

WHAT DRIVES THE SYSTEMS? FROM CONATUS TO DYNAMICS
—DESCARTES, HOBBS, SPINOZA, LEIBNIZ, AND KANT—

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Abstract

I will highlight the concepts of conatus and dynamics in Descartes, Hobbes, Spinoza, Leibniz, and Kant. These philosophers' ideas are sometimes referred to as precursors of modern systems theories, or cybernetics.

First, I will analyse the idea of conatus in Hobbes's theory, comparing it with those of Descartes and Spinoza. For Hobbes, conatus is motion through the length of a point and a small beginning, which causes interaction between matter. All natural and social systems then begin to move automatically. Conatus is thus just a trigger of motion.

After I discuss the transition from the notion of conatus to that of dynamics in Leibniz's thought, I will illuminate Kant's in both his pre-Critical and mature philosophical works. His idea is that the soul has a dynamical relation with the body, making it the prime power to move the body. Kant then examines the phenomena of the world from this viewpoint of dynamical interrelation. Thus, it lies behind the systems of recognition, which is formed simultaneously with the natural and social systems, according to Kant's philosophy.

The interaction between elements in systems is essential to modern complex systems theory. I would like to say that these philosophers, especially Hobbes and Kant, are pioneers of complex systems theory.

Key Words: conatus, dynamics, systems theory, Hobbes, Kant

I Conatus —Descartes, Hobbes, Spinoza, and Leibniz—

We tend to think of great philosophers of the past as cultural artefacts, historically significant but long since superseded. But some earlier philosophers are more than cultural artefacts. We can read these philosophers not just as an archaeological dig into our roots but to see what we can still learn from them. The five philosophers I will highlight in this paper are some of these thinkers.

Now, I would like to examine the ideas of conatus (part I) and dynamics (part II) in the seventeenth and eighteenth century, which would shed light on systems thinking.

Conatus is the innate inclination of a thing or mind to continue existing and to enhance itself. The

concept of conatus dates to classical thinkers, such as Cicero (106-43 BCE), and throughout the middle ages there was a principle of self-preservation and a notion of motion-generating, an impetus within.

In the seventeenth century, R.Descartes (1596-1650), T.Hobbes (1588-1679), B.Spinoza (1632-1677), and G.Leibniz (1646-1716) made important contributions to developing a more modern concept of conatus.

Some have mentioned that the notion of conatus in these philosophers, especially Spinoza, is a forerunner of systems theory.

For example, T.Ziemke has argued: 'These more or less modern theories (Varela's autopoietic systems and so on) have a number of historic precursors, such as the concept of . . . or even much earlier than that, Spinoza's concept of the conatus' (Ziemke 2007 p.55).

B.Sandywell has also said, 'Spinoza, for example, defines the term conatus in terms of entities desiring to persist in their being. . . We might even consider modern Systems theorizing as a secularized variant of the language of conatus and possible essence (systematicity qua essence being the foundation of existence)' (Sandywell 1996 p.144f).

A.Damasio has also insisted on the importance of conatus: 'It is apparent that the continuous attempt at achieving a state of positively regulated life is a deep and defining part of our existence – the first reality of our existence as Spinoza intuited when he described the relentless endeavor (conatus) of each being to preserve itself . . . Spinoza's notion implies that the living organism is constructed so as to maintain the coherence of its structures and functions against numerous life-threatening odds . . . The conatus subsumes both the impetus for self-preservation in the face of danger and opportunities and the myriad actions of self-preservation' (Damasio 2006 p.36).

The conatus is thus seen as a motivation of motion, which drives matter into movement and into relation with other matter.

Spinoza's conatus is, thus, popular among systems thinkers but, in this paper, I would like to highlight Hobbes's theory, for Hobbes's concept of conatus is the most distinct among the philosophers.

Hobbes's definition of conatus in *De Corpore* is as follows: 'First, I define ENDEAVOUR to be motion made in less space and time than can be given; that is, less than can be determined or assigned by exposition or number; that is, motion made through the length of a point, and an instant or point of time' (*De Corp* chap.15-2).

He continues: 'Now that all mutation or alteration is motion or endeavour (and endeavour also is motion) . . . Moreover, I have shown that all resistance is endeavor opposite to another endeavour, that is to say, reaction' (ibid. 25-2). From here emerges Hobbes's definition of sense: 'SENSE is a phantasm, made by the reaction and endeavour outwards in the organ of sense,

caused by endeavour inwards from the object, remaining for some time more or less' (ibid.).

As for Hobbes, the concept of conatus doesn't lie only in the basis of natural philosophy, but in that of social philosophy. Hobbes is well known as an author of *Leviathan*, in which he proposes the social contract theory. There are some references to the conatus in this book: 'These small beginnings of Motion, within the body of Man, before they appear in walking, speaking, striking, and other visible actions, are commonly called ENDEAVOUR' (*Lev* chap.6). 'This endeavor, when it is toward something which causes it, is called APPETITE, or DESIRE: the latter, being general name; and the other, oftentimes restrained to signify the Desire of Food, namely Hunger and Thirst. And when the Endeavour is fromward something, it is generally called AVERSION' (ibid.). From here, Hobbes explains many kinds of passions and then proceeds to his theory of competition, the state of war.

J.W.N. Watkins has argued as follows:

Hobbes's theory of voluntary movement is most interesting. His sharp statement of the theory was difficult without the differential calculus, of which he had little knowledge. Later, young Leibniz perceived the importance of Hobbes's theory, and he did have the benefit of the calculus and, especially in his case, it was the integral calculus which was of most assistance.

Hobbes seems to have considered Descartes' mind-body dualism, the idea that the soul is an immaterial thinking substance which inhabits the body as so absurd that it scarcely needed answering.

The key concept with which Hobbes overcame the body-mind dichotomy was his concept of conatus (endeavour).

Hobbes defines conatus to be motion made through the length of a point, and in an instant or point of time. This appears to equate conatus with instantaneous speed (ds/dt). However, Hobbes defines velocity as the power by which a body moves as its present speed. And it becomes clear that by conatus he meant, not instantaneous speed, but instantaneous velocity in this sense – the pressure or motive force behind the movement, rather than movement itself.

Hobbes saw that a body's motion may be resultant of various conatuses. The physical world is filled by an invisible system of conatuses, powers, pressures, or forces. Even the most dead-seeming chunk of inert matter is, one might almost say, brought to life by this idea, transformed into something humming silently with incipient motion (Watkins 1963, chap.7).

Summing up, while Hobbes argues for the idea of conatus using, without knowing it, the method of differential calculus, Leibniz uses the method of the integral calculus deliberately in explaining the idea of conatus. There is also another contrast between Hobbes and Leibniz: the former regards the psychical world merely as matter, and the latter sees something spiritual in matter. They look in opposite directions. I shall look in detail to Leibniz later.

Conatus Dynamics

According to J.Pietarinen, Hobbes's conatus is to be interpreted as follows:

For Hobbes, the conatus is not an inherent power of a body but is determined by the motions of other bodies. However, he regards it as an active power, because the beginning of the motion of a body must be considered as action or cause. Thus, endeavour is the power by which a body affects the motion and resists the power of other bodies, and, in a sense, also causes the motion of the body itself, for Hobbes takes the principle of the persistence of motion to be true.

Pietarinen then proposed the principles of the conatus:

1. A body endeavours to preserve its state and resist the causal power of other bodies. Sensations endeavour to preserve their state and resist the power of external causes.
2. The will, i.e. the last desire or aversion in the deliberation, endeavours to preserve its state and resist the power of causes external to it.
3. The reason endeavours to preserve the truths it has conceived, and since nothing resists it, the truths are preserved forever.
4. A living being endeavours to preserve its life and resist anything contrary to it.
5. We endeavour to seek peace in order to preserve our life.
6. We endeavour to unify our wills and actions by making contracts in order to promote peace.
7. We endeavour to keep our contracts and resist any passions tempting us to break them.
8. When there are many who do not follow contracts, we rationally endeavour by all our power to preserve our life.
9. The sovereign endeavours to preserve the life of citizens by the joint conatus-power of rational individuals.
10. The sovereign endeavours to preserve its status and resist all attempts to forfeit it.

But, in my opinion, Pietarinen demands too much of the concept of conatus. Conatus is just the beginning of motion, and matter, a man, or society (they all are systems) begin their movement automatically after the first motion of conatus. They are self-generating systems, and the conatus is just a trigger.

Another important point is as follows:

S.Shapin&S.Schaffer have argued that Hobbes's natural philosophy is based on his political context. He insists on there being no vacuum in the universe, which shows his political needs: 'The world is full of body; that which is not body does not exist. And there can be no vacuum. The argument proving this was not developed within the discourse of natural philosophy that we described earlier in this chapter. Instead, the argument against vacuum was presented within a political context of use. In the cause of securing public peace Hobbes elaborated and deployed an

ontology which left no space for that which was not matter, whether this was a vacuum or incorporeal substance. He recommended his materialist monism because it would assist in ensuring social order. He condemned dualism and spiritualism because they had in fact been used to subvert order' (Shapin&Schaffer p.99). Such is also the case with conatus. Hobbes's natural philosophy and his social philosophy are therefore related.

So, the idea of conatus is useful for both natural and the social systems.

Now, I would like to compare Descartes' idea with that of Hobbes. To the extent that Hobbes treated mechanical subjects as distinct from his mechanical philosophy of nature, he did so along Cartesian lines. But both are different from each other.

Descartes proposed a mechanical view of nature and dualism of body and mind. Hobbes seems to accept the former and reject the latter. But the ideas of conatus in Descartes and Hobbes are beyond the mechanical view of nature. That is to say, the first anti-Cartesian was Descartes himself, then came Hobbes.

In *Principles of Philosophy*, Descartes argues: 'The striving (conatus) after motion in inanimate things, and how it should be understood. When I say that the globules of the second element 'strive' to move away from the centres around which they revolve, it should not be thought that I am implying that they have some thought from which this striving (conatus) proceeds. I mean merely that they are positioned and pushed into motion in such a way that they will in fact travel in that direction, unless they are prevented by some other cause' (Part III *PW I* p.259).

Matter strives by itself. This description seems somewhat metaphysical, not mechanical, for mechanical matter would not move by itself.

As for the dualism of mind and body in the thought of Descartes, he goes beyond it himself. I should highlight two points.

First, Descartes sometimes referred to the idea of an automaton, a machine with mind. In *Meditations on First Philosophy*, he argues: 'But then if I think out of the window and see men crossing the square, as I just happen to have done, I normally say that I see the men themselves, just as I say that I see the wax. Yet do I see any more than hats and coats which could conceal automatons? I judge that they are men' (Second Meditation *PW II* p.21).

In *Discourse and Essays*, he also says: 'This will not seem at all strange to those who know how many kinds of automatons, or moving machines, the skill of man can construct with the use of very few parts, in comparison with the great multitude of bones, muscles, nerves, arteries, veins and all the other parts that are in the body of any animal' (Part V *PW I* p.139). An automaton is a machine with a mind or man with a mechanistic body. The idea of automata should be beyond body-mind dualism (Schaffer 1999).

Second, Descartes distinguished body from mind but argued for their interrelation. In *The*

Passions of the Soul, he explains: ‘What is a passion with regard to one subject is always an action in some other regard’ (1-1 *PW I* p.328). He goes on to say, ‘Consequently we should recognize that what is a passion in the soul is usually an action in the body’ (1-2 *ibid.*) and that ‘The soul is united to all the parts of the body conjointly . . . we need to recognize that the soul is really joined to the whole body’ (1-30 *ibid.* p.339).

Then Descartes asks a question. How do the soul and the body act on each other? The answer is as follows: ‘Let us therefore take it that the soul has its principal seat in the small gland located in the middle of the brain. From there it radiates through the rest of the body by means of the animal spirits, the nerves, and even the blood, which can take on the impressions of the spirits and carry them through the arteries to all the limbs . . . To this we may now add that the small gland which is the principal seat of the soul is suspended within the cavities containing these spirits’ (1-34 *ibid.* p.341). Thus, the soul and the body interact with each other.

Then, he argues: ‘From what has been said above we know the ultimate and most proximate cause of passions of the soul is simply the agitation by which the spirits move the little gland in the middle of the brain . . . They (all passions) may sometimes be caused by an action of the soul when it sets itself to conceive some object or other . . . From what has been said, however, it appears that all such passions may also be excited by objects which stimulate the senses, and that these objects are their principal and most common causes’ (2-51 *ibid.* p.349).

He continues: ‘If, in addition, this shape (of the object) is very strange and terrifying – that is, if it has a close relation to things which have previously been harmful to the body – this arouses the passion of anxiety in the soul, and then that of courage or perhaps fear and terror’ (1-36 *ibid.* p.342). Thus, the soul is passion and the body is action, and they interact with each other.

Thus, I would like to repeat that the first anti-Cartesian was Descartes himself.

Next, I will compare Spinoza’s idea with that of Hobbes.

In *Ethics*, Spinoza defines the conatus: ‘The endeavour (conatus), wherewith everything endeavours to persist in its own being, is nothing else but the actual essence of the thing in question’ (Part III, Proposition VII *BSII* p.136). He goes on: ‘The mind, both in so far as it has clear and distinct ideas, and also in so far as it has confused ideas, endeavours to persist in its being for an indefinite period, and of this endeavour it is conscious’ (Proposition IX *ibid.* p.137). In the Note of Proposition IX, he argues: ‘This endeavour, when referred solely to the mind, is called will, when referred to the mind and body in conjunction it is called appetite’ (*ibid.*).

Spinoza’s theory of conatus differs from those held by Descartes and Hobbes. The latter two took it to be a principle of change, but the former thinks of conatus as the endeavours to persist in being or to preserve being, which rather resembles the conatus of the middle ages. Spinoza had been much influenced by Descartes, but then criticised him. Thus, Spinoza’s idea should be considered

modern.

Furthermore, Spinoza developed social contract theory. The first half of his arguments in *A Political Treatise* are like those of Hobbes. The other half is original, in which Spinoza says, ‘The power, not of every individual, but of the multitude, which is guided, as it were, by one mind’ (3-2 *BSI* p.301). The multitude is a system, which consists of many appetites, desires, and aversions of people. Thus, the influence of Hobbes on Spinoza should be considered great.

H.R.Bernstein argues: ‘It may seem a bit strange to add parenthetically that endeavor as Hobbes understood it, is not only kinematical but also that it is dynamical, a force-related idea. This makes good sense, I think, provided Newton’s and Leibniz’s respective mature concepts of dynamics are not conflated as they are apt to be. In as short a paper such as this, one can hardly do more than boldly state a point of view – and so I should like to suggest that Hobbes’s conatus is a common ancestor of two very different ways of conceptualizing force, that is, of Newton’s *dynamica* and Leibniz’s *dynamice* (Bernstein 1980 p.26).

Now, I go on to the next part.

II Dynamics - Leibniz and Kant -

N.Wiener, a father of cybernetics, traces the origins of cybernetic analysis to the philosophy of Leibniz, citing his work on universal symbolism and a calculus of reasoning: ‘At this point there enters an element which occurs repeatedly in the history of cybernetics – the influence of mathematical logic. If I were to choose a patron saint for cybernetics out of the history of science, I should have to choose Leibniz. The philosophy of Leibniz centers about two closely related concepts – that of a universal symbolism and that of a calculus of reasoning. From these are descended the mathematical notation and the symbolic logic of the present day. Now, just as the calculus of arithmetic lends itself to a mechanization progressing through the abacus and the desk computing machine to the ultra-rapid computing machines of the present day, so the calculus ratiocinator of Leibniz contains the germs of the *machina ratiocinatrix*, the reasoning machine. Indeed, Leibniz himself, like his predecessor Pascal, was interested in the construction of computing machines in the metal. It is therefore not in the least surprising that the same intellectual impulse which has led to the development of mathematical logic has at the same time led to the ideal or actual mechanization of processes of thought’ (Wiener 2013 p.12).

Thus, in this part, I will discuss Leibniz’s idea first. He was influenced from Hobbes’s idea of conatus, then he developed the idea of dynamics, which, then, gave much influence on I.Kant (1724-1804).

Conatus Dynamics

In 1670, young Leibniz (25 years old) wrote a long letter to old Hobbes (83 years old): 'I believe I have read almost all your works, in part separately and in part in the collected edition, and I freely admit that I have profited from them as much as from others in our century' (*PPLI* p.162). From this, we can see much affection of Leibniz for Hobbes.

The year after he wrote to Hobbes, Leibniz wrote an important article named 'The Theory of Abstract Motion: Fundamental Principles'. In it, he refers to the concept of conatus: 'Conatus is to motion as a point to space, or as one to infinity, for it is the beginning and end of motion' (*PPLI* p.218).

Then, he continues: 'There can therefore be many contrary conatuses in the same body at the same time' (*ibid.*).

The most important comment is as follows, showing he may have obtained the notion of conatus from Hobbes' and developed it to his original: 'No conation without motion lasts longer than a moment except in minds. For what is conation in a moment is the motion of a body in time. This opens the door to the true distinction between body and mind, which no one has explained heretofore. For every body is a momentary mind, or one lacking recollection, because it does not retain its own conatus and the other contrary one together for longer than a moment. For two things are necessary for sensing pleasure or pain – action and reaction, opposition and then harmony – and there is no sensation without them. Hence body lacks memory; it lacks the perception of its own actions and passions; it lacks thought' (*ibid* p.220).

In 'On Nature Itself, or On The Inherent Force and Actions of Created Things' (1698), Leibniz even says that a conatus or impetus is 'what I call a monad' (*PPL2* p.818).

According to Watkins, we can compare Leibniz with Hobbes and Descartes. He has argued as follows.

An awkward implication of the idea that a conatus is something psychical, as well as the beginning of something physical, is that there is something psychical in all moving bodies and, indeed, in all stationary bodies, since their zero-movement is the result of mutually opposed conatuses. Leibniz accepted this implication and handled it in the same way Hobbes had handled it: each body can be understood as a momentary mind, or a mind without recollection.

According to Descartes, mind is utterly unlike body: there is nothing included in the concept of body that belongs to the mind. A body is an extended (three dimensional) thing that does not think; a mind is a thinking thing that is not extended. Nevertheless, Descartes claimed that there is interaction between mind and body, as mentioned above. Here, Watkins thought that Descartes had deceived himself.

Leibniz believed that the idea of conatus would yield a solution of the Cartesian body-mind problem, for it suggested a way of overcoming Descartes' absolute dichotomy between matter

and mind. A conatus is a physical magnitude, but it is not extended (that means it is not matter). It is an intensity, and it has a direction. In Leibniz's concept of force, the physical and the psychical draw together.

One might say that Leibniz integrated matter from psycho-physical intensities, whereas Hobbes differentiated motion into psycho-physical intensities (Watkins 1973 chap.7).

Thus, we can create two tables:

Monism vs. Dualism

Descartes: mind-body dualism

Hobbes: materialist monism

Spinoza: neutral monism (the universal substance emanates both body and mind)

Leibniz: mind-monism = monad

Conceptions of Conatus

Descartes: strives to move away from centres

Hobbes: motion made in less space and time, resistance, reaction and appetite

Spinoza: persists in its being or preserves being

Leibniz: motion as a point, the beginning of motion, impetus, primitive motive force

Then I will go on. G.Banham has argued the transition from conatus to dynamics in Leibniz's thinking, citing Leibniz's *Specimen Dynamicum* (Banham 2006, 2007). I will follow his arguments.

Young Leibniz attempted to combine the Cartesian positions with the notion of Hobbes's conatus. But these are conflicting frames of reference, which requires something like the principles of dynamics to advance.

The mature Leibniz wrote *Specimen Dynamicum*, where he moves away from the Cartesian elements of his earlier position, indicating that he had taken the view that corporeal substance needs a different description. The view of body as essentially composed of extension (which is exactly Cartesian) is directly challenged in order that an interpretation of forces may arise. The factor of force is now added to the notion of extension with the result that rules of motion, which Leibniz terms systematic, are produced:

'We show, therefore, that there is in substance a force of action and that, if it is created substance, there is also a force of suffering. We show too that the concept of expression is not complete in itself but requires a relation to something which is extended and whose diffusion or continuous repetition it implies, and therefore that it presupposes also a bodily substance which involves the

power to act and resist, and which exists everywhere as corporeal mass, the diffusion of which is contained in extension' (*PPL2* p.728).

Here, Leibniz replaces the Cartesian principle of conservation of quantity of motion with the principle that what is conserved is rather the quantity of force.

We see the action of the body as arising from an internal force that exists within it. This appeal to internal force is understood by Leibniz on two levels. The basic claim he wished to make concerns what he calls primitive force. All bodies possess primitive force, which Leibniz relates to general causes that metaphysically supplement the laws of the physical. However, the primitive forces are introduced for metaphysical completeness. The function of accounting of nature is, rather, performed by derivative forces which result as limitations of primitive force arising from the collision of bodies. The derivative forces are what are appealed to Leibniz in accounting for motion. Bodies, when moving, possess a degree of velocity and if we add to this the direction of movement we arrive at Leibniz's mature notion of conatus:

'This velocity along with direction is called conatus. Impetus, however, consists in the product of the mass of the body by its velocity, and so its quantity is that which Cartesians usually call the quantity of motion, that is, the momentaneous quantity, although, speaking more accurately, the quantity of motion, having an existence in time, is an integral of the impetuses (whether equal or unequal) existing in the moving body through a given interval of time' (*PPL2* p.715).

'Hence force is also of two kinds: the one elementary, which I also call dead force, because motion does not yet exist in it but only a solicitation to motion, such as that of the ball in the tube or a stone in a sling even while it is still held by the string; the other is ordinary force combined with actual motion, which I call living force. An example of dead force is centrifugal force, and likewise the force of gravity or centripetal force; also the force with which a stretched elastic body begins to restore itself. But in impact, whether this arises from a heavy body which has been falling for some time, or from a bow which has been restoring itself for some time, or from some similar cause, the force is living and arises from an infinite number of continuous impressions of dead force' (*PPL2* p.717).

In a letter to De Volder (1703), Leibniz writes: 'If you think of mass as an aggregate containing many substances, you can still conceive of a single pre-eminent substance or primary entelechy in it. For the rest, I arrange in the monad or the simple substance, complete with and entelechy, only one primitive passive force which is related to the whole mass of the organic body. The other subordinate monads placed in the organs do not make up a part of it, though they are immediately required by it, and they combine with the primary monad to make the organic corporeal substance, or the animal or plant' (*PPL2* p.864).

Banham concluded as follows: 'The movement from the Cartesian conception of corporeal substances in terms of extension to the articulation of a dynamics takes thus at least three stages

though the story is here incomplete. The first stage would be Leibniz's reformulation of the Cartesian position which elaborates Neo-Hobbesian elements, the second would be the expansion of his correction of the Cartesian position and the move beyond kinematics to dynamics' (Banham 2007 p.24).

Banham's other concern is Kant's earlier natural philosophy. After the two stages of Leibniz's reformulation, there is the third movement, which would be Kant's initial recovery of the Leibnizian move. And he also refers to the subsequent fourth movement, which would be the attempt to reconcile the Leibnizian description of substance with the Newtonian conception of attractive power.

The third movement is in Kant's earlier work on 'Living Force'. The fourth movement is in his work on the 'Theory of Heavens'. Now, we should go on to Kant.

Kant's interest in the physics, metaphysics, epistemology, and theology of his predecessor Leibniz is evident in his early writings in the philosophy of natural science. Here, I would like to analyse "'Living Forces'" and 'Theory of Heavens', but these two articles are dense and have many pages. Therefore, I would like to show only their conclusions.

In 'Living Forces', Kant's explicit attempt was to mediate between the Cartesian and Leibnizian measures of force by respectively aligning them with mathematical and metaphysical modes of cognition.

In 'Theory of Heavens', Kant also attempted to mediate between Newtonian mathematical mechanics and Leibnizian metaphysical dynamics. In other words, Kant attempted to reconcile the Leibnizian description of substance with the Newtonian conception of attractive power. That this reconciliation requires a synthesis of mathematical and dynamical qualities is the key to the Kantian project.

Here, I would like to say that Leibniz's dynamics is a key and yet underappreciated context through which to understand both Kant's pre-Critical and mature philosophical works.

Thus, I will look to 'Lectures on Metaphysics', written from the 1770s to 1790s. In these lectures, the idea of dynamics is evident, which shows Kant's lifelong interest in the idea of dynamics:

'The soul is not material. Matter has no faculty of representations, therefore it cannot at the same time be its own principle of life' (*Lectures* p.396). Kant says that matter cannot think, has no faculty of representation, and he then also applies this proof to animals.

This is also his criticism of Leibniz's Monad, because the Monad is said to have the faculty of representation.

Now, we can look to the most essential statements on dynamics: 'If we think of an immaterial being (soul), then we can assign it no location, no local relation, but rather only a dynamic one, a

relation of virtual, not local, presence' (ibid p.398).

The soul has no location, but a dynamical relation of virtual presence: 'One has sought the seat of the soul in the seat of the senses, where the soul supposedly receives all impressions of objects. But since, besides the faculty of thinking, it also has a faculty of locomotion i.e., for moving the body, then that part by whose motion the soul moves the whole body would be the prime moving power' (ibid p.397).

Here is a dynamical relation between soul and body, which Kant says, is the relation of virtual presence. In that relation, soul has the power to move body, and this power is exactly the prime moving power of nature:

'Now since the soul stands in interaction with the body, we ask: where does the soul have its seat in the body? The location of the soul in the world is determined by the location of the body; my soul is there where my body is. But where in the body does the soul have its seat? The location of the body in the world is determined only by outer sense; now since the soul is an object of inner sense, but no location can be determined by inner sense: the location of the soul in the body also cannot be determined, for no outer relation can be determined by inner actions' (ibid. p.91).

'Thus there must be impressions in the brain of that which one has thought; there must be something bodily with thinking. Thus, the soul affects the brain quite a bit by thinking. The brain, of course, does not work out the thoughts, but rather it is only the slate upon which the soul draws its thoughts. Thus the brain is the condition of thinking' (ibid. p.74).

Kant reiterates the interaction of the soul with the body, which is the basis of his philosophy.

Kant in the period of Critique is often said to have left behind the influence of Leibniz's metaphysics, by which he had been so influenced in his pre-Critique era. But *Metaphysical Foundation of Natural Science*, written at the same time as *The First Critique (CPR)*, is Leibnizian. The second chapter of *Foundation* is 'Dynamics', where attractive force and repulsive force are treated as fundamental and dynamical forces, which have their virtual presence in matter:

'And so metaphysical investigation behind that which lies at the basis of the empirical concept of matter is useful only for the purpose of guiding natural philosophy, so far as this is ever possible, to explore dynamical grounds of explanation. For these alone permit the hope of determinate laws, and thus a true rational coherence of explanations. This is now all that metaphysics can ever achieve towards the construction of the concept of matter, and thus to promote the application of mathematics to natural science, with respect to those properties whereby matter fills a space in a determinate measure – namely, to view these properties as dynamical, and not as unconditioned original positings (Positionen = positions), as a merely mathematical treatment might postulate them' (*Foundation* p.74, the last parts of chapter 2).

Metaphysical investigation is then useful, for it could explore the dynamical relation in matter.

Now, I should go on to the most important work, *Critique of Pure Reason* (1781-87), in which Kant defines his theory in detail. This work has been cited as the most influential volume of metaphysics and epistemology in modern philosophy.

It critically proposes the categories of the faculty of understanding: 'We cannot think an object save through categories; we cannot know an object so thought save through intuitions corresponding to these concepts' ('Transcendental Deduction' *CPR* p.173).

The categories are preconditions of the construction of objects in the mind. To think of some matter presupposes the category of subsistence, that is, substance, for the categories synthesise the random data of the sensory manifold into intelligible objects.

Judgements are then preconditions of any thought. Kant proposes four groups of judgments according to Aristotle's syllogistic logic, as described below.

Table of Categories

1. Of quantity (unity, plurality, totality)
2. Of quality (reality, negation, limitation)
3. Of relation (substance, cause, community)
4. Of modality (possibility, existence, necessity)

(*CPR* p.113)

Kant explains them through other terms.

1. Axioms of intuition
2. Anticipations of perception
3. Analogies of experience
4. Postulates of empirical thought in general

(*ibid.* p.196)

Kant says: 'the categories in the first group (quantity, quality) I would entitle the mathematical, those in the second group (relation, modality) the dynamical' (*ibid.* p.116, p.196, p.197). Here it is clear that the mathematical comes from Descartes' and Newton's methods and the dynamical from Leibniz's metaphysics. Indeed, it is often said that Kant threw away the idea of Leibniz's metaphysics after being awoken from 'dogmatic slumber' by Hume (around 1757). In reality, he reconciles Leibniz's idea with Hume's criticism and Leibniz's metaphysics with Newton's mathematics.

The latter two categories are here dominant and control the former two, so the whole of the categories should be seen as dynamical.

Again, I should say that the categories are preconditions of the formation of the objective world (=nature). Thus, we can examine all the phenomena of the world from the viewpoint of dynamics. As I have already shown, the importance of the concept of dynamics in Kant's philosophy is also seen in *Foundation*. While *Foundation* is concrete natural science, *CPR* is abstract natural science. *CPR* deals with the formation of recognition, with which all systems of nature are formed simultaneously. The dynamic relation between soul and body lies behind all systems of recognition and nature.

For Kant, however, both body and mind are not substances, unlike for Descartes. That the soul is substance is a paralogism (wrong reasoning). That the soul is in relation to possible objects in space is also a paralogism (*CPR* p.330ff.). Thus, body and mind are in a dynamical relation of virtual presence.

K.Kikuchi argues in his Japanese-language book that the idea of dynamics is fundamental in all of Kant's works: not only *CPR* and *Foundation*, but also *Critique of Practical Reason*, *Metaphysics of Morals*, *Critique of Judgment*, and *Perpetual Peace*. Therefore, according to Kikuchi (2015), that the dynamical relation of soul and body lies behind natural systems is also true of social systems. But, to demonstrate this, I would need another paper.

Conclusions

The interaction between matter is important to Hobbes. The small motion, conatus, begins the movement of the systems of nature, of systems of humanity, and systems of society.

The dynamical interrelation between mind and body, meanwhile, is fundamental to Kant. This relation with virtual presence is the prime power to move the body. Then, Kant examines the phenomena of the world from the viewpoint of this dynamical interrelation. Thus, it lies behind the systems of recognition, which are formed simultaneously with natural and social systems, according to Kant's philosophy.

Further the interaction between elements in systems is essential to complex systems (Kaneko 2010), which I have explained before (Takahashi 2015). I would thus like to say that Hobbes and Kant are pioneers of complex systems theory, just as Spinoza is a precursor of modern systems theory and Leibniz a patron saint of cybernetics.

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The following abbreviations are used:

Hobbes

De Corp: Elements of Philosophy, The First Section, Concerning Body, The Collected Works of Thomas Hobbes, Volume I, edited by Sir W.Molesworth, Routledge Thoemmes Press, London, 1992

Lev: Leviathan, edited by C.B.Macpherson, Penguin Books, London, 1985

Descartes

PW: The Philosophical Writings of Descartes I,II,III, translated by J.Cottingham et .al., Cambridge University Press, New York, 1984-91

Spinoza

BS: Benedict De Spinoza, translated by R.H.M.Elwes, Dover Publications, INC., New York, 1951-55

Leibniz

PPL: Philosophical Papers and Letters, translated by L. E. Loemker, 2 vols., The University of Chicago Press, Chicago, 1956

Kant

NS: Natural Science, translated by L.W.Beck et.al. Cambridge University Press, Cambridge, 2012
'Living Force': 'Thoughts on the true estimation of living forces and assessment of the demonstrations that Leibniz and other scholars of mechanics have made use of in this controversial subject, together with some prefatory considerations pertaining to the force of bodies in general' (1746-49) in *NS*

'Theory of Heavens': 'Universal natural history and theory of the heavens, or essay on the constitution and the mechanical origin of the whole universe according to Newtonian principles'(1755) in *NS*

Foundation: Metaphysical Foundations of Natural Science (1786), translated by M. Friedman, Cambridge University Press, Cambridge, 2004

CPR: Critique of Pure Reason, translated by N. K. Smith, Palgrave Macmillan, Hampshire, 2007

Lectures: Lectures on Metaphysics, translated by K. Ameriks, Cambridge University Press, Cambridge, 1997

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