefore materiality (which Bergson saw as resulting from the ability to partition space), but it does not seem necessary or possible to throw it away altogether. Recent applications of Bergson's ideas, such as by Deleuze, Wood etc. (see Chapters 6 and 7 for more details) have reversed this de-centering by applying his ideas to space, but this seems to ignore the whole intention of Bergson's work in de-centring space. Perhaps both projects are equally flawed because both attempt to split time and space when scientists have (for some time at least) been exhorting us to consider the two inseparable. It seems, therefore, that a reasonable starting point for this ontological exploration is exactly this: an understanding of the ontological significance of Spacetime.

This essay is divided into three sections. In the first section I attempt to provide the foundations of this proposal: a basic framework that encompasses all reality. I have called this a Physical Ontology because it is primarily concerned with the physical forces that shape the universe. In the second section I move inwards to identify a Biological Ontology: a reality that is shaped by biological processes. In the third and final section I move inwards again to explore a Social Ontology: a reality that is shaped by social processes. Each of these three ontologies is nested within its predecessor: social within biological within physical. And each ontology is examined from two different perspectives: an external objective perspective and an internal subjective perspective.

Before I can get started on this project I need to establish some basic assumptions, so that you, the reader will be able to better understand the approach I am proposing and perhaps set aside some of the concerns and blockers you are otherwise bound to have during this little journey.

Some Preliminary Assumptions

I consider that the purpose of ontology is to provide the fundamental staging of philosophy upon which everything else can be constructed. This, I understand, defines me as a Realist[6], because I have placed reality at the centre of all issues. For me, therefore, ontology is about defining the actual nature of reality as opposed to what we perceive Reality to be. In this definition I difference ontology from a more local version "the study of being", which implies a subject,

[5]Tegmark 1997

[6]There is a rich and often confusing tradition of capitalising (and not) the "R" when using the words reality and real in order to emphasise a certain philosophical position. My understanding of this is that to capitalise is to indicate the use of a proper noun, which is intended to imply that Reality is a thing or an actor cast into a play that we have written, to be distinguished from plain old taken-for-granted reality. That is why I prefer to refer to reality as a human-independent concept as opposed to Reality as something that is socially constructed.

that which is being, and from metaphysics, if only because the latter has created so much excess baggage that I cannot control the word.

I am not attempting to define a Philosophy *per se* but more a *social philosophy* or a *pragmatic* philosophy (if that is not too much of an oxymoron). Alternatively, you could see it as a sort of methodological primer, the necessary framework or basic set of assumptions about reality needed in order to carry on research along the lines that I am looking to explore. Which brings me to my second assumption, or at least a significant problem that requires me to make an assumption in order to overcome or bypass it. This is that my study of ontology immediately brings me into a conflict and a circularity from which I cannot seemingly escape. If, as I will later attempt to demonstrate, all social conceptions of "reality" are themselves detached from and obscuring of reality itself, then any ideas that I may contribute on this matter are inevitably inaccurate, being subject to the distortions and transformations that are inherently part of the social condition. Put another way, I want to describe to you an ontological perspective that is, by definition, indescribable. I am not sure that I can overcome this problem but I can aim to minimise its impacts by using methodologies that I have not yet been able to describe. There is therefore an ontological problem that I am here attempt to address, an epistemological problem because I cannot conceive of this problem without obscuring it, and a methodological problem because I cannot carry out research without solving one or other of these former problems. It is a Gordian knot that can only be untangled by making liberal assumptions about one or more of the others in order to understand the first.

Here are my initial tactics. First I will try to minimise my use of language, something that Bergson may have applauded, in order to describe the barest ontological schema. Second I will acknowledge that any theorising of this schema is made inevitably speculative by the weakness of my epistemological position, while playing to common denominators and minimalist descriptions in order to convince myself that this weakness is not a problem. Third, I will apply something similar to Bergson's intuition by asking you, the reader, to use your imagination in order to understand certain situations without the need for language.

This could be seen as a form of black-boxing the ontological problem[7], only perhaps in this case the analogy is better inverted: we are all inside the black box looking out. Inside it is possible to put forward any number of speculative theories about what goes on outside the box. What I am trying to do though is put away such speculations and instead determine some minimal set of assumptions that are just sufficient to understand what lies at the *interface* to the outside, or

[7]See, for example, Latour 1999 page 304 for a definition of Black-boxing.

perhaps just on the other side. Its a sort of minimalist approach to ontology in contrast to those who like their ontological furniture to be heavy and elaborate[8].

3 A Physical Ontology

The brute reality of Spacetime from outside

This starting point, in setting forward a Theory of Reality, is the the acceptance of a simple basic space or volume within which everything exists. This concept has been given the name Spacetime. It is the recognition that our common-sense perceptions of 3-dimensional space and 1-dimensional time are not two separate systems but one 4-dimensional system, or more accurately, one (3+1) dimensional system. This most fundamental conception of reality is, therefore, an infinitely large (3+1) dimensional volume through which energy is distributed, where energy can be seen as being in the form of matter and radiation or waves.

The perspective I want to adopt in order to view this 3+1 dimensional volume is taken from a viewpoint that is outside Spacetime, albeit that there is no possibility of such a point existing. It is not, however, impossible to imagine such a perspective and that is precisely what I am asking you to do. What would you be able to *see* from this perspective (to make a metaphor of sight for a moment)? Imagine that you can see a vast three-dimensional volume spreading out in every direction. Imagine that you can see scintillas of light spread across this volume, from far red to ultra-violet. This light betrays the distribution of energy through Spacetime. Now imagine that you can see beyond far red and ultra-violet, that you can see the entire electromagnetic spectrum: from radio, microwaves, x-rays, to gamma-rays. And now imagine that instead of three dimensions, you can somehow see four. And finally, imagine being able to see unimaginable detail: from the massive (on the scale of light-years) to the minute (on the scale of femto-seconds).

What can be said about this Spacetime, seen from this external perspective? Perhaps it is easier to define what cannot be said about it. For a start, being able to see all of time means there is no concept of past, present or future. Such concepts only have meaning relative to a point within Spacetime, and therefore have no meaning when seen from outside. It also means there is no movement: everything before you is stationary. There is no happening nor has anything happened: it just is.

Although we can discern energy distributed through Spacetime we cannot describe it in terms of continuants[9]: objects or things. Partly this is due to our amazing ability to see so much detail: it means we can see into what we might think of as things, like a lump of rock, and see the spaces

[8]Kivinen and Piirionen 2004.
[9]Mellor, 1980

between the energy within so that the boundary that seems so apparent to us as humans is no longer clear. Partly it is because we can see the geodesics[10] of each and every energy particle[11] over time, betraying the rock as little more than an event in each energy particle's infinitely long history.

If you imagine this perspective for a while you may, like me, come to the conclusion that there is very little that can be understood or said about reality from it. I cannot, for example, point to some features and say "there is the Milky Way, and there is the Large Magellenic Cloud". Out here such statements have no meaning. There is no language that can be used, and without language there are no Things. We cannot talk about planets or stars, or lands and oceans, or people and dates. There are not even any numbers[12] There is no meaning or sense.

You may feel justified in thinking that this ontological perspective is at least pretty unhelpful and at worse totally useless. And I would have to agree with you, but for one thing: The *meaning* of this reality is that *outside* our social black box there is absolutely no meaning at all. We have to close our eyes and feel what it might be like with no language, no ideas. But we also have to feel that in this meaninglessness lies *everything*: the entire universe lies within this uninterpretable volume. To try to get close to an understanding of what this reality is like we have to pare back all of our language and concepts to an absolute bare minimum.

The concept of a *Brute Reality* can be found in several philosophical ideas, being a reference to a reality that lies beyond the human condition, and therefore beyond language. Chia refers to an "an undifferentiated flux of fleeting sense-impressions" and "this brute, aboriginal flux of lived experience"[13]. He illustrates with a quote from James:

> *'…in the sky "constellations", on earth "beach", "sea", "cliff", "bushes", "grass". Out of time we cut "days" and "nights", "summers" and "winters". We say what each part of the sensible continuum is, and all these abstract whats are concepts'* [14]

John Searle, the inventor of the ontological idea of Biological Naturalism, describes a two level ontology having *Brute Facts* as the substructure and *Institutional Facts* as its superstructure[15].

[10]The line through Spacetime that defines the life-history of a particle of energy.

[11]I use the term "energy particle" to refer to the most essential forms of energy regardless of their state at any particular time. I mean it to be ambiguous if only because our understanding of fundamental particle physics is not itself complete.

[12]Which is, in itself, ironic if only because the entire edifice of Spacetime was developed through Mathematics.

[13]Chia 2001, p. [???]

[14]Chia 2001, p. [???]

[15]See Searle 1997

These references are made, however, from perspectives that are firmly inside Spacetime and within Biological and/or Social processes that we have not as yet discerned. Chia's "sense-impressions" or "lived experience" have no meaning out here. We cannot say that "Jupiter is a planet that exists independently of us", when by simply naming Jupiter we create a Thing that does not *really* exist. What volume of Spacetime should we try to section off to call Jupiter? And what would it mean if we did? Bhaskar identifies an *intransitive dimension* that could be described as co-incident with this Objective Reality, but he populates this dimension with *intransitive objects* and in so doing falls back within the social black box, obscuring Objective Reality with Scientific Knowledge.

Each of these brute realities introduces the concept of things, and in that sense each fails to provide an adequate foundation for a "thing-less", process-based ontology. This is why I realised I needed to construct something that is different, albeit at this stage its usefulness remains to be established. But then my Ground Zero, ontologically, is having some sort of sense of the sheer vast, meaningless, undifferentiated volume that is Spacetime. And perhaps accessing that sense requires us, at the very least, to employ some sort of Bergsonian Intuition. If you prefer you could approach it with a more "Eastern" philosophical tradition, but please be wary of bringing along that more western mystical eastern philosophy!

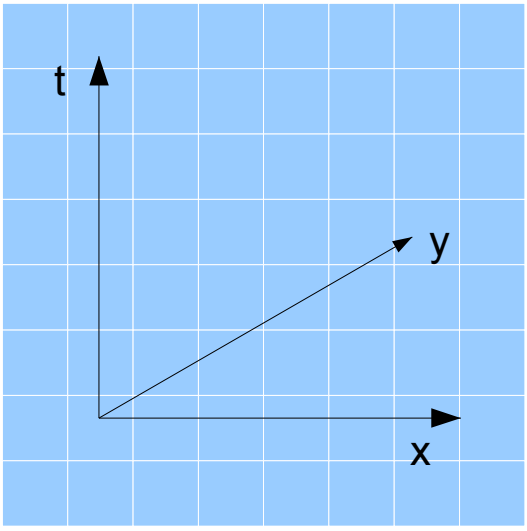
Concepts of Spacetime and their impact on an Objective Ontology

Is Spacetime in this most basic ontological conception, entirely without anything to tell us? Perhaps not, but to find out more about it I need you to adopt a few more "concepts" or "beliefs". Methodological I am in something of a bind, and it is one that haunts processism at all levels. I cannot send you to this objective viewpoint, deprive you of language and meaning and then expect you to have insightful thoughts about what you see. I therefore need to introduce a methodological device, or trick if you prefer. I need you to imagine that within the walls of our social black box there is a door. You can go through this door to access my special viewpoint and *absorb* the universe beyond. You can then return into the black box to reflect on what you absorbed, and to consult with whatever ideas you feel are needed to make sense of what you absorbed. You can repeat this process as often as you like. The only rule is that you must take all necessary steps to avoid taking any of these concepts with you when you go outside the black box.

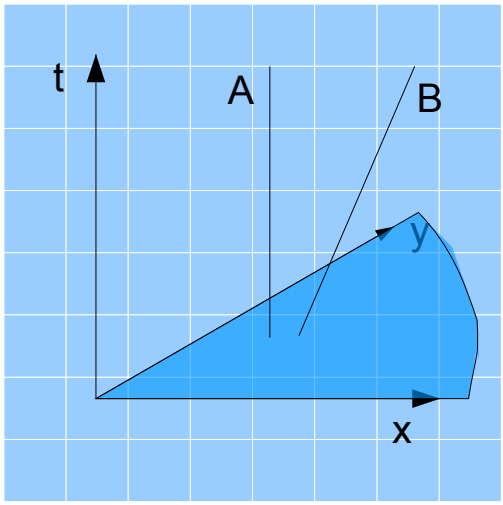
Before you go outside again, I want to take a closer look at the idea of Spacetime itself. It is difficult to describe 4-dimensions[16] on paper so imagine instead a (2+1) Spacetime model in which the x-axis and the y-axis are two space dimensions and the t-axis is time. This just

[16]more specifically what mathematicians refer to as a Lorentzian Manifold: a smooth curved four dimensional space.

ignores the z-axis, leaving it as constant or considering the other three as relative to it. The x-axis runs across the paper horizontally, the t-axis runs vertically up the paper and the y-axis is at right-angles to them both, running back into the paper.

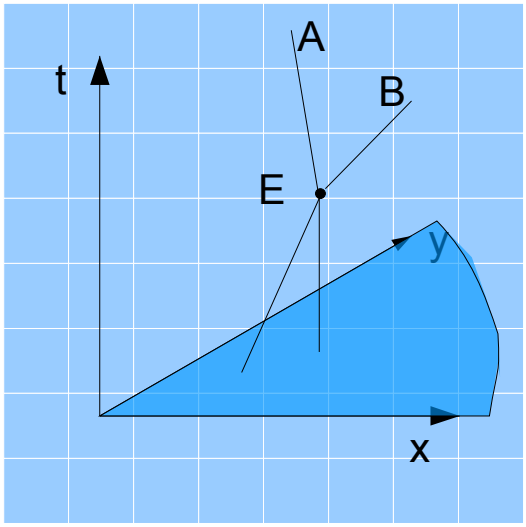


Consider the simple case of a single point of energy fixed in space but existing over a period of time. This would form a something equivalent to a straight vertical line changing in neither the x nor y axis (A on the figure below). If a point moved at a constant velocity in both or either x and y axis then it would form a straight but angled line (B). Both of these lines are called *world lines*, being the path taken by a point of energy through space and time as opposed to the more conventional path taken through space.



An *event* (E, below) can be considered to have occurred at the co-incidence of two or more world lines, representing where two or more particles interact with each other in some way,

resulting in one or more of the particles changing its velocity (gradient), with a consequent change in direction of its world line.



From our viewpoint outside of Spacetime, looking in at the (3+1) dimensional universe we can imagine infinite instances of these events and world lines. If we look long enough and hard enough we may absorb something of the patterns they make. To reflect on these patterns I need you to return inside the social black box for a while.

If the universe were devoid of any causal forces then it would seem fair to expect these patterns to reflect nothing more than randomness: a uniform noise across the whole Lorentzian Manifold. Back in our social black box, however, current “speculative” theory suggests there is likely to be a more structured pattern, one that is caused by the process referred to as Thermodynamics, or more recently Statistical Mechanics. There are various Cosmological Theories that attempt to describe this causal force in detail, but in terms of interpreting the patterns that can be seen from outside Spacetime, they will all generally agree on the causes: a fair proportion of the energy of the universe is bound up as matter for most of its history; that across most of the volume of Spacetime this matter expands outwards from some sort of massive explosion; and that the behaviour of this matter approximates to a set of laws that are not dissimilar to Newton's, particularly the laws of gravity and the laws of entropy. Follow the life-history of almost any energy particle across Spacetime and these concepts are a good enough approximation. If you described what you had seen from this outside viewpoint to anyone engaged in the current cosmological debates, and you asked them to define the causal

force of these patterns, it is likely they would provide more or less the same answer: the thermodynamic expansion of the universe.

This provides a minimalist explanation of what is going on *out there*. It is a crude approximation but is it necessary to understand complex debates about Substantivalism, Holes, Bundles and other Laws. Given I have my eyes screwed up, looking at something indescribable from an impossible perspective, this is an assumption I am content with.

Developing a Subjective Ontology – Spacetime seen from inside

Up to this point I have tried to establish a fundamental reference point through my imaginary-impossible perspective of Spacetime-from-outside. I have, hopefully, demonstrated the paucity of this viewpoint: the utter lack of meaning in the universe beyond our social world. I have also tried to convince you that this represents an Objective Ontology. Then what if I move my viewpoint to inside Spacetime, and yet remain at this fundamental physical level of description? Would this represent a universal Subjective Ontology that perhaps could complement this Objective Ontology and even enrich it?

If I take as my perspective a single fixed point in Spacetime then I can access the energy located at that point in space at a fixed moment in time. Unfortunately this is very little information and far less useful than my objective ontology so I am going to have to permit some degree of freedom within the Spacetime continuum. There are three choices I can make: to move forward in time, to move backward in time, or stay at the same point and move instead through one or more of the spatial dimensions. I could choose any of these options but the reality I would create by choosing either of the latter two would be quite alien to our own reality, our lived reality. Moving backwards in time would be like trying to make sense of a movie you can only watch being played backwards. Moving through space and not time would be similar to using one of those three-dimensional cameras that allows the viewpoint to be moved around a fixed subject. Interesting for a few moments and useful for making advertisements but not very helpful. Therefore I conclude that this provides the most meaningful perspective while the other 2 options would be nothing more than a diversion or distraction. Back in our social black box, I can find ideas in the realms of physics or mathematics that tell me the laws of physics work equally well going backwards in time as they do going forwards. Indeed, since the laws of thermodynamics got replaced by statistical mechanics, even the law of entropy can be reversed[17].

[17]This law states that the expenditure of effort must result in an increase in the level of entropy (think of it as chaos) in the universe, but statistical mechanics has shown that the reverse can happen, but is very very unlikely.

Imagine you are now at this fixed-point in the three spatial dimensions and moving forward in the one time dimension. What would it be like? For a start you would have no extension, no sense of space. Being able to sense remote events requires a means of perceiving that is not, in this purely physical world, available to us. The only events that you can describe are those that actually occur at this point in space (along this world line). You can not know what is happening anywhere else. If an event occurs a mile or a millimetre away you do not know about it. Consider three photons of light arriving at our observation point in sequence. They are all the same at this point regardless of the fact that one originated only 1 metre away, the second came from the Sun, and the third from the most far flung galaxy ever to illuminate this planet. You you have no means to determine distance or even angle of arrival.

What if this viewpoint happened to coincide with a solid piece of matter: a speck of dust or a rock floating in space? Wouldn't that grant us some extension at least through the translation of events affecting the whole of this body? A remote event on one side of the rock, such as a collision with another rock, causes an event at our viewpoint, such as the movement of particles through the viewpoint, but it does not extend this viewpoint. We have no means of knowing what caused this event or even of knowing where it originated from. All that we can know is limited to exactly what occurs at this one fixed point.

Welcome to Subjective Brute Reality. It is not quite as you imagined it? A very impoverished place perhaps? But then don't forget that most of the reality is just emptiness. But perhaps it is not as impoverished as it might at first seem. This viewpoint is almost bound to be bathed in a huge spectrum of electromagnetic waves, most of which we (as humans) are not aware of. Also don't forget that from this viewpoint you can observe the same level of detail in this one point that you could see across the entirety of Spacetime, such as changes in energy that last only femto-seconds and you are equally able to observe changes that take aeons to even be noticed. Unfortunately, as with the objective reality there is no room here for concepts such as Things or objects, which are all spatially extended. There is no meaning or language either, which is perhaps not that much of a problem given that there is not much to talk about anyway.

One of the reasons I wanted to explore this Subjective Physical reality is to emphasize just how much our view of Space is determined by our biology (an idea that is developed further in the next section). I contend that most non-mathematical conceptions of subjective brute reality are heavily anthropomorphized. Just to get a flavour of what this reality might be like, we have to abandon the view from our eyes and imagine instead the spectral richness of this single point and its infinitesimal detail.

Time and the Subjective Physical Perspective

There is another aspect to this subjective ontology that was wholly absent[18] from the objective: the notion of time. Seen from within our comfortable social black-box, there is a view that everything within Spacetime exists all at the same time, a view that has been called Eternalism[19]. It is countered by the view that the only thing that exists is the present, called unsurprisingly, Presentism. The two views seem to be incompatible but this incompatibility disappears if we decide to make each view belong to a different perspective. In an objective ontology, where the viewpoint is the impossible outside-time perspective, it is not possible to talk in terms of past, present and future. All time exists at once and, in effect, all time is over. From this perspective Eternalism makes sense and Presentism is an impossible concept to hold. Equally when I move my perspective inside the Spacetime manifold I find that the only reality is the present and therefore the idea of Presentism make sense and Eternalism is impossible to conceive. By making this assignment these two apparently incompatible ideas become justifiable while being completely incomparable. They are both right but both must be seen as having different usefulness.

In addition to the polarised views of Eternalism and Presentism there are other views that lie somewhere in between. The Growing Block theory[20] is like an infinitely large bath that is slowly filling with water. The Present is located at the surface of the water while the Past is everything that lies underneath. The Future, however, does not yet exist. Its a chimera with Eternalism below the surface and Presentism at the surface. Maybe it reflects an underlying anxiety that Eternalism implies some level of determinism, with all of its moral (or amoral) implications. But when Eternalism is seen in the context of a viewpoint from outside Spacetime it can not be said to be deterministic because determinism is a concept that is about the *future* being already defined in the past whereas the future and the past do not exist *outside of time*.

Another idea of time is called the Shrinking Tree theory[21] in which the future is envisaged as the rising branches of a tree that reduce to one single trunk at the moment of becoming. As time progresses, the number of branches intersecting a moment in the future reduces, reflecting the fact that fewer possible futures exist with each passing moment. This has to be seen as only having meaning from the subjective perspective, but as we cannot see into the future from this perspective we have no way of visualising or understanding in anyway what is “out there”, so the idea becomes, at the same time, meaningless, or at least value less.

[18]It is probably not accurate to describe it as absent but rather totally contained within.

[19]Rea 2005 provides an excellent summary of these issues.

[20]See Rea 2005 again who attributes the idea to CD Broad although the latter did not endorse it.

[21]Rea 2005 directs the reader to McCall 1994 for details on this idea.

Consulting plausible theories of time and fitting them to these two different perspectives provides some answers but not all of them. Objectively there is no past, present or future because we are outside time altogether and can see everything all at once. Subjectively there is only a present because we are reduced to a single point in the Spacetime manifold. Is there a reality that contains the past and the future as well as the present? I believe that there is but also that understanding the past and the future depends on developing my ontological scheme a lot further. So that is what I will do, returning to the issue of time later on.

4 The Physical, the Biological and the Social

I want to return through the door to a viewpoint looking over the whole of Spacetime. As I scan this infinite Lorentzian Manifold I notice a volume where the pattern is different. It looks more complex – screwed up in some way. As I study this volume I realise that something is happening here that is other than the thermodynamic expansion of the universe. Energy is ordered at its heart while overall more energy is dissipated. I can not say what it is because, like the rest of Spacetime seen from outside, it is without meaning. But when I return inside the social black box and consult with contemporary ideas I conclude there is a new process at work creating this different pattern, and that there is general support for the idea that this new process is *biological*. In the next section I explore this biological process in more detail and demonstrate how it creates its own subjective ontology.

But before returning to the comfort of the social black box I notice something else. Zooming in on this new complexity, I can discern a further volume of even more complex patterning, nested within it. This involves even greater levels of order being achieved over significantly shorter time periods, but not without an increase in the overall dissipation of energy. In section 6 I will try to explain that the ultimate cause of this complexity can be loosely termed the social.

5 Autonomous Complexity: A Biological Reality?

In the comfort of our social black box, what plausible explanations are that that could explain the pattern of increased complexity that I have chosen to attribute to the Biological? There are certainly plenty of ideas that try to explain "What is Life"[22] and from what I can determine most of them seem to have the following in common:

1. The events that caused the patterns I observed are chemical reactions involving complex molecules that are themselves parts of molecular complexes.

[22]Edwin Schroedinger published a short book with this title in 1951 and it has come to signify the involvement of physics in what was previously seen as a biological problem. It is even attributed to motivating Watson and Crick to carry out their research that eventually led to the discovery of DNA (Wikipedia, 2006).

2. These chemical reactions are operating "far from equilibrium", in that they are apparently unstable and can only be maintained through the continual utilisation of high levels of energy. Hence they have been referred to as "dissipative structures" because of the energy they dissipate. Being keen to avoid any notion of Things, I am bound to prefer to think of them as "dissipative processes". [23]

3. They are bound to operate in compliance with the second law of thermodynamics: that every event increases the overall entropy (state of disorder) of the universe, but they achieve a local reversal of the second law by creating highly ordered processes and then paying the entropy debt through dissipating energy elsewhere.

4. They are essentially autocatalytic processes.

A catalyst is a substance required to complete a chemical reaction but not itself part of that reaction. A catalyst typically enables a reaction that would otherwise require much higher levels of energy. Many reactions depend on catalysts to occur and this is especially true of biochemical reactions where high levels of energy would otherwise destroy the systems involved. But a catalytic reaction can only progress at a fixed rate (assuming the reagents involved are freely available). So, for example[24], a catalysed process capable of generating molecules at a rate of 1 million a second would take 20 billion years to produce a single mole of reagent; a mole being 10^{23} molecules and a mole of carbon weighing just 12 grams. An autocatalytic reaction is similar to a catalytic reaction except that the product of the reaction is itself the catalyst. Each reaction increases the amount of catalyst available and therefore the rate at which the reaction can take place. Assume a free supply of reagents, what takes 20 billion years to complete as a catalysed reaction can be completed in just 79 microseconds[25] as an autocatalytic reaction!

The difference between the potential of a catalytic and an autocatalytic system is significant: a catalysed reaction simply cannot occur fast enough to have the impact that living systems have clearly had on our planet at least. Where the catalyst/product is a long-chain biopolymer with each reaction able to extend the length of the polymer or create new polymers then we have conditions that are clearly prebiotic. Where these long-chain biopolymers involve variety then we can add to these prebiotic processes a means of molecular evolution. If these biopolymers can evolve to the point where they not only autocatalyse their own replication, but also catalyse the creation of other compounds, such as proteins, that in turn can confer benefits to the

[23] See, for example, Pross, 2003 who provides a good summary of non-equilibrium thermodynamics as established by Schroedinger, Bertalanffy and Prigogine in the second half of the 20th century.

[24] I have borrowed this example from Pross, 2003 although it can be easily derived from first principles.

[25] Pross, 2003

biopolymer then we have the conditions for replicating assemblies of molecules, which is perhaps just another way of defining living systems?

How can living processes be reduced to autocatalytic dissipative biopolymeric structures? How does this explain their apparent teleonomic character[26]: that living systems display a purpose; an intentionality. As the Nobel laureate Francois Jacob observed: "A bacterium, an amoeba, a fern - what destiny can they dream of other than forming two bacteria, two amoeba, two ferns?"[27] Yet seen at the molecular level there is nothing mysterious about this apparent teleonomy. Living processes depend on thermodynamically favourable reactions to drive the thermodynamically unfavourable reactions that characterise them[28]. Therefore, for these autocatalytic or replicative processes to overcome the thermodynamic consequences of increasing complexity as they evolve, any changes that would improve their ablity to find and exploit energy sources will be favourable and therefore automatically selected. As these molecular processes develop into cellular processes they would have to evolve their replicative processes to adapt to the task of replicating entire cells. With the evolution of multicellular organisms these replicative processes would have to adapt further to enable whole organism replication. At each stage the overheads incurred by increasing complexity of cellular and then multicellular living involve a trade-off between variety and stability. If cellular evolution carried on within an organism it would be debilitating, but without variety evolution would slow down enormously. Hence the emergence of sexual reproduction as a means of putting variety back into organism reproduction while keeping cellular reproduction under control.

It is the power of evolution and selection (being differential mortality) to give the impression of a teleological driving force where this is none. Evolution shows a trend towards greater complexity, but it is misleading to ennoble this with a teleological purpose by calling it "progress". As Stephen Jay Gould pointed out, the increase in complexity is nothing more than an evolutionary consequence[29]. If life started out at a minimal level of complexity (what Gould referred to as being along the Left Wall) then evolution can only take it in one direction – towards greater complexity. And as greater complexity throws up its own challenges (such as multicellular living) then evolution will eventually find a way round.

The Story of Phage Lambda

[26]Pross, 2003
[27]Jacob, 1989.
[28]Pross 2003.
[29]Gould, 1994.

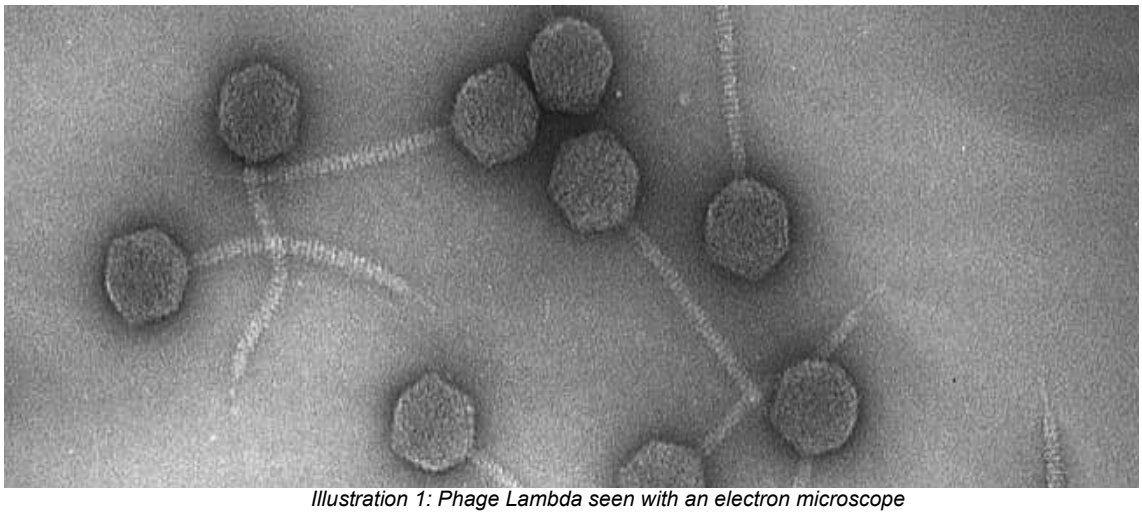


Illustration 1: Phage Lambda seen with an electron microscope

There is a story worth recalling that appears to contradicts this statement and yet on closer examination, confirms its validity. This is the life cycle of a tiny living form called bacteriophage Lambda (λ-phage), a virus. This virus has evolved a minimalist life cycle that would seem to betray the work of a very skilled designer capable of the most ingenious schemes. Surely it must demonstrate that living processes are teleonomic in character?

Phage Lambda contains a very small genome of RNA (similar to DNA and produced in most higher cells as part of the process of expressing genes as proteins) consisting of just 48,502 base pairs[30], which is 1/125,000th of the genome in a human cell. This RNA is encased within a dodecahedral protein head to which is attached a tubular protein tail. On making contact with the surface of its host (Escherichia coli or more familiarly E-coli) the RNA genome is injected into the cell where its genes are expressed by the cells apparatus along with the cells own genes.

If the cell is thriving and healthy then it will quickly degrade one of the proteins produced by the virus, but with dire consequences to the cell. This protein (unimaginatively called “cl”) represses the expression of Phage Lambda's other genes, effectively keeping the virus dormant. Without the cl protein the virus quickly takes over the cell's systems, producing lots of copies of its own genome together with all the proteins required to assembly new heads and bodies. As copies of the virus multiply another of the virus' proteins builds up in the cell leading it to burst open at about the same time as the cell's nutrients are finally used up.

If the host cell is not thriving when the virus first arrives then the cl protein will not be degraded and will inhibit the virus from copying itself. Instead it promotes the creation of proteins needed to integrate the virus into the bacteria's own DNA. This is a complex process that involved

[30]Strands of DNA and RNA consist of pairs of Bases, being a four digit “code” used primarily to define the sequence of amino acids that make up the proteins that each gene encodes.

transcribing the virus' RNA into DNA, locating a special point in the bacteria's DNA and inserting the viral DNA into the bacteria's DNA at this point. Once in, the virus effectively shuts down, but not before it produces another protein that binds to the DNA and represses all of the viral genes. The bacteria carries on as if nothing had happened and the viral DNA is reproduced simply as part of the bacteria's overall genome.

At some point the bacteria or its children (now carrying copies of Phage Lambda within them) is likely to suffer stress, such as being attacked by some form of antibiotic. Under these conditions the bacteria naturally modifies a protein it contains with the intention that this modified protein can set about repairing the bacteria's DNA. But Phage Lambda has prepared a trap that hijacks the process. Its suppressing protein bound to its DNA preferentially binds with this repairing protein causing it to detached from the viral DNA and thereby allowing the viral genes to be expressed again. These genes liberate the DNA and start the process of mass replication leading to the final moment when thousands of new phages burst from the now-dead bacteria and float off in search of a new host[31].

Its a brilliant system that clearly capitalises on healthy cells to make a quick biological profit and move on, while recognising when conditions aren't worth exploiting and instead investing in the cell's longer term. Once in, the virus gets replicated with the cell so its not losing anything: it may as well stay there. But as soon as conditions look bad its time to up sticks and leave. Its going to make a better return finding another host regardless of the bacteria's poor state of health.

That this virus can achieve so much from so little is something of a mystery. The number and complexity of the proteins produced by the virus, and needed to exact such a complicated lifecycle, is completely disproportionate to the size of its genome. Small viruses like λ-phage need to keep their genomes very short in order to pack them into the small space inside the head. But how then could it produce so many different proteins? Evolution, as usually finds a way. One sequence of RNA can be re-used to produce more than one protein. For example, Phage Lambda overlaps some of its genes so that the start of one is half-way through another. By making the gene circular you can increase the effectiveness of overlap without losing opportunities at either end. And if that is not enough, Phage Lambda's last trick is reading the genome in the opposite direction to create completely new proteins from the same length of RNA.

[31]There are numerous resources that describe the life cycle of phage lambda in more or less detail. This description is based on “Lambda Phage” 2006. Another is the nicely animated slide show that can be found through Trun and Trempy, 2004.

I have recounted this story because it demonstrates, in an entirely grounded example, how easy it is to mistake evolutionary consequences for purposeful design, and because it illustrates that evolution is a random walk that will turn back on itself when conditions are favourable. Many viruses demonstrate an astounding simplification of life but one that can only come about when there are more complicated hosts available to take advantage of. Evolutionary processes push in all directions, but when you start along the left wall it is bound to appear as if all progress is directional.

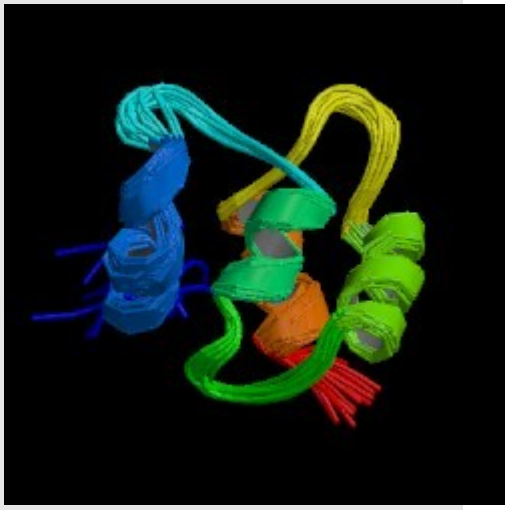
The Philosophy of Membranes

There is an important aspect of living processes that has significant consequences: the evolution of boundaries or membranes. Although Life's autocatalytic replicative processes may have emerged in some sort of prebiotic soup, the advantages of including an encapsulating membrane around these systems is enormous. Being within a skin of some sort is regarded as a characteristic of all living systems on this planet, although it is possible to argue that it is not a defining characteristic. The purpose of this boundary is to enable the precise control of the environment within, to the advantage of the replicating systems that it contains. The consequence is that with this encapsulated environment you can now escape from the prebiotic soup, effectively taking your own soup with you wherever you might choose to go. And life on this planet at least, has gotten everywhere. There are bacteria in virtually every environment on Earth regardless of how harsh they appear, from the depths of the ocean to the tops of mountains and from the Arctic to the burning desert. Every higher form of life is coated in bacteria and every crevice is filled with them.

Inside the primordial soup everything was effectively equal. The soup is filled with autocatalsying self-replicating polymers engaged in far-from-equilibrium reactions and consuming energy in order to pay their entropy debt. Reagents permeate the soup to be consumed by all. Location is irrelevant. But then, with the evolution of boundaries and escape from the soup come new problems and new dynamics. The soup “inside” needs to be regulated; letting some things through the membrane, keeping others out and dumping unwanted substances and energy back outside the boundary. And the outside needs to be navigated to find the energy needed to keep the inside going and later to find others in order to reproduce.

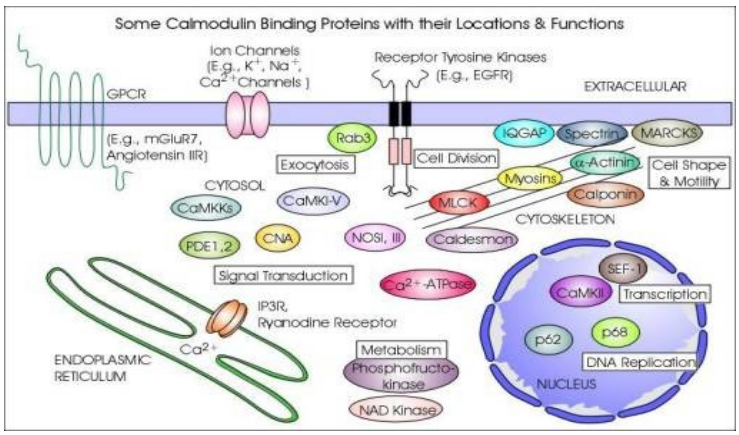
Therefore, the inside takes on a new ontological significance. It effectively provides a means of extension by becoming coordinated. Events that occur *on the outside* can be detected and responded to *from the inside*. An increase in certain chemicals needs to be recognised and channels opened or closed to regulate the level of those chemicals inside. The result is extension through the relaying of events from one place to another.

The Story of Calmodulin



Let me indulge with another plausible tale, this time about one particular molecule called Calmodulin – a protein that is involved in many biological processes. Calmodulin takes on 3 different forms depending on the number of calcium ions that bind to it : none, two or four. In these different forms it binds with a wide range of other proteins to control a wide variety of specific cellular processes. For example, Calmodulin bound to only 2 calcium ions will open calcium channels in the cell's membrane to allow calcium into the cell. Yet when bound with 4 ions, Calmodulin causes the same channels to close. The result is a control system that is attuned to the concentration of calcium in the external environment. When calcium levels drop the channels are opened to let more calcium in, until the level rises enough and the channels close.

Calmodulin can also control cellular motility. Without calcium, Calmodulin binds to proteins called myosins which themselves then bind with and slide along structural proteins called actins that make up the cells skeletal structure (cytoskeleton), enabling cellular movement. In the presence of calcium, calmodulin dissociates from the myosins, which stop sliding so that the cell stops moving[32]. The role of calmodulin is to enable different events within the cell in response to different levels of calcium outside. The number of different events enabled by this one molecule is large, ranging from the control of neurotransmitters, the operation of muscle cells, basic cellular division, and the control of heart muscle.



[32]See, Morris 2003 for full details of the regulation of myosin binding by calcium activation of calmodulin.

Calmodulin provides an example of how events in the abiotic thermodynamic world (the rise and fall of calcium concentrations) are translated and amplified into response events in the biological world. The ultimate cause of these calmodulin-mediated processes can be seen as the expression of genes, which is itself the central part of the process of self-replication. These biological events represent how life-processes respond to external events. In Physical Reality there is no concept of a *response*, there is just occurrence. In biological reality, living processes can respond to their environment, creating a new chain of causation. This response could be described as having three stages: *sensing*, *detection,* and *activity*. Sensing could be seen as the existence of processes that are sensitive to certain stimuli, which could be light waves, calcium ions, etc. Detection involves processes that are triggered by certain sensed events. These could be certain levels of certain wavelengths of light or particular concentrations of calcium etc. Activity are those processes that result from detection, with calmodulin providing a range of examples.

As a subjective reality, the Biological is qualitatively different from the Physical. In the Physical we were susceptible to every event that occurred at our single point of existence. In the biological, we can sense specific events or conditions that occur over an extended space, both within the cell and without, filtering out the rest of the events. Imagine the subjective physical experience as being overwhelmed by noise. Compare this to the precise vocabulary enabled by the biological. Calcium is picked out from the noise as a single expression that, combined with calmodulin, enables the articulation of a range of sentences. Biological reality is about selecting something from the noise of everything as a medium for enacting a response. It is inevitable that this selection results in backgrounding or ignoring the rest of reality as being, in a given context, irrelevant. Calcium is relevant to a range of biological responses, but is has also become relevant because it is there. Similarly light is central to a great many living responses both as a provider of energy and as a means of remote sensing, but teleologically we can see that it has become important because it is there: life can exist quite well without it.

A Brief Recapitulation

Looking across the Spacetime volume my attention was drawn to a pattern of events that stand out from the general thermodynamic expansion as markedly different. On closer examination I determine they are caused by novel processes that are operating far from the equilibrium around them. These processes are creating order against the tide of entropy, and dissipating energy to compensate. They have grown and spread from a simple localised spontaneity into persistent, mobile, evolving self replicating processes of increasing complexity. In doing so, these processes have created a new ontology: one in which there is sensing of events and responding to them. The noise of the physical world is filtered out to sense events that are relevant to these

processes and require a response. These living systems create extension by sensing events at one point and by relaying these events to cause response events at other points. They especially create a local extension through the division of space into a controlled inside bounded from a largely uncontrolled outside. They also create a temporal extension through their self-regulation and self-replication.

These ideas, describing what we imagine can be seen from an objective viewpoint outside Spacetime, may appear to be plausible explanations relating to molecular and cellular scale biological processes. But can they maintain this plausibility as we scale these processes up to the level of humans and their kind?

Scaling-up Biological Reality

Single cell organisms display a bounded event-detect-response ontology that is quite different from anything happening in the purely physical universe, but what happens as organisms become multicellular and more complex?

As multicellular organisms start to differentiate then individual cells specialise in certain event-detect-response processes, and have to evolve new event-detect-response processes to coordinate their activity with the rest of the organism. A simple example illustrates the point well enough. As a seedling grows up into a small plant the growing tips of the plant start to produce a chemical called Auxin, a plant hormone. This auxin inhibits the growth of cells and, as it diffuses away from the main growing tip, its influence decreases. The effect is that many young plants develop a pyramidal shape with the main growing tip repressing the side shoots immediately below it, but these side shoots become less and less repressed lower down. Pinch out the growing tip and the plant will respond by "bushing" out, the side shoots springing up as they are liberated from the effects of the auxin.

Differentiation and specialisation create more and more sophisticated internal event-chains and enable the multicellular collective to behave increasingly as a single organism. The evolution of the sexual function illustrates this well. Unicellular organisms have a claim on immortality: every cell dreams of becoming two cells – of continuing its genetic line forever. But in multi-cellular organisms, individual cells are required to sacrificing their immortality in favour of the organism as a whole. Efficient co-operation of organisms composed of millions of cells depends on these cells maintaining their genetic stability. In return, only a small few of the overall cell population get to fulfil their dream and create new organisms.

Ontologically the impact of simple multicellular organisms is not qualitatively different. The sense-detect-respond event chain is extended by new intermediate event-chains between different cells performing different functions. The overall boundary encapsulates the inter and

intra-cellular environment – the focus of order and control. The result is to offer a wider vocabulary of biological events and to achieve extension on a new multicellular scale. This scale can be appreciated as extending from the lichens growing on my roof tiles to the oak trees in the park opposite my office. But does it extend quite so easily through the domain of the animal?

Higher animals can be characterised through two features: they display much greater mobility than plants and therefore they qualitatively change the temporal aspects of reality; and they possess much greater sensing capabilities, both in terms of precision and responsiveness, which adds to the qualitative differences. The differentiation of animals cells is, therefore, not surprisingly much more profound: muscle cells forming muscles to power rapid responses, skeletal cells to form rigid structures that lever muscular responses, nerve cells to communicate events much more rapidly than by chemical diffusion, blood cells, blood vessels and heart cells to supply the much greater levels of energy needed to perform rapid movements, sensory cells to respond to light, sound, smell, and touch.

Yet the outcome is not profoundly different. The event-detect-response chain is much quicker, much more focused, and more sophisticated in the variety of events that can be detected, the ability to detect remote events, not just those in the immediate proximity. For example, the evolution of stereo sight is clearly directed by the need to find resources and avoid becoming someone else's resource, in an environment where speed of movement defines the range required and size of threat/food defines the resolution. The faster a predator can move the further away its prey needs to detect it. If running away is the main consideration then being able to judge distances is not as important as just detecting the threat. The rabbit sacrifices stereo vision in favour of all-round vision. If catching prey is the main consideration then the ability to judge range is paramount. The hawk trades field of view for ranging over long distances. If you need a bit of both then something in between will usually suffice.

These evolutionary trends have important teleonomic consequences: form and function evolve hand-in-hand to exploit the ever widening range of niches created by the drift away from the left wall. The way we perceive the world is not related to the way the world is, but instead is defined by the functional need to survive and replicate and the new opportunities created at each evolutionary iteration. It is still nothing more than the very same event-detect-respond chain that characterises molecular life, just operating on a different (but still related) spatio-temporal scale and with a much richer vocabulary. It is still a filtering out from the vast noise of the universe those events that matter, and what matters in this case is entirely defined by the process of survival and adaptation, which in turns defines the scale of events that need to be detected and the sensitivity of the sensors through which this detection is achieved.

Biological Reality and the Phenomenal Field

This seems an appropriate moment to break from this ontological conception and make some comparisons with related ideas. There is, for example, a thread of ideas permeating our notions of reality that is critical of the way we *conceptualise* reality while ignoring or even dismissing the way we actually *perceive* reality. One author who has done much to promote these ideas is Maurice Merleau-Ponty[33]. He articulates the notion of a Phenomenal Field; a pre-objective experience of the world as appearances[34], even an experience that is essentially embodied in the human body itself. This is an ontological claim that reality has to be more than just conceptual, textual, meaningful; it is also something we live with our bodies. Hubert Dreyfus provides a different approach to the problem. In considering the difficulties encountered by those attempting to create artificial intelligence, he points out that: "the meaningful objects ... among which we live are not a *model* of the world stored in our mind or brain, *they are the world itself*"[35].

It is implicit in the biological ontology above that life selectively filters events impinging on it and its environment to focus on those that are relevant to its "intentional arc"[36], and therefore form and function should evolve around efficient sense-detect-respond processes. However, that also means that while there is a subjective biological ontology defined within these processes, there are no particular grounds for claiming that any objective ontological position can be derived from them.

If Phenomenology has been here before, does it indicate how I might move from the biological to the social? It seems to consider the emergence of something called consciousness, and that our perceptions of reality are in some way derived from our being conscious. I have concerns with this assumption for several reasons. Not least because it has been a rock upon which many ships have sunk since the Sceptics first starting navigating these waters[37]. And because of its individualistic focus: that our understanding of what distinguishes us from the rest of the living world can be reduced to "consciousness". And finally, in the spirit of this minimalist enquiry, is this an assumption that I need to make? Isn't it entirely possible that other animals are just as conscious of the world around them as we are? I often wonder about my cats, for instance, but more seriously I have to accept that Dolphins and Whales seem to possess a fair chance of being

[33]See Flynn 2004 for details on Merleau-Ponty's life and works.

[34]See, Dreyfus, 1964.

[35]Dreyfus 2006, p44. quoting his own work.

[36]To borrow a phrase from Merleau-Ponty, see, for example, Dreyfus 2002.

[37]See chapter 4 for more details on 16th Century scepticism.

conscious and yet have not demonstrated any tendency to support that third pattern in Spacetime: the social.

So, my decision is to continue along the lines I have already traced with the biological and then return to the issue of consciousness and phenomenology once I have something more defined to compare it against.

6 The Emergence of Social Processes

I have accounted for the primary patterning of Spacetime through the physical processes and provided a physically based objective and subjective ontology. I have also accounted for that small volume in which I thought I could discern a new patterning through the development of a biologically mediated objective and subjective ontology. Now I need to address that smaller volume within that seems itself to defy both the physical and the biological.

I found it helpful to begin my exploration of The Biological by considering its emergence from The Physical, so it seems suitable to repeat the approach in order to start exploring The Social. Returning once more to my objective viewpoint looking over the entirety of Spacetime, is there anything I can glean from here that may give me a clue as to its nature? It is very difficult to conceptualise out here without breaking my own rules, but again I think I can discern something in the patterning around the start of this third, inner volume that might provide me with some form of traction. Its not much, but then its not meant to be much in my forced impoverished perspective.

The biological process is fundamentally situated within the biochemical, in that all forms of biological events or actions can be seen to be driven by biochemical reactions. Even the movement of a mammal through space, its capture and killing of another animal and its consumption of that animal are all processes involving biochemical reactions. It seems therefore possible to say that from this distant objective viewpoint, the fundamental drive force of The Biological can be seen as molecular level interactions: those far-from-equilibrium dissipative processes. In among these processes there are some that cause gross changes to the materiality of the world at a larger scale: the building of birds' nests and beavers' damns, the rising-up of termite mounds. But these material changes are, nevertheless, still biologically and only biologically mediated: they depend solely on the availability of raw materials and biological agents. They are could be seen as technological but only as single leaves on the end of biological branches. But then again, hidden amongst these technobiological processes are a few that appear to show a dependence on some other, pre-existing technology as well as raw materials: some form of “tooling”. And then, in one species in one very limited period of time these few technobiological processes seem to achieve an autonomy from their biological

constraints and burgeon up into a whole new pattern of events for which there is no direct biological encoding. It is this period, this emerging process that should suggest what is fundamentally different about the Social and yet also show how it has come to develop from the biological.

Of Tools and Artefacts

One thing that seems to distinguish the emergence of The Social from the purely biological is the development of what could be called *artefacts*, or perhaps more generally, technology. Consider just a simple example such as flint tools. There is plentiful evidence that some species of hominids pre-dating our own started to craft tools from flint probably more than 2,500,000 years ago[38]. With time, the process of working flint developed and the quality of the resulting tools improved until, by the late stone age, they had become more than just tools, being prize possessions with a beautiful finish. But tool-use is not unique to hominids and so it seems necessary to understand how other animals use tools in order to better understand their relevance to the emergence of social processes.

Illustration 2: Betty, a clever crow at Oxford University

Clever Crows and Tool Skills

Corvus moneduloides, the New Caledonian Crow, fashions various tools from the edges of certain types of leaves, from sticks and other sources, using them to hook food out from holes and crevices[39]. It shares a surprising range of skills with Humans and Chimpanzees including frequent use of different types of tools, making their tools, selecting the right tool for different tasks, and making new designs when needed[40]. Considerable research interest has been shown in *Corvus moneduloides* not just because of its unique tool-using skills, but also because of the potential it offers for better understanding of how tool-usage may have developed in Hominids[41]. Tests carried out on captive bred and isolated young crows suggests that this tool use is probably genetic. However, none of these captive birds were able to fashion the tools in

[38]Semaw, 2000 provides a useful summary of the early development of human tools and has proposed that the earliest evidence dates from over 2.5 million years ago.

[39]See Hunt, 2000 and Hunt and Gray 2004 for further details of the tools made and used by *Corvus moneduloides*.

[40]Oxford University Behavioural Ecology Research Group 2007

[41]Hunt, 2000.

the way that wild birds could[42], suggesting that this genetic disposition is further developed through learned skills. In another experiment, when presented with novel materials in the form of flexible wire, one crow (called Betty) showed the ability to innovate by bending the wire as required to complete certain tasks[43]. Further tests along similar lines and with entirely novel materials re-inforced these results, strongly suggesting that these crows are capable of limited problem solving without an extended period of trial and error[44]. This ability has never been recorded in any other non-human animal, including chimpanzees[45]. This is partly why *Corvus moneduloides* has attracting attention with respect to human tool-use. Interestingly, in the tests carried out at Oxford University the male crow has shown no skill in creating tools, preferring to wait until Betty has retrieved the food before taking it from her!

We might consider a model of human tool-making based on *Corvus moneduloides* that involves a genetic pre-disposition to tool creation and tool use, a strong tendency to experiment, a plentiful supply of suitable materials, including finished products, and some level of problem solving that enables both humans and crows to conceptualise the problem and select or devise an appropriate solution. One piece of evidence that suggests a common neurological capability between humans and crows is handedness. It is believed that humans show a predominance of right-handedness in using tools because of the role of the left hemisphere of the brain in controlling sequential, purposeful behaviours[46]. Chimpanzees show consistent laterality in individuals but with no discernible species level bias to the right of left. New Caledonian Crows, share the same pattern of laterality with Chimps when using tools[47] but also show a more consistent species level lateralisation for creating tools in the wild along the edges of leaves[48].

Illustration 3: Betty using her own wire hook to retrieve food

[42]Kenward et. al. 2005.

[43]Betty, the crow who first showed the ability to create hooks with wire, originated in the wild but currently resides at Oxford University and has yet to achieve publication. She can be seen working on various movies that can be downloaded from the University's Behavioural Ecology Research Group's website: http://users.ox.ac.uk/~kgroup/index.html.

[44]See, for example, Weir et. al. 2002 and Weir et. al. 2006.

[45]As above.

[46]See Hunt, 2000 who quotes Corballis, M. C. 1991 *The lopsided Ape*.

[47]Weir et. al. 2006

[48]Hunt, 2000.

Clearly there is no biological connection between *Corvus moneduloides* and *Homo sapiens* and Crows have not, as yet at least, shown anything that might suggest a biologically independent social process, so is there really anything to be learned from them? Surely their lack of any language capabilities must make the whole comparison meaningless? Perhaps, but then that overlooks one very important fact that has been established about the evolution of Hominids: that tool use pre-dates language development by a considerable period. A better understanding of the emergence of social processes may be achieved by setting aside the issue of language until after the role of artefacts has been appreciated.

From Crows to Humans?

Perhaps the difference between pre-language humans and crows is not all that profound. Humans certainly have a major biomechanical advantage in having an opposed thumb and strong binocular vision, making it possible to carry out a much wider range of operations on various materials and to show a greater degree of fine control. When directed into a technology such as the flint axe or arrow-head, any biological advantages conferred by a technology are bound to be quickly selected. The result would be a predictable genetic drift towards effective tool-making and tool-using skills. In other words the main difference between crow tool use and early hominid tool use could be no more than this: a technical advantage. There is no need to add anything else to this explanation, such as consciousness or intentionality, or indeed any of the more "mystical" or "romantic" ingredients that have been postulated as distinguishing *Homo sapiens* from the rest of the animal kingdom.

Tool Skills in Primates

Tool usage in the Great Apes is best illustrated by some of the behaviours of the Chimpanzee *Pan troglodytes*. Certain groups of chimpanzees (but not all) use stones to crack open particularly hard nuts[49], a large one, in the role of an anvil and a smaller one used as a hammer. These stones are relatively hard to come by and are therefore used over and over again. It appears to take some time to master these techniques, but there is no compelling evidence to indicate that mothers actively teach their offspring how. Another instance of tool use is fishing for insects with sticks. These sticks appear to be prepared and sharpened for the task. Once they become blunt they may be discarded by some while being re-sharpened and re-used by others[50].

The creation of tools fits one of two models: the trial-and-error model and the rules model[51]. Chimpanzees appear to fit the trial and error model because there is little evidence that they make their tools according to specific rules. For example, they often use a stick tool first before

[49]Byrne, 2003 and Arbib, 2005

[50]Byrne, 2003.

[51]See Hunt 2000 for further details and references.

shaping it. The rules model involves the making of tools to certain rules rather than by trial and error. It is thought to imply a more abstract level of thinking: the ability to conceive of the outcome in some way beforehand and then to apply certain techniques (processes or procedures) to achieve that outcome. Apart from crows (see above), the only species thought to apply to the rules model is *H. sapiens*, although the same is probably true for all species of *Homo* and some of its immediate ancestors. However, evidence of how Gorilla' process certain foodstuffs suggests a link from a more immediate trial and error approach to the more sophisticated rules approach.

One of the Mountain Gorillas' (*Gorilla beringei*) favourite foods is the nettle[52]. Unfortunately for the Gorilla, these are very difficult to eat, being covered in nasty stinging hairs, but the nutritional reward has obviously been enough to promote the animal into developing safe techniques for doing so. Adult gorillas display a relatively complex 5-stage process for gathering and eating the leaves that includes the use of both hands to gather enough stems, the bunching of leaves and removal of stems and the final folding of leaves to avoid stinging the mouth. The exact process used varies between different populations of gorillas, but the basic sequence of stages remains the same and is usually copied by young gorillas after about 3 or 4 years of watching their mother in action.

These gorillas are believed not to be engaged in a rules-based process nor to have any understanding of the intentions of their actions in any abstract sense. A plausible and simpler explanation involved their learning about individual elements of the process (through repeatedly watching their mothers) and then learning to string these elements into sequences that yield the desired result (hunger sated)[53]. Thus it becomes possible to see how manual/mechanistic processes can be learned in such a way to give the impression of there being abstract intentions. Similar processes could have easily led to early stone technology where the hominid's opposed thumbs are better adapted to task of manipulating small objects.

[52]Byrne 2003

[53]Byrne 2003

Tool Skills in Homonids

For well over 2 million years, these technical advantages were sufficient to enable us to achieve what we did. As long as 2.5Ma[54] early pre-hominids (Australopithecus) were breaking stones up to create a variety of basic tools, primarily different forms of "chopper"[55]. This activity appears to have been localised to East Africa. For perhaps 1 million years (2.5Ma to 1.5Ma) it appears that this "simple" technology continued with little development. Currently experts use the term "Oldowan" to describe the type of tools that typified this period and therefore to describe the period itself. But this does not mean we can assume their findings to be concrete fact. To illustrate the fragility of any assumptions based on the broken stones and flakes that mark the Oldowan, in the early 1990's these experts changed their view from believing that the large broken stones were the main tools and the flakes a waste product to the opposite view that the flakes were the primary target and the broken stones were waste!

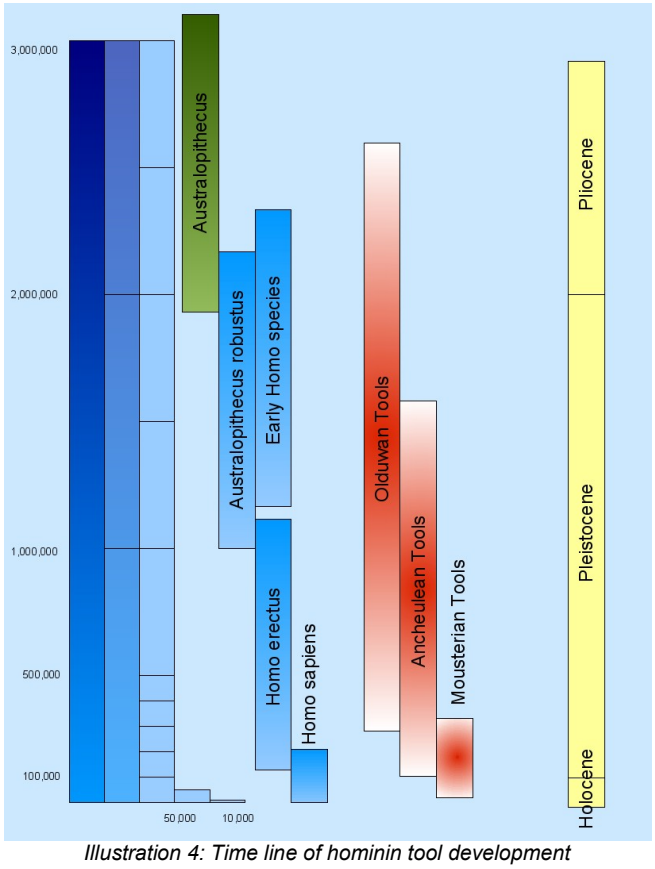


Illustration 4: Time line of hominin tool development

Stone technology changed about 1.5Ma with the appearance of different, more sophisticated tool forms. Although termed "the Acheulian", to distinguish it from the earlier, simpler Oldowan, this was not perhaps as dramatic a change as is suggested by the appearance of a "New Era". Later Oldowan tools now appear to be intermediate between "Oldowan" and Acheulian, suggesting a gradual development of stone technologies and techniques from one form to the nextrather than a revolutionary change[56].

[54]Ma is widely used to mean Million years ago – avoiding the somewhat western-christian conception of BC/AD.
[55]Semaw 2000 and de la Torre et. al. 2003
[56]De la Torre, et. al. 2003

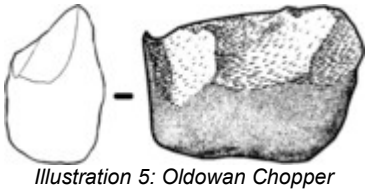


Illustration 5: Oldowan Chopper

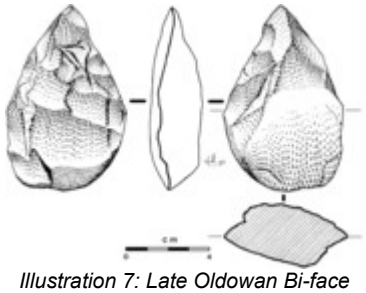


Illustration 7: Late Oldowan Bi-face tool

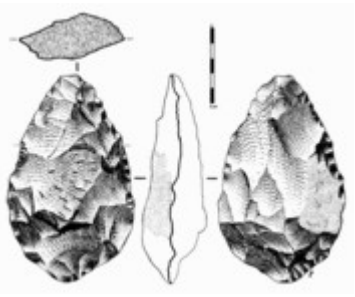


Illustration 6: Acheulian Tool

By the time the first members of the genus *Homo* were walking on this planet, stone tool making had been around for some 1.5 million years and was already in the second stage of its development. That species of hominids were evolving at a similar rate to which stone technology was developing is a good suggestion that the two must have been closely linked.

Around 100-300Ka ago there were further developments in stone tool technology, with what Archaeologists call the Mousterian period , after the location where they were first characterised, or somewhat more simply Mode 3[57]. These tools appear to be similar to Acheulian but generally show a finer degree of craftsmanship. They have been associated with *Homo neanderthalensis* in particular and have been merited with freeing the teeth and jaws from the need to be robust and strong in order to process food, being one of the main differences between *H. neanderthalensis* and *H.* sapiens. This conclusion has to be speculative and does not appear to be compatible with the current concept that *H. sapiens*

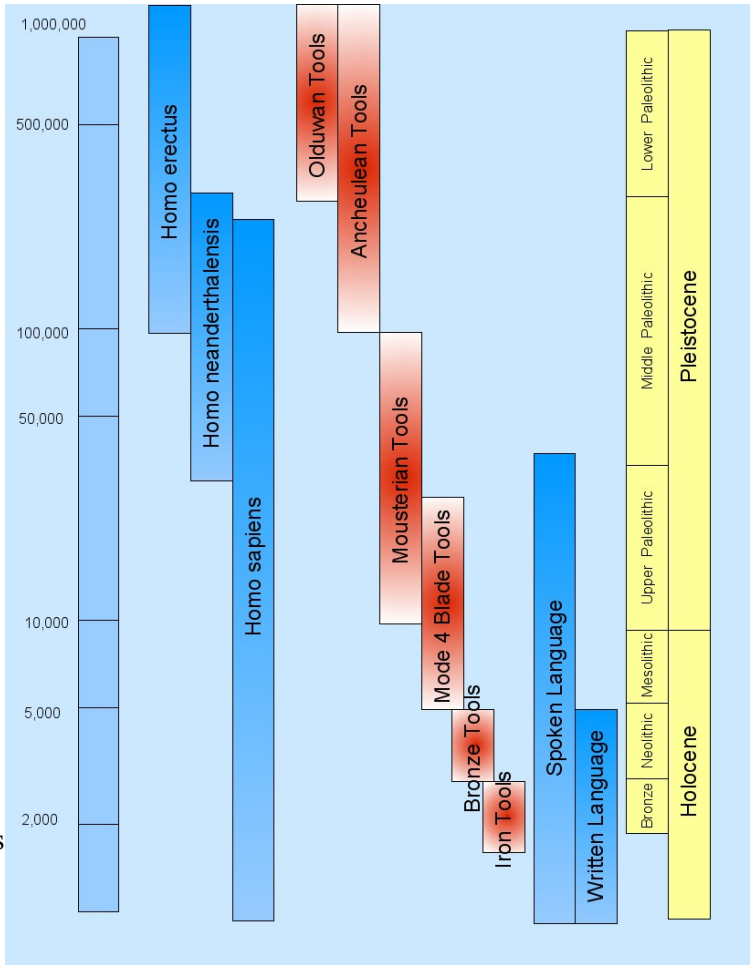


Illustration 8: Timeline for the last 1 Million years

[57]The terms Oldowan and Acheulian are widely used while Mousterian is less so. There is another, simpler typology consisting of modes 1 – 4, where Oldowan is 1 and Mousterian is 3. Mode 3 is often used instead of Mousterian and mode 4 does not appear to have a name as such.

and *H. neanderthalensis* evolved from the same ancestor (*H. Heidelbergensis*) and therefore any evolutionary pressure on *H. neaderthalensis* would not effect the evolution of *H. sapiens*. It is, however, illustrative of the variety of theories and views that characterise our understanding of early human history[58]

Despite the differences in opinion, all experts in human history would probably agree with certain over all themes. First, that technological evolution, in the form of gradually changing and improving artefacts has been occuring in hominids for the last 2.5Ma, long before the appearance of language. They would also probably agree that through-out this period, technology and biology advanced together in a positive feedback loop: biological changes that supported better tool making and usage would be selected through the advantages conferred by better tools. Finally, the inevitable conclusion that has to be drawn is that >98% of the technological history of hominids involves stone tools only and pre-dates language. Of the remaining 2%, just 0.08% accounts for the last 2 thousand years and 0.008% relates to what might be called "industrial" or modern human history. If nothing else, this supports a compelling need to understand what might have been happening in the 98% of technological history that led up to what Stringer refers to as the evolutionary package of modern morphological and behavioural features:

> *"This package included...a mental eminence...the presence of blade tools, symbolism, and (inferred) complex language"*[59]

Development of Early Stone Technologies

Early (Oldowan, see above) stone tools are relatively simple, having been created through breaking a hard stone (typically flint) by striking it with another stone (or hammerstone) so that it breaks in two. The result is a piece of stone where one or more sides provide a sharp scrapping or chopping edge depending on the thickness of the stone and the straightness of the edge. Chopping stones appear to have been used to assist in processing the meat of a killed carcass, offering the advantage to their users of being able to kill and consume fresh carcasses rather than fighting with the numerous carrion species to obtain foodstuffs from left over carcasses. Scrappers could have been used to a number of processes, including scrapping meat and other materials from skins.

As stone technology developed, techniques must have progressed from simply striking stones to form two halves, to more precise shaping so that, for example, chopping edges could be more readily and accurately made. This appears to have involved further striking of the stone to shape it and then the innovation of striking it with softer implements, such as bone, antler or wood.

[58]See Stringer 2002 for a general synopsis

[59]Stringer, 2002 p. 564.

With these techniques it was possible to make sharper choppers and for choppers to start to acquire a more characteristic shape. Perhaps the best example is the hand axe.

It is perhaps at this stage that the process becomes more like the rules model rather than being trial and error. These rules are easier to understand if they are not regarded as purely abstract, but rather encoded into the technology of production: the use of a good hammerstone that consistently breaks stones into desired cores, the retention of certain bones that are good for chipping smaller fragments from these cores to shape them, and perhaps most useful of all, real axes to be used as models to show the flint-worker what the desired outcome should look like. Is this really that far removed from the Gorillas' preparation of nettle leaves?

There was another innovation in stone working: the technique of pressing the thinner edges of the core stone with pointed wooden sticks to fracture flakes of flint away from the opposite side. This technique enabled much finer control over the shaping of the tool, and with it much greater consistency in the production of small items such as spear and arrow heads. The rules have become more complex, but they are still encoded in the tools of production, observable techniques, and existing templates[60].

The advantages of each innovation must have been substantial and the skills involved in manufacture highly valued. As an indication of this value there are many examples of very fine stone weapons that could never have been used in earnest because they are too fragile. The most plausible conclusion has to be that they became valued in their own right: as pieces of art to be collected and owned by people.

The Emergence of a Technological Process

Is there a point in this early emergence of tool making when the technological becomes autonomous from the genetic? There is a convincing and plausible explanation for the two developing hand-in-hand, with genetic adaptations that favour technical abilities being selected through the advantages they confer. If the rules that govern tool production are gradually encoded in the technology of tool production, rather than genetically encoded in the biology of tool production, then clearly the balance between biological and technological is tipping away from one towards the other. But at what point could the latter be said to have achieved autonomy?

You may recall that one of the key attributes of living processes was the property of autocatalysis? It is plausible to consider the technology of tool production to be a form of catalyst. In the case of the templates used to guide the production of replicas, it could be argued that they are even autocatalytic. Without language or any means of symbolism, any examples of

[60]This account of flint knapping is based on the website at: http://donsmaps.com/makingflinttools.html

a finished tool would be involved in the spread of that tool through the community. But is this enough to claim autonomy? I think the answer is yes, but only to a limited extent. Yes, because with the building block skills and tools and a plentiful supply of raw material, the appearance of a new form of shaped tool and some understanding of how it is intended to be used could be sufficient for the production of replicas. In other words, a wandering tribe with an innovative technology would spread that technology through the communities they meet without the need for any biological adaptation. However, the question that this does not answer is how did they achieve an innovative technology in the first place?

Random changes might lead to innovations in technology just as they do in biology, although genetic change is nevertheless directed to some extent. However, random change is not an adequate explanation of how technology developed at a much faster rate than biology. And it does not seem to provide the means for some of the great developmental steps in technological history, such as how we progressed from stone to metal technology. While technological processes might have the means to achieve autonomy, they do not provide the means of achieving variety that would be essential for technological progress. What is needed for that is some means of being able to conceptualise technology and its use so that variety can be generated much more easily and then tested through changing the process of technology. And the means of conceptualising variety would seem to be best served by the emergence of Language, the enabler of conceptualisation.

The Evolution of Language

Understanding how language evolved will always be contentious because there is no solid evidence to support any of the various (and therefore speculative) theories that have been proposed. These theories can be divided into two basic groups: those that broadly follow the *continuity hypothesis* and those that follow the *discontinuity hypothesis*[61].

The continuity hypothesis is based on the assumption that the capacity for language effectively evolved through the hominid line[62] as a gradual development from non-humans to humans. It is implicit in this theory that speech and language are not qualitatively different across this progression, and that therefore language is not something necessarily unique to *Homo sapiens*. By contrast, the discontinuity hypothesis assumes that language is unique to humans and that there is no connection back to pre-human communication systems. The latter is more driven by linguistic theory than evolutionary anthropology. In order to find evidence to support their theories, supporters of the continuity hypothesis tend to study existing pre-hominid species and infant human behaviours.

[61] See Falk 2004 for a summary.
[62] Falk 2004

I feel bound to explore these continuity based explanations if only because I am looking to describe how The Social *emerged* and therefore I would naturally favour an emergence theory. I should confess that as a trained biologist I am far more inclined to believe these explanations and discount the alternatives as not addressing a central issue: that speech – the underlying technology of language, is biologically mediated and must therefore have arisen through a process of evolutionary selection. Perhaps I ought to explore this choice in more detail, but then I believe that any such exploration would require me to second guess the outcome of my own hypothesis. Instead I can look forward to defending my decision in the light of this hypothesis later in my story. In the meantime I would throw just one consideration in as support: that The Social, being something that apparently has emerged from the behaviours of the biological processes we associate with *Homo sapiens* is therefore bound to be inscribed *within* the biological. It is my contention that to assume that the social somehow *transcends* the biological is a misnomer.

Continuity Theories of Language Emergence

Of the many theories of speech development within the continuity camp there are two contemporary ideas that I would like to consider as offering plausible explanations. I shall refer to the first of these as the *Mirror Theory* and the second as the *Motherese Theory*. They share a number of key assumptions, and although they appear to provide alternatives, they may both be valid to a degree without contradicting each other.

The Mirror Theory is based on the observation that monkeys and humans alike show a very striking type of neurological behaviour. When a monkey or human observes another grasping an object, there is certain neural activity in a specific zone of the brain that also occurs when the monkey sees the same graspable object and when the monkey actually grasps the object[63]. This supports a theory that monkeys and humans show a predilection to "mirror" observed behaviours as part of their own system of learning. Specifically, this learning relates to complex manual and bimanual activities. On seeing either the objects to be handled or another handling these objects there is a compulsion to mimic the actions suggested or involved.

Proponents of the Mirror Theory point out that in Humans these mirror neurons are located in the same area of the brain as is involved in speech: Broca's area[64]. They hypothesize that mirroring and imitation are central functions in developing a "language-ready brain"[65]:

[63] Arbib 2005

[64] See Rizzolatti and Arbib 1998 and Arbib 2005, page 106.

[65] Arbib 2005, page 105

> *"that such an observation/execution matching system provides a necessary bridge from 'doing' to 'communicating',as the link between actor and observer becomes a link between the sender and the receiver of each message."*[66]

Some of these theorists go further in proposing that the link between the grasping zone and the language zone was achieved through a manual signing stage that in time led to protospeech and finally language itself[67].

One of the stages of this progression, from basic mirroring to language, is imitation. Arbib defines imitation as being different from mirroring because it involves the understanding of a goal[68]. Interestingly, this crucial stage of development is common to both *Homo sapiens* and other primates, including Chimpanzees and Gorillas. Earlier I discussed how young gorillas learn the tricky process of eating stinging nettles through careful observation and imitation long before they care to tackle the problem for real[69]. They appear to achieve this learning by observing their mothers behaviour and breaking this behaviour into strings of increasingly familiar actions: a process called behaviour parsing. In *Homo sapiens*, behaviour parsing develops into complex imitation, which involves being able to creating increasingly novel processes by stringing together more or less familiar unit actions in order to achieve more sophisticated goals.

For Arbib, the way to language is now virtually prepared. Complex imitation leads to pantomime. The need to disambiguate mimed sequences is resolved by the introduction of conventional forms, which in turn becomes protosign as conventionalised gestures. The foundations for language have been developed: behaviour parsing provides grammatical sequencing and protosign a vocabulary. By replacing signed gestures with voiced gestures we move from protosign to protospeech, and by fragmenting and disambiguating these voiced gestures we move from protospeech to language proper.

The Motherese theory has something in common with the Mirror theory, being focused on the vocalisations between mother and child and therefore, to some extent at least, concerned with skill acquisition[70]. Unlike the Mirror Theory, Motherese uses pre-linguistic vocalisations between mother and child as the stepping stone to language, showing how contemporary human

[66]Rizzolatti and Arbib 1998, page 188.

[67]This is the theory set out in Arbib's Target Article (2005), whose peer-reviews clearly demonstrate the breadth of opinion both for and against it (pages 125 - 149)

[68]Arbib (2005) refers to the idea of intentionality but other authors (e.g. Byrne (2003)) do not believe that imitation necessarily involves intentionality as such. Perhaps in response to these concerns, Arbib divides imination into simple and complex where the former is shared with the Great Apes and the latter is unique to *Homo sapiens.*

[69]Byrne 2003

[70]See Falk, 2004, page 494 where the author refers to mother Chimps teaching their babies to use stones to crack open nuts. The same group of animals is also refered to by Arbib (2005) on page 114 where he explores the concept of imitation.

vocalisations gradually develop from the melodic and somewhat meaningless "infant directed" sounds to gradually more meaningful "adult directed" speech, in some ways perhaps reflecting the move from protospeech to language.

It does not seem necessary to support one theory against the other, if only because both seem to have something to offer without precluding the other. The nub of each theory may be to identify the exact sequence of enablers leading to language, but as more general drivers of language it seems possible to embrace the idea that both motherese and mirror theories have something to contribute. Perhaps it would help to re-scope each theory into more general terms. The mirror theory strongly suggests a link between the facility of language and the skilful manipulation of objects by hand. Learning to carry out a sequence of manual operations involves behavioural parsing and imitation. The earliest hominid flint knappers had to learn such behaviours, as did those who wielded the tools that they produced. It is possible to conjecture that some sort of vocalisation, similar perhaps to chanting, would assist such processes both by prompting the correct sequencing of actions and by providing a rhythm for repetitive instantiations. The motherese theory identifies the key role of the mother-infant relationship. Vocalisations that establish an emotional unity between mother and infant are common to primates and humans. Vocalisations that involve teaching infants complex sequences must occur in the context of these emotional communications: perhaps they provided a pre-existing means to an emerging end.

However it came about, the biological benefits of being able to "teach" others through a sequence of gestures and/or sounds that correspond to the actions required must have been enormous. What clearly marks the evolutionary history of the Hominids is the sudden change in the rate of development that occurred with the arrival of language. Prior to that, technological evolution could be roughly defined as linear: the gradual movement from Oldowan to Acheulian etc. With language the rate of development seems to become more exponential.

7 Language, Technology and Autocatalysis

The story so far concerns the gradual evolution of primate motor skills focused around the physical manipulation of tools and materials: technology. Something as simple as the opposed thumb is sufficient to account for Hominid advancement around 2.5Ma. What happened next is highly debatable but there seems to be significant evidence to point towards the emergence of a rule-based process in which pre-existing tools and templates provide the constraints and the moments of variation. In other words, the technology of production acts as a catalyst ensuring that the process of manufacture is guided by the properties of this technology and the operations that it can perform. Further more, the existence of a template suggests that this process is also

autocatalytic. Without such a template, each act of production has to effectively rediscover the secrets of success, with a good possibility that many attempts will fail to do so. With the template success if much easier to reproduce.

But there is a limitation, and one that is strongly suggested by the relatively slow rate of stone tool evolution: the source of creativity or variation is significantly constrained. The parameters through which variety may be achieved are limited to varying the tools of production, the techniques, and the form of the result. In other words, you can hit it with something different, you can hit it in a different way, and you can keep hitting it until it looks like something different. But what you cannot do is conceive of something entirely unexpected, other than by pure chance.

Spears can be made by cutting down branches of trees, trimming off any side shoots and cutting a point, all probably done with a stone axe. Hardening the point with fire could have been discovered when tending a fire or roasting meat on a fire, which was preserved and transported from natural fires for a long time before ways of starting fires directly were discovered. But hafting a flint head onto a spear is a comparatively recent innovation, most probably since the emergence of language. It requires the ability to conceive of something novel out of the two separate objects: the wooden spear and the flint cutting tool, which would seem to be a language depend technique.

I seems possible to postulate that the real significance of language lies primarily in its separateness from action. If the scaffolding for language evolved through manual operations, and through the need to teach/learn such operations, then pre-linguistic utterings would quite probably have been inseparable from the actions they represented. Pantomime and protosign are both movements that separate meaning from action, while still being largely based on mimicking or symbolising those actions in some way. What distinguishes language in this evolutionary progression is its complete separateness: it can be used without having to be related to action at all. In pre-language any correspondence would be direct and implicit. In language the correspondence between sound and action becomes abstract, and no longer needs to be direct. In language, the sounds, the words take on a meaning of their own, albeit still with the intention of representing what had previously been implicit.

What is crucial to the technical development of hominids is the ability that this decoupling creates for injecting creativity into the process. As soon as words become freed from their direct relationship to actions, they can begin achieve three novel outcomes. First, they can come to represent more than just the specific actions they probably originated from: they can become generalised. Second they can be used to represent outcomes and intentions that were previously

inarticulable. And third they can be recombined to represent novel outcomes or novel means, and therefore to direct actions towards achieving these means. In other words, language provides an important means of injecting creativity or variety into the autocatalytic process of technology production and use. It may also be considered to be an autocatalytic process in its own right: once you have words, you can keep on reproducing them and evolving them with new words and endless new meanings – even when there is no real-world basis for such meanings.

On this basis The Social could be postulated as the product of a three-fold nesting of autocatalytic processes:

1. The biological, which eventually through the process of genetic replication and variation enables precise interactions between the biological and the technical and provides the physical media of language: speech, hearing, writing, and reading;
2. The technical, which involves the production of technology using pre-existing tools, templates and techniques; and
3. The lingual, which involves the representation of technology its intentions and outcomes, but more crucially perhaps, introduced the possibility of new outcomes and new technologies that had no existence in the previous two processes.

Perhaps it would be better to conceive of the relationship between technology and language as being more interdependent than this: a sort of mutual catalysis rather than two separate autocatalytic processes. This serves to remind us that the effective source of creativity in technology comes from language and that language itself is a form of technology, as well as depending on the world of technology as the foundations of further creativity. One final refinement (at this early stage at least): the third process would be better expressed as being The Symbolic rather than The Lingual. That way it can account for all forms of representation including drawings, pictures, images, films, and even perhaps music and other symbolic sounds.

8 A Subjective Social Ontology

This three-layered ontological model is offered essentially as a plausible explanation of the third type of observable pattern in Spacetime seen from without. It seems necessary therefore to follow the process developed in considering the first two patterns, the Physical and the Biological, to re-position my observation point from this impossible perspective to being within Spacetime. In the case of the Physical, this subjective reality was nothing more than the succession of events occurring at a single point in space seen through time, with no concept of extension, distance etc. In the case of the Biological, I argued that biology effectively provided

extension through Spacetime by creating boundaries around controlled inner environments, such that events on or nears these boundaries could be communicated across these inner environments. I also argued that higher level organisms showed how this extension could be enhanced through the development of highly focused senses and through the evolution of animal forms able to interact in diverse ways with the physical universe at a particular scale.

What are the implications of this third processual form on a subjective viewpoint?

Technology as a means of physical extension

The biological achieves extension through the biochemistry of the cell and, through upwards integration, the biophysics of the body. In particular, the development of sensory organs allows us to focus in on very particular (and usefully interesting) remote events and to locate these events in Spacetime, while the development of our bodies (bones, muscles, physical extension) gives us the necessary physical strength to interact with the world around us. It could, therefore, be said that one of the roles of social technology is to extend these abilities. As technological processes first emerged they would have conferred advantages by primarily levering biophysical abilities: the strength of the hand held stone scrapper compared to human teeth or a weapon made from a thigh bone compared to the human fist. Much later in the history of these developments we discovered a range of technologies that could extend our very perceptions of the world: Hooke's microscope and Galileo's telescope for example. With these technologies, we discovered that the universe was not as it had seemed with our unaided senses, but was in fact much bigger and much more complex. From these new perspectives we also developed physical technology that could enable us to manipulate this more complex world to achieve greater precision and increased accuracy. These in turn enabled the development of more accurate and more powerful means of sensing this world, feeding a cycle of evolution that has been constantly progressing. It is possible, perhaps, to conjecture that the development of science has been driven by the development of "instrumentation", being the technology of sensing, progressing always towards higher resolution, greater accuracy and wider spectral coverage. In other words, whereas biological extension filtered out much of the energy impinging on that raw physical point in Spacetime, social technology has been focused on re-discovery.

Physical extension in space is not the only means by which technological processes have affected the subjective perspective. Technology also provides extension through time that could best be defined as durability. In creating technology we endow it with the potential to perform a variety of processes. Once created this potential becomes enduring – the technology becomes a catalyst for these potentiated processes. Durability is a form of temporal replication: it provides

the means to replicate process instantiations without having to re-discover or recreate the apparatus each time. This durability can also be replicated in space: others can also access its potential without having to learn the process of its creation. This is perhaps more significant than it seems at first? Is it not the means by which the collective becomes capable of doing more than any of its individuals can on their own? Durability means that any one individual can share in the potential of any other individual through the exchange of technology. Which in turn leads to another important aspect of technology: that of mobility. Because technology is durable then, where it is also portable it is mobile and can therefore progress through a community at a much faster rate than would otherwise be possible. The more an individual engages with mobile technological processes the more extensive those processes become, creating a wider involvement for that individual. As direct physical contact plays a lesser role in an individual's perception of the wider world, the importance of this mobility increases. Mobility becomes a criteria of success: less mobile or immobile social processes having less influence or impact on the subjective world. For examples think of music, movies, advertising, brands and the affect of these highly mobile technologies on any individual compared to the very localised events from which they may have originated.

Language as a means of extension

Language is technological, and is therefore subject to much of the above regarding durability and mobility. Indeed, language's durability and mobility could be considered to be critical to its success. If written or remembered words were not durable then the associations that they represent would be lost between every utterance. It is the ability to repeatedly associate the word “tiger” with the creature that it represents and the dangers of this creature that provides the word with a certain utility. That we can then share this word through its mobility with others means we can share this utility when perhaps it matters most. However, the course of events implied by these particular statements are no different from the alarm calls used by our primate cousins to achieve the same ends. But because language is effectively detached from the direct world of experience we can “think” with it, we can play with it and imagine things in ways other than how they are, and share these imaginings. “Next time we see a Tiger, rather than all of us panicking and running away, perhaps we should...” Which points to a way in which language extends our subjective experience in an entirely new way: it creates a past and a future.

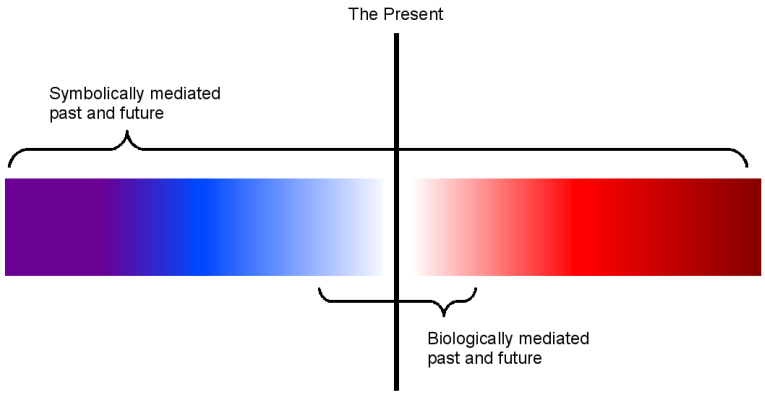
Could I recall the past without language? Perhaps, but equally I suspect it would be better to regard this as “reliving” the past than being able to “recall” it. Could I think about the future without language? Perhaps again, but would this be anything more than responding to or feeling an intention: like feeling hungry predicts future eating? What language does provide is a means

of capturing the past and projecting the future such that we can a) reflect on what we have experienced and b) plan for a different experience in the future (or repeating a pleasant experience perhaps). It does it quite imperfectly, which in some ways is very fortunate but in others not so. If History (by which I mean the narratives we tell each other about what has happened) was accurate[71] it would also be tremendously verbose, having to describe everything in sufficient detail for it to be precise and unambiguous. That it is not adequate means that it can also be relatively brief. Even the most thorough historical descriptions should be judged as brief compared to the huge realm of possible description that could be provided for any past event. The downside is that as well as being brief it is always inaccurate and often so inaccurate as to hold no relationship to whatever actually comprised the events to which it refers. It also suffers from ambiguity, which stems from what Literary Theorists call its "metaphoricity", meaning that language contains a surfeit of meaning. The same issues hold for our plans for the future with the additional condition that they can never be held to be accurate because they refer to things that have not yet happened. That does not mean that they might not turn out to be accurate when the are no longer predictions.

Is it one of language's benefits that it enables us to think of ourselves as being part of a trajectory, tracing our path out of the past and into the future? If so then it must play a key role in stabilising our subjective experience of reality, which might otherwise be too frightening, unpredictable and immediately unmemorable? But perhaps this view is too extreme, over-emphasising the role of language as part of our immediate consciousness. Clearly animals exist in some sort of trajectory and seem to display some level of continuity in their reaction to the world about them and their intentions within it. Maybe language plays a longer term role – like long term memory as opposed to short-term – transcribing our biologically-sensed perceptions and memories into stories that are easier to recall while providing a sense-making framework for our actions and our lives:

Words, Things and Substance

This image of a biologically-mediated experience tempering into a lingually mediated narrative seems appropriate for considering another aspect whereby language affects the way we subjectively see the world. Language is (inevitably?) a grammar articulated in terms of "subjects" and



[71]Or perhaps this should be the "adequate" as the corrollary of the Literary theorists "inadequate", see Tang 1999.

"objects". It is at the point at which language separated from action that it created Objects; Things; the world of Substance. It has to be acknowledged that our biological senses already pre-process the world in ways that suggest individual "objects". In particular, sight being our dominant sense, means that our experience of reality is largely visual, and therefore the way in which language references this reality is also largely through the media of vision. Would we be so object-oriented if our primary sense was smell, I wonder? The world of Things can perhaps be seen as flowing from the co-incidence of language's objects and the biophysical interactions between us and the world. But outside of this immediate experience, language is the primary means by which Things exist and endure, as language itself is enduring (see above).

If language is the medium through which we bring Things into existence, then their reification is made whole by the notion that language "corresponds" to reality in some way. This does not need to be as rigorous as Tarski's theory of Correspondence[72], but merely the implication that the word "cat" is in some manner equivalent to the biophysical process complex to which it refers when we say something such as "the cat sat on the mat". It is perhaps the implicit acceptance that the word represents a thing in the real world, despite the obvious inadequacy of such statements[73]. This perhaps betrays a form of reverse engineering in the way we regard language. Rather than seeing it as a tool we have created to make it easier to live in this world, we have endowed it with inherent qualities. Cats must exist because we can ascribe to them the word Cat. The world must fall in with language because there is an supposed to be an inherent correspondence between language and the world.

Perhaps the truth is that language has not been able to keep pace with our understanding of the world. There is enormous utility in using words that map ambiguously onto a perceived pattern despite particular differences in every instance (we can refer to any cat with one word, which has to be better than having a unique name for every cat). But then we reify these perceived patterns into things and then find ourselves frustrated by our inability to precisely and consistently articulate the differences. As our frustrations build we recognise that language is inadequate but still insist on its correspondence.

And yet there are different models being developed about how we interact with the world that provide language with an alternative to this Correspondence theory. One area of particular relevance is the study of how the brain works, or more precisely how it stores "information". Amongst the various theories within this field (as in any field) there is on of particular relevance. It is called the Theory of Connectionism, or perhaps more accurately, the Theory of

[72]See for example, Keuth 1978 or Tang 1999

[73]Which cat sat on which mat, where and when?

New Connectionism[74]. Rather than regarding the brain as containing "representations" of the world outside, New Connectionism provides a model whereby perceived events (or inputs) produce certain responses (or outputs) through their creation or recollection of particular patterns of connections.

What this suggests is that words, rather than corresponding to the world, are stimuli that cause certain responses, inputs that create certain outputs. Or put another way, words are references that can be used to connect to given meanings. These meanings are never inherent in any way, but rather lie in the connections themselves, and are created through what might loosely be called learning. The relationship between words and meaning are therefore entirely individual and essentially unpredictable, but what provides any uniformity is the way we interact with words and the world: the process by which we learn meaning and the ways in which this meaning may be refined or even challenged through subsequent use and experience. Words, and more generally language can therefore be seen as the catalyst around which we learn to build responses and behaviours and which subsequently solicit certain responses and behaviours. Language extends our subjective experience not by animating a world out there for us to interact with, but by providing its own interactions that more or less extend the ways in which we interact with the physical world itself.

9 The Ultimate Extension of the Self?

The final act of extension enabled by the technology of language could be the very creation of the Self – the ultimate subject insisted upon by language's own grammar. If conceptual and reflexive thinking are primarily language mediated, then to reflect on ourselves requires us to cast ourselves a part in the lingual play we use to think about the world. This textual Self is just another reference to the real thing, but it is also our proxy through which we conceive of ourselves as part of that world that we use for sense-making. It is inherent in language's separateness that this textual self should also be seen as separated from the world outside. The confusion that naturally arises is the assumption that we *are* this self, and that therefore we too lie on the wrong side of this divide. But if we accept that this is only our proxy selves then surely the gap between mind and body can be dispelled with certainty.

[74]See Bereiter 19991

One way of conceiving of this extended self is through the even more extended example of the computer avatar: a virtual self with which computer users can interact with others in some form of defined cyber-world. My avatar is me, but with an entirely different body. The way I feel about this other me is just an exaggerated version of how I feel about the conceptual me in my head: I feel emotional towards it and I see myself in it, particularly the bad bits. But I also feel some level of alienation from the outward me that I see on the screen: as if the inward me might seep through and betray my chosen skin. Its a feeling of discomfort that we all have from time to time, especially when confronted unexpectedly with our own image.

In conclusion, this subjective social ontology shows how the social extends the physical through both space and time. This is the frame of reference in which there exists a future and a past. It is also one into which we attempt to fold something of the wider world outside, and one from which it is too easy to mistake what we perceive for the reality out there. Finally, it is the frame of reference in which there exists the individual, the self.

10 Again, What is Reality?

I wrote the essay above long before I concluded the main thesis and therefore before I chanced upon the notion of an ontomethodological synthesis. Having re-read the essay it seems to be leaning in the same direction: that the different "realities" of the physical, biological and social are functions of the processes through which they exist. Reality is not a thing or state but a process, and therefore generated by the technology through which these processes are expressed. It may be interesting to revisit this essay to better reflect the notion of an ontomethodological synthesis, but that is for another time...

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Annex F

An Essay on the Longer History of Money

1 Preamble

Money is the fundamental idea that flows through the whole of the Value Based Management case study. Value in this sense is derived directly from money. Therefore it seems appropriate to start the study with a vignette based on an historical cross-section of this idea. This vignette demonstrates just how far back it is possible to look to see the full extent of a still unfolding idea. It also provides a clear example of a materially situated process based around cash and cash equivalents.

The study draws widely on works by Szabo[75] and Davies[76].

2 Introduction

In the opening years of the third millennium, money is a taken-for-granted aspect of everyday life. Inflation is running in the low 2-3%s. Although counterfeiting continues to vex authorities it seldom if ever encroaches on the people in the high street. It is, therefore, easy for us to

[75]Szabo, 2005.

[76]Davies, 2002.

assume an understanding of money as something fixed within our current social institutions. This is certainly the case within commercial businesses where money is accounted for as the durable fixed life blood of the company. Yet a brief examination of the processes which make up the idea of money and how they have evolved reveals something that is far more fluid and unreliable than we might hope to assume.

This case contains an outline of the idea of money developed in three sections. The first section is purely narratival, with no cross references or justification. The intent is to immerse the reader in the flow of the idea as it developed over time to give something of a sense of the changing dynamic with interruption from the author's justificatory asides. The second section is an analysis of the narrative: looking at the idea from the outside rather than the inside to develop some sort of structure and behaviour. This is akin to understanding the maths of a particular fractal having admired and explored its graphical representation. The final section is dedicated to testing the hypotheses emerging from the analysis by referring outwards to the wider world.

This case study therefore serves two purposes. First it describes a key enabling idea relating to the main case to be developed. Second it prototypes and develops a methodology for exploring case studies [cross reference] as close to the process mindset as possible. The case study also illustrates the breadth of an idea and therefore the challenges facing the process researcher: forced to take on this breadth when perhaps scholastically ill-equipped for the greater part of it!

3 The Narrative: A Story about Money

Stage 1 – Subsisting

Imagine the very earliest social state for *Homo sapiens*: Tribes or clans of people, mutually interdependent but self-sufficient. Survival is *the* priority. Within the tribe everyone is known. Outside the tribe everything else is either predator or prey. There is no trade or bartering and no need for money. Mutual aggression prevents any meaningful interaction with other tribes. In other words society is not much more advanced than today's Chimpanzees. This is a world totally devoid of money. Perhaps this was what life was like for the early Hominids[77], while *Homo sapiens* has its earliest days had the benefit of some form of trading, an idea which gave it a distinct advantage over its cousin, providing an edge that lead to the latter's extinction.

Stage 2 – differentiation and bartering

If people could trust each other then they could arrange for a division of labour in which one person or group depends on other people or groups to survive. For example, those who were skilled in knapping flint may have become dependent on the hunters for food while these depended on the flint knappers for their weapons.

[77]See [Annex E] for a time line of Hominid development

This level of specialisation and differentiation within a clan does not require any exchange of value if the entire clan remain interdependent. However, these specialisms were probably quite marketable between tribes (Szabo (2005) refers to how tribes specialised in hunting different prey and then traded with other tribes when that prey was not plentiful). These exchanges would have been valued by reciprocal exchanges of goods in what is fundamentally bartering.

Main barriers to progress were similar: unless the exchange of goods was immediate and the needs co-incident then any exchange would require both parties to trust each other, to be capable of memorising the value of the exchange and later agreeing when the debt was paid.

Stage 3 – Proto-money

There are lots of examples given by various authors that all describe the same process: the emergence of what may be described as proto-money. Bartering between more than two people becomes more effective if all of the parties tend towards trading in one particular commodity. As this process develops it seems likely that this commodity will take on certain characteristics:

- it will tend to shrink in size, so that it is easier to transport and store and so that it can be safeguarded against theft;
- it will tend to become more durable so that it survives for a reasonable period of time, and is therefore involved in many transactions; and
- it will tend to become uniform in size so that its value is more easily assessed and agreed between the various parties.

In many instances these tendencies created similar proto-money: shells and beads. In many cases these forms of proto-money seemed to have an aesthetic value. Perhaps this reflected the need for insurance – that proto-money developed an intrinsic value that was more than just an intermediary within the bartering process. Could it also have been that these forms of money were also ornamentations: simultaneously displaying the bearers wealth while ensuring it was always to hand and safe?

To a degree the use of high-value intermediaries in the bartering process remained an important aspect of the economy until recently. This is illustrated well in Neil Stephenson's novel *The Confusion*[78]. During the late 17th century silver was highly valued in the west and was tightly controlled by the Spanish. To overcome these controls, a group of men set of on a world trading tour. They travel to India where they collect ingots of Wootz[79]. They then take these to Japan where the wootz is used for making samurai swords and trade it for flasks of mercury. These are then taken across the pacific to South America where the mercury is vital for the purification of

[78]Stephenson, 2004

[79]Verhoeven et al, 1998

silver[80] and they trade it there in return for illicit silver. On their return to England, the silver is used to make much needed coin.

Stage 4 – Hard Money

Proto-money and high-value bartering intermediates enabled the development of effective trade, but there were significant limits. For one thing, the value of each form of proto-money would be much more variable when considered over a wide geographical area. Also, wider trading required greater durability. This must have created pressure to generate forms of money that were more durable, more uniform and universally recognised as valuable. The advent of metal working provided the means to achieve this.

The stater is regarded as the first example of this type of money, being made from electrum and in a form that resembles a coin. The electrum was soon replaced by silver, gold or copper and the form became a coin with the advent of stamping instead of casting. The advantages of hard money are easy to imagine: very durable, dense and small, and in a form that is almost universally recognised as valuable.

But hard money is not without problems. As civilisations developed the need for hard money soon outstripped the supply of valuable metals to make it with. More often than not, that need was created by war. As Greek and Roman armies were mobilised and started to create geographically large dominions money was essential for supplying the armies and for paying the troops.

The role of money appears to change during its development. Proto-money probably had little intrinsic value and was more like a tally [ref the medieval tally's in England] for remembering bartering transactions distributed through time. As trade broadened and trust between traders diminished money itself acquired intrinsic value, e.g. as gold. But as money then became more standardised and with it the economic institutions through which it circulated became more stable, its intrinsic value diminished.

The credibility of a coin's extrinsic value provided a solution to the problem of limited supplies of metal with which to make coins. By diluting these rarer metals with more available, base metals the supply of coins could be increased again. It was a simple and obvious solution, but also one with consequences. As the intrinsic and extrinsic value of coins drifted apart, trading partners sensitive to the intrinsic rather than the extrinsic value responded by increasing prices proportionately. Increasing prices stoked the demand the money, which once again became limited by supply. The answer: dilute the coinage further. Thus was born the first cycle of inflation.

[80]Stearns, 2001

Inflation has dogged the idea of money throughout its history. The Roman Empire suffered severe inflation from the 1st century AD onwards until Constantine replaced all of the coinage with a new gold standard. He was able to achieve this by tapping into a vast reservoir of gold: by adopting Christianity he was able to outlaw pagan temples and confiscate their treasures.

This pattern was maintained for centuries. Through state control, money could be recycled periodically to re-establish its quality. In England, for example, the King was able to profit from this process, which inevitably drove up the frequency of the reminting process although this skimming of profits was not sustainable. In the late 17th century the supply of coins reached such a crisis level that trade broke down and thousands of people died of starvation.

Stage 5 – Paper Money

The Chinese empire needed money to pay its armies and wealth to pay off potential aggressors. Instead of diluting coinage they replaced it altogether with something that had no intrinsic value: paper money. This avoided the problem of diluting coins because paper money simply had no intrinsic value to begin with. However, it still had a notional value corresponding to the actual wealth of the people or institution that had created it.

This created two inflationary pressures: stimulate the internal economy simply by creating more paper money without changing the underlying value of the economy; and give away hard valuables to those outside the internal economy without reducing the corresponding amount of paper money. The result was the re-emergence of inflation with twice the bang! The Chinese struggled with paper money for several centuries but they never managed to control inflation. In the end they abandoned it and reverted to coins. Paper money appeared in a few other cultures but each time it was abandoned within a few years.

Stage 6 – Soft Money

Money originated as something like a tally between traders – identifying a transaction half complete. As trading extended and trust between traders diminished the intrinsic value of money, as universally tradable rather than a tally became a dominant factor. However, as money became more tokenistic again to sate demand it became less reliable and therefore less trustworthy. Paper money, with no intrinsic value at all became the least reliable of all. How, then can we expand the supply of money without simultaneously diminishing its value? For without this capacity money is always ultimately going to be linked to the supply of valuable materials and economies will therefore always be limited in their growth capacity.

The solution to this problem lay in returning to the original role of money – as a tally between trustworthy traders. If you could trust a trader then you could dispense with the need for hard cash completely. But in order to trust a trader – or to trust traders in general, you needed to

achieve a level of social stability and control that was perhaps not present in the world until the 17th century.

In the 17th Century systems of trade between countries became sufficiently well developed that relatively wealthy individuals, usually the owners of large merchant operations, were regarded as more trustworthy than the state (who controlled the money supply). Under these conditions, a receipt from a gold merchant became more valued than cash. Always quick to exploit any value opportunity, a system of trading based on the passing of receipts started to be used that completely avoided the need for hard cash, and therefore circumvented the limitations of the cash supply.

Thus the concept of soft money was born. If trade could take place without the need to mint new coin then economic growth could be achieved at a much greater rate. Of course soft money was not an instant success. For a start, while most of the economic activity of a country still relied on hard money what could be achieved with soft money was very limited. Despite the "innovation", inflation and cash shortages still precipitated an economic crash at the turn of the 17th century. What was needed was a corresponding reform in the banking system, achieved largely through the creation of the Bank of England, and the development of a similar system for trading in the capital of businesses and not just their revenues and expenses (e.g. the stock market, more of which later). And of course the age-old prejudice for intrinsic value resisted these reforms. Land continued to be seen as the primary form of wealth in England while trade was scorned. To some degree these prejudices continue even today with the English aspiring to home ownership more than any other country in Europe.

Once this system of reliable trading achieved a certain critical mass the trading of receipts effectively converged with the idea of paper money, the Bank of England's IOU being sufficiently reliable to overcome the fear of inflation. Together, soft money and paper money provided the conditions that effectively financed the industrial revolution.

Stage 7 – Negative Money or Credit

Is there another stage in the development of the idea of money? Possibly, and if there is then it has something to do with the rise of credit.

Overcoming the prohibition on lending was an important issue for establishing systems of soft money. That way creditors were able to benefit from the risks implicit in almost all trading where control over the valuables concerned passed outside the owner. However, credit in this sense was not itself a driver of the development of money, just an important enabler. Soft money expanded wealth through trading and, together with the establishment of capital markets, through industry business in general.

At some point in the last 30 – 50 years, however, the supply of money has been massively expanded by the growth of credit, primarily personal credit. Wealth has been created through property, which has in turn been fired by mortgage lending. The role of manufacturing as the pillar of the western economy has been usurped by retail, funded by the consumer. And the consumer has been kept liquid by an ever more accessible source of credit.

Perhaps this boom in lending has been made possible by the underlying increase in personal wealth? But then perhaps this is an illusion, given that much of this wealth has been levered through mortgage lending. Perhaps a different driver has been the increased accountability of individual credit, which has reduced the risks of bad debt and made lending altogether cheaper. This is again about systems of trust, this time in the form of credit ratings, computer databases, and bailiffs.

In hard money economies, expanding the money supply was achieved either by expanding accessible value (gold, silver) or by diluting the value of money itself. As inflation played out the value gap between circulating money and underlying wealth became unsupportable with ensuing collapse. In the credit economy money supply is expanded by making it easier to borrow. At some point the amount of money being borrowed will far exceed the underlying wealth of the systems providing it. If the systems of trust upon which this edifice depends should start to weaken then this ensuing collapse could be unimaginable[81].

4 Analysis : The Technology of Money

This is the story of cash, the hard technology that forms a key part in the process/idea that is money. Its a process in an endless cycle: cash moving from pocket to till, back to another pocket or the bank, back to another pocket, and then perhaps the piggy bank or the back of a sofa? It is not surprising that cash became so durable to last all that physical handling by sweaty hands and jangling in people's pockets. And its size needed to be small enough to be easily carried on the person both for convenience and security. The physical demands of the day-to-day process of money have been a shaping influence over its form.

Cash also needs to be regular in size and shape so that its value can be more easily judged. Very early forms of proto-money, such as shells, were cut into shapes and strung to form necklaces etc. Not only was this convenient, it also provided the owner with aesthetic value, but shell is not particularly durable and not that easily shaped. Iron nails were once used by the Athenians as money but their tendency to rust can't have made them too popular. Precious metals, however, made durable tokens which could be easily stamped into regular shapes with

[81]This was written in late 2005, long before the phrase "sub-prime loans" was heard by the general public. At this point (late 2007) it is still unclear whether or not credit economy will collapse spectacularly or slowly unwind.

the advantage of high intrinsic value. This high value was also a limitation because it unsurprisingly reflected a limited supply. So as the demand for cash increased the technology of cash had to adapt to meet it.

The most obvious solution was to dilute the scare precious metals with something less scarce and not so precious. As described in the narrative, the result was to create an inflationary cycle: as the intrinsic value of money declined the cost of goods increased, stoking demand and causing further dilution. Attempts to halt the decline involved collecting up the bad coins, melting them down and refining the metals and reminting new coins. Adorning coins with the head of state's bust became a part of identifying reminted, higher value coins. Unfortunately this practice may have restored the intrinsic value of coins but it did not expand supply, and if it was not done thoroughly enough then the residual bad coins would become the lowest common demoninator, reducing the value of the good coins quite rapidly. Constantine's confiscated treasures increased supply and stabilised value for the next 700 years, but it still didn't overcome the fundamental problem. Neither did paper money, at least when it was only a substitute for coins. With no intrinsic value it was not subject to the same cycle of inflation that dogged coins. However, it was easy to produce more paper money than the underlying wealth of the issuing institution justified, and the result was a level of inflation that was unfettered by the inertia that characterised the gradual dilution of coinage. Perhaps it is more surprising that the Chinese didn't abandon paper money sooner.

The solution to this problem of supply came in the form of another technology: accountancy. Accountancy developed through three enabling technologies. First the Roman numbering system was replaced by Arabic numbers. With the spread of Arabic numbering came a much better understanding of mathematics. Finally, in 15th century Italy the idea of Double Entry Book keeping is created and developed.

The spread of double-entry book keeping, and with it the “professionalisation” of accountancy enabled commercial institutions to offer a more reliable account of the monies they owed (to creditors) and were owed (by debtors). The ability to keep track of monies passing through a company was essential if physical cash was no longer to be the common denominator. The success of soft money can be seen to have been precisely because of this accountability, which itself probably depended as much on the establishment of significant financial institutions, themselves made more possible through the mechanisms of accounting. In effect the whole edifice gradually bootstrapped itself out of the chaos that was 17th Century finance simply because the problems of cash at that time were so great that the need demanded a solution.

It is possible to discern a secondary pattern in the processes of cash and money involving the much more intangible concept of trust. In our imagined pre-money society everyone could trust everyone else on whom they depended and otherwise they trusted no-one. Bartering enabled people to exchange goods with others where trust was lacking and money replaced bartering to enable trade between many more people where trust was almost non-existent. But, by its own paradox, to be valuable it had to possess some level of scarcity so cash was always going to be a limiting factor on economic growth. Paper money failed to overcome these limitations because it was, in its earliest instantiations at least, merely a poor substitute for coins. What was needed to overcome these limitations was to overcome the trust issue. If everyone wanted to trade could find some way of being able to trust one other person sufficiently to look after the value we seek to protect then we would not need to convert it into the tangible form of value that is cash. The development of accountancy enabled trading institutions to achieve precisely this end, thereby liberating the restraint that hard coins had imposed on money for so long. But now, in the early 21st century, trust has again become the issue. Its not that we can't trust the lenders, but that they can no longer trust us. The credit economy has grown so rapidly that it has lent to those that it now finds are unlikely to repay their debts. And if the supply of money has to contract as we recalibrate the volume of trust in the system then it seems likely that the economic systems which depend upon it will contract as well.

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