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The Biomatrix Model:

The Development and Formalisation of a General Systems Model

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Dedication

This work is dedicated to the loving memory of my father,
who gently infused me with his passionate love,
and intuitive understanding of Nature.

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Abstract

The purpose of this thesis is the further development and formalisation of the biomatrix model as proposed by Járos and Cloete (1987). It focuses on the formulation and description of the model per se and not its application, and is essentially a *conceptual-theoretical study* positioned within the broader systems paradigm. The research is conducted within the framework of *new paradigm research* and the complete model is presented as its central theoretical thesis. The outcome of the research process is the formulation of the biomatrix model into a logically consistent and contextually congruent general systems model: to be viewed as a rigorously defined proposition.

The biomatrix model is a *general systems model* which views reality fundamentally as a web or *field of process-threads* criss-crossing physical or conceptual space. In a way this means that everything can be considered primarily as process, a notion that was expressed by Heraclitus in his famous saying "panta rhei" 2500 years ago. Process-threads interact and become focalised in certain areas, thereby giving rise to the emergence of focalised entities with qualitatively different properties. In addition to having an emergent core-body (classically associated with the notion of a discrete entity or system) these entities have an associated field of interacting process-threads permeating their surrounding space. **The biomatrix model views reality as a complementary matrix of process-threads and focalised-field-like-entities, respectively referred to as *teleons* and *doublets*.** Together they constitute the two fundamental classes of systems in the model. This dual and complementary approach towards the fundamental nature of reality is suggested to be analogous to the wave-particle duality in physics. In an ontological as well as epistemological sense the two classes are considered to constitute a complementary pair.

The biomatrix model thus introduces the notion of a 'wave-like' or a thread-like-process-system. It furthermore extends the classical notion of discrete entities or systems into that of focalised-field-like-systems with diffuse boundaries. It is proposed that the basic substance of all existence is an integrated field of matter, energy and information, referred to as *mei* (matter-energy-information). Together all systems constitute a dynamically organised field of mei in flux, referred to as the *biomatrix*. It is maintained that the web of thread-like, process-based systems exhibits a meta-pattern of *teleonomic continuity*, reaching across different levels of organisation within the biomatrix; hence the term teleon. The focalised-field-like-systems on the other hand exhibit a duality in their respective teleonic fields, with one pole in its field teleonomically directed at its outer environment and the other pole directed at its inner environment; hence the term doublet.

The observer is encouraged to search for and identify teleons within the field of observation. This leads to an abstraction of the integrated pattern or web of teleons, spanning the different levels of organisation under investigation (i.e. maintaining a *teleonic perspective* on a *multi-levelled reality*). This is radically different from the more conventional perspective on reality whereby the observer is in the first instance guided by the existence of discrete entities or 'things', followed by a study of their interactive processes. In the teleonic approach the focus is in the first instance on the process-threads traversing space, with the focalised entities strung along them like beads on a string, or drops of water on a spider's web. **The existence of 'stress' or uncertainty in terms of the outcome of processes within this teleonomic web gives rise to a state referred to as *telentropy*, inspired by (but not directly related to) the physical concept of entropy.**

The biomatrix may be viewed from different perspectives; this is analogous to shining different coloured light onto the biomatrix space, thereby rendering a particular aspect of its field more visible. In the first instance a distinction may be made between the doublets and the teleons, thus deciding whether the focus should be on the thread-like systems or the focalised-field-like systems; not unlike investigating wave-like or particle-like properties of sub-atomic entities in physics. **Both teleons and doublets may be looked at from what is referred to as the generic system aspects, i.e. from the perspective of *substance* (or mei), *dynamic organisation, ethos, teleos, process* and *structure.*** The model furthermore describes and explores the interplay between these aspects in terms of the evolution of systems in general. The analysis and synthesis of systems within the context of the biomatrix model (i.e. the application of the model) is referred to as the *biomatrix approach.*

The biomatrix model is potentially applicable to all types of systems, i.e. on all levels of organisation and in all spheres of being. It is a work in progress and at this stage of its development it is considered to be of especial importance in the biological, psychological, and social spheres, extending to and integrating all relevant levels of organisation in those fields. **It is considered a useful model in providing a conceptual map for reductionistic and holistic excursions into multi-disciplinary fields and its associated problems.**

However, **ultimately it is more than a way of inquiring:** it does in fact make very specific statements about the nature of all systems (e.g. causality and the notion of an 'emerging middle'), which if accepted as valid, would have profound epistemological and ontological consequences for our understanding of the universe in which we participate.

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We dance around in a ring and propose,
But the Secret sits in the middle and knows

Robert Frost

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1. Part 1: Introduction

Part 1 of the thesis document serves as an introduction to the thesis. It essentially sets the scene for the main body of the research work presented in this thesis, that is to say, the development and formalisation of the biomatrix model.

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1.1 Introduction

According to present wisdom, the world we live in consists of concrete entities of matter that interact with one another to create the processes of life. Therefore, priority is attached to entities, while processes play only a secondary role. This wisdom also determines the way we study life, that is to say, to explore structural entities before we concern ourselves with processes. However, such a view on its own is inadequate to gain complete understanding of the living world. An alternative notion of reality is introduced in this thesis, according to which life comprises a web of process-threads criss-crossing space in which concrete entities are not the basic components but emerge out of an interacting field of processes. This means that everything can be considered primarily as process, a notion that has been attributed to Heraclitus in his famous supposition that everything flows and is in flux.

There are thus two complementary views, namely, the classical view that endows concrete entities with priority and another view that gives this privilege to processes. It is proposed that greater recognition should be given to the latter, which unfortunately is not widely accepted at present. It is suggested that clusters of processes give rise to thread-like systems that traverse physical and conceptual space, with several of them interacting closely at localised points, giving rise to focalised field-like entities. Put differently "we should begin by assuming that all we have are actions and interactions. From this, we might begin to ask how it is that some kinds of interaction become recursive and appear to 'succeed' in stabilising and reproducing themselves, generating patterned effects such as organisations, whilst others disappear completely" (Chia 1996, p.53).

The arrangement of these process-threads in conceptual space looks something like a fisherman's net: the process-threads are the strings and the resulting focalised entities the knots. On closer examination of a fisherman's net one realises that knots are simply entangled strings and it is difficult to say where their boundaries are or whether they have any boundaries at all. The strings belonging to one knot 'reach out' towards neighbouring knots and it is difficult to say where one knot ends and where the next one begins. The boundaries of the knots are thus fuzzy, that is to say, not discrete. An even more 'illuminating' analogy for the fuzziness of the knot boundary is that of a shining star seen at a distance, from which rays seem to be emanating in all directions and extending into surrounding space for differing distances.

In the *biomatrix approach* the thread-like process systems are called *teleons* and the localised systems resulting from their interactions are referred to as *doublets*. The reasons for these names will become clear as we progress with this thesis. Together they comprise a network called the *biomatrix*. This word is derived from the Greek concept of *bios* that indicates the totality of life within the universe and of *matrix*, a mould or pattern that indicates the configuration of processes and entities.

We believe that it is possible to distinguish universal patterns within this universal web of matter-energy-information (mei) in flux as perceived by the observer. It is those patterns which are universally applicable to all parts of the web, i.e. a meta-pattern that we attempt to depict within the biomatrix model. In the words of Gregory Bateson:

> The *pattern which connects is a metapattern*. It is a pattern of patterns. It is that metapattern which defines the vast generalisation that, indeed, *it is patterns which connect*. (Bateson 1985, p.20)

The biomatrix model was thus created in response to a need for a process and field-based approach towards systems, where 'processes' and 'discrete entities' are viewed as complementary modes of manifestation within a broader field of mei in flux. This complementarity is considered to be analogous to the duality that exists for light, which can be considered either as waves or as an ensemble of discrete entities (i.e. photons). This dual approach is in contrast to the more traditional approach where discrete entities are regarded as the primary components of a system, with processes viewed as the interactions between these components.

1.2 Central theoretical thesis

The purpose of the thesis is to develop a generalised systems model; more specifically, it addresses the development and formalisation of the biomatrix model.

The model is potentially applicable to systems on all levels of organisation, extending from the atomic level through the cellular, individual, institutional, national and planetary levels. It deals with both the natural (animate and inanimate) as well as the human (psychological and social) spheres on all the relevant levels. In the quest for knowledge the modelling process searches for general principles which are considered to be universally valid for all levels and spheres of being.

The 'hypothesis' or *central theoretical thesis* is considered to emerge from the model in a qualitative sense, and the meaning of the thesis resides in the delimitation of its associated theoretical concepts, as well as the way in which they have been related and organised into a framework for conceptual inquiry (Reason 1981a). In this regard it should be noted that the thesis is neither aimed at the application, nor the validation of the model per se.

In the context of this thesis the model should be judged primarily on the basis of its "*logical consistency*", "*contextual congruence*" (Reason 1981b) and "*soundness of endeavour*" (Reason 1981c).

1.3 Theoretical paradigm

A researcher generally commits herself to a particular paradigm, because she regards that paradigm as more promising than other competing paradigms. Furthermore, the acceptance of a paradigm is regarded as a commitment by the researcher towards:

- a specific theory or set of theories and
- particular metaphysical assumptions and pre-conceptions (Mouton and Marais 1988).

Seen against this background, the biomatrix model is first and foremost grounded in the *systems* paradigm (Laszlo and Laszlo 1997). More specifically, the model has its roots in the paradigm of *general systems theory* (Boulding 1956; Mesarovic 1964; von Bertalanffy 1968; Laszlo 1972; Weinberg 1975). The biomatrix model puts great emphasis on the *teleonomic* nature of systems in general, and in this regard it has an affinity with the *purposeful systems* of Ackoff (Ackoff and Emery 1972).

The critical reader will recognise elements of general systems theory, cybernetics, system dynamics, soft operations research and soft systems thinking in the biomatrix model (Dash 1994; Lane 1994; Lane and Jackson 1995). One of the aims of the model is to serve as a conceptual map in order to facilitate looking at a problem from different perspectives, as opposed to serving as a quantitative model for the analysis and design of systems. In this respect it leans towards the "*soft systems*" paradigm as advocated by Checkland (Checkland and Haynes 1994).

The model focuses on *systems as organised processes* (or events) rather than as interacting entities. In this regard it is considered to be grounded within a *process* paradigm. The statement attributed to the Greek philosopher Heraclitus that "everything flows" is well known, albeit not that widely understood. For Heraclitus everything emerges from one substance, that, in turn, has a dynamic aspect (fire) and an informational aspect (logos) (Sabelli 1989, p.239): "Who, if not Heraclitus, was the great thinker who first realised that men are flames and things are processes?" (Sabelli 1989, p.237). In more recent times the process paradigm was philosophically argued by Whitehead (Whitehead 1969; Whitehead 1985). Aspects of the process paradigm has been introduced into systems theory by Checkland, in what he referred to as *human activity systems* (Checkland 1981). Jantsch viewed process from an evolutionary perspective (Jantsch 1979); and Smuts, with his theory of *Holism*, saw process as a fundamental tendency towards the evolution of "wholes" (Smuts 1987). The concept of the "*union of opposites*", itself seen as a process, was introduced by Sabelli (Sabelli 1991a; Sabelli 1991b). From the perspective of physics Capra explored the notion that *events* constitute the primary reality underlying the manifestation of the material world (Capra 1976).

The biomatrix model assumes that the *flux of mei* (matter-energy-information) constitutes a *field* in physical and conceptual space. In those areas where the field becomes 'dense', discrete entities

emerge out of the underlying field. The model furthermore introduces the concept of 'thread-like' process systems within this field, which are considered to be analogous to the concept of *field-lines* proposed in the field-theories of physics. In that respect the model is grounded within the *field* paradigm of physics, e.g. electro-magnetism, gravity and quantum physics (Einstein and Infeld 1966; Gribbin 1984).

Aspects of *chaos theory* (Gleick 1987; Ayers 1997), *fuzzy logic* (McNeill 1993) and *fuzzy system dynamics* (Tessem and Davidsen 1994) have been incorporated in the model (even if only in a metaphorical sense).

1.4 Novelty of the biomatrix model

The novelty of the biomatrix model is considered to reside in the way its constituent parts have been contextualised into a meta-framework for inquiry. At first glance one may argue that many of its individual elements have already been proposed by others and addressed in a variety of systems theories as well as other scientific disciplines. However, in most instances elements of the model have been contextualised or defined in a different way.

The following quotes from the literature are considered to set the tone for what has been aspired to in this thesis:

> Attention in the contemporary natural sciences has shifted from the description and classification of individual entities to the theoretical explanation of classes of entities forming ordered structures or events. ... Thus classical physics gave us particular entities as the ultimate furnishings of this world, with classification serving the primary heuristic purpose of building theories for calculating their behaviour. ... The new physics deals with ordered sequences of events, forming wholes, which can only arbitrarily, and usually without success in formulating exact laws, be analysed to individual components. The general construct for these ordered wholes is field. (Laszlo 1972, p.23)

> Before Clerk Maxwell, people conceived of physical reality – insofar as it is supposed to represent events in nature – as material points, whose changes consist exclusively of motions...After Maxwell they conceived physical reality as represented by continuous fields, not mechanically explicable...This change in the conception of reality is the most profound and fruitful one that has come to physics since Newton. (Einstein in: Laszlo 1972, p.23)

> Physics' conception of nature as forming ordered fields with complex subsidiary patterns is reflected in the new chemistry, where molecules are viewed as complex dynamic patterns formed by the sharing of the outer electrons (conceptualizable both as waves and particles) between several nuclei. Further counterparts to these concepts are found in biology.

> There, organisms are no longer viewed as discrete entities made up of similarly discrete components in some mechanistic type of interaction. The new concept of organism is that of a whole which, rather than being constituted by the mechanical interaction of discrete parts (organs, cells, molecules and atoms), forms a system within which such elements are discernible as co-ordinate subsystems endowed with boundaries consisting of semi-permeable surfaces, concentration gradients and energy transfer interfaces. Moreover, even the full organism is no longer thought of as a strictly delimited, rigorously bounded system but is believed to merge with its environment over a series of further boundaries, none of which are absolute (i.e. adiabatic walls). The organic boundaries themselves are interfaces, permeable to some – though not all – informations, energies and substances. ... Its concern is the discernment of ordered totalities constituting, at the basic physical level, fields, and on higher levels, systems within the fields, and systems within systems within fields – and so on, in a complex hierarchy of organization of nature. (Laszlo 1972, p.24-25)

> A true scientific breakthrough comes today when somebody has sufficient creative imagination – and courage to follow up, which may be even more important – to say: Let us look at the universe in terms of some new kinds of entities, some new kinds of units, or, what really comes to the same thing, in some new way of combining units; because combining units gives a new unit at the superordinate level. (Gerard in: Laszlo 1972, p.25)

> And the many breakthroughs which have occurred in the recent past, and are likely to occur in the next future, come when someone looks at the universe in terms of entities which are not atomic material substance but organized functional systems, related to one another by horizontal interactions within their own level as well as by vertical interactions between different levels. (Laszlo 1972, p.25)

1.5 Postulates of the biomatrix model

The primary postulates relating to the biomatrix model can be summarised as follows:

- A *field* of matter-energy-information in *flux* underlies all manifestation on all levels and in all spheres of the universe.
- 'Systems' and are considered to manifest in a *dual* and *complementary* manner: i.e. as *extended threads of activity* on the one hand, and *focalised fields of activity* on the other hand.
- The activity-threads and focalised-fields-of-activity together constitute a *multi-layered* and *holarchically configured* field of mei in flux (referred to as the biomatrix).
- A *continuity of 'teleos'* (i.e. a teleonomic continuity) exists in terms of parts of the mei flux across levels of organisation in the field.

- The teleonomic continuity constitutes a *symmetrical* and *complementary meta-pattern* in conceptual 'teleos-space' (i.e. a teleonomic projection in phase-space).

1.6 Expectations for the biomatrix model

The expectations for the biomatrix model may be summarised as follows:

- The model is envisaged to be a *generalised model* in the sense that it enables the observer to derive a better understanding of systems on all levels of organisation and in all spheres of manifestation (i.e. natural, social, psychological, biological, physico-chemical spheres).
- It provides a *model for inquiry* which might lead to a better understanding of the system under investigation (i.e. analysis), or alternatively the design of a system (i.e. synthesis).
- The model addresses the need for a formal *meta-language* which allows for the transfer of knowledge between specialised fields.
- It is supportive of different points of view as well as diverse fields of knowledge.
- It makes *ontological statements* about the quintessential nature of systems in general, which may serve as a basis for future inquiry into the nature of reality per se. The model is supportive of the need for a "universal organizational science" as suggested by Bognadov (Dudley 1996).

1.7 Potential application of the model

The biomatrix model is potentially applicable to all types of systems, i.e. on all levels of organisation, all spheres of being and in all fields of knowledge. However, at this stage of its development it is considered to be of especial importance in the *biological*, *psychological* and *social* spheres, extending to and integrating *all levels of organisation* relevant to these domains.

1.8 The modelling process

The biomatrix model essentially includes the following elements of modelling:

- The drawing of *distinctions* and focusing on different *perspectives* (i.e. by the observer).
- A *description* of the nature of each of these distinctions and perspectives.
- A higher order description of the *relationship* between distinctions which in its turn results in a higher order distinction (Keeney 1983).
- The notion of *metamodelling,* in addressing issues at a higher level of logic and of abstraction. "Higher level of logic means that we are modelling at the metalevel instead of the object-level inquiring system. Higher level of abstraction means that we are one step further removed from the real world of objects and things than when we modelled at the object level of abstraction" (van Gigch 1993, p.253).

The distinction between the ontological basis (i.e. the nature of 'being') and the epistemological basis (i.e. the nature of 'seeing') is not always that clear-cut within the biomatrix. We like to think of the biomatrix model as a complementary fusion between the two poles of 'objective' observation and subjective construction. Stated in the context of *cybernetic epistemology*: "It is only partially true that there exists a 'real' physical world outside our skins that we are capable of perceiving. The notion that an external world lineally acts upon our sensorium in order to shape the descriptions of representations is incomplete. Similarly, it is a partial view to see the entire world as made up by our prescriptions for construction" (Keeney 1983, p.50). Likewise the *phenomenalist* intention includes "the viewpoint of the observer within the scene of the study. It attempts to describe the manifestation of things within the context of 'being-in-the-world' "(Fuenmayor 1991b, p.450). Furthermore, "things are not simply in themselves, nor do they exist 'out there' independently from us. Their being is always constituted by a 'showing themselves to us', and by our way of access to them" (Fuenmayor 1991b, p.451).

The biomatrix model thus acknowledges the role the observer plays in experiencing 'reality' as well as his potential as a creator in constructing 'reality'. Likewise the model attempts to describe the 'objective' *being* of a universe which has evolved up to its present state, driven by an implicit creative potential of *becoming*.

1.9 The notion of a model as opposed to a theory

Mouton and Marais (Mouton and Marais 1988) argue that the *heuristic* function is the most common characteristic of a model, whereas the explanatory function is usually attributed to a theory. However, the differences between models and theories are largely differences of degree.

In a model an attempt is made to represent the dynamic aspects of the phenomenon under focus by illustrating the relationships between the major elements of that phenomenon in a simplified form. A model merely agrees in broad outline with the phenomenon of which it is a model. Certain characteristics of the phenomenon, considered to be irrelevant for the model, are conveniently excluded, while the most obvious aspects are emphasised. The value of this simplification is that it draws the attention of the researcher to specific themes. It is this guiding function of models that is referred to as its heuristic function (i.e. to discover or reveal). The model, by suggesting relationships between variables and concepts, does explain the order or pattern of that phenomenon in a superficial manner (Mouton and Marais 1988).

On the other hand, a theory can be defined as "a set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations between variables, with the purpose of explaining and predicting the phenomena" (Kerlinger in: Mouton and Marais 1988, p.142). Furthermore, "where the criterion of a good model is situated in its heuristic

potential (rather than its accuracy), the criterion of a good theory is associated with its ability to explain: the ability to explain actual relationships between phenomena" (Mouton and Marais 1988, p.144).

Bearing in mind these distinctions between a model and a theory, it can be stated that the biomatrix is considered to be a model. It may be regarded as a "precursive theoretical model" in the sense that "most models in the social sciences (in contradistinction to those in the physical sciences) are characteristically precursors to subsequent theories" (Mouton and Marais 1988, p.141). It is a theory in making, calling for validation under different conditions and in different spheres of manifestation. The more it is applied to actual situations and proves its "practical worth" (Reason 1988a) and ability to explain diverse phenomena, the more it may be considered as a formally validated theory.

1.10 Evolution of the thesis

The biomatrix model has been under development for a number of years. It originated from the work of Járos, pertaining to the generic organisation of physiological processes in human beings and higher animals (Járos, Guyton et al. 1980; Járos, Belonje et al. 1988), and was subsequently extended and generalised by Járos and Cloete (Járos and Cloete 1987). In 1990 an interdisciplinary discussion group was initiated in order to explore its relevant concepts. The group comprised Járos (focusing on the development of the model in general and its application to a variety of disciplines), Cloete (focusing on the development and formalisation of the model in general), Dostal (focusing on its development and application to institutional organisation), Edwards (focusing on its development and application to the field of psychology) and Muller (focusing on principles of harmony as inspired by music). Although formal meetings of the group were terminated in 1996, the exchange of ideas continued on a more informal basis. Numerous publications have seen the light since its inception, with co-workers from different disciplines contributing (as reflected in the biomatrix bibliography). Many people from a variety of disciplines were consulted for their feedback, both in informal discussions and at international conferences on systems theory. The outcome of this thesis was enriched by an on-going recursive process between the development and formalisation of the model on the one hand, and its application, on the other hand, to a variety of conceptual scenarios and practical case studies within the research group.

The model has already been applied in the fields of *psychology* (Edwards and Járos 1994a; Edwards and Járos 1994b; Edwards 1996; Edwards and Járos 1999) and *education* (Dostal and Járos 1996; Dostal 1997), producing two PhD theses in those fields; as well as to the fields of *healthcare*, *business science* and *governance* (Dostal and Járos 1994a; Dostal and Járos 1994b; Járos, Irlam et al. 1994; Járos and Peeno 1996; Dostal, Járos et al. 1997; Járos and Baker 1999) (see the biomatrix bibliography for a complete list).

The model should be regarded as in a state of evolution and certainly neither complete nor perfect. However, it is envisaged that its current state may serve as a congruent framework for future inquiry into its structure, content and validity. The validity and usefulness of the model should eventually prove itself through its application to a variety of real world problems across different disciplines. Time will tell whether it will ultimately survive, and have the ability to adapt and transform and become a viable theory within the conceptual environment of other competing and synergistic theories. In the words of Varela: "there are no personal creations without a context: that an idea has impact is an historical fact and not a personal adventure or a question of 'being right'" (Varela 1996, p.415).

1.11 Format and reading of the thesis document

The thesis is presented in six separate parts, followed by three appendices:

Part 1: Introduces the subject matter and establishes the context of the research work.

Part 2: Deals with the research paradigm for the thesis.

Main body

Part 3: Introduces and provides a contextual perspective on concepts, i.e. emphasises relationships between concepts.

Part 4: Provides a linear and reductionistic perspective on concepts. That is to say, concepts are introduced separately in a hierarchical order of increased complexity. Furthermore, each concept is reduced to its constituent elements in a reductionistic manner.

Part 5: Is essentially a culmination of part 4 and deals with the two classes of systems in the model (in a similar manner as the concepts dealt with in part 4).

Part 6: Discusses contributions, future research and conclusions of the thesis.

Appendix A: Presents a glossary of key concepts (i.e. an alphabetical list of definitions).

Appendix B: Presents a synopsis of the most important concepts, principles and contributions of the biomatrix model.

Appendix C: Presents a critical response to the systems paradigm, the biomatrix model and this thesis in particular.

Part 3 may be viewed as, and is written in the style of a 'story'. It introduces the theoretical concepts and puts them into context by way of a series of themes comprising six different chapters. It represents an experiential and exploratory perspective **primarily aimed at influencing the mindset of the reader.** Concepts are introduced in the context of a theme and sometimes re-explored in a

different context and from a different perspective. The 'story' sets out from one of many possible points in its journey of exploration and ends at one of many possible points of arrival.

Together, **Parts 4 and 5** constitute the **definition and in-depth discussion** of a series of concepts. Concepts are introduced in a linear way, i.e. in the sense of a hierarchy of concepts, each new concept relying on all the previously introduced concepts for its formulation. Together they constitute a hierarchical tree of meaning. Each concept is dealt with in a reductionistic way, i.e. by being reduced to its essential components or sub-concepts.

Part 3 and parts 4 and 5 essentially deal with the same subject matter, but from a different perspective and in a different style.[1] The reader is thus informed from two different perspectives (i.e. synthetic and analytic), considered to complement each other. Understanding and insight are meant to emerge from the complementary interaction of these two perspectives on the model. Inevitably, dealing with what is essentially the same subject matter from two different perspectives leads to a degree of repetition, which is intended to confirm understanding of the concepts and to clarify some of the detail.

The argument traces a 'spiral of understanding', which essentially remains open-ended, ready to be re-explored, leading to new insights, greater depth, perhaps even a new-found state of perplexity, to be followed by greater clarity. Understanding is intended to arise by means of "*internalization*" of concepts and principles through a "*contemplative process of holistic meditation*" (Muller-Merbach 1994, p.24), accompanied by an "*emerging change of consciousness*" (Murthy 1994, p.463).

The introductory and concluding remarks at the beginning and end of each part and chapter primarily serve to orientate the reader within the larger body of text; it is not intended to serve as an overview or summary of the work.

The theoretical constructs and terminology used in the model are defined in as precise a manner as possible. Definitions are either printed in italics or framed. In many instances the biomatrix model shares its terminology with other systems models or scientific disciplines. However, the definition of these concepts in the context of the biomatrix model may differ considerably from their conventional meaning. In a few cases it was deemed necessary to introduce a neologism, of which the *teleon* and *doublet* are probably the most important. As a constant reminder of their meaning, neologisms are

[1] Ideally these two perspectives should be written in *hypertext* to be read on a computer, in which case the reader would be able to 'jump' back and forth from a contextual or story perspective to a more reductionistic or analytical perspective.

often accompanied by, or interchanged with a descriptive phrase, e.g. *thread-like entity* for the teleon. In those instances where the meaning of a concept has not been defined or referenced in the text, it should be assumed that, given the context in which it has been used, the meaning is as defined in a standard English dictionary.

Bibliographic references in the text are all done according to a uniform format and always include the author's name in brackets, irrespective whether or not the author is actually mentioned in the accompanying text.

This thesis is informed by the belief that "our view of error does not necessarily have to be one of 'wandering from the truth'. Instead, we can see it as a feature of a path taken purposefully into uncertainty, as a consequence of necessary risk taking, and as a resource for designing. Perhaps that path into uncertainty, even though it may not bring 'truth', will trigger a leap to something especially useful and worthwhile" (Rowland 1995, p.287).

It should be noted that the subject matter of this thesis is the development and formalisation of the model and not its application per se. That is to say, it deals primarily with the formulation and contextualisation of theoretical constructs. Furthermore, it is not expected from the reader to be able to apply the model on the basis of reading this thesis alone. The numerous short examples presented throughout the work are meant to clarify the relevant concepts and should not be seen as formal applications of the model. A different interpretation of some of these examples would not necessarily detract from the concept being illustrated. Readers interested in the actual application of the biomatrix model are referred to the biomatrix bibliography (inclusive of two PhD theses dealing with its application).

Finally, it should be stated that in the completion of this thesis a balance had to be struck between a state of synthetic wholeness and a state of analytic perfection. Neither of these states has been attained and the end result, not unlike our human condition, lies somewhere in between these two extremes.

2. Part 2: Research paradigm

Part 2 describes the research paradigm within which the research work is conducted, namely new paradigm research with its associated qualitative research methods. It sets out to do this under the following headings:

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2.1 Introduction

The research methodology of the thesis is grounded in *new paradigm research* as proposed by Paul Diesling (Reason 1981b), and *qualitative research methods* as discussed in Mouton & Marais (Mouton and Marais 1988). The research paradigm adhered to in the development of the biomatrix model has been discussed by Edwards (Edwards 1996, p.77-86) and Dostal (Dostal 1997, p.4-9); what follows here is primarily an integration and summary of these two documents. The general nature of the research paradigm is perhaps best illustrated by the following two quotes:

> a potential discovery may be thought to attract the mind which will reveal it - inflaming the scientist with creative desire and imparting to him intimations that guide him from clue to clue (Polanyi in: Moustakas 1981, p.209);
>
> it would be a very healthy emphasis in the sciences if it was recognised that it is the dedicated, personal search of a disciplined, open-minded individual which discovers and creates new knowledge. No refinement of method can do this ... (Rogers in: Moustakas 1981, p.217)

Essentially, a research paradigm describes the principles on which scientists are supposed to base their approaches. Mitroff distinguishes two fundamentally different research paradigms (Rowan 1981):

- The conventional norms of science: e.g. faith in rationality, emotional neutrality, impartiality, suspension of judgement, absence of bias;
- The counter-norms: e.g. faith in rationality and non-rationality, emotional commitment, partiality, exercise of judgement, presence of bias.

Mitroff and Kilmann developed a model of the way scientists think about science (Reason 1981a). In this model, based on the psychological types as proposed by C.G. Jung, there are four different modes derived from two independent dimensions. The first dimension concerns the kind of input data the individual characteristically prefers (i.e. the informational dimension), and the second is about the preferred way of dealing with this information (i.e. the decision-making dimension). The two dimensions, being independent, can be represented by two orthogonal axes in a plane.

Concerning the information axis, it is assumed that individuals can obtain information from two sources, viz. internal sources, through intuition, and external sources, through sensation. It is also assumed that these two modes of obtaining information are mutually exclusive. Those who prefer to take in information through the senses are interested in details and the specifics of a situation; they prefer hard, realistic facts, and pay attention to the practical. By contrast, those who prefer to take in information through their imagination are interested in the whole, in the gestalt; they are idealists, interested in hypothetical possibilities, in what might be, in the creation of novel, innovative

viewpoints. (People can be very sensitive to external information and at the same time be very good at intuition, whereas some persons may be bad at both. However, the distinction, albeit limited, illustrates the point that there can be more ways of functioning than the simple analytical way.)

On the decision-making dimension, Jung saw two antithetical possibilities: on the one hand thinking, and on the other hand, feeling. Individuals who prefer thinking use reasoning which is impersonal, formal, or theoretical; they are interested in abstract generalisations. On the other hand those who prefer the feeling mode are interested in reaching personal value judgements which may be unique to the individual; they explain via empathy, and value things in human terms. This mode reaches its highest form in the variety of ethical systems which have been developed. (Again, the proposed antithetical nature of the two modes is an extreme case; after all, one can be very ethical and very rational at the same time. But the simplification will be accepted for the sake of the argument).

A juxtaposition of these different modes gives rise to four different quadrants, each representing a different mode of inquiry (see Figure 1). In reality each individual person will have a mode which is a mixture of all four, with perhaps one of the modes dominating in each case.

These four modes can be summarised as follows:

Analytical scientist (i.e. sensing / thinking mode): The aim of the analytical scientist is accuracy, certainty and reliability. The style of inquiry is the controlled experiment and the orientation towards science is impersonal, theoretical and unambiguous. Any endeavour that cannot be subjected to this approach is either suppressed, devalued or set aside as not worth knowing or capable of being known.

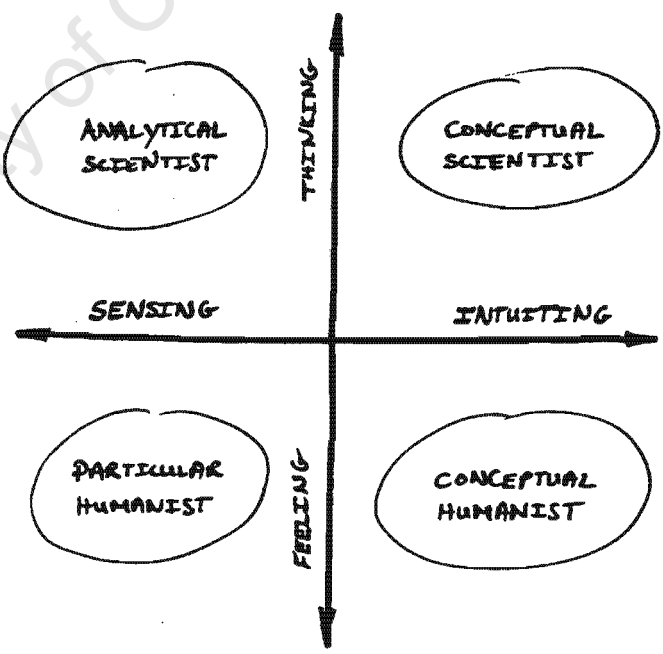

Figure 1: A typology of scientists

Conceptual theorist / scientist (i.e. intuition / thinking mode): The conceptual theorist shares the impersonal and theoretical orientation towards science with the previous category. However, whereas the analytical scientist is concerned with accuracy and certainty, the conceptual theorist is concerned with imaginative and speculative theory building. The aim is to construct the broadest possible conceptual schemes, with the emphasis not

necessarily on 'truth', but on coming up with an 'interesting' theory that may lead to further exploration. The style of inquiry is exploring, creating and inventing multiple possible representations of the world.

Conceptual humanist (i.e. intuition / feeling mode): This approach concerns passionate and personal knowledge. The goal is to develop a science that will further the development of human growth, awareness and personal welfare. Emotions, personal knowledge and values are accepted and acknowledged in the inquiry.

Particular humanist (i.e. sensing / feeling mode): The orientation of the particular humanist is similar to the conceptual humanist, but differs in that the focus is on the unique individual person; the individual case study is the preferred mode of inquiry, i.e. the in-depth detailed study of a particular individual.

The 'problem' is that the traditional scientific paradigm falls predominantly within the analytical-scientist mode of inquiry, whereas the other three types fall predominantly within the realm of new paradigm research. In addressing multifaceted problems it is not advisable to limit one's thinking to one particular extreme mode, but one has to open up to other ways of thinking and acting and preferably to utilise a mixture of modes for each task.

Although the development of the biomatrix model was approached predominantly within a *conceptual-theorist* and *conceptual-humanist* mode of inquiry, it was inspired by 'facts' derived from the *analytical-scientist* mode of inquiry and put together in an atmosphere where personal experiences in the particular humanist mode were valued and accepted. Information was obtained through personal observations in the biological, social and engineering sciences, as well as through the study of relevant literature, complemented by the process of personal imagination (i.e. the creation of novel and innovative viewpoints) (Mouton and Marais 1988). It therefore aims to be a truly multi-modal approach, compared to the limited analytical scientific mode.

The following sections address some of the philosophical ideas considered to be supportive of new paradigm research:

2.2 Critical subjectivity

Post-modern methodology represents a shift from objective consciousness to critical subjectivity (Reason 1988b). In this shift one goes beyond the split between subjective and objective to a quality of awareness where we do not suppress our primary subjective experience, nor allow ourselves to be swept away by it; rather we raise it to consciousness and use it as part of the inquiry process.

On the one hand it is recognised that:

> Observations are not absolute but relative to an observer's point of view; ...Observations affect the observed so as to obliterate the observer's hope for prediction. (Bateson 1972, p.1)

On the other hand, the role of the subjective describer of an apparently objective universe needs to be recognised:

> What we need now is the description of the "describer" or, in other words, we need a theory of the observer. (Bateson 1972, p.1)

This refers to the fundamental epistemological issue that perception is a product of the functioning of the nervous system of the observer, triggered by the external reality (Maturana and Varela 1992); that the mind does not passively receive information but actively and creatively structures it (Tarnas 1993); that it would not be possible to make a description if the observer did not have the properties that allowed him to generate such a description (Keeney 1983).

Heron (Heron 1981, p.26-27) suggests that one must appreciate that "my considered view of your reality without consulting you is a very different matter from our considered view of our reality." This is important to remember in suggesting and interpreting the meaning of research findings. Sabelli and Carlson-Sabelli (Sabelli and Carlson-Sabelli 1989) suggest that we mean what we say, whatever we think we mean to say. This indicates the importance of critical subjectivity since the method which we use to communicate in the research process is essentially one of language.

2.3 Complementarity of inductive and deductive research methods

Inductive and deductive research methods are not necessarily opposed to each other but may be complementary, whereby induction informs deduction and vice versa. Within the new paradigm, induction starts with a researcher's orientating constructs, which are informed by his experience and values. These are matched to a body of data, thereby reducing and focusing the data that could be collected. Deduction from the gathered data is used to modify and rebuild the original theoretical constructs (Sowden and Keeves 1990).

2.4 Heuristic research

Moustakas (Moustakas 1981, p.207) defines heuristic research as "a research approach which encourages an individual to discover, and methods which enable him to investigate further by himself." Often such research proceeds without hypotheses, research goals or a research design. Rather, these emerge in the course of other pursuits. Personal experience, intellectual, emotional and spiritual, may be important aspects of heuristic research. Literature studies are often added at a late stage in the research process rather than at the beginning. Therefore, the research is not clouded by

pre-digested ideas. Validation may occur in the form of feedback from related experiences of others. Self-inquiry and inquiry of the research subject are interrelated throughout the project, mutually informing each other (Moustakas 1981).

2.5 Recursiveness and self-reference in scientific investigation

Recursion refers to those processes which loop back into themselves by forming circular repetitive patterns of organisation. Recursions are, however, not a return to the same beginning, but generally imply a new beginning at a different level of organisation. For example, recursive cognition may imply that an intuitive understanding of a field of investigation serves as a basis for logical thinking, which in its turn may lead to insight and a deeper intuitive understanding.

In the context of research recursiveness includes the detection, description and analysis of underlying patterns of organisation; a distinction between different levels of organisation; higher order feedback (i.e. feedback about feedback); as well as the observer's observation of the process of observing (i.e. self-referential science) (Keeney 1983).

2.6 Wholistic or patterned knowing

Patterns describe the interrelationship of the parts that comprise the pattern. A pattern is a web of meaning, which cannot be understood by understanding its parts. Patterned and synthetic thinking can grasp meaning, while linear reductionistic thinking cannot. Often, patterns are repetitive, and can be extended and filled with more detailed information (Reason 1981b). The discerning of pattern or Gestalt as an aspect of reality is a "tacit co-efficient" of every scientific theory and is often associated with intuition. It involves perceiving a phenomenon as a whole or unity (Moustakas 1981).

2.7 Validity

The notions of absolute truth and certainty are challenged by new paradigm research. Consequently the issues of validity and reliability as used by the classical scientific paradigm are also challenged. Reason (Reason 1988a) refers to validity in the context of new paradigm research as "soundness of endeavours". Relative meaning, practical worth, individual and consensual judgement and triangulation are to be considered in judging the soundness of the research endeavour.

Meaning is essentially derived from relationships between concepts as they inform each other, whereas *validity* can be derived in terms of dialectical opposites, logical coherence, and evaluation of subjective knowing. *Validity* associated with dialectics refers also to the research process itself, as a process of dialectical engagement with the field of research (Reason 1988b).

3.1 The biomatrix: a holarchic and co-emerging field of teleons and doublets

This chapter serves to introduce the key concepts of the biomatrix model. In a sense it provides an overview of all the key elements of the model, although some concepts are touched on very briefly or perhaps only by way of being named. It relies strongly on the use of imagery and metaphors, in an effort to convey what is essentially a message requiring a shift in mind-set from our more conventional perspective on the world we live in.

As an introduction this chapter may seem rather 'dense'. Certain concepts or areas which may not be totally accessible at this stage are revisited at other points in this thesis, where their meaning should be clearer.

This chapter may be likened to the beginning of a novel, at which point the identity of the characters or the nature of the plot may not be entirely clear, but where the basis for interest and later illumination is established.

The chapter comprises six different themes, as depicted below.

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3.1.1 A field of co-emerging rays and stars and rays and ...

- *The essence of the world we inhabit and participate in, is that of thread-like-processes traversing space.*

The biomatrix model maintains that 'reality' on the one hand comprises *thread-like-entities* or 'rays'of matter, energy and information flux, traversing time and space; on the other hand it comprises *focalised entities* or 'objects' of matter, energy and information, whether material objects or 'objects' of information (e.g. concepts).

In all instances, what lies behind our actual perception of reality is matter, energy and information. We know that matter and energy are interchangeable (Einstein and Infeld 1966), and we also know that information is contained in both of them (Shannon and Weaver 1963). The three are thus like inseparable triplets that make up everything in this universe. To highlight this cohesion between them we have coined the word mei that stands for matter-energy-information (Járos and Cloete 1990).

In our observation and construction of reality we tend to favour the focalised entities or 'objects'. After all, they are the things we can see and touch and all those concepts and ideas we hold so dear in our minds. They give us a sense of a tangible reality like that of our own bodies, our planet earth and the soil we live on, the moon, and the sun that provides us with light and energy. Then there are our loved ones, the company we work for, the government we vote for or against, our distinct memories of the past and our ideas of a preferred future state. Together all these entities are thought of and expressed in terms of the most powerful 'objects' of them all, i.e. the symbols or words constituting our language.

We can hardly imagine a world without focalised entities. Yet, all these things emerge out of an underlying, more subtle and flowing reality in time-space (Bohm 1980; Bohm and Peat 1987; Hiley and Peat 1987), a reality which comprises threads or rays of ever-flowing mei. Put differently, "we should begin by assuming that all we have are actions and interactions. From this, we might begin to ask how it is that some kinds of interaction become recursive and appear to 'succeed' in stabilizing and reproducing themselves, generating patterned effects such as organizations, whilst others disappear completely" (Chia 1996, p.53).

Generally we are only aware of processes by virtue of their influence on the world of objects, and in our language verbs expressing actions are characteristically attached to nouns that represent entity-based systems (it should be noted though that intransitive verbs are not thus attached). We all know too well that objects (and concepts) evolve, move, get transformed and interact in a complex physico-psycho-social dance. The question that we have to ask ourselves is: where are the musical strands and what are the laws of harmony for this dance ?

Let us approach this question with a metaphor. Imagine an empty dancing hall in which the orchestra has taken its place and has started to play. The sound waves permeate and fill up the empty space: we can imagine the movements it might elicit from the dancers when they arrive, except that there are no dancers, only the sound waves traversing the air. As the first pair of dancers enters the floor the music immediately acquires a 'body': we can actually 'see' with our eyes. When the subsequent dancers join in, the dynamics change every time, albeit in a very subtle way, being dictated not only by the music but also by the interaction between the dancers. In fact, if we observe the dance from behind a soundproof glass without hearing the music, we could arrive at all sorts of conclusions about the nature of interaction between the dancers. However, should the mood or rhythm of the music change, there will be an inexplicable change in dynamics of the group, something completely unexpected and unpredictable, which we could never explain without listening to the actual music as well.

In summary, 'laws' and conclusions based on observation of the interaction between entities are partial truths. They will remain partial no matter to what extent and detail we study the processes of interaction until we become aware of and acknowledge the underlying process-strands that permeate and traverse space. These process-strands are the threads that connect and dynamically organise the components of the biomatrix into a whole.

- *The wave-particle duality of light serves as a universal metaphor for all observations made of reality.*

In physics the conceptual jump towards the dual nature of light was made at the beginning of this century. It is now known that light is *both* particle-like and wave-like in nature (Gribbin 1984; Feynman 1985). The implication of this is that when studying the interaction of photons (i.e. the particles of light) the observer arrives at certain conclusions and laws, which are known to be true, but which are only partial truths. Conversely, if the wave-like or thread-like nature of light is focused on, another set of laws of dynamics is arrived at. Together, these different sets of laws make up a greater truth and give us more insight. It should be noted that these two approaches require a change in both perspective and focus on the part of the observer (and the actual experiment for that matter). For example, we can observe the interaction of photons from a certain perspective and arrive at a description of the dynamics or logic of the process. This is often referred to as a "process approach", i.e. implying that we are focusing on the interaction between and changes within a group or system of particles. The fact is, until we re-assess our mind-set and means of observation, we will be unable to observe its *wave-like* nature. It is only once we have made a conceptual jump and followed this through in the real world, that we realise there is another dynamics as well. This is the dynamics of wave-like entities extended as a field in space and giving rise to another kind of behaviour (Gribbin 1984). For example, on a macroscopic scale a *field* of gravity and the existence of a warped space-time was postulated by Einstein (Einstein and Infeld 1966). He described warped space-time as a field engulfing all matter and influencing the dynamics of interaction between material objects, but at the

same time also being shaped by these very same objects (Clarke 1979). The biomatrix approach is an attempt at acknowledging and observing a universal field of waves or web of process-threads, traversing the biological and psycho-social domain. It requires first, and foremost, a re-shaping of our mind-set, and the eye will follow in due course. It is noteworthy that the term *'field'* does not appear as a core concept in the general systems literature (Robbins and Oliva 1982).

- *The process-threads (waves) and the focalised entities (particles, objects or concepts) are co-emergent; i.e. they come about in a mutually created and mutually sustained way.*

Let us return to the metaphor of the dance floor. There actually comes a time when the dancers become so immersed in the music that they start to take part in it. Something very ordinary, but at the same time very profound, happens: they start to sing in harmony with the music. They actually create their own music. From each individual dancer emerges her own music, some more in tune than others, and every now and again somebody comes up with a completely different melody which, if it is 'good', spreads among the group. At this point we can actually switch off the original music since the participants have become both the dancers and the musicians. The dancer and the music co-emerge, the dancers have become 'stars', each shining forth according to his own nature. Thus, the circle of co-emergence, of the field and the thing, of the rays and the star, is completed.

3.1.2 Setting the 'system' free: an exercise in seeing the light

- *The biomatrix is the interrelated web of process-threads and focalised entities that constitute all living and non-living things in the universe.*

The universe is thus viewed as a complex web of process-threads stretching into infinity in every conceivable direction, and the entities that we generally refer to as objects or 'things' are dispersed in space. It should be remembered that this is equally true for conceptual space, e.g. ideas, symbols and even laws (i.e. conceptual entities) as opposed to our 'lines of thought' (i.e. conceptual process-threads). When we have a closer look at these entities we see that they are actually situated at the points in space (conceptual or physical) where the process-threads converge and become dense. These entities are in fact the focal parts of the interactions where process-threads densely cluster together as if they are attracted to a point in space. When we have an even closer look it becomes apparent that each of these points in its turn gives rise to its own field of 'rays', or process-threads, 'radiating' into space. We thus have a web or network of interwoven 'rays' and 'stars'. The 'rays' become dense at certain points in space and give rise to the focalised entities or 'stars', which in their turn shine forth and create new 'rays' (see Figure 2).

Turning our mind's eye from the stars to the beach renders another rich metaphor, i.e. that of the fisherman's net. Always bearing in mind the limitations of metaphors, the web can be depicted as a fisherman's net: the connecting strands represent the process-threads and the knots the focalised entities (see Figure 3).

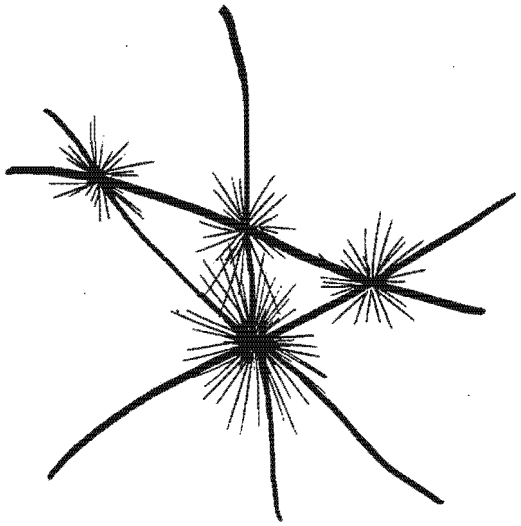

Figure 2: Interacting process-threads giving rise to focalised-field-like-entities

The universal web of all process-threads and focalised entities is referred to as the *biomatrix* (Járos and Cloete 1987). It is derived from the Greek concept of *bios* that indicates the totality of life within the universe, and of *matrix*, i.e. Latin for womb (in the sense of a space within which processes take form).

We believe that it is possible to distinguish universal patterns within the web of reality as perceived by the observer. It is those patterns which are universally applicable to all parts of the web, i.e. a meta-pattern that is holographic and fractal-like, that we attempt to depict within the biomatrix.

- *Teleons are fields (or clusters) of process-threads, and doublets are fields (or clusters) of teleons.*

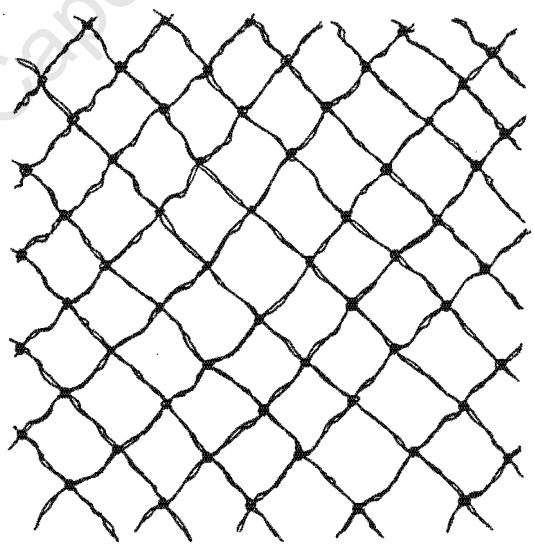

Figure 3: A fisherman's net as metaphor for the biomatrix

Upon closer inspection of the fisherman's net analogy, the strings turn out to comprise even smaller strands, in a similar fashion as the strands in a rope consist of thinner and thinner threads enclosed in each subsequent thread. The force or 'glue' that keeps all the threads together is the frictional forces between the strands. What keeps the processes in the biomatrix together turns out to be a shared function, goal and/or purpose. In biomatrix terminology, these concepts are collectively referred to as *teleos* (Greek for end) (Cloete and Járos 1994). Teleos is probably the most important concept that serves as the primary means of demarcating and 'grasping' such a collective cluster of processes. From a teleos perspective all the strands that constitute the collective process-cluster are

aimed at the same general direction in conceptual teleos space (Figure 4). As such, these clustered process-threads resemble arrows or vectors in conceptual teleos space.

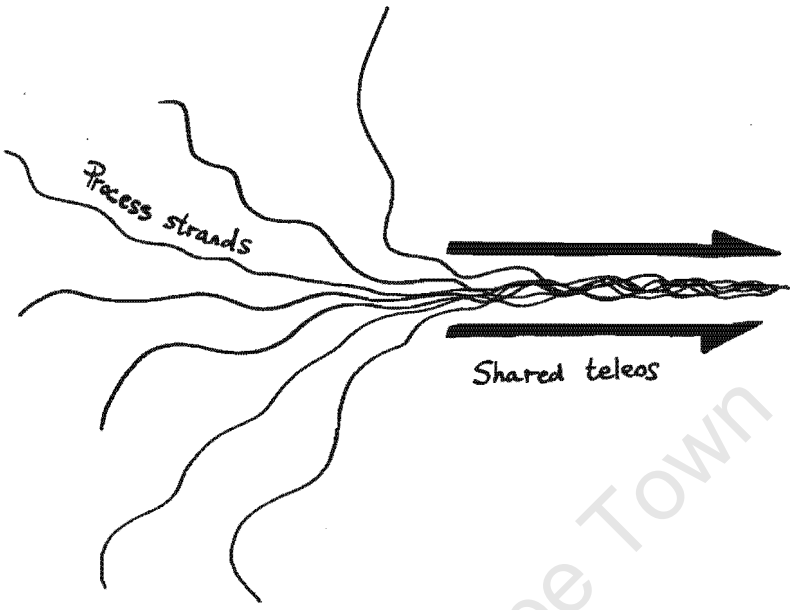

Figure 4: A cluster of process strands in teleos space

In biomatrix terminology these teleonomically clustered process-threads are referred to as *teleons* and constitute one of the two primary classes of systems in the biomatrix model (Cloete and Járos 1989; Járos and Cloete 1990). It is partly because of their relationship to teleos that they are referred to as such, but there is another reason why the name is appropriate. The "tele-" in Greek means to reach out or stretch far ahead in space and teleons generally stretch between two or more levels of organisation in the biomatrix space. The "-on" part of the word teleon is meant to highlight the existence of these teleos-related process-threads as autonomous systems in their own right. The teleon as a system is depicted symbolically in Figure 5.

'Focalised entities' are created where the vector-like teleons cluster around a focal point of attraction. The metaphor we choose to use is that of a tree. Both the branches and roots of a tree cluster together at the trunk which acts as a node of attraction or focus for both of them. The system of the roots and that of the branches represent two fields, reaching inwards towards the centre of the earth and reaching outwards towards the sky, respectively. The roots are thus

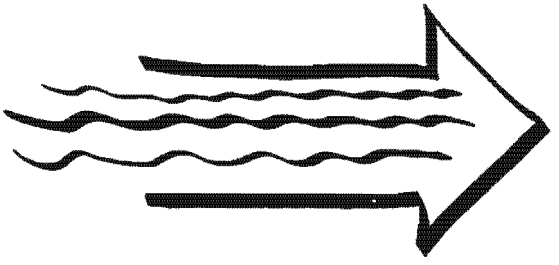

Figure 5: A symbolic depiction of the teleon

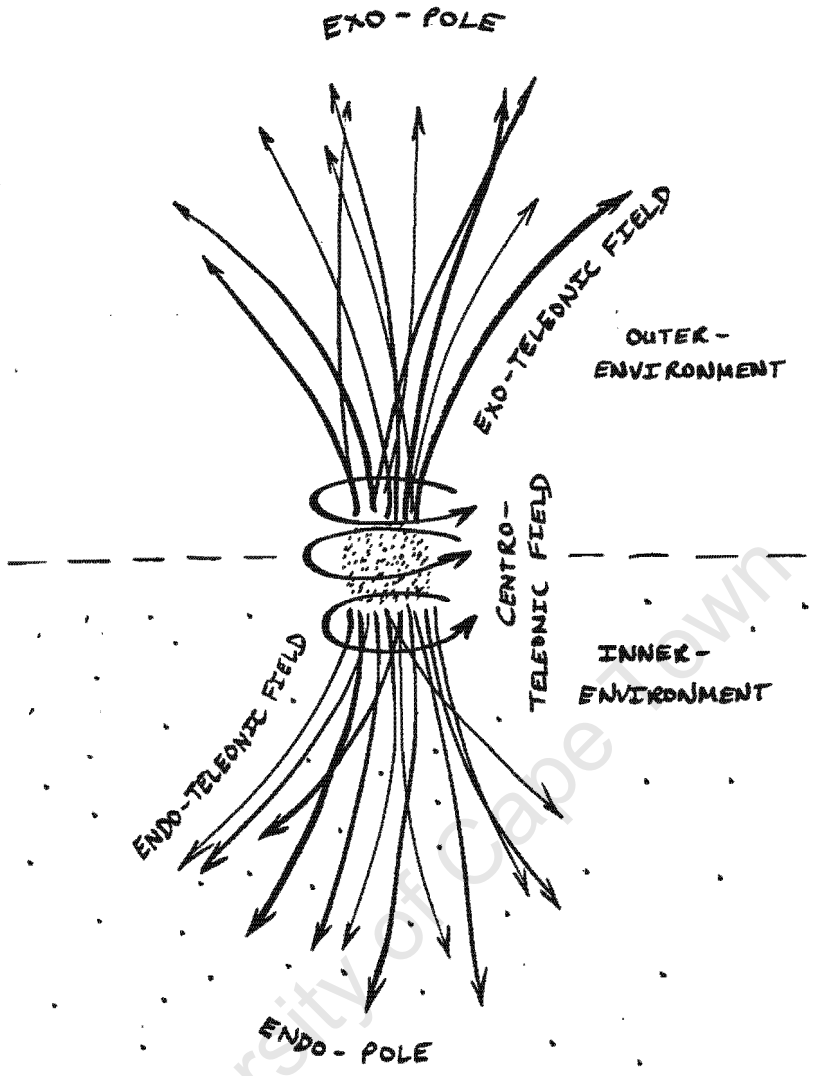

Figure 6: The doublet as a tree-like field of teleons

downward looking vectors and the branches upward looking vectors forming two major fields, i.e. the endo- and exo-fields respectively. Indeed, the tree is like the "Janus-faced holon" of Koestler (Koestler 1978). Within the trunk there are cohesive forces that pull the branches and the roots together into a whole, which is referred to as the centro-field. It turns out that the focalised-field-like-entities within the biomatrix are like the tree with its endo, exo and centro fields of teleons (see Figure 6). To highlight the important duality between the exo and endo fields we chose the name *doublet* (Járos and Cloete 1987).

The doublet represents the other primary class of systems in the biomatrix. Originally the term doublet was intended to describe the tendency of all these systems to comprise a bipolar field of teleons, or two clusters of teleons, i.e. those teleons 'aimed at' its inner environment (the endo-dynamic teleons or endo-teleons) and those 'aimed at' its outer environment (the exo-dynamic teleons or exo-teleons) (Járos and Cloete 1987). Subsequently other dualities present within the doublet were

also recognised and a third field was added, namely the *centro-field*. It refers to those teleons that are actually 'aimed at' the same doublet from which it originates, thus 'aimed at' itself. Conceptually this third field belongs to another plane of abstraction (the exo- and endo-fields are both in the vertical plane, whereas the centro-field is in the horizontal plane), and need not detract from the dual-field-like nature associated with the doublet. Another very important dual field was subsequently added, namely that of the exo-tapping-teleons and the endo-tapping-teleons, the teleos of both these clusters being to facilitate the 'linking up with', or 'tapping of', the available fields of teleons in the outer and inner environment of the doublet respectively. The doublet as a composite-field-like system in conceptual teleos space is depicted in Figure 7.

It must be noted that the doublet is not equivalent to the trunk of the tree in the metaphor but rather to the entire tree. As the roots and the branches stretch out from the trunk to varying extent it is very difficult to define where the boundary of the tree is. In the case of the roots there are micro-roots that

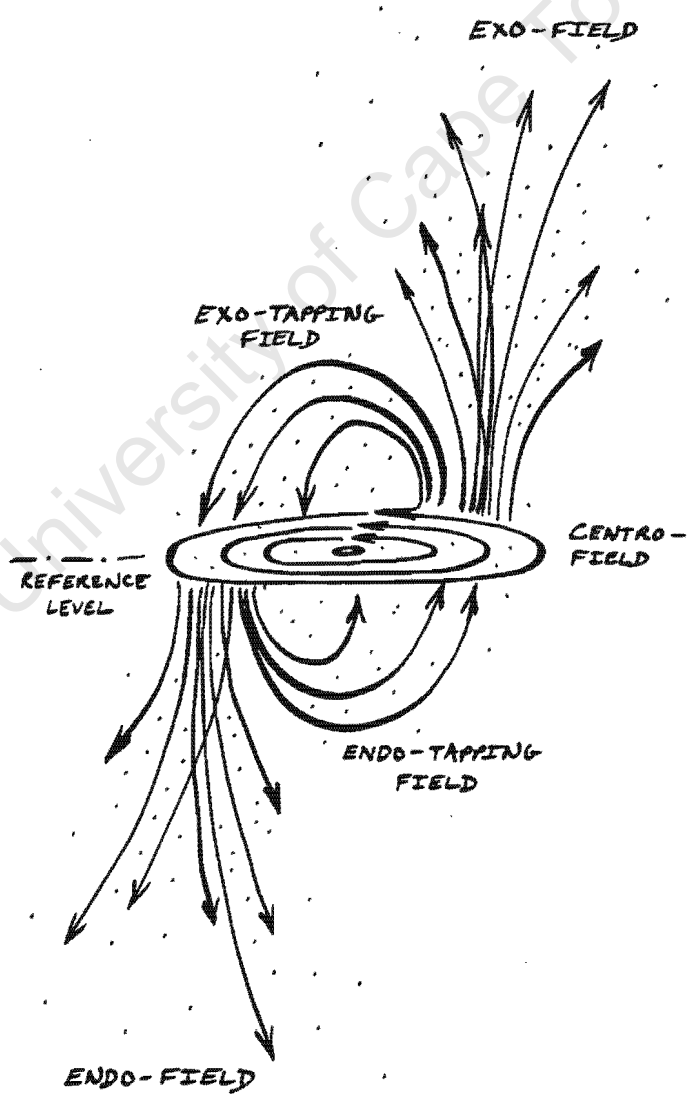

Figure 7: The doublet as a composite-field-like system in conceptual teleos space

can stretch out to great distances without revealing their existence to the naked eye. They are, however, part of the doublet called the tree. In the biomatrix, the doublets are ensembles of teleons. A doublet comprises more than just the entities we see, as it includes the entire field of processes reaching out from them. Thus we can say that the biomatrix, like the fisherman's net, consists entirely of process systems, viz., the teleons and focalised fields of teleons, i.e. the doublets. From this point of view, Heraclitus' notion of "everything flows" is supported by the biomatrix.

Associated with a doublet there always is a *nucleus* that provides the point of attraction or focus and serves as a reference for the 'self' or 'whole'. Ultimately, it is the nucleus which gives rise to the doublet as an autonomous and integrated system. It represents the shared organisational principles and values of the field of teleons (together referred to as the field of *ethos*). At this point the tree analogy falls short, except that one could, from a causal point of view, consider the original seed to be analogous to its nucleus. The image of a double spiral (i.e. the exo and endo teleonic fields) encircling a point of focus (i.e. the nucleus) is perhaps a more apt metaphor at this point (see Figure 8).

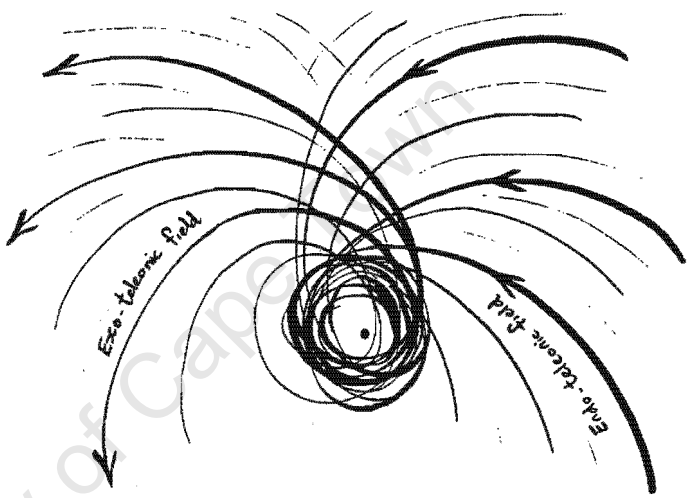

Figure 8: A double spiral encircling an attractor as metaphor for the doublet

A *core body* or *centro-body* may emerge from the interacting fields in the doublet (i.e. the area of densification as depicted in Figure 9). The core body is perceived as a discrete structural entity in space (conceptual or physical). In the case of living organisms the core body represents its anatomical body, whereas in social systems one may associate it with the physical premises of an organisation (e.g. the headquarters of a business organisation, the geographical region of a city or an entire country). The important point which needs emphasis is the fact that one should not mistake the core-body for the doublet. In other words, the emergent and discrete core body should not be confused with the entire field-like entity from which it arises, which comprises a vast field of teleons (i.e. clusters of processes) reaching into an outer- and inner space.

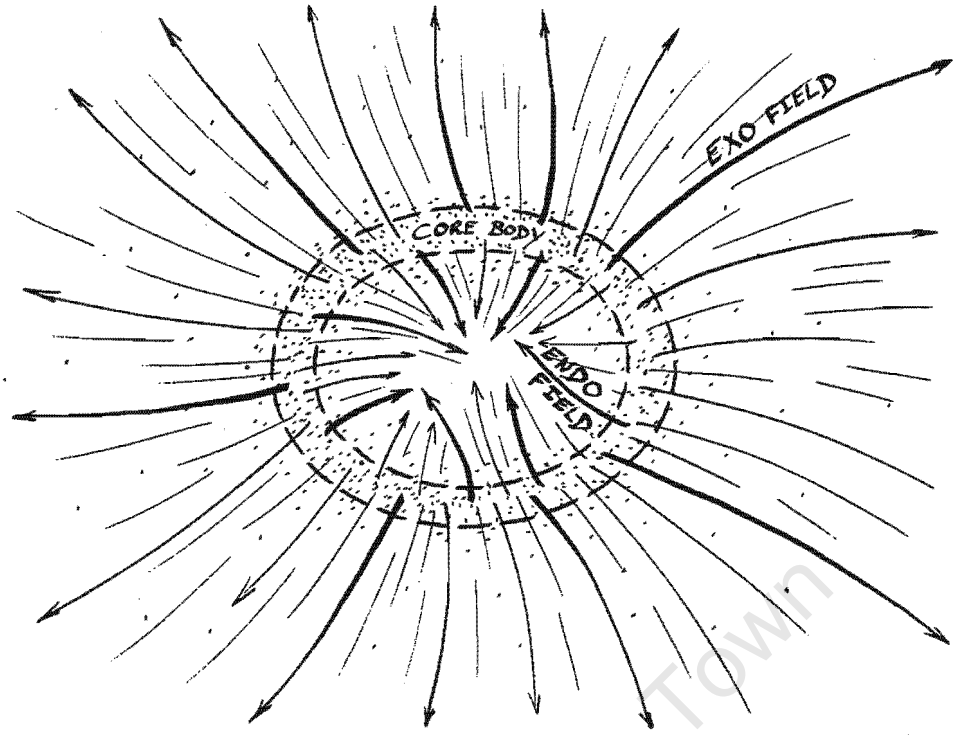

Figure 9: The core body of the doublet as an emergent entity with discrete boundaries

There are thus two types of *complementary* systems in the biomatrix: the teleons and the doublets. Both are process-based in the sense that they comprise a cluster or field of processes. However, in the case of the doublet the field is focalised in space around its ethos-related nucleus and may give rise to an emergent core body, analogous to a star and its circular field of rays stretching across the universe, whereas in the instance of a teleon the field is focalised in terms of its shared teleos, stretching like an arrow or bundle of light across space (pretty much like a bundle of laser light sharing the same frequency). These two types of systems are co-emergent and co-creating. That is to say, a doublet emerges from the interacting field of its associated teleons; and likewise, but viewed from another level of organisation, a teleon emerges from the interaction between its associated doublets. In our fisherman's web metaphor the threads actually emerge out of the interaction between the atomic doublets.

Although teleons and doublets are co-emergent, they both display emergent properties that are not present in its complementary pair. The doublet is thus different from the sum total of its field of interacting teleons, and the teleon is different from the sum total of its interacting doublets. Returning yet again to our metaphor: the knots are not the threads and the threads are not the knots.

- *The boundaries of the doublets and the teleons are field-like and fuzzy.*

Classically, when we refer to a system we draw boundaries, even though we acknowledge the openness of systems. In fact, it is the boundary which defines the extent of the system (Bailey 1995). In the instance of both teleons and doublets we are not dealing with distinct boundaries at all. There is a gradual distinction between the system and its environment, more like the glow surrounding a light source. It is not so much a matter of defining a boundary, but rather of identifying the focal area and exploring the area that is being 'lit' by its associated field. The extent of this area depends on the sensitivity of the exposure of the 'lens' through which the observer looks at it. The point of departure for a doublet is always its focalised nucleus (i.e. its shared ethos) which lends it an identity and ultimately serves to demarcate it as an entity (or system). Likewise, in the case of a teleon it would be its focalised teleos.

In addition to the boundaries being diffuse, they are also fuzzy. The fields of the respective systems within the biomatrix overlap (not unlike the glow of the stars) and are analogous to membership functions as defined in fuzzy logic (McNeill 1993). It should be noted that "the fuzziness of reality is a natural phenomenon rather than a result of our ignorance about it" (Sushil 1997, p.262). Interacting systems share a common field, or more appropriately, systems interact by virtue of the fact that their respective fields overlap (to a greater or lesser extent).[2] The boundaries of systems in the biomatrix overlap in a very fundamental sense, which is qualitatively different from defining systems with discrete boundaries interacting with one another *across* their respective boundaries (see Figure 10).

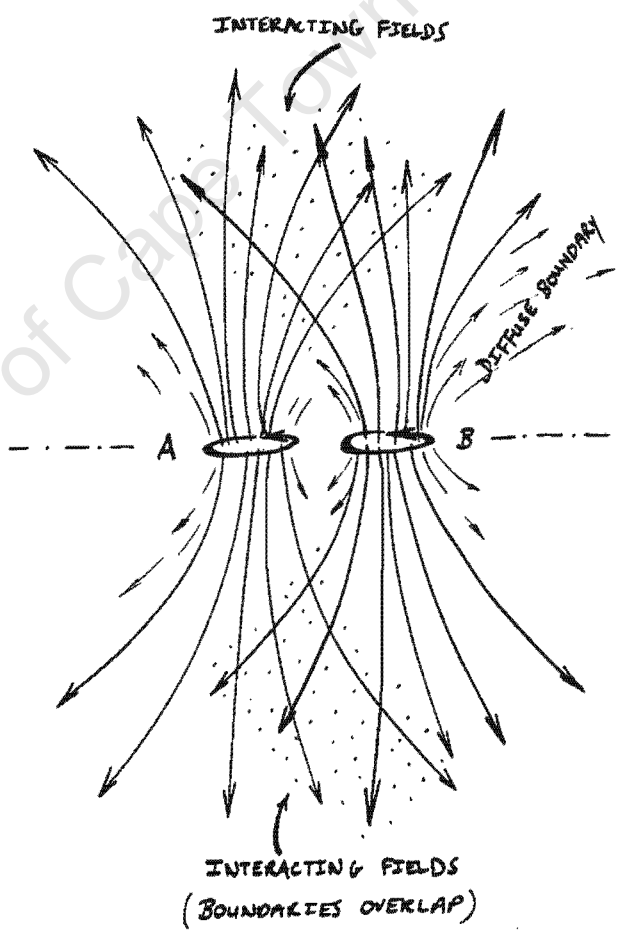

Figure 10: Field-like overlapping of doublets A and B

[2] This is not unlike the notion of *interaction at a distance* between entities as envisaged by Newton, as opposed to *interaction by virtue of a shared field of space-time*, as envisaged in the general theory of relativity by Einstein.

On closer examination of a fisherman's net one realises that knots are simply entangled strings, and it is difficult to say where their boundaries are or whether they have any boundaries at all. The strings belonging to one knot 'reach out' towards neighbouring knots, and it is difficult to say where one knot ends and where the next one begins. The boundaries of the knots are thus fuzzy, not discrete. An even more 'illuminating' analogy for the fuzziness of the knot boundary is that of a shining star seen at a distance, from which rays seem to be emanating in all directions and extending into surrounding space for differing distances. Looking at the 'stars' we thus have to learn to see them not only as points of light, but also to focus on the *glow* or field of *rays* which surrounds them, reaching into infinity. This glow or field represents the relative boundlessness of the doublet and its associated teleons.

3.1.3 Fractals, holograms and holarchies: fields within fields within ...

- *The pattern of the biomatrix resembles that of a fractal.*

When a particular doublet within the biomatrix is expanded in more detail we find that it actually contains a multitude of smaller doublets within its field, similar to *fractal* patterns (Gleick 1987). There are thus doublets within doublets, referred to as endo or sub-doublets relative to the doublet of focus. Likewise, the doublet of focus belongs to a more encompassing doublet, the supra-doublet. The same is true if we choose to focus on a particular teleon within the biomatrix: we find that it contains sub-teleons and at the same time it participates in a supra-teleon. Due to the fuzzy nature of both doublets and teleons, they may in fact belong to more than one supra-doublet or -teleon at the same time.

In addition to this repetition of the same structure within ever finer levels of distinction within the biomatrix there is also another type of embedding of pattern. If we were to expand a teleon, we find not only its sub-teleons, but also a multitude of doublets participating in its processes. These are referred to as the participating sub-doublets of the teleon. Similarly the teleon under focus may in its turn participate in a number of doublets. The complementary pattern of doublets and teleons thus repeats itself in its entirety, at all areas of focus within the biomatrix, no matter how small or how large, analogous to some fractal patterns (see Figure 11).

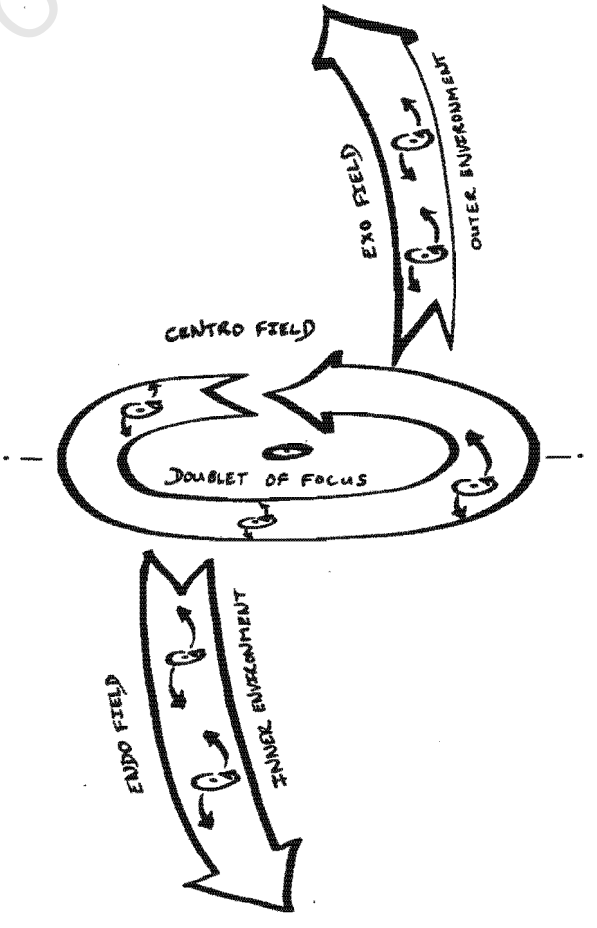

Figure 11: The fractal-like configuration of the biomatrix

- *The biomatrix is holarchically organised.*

The hierarchical structure of nature and its systems is widely acknowledged in systems theory (Wilby 1994). Wholes (or systems) cluster together to form larger wholes (or supra-systems) and so forth, giving rise to a root-like structure or hierarchy (Kline 1995, p.108). For instance, atoms cluster to form molecules, the molecules form living cells, the cells together form the organism, the organisms a society etc. (see Figure 12). This is classically referred to as a systems hierarchy. The biomatrix takes this concept a few steps further. Koestler suggested the concept of a holarchy (Koestler 1978), basically referring to the fact that there are holons (his term for a system comprising sub-systems and participating in a supra-system) within holons, making up the hierarchy. We would like to suggest the use of the term holarchy, but for a different reason.

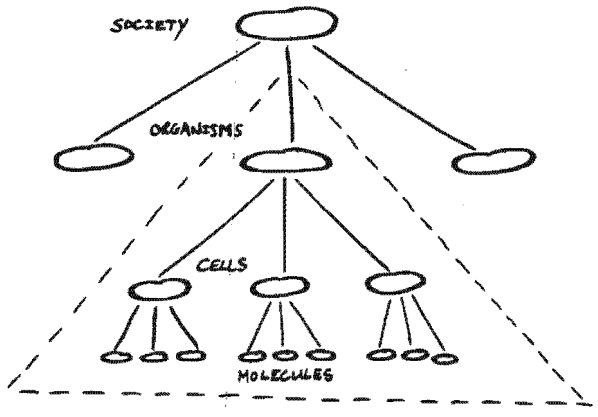

Figure 12: The classical pyramidal hierarchy of systems

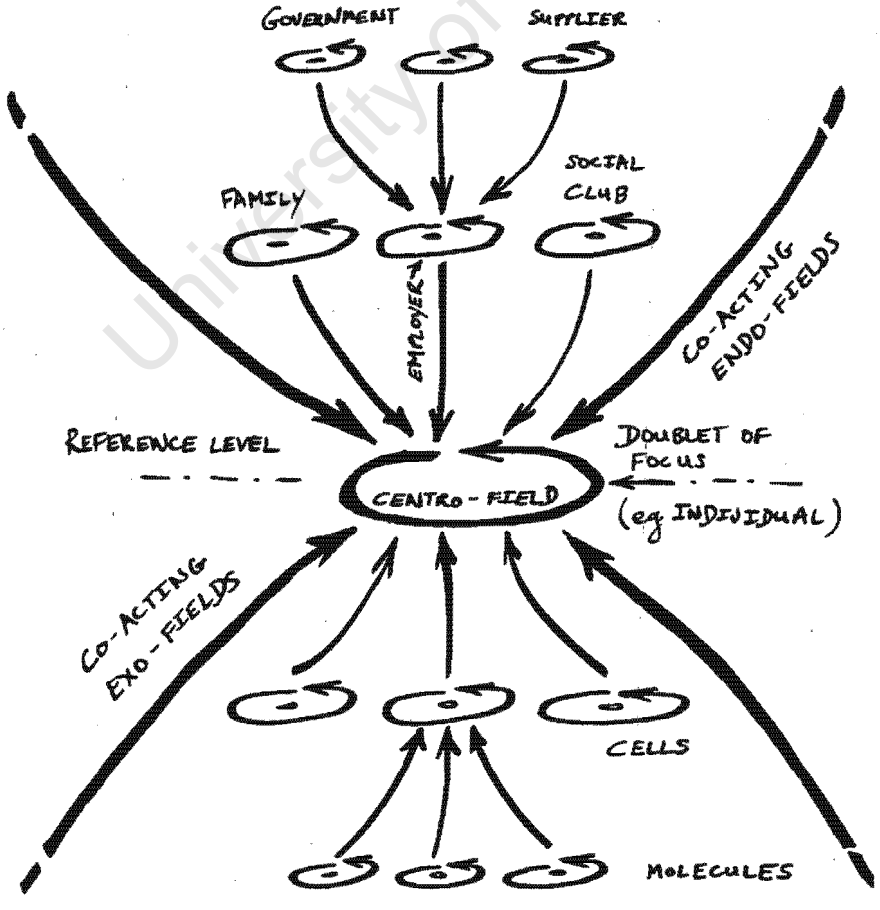

Figure 13: A symmetrical 'hierarchy' of fields

It turns out that the hierarchy within the biomatrix is pretty much like a hologram. It is not only a simple root-like structure, but actually contains mirror-like properties (referred to in physics as the principle of symmetry), giving rise to a complete tree with the hierarchy of its roots mirroring that of its branches. The 'hierarchy' of the biomatrix thus expands in both directions, relative to the point of reference of the observer (see Figure 13). In addition to its mirroring properties, the 'levels' of the 'hierarchy' within the biomatrix are not always hard and fast. Intermediate levels can actually be 'skipped', giving rise to a new 'hierarchy' where a very 'low' level directly links up with a very 'high' level. This is a direct consequence of the fields of all doublets (no matter how small or how big) potentially stretching into all regions of the biomatrix (the infinitely small and the infinitely large). It is in a sense analogous to the holographic plate where a very small section of the plate potentially provides the same holographic picture as any other larger section. This notion of reality is supported by the *holographic paradigm* in science (Wilber 1982). The holographic nature of reality is perhaps better explained through the metaphor of the wild fig tree (considered to be a holy tree in India). At certain points within its branches it actually forms roots drooping down towards the earth, and each of these points resembles a small tree in its entirety. It is a tree within a tree (see Figure 14). The 'hierarchy' of the biomatrix is thus not firmly 'grounded': some parts of it hang in the 'air' and repeat the same pattern again; it is in a sense a very dynamic, 'distributed' and relative hierarchy. For all the aforementioned reasons we prefer to call it a *holarchy* (i.e. referring to its holographic nature).

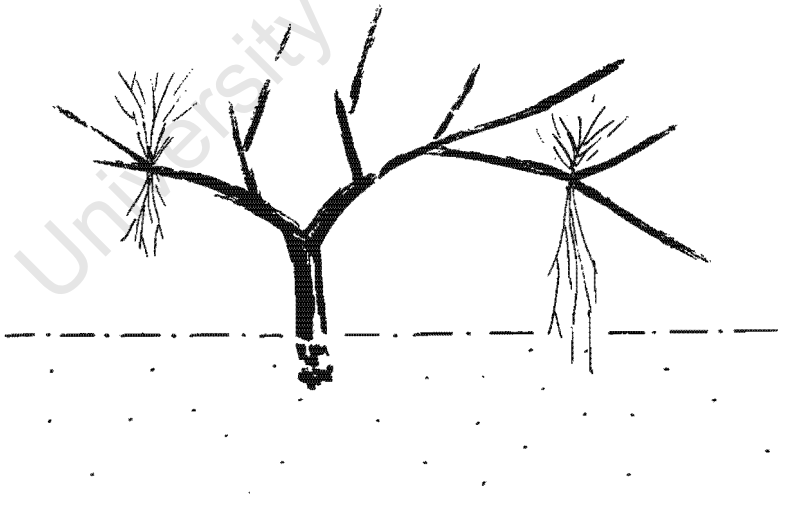

Figure 14: The fig tree as metaphor for the holarchy

3.1.4 The biomatrix: multiple perspectives on reality

The matrix of doublets and teleons and their relationships forms a rather complex configuration when we try to depict the real world. Building a conceptual model of the world 'out there' always remains a subjective exercise, no matter to what extent we try to justify an objective approach. The decision as

to what we want to model is our first subjective choice. This is followed by a decision as to from what 'angle' we wish to model the thing under observation and to what level of detail. This is in a sense analogous to an artist deciding what she is going to paint and then deciding what style is going to be used. Realism, expressionism and abstract art all depict the same thing but with very different end results, depending on the personal preferences of the painter, his own style and also the message to be conveyed. In the end, no matter how much we theorise about it, the proof of the pudding is in its eating. We stand in front of a painting and it either does something for us, or it does not. It is either meaningful and enriches our perception and understanding of things, or it is not. The biomatrix approach is something in-between a technical drawing and a work of art; the scope is there to explore it in either direction.

The biomatrix potentially contains all those aspects of a system that we consider to be primary and universal. These are: its ethos, teleos, process, structure, dynamic organisation (intended and emergent) and the substance (mei). All these things pertain to different aspects of the same system(s), while remaining distinctions in the perception and mind of the human observer, some of them having more of an objective reality than others. It is easier to reach inter-subjective agreement and thereby attain a degree of objectivity on something like the structure or anatomy of a human being, than to reach agreement on an individual's ethos (i.e. values and beliefs). This does not mean the one is more important or meaningful than the other.

The biomatrix model maintains that our personal 'reality' comprises both a "*constitutive ontology*", where things are brought into being by being distinguished, as well as a "*transcendental ontology*", which assumes access to a true reality (Mingers 1997). It is suggested that reality should be looked at from as many angles as possible, always retaining a balance between what is objective and 'known for a fact', and that which is subject to our own personal perceptions and feelings.

The biomatrix could be viewed as a multi-dimensional matrix of all the different aspects of systems and their relationships. The biomatrix model provides the observer with a 'map' to approach and explore totality from different perspectives, in the end to arrive at a better understanding. What is being explored may be painted only in bold strokes, depicting only its outline, but capturing its essence with the option to paint certain parts or aspects in minute detail. The approach may be likened to shining a different coloured light through a multicoloured net, lighting only a single colour at a time and projecting this onto a conceptual map. We could for instance light up the mei flow within the matrix, thereby looking at the fields from a pure mei perspective. This would effectively foreground and trace all the lines of mei flow between the doublets, i.e. look at what is actually flowing in space.

Alternatively we can look at a meta-pattern, a pattern of patterns of flow. In this instance we actually look at the mei lines of flow in space and then complement this with another level of abstraction, namely that of teleos. This view is referred to as the *teleonomic projection* and it looks at the pattern

of teleos super-imposed on the pattern of mei flow. We consider this to be one of the most meaningful and insightful projections to be made within the biomatrix. It is indeed "the pattern which connects..." (Bateson 1985, p.20). In fact, it is from this teleonomic projection that the exo-, endo-, centro- and tapping-teleons of the doublet were derived.

3.1.5 The pattern that connects: a universal meta-pattern of teleos

Pre-empting possible criticism with regard to a teleological approach based purely on religious notions (i.e. teleology), creationism or anthropomorphism, it should be noted that the concept of teleos within the biomatrix is more widely defined. Teleos refers to any *attractor or preferred state (in conceptual space) towards which the state of a system tends to be attracted or dynamically organised.* It either emerges from the system and is being observed (abstracted) or is intended (projected onto the system). A system is considered to be attracted towards a preferred state if it persists under different prevailing conditions in its present state, or persists to progress towards a particular future state (or end-state). Whenever a system exhibits the aforementioned properties it is said to be *teleos-related.* The overall concept of teleos is inclusive of and depicts a range of concepts in the same class: i.e. purpose, mission, ideal, goal, objective, strange attractor (as in chaos theory) and function.

Let us make a brief exploration of this meta-pattern of teleos. It is essentially a 'linking' of the individual doublets within the biomatrix. For the purpose of this discussion let us assume $\mathbf{D}_0$ (our doublet of focus) is a human-being (i.e. $\mathbf{D}_h$).[3]

[3] In order to avoid confusion and to facilitate discussion we have designed a shorthand notation:

- For doublets a subscript defines the relative level at which the doublet is considered to be located and the parenthesis identifies the particular doublet either by number or name.
- Therefore $\mathbf{D}_0$ is a doublet situated at the chosen level of reference. $\mathbf{D}_{-1}$, $\mathbf{D}_{-2}$, $\mathbf{D}_{-N}$ are subdoublets relative to the doublet of focus. For example $\mathbf{D}_{-1}$ (cell) denotes a cellular subdoublet considered to reside on level (-1) relative to the human doublet $\mathbf{D}_0$ (human), and $\mathbf{D}_{-2}$ (molecule) is a molecular subdoublet considered to reside on level (-2) relative to the human doublet. Likewise $\mathbf{D}_1$, $\mathbf{D}_2$, $\mathbf{D}_N$ are supradoublets. For example $\mathbf{D}_1$ (family) denotes the family supradoublet considered to reside on level 1 relative to the human doublet, and $\mathbf{D}_2$ (society) denotes the societal supradoublet considered to reside on level (2) relative to the human doublet. This notation may be further shortened. For example $\mathbf{D}_{\text{human}}$ denotes a human doublet and by implication resides on the level of human organisms.

Footnote continued on next page.

Let us first focus on the teleonic field originating in its outer environment, with the endo-teleons originating from the societal doublet and interpenetrating the human doublet, i.e. T-endo $_{s\rightarrow h}$ (see Figure 15). Such an endo-teleon could, for example be the teleon for food production or the teleon for the provision of knowledge within society.

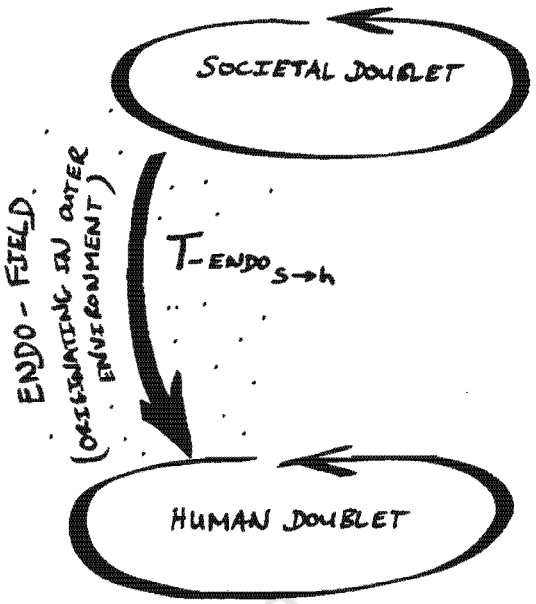

Figure 15: The endo-field originating within the outer environment

However, it is one thing for a teleonic field to interpenetrate the space or teleonic field of another doublet, and another thing for it to be fully assimilated by the doublet of focus (thus being integrated with its own field). This requires an act of 'tapping' on the part of the doublet of focus, either as an intentional or autonomic process. Tapping teleons are depicted by a vector which starts at the origin, taps into another field and then returns to its origin.

An example of this would be $T_{0\rightarrow -1\rightarrow 0}$ through which the human doublet internalises through her own actions what is being offered by the societal endo-teleonic field. For such an internalisation it is essential that one has the ability and desire to do so. Thus for these endo-teleons to be assimilated within the human doublet, some sort of facilitation has to be

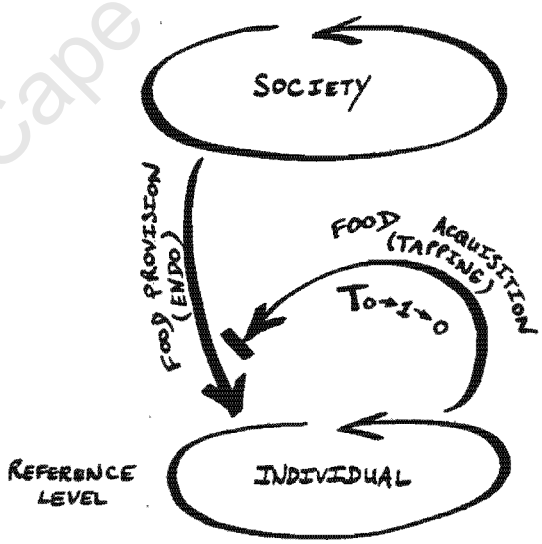

Figure 16: Tapping into the external environment

- For teleons the subscript denotes the direction or route of the teleonic 'vector': i.e. the level (or doublet) from which the teleon originates and the level (or doublet) it is directed at. Thus, Tendo $_{s\rightarrow h}$ is an endoteleon from the societal level, aimed at the human level. In this case one knows that the societal level is higher than the human level and therefore the teleon is an endoteleon. In the relative notation, Texo $_{-1\rightarrow 0}$ is an exoteleon from a level below the reference level, aimed at the reference level. The exo nature of the teleon is evident from the fact that the teleon is directed from a lower (-1) to a higher level (0).

effected, either as an intentional or autonomic process. For example, at the very least we have to use our hands, open our mouths and swallow in order to assimilate the food 'on offer' in our outer-environment (see Figure 16). Similarly the search for and being receptive to knowledge requires some attunement or 'tapping'.

Tapping can also be completely passive. For example, our cells also absorb energy of the sun through an endo-teleon originating at the level of the solar system and reaching out towards the molecular level. In this instance it happens by virtue of an attunement between our molecules and the solar spectrum; however, it is still a 'tapping' which comes about through an attunement to that window of energy on a molecular level.

In all these examples the process entails a tapping into the teleonic field originating within the *external* environment of the doublet. It thus referred to as an exo-tapping teleon and depicted as follows (see Figure 18): **T**-exo-tap $_{0\rightarrow 1\rightarrow 0}$.

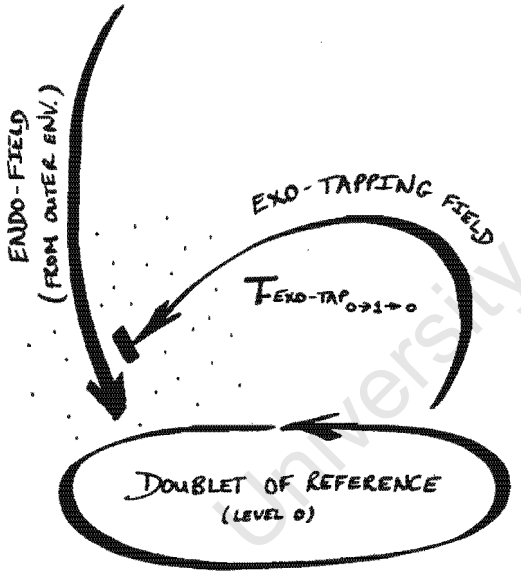

Figure 18: The exo-tapping teleonic field

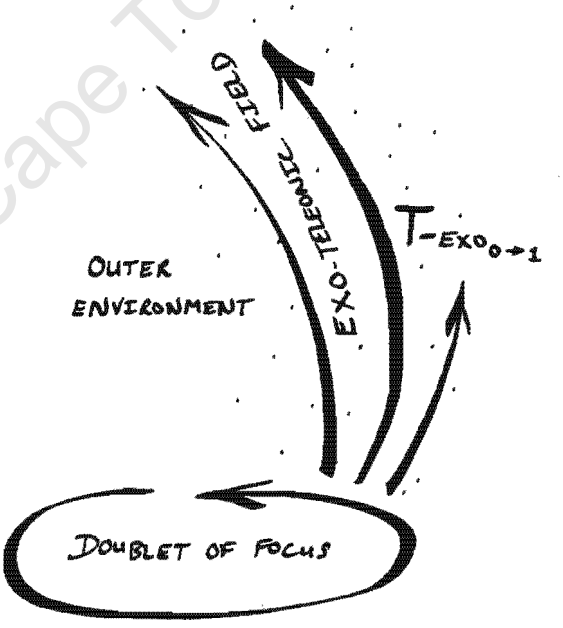

Figure 17: The exo-teleonic field

Let us now focus on the exo-teleonic field originating from our individual and extending into his outer environment, i.e. the exo-teleons (see Figure 17): **T**-exo $_{0\rightarrow 1}$. This field of teleons represents the individual's contribution to his outer environment, for example, being productive at work, giving to another person, building a house, or planting a tree.

This exo-teleonic field is also tapped, but this time from the level of society inwards (i.e. directed at its members). These teleons are referred to as endo-tapping teleons (see Figure 19): **T**-endo-tap $_{1\rightarrow 0\rightarrow 1}$. For example, an employer not only 'employs', but has to tap into the full potential of each employee.

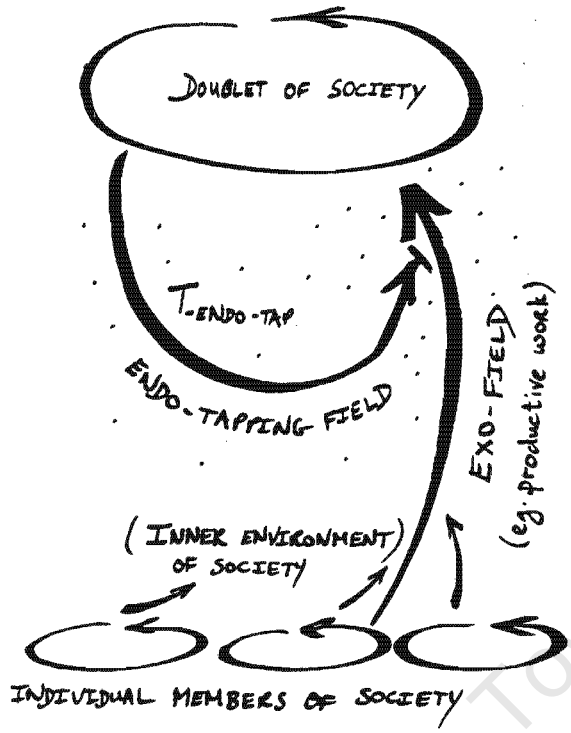

Figure 19: The endo-tapping teleonic field in society

Likewise society actively taps into the resources of its individual members through a variety of institutions.

The teleonic field which maintains the identity and integrity of a doublet as a distinct entity is referred to as the centro-teleonic field. This field constitutes the centro-teleons. A centro-teleon originates at the doublet of focus and refers back to itself (see Figure 20): **T**-centro $_{0\rightarrow 0}$.

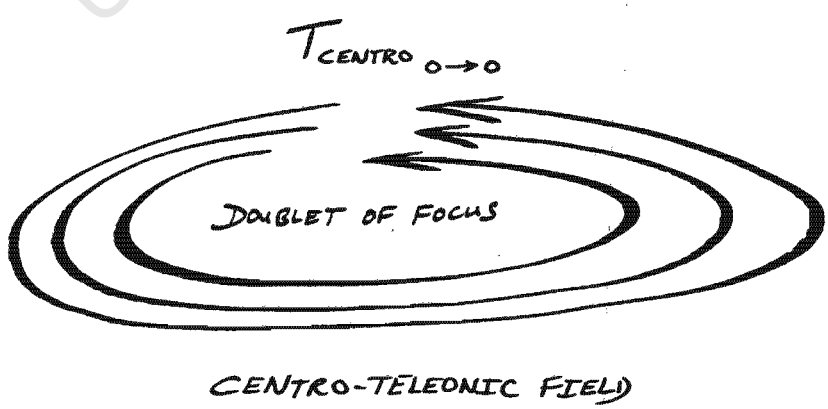

Figure 20: The centro-teleonic field

In the human being centro-teleons are the processes which create and maintain a sense of self and which lend us an identity which is distinct from that of our neighbour. It includes all those processes which are neither aimed at our inner environment (i.e. the cells) nor our outer environment (i.e. the society in which we participate), but rather at 'ourselves' or the ego. In an individual, parts of the central nervous system perform this role, e.g. the processes of self-reflection and self-preservation. This is also the field in which our selfishness is enacted. For instance, we may consume food not because we are hungry or because we participate in a social activity, but purely for our own personal enjoyment. The nervous system may 'make a decision' (either consciously or unconsciously) to put certain groups of cells in danger, or fellow members of society for that matter, in order to preserve the integrity of the individual. For us human beings, though, the greatest of all centro-teleons is the act of becoming self-conscious.

Let us now focus on the inner environment of the human-being-doublet, and start with the endo-teleonic field aimed at the cells within the body (see Figure 21): **T**-endo $_{h\rightarrow c}$. This field of teleons permeates the inner environment of the doublet and therefore also the outer environment of the cell-doublets. It is teleonomically aimed at the level of the cells. For example, it is the process of providing oxygen to the cells, but at the same time it is also the process of removing carbon-dioxide from the cells. This last point illustrates a very important principle of the teleonomic projection, namely the fact that the direction of the arrows or teleons is not determined by the direction of the flow of the mei, but rather by the direction of its related teleos in the conceptual teleonomic space. The devil's advocate could easily argue that the teleos of the production of carbon-dioxide and its subsequent removal from the cells is a matter of serving the needs of the trees in our environment and that the

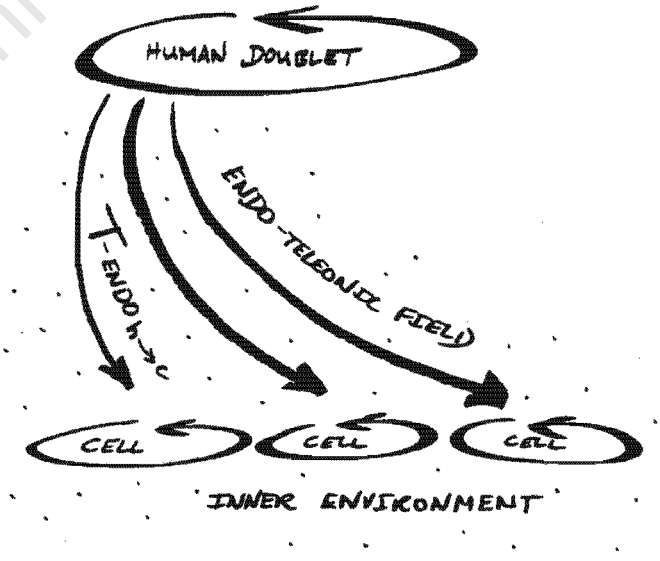

Figure 21: The endo-teleonic field relative to the human doublet

arrow therefore points up towards the environment rather than down towards the cells. Whenever in doubt about the direction of a teleon, observe its governance and from this position draw conclusions as to the possible teleos it may serve. In the case of the removal of carbon-dioxide, the process is regulated in such a way that it maintains the levels within the blood within very narrow levels. The regulatory probes are situated within the inner environment and certainly not the outer environment of the doublet. It thus appears that the regulatory 'concern' is in this instance for the cells participating in the inner-environment and certainly not the trees in the outer environment of the doublet.

The cells also have to tap their outer environment through an exo-tapping teleon (see Figure 22): **T**-exo-tap $_{c\rightarrow h\rightarrow c}$. For example, the process of taking oxygen from the blood depends, amongst other processes, on an active transportation process (initiated from within the cell) across the cellular barrier (i.e. the core body of the cellular doublet).

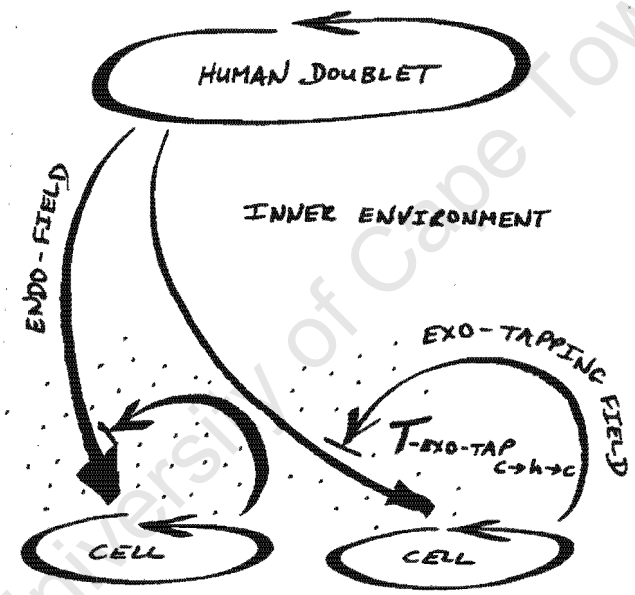

Figure 22: Exo-tapping fields of cellular doublets in the human doublet

The cells in their turn also make certain things available to the body at large, i.e. their exo-teleonic-field (see Figure 23): **T**-exo $_{c\rightarrow h}$. For example, the secretion of hormones, the release of metabolised food substances, and the mechanical contraction of muscle cells that contributes to the functioning of our bodies as a whole.

In its turn, the organism has to tap into these fields of activity referred to as its endo-tapping-field of teleons (see Figure 24): **T**-endo-tap $_{h\rightarrow c\rightarrow h}$. For example, we tap into the contractile potential of our muscular cells in the act of walking, we also tune into the electro-chemical activity of the brain cells in all our thinking processes, ultimately becoming self-conscious in the process. Thinking is largely an intentional 'switching on' of the brain and tuning into or 'listening-in' on the inner 'conversation'

emerging from the level of the brain cells. The body also chooses to suppress the contribution of some cells and favour those of others, for instance the development of particular innate skills and the relative under-utilisation of others.

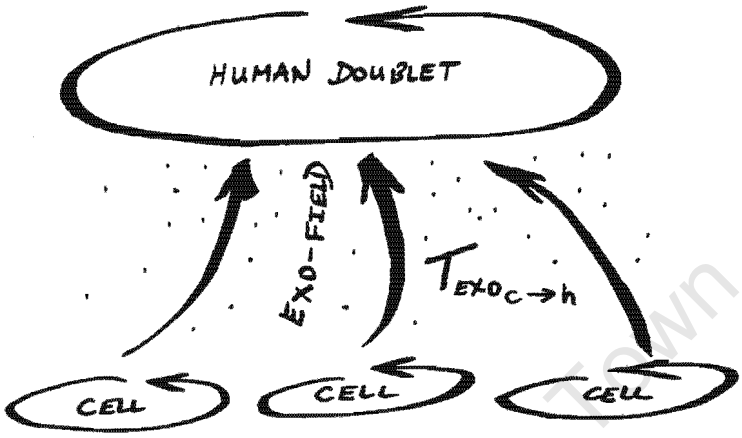

Figure 23: Exo-teleonic field of cellular doublets relative to the human doublet

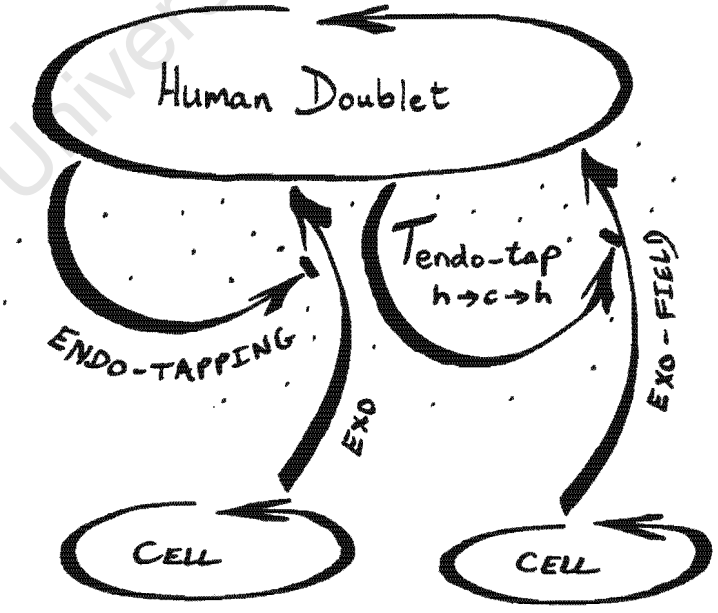

Figure 24: Endo-tapping field of the human doublet

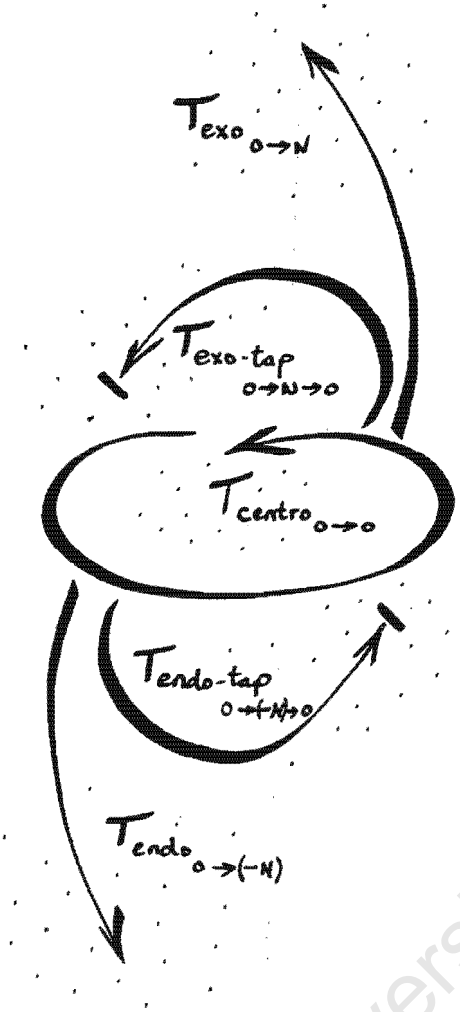

Figure 25: Teleonic fields originating within the doublet of focus

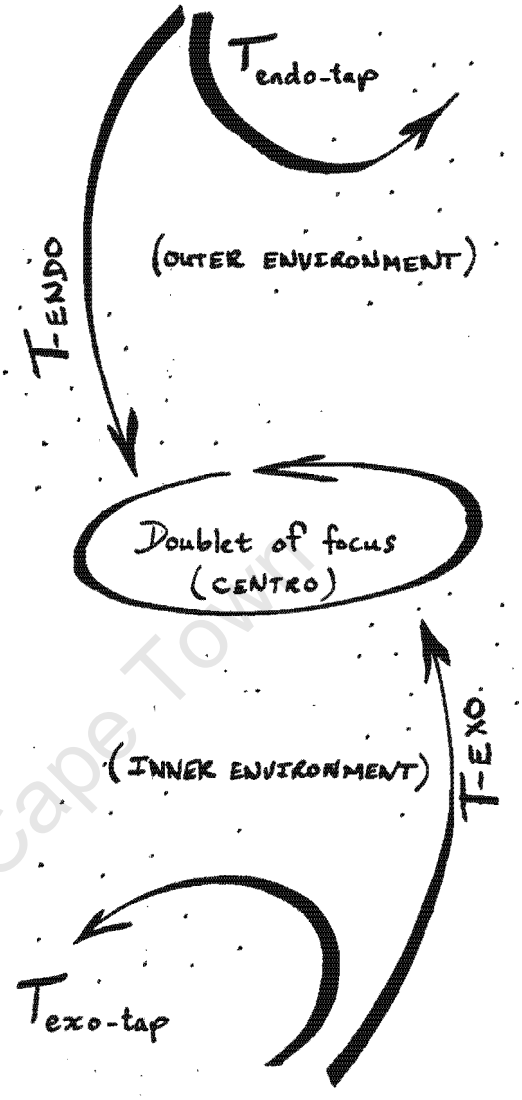

Figure 26: Teleonic fields originating from outside and inside the doublet of focus

The following expression summarises all the teleons originating within the doublet of focus and directed at its immediate internal and external environments as well as itself (N represents any relative level of organisation) (see Figure 25):

$$\mathbf{T}_{0\rightarrow -N,\,N,\,0} \equiv \mathbf{T}\text{-centro}_{0\rightarrow 0} + \mathbf{T}\text{-endo}_{0\rightarrow -N} + \mathbf{T}\text{-exo}_{0\rightarrow N} + \mathbf{T}\text{-endo-tap}_{0\rightarrow -N\rightarrow 0} + \mathbf{T}\text{-exo-tap}_{0\rightarrow N\rightarrow 0}$$

The following, on the other hand, are all the teleons directed at the doublet of focus but originating from another level (see Figure 26):

$$\mathbf{T}_{-N,\,N\rightarrow\,0} \equiv \mathbf{T}\text{-endo}_{N\rightarrow 0} + \mathbf{T}\text{-exo}_{-N\rightarrow 0} + \mathbf{T}\text{-endo-tap}_{N\rightarrow 0\rightarrow N} + \mathbf{T}\text{-exo-tap}_{-N\rightarrow 0\rightarrow -N}$$

The idealised teleonomic pattern or projection of mei flux in the biomatrix constitutes an integration of both the aforementioned patterns (see Figure 27).

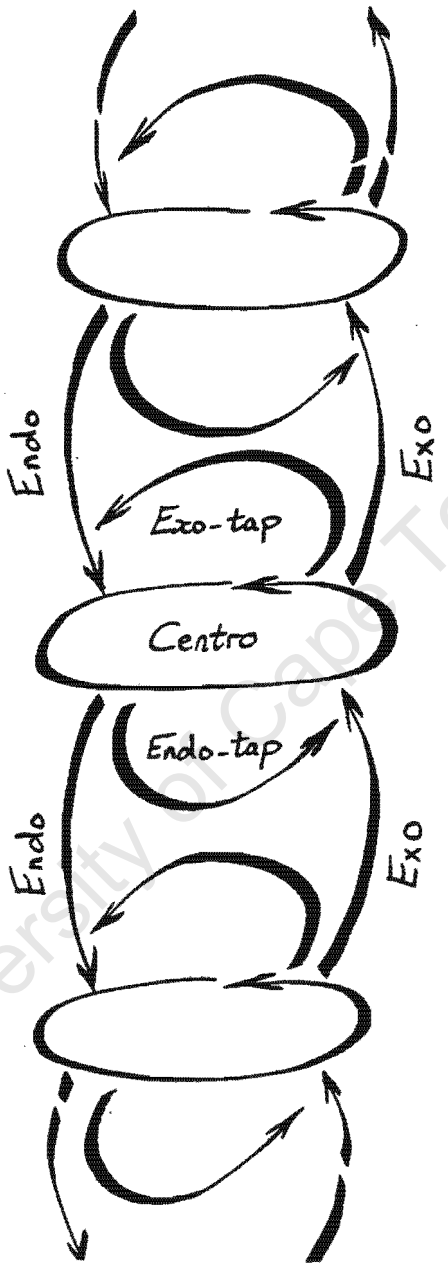

Figure 27: The idealised teleonomic projection of mei flux in the biomatrix

Some teleons actually span more than two levels within the biomatrix, giving true meaning to the concept of a teleon as an independent thread-like-entity in its own right, as opposed to a mere process of interaction between two entities, and justifying the name signifying something that reaches out far.

Such a supra-teleon may be depicted as follows: T-endo $_{N\rightarrow\ 1\rightarrow\ 0\rightarrow\ -1}$. This endo-teleon spans at least four levels of organisation with the relative level of focus represented by level (0).

The nutrition and education teleons are both excellent examples of such a multi-levelled endo-teleon. In the first instance food is produced on an ecological (planetary) level, it is processed and distributed on the societal level, gets consumed by the individual and finally ends up within the individual cell as metabolised substances: T-endo $_{ecological\rightarrow\ society\rightarrow\ individual\rightarrow\ cell}$ (see Figure 28). Similarly knowledge is created on a global level, gets interpreted, screened and distributed within the society, is taught to the individual and on a cellular level induces a change of the brain-cell configuration which leads to an altered memory and understanding.

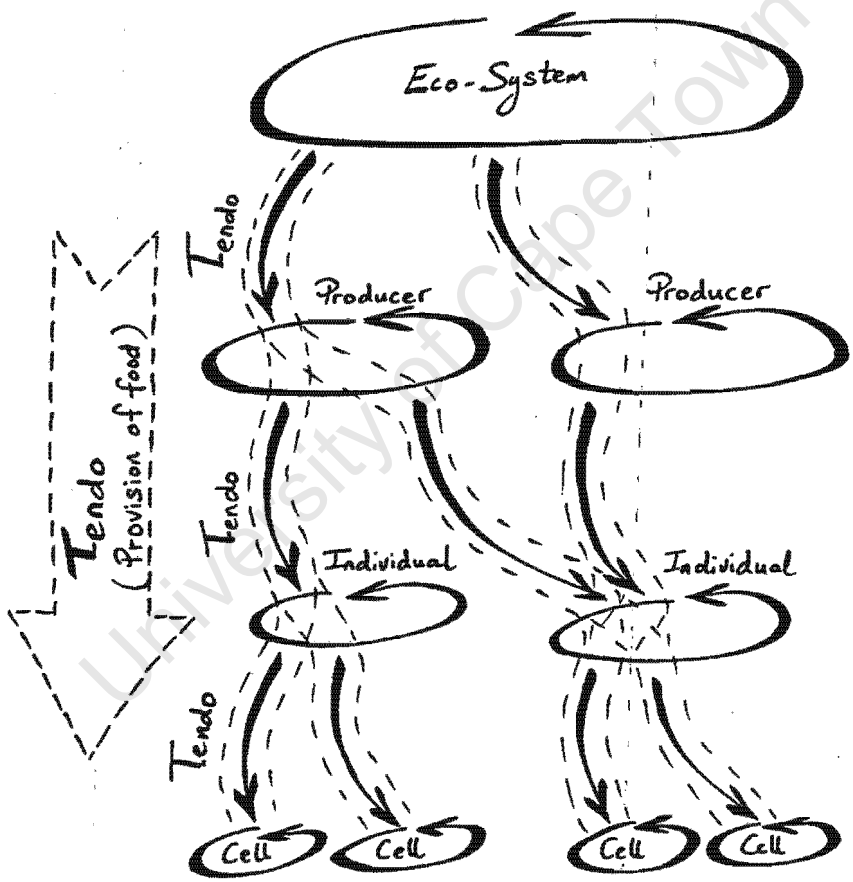

Figure 28: Multi-levelled endo-teleonic chains of food 'provision'

It should be emphasised that the pattern as depicted in the teleonomic projection of the biomatrix is an idealised pattern of teleos. In reality many of the teleos-related processes do not map onto this teleonomic pattern in a one-to-one basis. In other words, many real-life processes are a combination of different teleons on the idealised pattern. This does however, not detract from the usefulness of the idealised pattern. In this sense, teleons are analogous to primary colours, in that most real-life colours

are a combination of the three primary colours with some being closer to one of the primaries than others. In reality, though, our knowledge of the primary colours gives us tremendous insight into the colours we observe around us, both in terms of their analysis and their synthesis.

3.1.6 The cosmic experience: layer upon layer of evolving

It is often meaningful to make further distinctions within the web of the biomatrix, based on the different qualities inherent in the different layers of the web, and also to take into account its evolution. Instead of viewing the biomatrix as a single web of teleons and doublets, we may in fact distinguish parallel webs with each one comprising its own levels and unique holarchy. Although they are separate holarchies, these webs do in fact intermingle and are attached at certain points or whole areas, not unlike a multi-layered patch-work of webs. The first distinction to be made is that between a naturo-sphere and a socio-sphere. The naturo-sphere pertains to the whole of nature, excluding man and all man-created entities and institutions, whereas the socio-sphere pertains to human beings and all their associated artefacts (physical as well as conceptual), inclusive of society at large. A further distinction can be made within the socio-sphere between the cultural, technological, economical, and political spheres. An additional distinction may be made between a physico-sphere and bio-sphere, respectively referring to inanimate and animate things.

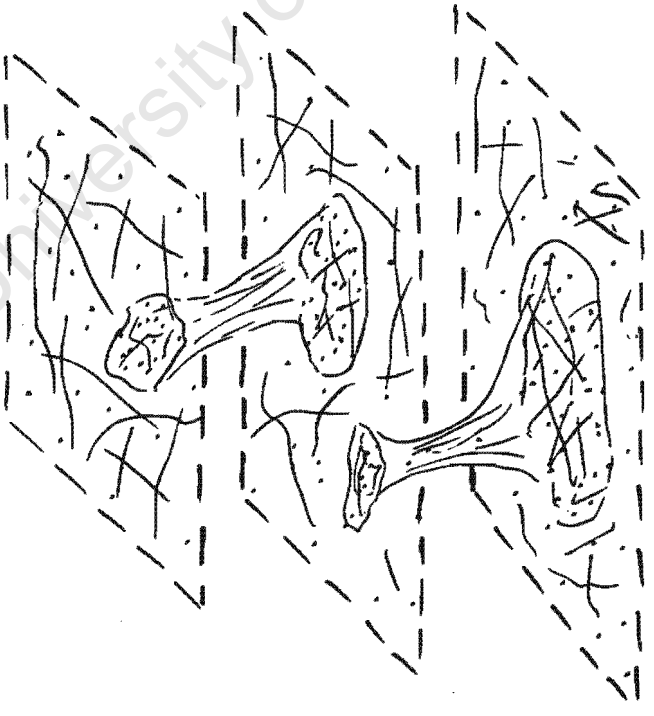

Figure 29: Parallel and interacting holarchies

One may imagine the process of evolution as a process whereby a new web with different emergent qualities attaches itself onto 'vacant' areas of the pre-existing web, and gradually evolves its own network. In some instances it may even expand over the pre-existing web and attach itself to additional points of overlap (see Figure 29). Although there may be many points of attachment which are shared, they retain their own respective holarchies and qualities. The evolution of life from the original physico-sphere is a good case in point; thus the distinction of organic chemistry (and biology) as opposed to chemistry (and physics). The advent of life gave rise to radically different forms of matter and new 'laws'. Similarly the advent of human artefacts changed the face of the planet; the socio-sphere (inclusive of the technological sphere) has reached the point where it interacts with vast areas of the naturo-web and even changes it in a significant way, though not always for the better. The challenge is to evolve *ecologically sustainable organisations* (Starik and Rands 1995).

3.1.7 Conclusion

The concept of a complementary pair of systems in the biomatrix, namely the teleons and doublets, introduces a novel approach in systems theory. We fully acknowledge the fact that systems theory has always been about the interactions (i.e. processes) and relationship between systems and within systems (i.e. their units or parts). Furthermore, the process-based approach within systems theory emphasises even further the primary role played by process, serving as a departure point for the observer. However, we are of the opinion that the notion of a teleon adds a new dimension to the process-based approach, in the sense that it fully acknowledges the fact that ***processes do not merely manifest as a transformation of 'entities', but actually have an objective existence as thread-like entities traversing space*** (Járos and Cloete 1990; Cloete and Járos 1994). This is in a way analogous to introducing the concept of a wave, and a theory of wave dynamics into systems theory. In addition to the notion of a wave we retain the concept of the 'particle', but in this instance it is viewed as a ***focalised-field-like entity*** (i.e. the doublet). Together the teleons and doublets serve as a complementary couple of systems, thereby acknowledging the complementary nature of reality (analogous to the wave-particle duality in physics). We thus fully respect and endeavour to integrate the 'objects' as well as process-threads of this world, putting both on an equal footing so to speak.

The biomatrix serves as a useful conceptual map or model within which the observer can explore the dual nature of reality. The teleonomic projection within the biomatrix provides a meta-pattern of teleos which we believe is universally true for all systems. In our opinion it constitutes a novel abstraction of the underlying teleos of all systems in the universe, which could serve as a means of understanding and gaining more insight into systems and their associated 'problems'. At the same time it also serves as a means of interdisciplinary study and communication by providing a comprehensive, but relatively simple, framework of our multi-faceted human condition and the universe within which we live.

3.2 Symmetry, complementary pairs and the emerging middle: universal principles within the biomatrix

This chapter elaborates on the nature of the biomatrix model by exploring key aspects of its organisational structure and its implications, namely the concepts of symmetry, complementary pairs, tapping, the 'emerging middle', dynamic equilibrium and co-evolution. These principles essentially all share the common theme of a *'complementary and symmetrical duality'*. Some of the concepts that have been introduced in the previous chapter are re-explored here, albeit in a different context.

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3.2.1 Symmetrically organised complementary pairs

At the heart of the biomatrix model is the premise that there is a symmetrical organisation of complementary processes and structures, relative to a common point of reference. The principle of *complementarity* that refers to two (or sometimes more) systems or processes *co-acting in a mutually reflective and recursive way* is closely related to the concept of the "union of opposites" (Sabelli 1989). These 'opposites' are considered to belong to mutually interdependent, not mutually exclusive, poles. The symmetrical organisation, in conceptual space, of complementary pairs, is referred to as the principle of *symmetry* in the biomatrix. We believe that the symmetrical and complementary configuration of processes (and structures) exists both in an epistemological and in an ontological sense. In other words, it exists in an epistemological sense as a dual distinction in the mind of the observer and in an ontological sense as inherent in the nature of being in the cosmos.

The recursive and symmetrical organisation of systems in the biomatrix is supported by the concept of *dynamically-coupled* systems in dynamical systems theory, where "organism and environment are interpreted as the two, dynamically coupled, parts of a single organism-environment system"; and "the result is two systems in which the dynamics of each one has a strong influence on the dynamics of the other. When the first system moves through its state space, it changes the layout of the state space of the second system. However, the changed dynamics of the second system will in turn change the state space topology of the first system, and so on" (Keijzer and Bem 1996, p.336-337).

Let us explore some of these symmetrically organised complementary pairs in order to elucidate this fundamental aspect of the biomatrix model:

The most basic complementary pair is directly related to the distinction based on the inside and outside of a system. From this follows the classical distinction between the inputs and outputs of a system, i.e. the mei flowing across the system boundaries into and out of the system. An example of an approach which relies strongly on this distinction is that of the cybernetic systems approach (see Figure 30). Ultimately the distinction

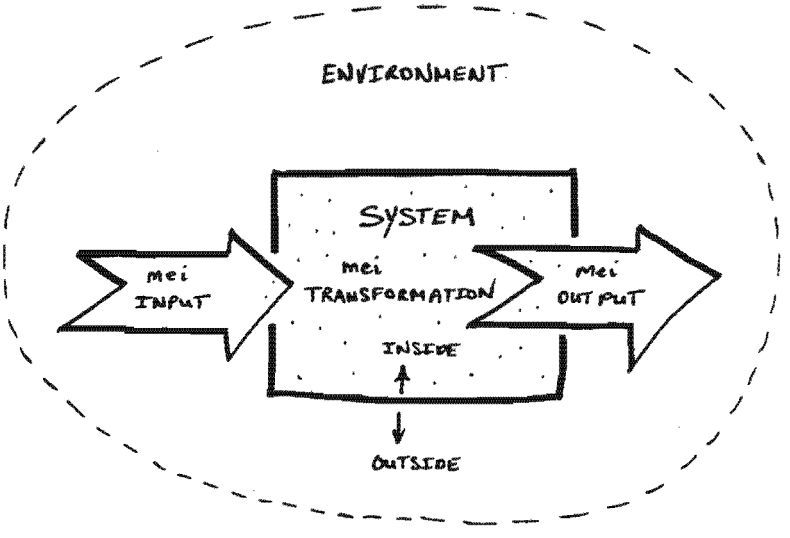

Figure 30: Classical cybernetic distinction of system boundaries

between input and output of mei may be traced back to the fact that in an open system the mei flow happens in a continuous spatial sense. In other words mei gets transformed within a system, but although it may be temporarily stored within the system or environment, it ultimately crosses the system's boundaries again, albeit transformed. In short: energy (in the form of matter, information or 'pure energy') crosses the boundaries of a system as a continual flux from the inside out and from the outside in. In the biomatrix a distinction is made between the input and output processes comprising the field of processes associated with a doublet. The field of mei flow is considered to be symmetrical in the sense that the mei flows inwards as well as outwards relative to the inner and outer environment of the doublet. It is complementary in the sense that it is a mutually interdependent flow of mei; the one can not manifest indefinitely without being complemented by the other. This is supported by the fact that energy can not be created or destroyed, and space is continuous, i.e. mei can not 'jump' from one point in space to another (at least not on the macroscopic level). A human being thus 'consumes' mei in the form of food, oxygen, information made available in the form of books, etc., and returns it to the environment in a transformed way via the excretion of waste products, radiation of heat, and communication of ideas.

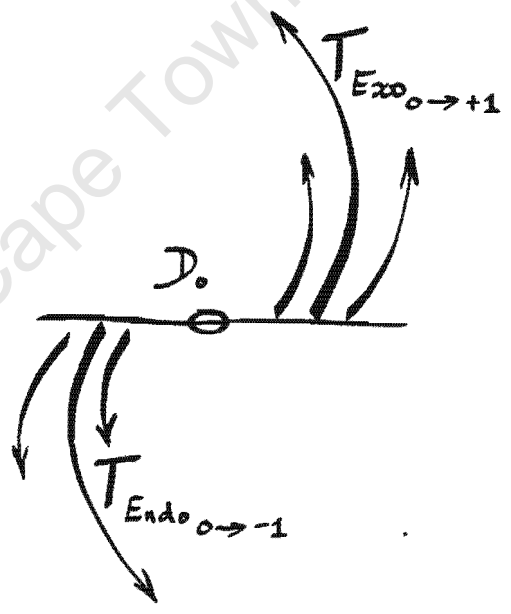

Figure 31: The dual teleonic field of the doublet (i.e. a centro-symmetry)

When the biomatrix approach was introduced (Járos and Cloete 1987), the notion of the doublet as a dual field of processes was not based on the actual flow of mei, as mentioned above, but derived from the fact that there is a symmetrical and complementary organisation of teleos in the conceptual space of the biomatrix. We believe that this symmetrical and complementary organisation of teleos in all systems, and the biomatrix at large, is one of the most powerful concepts in the biomatrix approach. It is primarily a distinction between those processes which are teleonomically aimed at the outer environment of the doublet (exo-teleonic field or exo-teleons, $\mathbf{T}_{0\rightarrow1}$) and those processes which are teleonomically aimed at the inner environment of the doublet (endo-teleonic field or endo-teleons, $\mathbf{T}_{1\rightarrow0}$). These two clusters of teleons are symmetrically arranged around the common point of reference, namely the nucleus or focal point of the doublet under investigation, $\mathbf{D}_0$ (see Figure 31). Furthermore, these two fields are mutually supportive and complementary, in the sense that the one cannot exist indefinitely without the other. One can regard the spatial organisation of the teleos as a teleonomic projection that highlights

the configuration or pattern of the teleos associated with a particular process-system or set of process-systems in the holarchy.

Let us explore a few examples of this dual field. In the human doublet the processes of walking, talking, in fact all inter-personal relations, are associated with the exo-teleonic field (T-exo $_{\text{human}\rightarrow \text{environment}}$) because they are predominantly aimed at the interaction of the human doublet with its outer environment. On the other hand the processes of nutrition, breathing (inhaling of oxygen and exhaling of carbon-dioxide), and intake of information (e.g. reading) are considered to be associated with the endo-teleonic field (T-endo $_{\text{human}\rightarrow \text{cells}}$) as they are predominantly aimed at the inner environment (cells) of the human doublet. In the case of an organisational doublet (e.g. a business) the processes of production, marketing, and selling are considered to be associated with its exo-teleonic field (T-exo $_{\text{organisation}\rightarrow \text{society}}$), i.e. they are predominantly aimed at its outer environment. On the other hand, the processes of personnel management, financing and all maintenance processes are considered to reside in the endo-teleonic field (T-endo $_{\text{organisation}\rightarrow \text{inner resources}}$).

Thus, in the human doublet all processes associated with the support of the inner environment, namely the cellular doublets, are considered to be endo-teleons. Similarly in the organisational doublet all processes associated with the support of the inner environment, namely the employee doublets and the physical infrastructure, are considered to be endo-teleons. Conversely in the human doublet there are those processes teleonomically aimed at its outer environment, e.g. the family, the employer and society at large, all of which are considered to be exo-teleons. Likewise, processes directed at the outer environment of the organisational doublet typically comprise interaction with customers, suppliers and society at large (e.g. social responsibility of organisations), all of which are considered to be in the exo-teleonic field.

At this point it is apt to explore the difference between those distinctions which merely exist in the mind of the observer and thus have an epistemological base and those distinctions which have an ontological basis, in other words are considered to have an objective reality. Although the teleonomic projection of processes in the biomatrix exists in the first instance as an abstraction in the mind of the observer, it may in fact also have an objective reality, in the same way that we observe the objective existence of a gravity field or the magnetic field in the physical world.

The teleos of a particular process may be measured in an objective sense by observing the dynamic behaviour of a particular process in its 'quest' to reach a particular outcome. For example, the teleons of oxygen supply and carbon dioxide removal from the cellular environment are clearly regulated towards the levels of these gases in the inner environment (i.e. the cellular level) of the organism and definitely not by the concentration of these gasses in the outer environment. For this reason both these systems of gas flow should be considered to be endo-teleons (see Figure 32). Similarly, the processes of inter-personal communication and of walking to get from point A to B, are steered in terms of their

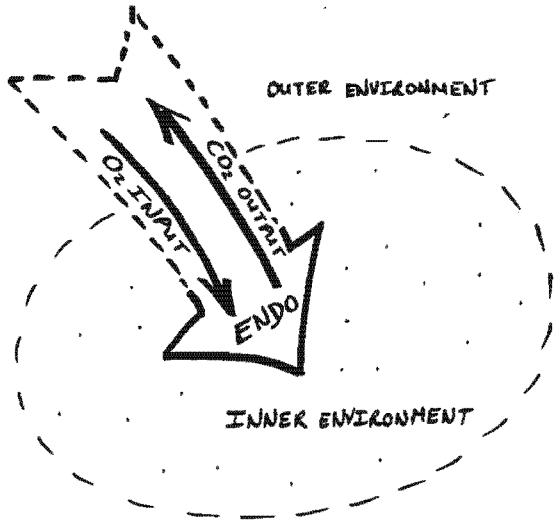

Figure 32: The direction of mei flux, vis-à-vis the direction of its associated teleos

outcomes relative to the outer environment and not the inner environment. They are therefore exo-teleons. In other words, we can objectively observe the process of walking and actually establish the fact that, in this particular instance, the outcome of the process is steered by a specific outcome to be achieved relative to the outer environment (e.g. reaching my car) and not by a specific outcome to be reached relative to my inner environment (i.e. the cells). When my aim is to walk towards a car and the car moves, the teleon of getting to the car will adjust itself accordingly until I reach my car. On the other hand, if the conditions of my inner environment are altered, e.g. my blood sugar level is changed, it may influence my walking process, but certainly will not change the desired outcome of the process, i.e. reaching my car. In this sense it is stated that the process of walking in terms of its associated teleos is organised towards the human doublet's outer environment. It should thus be clear that the dual distinction between an exo- and an endo-teleonic field has a real ontological basis that is not less real or more of an abstraction than the existence of the earth's gravity field or the second law of thermodynamics (in which instance the organisation of all systems is observed to move towards an outcome associated with an increased entropy level). The teleos of a process under observation may thus be objectively observed on the basis of the dynamics of the organisation of the particular process, and the teleon classified accordingly.

In many instances more than one teleos may be associated with a particular process, and as such it may actually reside in both the exo- and endo-poles of the teleonomic field of processes. For example, we may eat because we are hungry and need to feed our cells, in which instance the process is regulated by the inner environment (e.g. blood sugar levels) and belongs to the endo-pole; on the other hand we may eat as part of a process of social interaction with friends, in which instance it is regulated intra-psychically (e.g. intra-personal conditioning in our culture). We may, therefore, also

eat as a means of socialisation. Likewise, we may decide to eat for our own enjoyment, i.e. egocentric reasons. In practice a particular process may serve all these aims, in which instance it is considered to be multi-polar and residing in more than one of the teleonic poles. The single process of eating (or more specifically the intake of food) thus gets 'split up', mapped, projected or abstracted in the teleonic projection of the biomatrix, into an endo-teleon (i.e. nutrition through food intake), an exo-teleon (i.e. socialisation through food intake) and a centro-teleon (i.e. eating for 'selfish' reasons) (see Figure 33). The same argument holds true in the case of walking (or jogging) for health reasons, walking to work, and walking for personal enjoyment.

To sum up: in the first instance we may trace the flow of mei within and between systems and identify a complementary and symmetrical organisation of both input and output processes. This is the classical distinction made for any open system. In addition to this duality of mei flow another duality exists on another level of abstraction, namely the duality of teleos. This symmetrical and complementary organisation relative to teleos is depicted in the teleonomic projection of the biomatrix (as opposed to the mei flow projection which traces the actual flow of mei in space-time). We believe that this duality of teleos holds in general and exists for all systems in all holarchic spheres, in the same way that an input and output of mei flow exists for all open systems. Furthermore, this teleonomic duality is considered to be both epistemologically and ontologically founded. Acknowledging the objective existence of, and identifying the teleological symmetry of processes inherent in all systems, contributes to our understanding, analysis and synthesis of all systems. The explicit statement and formalisation of this complementary and symmetrical organisation of teleos in all systems is one of the greatest contributions of the biomatrix model towards systems theory. While this is related to the concepts of autonomy and integration, and the Janus faced holon as introduced by

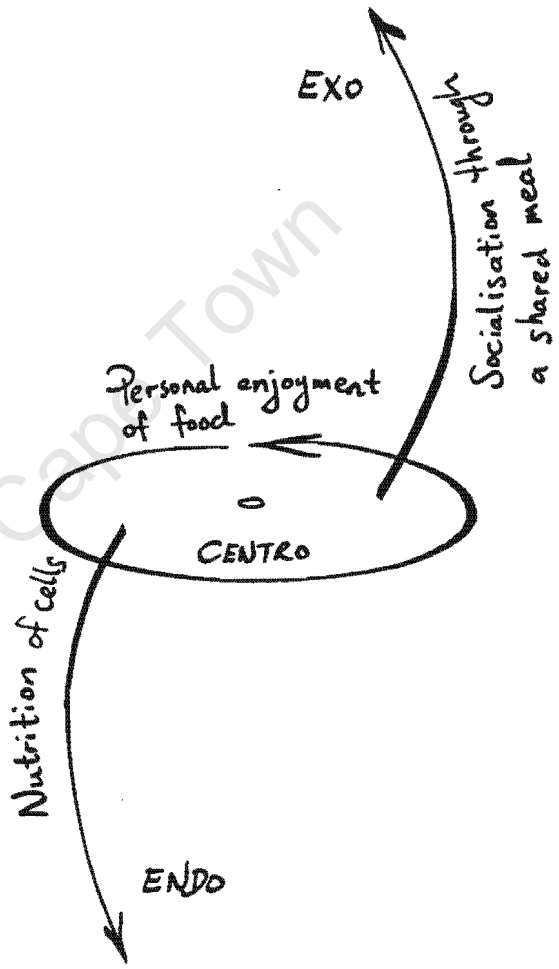

Figure 33: Multi-polar teleonomic projection of the eating process

Koestler (Koestler 1978), it extends these concepts in a way which will become clearer in the subsequent sections.

In addition to the symmetrical organisation of teleos originating within a particular doublet-system (i.e. a centro-doublet symmetry), another type of symmetry can also be distinguished. This is an inter-level or inter-doublet symmetry within the holarchy of systems which refers to the symmetrical coupling of systems between the different levels of organisation. The inter-level symmetry implies that the teleos originating within the reference doublet $\mathbf{D}_0$, the teleos originating within the inner environment (i.e. endo-doublets $\mathbf{D}_{-N}$) and the teleos originating within the outer environment (i.e. exo-doublets $\mathbf{D}_N$), all couple in a symmetrical and complementary fashion as well (see Figure 34). This may be viewed as a duality of 'give' and 'take' in the teleos space.

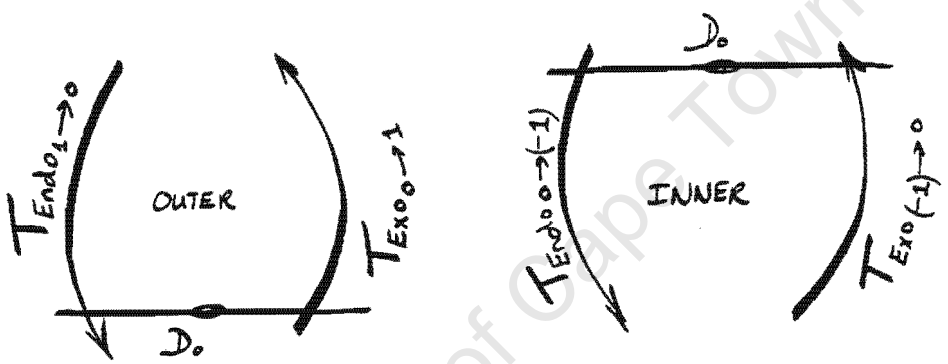

Figure 34: An outer and inner teleonomic symmetry (i.e. an inter-doublet symmetry)

Let us look at the business organisation as a case in point, focusing on the outer symmetry first. There are processes within the environment considered to be teleologically directed towards the business doublet ($\mathbf{D}_b$), e.g. the supply of mei and trained personnel as well as the regulations set up by government to facilitate favourable conduct of business; these are the endo-teleons originating within society ($\mathbf{D}_s$) and directed at the business doublet (**T**-endo $_{\text{society}\rightarrow\ \text{business}}$). On the other hand, certain processes which are considered to be directed at society have their origin within the business doublet, e.g. marketing and the provision of services and goods. These are the exo-teleons originating within the business-doublet and aimed at society (**T**-exo $_{\text{business}\ \rightarrow\ \text{society}}$). These two fields of processes represent one type of symmetry, namely the outer-inter-doublet symmetry of teleos.

Similarly, there is an inner-inter-doublet symmetry of teleos. There are processes within the business doublet aimed at its inner environment, for instance taking care of its personnel ($\mathbf{D}_p$) and maintenance of its infrastructure; these are the endo-teleons originating within the business doublet and directed at its inner environment (**T**-endo $_{\text{business}\ \rightarrow\ \text{inner env.}}$). Conversely there are processes originating within its

inner environment directed towards the business doublet, for instance, the productive contributions of all employees and technological aids, which are considered to be the exo-teleons originating within the inner environment and aimed at the business doublet (**T**-exo $_{\text{inner env.}\rightarrow\text{ business}}$).

Thus three classes of teleonomic symmetries may be distinguished, namely:

- a centro symmetry, i.e. of endo and exo-teleons originating within the reference level itself:

  $$\textbf{T}\text{-endo}_{0\rightarrow -1} \Leftrightarrow \textbf{T}\text{-exo}_{0\rightarrow 1}$$

- an outer symmetry, i.e. of exo and endo-teleons originating within the reference and outer levels respectively:

  $$\textbf{T}\text{-exo}_{0\rightarrow 1} \Leftrightarrow \textbf{T}\text{-endo}_{1\rightarrow 0}$$

- an inner symmetry, i.e. of endo and exo-teleons originating within the reference and inner levels respectively:

  $$\textbf{T}\text{-endo}_{0\rightarrow -1} \Leftrightarrow \textbf{T}\text{-exo}_{-1\rightarrow 0}$$

Together these distinctions represent a triple symmetry which has its roots in the duality of teleos within a particular reference doublet, as well as in the three-level distinction made between the reference doublet and its inner and outer environment.

3.2.2 Tapping: a pre-requisite for being

Doublets within the biomatrix appear as points of convergence of teleons. In the mei flow perspective doublets are observed to be inter-linked by a network of input and output processes. In the teleonomic perspective, focus is on the teleos associated with the mei flow, and one observes a network of endo and exo-teleons linking the respective doublets. Thus, a symmetrically organised meta-pattern of teleons, interlinking the doublets, can be observed in the teleos domain.

The biomatrix is not simply a single neatly arranged teleonic field, but a complex arrangement of overlapping fields. The Russian Doll arrangement is only an extreme simplification to get the discussion started. To see some clarity in this very complex entanglement it is important to distinguish between the different *fields* and their *interactions*. An overlap of fields in time-space is a necessary but not sufficient requirement. In addition one needs what is referred to as resonance in the physico-sphere, when two bodies interact by virtue of their mutual attunement to the energy emanating from and absorbed by them. For example, without this basic attunement the energy of a sound wave will permeate the environment of a physical object without actually interacting with it, unless it is 'attuned' and hence absorbs some of the surrounding energy. Optimal absorption of energy takes place when the incoming wave resonates with the inherent dynamics of the object. For example, plants only absorb a certain spectrum in the electromagnetic spectrum and allow the rest simply to pass it by. Similarly, human beings find themselves in an environment permeated by the fields of other doublets. However, they only tune in to a few of the fields and then only interact with certain

aspects of these fields. For example, as the result of the process of evolution we have become attuned to particular food substances and thus are able to ingest and digest those. We select and read information in a similar way when we pay attention to a particular person talking in a crowded and noisy room. The same holds true for an organisation or society filled with a great number of doublets all being involved in a great number of teleons at any particular time.

Within our bodies cells are exposed to a great variety of substances transported in the blood, but only respond to some of these by virtue of the fact that they are attuned to that particular substance. For example, this makes it possible for hormones to have selected targets within the body and thus exercise particular control over these targets. Similarly, nutrients are transported across the cell membrane, either because the cell membrane allows diffusion (i.e. a passive process of attunement by virtue of its innate structure) or because there are specialised active transportation processes in the membranes. A cell may die because its means of attunement with the blood stream is defective. Similarly an individual or organisation within society may be dysfunctional or actually cease to exist as a result of not being able to attune to the field of processes permeating its environment. The reasons for the lack of attunement can be numerous and include the lack of desire, inability or unavailability, among other things. These reasons shall not be dealt with in this chapter. The main point to remember is that some form of attunement (referred to in the biomatrix approach as *tapping*) is required for a doublet to interact with another doublet. We believe that it is mainly due to the principle of tapping that doublets become integrated into a more extensive web of mei flow and a meta-pattern of teleos. For this reason, the principle of tapping will be discussed in great detail. The term 'tapping' is to be used in preference to attunement as it is a much more descriptive term. *Tapping is considered to perform the function of coupling teleonic fields from the inner and outer environment with the field originating from the doublet of focus.* For example, the opening of a tap when we need water is a very descriptive metaphor of attuning ourselves to the available water supplies in our environment.

The examples mentioned up to now were all concerned with doublets responding to other doublets in their external environment. In other words the doublets reach out to tap from outer layers of the concentric holarchy. This is referred to as *exotapping*.[4] In the case of an individual (human being),

[4] Exotapping is represented by the expression: T-exotap $_{0\rightarrow N\rightarrow 0}$, the subscript indicating that the teleos originates at the level of origin (D_0), and reaches out to a doublet above the level of origin (D_N), integrating parts of this outer field with the doublet of origin. T-exotap $_{i\rightarrow s\rightarrow i}$ represents the individual's exotapping from society, while T-exotap $_{c\rightarrow i\rightarrow c}$ represents cellular exotapping from the individual field.

exotapping generally, but not always, requires a conscious willed act. For example, we tap water because we want to drink it. It is like taking the horse to the water. An example of unintentional tapping is our breathing that occurs in an automatic repetitive way. However, even that can be overridden at will when we take a deep breath for a particular purpose. On a cellular level the question of will is absent and tapping is always done in an automatic way (at least from the perspective of the organism). However, even the cells regulate their own uptake and only extract as much oxygen from the blood as they need for their functioning: no more, no less. Tapping for them is regulated by the optimum amount necessary for their functioning. It is perhaps time that human beings also applied this principle and replaced the customary tapping for maximum with tapping for optimum amounts. The idea of tapping within the biomatrix, in fact, originated from the important physiological principle of optimum uptake of oxygen from the blood, so vividly compared to the tapping of water from the water supply of a city by the great physiologist Dr Arthur Guyton when he taught his medical students the principles of circulation (Járos 1998).

The doublet also taps into its inner environment, in which case one talks of *endotapping*.[5] This may not be obvious at first glance and is thus largely neglected on most levels of organisation above the individual human level. In order to maintain the flow of mei and to create a harmony within the field of teleos between the inner and outer environment it is essential for any doublet to tap into its inner environment of sub-doublets and utilise the processes they offer. For instance, management of an organisation has to take deliberate steps to utilise the full potential on offer from its employees thereby integrating it with the overall organisational objectives and goals. This applies to any process which may facilitate the integration of the individual worker's talent and contributions into the larger whole (i.e. the organisation). It is not uncommon for the individual employee to make suggestions, write a report or offer to make a particular contribution without any response from the immediate superiors or management. These suggestions are completely in vain and are thus lost to the organisation as a whole. It is essential for the organisation to actively tap the individual fields in order to integrate them as full members of the organisational doublet. This also holds for all technological aids and other resources available within the organisation.

In case of the human doublet the various processes emanating from the cells within our body are integrated (tapped) either intentionally or unconsciously through automated nervous or hormonal

[5] Endotapping can be symbolised by the following expression: **T**-endotap $_{0\rightarrow -N\rightarrow 0}$, where the teleos originates at $\mathbf{D}_0$ and the tapping is done with respect to a level below ($\mathbf{D}_{-N}$). **T**-endotap $_{i\rightarrow c\rightarrow i}$ represents the endotapping of the individual from the cells, and **T**-endotap $_{s\rightarrow i\rightarrow s}$ represents society's endotapping into its participating members.

mechanisms. For example, in order to walk we have to send a signal to the muscle cells to increase their low level activity (tone) into a meaningful movement of parts or of the entire body. In the brain there is a continuous random activation on the neuronal level and it is up to the individual to focus on it in order to turn it into a meaningful activity. Tapping of cellular doublets is effected mainly through the neuronal and hormonal signals regulated from the level of the human doublet. Should these signals be absent or at fault, the particular cellular doublets will not be fully integrated within the larger human system and will for all practical purposes cease to be active members of the human organism. The challenge within the societal doublet is to fully integrate all its members according to each member's particular desires and contributions. The creation of appropriate job opportunities is one form of tapping the potential of individual members of society. It also happens when members are made to feel needed and given the opportunity to become fully integrated into society. One of the most powerful means of achieving this is to create opportunities for individuals to express their individual creative talents and at the same time satisfy their need for belonging to a group. The family doublet also has to reach towards its family members and allow each of them to contribute according to his abilities and desires.

The tapping process is considered to belong to a special class of teleons with an explicit teleos of integrating what is on offer from the fields of the sub-doublets (inner environment) and the fields of the supra-doublets (outer environment) into the field of the reference doublet. The division of tapping teleons into the endo-, and the exo-tapping groups is based on a dual distinction. On the one hand it concerns a functional distinction (i.e. tapping) and on the other hand it concerns the direction of the function relative to the reference doublet (i.e. inwards or outwards). It should be noted that tapping teleons are symmetrically organised around the reference level and collectively grouped into the exo-tapping and endo-tapping fields of teleons (see Figure 35).

The concept of tapping is related to the concept of integration in systems theory (Koestler 1978; Gharajedaghi 1985). However, in systems theory integration is largely used in the context of integration of the system into a larger whole. This is seen as complementary to the concept of autonomy or self-assertion, which concerns the system itself or the 'reference level' (Koestler 1978; Bateson 1985). On the other hand the biomatrix model considers the process of integration to have two complementary poles, namely integration of the system with the outer environment (i.e. the larger whole) and integration of the system with its inner environment (i.e. integration of the inner processes, or units, into the system itself). Integration in the biomatrix thus 'looks' both up and down (outward or inwards) in the holarchy in a symmetrical and complementary fashion. The concept of integration within the biomatrix model is thus based on the fact that it explicitly focuses on at least three levels of organisation, i.e. the level of the system itself ($\mathbf{D}_0$) , its outer environment ($\mathbf{D}_1$), and its inner environment ($\mathbf{D}_{.1}$). It is obvious that sub-, or endo-doublets self-organise or integrate themselves into the larger whole of the reference doublet, but not so obvious that there is also another process of

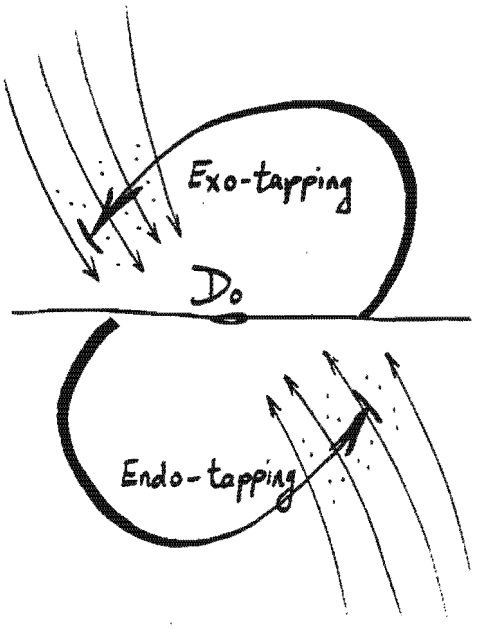

Figure 35: Symmetrically organised exo and endo-tapping fields

integration which originates from the reference level and reaches inwards towards the subdoublets. We believe this symmetrical arrangement of the process of integration, relative to the same level of organisation, has not been sufficiently addressed in systems theory.

3.2.3 A triple, three-levelled distinction: the outer environment, the self and the inner environment

The previous sections have dealt with the dualities which exist within all doublet-systems, i.e. its inner and outer environment and the duality in terms of the teleos associated with the two teleonic fields directed at the inner and outer environment respectively. It is now time to focus on the doublet itself that exists as an autonomous entity within the field of teleons in the biomatrix.

The identity of a doublet is 'embodied' in its nucleus, which acts as an attractor towards which processes converge. When the processes encircling the nucleus become organisationally closed (Maturana and Varela 1992) then an autonomous identity emerges within the field of processes. It is the structure embedded within these organisationally closed processes that specifies how the system will behave within different fields and what will be its unique character and identity. These self-referential processes are referred to as the centro-teleons or centro-teleonic field of the doublet. The name centro-teleon, was derived from the fact that these teleos-related processes encircle the centre, i.e. the nucleus, as well as the fact that it is associated with the central, or reference, level of organisation The teleos associated with this field of processes is directed back at itself, i.e. at the reference level of organisation. This is symbolised as: **T**-centro $_{0\rightarrow 0}$ (i.e. $\mathbf{D_0 \rightarrow D_0}$).

In other words the teleos associated with these processes encircles the nucleus residing within the doublet and consequently also the reference level. It may be envisaged as a serpent biting its own tail, i.e. depicted by the symbol of the *ouroboros*. This centro-teleonic field of processes is responsible for maintaining the doublet as an autonomous whole (Koestler 1978; Maturana and Varela 1992), thereby asserting its own characteristic pattern of activity. Centro-teleons are typically associated with the processes of governance (more specifically organisation of the self) and self-referral. In the human doublet the centro-teleons are all those processes which directly focus on the human being as a whole and not on the individual organs or on its participating doublets in the outer environment. For instance, in the human doublet centro-teleons would be those processes within the autonomic nervous system responsible for prioritising between the different organ systems relative to the whole body, e.g. in the case of hypothermia the blood supply to the extremities (arms and legs) is severely limited in order to preserve heat within the body as a whole, at the cost of the cells within the extremities. The focus is thus not on maintaining the individual cells within the body but rather on keeping the body as a whole alive. To achieve this, priorities need to be established relative to the body as a whole. In the psychological dimension it would entail establishing an ego, i.e. a sense of self. Ultimately this comes down to the processes of self-consciousness and self-reflection within the individual. In the language of second-order cybernetics: "the process of human knowing is the process in which we, through languaging, create the difference between the world and ourselves, between the self and non-self, and thereby to some extent create the world by creating ourselves" (Brier 1996, p.234). Centro-teleonic processes all refer back to the individual's personal ethos, i.e. what is considered to be of importance. In a business organisation centro-teleons would typically be those processes associated with policy-formulation and self-reflection within the organisation, i.e. formulating a mission statement and evaluating on a continuous basis its overall performance against its mission statement. Furthermore, all processes concerned with setting priorities relative to the overall performance of the business would be viewed as centro-teleonic, e.g. the approval and allocation of budgets by an executive committee (i.e. representative of the whole). In the physico-sphere, centro-teleonic processes would be those responsible for maintaining the structural integrity of the entity as a whole. For example, in the solar system it could be associated with the force or processes of gravity, whereas in the atom it could be ascribed to the electromagnetic force.

In the middle of the centro-teleonic field resides the nucleus which is associated with a focalised field of ethos. The ethos is considered to be focalised since it is shared by all teleons within the doublet. Although each teleon within the doublet is associated with its own focalised field of teleos, there is a single set of values or organisational principles shared by all teleons within the doublet. It is that single set of principles which binds all the teleons within a doublet, aimed as it is in different directions within conceptual teleos space, into an autonomous whole. The unity of the doublet as a field of teleons is thus achieved through its shared ethos acting as an attractor for the divergent teleoses. To sum up, the doublet has multiple functions, goals and purposes as embodied by its

teleonic field, but has a single focalised field of ethos. This single focalised field of ethos is a shared set of organisational principles and values which is embodied by the nucleus in the middle. The galaxy serves as a useful metaphor for the focalised fields of teleos and the single field of ethos within the doublet. In this metaphor the individual suns within the galaxy resemble the individual points of focus in the teleos space associated with each teleon, with the planets resembling the sub-teleons or sub-teleonic fields of focus. The suns thus act as focal points within a conceptual teleos space. On the other hand, in the centre of the galaxy there is a central 'attractor' which pulls all the suns together. This central attractor resembles the focalised and shared ethos of the doublet as a whole. Similarly, within the doublet there are the foci of teleos and the single ethos focus, which are two qualitatively different distinctions. The difference is that the one group of points resides in conceptual teleos space and the other point in conceptual ethos space (see Figure 36). All these foci act as attractors and are analogous to the concept of attractors in chaos theory (Gleick 1987). In the one instance they attract processes towards a preferred outcome and in another instance they attract fields of teleons towards a shared set of values and principles. It is a double distinction based on two different *logical types* (Keeney 1983; Roach and Bednar 1997).

The endo and exo-teleons in combination with the respective tapping teleons are associated with the integration of the system in the teleos domain, whereas the centro-teleons are associated with the autonomy and identity of the system itself. The biomatrix explicitly makes a distinction between integration of the reference doublet ($\mathbf{D_0}$) with doublets in its outer environment ($\mathbf{D_N}$) through the exo-teleons (**T**-exo $_{0\rightarrow N}$) and exotapping teleons (**T**-exotap $_{0\rightarrow N\rightarrow 0}$) on the one hand, and the integration of the reference doublet ($\mathbf{D_0}$) with doublets in its inner environment ($\mathbf{D_{-N}}$) through the endo-teleons (**T**-endo $_{0\rightarrow -N}$) and endo-tapping teleons (**T**-endotap $_{0\rightarrow -N\rightarrow 0}$) on the other hand.

This brings us to the very important concept of a *three-level distinction* for all doublets within the biomatrix. It is a distinction between the following three levels of organisation and the associated teleonic fields:

- an inner environment ($\mathbf{D_{-1}}$) with its endo-teleonic field of processes (**T**-endo $_{0\rightarrow -1}$), (**T**-endotap $_{0\rightarrow -1\rightarrow 0}$),
- the reference level ($\mathbf{D_0}$) with its centro-teleonic field of processes (**T**-centro $_{0\rightarrow 0}$) and its associated nucleus in the ethos domain,
- an outer environment ($\mathbf{D_1}$) with its exo-teleonic field of processes (**T**-exo $_{0\rightarrow 1}$), (**T**-exotap $_{0\rightarrow 1\rightarrow 0}$).

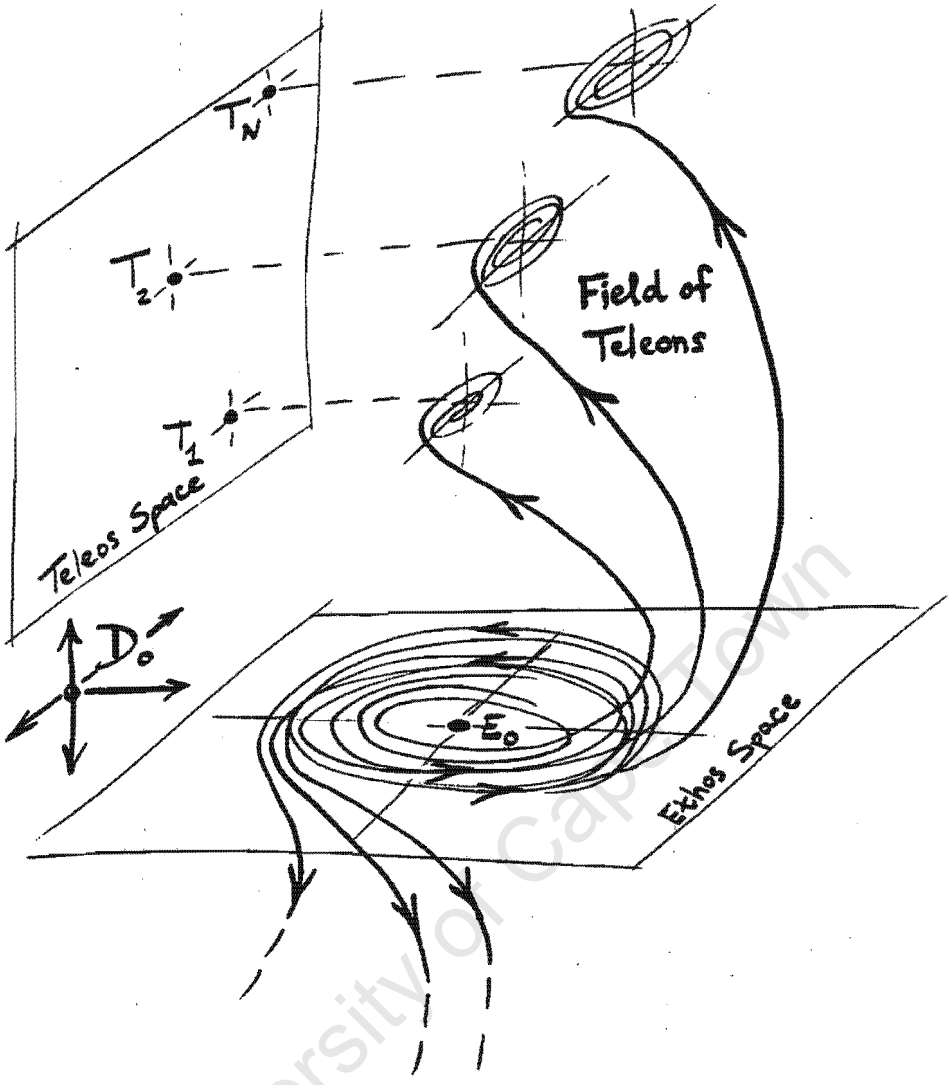

Figure 36: The doublet as a teleonomic field with multiple attractors in teleos space and a focal attraction in ethos space

Although a doublet is focalised on a particular level of organisation within the holarchy, its field of teleons reaches into both the outer and the inner level. *The doublet as a system therefore spans at least three levels of organisation and is symmetrically organised as a field of teleons around the reference level or level of focus.* This symmetrical organisation relative to the levels of organisation within the holarchy has far-reaching implications for the analysis and synthesis of systems. Traditionally the whole is considered to be made up and emerging from the parts or units of the system. The units may be either structural entities, e.g. the cells within the body, or processes (as is the case of a human activity system (Checkland 1981)). However, traditionally, when reference is made to the whole, it is implied that it is inclusive of its parts but not the environment, i.e. the outer environment is by definition excluded from the whole (see Figure 38).

In the biomatrix this is changed into a description whereby the whole is considered to be *focused on a particular level of organisation, but with its field extending both into the inner and outer levels of organisation* (i.e. inner and outer environment). The whole is thus symmetrically organised as a field of teleons around the level of focus. The exo-teleonic, centro-teleonic and endo-teleonic fields permeate and embrace the upper, reference and lower levels of organisation respectively. This results in a triple distinction when referring to the 'units' of the whole. It implies that the inner and outer environment participate equally and in a symmetrical way in the whole. This is in contrast with the more conventional distinction between the parts of the system, viz., the whole emerging from the parts on the one hand and the environment on the other hand. The concept of a doublet incorporates all these concepts into a 'new whole', i.e. a *symmetrically-focalised-field-like* system. This 'new whole' considers the outer and inner environment to be of the same logical type from both an epistemological as well as

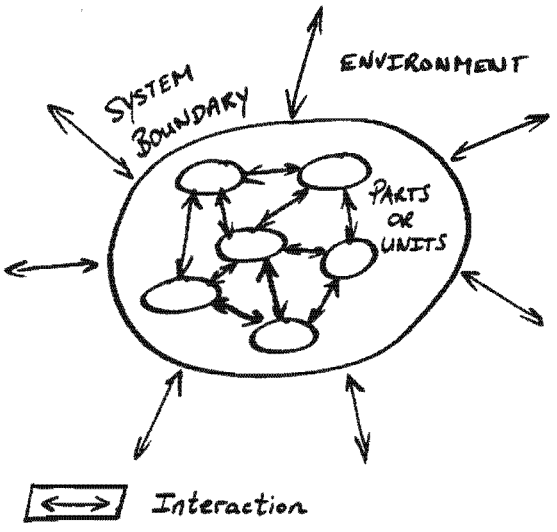

Figure 38: Classical distinction between a system with its 'parts' and the environment

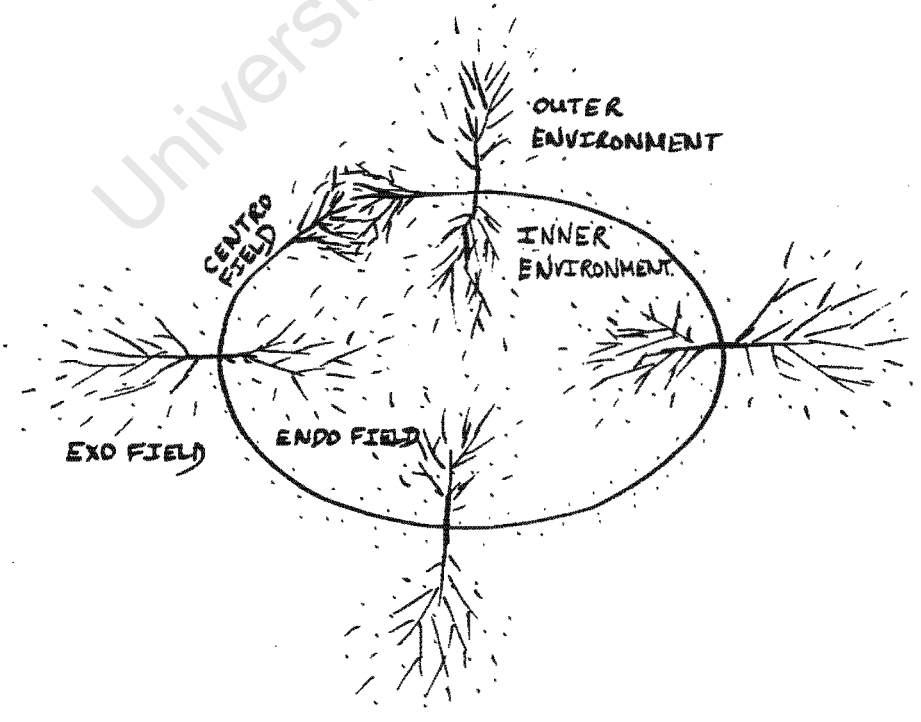

Figure 37: The endo, centro and exo fields of the doublet as a fractal-like tree of flux

ontological perspective. In other words the units (i.e. teleonic field) of the system stretching into the outer environment belong to the whole (i.e. the doublet) equally and in the same sense as the units stretching into the inner environment (see Figure 37).

In *scalar hierarchy theory* "three levels are requisite for a non-reducible description of complex systems: the focal level of jostling entities; their internal dispositions (the 'initiating conditions' of Salthe), which give rise to their behaviour; and the external constraints (boundary conditions) limiting that behaviour" (Salthe and Matsuno 1995, p.332). Although the three levels of the biomatrix bear some similarity with this distinction, it should be noted that the teleonomic projection of the biomatrix space comprises a vector field (i.e. the field of teleons) which is considered to be symmetrical also in a causal sense. That is to say no distinction is made between internal *initiating* conditions and external *constraints*: both the inner and outer environment co-act in a causally symmetrical sense in the emergence of the 'middle' level. Khalil is close to the biomatrix viewpoint when he argues that "the idea of complexity is imperative for the understanding of the nature of organisation. A complexity approach offers insights on the behavior of households, firms, and even higher-level organisations like states. The approach accords higher-level organisations ontological importance equal to lower-level ones. This certainly allows a new look at the ontological proposition that social organization is neither an artificial construct from lower-level individuals nor a hegemonic individual which manufactures lower-level human action" (Khalil 1995, p.415). Moreno argues that "the origin of cognition in natural systems (cognition as we know it) is the result of the appearance of an autonomous system - the nervous system - embedded into another more generic one - the whole organism. This basic idea is complemented by another one: the formation and development of this system, in the course of evolution, can be understood only as the outcome of a continuous interaction between organisms and environment, among different organisms, and, especially, among the very cognitive organisms" (Moreno, Umerez et al. 1997, p.126).

In addition to the symmetrical distinction or duality between the environments, there is also the concept of the nucleus with its embracing centro-teleonic field residing on the reference level. A clear distinction is made between the 'self' and the 'non-self' of the whole. The traditional notion of a system and its units has thus been extended and changed resulting in an explicit distinction between the autonomous aspects of the whole (i.e. the nucleus and centro-teleonic field, the 'self') on the one hand and its inner (i.e. endo-teleonic field) and outer units (i.e. exo-teleonic field) on the other. Dualities exist both between the inner and outer fields and between the organisation of the 'self' (i.e. centro-teleonic field and nucleus) and the non-self (i.e. inner and outer-teleonic fields combined). It is a double description of dualities (Keeney 1983). An interesting parallel may be drawn between the complementary pairs of teleons (the centro-teleon being in the middle) and the complementary nature of personality types within a group, as suggested by Ackoff (Ackoff 1996).

Although the aforementioned distinctions may appear to be of only philosophical importance, they hold very real implications for the way we perceive existing systems and for the way we design new systems. For instance, the tendency of integration is looked upon as both an inner and an outer integration, e.g. in the process of integration the human doublet 'reaches' inwards (i.e. to the 'society' of cells and inner physiological environment) as well as outwards (i.e. to society and the physical environment). With the concept of the nucleus as a distinct entity (in physical or conceptual space) it becomes possible for a system to potentially exist in an enfolded state without any parts, analogous to the seed which contains the full potential for the plant to manifest itself, or to the idea for a design in the socio-sphere. The concept of a doublet as a field also forces us to acknowledge the fact that the system just as much participates in its outer environment as it participates in its inner environment. It highlights the fact that, for instance, an individual is in a direct sense dependent on the environment, since the individual doublet actually comprises part of the environment (i.e. its exo-teleonic field permeating the outer environment).

This brings us to the important 'three-level' rule in the biomatrix namely that whenever the observer focuses on a doublet-system, at least three levels and its associated fields should be taken into consideration, viz. the reference level, the upper or outer level, and the lower or inner level of organisation. Although this may be implied in other systems models, the biomatrix explicitly makes this three-levelled distinction with reference to all doublet-systems. The *triple-field-like nature* of the doublet demands that the observer in all instances considers **at least three levels of organisation**, with the level of focus residing in the middle (see Figure 39).

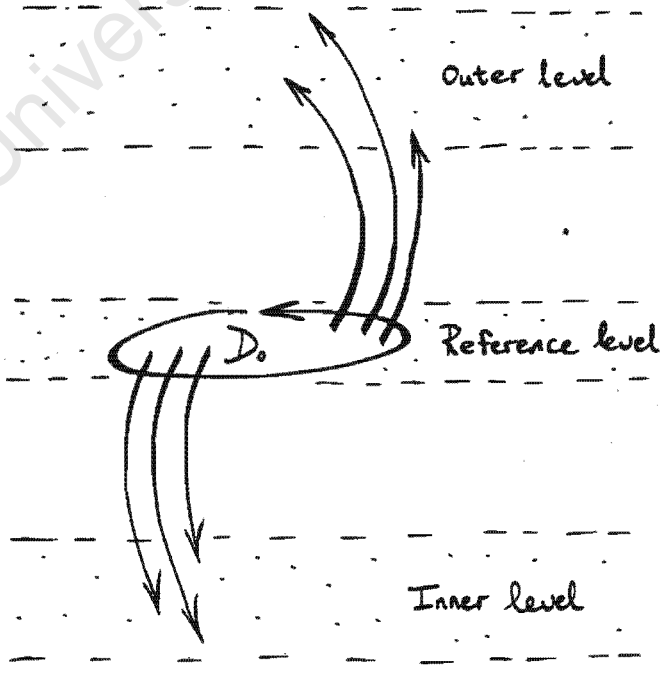

Figure 39: The three levels of organisation

3.2.4 Dynamically balanced complementary pairs: a cosmic balancing act

In addition to the symmetrical organisation of complementary pairs, there is a complementary symmetry of another logical type, namely a symmetry of dynamic organisational principles. Thus, the dynamic organisation (i.e. the moment to moment organisation) of these complementary pairs relative to each other exhibits a symmetry of its own. This principle is referred to as a dynamic balancing of complementary pairs relative to a common point of reference. The metaphor of a tightrope walker is useful to explain the concept of dynamic balancing. We all know that in order for the tightrope walker to move forward, he has to sway the balancing pole from side to side, thereby maintaining a delicate balance. It is in fact impossible to retain a balance in a state of rigidity, or trying to remain perfectly upright all the time. There is a continuos oscillation from the one side to the other, but overall, over time, a dynamic balance relative to the upright position is maintained. This principle of dynamic balance or equilibrium also applies to riding a bicycle, even though the movements sideways may be very small and in some instances not even noticeable to the untrained eye. Asymmetries and imbalances do exist at a specific moment in time, analogous to a piece of music wandering away from its key in periods of dissonance; i.e. tension is created which may give rise to a 'force' aimed at restoring a balance. Put differently, "any precise sort of homeostasis is unlikely; the system's values move hither and thither as various influences assume momentary prominence. Therein lies the strength of living systems - their ability to respond to the stresses that constantly impinge on them" (Tracey 1995, p.16).

We believe that a dynamic balance should be maintained between all complementary pairs within the biomatrix. The periods of oscillation may differ from case to case, though, depending on the dynamics of the system and its overall context. What may be perceived as an imbalance or asymmetrical state of affairs is, in the context of the biomatrix, considered to be part of a larger cycle which will eventually sway over to the other side again, and so forth. Over the 'long term' all systems maintain a dynamic balance between complementary pairs, with the period of oscillation depending on their particular dynamics. Philosophically this viewpoint is in line with that of a "complementarity of opposites"; more specifically it refers to harmonious, cooperative and complementary cycles, as opposed to the other viewpoints of conflict and opposition, separation or hierarchical domination (Sabelli 1989, p.33). At a specific moment in time complementary pairs are partly asymmetric in terms of their dynamic organisation or mutual balance; this temporary imbalance gives rise to a unidirectional process or force of "correction" (Sabelli 1989, p.56). This imbalance may be a driving force leading to bifurcations, creativity and novelty within the system.

The following are some of the dynamically-balanced complementary-pairs in the biomatrix:

- exo-teleonic-field vis-à-vis endo-teleonic-field (i.e. outer-environment vis-à-vis inner-environment).
- centro-teleonic-field (i.e. self) vis-à-vis exo- and endo-teleonic-fields (i.e. non-self).
- give (endo/exo-teleonic-fields) vis-à-vis take (endo/exo-tapping-fields)

3.2.5 Co-evolution and the emerging middle: betwixt and between the 'heavens' and the 'seas'

It is generally accepted within systems theory that there is a tendency for wholes to self-organise themselves into larger wholes (Koestler 1978; Smuts 1987), with so-called emergent properties arising on this newly formed level of organisation. A distinction has been made between ontogenesis, which refers to the growth and maturation of the young of self-reproducing species, as opposed to phylogenesis, which refers to the creative advance of nature into novelty (Laszlo 1972). Evolution is considered to be the process whereby new levels of complexity emerge from the "simple" (Laszlo 1972), or from a slightly different perspective, the formation of evermore encompassing or complex wholes (Young 1976; Smuts 1987). Some of the characteristics of the newly formed level of organisation are not explainable from its constituent units and are considered to be "new" or "emergent" (von Bertalanffy 1968). It has been suggested that synergy of various kinds has been a major source of creativity in evolution, of which 'emergent effects' are considered to be a subset (Corning 1995). Maturana and Varela view the evolutionary path of a system as the course followed by the conservation of "structural coupling" of the system in its environment (Maturana and Varela 1992). It is the relationship between a structure-determined entity and the medium in which it exists. The structure of an object specifies which events in its medium it can interact with and how it will behave under each and every one of these interactions. Structure is not a static thing, it alters with every interaction that it undergoes.

In the biomatrix evolution is viewed as a process which always occurs within two levels of organisation, viz. an upper or outer level and a lower or inner level. Let us focus on phylogenesis or the creation of a completely novel system. Although the exact nature of the dynamics has not been fully explored, it is our belief that the nucleus of a potentially new system originates as a result of the flux of mei between the upper and lower level. In addition to the exo- and endo-teleons there also need to be endo- and exo-tapping teleons in place. The emergence of the nucleus may conceptually be viewed as the emergence of an attractor in the space in-between these two levels due to the presence of several outcome-enhancing feedback loops between them. It is believed that if the dynamics of the respective teleons between these two levels become sufficiently closed in terms of its coupling or organisation, it may give rise to the new attractor or nucleus of a potential doublet (see Figure 40).

This is analogous to the emergence of turbulence or a whirlpool in a fluid. Once a nucleus has emerged in relation to the pre-existing levels it may evolve into a doublet and may even undergo further changes (i.e. ontogenesis).

The point that needs to be emphasised is that evolution is viewed as a process whereby the 'space' in-between pre-existing levels of organisation, is 'filled in', thereby creating new levels of organisation in-between. Both the *upper and the lower levels of organisation interact in a complementary and symmetrical manner to bring a new system forth.* Evolution is thus not viewed as a process whereby wholes get together into ever-larger wholes under the influence of the environment. It is rather a matter of 'heaven' getting together with 'earth' and the one 'lending the other a hand' in creating

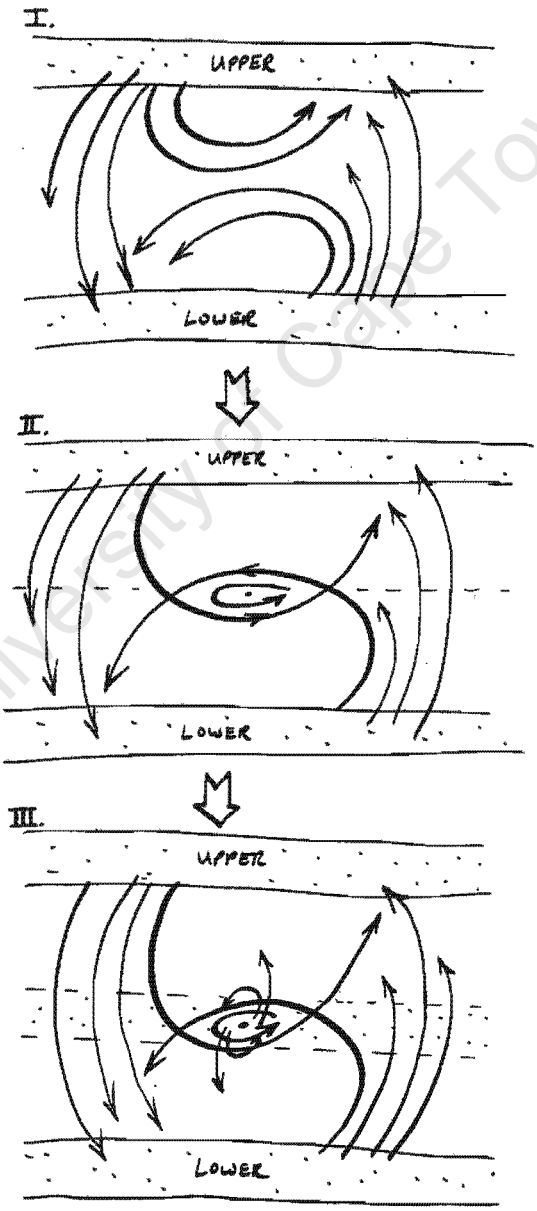

Figure 40: The 'emerging middle' as a fundamental principle of evolution

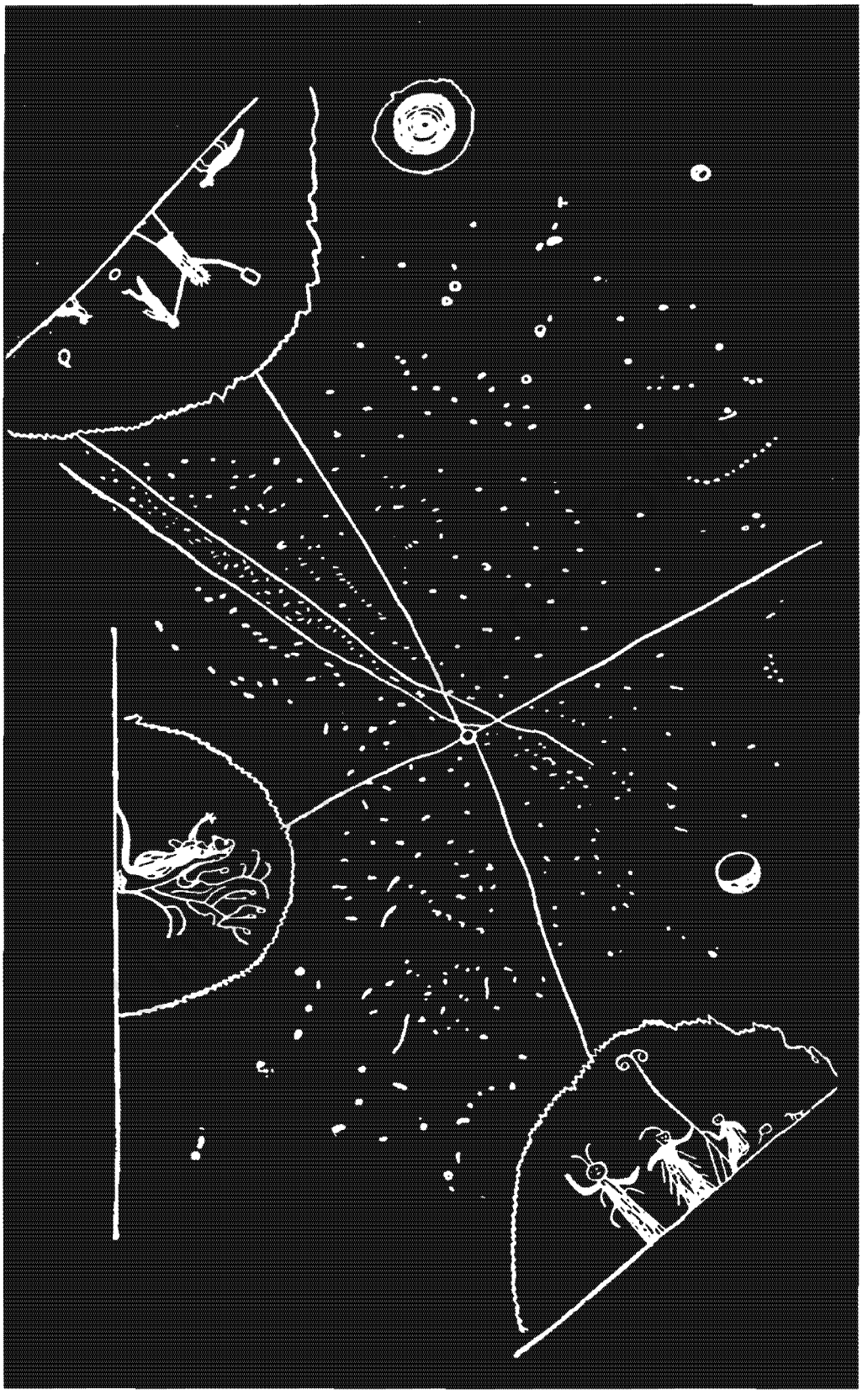

Figure 41: A Chukchi drawing of the "three worlds"

something new out of the pre-existing flux between these two poles. When these 'hands' (i.e. the teleons) become sufficiently 'locked' or dynamically coupled in a way that gives rise to 'turbulence', something new comes about.

'Heaven' (i.e. an upper or outer level) couples with the 'sea' (i.e. a lower or inner level) and in-between these levels chaos (i.e. a turbulent flux) arises, which gives rise to nuclei (or attractors in the sense of chaos theory) which act as the seeds for new doublets. 'Earth' (i.e. the middle level) thus emerges out of the interaction between the 'heavens' and the 'seas'.The concept of *morphogenetic fields* as postulated by Sheldrake may account for information stored in the 'upper level' and his hypothesis of *formative causation* suggests an inclusion of 'top-down' causation in the process of evolution (Sheldrake 1987).

Paleo-Siberian mythology of the "three worlds" also appears to support the concept of the emergent middle. This is rather well illustrated by a Chukchi drawing (Dogoras in: Grimal 1989, p.439) (see Figure 41). Dogoras renders the following explanation: "In the centre is the pole star, the axis of the world, with stars all about it and linked by the Milky Way to the World of the Dawn. The Man of the Dawn is preparing to give foxes in exchange for the sacrifices he receives. Opposite, the Evening and his family, wearing ceremonial costumes, are celebrating the Feast of the Sea-God. In a third world, between the two, Darkness is emerging from a tree with many branches" (Grimal 1989, p.438).

The biomatrix evolutionary model thus postulates ***the pre-existence, in all instances, of at least two interacting levels of organisation in a mutual causative way.*** *This calls for an 'original' or primordial split into two levels of organisation, from the 'one' or unity.*

Concluding remarks

This chapter dealt with the important principles of duality, complementarity and symmetry, and how these influence the biomatrix model. Some of the important implications were shown to be the symmetrical and dual pattern of the inner and outer teleonic fields of the doublet, as well as how the middle level of organisation emerges out of the interaction between these two fields, necessitating in all instances an emphasis on at least three interacting levels of organisation. In this regard, the function of tapping was explained as an essential element in all systems.

3.3 Being in the biomatrix: generic aspects and their relationships

This chapter explores in more depth the universal aspects of all systems, namely the *generic systems aspects*. These universal distinctions are: ethos, teleos, process, structure, substance and dynamic organisation. The focus is on generic relationships within the biomatrix, i.e. the nature of being, as opposed to evolution or becoming (which is dealt with in the next chapter).

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3.3.1 The biomatrix space (BMS)

As a means of preparing the ground for the various distinctions made within the biomatrix model it is perhaps appropriate to first address the notion of 'space'.

In accord with the ideas explicated by Mathews, the biomatrix model subscribes to an ontology of "substance monism" (Mathews 1991, p.66). Reality is portrayed in terms of a single, extended, universal substance, an indivisible continuum or a *field of universal substantival flux*. Seen in this context, the biomatrix refers to the universal web of 'mei' flux in a physical space-time continuum.

Space-time and *substance* are seen as one and the same 'thing'; space-time is not an arena, but it is everything, it is the basic fabric of the universe. This suggests a reality where space-time is the 'stuff' of which the world is made and the structure of space-time is the world's physics. In accord with the ideas put forward by the general theory of relativity "space-time is not only absolute, it is physically active: it acts on matter and is acted on by it. It is an evolving, internally differentiated physical entity" (Mathews 1991, p.66). Space-time "is not a passive arena, but the source and medium of all interactions, its parts both acting on and acted upon by each other; and...spacetime is a unified whole, with global and topological as well as local characteristics. It is not a collection of things, but a single thing - the only thing that is really real. One could call it by such names as pure substance, or being as such" (Graves in: Mathews 1991, p.68).

The primitive form of motion in the plenum is seen to be *wave-like*; suggesting that "bodies are merely local disturbances in the 'fabric' of space - wave-knots, or complex dynamic configurations in the substantial medium" (Mathews 1991, p.83). Furthermore, "certain wave-forms or constellations of motion within the substantival continuum distinguish themselves from their surroundings by actively maintaining their own structure in the face of the external ebb and flow which otherwise shapes local configurations in the field. By this intrinsic activity they create a genuine - ontological - self/other distinction, though their individuality in no way implies their separability or discreteness from the substantival matrix. Indeed this individuality connects them to their environment with even stronger ties of dependence than do their mere substantival or topological ties" (Mathews 1991, p.143).

Both process and substance are accorded equal ontological status. Thus, process is not viewed as 'a dance, danced by the dancers' or even 'a dance without dancers'; instead process and substance are viewed as aspects of a singular underlying reality. It is a reality where the 'dance', the 'dancers' and the space-time continuum are *recursively co-created.*

The space *described by* the biomatrix model is referred to as the *biomatrix space* (BMS), insofar as the model essentially comprises the matrix of holarchically organised process-threads (i.e. teleons) and focalised-field-like-entities (i.e. doublets) *as distinguished and described by the observer.*

Distinctions within the biomatrix space either derive from the 'objective' observation and experiencing of mei flux within physical space, or from the processes of imagination and conceptualisation within the mind of the observer. Our perception of 'reality' is essentially an outcome of both these processes; i.e. objective observation of mei flux in *physical space* and subjective imagination in *conceptual space* (i.e. in the mind of the observer). This is not to say that these two spaces are necessarily separate and that a duality between 'mind' and 'body' is implied. From the viewpoint of a *cybernetic epistemology* mind and body are considered to be a unity and suggests a "typology of closure"; i.e. these two 'spaces' are considered to "recursively generate" each other (Keeney 1983; Barnes 1996).

A distinction is thus made between those processes considered to originate within physical space and those processes considered to originate within the conceptual space of the 'mind'. These distinctions are best thought of as *spheres* or *fields* within a universal biomatrix space and are considered to overlap in the same way that fuzzy logic distribution functions overlap (see Figure 42). This fuzzy distribution is further supported by the notion of overlapping *fields* within a *field-like space*.

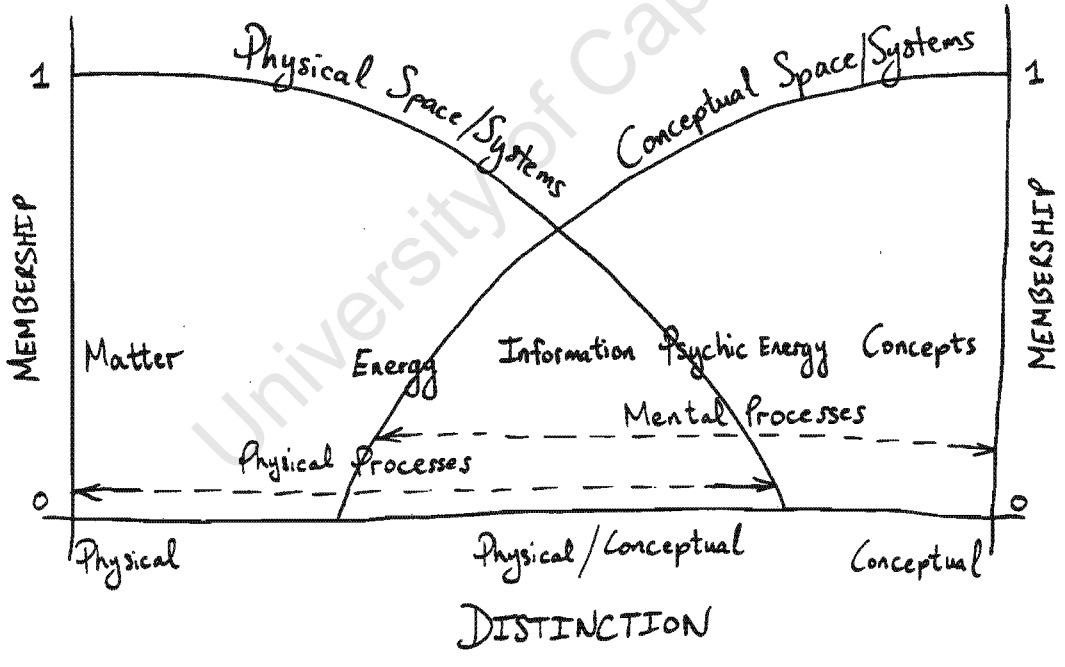


Figure 42: Fuzzy distribution functions of physical vis-à-vis conceptual space/systems

Systems originating within physical and conceptual space are respectively referred to as *physical systems* and *conceptual systems* (the notion of a "concrete system" in LST (Miller 1978) is essentially similar to that of a physical system).

To sum up: all systems in the biomatrix model are considered to manifest as a *field-like flux of mei* within the biomatrix space. The observer may find it useful to draw a distinction between physical and conceptual space, i.e. between *physical* and *conceptual systems*. Belonging to another logical type is the distinction between the two classes of systems in the biomatrix model, i.e. *teleons* and *doublets*. In addition to the aforementioned distinctions the observer may also draw distinctions based on what is referred to as the *different aspects* of a system. It should be noted that distinctions drawn within the biomatrix space are essentially field-like and fuzzy in the sense that there is seldom a clear-cut separation between them; i.e. generally there are areas of 'overlap' between distinctions of the same logical type.

The distinctions based on the different *aspects* of a system in the biomatrix model are subsequently addressed.

3.3.2 Generic aspects and their relationship

Boulding suggests a system is *a way of looking at the world* (Boulding 1956). Stated differently, the observer abstracts certain aspects from reality as observed, and builds an image or interpretation around his sensory information. Perception and interpretation becomes a process of attaching meaning to what we observe out there. This implies a largely subjective interpretation of reality. Opposed to this viewpoint is the 'objective' observation and interpretation associated with the scientific process of measurement and inter-subjective agreement. Both these processes, however, entail a degree of abstraction in the mind of the observer. The biomatrix approach comprises a combination of both, in fact, the one process complements and enriches the other, ultimately leading to an image of 'reality'. If this image proves to be meaningful and useful it will endure and survive the test of time.

The biomatrix model associates six *generic systems aspects or perspectives* with all systems. These are partly based on objective observation of the 'way things are' in the real world, and partly on meaningful abstractions which enrich our understanding of the world (i.e. our inner and outer worlds).

The following aspects, each representative of a different systemic quality, are associated with all systems in the biomatrix: i.e. ***ethos, teleos, process, structure, substance (mei)*** and ***dynamic organisation.*** These are distinctions which together make up a generic image of all systems. They are field-like in their nature: i.e. each in its turn comprises a whole ensemble of other aspects and the boundaries of these six distinctions are fuzzy by their very nature, i.e. their membership functions overlap (see Figure 43).

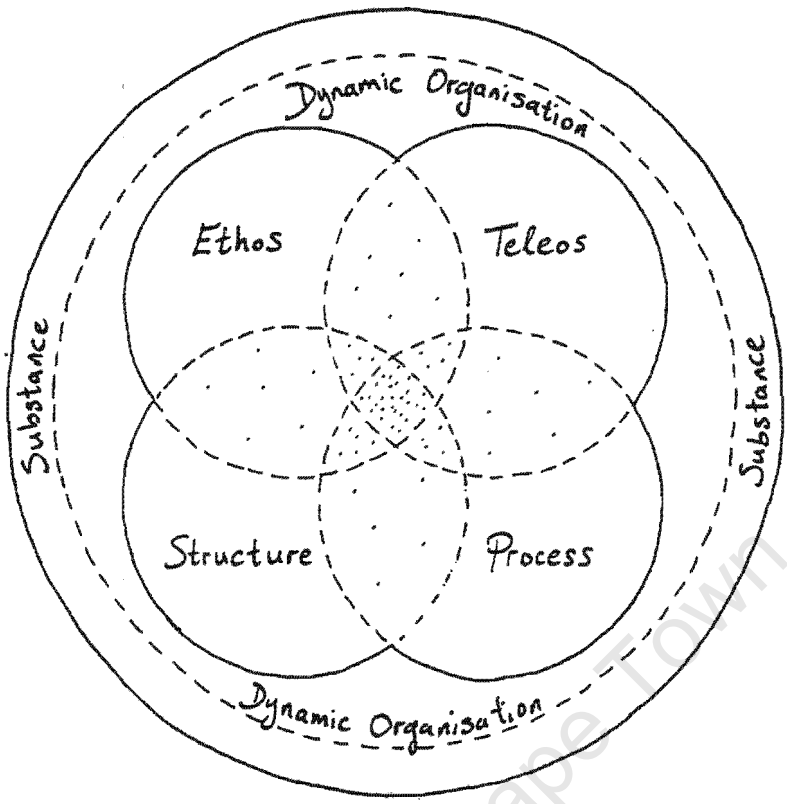
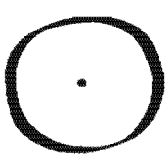


Figure 43: Interrelatedness of the generic systems aspects

The subsequent sections explore the generic systems aspects in more detail.

3.3.2.1 Ethos aspect



The ethos aspect of a system refers to the field of organisational and governing principles that are associated with the nature and behaviour of a system in time and space.

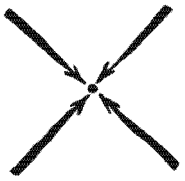
Typical examples are:

- **Guiding principles** in society determined by culture, customs, ethics, morals, politics, among others.
- **Business ethics** of an organisation relating to competitiveness, excellence and social commitment.
- **Values** of an individual based on morals, attitudes, beliefs, etc.
- **Genetic code** on the cellular level providing guiding principles for cellular processes and evolutionary strategies.

- **Laws of nature** on the various levels of the physical reality, including the laws of gravity, electromagnetic attraction and repulsion, and chemical affinitiveness.

The ethos of a system answers the question: what is of importance ? It prioritises between different possible outcomes and acts as 'judge' between what is preferable and what not, the 'good' and the 'bad', the 'beautiful' and the 'ugly', 'right' and 'wrong', what is important and what not. Ethos manifest as guiding principles in conceptual space and is perceived differently on various levels of the living holarchy. For example, the laws of nature appear to be firmly established, whereas ethics, morals and world views undergo continuous evolution.

3.3.2.2 Teleos aspect



The teleos aspect refers to a state or outcome towards which a process (or system) tends to be directed, attracted or which it dynamically persists in.

Teleos either emerges from or it is projected onto a system. On those levels that include sentient interaction such as the individual, groups, society and many other forms of life, teleos may be projected.

a. Emergent teleos

Emergent teleos is derived by abstracting it from the behaviour as observed in a system. On the physical level, teleos is derived from the laws of nature and is therefore of an abstracted nature. Emergent forms of behaviour such as those governed by customs generally present a teleos that is abstracted. A system is considered to present an emergent teleos if it persists in its state or continues to progress towards a particular end-state under different prevailing conditions.

b. Projected teleos

Projected teleos is determined either within or outside a system according to intended or planned outcomes. Planned behaviour such as that obtained through legislation is generally considered and projected upon the relevant system. It is important to stress that teleos in the context of the biomatrix approach does not specifically refer to divine intervention as interpreted by some of the adherents of teleology, although it does not exclude it.

The overall concept of teleos is inclusive of a range of concepts in the same class: purpose, mission, ideal, goal, objective, strange attractor (as in chaos theory) and function. These concepts are generally interrelated and interchangeable, depending on the focus and intent of the observer. Thus, the teleos of a system is the projection of a preferred outcome (intended or emergent) in the time domain. Furthermore, in some instances it may also contextualise these projections (e.g. goals) in terms of an ascribed purpose statement. For each type of teleos the question it poses is different:

- **Goals**: e.g. What is the preferred outcome? When is it going to happen? How much of it is going to happen?
- **Purposes**: e.g. Why is it happening?

Examples of teleos are:

- the *sun* acting as *an attractor* for the earth or a plant; thereby determining movements over time.
- an *emergent* behavioural or dynamic organisational *pattern* that acts as an *attractor* and persists over time: e.g. a habit, the development of a city tending towards a certain direction in space, and preferred states of chemical bonding on the atomic and molecular level.
- an intended *goal* by a sentient being: e.g. to produce a certain amount of goods by a certain time or to arrive at a particular destination.

3.3.2.3 Process aspect

A process is a series of actions over time leading towards an end-state relative to a particular period of observation.

A process focuses on the *actual flux of mei* in space (conceptual or real) and over time. It typically answers the question: how are things happening ? or more specifically, how are the actions connected and what does the mei flux look like over time and in space ?

A process may be *teleos-related* or *open-ended* in terms of teleos (i.e. with no preferred or pre-determined end-state or outcome):

- if it is associated with a purpose, it is referred to as a *purposeful process*.
- if it is dynamically organised towards a specific preferred end-state, it is referred to as a *goal-related process*.
- if it is dynamically organised towards a preferred class of outcomes (i.e. a generic outcome), it is referred to as a *functional process*.

In practice processes typically constitute a combination of the above distinctions.

Typical examples of processes are:

- A river network: a confluence and branching of rivulets; forming *an interrelated web of flow.*
- *Commuting* (e.g. walking→ driving→ parking→ walking→ arriving at office).
- *Design* (e.g. brainstorming→ analysing→ synthesising→ design specification).
- *Transformation* (e.g. re-designing→ implementation or re-structuring).
- *Nutrition* (e.g. selection of food→ preparing→ eating→ digesting→ metabolising).

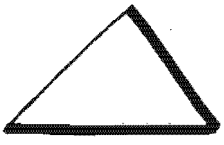
3.3.2.4 Structure aspect

Structure refers to those relationships between elements (e.g. discrete entities, actions or processes) which appear to remain constant relative to a particular period of observation and level of organisation as defined by the focus of the observer.

Structure exists in physical and/or conceptual space (referred to as a *configuration*) and/or in time (referred to as an *action-pattern*). The distinction between structure and process is relative to the perspective of the observer (this statement will be elucidated in another section).

It is noteworthy that *structure may exist in both a spatial as well as a temporal sense*. In a way structure or form is something which transcends both time and space. Within the space-time continuum it provides a link between these two modes of perception. The structure inherent in a process, for instance sound (e.g. music or the spoken word) should be viewed against the structure inherent in a spatial entity (e.g. a building, the human body, or an organisational structure) existing in conceptual space. The terms structure, form and pattern are used in different ways by people; we therefore thought it wise to make a clear distinction between structure in the spatial domain and structure in the temporal domain. The term *structure* was chosen to depict both these concepts (the fact that it is both a noun and a verb is thus quite appropriate).

a. Configuration (spatial structure)



Spatial structure or configuration refers to the relative arrangement of the elements of a system in space.

The focus here is in the first instance on the spatial aspect of the system. For example:

- the three-dimensional structure of a molecule;
- the anatomy of the human body;
- the organisational structure of an institution (i.e. in conceptual space);
- the structure of the theory of mathematics (i.e. in conceptual space);
- the geographical structure of a town.

b. Action-pattern (temporal structure)

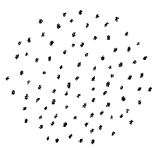
Implicit to a process is a *pattern of change* which refers to the sequencing of actions. If this pattern is *repetitive* it manifests as a structure in time, generally referred to as an *action-pattern*. In this instance the focus is on the temporal structure of the system, which subsequently may lead to its representation in the spatial domain.

Examples of action-patterns are:

- a musical score;
- the sound of a word;
- a behavioural pattern;
- procedures in an institution.

3.3.2.5 Substance (mei) aspect

The *substance* of a system refers to all those separate *'entities' which embody a system* (conceptual and/or physical), in other words, *that which makes a system perceptible* to our senses, to our mind or to our measuring devices.



It may in its turn comprise a more subtle substance; i.e. smaller, more fundamental or more refined 'entities'. Matter, energy and information together is considered to constitute the three main classes of substance. From a physical point of view these three entities are very intimately related. Their interrelationship is reflected by their ability to transform into one another. Apart from 'pure energy' none of these aspects can really exist out of relationship with at least one of the other. Information, for instance, is stored in some material form and is conveyed through the exchange of energy. Matter always contains some sort of energy with information stored in its unique structure. To signify the close symbiosis between these three aspects of substance, they are referred to as a single entity, namely ***mei***.

Physics distinguishes between four different phases (states) of matter i.e. solid, liquid, gaseous and plasma states. Likewise the Greek philosophers distinguished between the four "elements" of the world i.e. earth, water, air and fire. These "elements" did not refer to the modern day concept of an element as depicted in the Periodic Table of the physical elements, but rather referred to different phases of the material/physical universe. Similarly the biomatrix with its **m-e-i** distinctions of substance considers these three aspects to be different phases or states of substance. Unfortunately these three distinctions of substance can be separated and fragmented in our minds. When this occurs we do not recognise the fact that they are merely manifestations of the same underlying 'thing'. This may lead to a fragmented perspective on and, consequently, solutions to the problems we encounter in the world.

A *functional* distinction pertaining to substance can be made as follows:

a. Input / Output entities ('building blocks' and 'products')

Input/output-entities form part of the throughput of mei entities in a system. The input entities refer to the 'building blocks' or those entities which are being processed / transformed into products, whereas the output entities refer to the emerging entities or products of the associated process or transforma-

tion. For instance, a book acts as an input entity for a student and becomes transformed into skills and understanding as an information-based output.

b. Transformers (actors)

The transformers or actors are all those entities which are actively and explicitly engaged in the process of transforming other entities into outputs or products of a system. Actors are transformers, whereas input/output entities are being transformed. Actors and input/output-entities are analogous to the subject-object relationship in a sentence. The student and her learning processes would act as the transformers in the education system.

c. Supportive entities

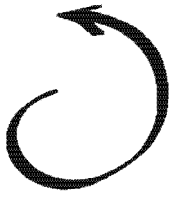
The supportive entities are all those entities which are not explicitly engaged in the transformation process and are also not 'flowing through' the system as part of the input/output entities (e.g. buildings). The distinction between an actor and supporting entity is not always that clear and may depend on the perspective and intention of the observer. The educational infrastructure as well as parents, transport and so forth constitute examples of supportive entities.

3.3.2.6 Dynamic Organisation aspect

Dynamic organisation refers to the combined outcome of all the 'guiding forces' in a system, i.e. the combined outcome of the emergent-organisation vis-à-vis the intended-organisation or governance of a system

Emergent organisation and governance are intimately related in a recursive sense, the nature of which will be elaborated on in a subsequent section. An important point to make is that these concepts are relative to both the level of observation and the perspective held by the observer.

a. Emergent organisation



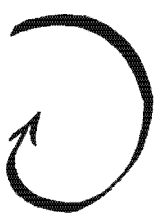
Emergent organisation refers to the innate ability of a system to organise itself as a result of the interaction between its units.

It is an organisation which *emerges* from the interaction of the parts of the system and cannot be traced back to a particular decision-making element. The system reaches stable states at non-equilibrium points, or in Prigogine's terminology "far from equilibrium" (Prigogine and Stengers 1984). In *complexity theory* it is assumed that complex adaptive systems basically run themselves without any intervention from a specific 'governing' element. The adaptive responses appear random, because the individual activities are not 'controlled' or pre-determined (Kauffman 1993). It is a type of

organisation based in apparently random actions on the "edge of chaos" (Gleick 1987). The stable state towards which a system is naturally drawn is referred to as an *attractor* (which exists in conceptual phase space). The principle of emergence is at the heart of the tendency of parts to form larger stable 'wholes' (or systems) of their own accord, exhibiting qualitatively different properties, i.e. maintaining or organising itself around a newly acquired stable state (i.e. far from thermodynamic equilibrium). All these aspects of organisation are collectively referred to in the biomatrix as *emergent organisation.*

On the atomic level emergent organisation refers to the ability of matter, e.g. molecules, to organise itself into stable structures as a result of the interaction between the various parts or atomic constituents. The very complex molecular structures of proteins in living systems is an excellent case in point and is referred to as 'protein folding'. Other examples are the ability of groups of cells to organise themselves into larger complex structures of organisation, e.g. single-cellular cultures and sponges, and the emergence of new patterns of thought or novel ideas in the. Furthermore, we are all familiar with the emergence of new patterns of organisation within a group of interacting individuals, without being able to pin-point its origin to a particular individual. Some human settlements evolve from a large scale perspective (e.g. the city as a whole) in an emergent sense, without any overall planning. In fact, any culture is to a large extent the collective outcome of all the interactions between a particular group of individuals over time. Emergent patterns may thus persist and become viable patterns of organisation in their own right.

b. Governance (governed organisation)



Governance or governed organisation refers to 'intended', planned, programmed or pre-determined organisation of a system.

Governance pertains to those aspects of organisation which originate with some form of 'intent', plan or programme and subsequently manifest as a preferred outcome. The 'origin' of the governance may be traced back to an identifiable 'decision-making element', called the "governor" or the "decider" (Miller 1978), which can be either outside or inside the system being governed. Once the 'decision has been made' it is considered to be pre-determined. Although this type of organisation appears to be limited to what are generally considered to be living systems, it may also be imprinted or programmed into artefacts and technological extensions found in those systems.

Depending on where the *decision-making-process* resides it can be referred to as *intrinsic or extrinsic governance*. However, these modes of governance can be mixed, with some aspects determined from outside and others from inside. For example, in an institution values and even goals may be

determined outside the system that is responsible for its execution, whereas regulatory decisions are made within the system responsible for their execution, e.g. a particular production process.

The notion of *intention* is important but rather slippery and difficult to define. Christensen argues that "we must understand intentionality as a complex property of information-utilising systems, varying in degree with the *way* in which systems exploit information" and "that the control strategy focused on explicit, context sensitive exploitation of information is the one which generates strong forms of intentionality" (Christensen 1996, p.316).

On a cellular level governance would typically be associated with the pre-programmed regulatory mechanisms of the nucleus (DNA and RNA processes of regulation). In this instance governance is considered to be pre-determined in the sense that the organisational 'decisions' have been 'made' in the process of evolution. On the organismic level it pertains to all homeostatic regulatory processes, whereas in the psyche of the human (or of any other sentient being), it is associated with all intentional forms of organisation, e.g. individual values, plans, ideals, strategies, goals and ultimately its actions. On the institutional level it refers to all intentional forms of managerial processes, e.g. policy formulation, planning, goal-setting, decision-making processes and regulation. On a national level it refers to all processes associated with orderly 'government'.

c. Generic perspectives on dynamic organisation

Further distinctions of dynamic organisation can be made pertaining to the generic aspects of a system:

- **organisation of ethos:** establishing the principles and values of organisation (e.g. a bill of rights, the ten commandments, aspects of institutional mission statements, "survival of the fittest" as an evolutionary value);
- **organisation of teleos (*teleos-setting*):** establishing the purpose, goals and objectives of organisation;
- **organisation of process (*regulation*):** 'decision-making' processes that are responsible for continuous adjustments to the mei flux in order to achieve a preferred teleos (e.g. goals);
- **organisation of structure** (i.e. of the organisational action-pattern): establishing procedures and strategies (e.g. legal procedures, decision-making procedures and the DNA code in organisms);
- **organisation of substance:** selection of entities participating in a system (e.g. personnel and all other mei resources).

d. Functional perspectives on dynamic organisation

Maruyama (Maruyama 1963) defined the nature of regulation as either deviation-counteracting or deviation-amplifying. Deviation in this context refers to any deviation from the goal (as selected through the control function) that occurs in the output. We have extended this concept to apply to all forms of dynamic organisation, i.e. either emergent or intended (or pre-determined).

d.i. Deviation-counteracting dynamic organisation

Deviation-counteracting organisation (*morphostasis*) ensures that the outcome of a process remains within close range of its preferred outcome, and any deviation from this outcome is counteracted with the necessary adjustments in its functioning.

In most cases this type of dynamic organisation is achieved through the process of feedback and more specifically negative feedback mechanisms. This is typical of all homeostatic control mechanisms as elaborated on in the field of cybernetics.

d.ii. Deviation-amplifying dynamic organisation

Deviation-amplifying organisation actually enhances any deviation from the preferred outcome. This may either lead to the creation of a new order (*morphogenesis*) or the destruction of the existing order (*morpholysis*). Deviation-amplifying organisation is typically achieved through positive feedback techniques. It may lead to destruction of the existing system and/or the emergence of a novel transformed system.

Deviation-amplifying organisation would give rise to an unstable situation if it were not somehow limited. Limitation of deviation-amplification organisation is typically achieved by means of higher level deviation-counteracting organisation imposed on it. The higher level mechanism actually sets the boundaries within which the lower level organisation freely operates. For example, a population explosion (i.e. deviation amplification) may be counteracted by a limitation of resources (i.e. deviation counteracting).

The concepts 'positive' and 'negative' feedback should be used with caution though. Both deviation-amplification and deviation-counteracting could be achieved by either of these cybernetic techniques, depending on the spatial and temporal configuration of the feedback loops in the cybernetic configuration. These concepts may also cause confusion when applied differently in other disciplines (e.g. psychology). In order to distinguish unambiguously between feedback configurations for deviation-amplifying and deviation-counteracting organisation, the terms *morphogenetic* and *morphostatic feedback*, respectively, are preferred.

e. Other systems perspectives on organisation

The term *self-organisation* is used in different contexts in the systems literature (von Bertalanffy 1968; Jantsch 1979; Prigogine and Stengers 1984; Goertzel 1992) and depending on its use, may actually refer both to intrinsic governance and to emergent organisation. Thus the ability of a system to organise itself does not necessarily distinguish the 'mechanism' of organisation at stake. For instance, it may either be as a result of an internal decidor (e.g. homeostatic regulatory mechanisms in the human body) or it may be as a result of emergent properties (e.g. the ability of a group to organise itself without any apparent decidor).

Living systems theory (LST) essentially associates a *cybernetic viewpoint* with organisation: "the basic observation that informs LST is that systems (e.g. cells, humans, organizations, and societies) can maintain regularity despite irregularity in the system's environments. This regularity is accomplished by comparing current or anticipated states with internally represented desired states and converting any difference into actions that will keep differences small. ... Thus, living systems theory is concerned with self-regulating systems at or above level four in Boulding's hierarchy, as well as the properties of the lower level systems, particularly the cybernetic properties of level three" (Vancouver 1996, p.166). The role played by different categories of information in the organisation of systems, as seen in the context of LST, is explored by Banathy: "a key organizational feature in LST involves the assignment of tasks (functions) to components in order that critical processes may be carried out in an appropriate manner. ... If the process in question is not state-determined then we may see fluidity in the components that are assigned (or take up) responsibility for the task, as evolution is taking place. In this case the traditional notion of cybernetic feedback fails to account for effective behavior" (Banathy 1996, p112).

Cybernetic-based concepts of organised complexity, regulation, transformation, equilibrium, information exchange and feedback and control are central to the organisation and *viability* of systems in the *viable systems model* (Jackson 1992).

Maturana and Varela emphasise the principle of *autopoiesis* according to which a system can create and maintain its own stable state and boundary, and at the same time also have the ability to reproduce itself, or more specifically, to reproduce this unique type of organisation (Maturana and Varela 1992). These systems differ from each other in terms of their structure (or more specifically their spatial configuration) but they are alike in terms of their organisation.

Ackoff's *circular organisation* suggests an organisational design that addresses the quality of work life of an increasingly educated work force and by so doing better serves both their purposes and those of the organisation as a whole. The design also effects the type of organisational changes required to facilitate the interaction of the parts of an organisation, and of the organisation as a whole with parts of its environment. It is essentially a democratic process where there is a *circularity of*

power and each member participates directly or indirectly in all decisions that affect him (Ackoff 1994).

Shakun considers *purposeful complex adaptive systems* and processes to "involve multiplayer, multicriteria, ill-structured, evolving, dynamic problems subject to self-organization in which players both cooperate and conflict in choosing and delivering values to participants as operational goals through decision making. Thus, such systems are both cybernetic and self-organizing" (Shakun 1996, p.305).

Corning considers the concept of *synergy* to be the overall organisational principle in living systems, with its related concepts of self-organisation, emergence and complexity (Corning 1995). Kauffman suggests that *autonomous, autocatalytic processes* are the primary sources of order in nature and that natural selection merely fine-tunes the results of these processes (Kauffman 1993). Thus, a new "physics of biology" is envisioned in which emerging natural laws of organisation will be recognised as being responsible both for driving the evolutionary process and for truncating the role of natural selection (Corning 1995).

Miller distinguishes between six different classes of *organisational learning*: i.e. *methodical learning,* which in its turns comprises systemic analysis, experimentation and structural learning, vis-à-vis *emergent forms of learning,* which in its turn comprise synthesis, interaction and institutional learning (Miller 1996). Parallels may be drawn between methodical and emergent learning as opposed to the governed and emergent organisation of the biomatrix model.

Multimodal systems thinking distinguishes between two intertwined forms of organisation: "the *determinative*, that is, it always exerts its own fulfilment. To this belongs gravity. ... All the cosmos, including man, is subject to the determinative order. Only man, however, is subject to the second form of order, the *normative*. This is because this order addresses the human will and only humanity has will" (de Raadt 1997, p.18).

3.3.3 Contextualising the generic aspects of a system: a juxtaposition of dual distinctions

The generic aspects of a system all represent different perspectives of the same system under observation. As such these aspects are intimately interwoven and certainly not independent. They all contain, to a lesser or greater extent, aspects of each other. For instance, process always contains elements of substance and in most instances also organisation and structure. On the other hand, all of the aspects contain elements of substance. They are not all related in the same way; this would have implied a range of rather trivial distinctions. In an attempt to clarify the relationship between the generic aspects, it has proven useful to contextualise them in terms of two additional pairs of dual distinctions. These distinctions are a *temporal perspective* vis-à-vis *spatial perspective*, as well as a

distinction between the *conceptual sphere* (i.e. having existence in the 'mind' of the observer) vis-à-vis the *physical sphere* (i.e. having existence in conventional physical space). These two complementary distinctions have been chosen, since they are representative of some of the most fundamental distinctions to be made in the process of perceiving 'reality'. It does, to some extent, assist us in understanding the relationship between the different generic aspects. The juxtaposition of these distinctions is depicted in Figure 44 and is subsequently explored against the background of three pairs of generic systems aspects.

3.3.3.1 Dynamic Organisation and Substance (mei) perspective

As a first order of abstraction the dynamic organisation and substance perspectives of being are considered. These two perspectives represent the most fundamental or 'primary' generic aspects of being, since ultimately all creation emanates from the organisation of substance (mei). For example, energy is organised into matter, and the mere fact that there is some form of organisation actually implies the presence of information, and vice versa. It also appears to hold in a cosmological sense, since all being manifested through the organisation of energy at the birth of the cosmos (e.g. the theory of a big bang of energy, or radiation, emanating from a singular point in time-space). From a spiritual and mythical perspective it also seems to be well supported, since most religions or creation myths refer to the creation of the world out of the 'waters' (i.e. energy or substance) through the intervention of a 'creator' or other organising principle (i.e. conscious intent or emergent organisation). It should also be noted that within the conceptual sphere of quadrants A and B (see Figure 44), the information element of substance predominates (depicted as **mei**), whereas in the physical sphere (i.e. quadrants C and D), the energetic and material elements of substance predominates (depicted as **ME**i).

3.3.3.2 Structure and Process perspective

As the next order of abstraction we consider the notions of structure and process. Let us first focus on the process aspect of a system. Process manifests essentially in the temporal domain as a sequence of actions over a period of time. More specifically, we focus on the flux of mei over time, i.e. the transportation of substance or the transformation of substance in time. This does all happen in space as well, but in the case of the process aspect of a system we choose to emphasise only the temporal changes, albeit in space. As has been pointed out by Einstein, the distinction between time and space is merely an abstraction which in reality exists as a space-time continuum (Clarke 1979).

The mei flux may manifest predominantly in a conceptual sense (i.e. quadrant B), as would be the case for all thought processes, for example, changes over time in our attitudes, as well as problem-solving and design processes. It may also entail processes that are expressed symbolically, e.g. a written 'story', computer programmes and expressions of mathematical transformation. On the other

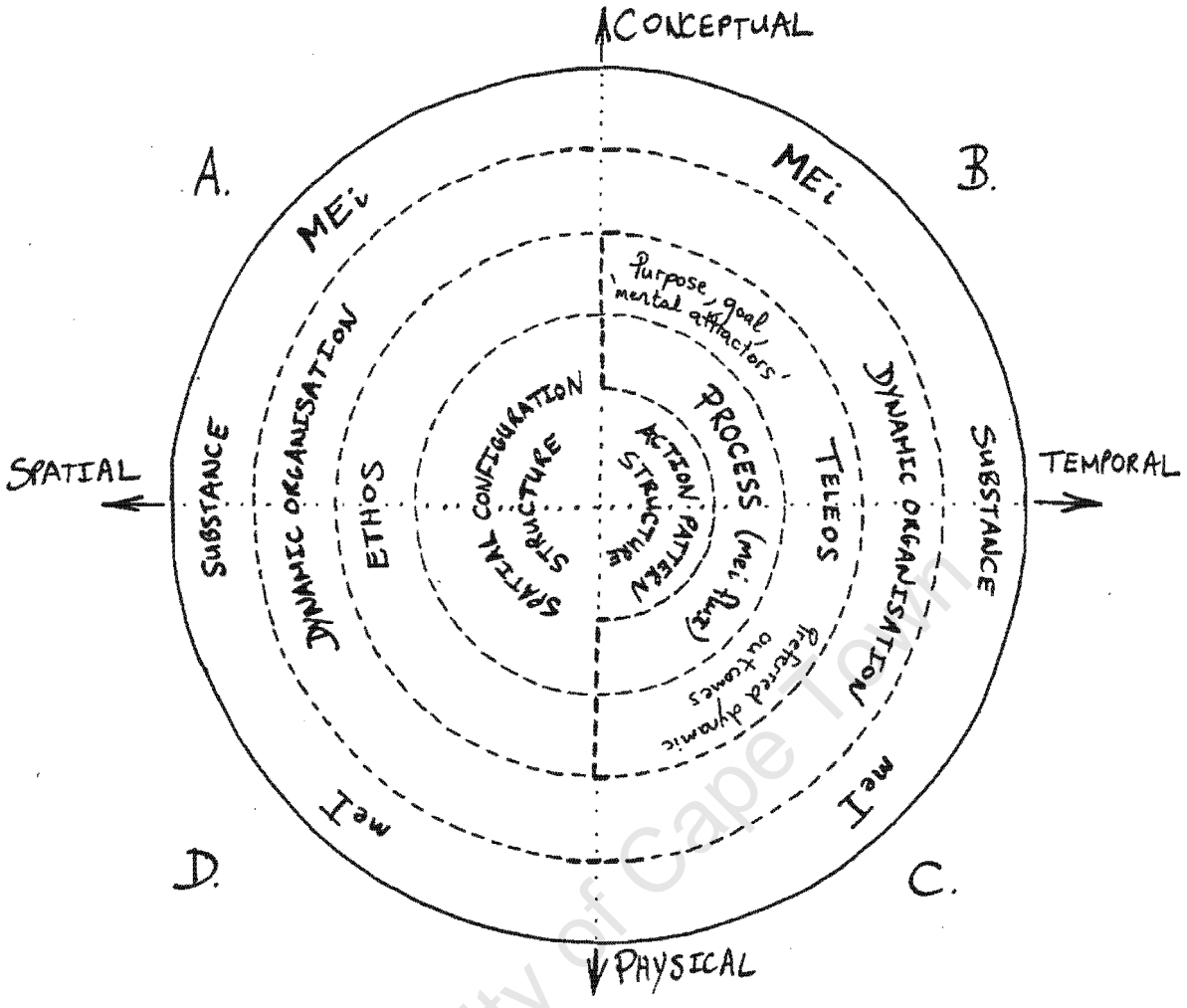


Figure 44: The generic systems aspects in the context of a double distinction of spatial vis-à-vis temporal and physical vis-à-vis conceptual

hand, mei flux also has a physical component (i.e. quadrant C), for example, radiation of energy in space, all movement of matter in space, talking, walking, manufacturing and distribution of resources and products.

Structure is an aspect which manifests both in a spatial as well as a temporal sense. On the right half (quadrants B and C) we have the *action-pattern* which represents *the structure inherent in a repetitive type of process* (i.e. mei flux); whereas on the left half we have the *spatial configuration* which in its turn represents the configuration of mei in space (both conceptual and physical). The distinction between these two aspects of structure is relative to the particular domain (i.e. temporal or spatial) as well as the to level of focus within the holarchy of systems.

For example, the anatomical structure of a human being is observed as a spatial configuration in quadrant D, whereas a unique walking pattern is perceived in a temporal sense as an action-pattern in quadrant C. It should be noted that both these aspects of structure are on the same level of observation

and abstraction. However, we are well aware that underlying the anatomy (i.e. on a cellular and atomic level) there is a myriad of bio-chemical and sub-atomic processes giving rise to the relatively stable human anatomy. The distinction between action-pattern and spatial configuration may thus be drawn within the same level of organisation and abstraction, or alternatively it may be drawn in a 'vertical' sense across different levels of organisation.

Another example is the design, manufacturing and implementation of a particular technology. For instance, the technical documentation pertaining to the design of an aircraft exists predominantly as a spatial configuration in quadrant A, whereas the manufacturing procedures exist as an action-pattern in quadrant B. The actual manufacturing of the aircraft manifests as an action-pattern in quadrant C, and when the aircraft becomes physically manifest, it also exists as a spatial configuration in quadrant D, and its actual flying patterns may be abstracted as an action-pattern in quadrant B, whereas in the mind of the observer it continues to exist as a spatial configuration or mental image (i.e. quadrant A).

3.3.3.3 Teleos and Ethos perspective

The teleos and ethos aspects represent the highest order of abstraction within the range of generic systems aspects.

Teleos manifests *predominantly as an aspect in a temporal sense* and is viewed as a projection in time, not unlike a vector or arrow pointing to a pre-preferred outcome at some point in the future. In the physical sphere teleos is representative of all processes with a preferred-outcome in physical space and may either come about as a result of an emergent organisation, or explicitly governed as such through sentient intervention.

Examples of teleos are all processes in nature which tend to move towards a preferred end-state as a result of the natural 'laws', e.g. a river running towards the sea and heat exchange processes like the persistent cooling down of an object in a colder environment. It also includes non-linear, far from thermodynamic equilibrium processes, like many biochemical reactions in living organisms (Prigogine and Stengers 1977b; Prigogine 1980). All planned or intended processes in the physical sphere, e.g. moving towards a particular destination or aiming for a particular level of fitness, are also included. In the conceptual sphere, teleos represents all purposes and goals as formulated in the human mind, as well as its symbolic expression (e.g. as expressed in a document or image).

Ethos as an aspect is *viewed predominantly in a spatial sense*. The values and principles are expressed as some sort of structure or hierarchy, which relative to the teleos aspect is essentially 'time-less' (analogous to the distinction between a system parameter and variable in cybernetics). In the conceptual sphere (quadrant A) it represents all the values and beliefs held in the mind or expressed symbolically, for instance, the expression of institutional values in a mission statement, whereas in the physical sphere (quadrant D), it may manifest as a physical 'entity' which contains the values and

organisational principles of a system, for example, the nucleus and its DNA code in the cell, the 'head' of a family and the board of directors of an institution.

Concluding remarks

This chapter dealt with the *generic systems aspects*. It explored the biomatrix from the different perspectives of ethos, teleos, process, structure, substance (mei) and dynamic organisation. The dual distinctions of dynamic organisation vis-à-vis substance, structure vis-à-vis process and teleos vis-à-vis ethos were contextualised through their juxtaposition.

3.4 Becoming in the biomatrix: the evolution and dynamics of systems in the biomatrix

Systems do not remain in the same state forever: they undergo slight changes or perhaps even a true transformation in order to adapt to changes within their outer or inner environment. Even if the system appears to be static on one level of observation, it is almost certain that there are changes happening on other levels (up or down the holarchy within its field of being). This chapter explores some of the generic organisational tendencies and thus throws some light on systems dynamics in the biomatrix.

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3.4.1 The three organisational tendencies: phases of being and becoming

As a means of setting the broader context it can be stated that all systems have a limited life that generally comprises three phases or organisational tendencies (Maruyama 1963):

- creative tendency (morphogenesis);
- maintenance tendency (morphostasis);
- destructive tendency, i.e. towards increased chaos (morpholysis).

Intuitively this makes sense. We all know that once something has been created, it needs to be maintained, otherwise it falls apart or gets destroyed. We only have to observe our own fragile lives to appreciate this fundamental truth. Obviously, from the point of view of the individual, destruction means the end of life and is generally avoided or delayed as much as possible. However, destructive forces should not necessarily be seen as a negative influence, since the old has to make way for the young, or in order to change we have to 'break down' at least some elements of that which exists. The maintenance aspect of organisation manifests primarily through deviation-counteracting (morphostatic) feedback mechanisms, whereas both the creative and destructive tendencies manifest primarily through deviation-amplifying feedback mechanisms. Deviation-amplifying feedback mechanisms may thus either facilitate the manifestation of something novel (morphogenesis), or facilitate the destruction of that which already exists (morpholysis). There is a critical point in all processes of transformation at which the system may either continue its 'downwards' spiral of breaking down that which exists or turn around and be transformed into something 'positive' and new. On the other hand, most of us are familiar with the feeling of utter frustration when we try to implement change, but the 'inertia' towards maintenance within the system is so strong that it becomes simply impossible to change parts of the existing structure. In practice, a *dynamic balance* needs to be struck between these 'three pillars' of organisation.

3.4.2 A dual pattern of becoming: governed vis-à-vis emergent organisation

The organisation of any system may be viewed as the outcome between two interacting organisational tendencies, i.e. the *governed organisation*, also referred to as governance and the *emergent organisation*. Let us now explore these two organisational tendencies in the context of the generic systems aspects: *Ethos* (**E**), *Teleos* (**T**), *Process* (**P**), *Structure* (**S**) and the two implicit aspects of *substance* and *dynamic organisation* (see Figure 45). The two circular pathways represent the essence of the different phases a system would go through in terms of its dynamic organisation over time, relative to its generic aspects. In other words they are analogous to *phase-trajectories* in *phase space*, with the generic aspects respectively representing the different possible dynamic-organisational states as the system evolves over time (Gleick 1987).

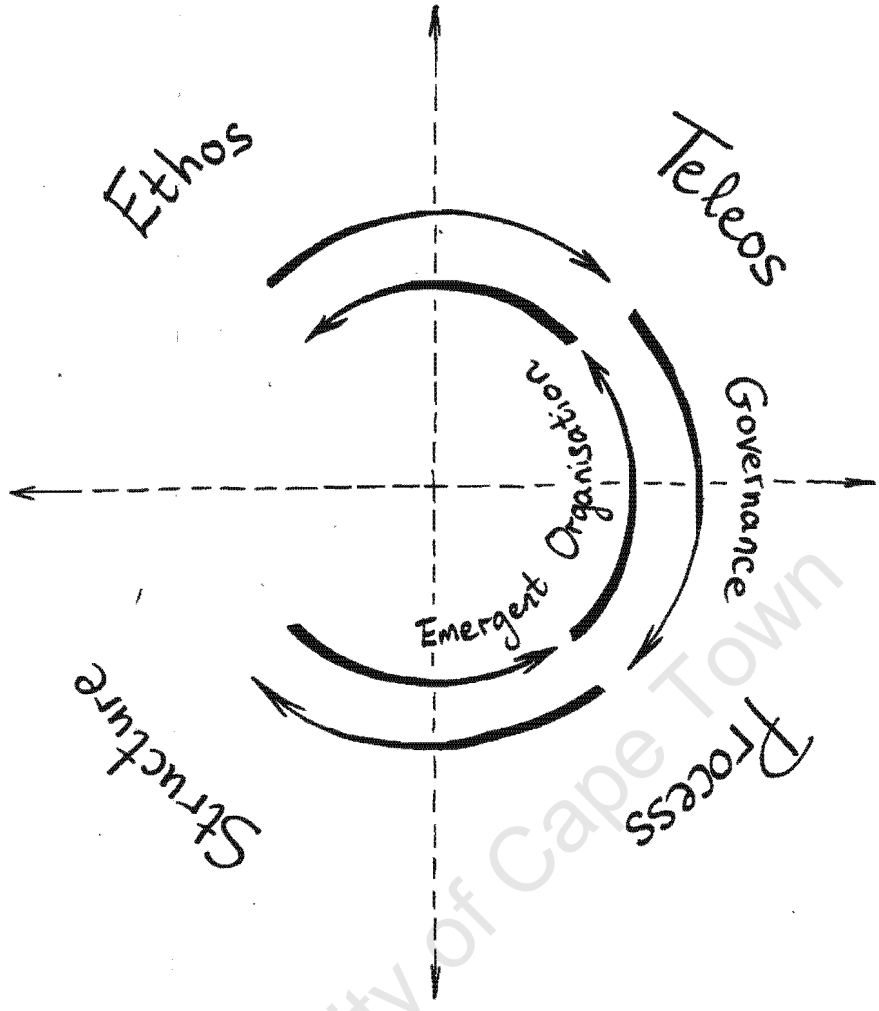

Figure 45: Phase trajectories of governance and emergent organisation relative to the generic systems aspects

3.4.2.1 Governed organisation

Let us first focus on the clockwise path representing governed organisation that typically starts with the search for or identification of an ethos (**E**). This is an extremely important phase, since it basically determines and sets the tone for everything that is to follow, tells us what is important, and serves as the 'judge' for the later stages of a system's evolution. In a society, for example, the ethos phase would involve referral to the institutions that embody the principles of general behaviour. Among these are the laws of the nation, the churches, the customs, and possibly a Bill of Rights. In an organisation, this phase would include the formulation of a mission statement according to which the organisation should work. Unfortunately, in practice relatively little time is spent on this crucial phase. A hasty production of the mission statement is generally followed by just as hasty pronunciation of goals and objectives, and a premature commencement of the activities. It is important not only to state the ethos, but also to spend time to clarify it within all the 'minds and hearts' of the

participants. Obviously, although a mission statement needs to be concise, its conciseness must be the result of a distillation process and not of a superficial improvisation. Ethos of any system is very complex in terms of its implications and it therefore needs a great deal of clarification (and time).

The next phase consists of the definition of the teleos (**T**), in the context of the ethos. It is important to clearly state the purpose (where applicable) and clearly define the goals. Participants in this process generally love spending time on this aspect, perhaps because it somehow resembles their own personal ideals and dreams.

Next in line is the process aspect (**P**). This is the point of implementation in the process domain, during which the processes that will produce the preferred outputs, as specified in the teleos, have to be put in place. In practice there is not always a one to one relationship between a particular process and a particular goal. There may in fact be a great deal of cross-linking and multi-functionality between process and teleos.

The system now 'proceeds' (evolves) to the structure aspect (**S**). At this stage it becomes necessary to identify all structures required to support the processes, in order to produce the desired outcomes. Again, there is not necessarily a one-to-one relationship with the process aspect: a single structure may be associated with different processes and vice versa. Some of us tend to get 'hooked' onto this aspect, perhaps because these are the 'things' that are ingrained in our minds and in the physical environment. We sometimes even go so far as to start out with this phase and then try our best to make the other aspects 'fit'. For instance, we may have acquired a particular item as a result of an aggressive marketing campaign and only then try to work out how it can fit in with the system. We may be impressed by the structure of a building or even a city, without giving due attention to how it will serve our values and life style. Likewise we may also become fixated on a pre-conceived or existing organisational structure (e.g. of a business institution) and thereby neglect or even reverse the 'clock-wise' perspective on governed organisational design. Structure also becomes ingrained in our minds in the form of action-patterns, i.e. action-patterns as pre-conceived and pre-programmed ways of seeing, thinking and 'doing'. This often makes it extremely difficult to start off with a 'clean slate'. In this regard it could be mentioned that Foucault's studies "are intended to help us understand how we came to be what we are yet without providing any definite answer, by assuming that current forms of rationality represent just one alternative amongst others. Consequently, if we assume that both ourselves and our problems are constructed in contingent circumstances, we could aim to deconstruct ourselves, to change characteristics that may be considered undesirable, and to rebuild ourselves in different ways" (Valero-Silva 1996, p.544).

The idealised sequence of phases for governed organisation is thus: **E→ T→ P→ S**.

3.4.2.2 Emergent organisation

Fortunately (or in some instances unfortunately) there is also another type of organisation, namely emergent organisation. If this were not the case we would have been completely dependent on what we can intend, imagine and cognise when it comes to the creation and organisation of all man-made systems. However, in reality things often simply just happen of their own accord, or so it appears to us. This can be attributed to the other path in phase space, i.e. the counter-clockwise route depicted as starting at the structure aspect (**S**) (see Figure 45).

The repeated interaction of structures or more specifically, configured entities with its associated mei or substance, may give rise to newly evolved processes. This takes the system to the process phase (**P**).

Through the repeated interaction between processes may evolve or emerge an action-pattern or attractor. This in its turn gives rise to a preferred outcome for the process(es), which leads us to the realm of teleos (**T**).

These processes, or more specifically their respective action-patterns and attractors, may now in their turn interact and give rise to generalised principles of interaction (or organisation). According to Mintzberg organisational strategies "are not plans produced by a certain group of top managers and technocrats but *patterns in streams of decisions*. The latter emerge, disappear, mutate, and get realized in a manner that is beyond a person's (or a group's) propositional knowledge and control" (Mintzberg in: Tsoukas 1993, p.509). Once these generalised principles have established themselves, the dynamic organisation has moved into the realm of ethos (**E**).

As has been mentioned before, in the evolution of human civilisation and especially its cultural dimension over the ages, a great deal has emerged purely as a result of the free interaction between its members within an ever-changing context, this is in contrast with a process of planned and governed organisation.
The idealised sequence of phases for emergent organisation is thus: **S→ P→ T→ E.**

3.4.2.3 Dancing in phase-space

In reality both organisational tendencies may progress in either a clockwise or anti-clockwise direction. However, the *long-term progression* of emergent and governed organisation are anti-clockwise and clockwise respectively. Thus, although emergent organisation may, for instance take a step 'backwards' (i.e. in a clockwise direction), it does in the long term progress in an anti-clockwise direction. For instance, the emergence of a novel structure out of the interaction of processes represents a step 'backwards' or a clockwise progression of emergent organisation. The 'forward' and 'backward' stepping between process and structure is also referred to as "zig-zagging" (Bateson 1985).

Furthermore, it should be noted that the two organisational tendencies are idealised states. In reality they always interact and give rise to a combined outcome, i.e. the actual *dynamic organisation* of the system. Thus, when it comes to dynamic organisation it always takes two to tango!

The reversal of direction of a particular organisational tendency together with the mutual interaction of the two organisational tendencies, gives rise to a complex 'dance' in phase-space.[6] This 'dance' represents the way in which the system's state moves with dynamism back and forth between the different phases, evolving new 'dance steps' on the way.

For example, let us assume we are looking at a business organisation with a phase trajectory as depicted in Figure 46.

Interplay between structure and process (see Figure 46): A business may start off by functioning with implicit procedures or action patterns (S_0). As a result of the emergent processes of interaction over time amongst employees within this environment ($EM_{S\rightarrow P}$), specific ways of dealing with the tasks at hand may evolve, causing unintended shifts in their tasks and thus in their job descriptions. Thus, without any governance or intended planning a new structure (S_1) emerges ($EM_{P\rightarrow S}$). This emergence is not attributable to the contribution of any specific member or any conscious decision made at a specific point in time. Should these patterns prove to be useful they may become formally adopted as explicit and standard procedure, viz., they become part of the process of governance; in this instance an anti-clockwise movement in phase space ($GO_{S\rightarrow P}$).

Interplay between process and teleos: Let us assume that no formal goals have been established as far as the level of output is concerned. Over time the employees will simply do their job as they see fit and as a result of this a certain pattern of preferred outcome (T_0) may emerge over time ($EM_{P\rightarrow T}$). The system has thus moved anti-clockwise from the process aspect to the teleos aspect. At this point in time the manager may analyse these outcomes and decide to establish these as formal monthly production goals. Chances are that she will actually increase the numbers slightly and then formally introduce it as production targets (T_1). The state of the system now thus moves clockwise again, from a state of emergent teleos to a state of intended governance, i.e. governance of the production-process in accordance with formal production goals ($GO_{T\rightarrow P}$).

[6] The concept of phase-space in the biomatrix is used in the same sense as in physics; i.e. it refers to a multi-dimensional conceptual space where a particular point in that space describes the dynamic state of the system. A trajecory in phase-space describes how the dynamic state of the system evolves over time (Gleick 1987).

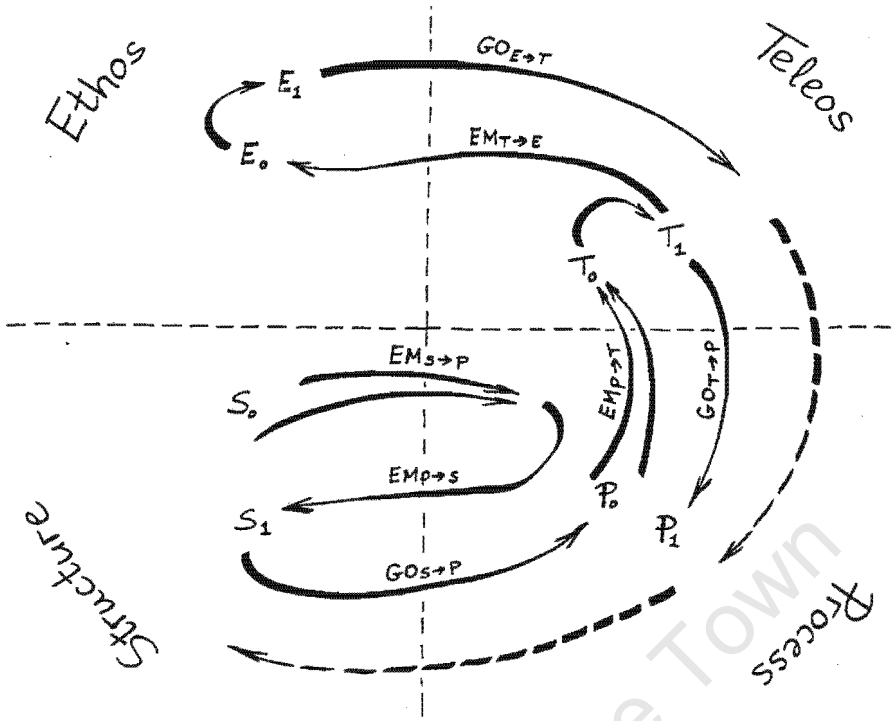

Figure 46: Phase trajectory depicting the dynamic organisation of a system relative to the generic aspects

Interplay between teleos and ethos : Based on the formal goals (T_1, T_N) there may now emerge amongst the members as a group, a sense of what is important and what is not (E_0). The system thus moves into the ethos realm, in an anti-clockwise direction ($EM_{T\to E}$). At some point in time the executive committee may sit down or a workshop may be organised for all the members in order to explore and formalise the new values. It may, for instance be decided that it is more important for the institution to increase its social responsibility towards its own employees as well as the society in which it participates. This may imply a reduction of profits and perhaps an increase in working hours and production goals. At this stage the system turns around again, i.e. the emergent ethos is formalised and adopted as policy (E_1). The teleos now becomes governed according to the formally adopted value system, and may be changed accordingly ($GO_{E\to T}$). At this point the phase trajectory may go all the way round in a clockwise direction, right back to the structure aspect, since it may be necessary to actually restructure the institution. This would be in accordance with the long-term direction in phase space of governed organisation. For example, it may entail the establishment of a department in order to assume responsibility for personnel and issues concerning social responsibility.

The aforementioned trajectory is of course a simplification of what happens in reality. In practice, a number of these trajectories may run parallel, and may be related in a much more intricate way than what is depicted in Figure 46. This rather simplified approach does, however, give the observer a

sense of understanding how the generic aspects relate to each other in a dynamic way. It should also be noted that through this whole exercise the level of focus remained essentially the same, i.e. the organisational level of the business institution as a system.

3.4.2.4 Organisational turbulence

In many instances the two organisational tendencies do not interact in a mutually supportive or congruent manner. They may in fact be in opposition and conflict. A helpful metaphor in this regard is that of turbulence. The two trajectories in phase space are viewed as counter-currents, opposing each other and interlocked in a head-on manner. This gives rise to a turbulent flow, i.e. off-shoots or eddy-currents are created, each off-shoot going its own way. This phenomenon is referred to as *turbulent dynamic organisation* and is depicted in Figure 47. We are familiar with this phenomenon in systems. For example, in an institution the processes emerging out of the multiple interactions between its members may actually be in opposition to its governed organisation (as intended by management). This is not as a result of a conscious or intended opposition on the part of any individual or group, but is merely a result of the overall dynamics of the system at that point in time. Until such time as the system's dynamics are changed (e.g. more effective processes of regulation are put in place or other intended changes are introduced), or even change of their own accord, the turbulence will remain. It is of no use looking for any specific 'culprit' since it is a phenomenon which arises out of the collective interaction of all the system aspects and participating elements.

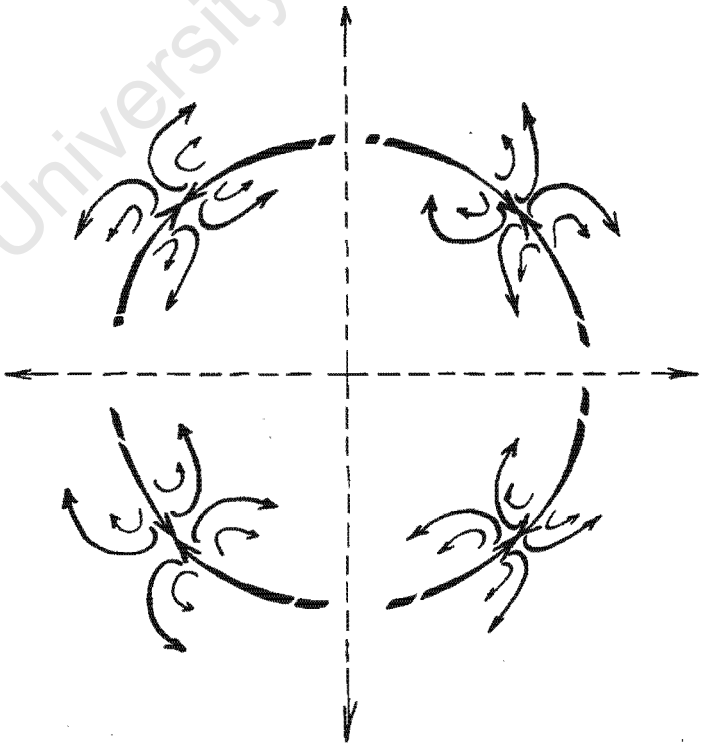

Figure 47: Phase trajectories depicting organisational turbulence

It may be useful to intentionally put a dynamic attractor in place (i.e. any thing or any change which serves as a point of attraction in phase-space), in order to coax the emergent organisation into more congruent interaction with the governed part. These attractors may be positioned in the domain of any one of the generic system aspects. For example, a family may experience problems in its inter-personal relationships. It may be helpful to acquire a television set, or else do away with the existing one. Alternatively, it may be suggested that the process of eating is changed, say from a rather haphazard ritual to a more formal ritual of sharing a meal around the table, or vice versa. It may be necessary to induce a reassessment of their mind-set with regard to values.

The smallest change, or more likely a combination of insignificant changes, may have extra-ordinary results, since living systems are typically non-linear, with strong chaotic undertones in terms of their organisation (Gleick 1987; Kauffman 1993; Ward 1995).

Dunsire suggests an organisational principle referred to as "collibration", or tipping the balance between binary institutions in a system: "collibration makes use of the built-in checks and balances of a particular kind of social subsystem or action arena...a relatively small use of power, as stick, carrot, or sermon may tip the balance of the self-policing tensions already manifest in the pair system". However, "even if an intervention of this kind did succeed in changing the dynamic system from one stable system to another preferable one, it is unlikely that the intervener would be certain that the new state would be wholly preferable, or how stable the new state would be. ... In such circumstances, the obvious tactic is an incremental one: a little at a time, let things settle, see whether another touch is required" (Dunsire 1996, p.321).

Johannessen et al argue that *"process organizing"* may be a promising route to creating sustainable competitive advantage within a business environment which is becoming increasingly turbulent and complex (Johannessen, Olsen et al. 1997). Ackoff suggests that reorganisation or transformation is only one possible way of responding to environmental changes. He proposes a *"multidimensional organization"* which adapts to change that affects it without actually reorganising (Ackoff 1994, p.169).

In the field of psychology, Maturana's theory suggests that "the therapist can only generate perturbations in the patient that may trigger his or her mental reorganization but never specify it" (Ruiz 1996, p.285). The experienced systems practitioner may rely heavily on her intuition and experience or even use more formal ways (Gomez and Probst 1987; Senge 1990) of analysing the system and predicting points of leverage or intervention, bearing in mind that in some instances the process of deduction may *in principle* never come up with meaningful answers to the problem (Smith 1995).

It should be noted that these turbulent off-shoots may not always be destructive (in a negative sense). They may serve to dismantle or facilitate change of an existing system which is actually in need of change. For instance, it has been noted that work teams go through periods of stability that are punctuated by brief periods of considerable change. These are followed by periods of renewed stability (Wheelan 1996). In short, organisational turbulence is one of the major contributors to creative and adaptive organisation, and is essential for the long term survival of any system within an ever changing environment (both its inner and outer environment). However, it is a risky path and not all systems survive the potentially rewarding phenomenon of turbulent organisation.

As a matter of interest, Emery predicts "the next thirty years (at least) will evolve around men's attempts to create social forms and ways of life that are adaptive to turbulent environments or which down-grade them to the less complex types of environments" (Emery 1997, p.917).

3.4.2.5 Spiral recursion

The concept of recursion (Keeney 1983; Bateson 1985) deserves some mention here. We prefer to refer to it as *spiral recursion*. In this instance there is an interplay between the various systems aspects, but actually on different levels of organisation. For example, the structure aspect may interact

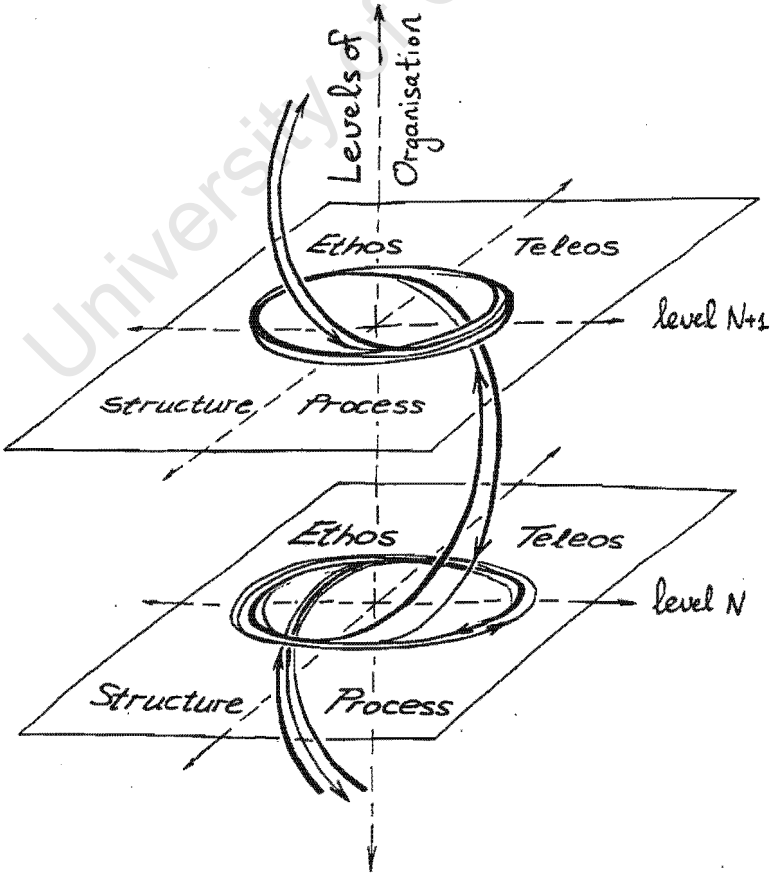

Figure 48: Multi-levelled phase trajectories depicting the principle of spiral recursion

with the process aspect and again interact with the structure aspect, but this time round on a different level of organisation, and so forth. It may be viewed as a spiral trajectory going upward (on the levels of organisation in the holarchy) or downwards. For this reason we prefer to refer to it as spiral recursion. For instance, the sub-atomic particles (structure) interact (sub-atomic processes) and give rise to a higher level structure (the atom), which in its turn interacts (molecular processes) and gives rise to a new structure (the molecule) and so forth, as depicted in Figure 48. It is a complementary interaction between different system aspects across levels of organisation. It does not necessarily involve only two aspects, but may spiral its way all around the other aspects, always climbing up or down the holarchic levels of organisation. For example, the ethos of an individual may impact on her processes within a business institution, in its turn influencing the teleos of the dynamic organisation and ultimately the institutional ethos, thereby completing the spiral from the individual ethos (on one level) to the institutional ethos (on the next level).

3.4.2.6 Change and transformation

Let us now briefly focus on change and transformation within a system and see how it manifests itself in the generic perspectives. Firstly, it must be stated that the distinction between change and transformation of a system is not clear-cut and must always be regarded relative to the observer and the level of focus. In general, however, the term *change* relates to an alteration in one aspect of the system while transformation is a more widespread alteration of the entire system. For instance, the *re-design* of an organisational system generally implies a transformation of sorts (Fruytier and Tilburg 1996).

Changes in ethos (**E**) are most likely to result in an overall transformation of the system, as opposed to changes to its structural aspect (**S**). Governed change will most likely proceed from the ethos (**E**) domain in a clockwise direction, moving through the respective aspects (**E**→ **T**→ **P**→ **S**). Depending on the nature of the problem, the practitioner decides in which aspect(s) to intervene. For example, if profitability goals are to be changed it is most likely to require an intervention in the process (**P**) and/or structure (**S**) aspects. On the other hand, it may turn out that the original goals are unrealistic, in which instance it may require an intervention in the teleos (**T**) aspect as well. Finally, it may require questioning the actual goal of profitability, in other words the original 'problem' needs to be turned back on itself, requiring intervention in the ethos (**E**) domain as well. This may include focusing on basic social issues such as job creation.

Thus, in order to transcend a problem it may be necessary to move one aspect back in the phase trajectory relative to where the problem manifests itself. Fundamental and sustainable transformation involves a process whereby all the generic aspects of the system are reconsidered with an open mind.

Concluding remarks

This chapter addressed the dynamic nature of systems in the biomatrix. It introduced the concept of the three phases of being and becoming. This was followed by an in-depth exploration of the nature of emergent vis-à-vis governed organisation, giving rise to what is referred to as a complex dance of these two principles in phase-space. The concept of spiral recursion was introduced as a complementary interaction between different system aspects across levels of organisation in the biomatrix.

3.5 Telentropy: incongruency and uncertainty in complex living systems

This chapter introduces the concepts of congruency and its anti-pole, incongruency. The concept of incongruency and the associated concept of continuity, lead naturally to the concept of telentropy. Telentropy is essentially a measure of disorder or uncertainty in the biomatrix and is considered to be one of its most useful tools to further the understanding of 'real life' systems in the biomatrix.

The chapter proceeds to explore the origins, transfer and transformation of telentropy in the biomatrix, followed by ways of dealing with telentropy in general.

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3.5.1 Congruency vis-à-vis incongruency

Focusing on a particular system within the biomatrix allows the observer to obtain a sense of how it 'fits in' with the holarchic web of systems in which it participates. In all instances, a system is viewed relative to an outer environment and an inner-environment, also referred to as the 'three levels'. Systems interact with their environment (inner and outer) as well as with itself by means of the exchange of mei. If this exchange of mei turns out to be mutually supportive, relative to the interacting systems, we say they 'couple' or that there is a 'fit'. Systems may be considered to 'fit' relative to any one of the generic system aspects, for example, the obvious 'fit' between two structures or the 'fit' between two goals or the values of two interacting institutions being in mutually supportive agreement.

The concept of *congruency*, vis-à-vis *incongruency*, is used to describe this type of interaction between systems. More specifically, two systems are said to be congruent if they are in harmony, mutually supportive or in agreement relative to: an ethos, teleos, process, structure, substance (mei) or dynamic organisation. Systems are not necessarily congruent in all respects, but may exhibit congruency only in one or a few of its aspects. For instance, two systems may have a shared teleos, but different ways of achieving it, i.e. different means but the same ends. Congruency, in the special case, also refers to the degree of 'fit' within a system itself, i.e. a system being congruent relative to itself and its own generic aspects.

A concept which goes hand in hand with that of congruency is *continuity*. Continuity refers to a *congruency within a particular series* of generic systems aspects over time (i.e. *phases*) or in space (i.e. *segments*). Continuity is a concept which applies essentially to teleons. It manifests either from a temporal perspective, i.e. between its phases, or from a spatial perspective, i.e. between its segments in space. A simple example of temporal continuity would be the time co-ordination of the different sub-contractors on a building site, whereas the linking up of a bus transport system with a train system would imply a spatial continuity. If these two systems are synchronised in time as well, it would imply both a spatial and temporal continuity. An ecological food chain may be viewed as a continuity of process (i.e. mei flow) in which the eater becomes the eaten. In this instance there is not necessarily a continuity of teleos as well; in the one instance there is a goal to 'kill' and in the other instance there is a goal to survive, which are in conflict. However, in the case of symbiotic relationships there is a continuity of teleos as well. According to Darwinian evolutionary theory, the continuity we observe in the biosphere is essentially a result of the emergent organisation between systems within an overall ecological context (Davies 1995). Conversely, in the socio-sphere continuity is mostly a result of human intent and planning, i.e. governance.

The observer may choose to trace a series of congruent phases within the biomatrix in the *temporal domain*, which have a bearing on any one, or combination of generic aspects. Alternatively, one may

decide to focus on the *spatial domain* and trace a chain of congruent segments traversing space. Generally our focus constitutes a hybrid of both. For instance, a teleon essentially represents a continuity of mei flux and teleos, extending in space and in time.

Obviously not all systems or aspects of systems within the biomatrix are congruent or continuous. In fact there are multiple areas of incongruency within the biomatrix. Furthermore, these areas of incongruency are in constant flux themselves, that is to say they move around within the biomatrix shifting from one level to another, moving within a particular level, or simply disappear; in other instances they may appear 'out of the blue'. These areas of incongruency and discontinuity are also referred to as *stress* within the biomatrix and are always viewed relative to a particular context, an ensemble of systems and the generic system aspects (Járos and Cloete 1994). The effects of incongruencies or stress specifically pertaining to teleons have received special attention in the biomatrix (Cloete and Járos 1989; Járos and Cloete 1990; Járos and Cloete 1993) and are dealt with in a subsequent section.

3.5.2 Entropy in context

The concept of incongruency is not entirely unrelated to the concept of entropy in the physico-sphere. Both serve as an indication of the degree of "disorder" within a system. Although the concept of entropy provides many advantages for interdisciplinary studies and certainly has a unifying potential in both the physical and biological sciences, it has limitations, one of the reasons being that it is extremely difficult to quantify entropy in complex living systems. Furthermore, although the negentropy principle of information has been introduced by Brillouin (Brillouin 1956) and extended by Shannon (Shannon and Weaver 1963), it still remains a concept primarily applied to the physico-sphere. The concept of entropy has admittedly made possible a more unified approach with relation to energy and information (Tribus and McIrvine 1971). In the biosphere, the concept of dissipative systems and the resulting order out of chaos has been introduced by Prigogine (Prigogine and Stengers 1977b; Prigogine and Stengers 1977a; Prigogine 1980; Prigogine and Stengers 1984). Haken explained emergent complexity and organisation of biological systems as manifestations of the self--organising capacities of living systems, or organisation emerging from the initial conditions (Haken 1977). Evolution has been viewed in terms of entropy by Brooks and Wiley and they have also attempted to unify the work of Prigogine and Haken in terms of biological systems (Brooks and Wiley 1986).

In a joint discussion of living systems theory (i.e. Miller), social entropy theory (i.e. Bailey) and macro-accounting theory (i.e. Swanson) the role of *money-information markers* in the recurring organisation and disorganisation of social entities is identified as an important aspect of *social entropy* (Swanson, Bailey et al. 1997). Negentropy is understood by them to be "the amount of organization of matter-energy forms in societal components measured on the attribute-specific

exchange value in terms of money units; entropy is the amount of disorganization in such components measured similarly; potential negentropy is understood to be the amount of organization in the money-information marker aspect of social structure in a societal component measured similarly; and potential entropy is the amount of disorganization in money-information marker structure measured similarly" (Swanson, Bailey et al. 1997, p.63).

In *social entropy theory* the primary use of entropy is viewed as a continuous measure of a system's state to replace the inadequate concept of equilibrium. It recognises that there are many types of entropy, depending upon the type of system analysed; hence the use of the adjective in the term *social entropy*. In social entropy theory both physical and statistical entropy are utilised, where statistical entropy "could refer to the degree of disorder in the symbol or category system that the physical actors construct and use in the course of their ongoing social interaction" (Bailey 1990, p.86).

The biomatrix model maintains that living systems are hierarchically ordered and multilevelled by nature and that their functioning depends on their ability to 'move' towards a preferred outcome that is relevant to their field of teleos. Katakis and Katakis suggested that a physico-chemical description of entropy is so far removed from the actual system with its purpose and goals, that the practical usefulness of entropy with regards to the behaviour of living systems is questionable (Katakis and Katakis 1982; Katakis and Katakis 1986). As a result they introduced the concept of *teleonomic entropy* in bio-psycho-social systems. Teleonomic entropy has been expressed in terms of a mathematical relationship, essentially based on the presence of steady preferences for certain states within a system, combined with the probability that these preferred states would be achieved, given the present state of the system. Probabilities are time-averaged probabilities of points constituting an ensemble of systems, in the sense as defined by Gibbs (Katakis and Katakis 1982).

Prompted by the notion of teleonomic entropy, the concept of *telentropy* was subsequently introduced for application in the context of the biomatrix (Cloete and Járos 1989; Járos and Cloete 1994).

3.5.3 Telentropy: welcome to the real world

Telentropy at any moment in time can be defined as *a measure of uncertainty associated with a teleon reaching its preferred teleos, given its present state*. Put differently, the telentropy associated with a teleon is *inversely proportional to the probability (at that moment in time) that it will reach its associated teleos, given its present state.*

In other words, should there be a low probability of the teleon reaching its preferred end-state, the telentropy is said to be high, and if the probability is high, the telentropy is said to be low. Like entropy, telentropy is directly related to the level of 'disorder', or more specifically the incongruency within a teleon. Unlike entropy and teleonomic entropy, it essentially remains a *qualitative description* and *fuzzy measure* (Bezdek 1994) of the level of stress within a teleon at a given moment;

since in most instances it is not feasible to obtain a quantitative measure of the probabilities at stake. It should always be remembered though that, as a measure, telentropy is completely dependent on the probability or uncertainty relative to a particular teleos as judged by the observer (which in its turn may also be relative to the particular focus of the observer). Put differently: "logical inference using fuzzy language and probability estimates are being used to capture the anticipatory logic characteristic of practicing managers who seek to bring a dynamic, uncertain set of conditions under control" (Comfort 1997, p.381).

At this stage the concept is not founded on a formal mathematical definition and is in a mathematical sense less formal than the concept of teleonomic entropy, as introduced by Katakis. However, both telentropy and entropy share the qualitative notion of disorder or chaos. In the case of entropy, disorder refers to physico-chemical disorder or uncertainty due to incomplete information, whereas in the case of telentropy it refers to a *teleological uncertainty or 'disorder'* within the context of the biomatrix. Thus, whereas entropy is dependent on the physico-chemical state of a system (or in the case of information theory, measurable units of information), the concept of telentropy is to a large extent determined by how the observer defines the teleon and its teleos. The moment this definition changes, the associated telentropy will change as well.

The exact outcome of most complex systems is seldom known in advance. The telentropy of a system is therefore non-determinate at any given moment in time, this necessitates a statistical approach. Whether the system is by nature non-determinate, or whether the uncertainty in its outcome is due to incomplete knowledge, is not really relevant for the purpose of this definition. It is hardly ever possible to perform a controlled and repetitive series of experiments on complex living systems (i.e. deriving a posteriori value of probability) and the underlying 'laws of chance' are seldom evident (i.e. a priori value). This implies that the probability referred to in the definition of telentropy is often more of an educated guess than a formally obtained value. However, it should be noted that the precise measurement of a limited subset of aspects pertaining to the system is often of less significance and may even prove to be misleading, when compared to an intuitive evaluation of all related aspects based on experience and, most importantly, insight into the nature of the system.

Whereas entropy is predominantly a spatially defined concept, i.e. dependent on the spatial configuration of a system at a given moment, telentropy is predominantly a concept which exists in a temporal sense as a probabilistic projection into the future of a system. As the perceived future of the system changes, so does the telentropy. This implies that the telentropy can change even though nothing in the teleon itself has changed, except for the predicted future, e.g. as a result of changes in some part of its environment. In a mathematical sense the telentropy function is not necessarily a continuous function in time. It can, and often does, change instantaneously to a completely different value as a result of some change in any one of the factors influencing it.

It should also be noted that most teleonic processes are irreversible and that the future is therefore not contained in, or prescribed by the present. It is the transition from the present state to the future state that can be regarded as the "arrow of time" and the associated notion that the future, and also time itself, is to some extent "constructed" (Prigogine and Stengers 1984).

As a quantitative measure it has proven immensely useful to throw light on the principles of incongruency and stress within a particular system under observation. It may lead the observer to a greater understanding of the nature of the 'problem', and at the same time serve as a useful means of communicating these insights to other interested parties. Figure 49 depicts telentropy as a measure of uncertainty associated with achieving a preferred teleos.

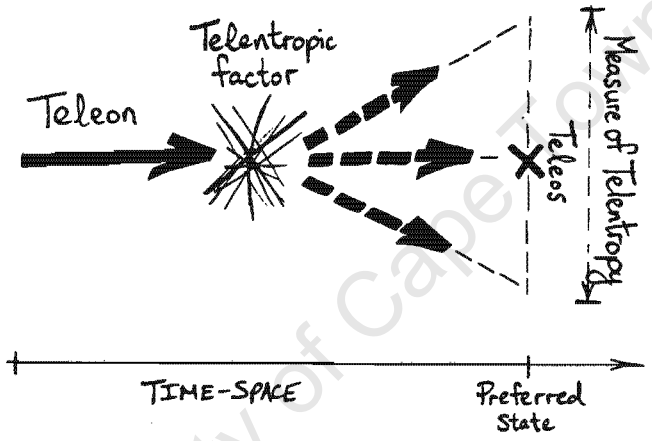

Figure 49: Telentropy as a measure of uncertainty associated with achieving a preferred teleos

3.5.3.1 Origins of telentropy

The origins of telentropy in a system are multifold. In short, anything that could possibly affect the likelihood of a teleon reaching its teleos is a possible source of telentropy. A useful way of dealing with the different origins is to focus on it according to the generic systems aspects: i.e. ethos, teleos, process, structure, substance and dynamic organisation. Added to this list should be the outer and inner environments as well. Essentially, any incongruency between these aspects relative to the teleos under investigation, may result in an increase in telentropy. Thus, in a mathematical sense it can be stated that telentropy is a function of the generic systems aspects, the environment, time and space.

Let us explore the origins of telentropy by means of a few examples:

a. Conflict between ethos and teleos

A certain production goal may be imposed on an employee but the work ethic of the employee may be in conflict with the meticulous and diligent inputs required in order to complete the task. It is perhaps more important to the individual to enjoy life and not take things too seriously. The likelihood of the employee meeting the required outcome is thus diminished. In the physico-sphere we may try to produce a certain chemical compound (i.e. desired teleos), but by the very nature (i.e. ethos) of the different chemicals they are not 'mixable' or compatible.

b. Moving the goal posts

In the teleos domain itself, a shifting of the goals may also be a source of telentropy. The metaphor of a hunter trying to shoot at a too fast moving target describes this dilemma well. Each teleon has its own inherent time constants, and one should be careful not to exceed the ability of the teleon to adapt to a changed goal. It may result in an unstable system, never reaching any goal at all. Psychologically, if an individual does not allow herself to attain a sense of completion before moving on to the next goal, it may give rise to a sense of under-achievement and frustration. In other words, instead of giving ourselves a pat on the back upon completion of a certain goal, we are quick to laugh it off as 'outdated' and have already moved on to the next target.

c. Telentropy from a process perspective

In the domain of process the possibilities are endless. In order to reach a goal a teleon may follow a short route (i.e. process) or a long route, a straight route or a more intricate route. The image of different paths, as a metaphor for process, all leading to the same destination, illustrates this all too well. We all know from experience that the shortest path is not necessarily the quickest or the most likely to lead us safely to our destination. It depends on a myriad of influences from the environment, as well as the ability of the system to respond to the particular demands of that 'path' (i.e. process). The process may *get obstructed*, suffer from a *lack of continuity*, get inappropriately *interfered with*, or simply proceed in an *inappropriate* way relative to the other generic aspects.

d. Telentropy from a structure perspective

A particular structure is invariably more suited than another in order to achieve the desired teleos. Trying to eat soup with a fork injects an incredible amount of telentropy into the eating teleon! From an evolutionary perspective it also true that organisms with particular structures (i.e. both spatial configuration and action patterns) are more likely to meet certain demands than others. An institution may also experience an increase in its telentropy as a result of not having adapted to a matrix-organisational-structure, in response to a more demanding and complex business environment.

e. Telentropy due to inappropriate (or no) substance

Our diet determines which nutrients reach our cells. Some are more likely to co-produce a state of health than others. Similarly, flooding a manager with the wrong information is just as likely to produce telentropy as no information at all. A shortage of resources is often perceived as a major source of telentropy in any system. However, improving the system's efficiency, or completely transforming it may take care of this seemingly insurmountable problem.

f. Dynamic organisation and the reduction of telentropy

For a system to meet the challenges within itself and within its outer environment it is essential to meet it with an equal degree of complexity, in terms of its own dynamic organisation. This ties in with the principle of "requisite variety", as formulated by Ashby (Ashby 1958). For instance, the chances of any system surviving within any environment depends largely on its ability to dynamically organise in line with its teleos and its environment. Ultimately it should have the ability to transform itself, if so required. In other words it should be able to change its dynamic organisation, in order to fit in with a changing environment, especially in those instances where the telentropy associated with an existing dynamic organisation becomes impossible to deal with in any other way. A political dispensation faced with an imminent revolution is a case in point; similarly an institution that is forced to completely transform itself in order to survive, as a result of insurmountable problems with production or sales.

3.5.3.2 Transfer of telentropy

Once telentropy has presented itself on a particular level of organisation within a system, it may be transferred to other levels of organisation, or passed on to other systems. It moves around the holarchy, like a wave or a ripple in a pond. The doublets may be likened to leaves floating on the water, getting 'bumped around' by the rippling effect of the telentropy, carried forth by the underlying field of teleons (or flux of mei). The transfer of telentropy between two teleons is depicted in Figure 50.

An example of the transfer of telentropy in the physico-sphere would be the simple transfer of heat within a system and between systems. For instance, if the spatial configuration of a crystal or complex molecule were considered to represent a preferred end-state (i.e. teleos), then the transfer of heat to this molecule may actually cause it to lose its structure and disintegrate. In fact, most of the molecules that underlie living systems are very sensitive to changes in temperature and are stable only within a rather narrow margin of ambient temperature. The transfer of heat, as a wave between these molecules, may cause an increase in telentropy (its unique crystalline structure may be considered to represent its associated teleos). On the cellular level (i.e. in the biosphere) an example would be the injection of telentropic information into the nucleus of the cell. This is typically what happens when a

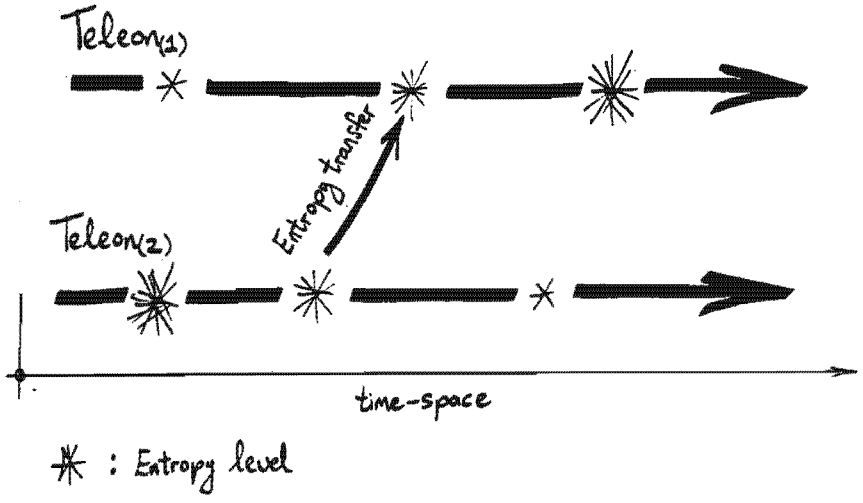

Figure 50: Transfer of telentropy between two teleons

virus invades the nucleus and changes its very specific programme (i.e. the teleos), or protein synthesis instructions of the cell. The telentropy now gets transferred from the cells to the level of the organism and may manifest itself as a virus-related disease (e.g. influenza). It may even get transferred another level up in the sense that the individual may not be able to go to work, and thus may be the cause of an increased workload in his working environment. A colleague may now come under extra pressure and transfer this stress at home to her spouse (e.g. in the form of an argument), thereby upsetting the normal family equilibrium. This may, in its turn, affect the behaviour and performance of their child at school. Telentropy is thus transferred two levels up starting from the virus and then across systems on the same level of organisation (i.e. virus→ cell→ employee→ colleague→ spouse→ child). The possibilities are endless. The important point which needs emphasis is the fact that the origin of telentropy on a specific level of organisation may be traced back to a lower or higher level of organisation, within the same system or from another system, as depicted in Figure 51.

Furthermore, in many instances telentropy is co-produced, thus it can be attributed to multiple origins and multiple generic aspects. For instance, a business institution may experience a decline in profits as a result of a world wide depression, in addition to problems with productivity in its workforce, as well as a shortage in supplies of 'raw materials', and so forth.

As individuals we seldom fall ill as a result of a single causative factor. For example, a bacterial or viral infection usually goes hand in hand with a weakened immune system, psychological stress, an inappropriate diet, an underlying genetic 'weakness' or disposition, or perhaps even changes in the climate or other physical factors in the environment (e.g. pollution). These telentropic factors together *coproduce* a sufficient state of imbalance and incongruency that manifests itself as *disease.* However, medical science generally likes to allocate single causes to diseases. For example, medical science

may state that we do not contract a cold because of a draft, but rather as a result of a bacterial or viral infection. This a gross simplification and far from the whole picture. The bacteria certainly is a *necessary criterion*, unlike, admittedly, the draft, but it certainly is not a *sufficient criterion* in a healthy individual.

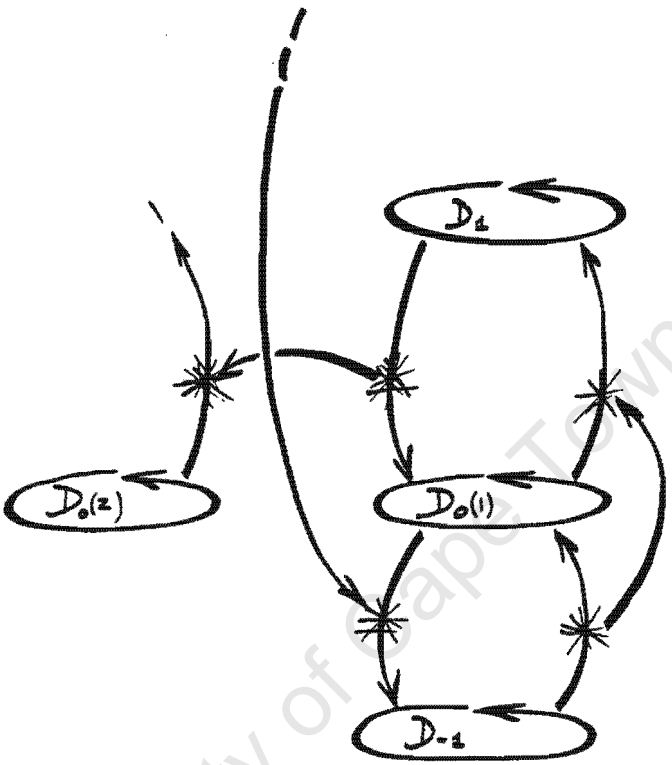

Figure 51: Transfer of telentropy between teleons, doublets and across levels of organisation

3.5.3.3 Transformation of telentropy

Telentropy (which may be likened to a multi-headed dragon) continuously changes its shape as it moves across levels and between systems, which may be either a blessing or a curse, depending on the situation. These transformations may be either as a result of changes in the telentropy itself, or a change in context. Let us explore some of the possibilities.

a. A telentropic factor changing or actually disappearing

For example, an individual's immune system may counteract a viral infection by actually destroying it. An institution may renegotiate working conditions for its employees and thereby alleviate worker's discontent. A depression in the economy may simply follow its natural cycle and eventually resolve itself, provided the recovery is not hampered by an inappropriate economic policy.

b. Telentropy moved on to a different context

In this instance telentropy may change, not due to any innate changes but simply because it has moved on to a different context. For example, unwanted waste products from one system may be utilised by another system. Waste may either serve as a source of telentropy in the environment (i.e. pollution) or may be recycled as part an economically viable process. Thus, the same item may be a source of telentropy in one context and a resource (i.e. a congruent substance) in another. An employee may perform unsatisfactorily in a particular job but actually excel when transferred to another section. Similarly, information which may cause telentropy within one system may be utilised within another.

Unlike entropy, *telentropy is not necessarily conserved when it is transferred between systems*. Its value may change drastically, perhaps even in a discontinuous way, the moment it participates in a new process. For example, the moment a discarded tin is picked up to be recycled it becomes part of a completely new process and its telentropic attributes change accordingly. The tin, however, remains the same, only its context changes.

3.5.3.4 Re-directing and dissipating telentropy

Telentropy may be re-directed within a system or to another system. In that process it may be transformed or even dissipated. Thus, a system may deal with telentropy within itself, or transfer it on to another system. This transfer need not always be negative, as was pointed out in the previous section.

In the physical sphere the body has evolved means of transforming toxins and waste products, and in other instances excretes (i.e. transfers) them. The detoxification function of the liver (i.e. transformation) and excretion of waste products (i.e. transfer) through the skin, lungs, kidneys and rectum are typical examples in our body.

Psychologically we have not quite evolved that far yet. Unfortunately psychological stress is often not dealt with in a safe way; it is frequently transferred on to the physiological sphere where it may cause tremendous harm, or it may simply be passed on to our fellow beings. Ways to dissipate psychological telentropy would for instance be to perform physical exercise or to perform mental relaxation techniques, whereas a change in life style and mind-set may serve to transform telentropy into something beneficial.

Environmental pollution caused by industrial waste products is another example of inappropriate directing of telentropy. Instead of dissipating or transforming the telentropy we release it in our rivers or in the atmosphere where it produces great harm.

3.5.3.5 Teleonomic flexibility

The ability of a teleon to cope with increased amounts of telentropy without an apparent change to its outcome is referred to as *teleonomic flexibility*. It may be likened to the flexibility of a material, allowing for *minimum strain* (i.e. deformation) in the presence of *lots of stress*. The flexibility of a teleon is primarily an indication of the degree to which it can deal with telentropy, in other words, still maintain its teleos in the presence of incongruencies within the system. Various strategies may be employed by a teleon to increase its flexibility.

Versatility, viz. the provision of different ways of achieving the same end, is one of them. Should a 'problem' manifest in a specific area, it may simply be bypassed by activating one of its other processes. This is typical of living systems. In the human being, for example, glucose, which is the primary source of energy for the cells, can be obtained from either carbohydrates, fats or proteins in the diet. Different metabolic processes are responsible for their conversion to glucose, thus there are three possible metabolic channels whereby glucose may be acquired for the cells. Likewise, should damage occur to part of the brain, it may also be possible for other areas to take over its function. In an institution it is commonplace for one employee to stand in for another should she be sick, or have to cope with an excess work load. However, should it be a very specialised job, it becomes more unlikely, and as a result the teleonomic flexibility decreases.

Redundancy, viz. having an excess of resources or processes, is another strategy. This may be an easy way out, but in some instances it becomes too costly, not only in an economical sense but also from other perspectives. However, when flexibility is of the utmost importance, it may be the only way out. This is typically the case in critical technological systems, e.g. the duplication of technological systems in space craft and the presence of a co-pilot in passenger aircraft. Unfortunately we have not evolved with two hearts, although we do have two kidneys!

The related concept of *connected variety* is concerned with stability of interacting systems (Hitchins 1993, p.626). It states that interacting systems stability increases with variety, and with the degree of connectivity of that variety within the environment. The greater the variety of systems, provided that variety can be exchanged between the systems, the more likely it is that outflows of some systems will match the inflow needs of others, through a variety of mutually redundant elements.

The evolving paradigm of *flexible systems management* views flexibility as "the exercise of free will or freedom of choice on the continuum to synthesize the dynamic interplay of thesis and antithesis in an interactive and innovative manner, capturing the ambiguity in systems and expanding the continuum with minimum time and efforts" (Sushil 1997, p.266).

3.5.3.6 Creation vis-à-vis destruction

Telentropy is not always harmful in the context of the biomatrix. In fact all innovation and creation is to a greater or lesser extent the outcome of some degree of telentropy in a system. In order to innovate

or create it is necessary to move away from the status quo and come up with something novel. The presence of telentropy may actually enhance and facilitate this process.

When a system is challenged by an exposure to telentropy it is forced to 'flex' itself in order to remove the telentropy. In this process of forced change the system may eventually stabilise at a new equilibrium point which may turn out to be an improvement. In a sense, telentropic challenges imposed on living systems are largely responsible for their adaptive responses to their environment leading to novel stable states. In other words: "it is precisely the intensification of possible disorder that can lead to self-organizing systems. It is the principle of *order from noise*" (Dotzler 1996, p.250). If there were no uncomfortable challenges in the environment the process of evolution would be greatly hampered. The process of brain storming, during which incongruent or 'crazy' ideas are generated by the group, is also based on the telentropic injection principle. It is also a well known psychological fact that people perform optimally under a certain amount of stress, better than in the presence of no stress at all (Jordaan and Jordaan 1984, p.574). Competition in the business environment or in the classroom leads to greatly improved and even novel systems and modes of understanding.

The the drive to replace competition entirely with co-operation should thus be viewed with caution. The two modes of acting are complementary and can only produce results if used appropriately in a complementary fashion. Competition creates the telentropy, while co-operation helps to resolve it and turn it into creativity.

Divergence and 'flexing' induced by telentropy should be counteracted by some process of convergence or stabilisation. In other words, it is essential that the tension gets resolved and a new stable state is reached. If it is not, it may lead to a completely unstable or 'wandering' system, and in extreme cases to total destruction of the system. Although, viewed from a broad perspective, even this need not necessarily be a negative outcome since it may open up an evolutionary path for other systems within the broader environment.

Concluding remarks

This chapter introduced the concepts of incongruency and telentropy in the biomatrix, and explored the concept of telentropy in relation to its physical counterpart, namely entropy. It suggested different ways that telentropy may originate in the context of the generic systems aspects. This was followed by focusing on its transfer and transformation in the biomatrix. In this regard it was shown that telentropy is relative to the particular context, as opposed to the absolute value of entropy. This suggests possibilities for dealing with telentropy by changing the context. In conclusion it was suggested that telentropy should not always be viewed in a negative sense, but that it may also be a contributing factor to the evolution of a system.

3.6 The biomatrix approach: a conceptual map to explore and design systems

This chapter focuses on the application of the biomatrix model, that is to say viewing the world from what is referred to as the biomatrix approach. It essentially focuses on general guidelines for the application of the model, as opposed to presenting a methodology for its application.

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3.6.1 The biomatrix approach

The *biomatrix approach* refers to the process of applying the biomatrix model, and thus refers to a specific systems approach with associated assumptions and concepts (as embodied in the biomatrix model). The term 'biomatrix' serves to distinguish it from within the broader systems field, without impinging on existing systems terminology (e.g. the rather unfortunate naming of 'systems thinking' and 'systems dynamics' (Lane 1995)).

The biomatrix approach is on the one hand "a way of looking at the world" (Boulding 1956) and as such refers to the process of interaction between the observer, the biomatrix model and 'reality'. This is not unlike "an explicit dividing line separating the everyday real world of the problem situation from the consciously organized systems thinking *about* the real-world situation." (Tsouvalis and Checkland 1996, p.37). However, Fuenmayer argues a systems approach is "not another scientific approach which simply deals with a special 'region' of beings; rather, it is a meta-scientific approach whose very claim concerns Being in general. It is thus an 'approach' or 'perspective' whose standpoint is of an ontological and epistemological nature" (Fuenmayor 1991a, p.422).

The biomatrix approach should not be viewed as a 'structured' method, a process to be followed, or a set of rules. In our experience practitioners who have applied the biomatrix model to specific 'problem situations' in their associated fields of expertise have developed their own unique methods based on the biomatrix model. In this way methods can be developed relative to disciplines, needs and acquaintance with other related systems methods (Edwards 1996; Dostal 1997). It also acknowledges the concept of *complementarism*, as introduced in critical systems thinking, which states that 'complete' evaluations of situations can be made through the use of different systems methodologies in application to a particular situation (Yolles 1996). In this regard the user is encouraged to be "critical" in the use of the various ideas and methods at our disposal (Jackson 1994). Furthermore, "the obvious need for methodological pluralism must be recognized and then fulfilled through a metatheory which resolves the problems of paradigm incommensurability" (Dash and Murthy 1994, p.473). In this regard the biomatrix approach may be viewed as a mindmap of primary concepts which guides the practitioner in the development and selection of appropriate methods of inquiry.

The biomatrix approach is supportive of the concept of *discordant pluralism* as a position in which different, competing and conflicting theoretical perspectives intersect. There may be many unresolved ambiguities and tensions in the plane which represents these different theoretical perspectives. However, instead of competing with one another "different methodologies from distinctive traditions will be seen as capable of assisting each other in providing an enriched understanding of the situation being investigated" (Gregory 1996, p.619).

The observer is encouraged to *reflect* on the actual process of analysis and design. In the words of van Gigch: "to create an artefact, the designer needs to be a *scientist* to model reality, an *epistemologist* to metamodel the design process, and an *artist* to contemplate the result" (van Gigch 1996, p.483). It also encourages a process in which the researcher "thinks creatively about the context within which the problem is located" before deciding which route will be followed (Brocklesby 1995, p.1285). Ultimately the biomatrix model may serve as a basis for a 'deep' and reflexive inquiry into 'systems thinking' itself (Fuenmayor and Lopez-Garay 1991; Fuenmayor 1997).

Although the biomatrix approach per se is largely 'unstructured' in the sense of a particular process to be followed, the biomatrix model does embody a great deal of structure. This is in contrast with some of the other systems theories, e.g. total systems intervention (TSI) and soft systems approaches (Flood 1995b; Flood 1995a; Midgley 1997), where the focus is on the process (or system) of *inquiry* and does not have that much to say about the generic nature of the actual systems under investigation.

In other words, the biomatrix model should not be viewed as a geographical map that indicates different roads which may be travelled leading from point A to B; instead it is more like a *topographical map*, which indicates the relative relationship between the concepts (and principles) in conceptual space. It is left up to the 'explorer' or observer to work out his own route on this terrain. How the journey is navigated and what methods of 'travelling' are used (e.g. specific problem-solving techniques complementary to the biomatrix model), will depend on the point of departure, the envisaged end-point and the traveller herself. The biomatrix approach supports the notion that the knowledge used to *apply* models in practice is not necessarily part of the models themselves. The knowledge of application may be *tacit* in the sense that it is practical, rather than academic; informal, rather than formal; and usually not directly taught (Dickover 1994).

Having said that, it is suggested that there are some guidelines which can be helpful in 'good scouting'. *In should be noted that the actual configuration of the biomatrix model (e.g. the universal pattern of teleos) serves as one of the primary guidelines when the jump is made from the definition of the problem to the actual formulation of a conceptual model.* In the context of soft systems methodology, the biomatrix model proposes a universal framework for "conceptual models" to be drawn from "root definitions" (Checkland and Tsouvalis 1997, p.158). The investigative power of the soft systems methodology "derives not from an ontological view of a systemic world, but the epistemological power of a set of systems concepts which may structure thinking about the world" (Rose 1997, p.252). In addition to the basic 'rules' and 'principles' of system ideas (e.g. an adaptive whole, emergency, hierarchy, self-organisation and autopoiesis) the biomatrix model, by comparison *actually proposes a universal framework of being and becoming.* This proposed framework is, for instance, reflected in the distinction between the teleon and the doublet, the "emergent middle" in the context of three levels of organisation, and the generic structure of the teleonomic projection.

A few general guidelines for the application of the model are subsequently discussed.

3.6.2 General guidelines for application

The following sections should not be viewed as a linear sequence or method to be followed, since in reality the observer continuously moves from one perspective to another in a recursive loop of inquiring.

3.6.2.1 The Doublet/Teleon dual perspective: "a difference that makes a difference"

Firstly one has to get a grip on the system or the 'problem' that one is faced with. In the biomatrix there are essentially two points of entry, i.e. focusing on the teleons and mei flux, as opposed to focusing on the doublets. Which one is the easier to start off with depends on the context. For example, when dealing with a business organisation as a whole, it is probably easier to start off with it as a doublet. Alternatively, when dealing with a particular function (e.g. production) within that business organisation or institution, it would probably be better to begin with the teleonic or a functional perspective.

The observer can and should move on to the complementary perspective and back again in a recursive fashion. So it does not really matter where one starts. Within each recursion the two perspectives come up with complementary questions and answers and may even lead to a transformation of the original 'problem'.

3.6.2.2 Focusing on the doublets: establishing a sense of space

A way of identifying the doublet systems is to search for points of focalised ethos in space around which is gathered its whole field of associated processes. These loci or focalised nuclei act as attractors, gathering the processes around it. The vantage point of the observer, within the vast web or field of processes, is thus one of searching for points of focalisation of process, all sharing or 'embracing' a common ethos.

It should be remembered that doublets are essentially field-like-entities and comprise a field of balanced exo-, endo- and centro-teleons. In some instances there may be an identifiable core-body. In addition the doublet also exhibits the following characteristics:

- It is an autonomous entity; i.e. it exhibits the properties of organisational closure (Maturana and Varela 1992). This is essentially achieved through its tapping and centro-teleons.
- It is self-referring in terms of some of its processes. This is achieved through its tapping and centro-teleons, relative to a 'self' which resides as an attractor in its nucleus.
- It is self-governing, which is achieved through its centro-teleons.

a. Tracing the mei flux

In this instance the observer essentially focuses on the flow and transformation of mei within space. It invariably leads the observer from one doublet to the next, since doublets are the primary points of interaction for mei. This is 'simply' an exercise in tracing the route followed by all the mei and also focusing on its transformations. This leaves the observer with a network of inputs, outputs and transformations of mei, in many ways similar to the input→transformation→output perspective of cybernetics and as applied in living systems theory (Miller 1978; Miller and Miller 1995). The mei flux perspective may result in a rather complex and dense network of threads in the biomatrix space (see Figure 54). It is essentially a network of interactions between points of transformation in space. This is typical of distinctions that are made in most systems theories. However, at this point no explicit distinction is necessarily made with regard to the associated fields of teleos.

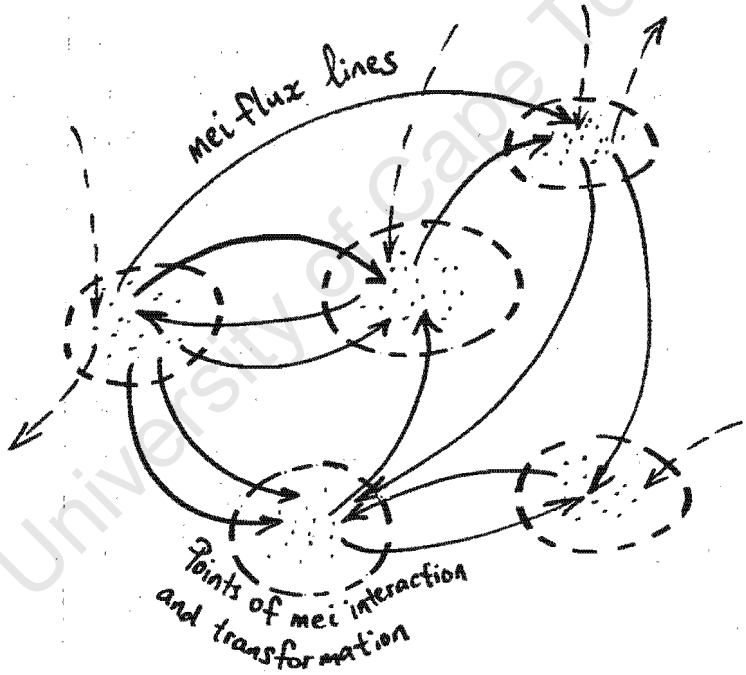


Figure 54: The mei flux perspective in the biomatrix

b. The teleonomic projection (teleonics): tracing the coupling and continuity of teleos in the holarchy

In order to move from a mei flux perspective to a teleonomic perspective the observer has to make a conceptual leap. It is not an easy leap, but it is a very powerful leap which may lead to an enhanced insight and understanding of the system under observation. It is at this point that the teleons need to be extracted from the network of mei flux. The observer thus abstracts teleos from the web of mei flux and reconfigures this web into a teleonomically based web (in conceptual teleological space). It is

only once this shift in perspective has been made, that the teleons become identifiable as independent thread-like-entities in their own right.

The way to go about this is essentially by focusing on teleos and its 'flow'. In other words the observer focuses on all persistent patterns of preferred outcome within the mei flux network. These patterns may couple in a congruent way, leading to a continuity or 'flow' of teleos in conceptual space. It is this congruent coupling of teleos which gives rise to the teleologically-congruent-segments in space, or teleologically-congruent-phases in time; referred to as the teleons. It should be remembered that there is not necessarily a one to one relationship between the mei flux network and the teleonomic web; in other words a particular thread of mei flux may be associated with more than one teleon and vice versa.

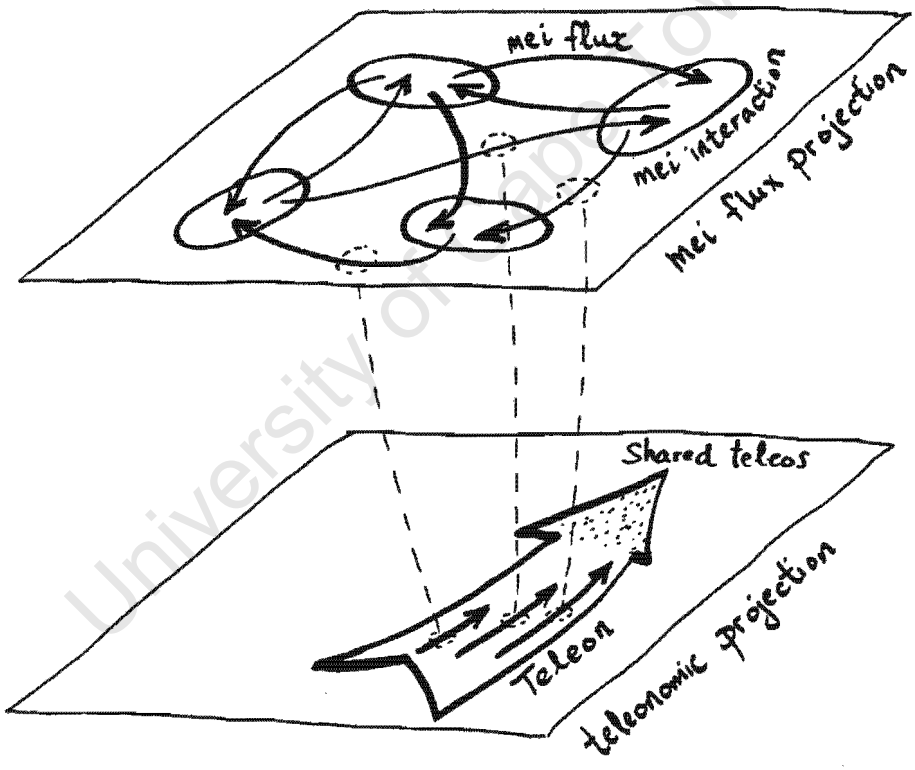


Figure 55: The relationship between mei flux and teleons in the biomatrix

In untangling the mei flux network and projecting it onto the teleonic plane, a very helpful point of departure is to *focus on the dynamic organisation* of the network of mei flux. It often turns out that there are clusters of mei flux which, together, are dynamically organised towards a shared and preferred outcome, or more generally, a *shared teleos*. In a sense the underlying pattern of dynamic organisation provides a 'handle', or 'grip' whereby the teleons, as teleologically-related clusters of mei flux, are 'lifted out' or extracted from seemingly unrelated areas in the web of mei flux (see Figure 55).

In addition, the observer may also *search for a continuity of teleos* within and across levels of organisation, in very much the same manner. At this stage the observer may also make the distinction between sub-teleons and teleons, thereby obtaining a perspective on the holarchic fields of teleons (within the conceptual teleos space).

3.6.2.4 The biomatrix: where it all comes together

Having identified both the doublets and teleons, the observer would now have reached the stage where he can combine the doublets and teleons in a holarchic network within the biomatrix. This is achieved by identifying each teleon with its doublet of origin, as well as with its other participating doublets. In other words the teleons are linked up with the holarchy of doublets, and vice versa.

a. Exo-, endo- and centro-fields of teleos

At this point all teleons are projected or mapped onto the idealised web of exo-, endo- and centro-teleonic fields, with the further distinction of exo- and endo-tapping teleons. Together, these fields comprise the universal teleonomic pattern as postulated in the biomatrix.

There is not necessarily a one-to-one relationship between the teleons, as identified by the observer, and the three generic fields of teleos, i.e. exo, endo, and centro. This means that in some instances a particular teleon may be considered to belong to more than one of these generic classes.[7] However, in most instances it is possible to identify a dominant generic class, i.e. either an exo-, endo- or centro-field. Membership of these generic classes of teleos is classified according to the rules of fuzzy logic (i.e. in terms of membership functions) (McNeill 1993). If a particular teleon is considered to belong equally to more than one field, one may be able to change this by actually breaking it up into sub-teleons, or perhaps looking at it from a slightly different perspective.

One may ask the question: why bother? The answer is reasonably simple: it is one of the basic postulates of the biomatrix model that all systems (i.e. doublets and teleons) are dynamically

[7] For the mathematically-minded it may be added that the observer effectively projects the teleons under observation onto the generic pattern of teleos. This is done in the same manner that the components of a vector are projected in vector-space, the generic teleos distinctions being analogous to the orthogonal axes or eigenvectors in a vector space. However, this is as far as the analogy holds, since these components cannot, for instance, be added in a quantitative sense, as is the case for vectors. The analogy essentially implies that like the three dimensions of physical space, the teleos space, being descriptive of all systems, also comprises three primary dimensions, i.e. the exo-, endo-, and centro-dimensions (which is another way to word this fundamental postulate of the biomatrix model).

organised into these three fields of teleos. Furthermore, these fields are in dynamic balance and interact in a symmetrical and complementary way within the holarchy of systems. If one were to assume that this is indeed the case, then it does become meaningful to analyse or synthesise systems according to this framework. One need not necessarily judge this postulate in an objective analytical sense, but rather judge it by its 'usefulness' in practice. In other words the model can be evaluated through personal and subjective experience, combined with inter-subjective consensus within a group of practitioners (Reason 1988a).

Once the observer has established the matrix of doublets and teleons for the field under observation, the opportunity presents itself to look at the generic systems aspects in more detail.

b. The generic systems aspects

Any area within the biomatrix may be focused on and expanded into greater detail. In other words, the observer may study any particular area in as great a depth as is required. However, this is always done within the larger context of the holarchy of doublets and teleons in the biomatrix. Such a detailed study may typically imply focusing on a particular network of teleons or alternatively focusing on a group of doublets and their interactions.

In addition to focusing on the teleons and doublets, the observer may choose to study a particular generic aspect of the chosen area, i.e. focusing on ethos, teleos, process, structure, substance and dynamic organisation. For example, the detailed dynamic organisational principles of a network of teleons may be explored. This in its turn may entail looking at the feedback mechanisms involved (e.g. morphostatic and morphogenetic feedback) as well as emergent organisation vis-à-vis governance.

In a broader context the observer may explore the principles of symmetry, complementarity and dynamic balance, in other words, ensure that all the generic teleons are represented and dynamically balanced. It may become apparent that part of this meta-framework has been neglected within the system under observation. For instance, it may turn out that no endo-tapping teleons have evolved for the system under focus. This is not unusual for some institutions. Hence, comparison between the system of focus and the generic framework of the biomatrix model may lead to a better understanding of the strong and weak points of the system under observation.

The practitioner is free to use any other technique available to her to further explore any aspect of the system. Most existing systems methods will in fact be enhanced by the meta-context provided by the biomatrix model. Most importantly it ensures that the observer does not get 'stuck' on a particular aspect or a particular part of the system. The model facilitates a 'balanced birds-eye view' of the broader context and allows for the application of other models and techniques, relevant to the subject matter under focus.

The biomatrix approach invites the observer to change focus 'up' or 'down', or 'in' and 'out' the holarchy of systems, thereby establishing a sense of the breadth and depth of the area of focus. It allows for multiple perspectives in terms of the generic systems aspects as well as the dual system perspective. The biomatrix model invariably asks for an interdisciplinary approach, since certain disciplines are traditionally associated with specific areas of focus in the biomatrix (as the observer moves 'up' or 'outwards' in the holarchy, different disciplines start to become more relevant: e.g. physics, chemistry, micro-biology, physiology, psychology, sociology, business science, political science, ecology, astronomy, cosmology, theology and philosophy).

c. The different spheres

The observer may also take note of the different spheres in the biomatrix. These are essentially areas of focus that exhibit seemingly different characteristics and are traditionally associated with different areas of knowledge, or ways of knowing. The integration of these spheres is in a sense analogous to the integration of the "four functions of the human psyche" within the human observer (Reason 1981a). These are: rational cognitive thinking vis-à-vis feeling, and sensory observation (and its technological extensions) vis-à-vis intuition.

The primary distinction to be made in the biomatrix is between the naturo-sphere and socio-sphere:

- The *naturo-sphere* pertains to the whole of nature, excluding man and all man-created entities and institutions; with a further distinction between the *physico-sphere* and *bio-sphere*, respectively referring to in-animate and animate things.
- The *socio-sphere* pertains to human-beings and all their associated artefacts (physical as well as conceptual), inclusive of society at large. A further distinction can be made within the socio-sphere between the *cultural*, *technological*, *economical* and *political* spheres or webs. Another distinction may also be made between the *psycho-sphere*, pertaining to the individual and the *social-sphere*, pertaining to the group.

These distinctions are not set in stone, they are mere guidelines and may be altered if deemed appropriate by the observer.

d. A Telentropic perspective

The observer may move on to explore the principles of harmony and disharmony within the area of focus. A harmonious system essentially refers to a system in which all the generic aspects co-exist in a congruent way. Invariably this is not the case. In fact it is one of the fundamental assumptions of the biomatrix model that there is a complementary interplay between chaos and order, i.e. disharmony and harmony in all systems at all times. However, even this apparent 'imbalance' could be transcended and elevated to a higher level of dynamic balance, or a complementary interplay between order and chaos. Hence, the chaos needs to be contained and so does the order.

In order to gain an understanding of these notions within the system, the observer may view the system from a telentropic perspective. In other words she may explore the origins of *telentropy* in the holarchy, trace its flow, or explore its transfer and transformation within the biomatrix. In doing this the observer gains information and insight that can suggest ways to deal with the telentropy.

e. Teleonomic spiral patterns

A useful technique to explore the dynamic character of teleons is to trace its interaction in the time domain. Specific interactions may be isolated or punctuated by the observer and can be referred to as events. If there are recurrent events over time, a discernible pattern may manifest itself. This pattern may be graphically depicted as a teleonomic spiral in conceptual phase, punctuated with recurrent events along its trajectory in time (Edwards 1996).

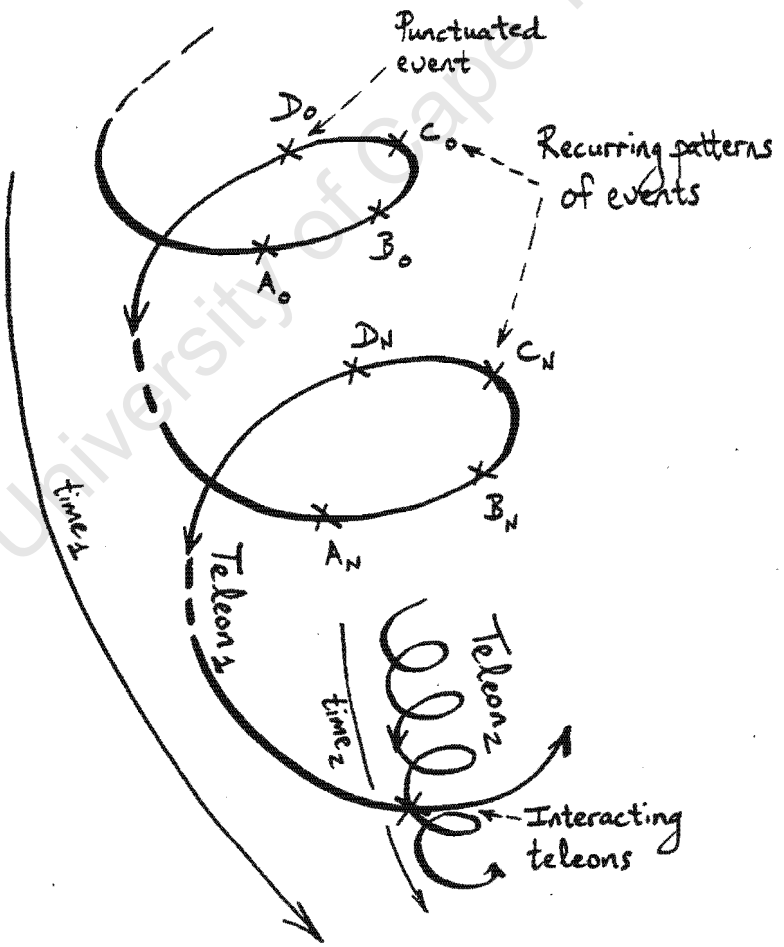


Figure 56: Teleonomic spiral trajectories (with recurring punctuated events)

The depiction of these spiral patterns give the observer greater insight in the underlying dynamics of the system, more specifically those events which tend to recur over time.[8] In addition to this, the observer may also explore the interaction over time of a selection of teleons across levels of organisation. This type of interaction is typical of many systems, where the recurring of events gives rise to an action-pattern, which in its turn may manifest itself as a configuration in space on another level of organisation. Figure 56 illustrates this technique of punctuation of events.

3.6.3 Reductionism vis-à-vis holism

It is perhaps apt to conclude this chapter on the biomatrix approach with a few remarks on reductionism and holism.

The biomatrix is the living network that depicts the totality of dynamic organisation of mei (substance) in the Universe. The problem is that the living network is extremely complex while even the most brilliant human mind can only deal with relatively simple chunks of information. In order to understand it, the complexity must be reduced to manageable sized concepts. This means that human inquiry into complex systems must in a sense be reductionistic. However, reductionism can be a dangerous tool as it by necessity breaks relationships that are the essence of a complex network. The so called holistic thinkers do realise that reductionism may lead to erroneous results and they also rightly point out the harm that can be caused by such reductionism. However, they are mistaken when they condemn reductionism itself for the sins of a particular reductionistic method.

The holistic attack on the reductionism of science is in many ways justified, since it has created schisms in the living network of the biomatrix. Some of these schisms are causing considerable problems today, in the form of pollution, desertification, famine, moral decay, to name just a few. Most of these are the result of ignoring linkages that could not be ignored with impunity. While a reductionistic science sinned on this, it has done many good things. To condemn it for the sins completely would be unwise. Conversely, holism has been criticised for presenting 'wishy-washy' general statements which do not enlighten anyone about the real nature of the universe and which do not necessarily assist us in solving the real problems of the world (Lilienfeld 1978; Coates 1995). In a

[8] These spiral patterns should not be viewed as rigorously defined patterns in for instance phase-space, but rather as a *qualitative graphic technique* to explore recurring events between interacting systems. The spiral patterns are reminiscent of the trajectories of systems in phase-space, however, the points of interaction between spirals are not indicative of systems being at the same dynamic state, but rather point to an interaction and exchange of mei between the systems at those particular moments (i.e. points in time) in their evolution.

historical context systems theory with its emphasis on the whole may be considered an "extreme reaction to an extreme reaction" (Berman 1996, p.46). On the other hand, van Gigch argues that "we risk 'over-quantification', which is the tendency to use inappropriate scales of measurement and the application of methods which the properties of the attributes being measured do not allow. As a result we obtain absurd results and wrongful conclusions. Applying 'the art' of measurement in a knowledgeable way should not require 'wholesale quantification' " (van Gigch 1997, p.36).

It turns out that neither reductionism nor holism provides a complete picture. As pointed out by Kline, "to move either upward or downward in level of aggregation within a given system with interfaces of mutual constraint, we must supply added information to what is inherent in each level for the particular system of interest. ... The existence of open degrees of freedom, not determined by other layers in the structure of hierarchical systems with interfaces of mutual constraint, tells us unequivocally that neither bottom-up nor top-down determinism is correct" (Kline 1995, p.116).

A possible solution to the problem of reductionism vis-à-vis holism perhaps lies in approaching it as two complementary ways of inquiry, resulting in a recursive pattern of analysis and synthesis. This approach implies an integration of a "top-down" determinism vis-à-vis a "bottom-up" determinism.

The following guidelines may assist the observer in a complementary quest for integration and differentiation:

- The biomatrix is extremely complex. Complex things can be reduced in many different ways. Hence the world has to be looked at from as many perspectives as possible. Classical science often errs in this respect, when it reduces a problem to a particular perspective and then proceeds to solve it with the greatest precision, but within a very limited context.
- 'Cutting' or differentiation must be done very carefully. Here one can learn a great deal from those masters of the art of reductionism, the surgeons. When they take something out of the body, they do it with the most judicious cutting possible. They take great care in observing the overall context or anatomy of the surrounding area.
- Ensure that the possible future damage done by 'cutting' is compensated for. Surgeons make sure that vital organs receive their blood supply after the operation. The job of the surgeon is the preservation of life and not just the removal of a part of the body.
- What is learned by reductionism has to be related back to the entire system. Putting it differently: maintain an awareness of the overall context throughout a reductionistic approach and reconnect the 'severed links' or integrate the knowledge gained as soon as possible.

In many ways the biomatrix model may serve as a convenient platform from which both reductionistic and holistic excursions can be made, leading to greater insight and understanding of the 'problem' and system under observation.

Concluding remarks

This concludes the chapter dealing with general guidelines for the application of the biomatrix model. It was argued that the model should be viewed as a conceptual map, guiding the observer through the terrain under observation. It does not prescribe the route to be followed, but rather throws some light on the area, leaving the choice with the observer. The identification of the respective teleons and doublets in the area of focus, followed by their integration into the overall context of the biomatrix (e.g. the teleonomic projection) was shown to be essential to any inquiry. This is complemented by the process of viewing the matrix from the generic systems perspectives, thereby throwing light on each one of these system aspects against the background of the multi-levelled holarchy.

Concluding remarks to Part 3

This also brings to conclusion Part 3 of the thesis document, with its focus on a contextual perspective of the model.

Part 3 introduced the reader to all the elements of the biomatrix model against the background of its six major themes or chapters, with its emphasis on drawing connections between all the theoretical constructs and principles of the model. The reader should now have acquired a basic familiarity with all the elements of the biomatrix model, and also come to realise that the dual and complementary concepts of the teleon and doublet, set in the context of a holarchic field of mei flux, do require a fundamental shift in the way we view the world, and in particular the 'system' under observation. The biomatrix does not resemble a hierarchy of entities, but rather a holarchy of focalised fields. Furthermore, the 'wave' is not the 'particle' and the 'particle' is not the 'wave'; however, they are intimately and fundamentally intertwined, and both have an objective existence.

4. Part 4: A linear perspective on biomatrix concepts

Part 4 comprises the definition and in-depth discussion of a series of select concepts. Concepts are introduced in a linear way, i.e. hierarchically, each new concept relying on all the previously introduced concepts for its formulation. Together they constitute a hierarchical tree of meaning. Each concept is dealt with in a reductionistic way, i.e. by being reduced to its essential components or sub-concepts, and has the following format:

- A short **definition**.
- An **introduction** to the concept.
- A **break-down** of the concept (if appropriate).
- **Perspectives** on the concept (if appropriate). This section explores the concept from different perspectives, in particular each one of the generic systems perspectives. It essentially draws on and emphasises relationships between different concepts, thereby rendering a contextual analysis of the subject matter.
- **Notes on related viewpoints** (if appropriate). This section refers to, and in some instances comments on, other viewpoints in the literature. It is by no means intended to be a comprehensive or comparative study, but rather draws the attention of the reader to the existence of some of the other viewpoints in the literature.

Table of Contents

4.1 Action

Action refers to a change of mei in time and space (conceptual or physical), as observed relative to the context and the period of observation.

4.1.1 Introduction

The biomatrix comprises a web of mei flux in both time and space. Actions are changes which are selectively observed over a chosen time period. An action perspective thus focuses on a specific 'package' of change over a period of observation. It is also possible to observe change in space at a given moment in time, such as the branching of a tree in space or the widening of a road at a certain point. This, however, is not referred to as action.

In order to observe an action, it is necessary to have an associated substance (mei) that is being changed or is changing, and a space within which this happens. A specific action is, however, not necessarily always associated with the same substance or space. For example, writing may be done with a pencil and paper or computer, either in the study or in the bedroom. It is thus useful to conceptually separate the action from its associated substance and space.

Action may either be associated with an underlying action-pattern or considered to be random with no apparent pattern. The recognition of a pattern in action is, however, relative to the observer and the method of observation employed, as is clearly illustrated with the revelation of hidden patterns in non-linear dynamic systems (i.e. fractal patterns in phase-space) (Gleick 1987). Furthermore, all actions are not necessarily teleos-related (i.e. with an associated preferred outcome). For example, a random action may not be considered to be teleos-related, such as a chance encounter with a friend or a random genetic mutation steering the path of evolution. Some people may argue that ultimately all actions do exhibit an underlying pattern, and may thus be considered to be teleos-related. However, it is not necessary to take on a universal standpoint, since in the biomatrix, the distinction is drawn by the observer (given the context and available information).

4.1.2 Perspectives on action

The observer may draw further distinctions, pertaining to the following perspectives on action:

4.1.2.1 Change in position vis-à-vis change in configuration

- **mei flow:** primarily a spatial perspective of change in the space-time continuum: e.g. transportation, or movement, of mei from one point to another;

- **mei transformation:** primarily a temporal perspective of change in the space-time continuum: e.g. the changing configuration of a mei entity at a set position in space.

4.1.2.2 Teleos perspective

- **non-teleos-related action:** i.e. action which is not associated with an apparent preferred outcome over time;
- **teleos-related action:** i.e. action which exhibits persistence and plasticity over time (see goal concept, section 4.9, for an explanation).

4.1.2.3 Action-pattern perspective

- **action with an associated pattern:** i.e. non-random action, considered to exhibit a repetitive action-pattern over time;
- **action with no apparent pattern:** i.e. random action, considered to exhibit no pattern over time.

4.2 Time

Time refers to the observer's perception or measurement of the progression and duration of events.

4.2.1 Introduction

Time is one of the cornerstones of 'reality' and very difficult to define in an exact way, without reverting to a circular argument (e.g. the use of the progression concept in its definition already implies some notion of time). Intuitively we all have a good sense of what is meant by time. However, it is important to acknowledge the different perceptions and qualities of time as observed and experienced in the different spheres and levels of organisation in the universe. Ultimately each process has its own inherent time; the question that needs to be asked is how does it relate to the time of other processes of interest? [9]

From one perspective time is seen as a *variable*, indicating the *duration* of an event, and from another perspective it is seen as an *operator* (in the mathematical sense) giving rise to an apparent flow or *progression* of events (Prigogine and Stengers 1984). In order to measure the duration of a specific series of events another progression of events is required to serve as a reference or standard. In our modern world processes in the naturo-sphere serve as a standard of reference, more specifically the frequency of the atomic emission of light (i.e. a physical standard of time). However, Thomas Aquinas maintained that each process has its own time and *all that is, is its own time* (Versfeld 1991, p.186). Furthermore: "tempus ipsa creaturae substantia est" or the temporality of a creature is its very substance (Versfeld 1991, p.89).

Thus "biological and abstract clocks also prove that complex systems evolve on autonomous time scales, i.e., without reference to the underlying physical processes" (Fivaz 1997, p.203). Following this idea "one first presumes that changes in living systems are expressed by *dynamical variables* specific to their components; one then presumes that these variables depend on '*a specific time*' characteristic of components dynamics. There is no *a priori* reason why this time should be identical to the 'perceived time' in the observer's consciousness or the time measured by physical clocks"

[9] The Special Theory of Relativity as formulated by Einstein has indicated that physical time is relative to the observer's frame of reference and velocity ; likewise the biomatrix model views time to be relative to the process under investigation and its context.

(Fivaz 1997, p.201). From a purely physical perspective this is not unlike what is maintained in the special theory of relativity (Clarke 1979). The biomatrix model thus acknowledges the fact that time referenced relative to other levels and spheres of being may also be valid and even more appropriate for the process of focus.

Although the measures of time for different types of processes and levels of organisation are generally related, time is not always of a linear nature and may also be discontinuous. Furthermore, in the case of time as experienced by a living entity, the subjectivity of time (i.e. relative to the unique perception of the observer) should be acknowledged. In conclusion it should be stated that the adoption of the physical standard of time is in some cases not appropriate and may even lead to incorrect conclusions.

4.2.2 Linear progression and directionality of time

Time is often perceived as a ceaseless and unstoppable progression of events. Viewed on a certain level of organisation of processes and perception, events are irreversible (e.g. biological growth and the degradation of energy in accordance with the second law of thermodynamics) and therefore lend time a sense of unidirectionality (Prigogine and Stengers 1984). It does, as seen from that perspective appear as an "arrow" pointing in the direction of the future. Once an event has passed in time, it will never appear again as the exact same event or entity.

The linear progression of time is especially evident in the material sphere, e.g. in the natural ageing process of all physical entities, including living bodies. The second law of thermodynamics implies that if any physical object is thermodynamically sealed off, it will tend towards a state of thermodynamic equilibrium, i.e. from a purely physical perspective it ultimately leads to a state of no differentiation or structuration on a macro level. In other words, if one were to place a pencil in a sealed container it would eventually deteriorate and break apart into 'dust' without any outside forces of normal wear and tear. The process of 'destruction' or 'falling apart' cannot be stopped, it can only be counteracted through a ceaseless process of maintenance; i.e. rebuilding over and over again those parts that fall apart. The moment the counteracting maintenance processes cease to function, the system will follow the natural process of falling apart, also referred to as death in living systems.

4.2.3 Spiral (cyclical) nature of time

Viewed from another perspective, time does seem to repeat itself, i.e. certain events seem to recur in a cyclical manner. The sun, for instance, rises and sets every day; the seasons repeat themselves on an annual basis; the moon goes through a monthly cycle (as do certain biological processes. The learning process of an individual also tends to go through cycles of repeating the same experience, albeit from a new perspective. The economy goes through cycles of growth and depression, and in inter-personal relationships the same old arguments always seem to crop up. Events do repeat themselves, but never

within exactly the same global configuration or context. The moment we become aware of the overall picture the differences become apparent, but if we focus only on the micro-events, they may in fact appear to be exactly the same as the previous cycle. Thus, the progression of events may appear to be cyclical, but the overall context on other levels may go through their own cycles, giving rise to a different context.

If one were to analyse the movement of the earth around the sun it would actually trace a spiral pattern due to the movement of the sun around the centre of the galaxy. Viewed relative to the sun alone it appears as an ellipse. However, if one adds the additional perspective of the centre of the galaxy the movement traces a spiral pattern. Furthermore, it seems that with each additional perspective added, another dimension is added to the spiral (i.e. spirals within spirals). The image of a spiral powerfully represents the cyclical repetition of events, circling the central axis which represents the linear progression and directionality of time.

4.2.4 Linear/non-linear relationship of time

Physical time seems to exhibit a strong linear relationship between physical processes and levels of organisation. For instance, for every cycle of the earth around the sun the moon completes approximately twelve (monthly) cycles around the earth, and for each daily cycle of the earth around its own axis the electron orbits the nucleus approximately 10^{20} times. The cycles of processes on the various levels of organisation exhibit a linear relationship, in a sense similar to the moving parts of a clock.

In some instances, though, processes exhibit a non-linear relationship. Let us assume physical time serves as the reference process (as would normally be the case) and consider the duration of events associated with a beating heart in the biological sphere. Normally the heart would beat approximately 115 000 times for each daily cycle, but in case of a fright or the climbing of a flight of stairs, the heart rate will increase, thus implying a change in its associated 'time' (i.e. a change in the progression and duration of events as seen from that context). In this example the biological time and physical time are no longer linearly related. Similarly, there is a heightened activity in the 'family time' before and during a meal, and the economy may go into a period of recession, which is totally unrelated to the annual cycle of physical time.

4.2.5 Discontinuous nature of time

In some instances the progression of events in a process on a particular level of organisation may completely cease to flow and the process with its associated 'time' comes to a halt. This is typical of processes of interaction between individuals who communicate every now and again. Whenever they meet (or interact over the telephone) the process comes alive and time resumes from where it stopped the previous time. Likewise, animals going into hibernation will manifest a discontinuity in their

biological time. In a sense the psychological time of our normal wakeful state is interrupted and resumed each day when we go to sleep. A particular trend or process in society may cease to exist and reappear again at a later stage. In this case the time for that particular process does not necessarily reflect the flow of physical time during its resting period (e.g. the evolution of a particular fashion trend).

Generally physical time appear to be continuous and does not exhibit any discontinuities; a discontinuity in physical time would for instance imply the sun being stationary in the sky (as in the Biblical account). According to the special theory of relativity, very fast moving objects do exhibit a slower flow of time, and in the extreme case, when the speed of light is approached, it is postulated that physical time, as observed for that particular object, will 'stop' (Einstein and Infeld 1966).

4.2.6 Subjective nature of time

In some instances the individual observer serves as her own time reference. In those cases the measure of time may not necessarily agree with other people's perception or with the standard physical reference. Normally the individual's perception of time on a psychological level is pretty much in agreement with physical time, and so are the circadian rhythms of biological time. However, this is not always the case: e.g. we are all familiar with the perception of time flowing slower during a rather boring process. The individual's sense of time may also be impaired or changed by chemical agents (e.g. alcohol, drugs, release of chemicals during exercise).

4.2.7 Time constants on different levels of organisation

The concept of a "time constant" derives from the field of cybernetics. In that field it is related to the time it takes for a system to recover to its original state after a unit impulse stimulus, or to stabilise at a new end-state after receiving an input which acts as a guiding signal for the new end-state (Gupta and Hasdorff 1970). A system may oscillate around an end-state only to stabilise after a few oscillations or it may reach the end-state without any oscillations. The system is considered to have reached its end-state after the oscillations have subsided within a certain limit from the end-level. The point which needs to be emphasised is that each process has its own time constant. Typically, the higher the process resides in the holarchy of the biomatrix, the longer is its time constant, although this may not always be the case.

In order to effectively govern or transform a process under consideration it is essential to have an idea about its time constant. The effect of any changes introduced can only be judged after the time constant of that particular process has lapsed; before such time no real judgement can be made for future action.

Spronck argues that "when systems dysfunction, for example when they get 'stuck-in-time' or 'freeze', the time-scale of the system and its environment get out of synchronisation. While the environment changes in a certain direction, the system tries to retain the equilibrium. Only through reorganizing is the system capable of resynchronizing the time-scales of the constituent parts. This matter is made worse when systems consist of subsystems which themselves are under strain to change (as is often the case in social groups)" (Spronck and Compernolle 1997, p.165).

4.2.8 Perspectives on time

The following perspectives pertaining to the sphere of reference can be distinguished:

Physical time-frame: as defined and measured in physical events. Originally based on the cyclic rotation of the earth around the sun as a one-year period (solar calendar) or alternatively the cycles of the moon (lunar calendar). In modern times the cyclical nature of the light wave emitted by a specific atomic element is used as reference. Processes manifesting on the following levels of organisation in the physical sphere may serve as indicators of time:

- atomic level (i.e. atomic reference);
- planetary level (i.e. geological reference);
- solar system level (i.e. astronomical reference).

Biological time-frame: referring to the cycles and periods of completion of physiological processes within the organism. Circadian rhythms and the effect of jet lag serve examples of the internal biological 'clocks' of an organism. Physiological processes are, however, not necessarily correlated or linearly related to physical time. For instance, a person running will experience an accelerated heart rate and metabolic tempo. This in turn implies that 'biological time' flows faster for the biological organism during the exercise period (more specifically the cells would experience a sense of accelerated time). Alternatively, a sleeping person exhibits a very low metabolic rate and therefore experiences a slower flow of biological time (as experienced on the cellular level). Processes manifesting on the following levels of organisation in the biological sphere may serve as indicators of time:

- cellular level (e.g. tempo of cell division and oscillatory bio-chemical processes).
- organismic level (i.e. circadian rhythms and intuitive sense of time).

Psychological time-frame: the flow of time as perceived by the individual (either intuitively or through sensory observation). The perception and experience of time by the individual may be of a very subjective and personal nature. What may feel like ages for one person, may feel like a fleeting moment for another. Some individuals are by nature 'slower' than others, seeming to have a slower and more relaxed perception and measure of time in general. Time as experienced in a dream or 'dreamtime' is totally different from that in the normal waking state (Castaneda 1993).

Social time-frame: referring to cycles and progression of events as observed in groups, institutions and societies. A business organisation may go into a period of heightened activity due to a deadline or increased demand, in which case time for the organisation will flow faster. Civilisations tend to go into periods of growth, stabilisation and stagnation, during which periods time will tend to flow faster or slower on the social level. In general, time flows more slowly for social processes than for any other living system.

4.3 Process

A process is a series of actions over time leading towards an end-state relative to a particular period of observation.

4.3.1 Introduction

Both the physical and conceptual worlds in which we as observers and co-creators participate comprise a complex interacting web of activity or mei flux. The observer, through the process of observation, interpretation, reflection and intervention orders and groups the web of activity into a meaningful pattern. This does not necessitate an idealist viewpoint of reality as it is assumed that regardless of the intervention of an observer a certain pattern of activity pre-exists. However, the observer will definitely influence what is actually abstracted from the existing pattern and what is projected onto it, since observation and interpretation are always subject to our ability to perceive, the nature of our understanding, and the aim of our inquiry. Consciously or sub-consciously we choose what we see according to what we want to know . The act of 'fore-grounding' or highlighting a particular process implies that the observer elects to focus on a particular outcome. This may in its turn actually change the pre-existing pattern, and hence we become co-creators of the world in which we participate.

Process exists in the first instance in time. Thus a process is recognised primarily by its existence in time as an activity and not as an entity in space. Focusing on a particular process or chain of actions implies the recognition of a causal link between the series of actions, constituting an interrelated *series of actions*. The serial distinction implies a directionality in time. It does, however, not necessarily imply a linear causality, since feedback and mutual coupling of actions may result in a circular causality, rendering a distinction between cause and effect irrelevant and meaningless (e.g. a chicken and egg situation). Consequently, it is more useful to focus on the *coupling of actions*; this is achieved by observing and tracing the actual flux of mei over a period of observation.

4.3.2 Perspectives on process

4.3.2.1 Teleos perspective

The concept of a process in the biomatrix implies a series of actions which may be associated with a teleos (see the concept of teleos). Depending on the level of analysis and the intention of the observer a process may exhibit multiple goals. However, conceptually a process is generally associated with a focalised field of teleos. For example, the process of marketing may be associated with the dual goal of selling a specified number of the product, as well as achieving a particular image of the product in

the minds of the consumers. Likewise, a transformation process typically comprises: redesigning→ implementation and restructuring→ monitoring. However, in each instance these multiple goals constitute a focalised field of teleos centred around the main foci of marketing and transformation.

Although all processes by definition lead towards an end-state relative to the period of observation, not all processes are explicitly related to an identifiable teleos, as they do not necessarily persist in bringing about a preferred outcome. Such processes may be random or chaotic. For instance, the process of evolution does not necessarily progress towards a particular preferred end-state, and its associated mutations may be viewed as random by nature. Similarly, many interactive processes between individual members of an organisation are not necessarily associated with a preferred end-state and thus are viewed as open-ended processes in terms of teleos. These types of processes also have a role to play since creative outcomes predominantly originate from random open-ended processes.

Processes may thus be viewed as:

- **open-ended:** processes with apparently no preferred end-state;
- **teleos-related,** including the following types:
  - **purposeful processes:** associated with a purpose;
  - **goal-related processes:** dynamically organised towards a specific preferred end-state;
  - **functional processes:** dynamically organised towards a preferred generic class of outcomes (refer to the teleos concept for an elucidation of these three classes of teleos).

Human beings are by nature meaning- and teleos-seeking systems which means that we tend to 'foreground' or focus on those activities that appear to be teleos-related in the world around us, at the same time neglecting the vast numbers of chaotic and random processes in the real world. Some people may argue that all activity is ultimately teleos-related (Davies 1995). In the biomatrix approach it is not necessary to take a stand regarding the presence or absence of an ultimate end-state or 'final cause'.

The sequencing of actions may be observed over a period of time with each action leading up to and supporting the following action, eventually giving rise to a particular end-state. When viewed over a shorter period of observation or from a different perspective, these individual actions actually appear as processes in their own right, again in themselves 'dissolving' into sub-actions. It can therefore be stated that any process on a particular level of organisation comprises *sub-processes*, each in its turn contributing to a more extensive process. The commuting process, for example, may comprise the sub-processes of walking towards a car, driving the car to work and getting transported in a lift to the office. Likewise the design process typically comprises the following sub-processes: brainstorming→ analysing→ synthesising→ design specification.

4.3.2.2 Structure perspective

The structure perspective focuses on the structure of a process both in space and in time, i.e. a spatial and temporal perspective respectively.

a. Spatial perspective

Although the primary focus for processes always remains time, one may also explore the structure of processes in space (conceptual or physical), referred to as its *spatial configuration*. The following distinctions pertaining to the spatial configuration of processes may be useful:

- **Sub-processes**: processes which are considered to co-act in order to produce the outcome under focus.
  - **Serial sub-processes (phases):** successive phases of the process over a period, for instance, the phases of education, e.g. primary, secondary, tertiary, depicted on a line representing the flow of time.
  - **Parallel sub-processes**: processes 'running' concurrently over a period of time co-producing an outcome, for example, the different processes running concurrently within the various departments of an institution.
- **External process couplings:** all those processes considered to be outside the boundaries of the process under observation, i.e. not co-producing the outcome over the particular period of observation. Generally any process under observation interacts or couples with other processes outside its own time-span of action (i.e. apart from those regarded as its sub-processes). This is a logical consequence of the fact that most processes are, by their very nature, preceded by other processes, whilst at the same time also contributing to successive processes.
  - **Preceding processes:** processes that 'feed into' the process under observation. The focus is on the temporal perspective or uninterrupted flow of actions in time.
  - **Successive processes:** processes which the process under observation 'feeds into'.

b. Temporal perspective

Implicit in a process is a series of changes. If the sequencing of actions is repetitive, it gives rise to a discernible *action-pattern* in space (conceptual or physical), albeit on another level of abstraction. It is in fact the recurrent sequencing of actions which serves as a link for structure in time (action-pattern) and structure in space (configuration). The sound produced (i.e. the action-pattern) by a gong and its physical shape (configuration) are intimately related, and are in fact manifestations of the same structure in time and space. The same could be said of the DNA molecule (spatial configuration) and the sequencing of actions (biochemical action-pattern) as a result of genetic governance in the cell.

4.3.2.3 Substance perspective

Implicit to any action, is the substance or mei that is in flux. The following distinctions may be useful in this regard:

- **Mei flow:** can be traced through the network of processes in time, for example, the flow of words in the communication process.
- **Mei transformation:** a substance may be transformed into a different substance or be reconfigured. For example, in the process of growth or production the mei is re-configured and transformed from the 'building blocks' to an 'end product'.

4.3.2.4 Dynamic organisation perspective

- In order to reach a point of completion it is essential that a process be continuous, i.e. *temporal and sequential continuity* (series of phases) should be maintained. Such a process may be continuous in time. Although, in some instances a series of actions may be interrupted in time and continued at a later stage, it should be continued from the point in the series from where it was previously interrupted in time, i.e. sequential continuity should always be maintained.

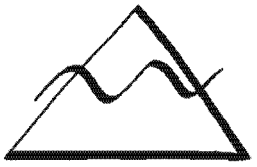
4.3.3 Notes on related viewpoints

- Living systems theory (LST) defines process as "all change of matter-energy or information in a system" (Miller 1978, p.23).

4.4 Structure

> Structure refers to those relationships between elements (e.g. discrete entities, actions or processes) which appear to remain constant relative to a particular period of observation and level of organisation as defined by the focus of the observer.

4.4.1 Introduction



Structure essentially refers to a particular perspective that may be held by the observer, either intentionally or unintentionally (e.g. as a natural outcome of our ability to perceive and distinguish between different forms and patterns). The biomatrix model views structure as emerging from the dynamic organisation of process. True to a process-based systems approach, it maintains that ultimately everything is in flux and all structure is dynamic in nature. *Structure emerges and exists by virtue of the relatively stable coherence of processes and their interaction over a period of time.* Process and structure thus constitute two complementary perspectives, and the distinction is subject to the period of observation and the viewpoint of the observer.

Our focus on structure may thus be either on its spatial aspect or on its temporal aspect. This is considered to be analogous to the wave/particle duality in physics (Gribbin 1984); i.e. the shape of a particle as it manifests itself in space and a wave-form as it manifests itself in space over a period of time. Structure thus manifests either as a configuration of elements in space, referred to as a *spatial configuration* (i.e. the more traditional notion of structure), or over a period of time, referred to as an *action-pattern*. Whereas a spatial configuration emerges as a consequence of the relatively stable arrangement or configuration of an ensemble of elements in space, an action-pattern emerges as a consequence of a relatively ordered sequence or recurrence of events over a period of time. Together these two modes of manifestation (of structure) constitute a complementary pair.

The concept of structure should not be confused or equated with our everyday notion of 'structures' or entities; these are referred to as discrete entities in the biomatrix. The concept of structure as explained above is essentially an abstraction performed by the observer, either as a natural and 'automatic' outcome of our sensory processes or measuring devices, accompanied by our mental constructs, or as an exercise in creative design and imagination. Obviously all 'structures' or discrete entities are associated with a structure, but so are many processes, manifesting as a pattern in time rather than in space.

4.4.2 The relative nature of process vis-à-vis structure

The observer may choose to focus on either change per se (i.e. process) or structure within the biomatrix. The dominance of a particular perspective depends on the focus of the observer as well as the period of observation.

For an anatomist the physical shape of the human body represents a structure or configuration of elements in space, whereas for an evolutionist or physiologist it becomes a process, albeit over different periods of observation. The geologist may either view a mountain as a structured and discrete entity or as a process of transformation. Likewise the organisational structure associated with an institution becomes a process when it is viewed as a "learning organisation" (Senge 1990). These examples illustrate the importance of the relative period of observation and the role that the viewpoint of the observer plays in perceiving structure.

It should be noted that not all processes are necessarily associated with a structure or action-pattern. Some processes appear to be random without any apparent pattern or structure, for example, many processes of change within the physical and socio-sphere. However, what appears to be unstructured change on one level may exhibit some pattern on another level of organisation. Random unstructured processes often exhibit an overall pattern when analysed statistically on a larger scale and over an extended period (Gleick 1987), as would be the case for the weather and some processes in society (e.g. the economy).

In general the 'special' case of structured processes (i.e. action-patterns) gives rise to what is perceived as stable patterns, configurations and discrete entities in time and space. Without the presence of action-patterns, reality would constitute a chaotic state without any discernible entities or distinctions. It is the infusion and emergence of structure in the 'sea' of chaotic energy flux which constitutes the extraordinary phenomena of creation and evolution and ultimately gives rise to an ordered universe.

4.4.3 The recursive relationship between action-pattern and spatial-configuration

An intimate relationship exists between structure as an action-pattern or structured process and structure as a spatial configuration. It is essentially a recursive relationship between different levels of organisation (Keeney 1983). The recurrent pattern inherent in a process (i.e. the action-pattern) on one level of organisation may emerge as a spatial configuration or focalised entity on another level of organisation. For example, recurrent subatomic processes (e.g. the orbits of electrons) result in the emergence of an atom as a spatial configuration or discrete entity. Likewise action-patterns inherent in cellular processes (e.g. protein synthesis) result in the creation and maintenance of the cell as a spatial configuration and discrete entity in space. On the other hand, structures as spatial configurations (or entities) in their turn participate in the creation of action-patterns on another level of

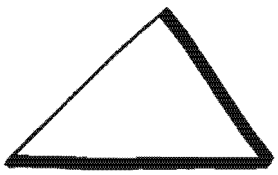
organisation. For instance, the family members (as configurations in space or discrete entities) interact and give rise to action-patterns (i.e. recurrent behavioural processes) which in their turn give rise to the higher level configuration of the family as a discernible entity in physical and conceptual space.

Thus all structure can ultimately be traced back to the dynamic organisation of an underlying action-pattern or recurrent process, and all processes in their turn exist by virtue of the interaction and transformation of entities in space (i.e. spatial configurations).

4.4.4 Perspectives on structure

The following perspectives on structure may be distinguished:

4.4.4.1 Spatial perspective (spatial configuration)



Spatial structure or spatial-configuration focuses on *the stable configuration of elements* within a system relative to the period of observation and the focus of the observer. It may refer either to the configuration of a group of discrete entities or to the configuration of a group of processes. For example, the atoms of an object represent a spatial configuration of discrete entities, whereas a traffic or communication network constitutes a configuration of processes. The configuration of an organisational structure generally includes both the relative arrangement of functions (i.e. processes) as well as the departments (i.e. focalised entities). Values, beliefs and aims are associated with configurations of ideas in the conceptual realm (i.e. a 'frame of mind').

4.4.4.2 Temporal perspective (action-pattern)

Implicit in all processes is a series of actions or events. If the series of actions is associated with a discernible pattern of change it is referred to as an action-pattern. An action-pattern perspective thus implies searching for the presence of a pattern in the temporal domain as a result of a relatively ordered and recurrent sequence of events over a period of time. It manifests primarily in the temporal domain but is abstracted by the observer into conceptual space.

Action-patterns are associated with supportive spatial configurations and vice versa. For instance, the sound produced (i.e. the action-pattern) by a gong and its physical shape (spatial configuration) are intimately related and are manifestations of structure in time and space. In physics a standing wave would be an example of an underlying action-pattern which at the same time also manifests as a configuration in space. All organisational procedures and behavioural patterns constitute action-patterns. A whirlpool or cloud would be an example of structure which manifests primarily as an action-pattern in time but which also gives rise to an emergent spatial-configuration or entity in space.

4.4.4.3 Conceptual vis-à-vis physical perspective

Structures may exist in physical and conceptual space: a physical structure generally has a counterpart in the mind of the observer as an abstraction of its physical manifestation. Furthermore, structure may elude the observer and never be fully conceptualised, e.g. subatomic particles or organisational structures in society. Some conceptual structures may remain as such, as would be the case for some purely mathematical constructs and unfulfilled dreams, ideals and aims On the other hand a conceptual structure may be projected with great success onto the physical realm, e.g. the imagined structures developed by a designer eventually becoming manifest in the physical realm.

4.4.5 Notes on related viewpoints

- LST defines the structure of a system as "the arrangement of its subsystems and components in three-dimensional space at a given moment in time" (Miller 1978, p.22). The concept of "pattern of action" is defined as follows (under the heading of spatiotemporal relationship): "the form of a change in organization or action among subsystems or components over time" (Miller 1978, p.70).
- Bateson's procedures of inquiry are punctuated by an alternation between classification of form and the description of process. The "*zig-zag ladder of dialectic between form and process*" is mapped out in his book, Mind and Nature (Bateson 1985, p.209-210) and subsequently by Keeney (Keeney 1983, p.41).
- "Although *systemology* strives to transcend 'structural' preconceptions of systems, it does not try to substitute some other single concept, e.g. 'process', but instead gives appropriate respect to both together, supplementing them with 'substance' and governance as well" (McNeil 1995, p.135). The concept of *form* in applied systemology is not unlike the concept of *structure* in the biomatrix; although form does not make an explicit distinction between the temporal and spatial dimension.
- Johannessen maintains there are "patterns of social behaviour, and by gaining insight into some of them, explanation and predication of social facts is possible, at least roughly and in a short time perspective. Patterns of this kind are to a great extent linked to particular types of societies, i.e. they are dependent on time and space" (Johannessen 1997, p.31).

4.5 Discrete entity

Discrete entities are spatial configurations of mei which are demarcated within real or conceptual space by distinct and finite boundaries.

4.5.1 Introduction

In the biomatrix, the concept of a discrete entity is associated with 'objects' or 'parts' which appear to cohere, relative to the level of focus and the period of observation. Discrete entities do not only refer to physical objects but also include 'packages' of information such as concepts. The latter could manifest either in physical space as information stored on a computer file or as a discrete entity in the conceptual realm as a distinct memory held by an individual. Some discrete entities are clustered to form larger entities while others can be 'broken down' into smaller entities. Examples of successive agglomerations are: molecules, bricks, houses, suburbs, cities, countries, etc. Similarly: letters of the alphabet, words, sentences, paragraphs, chapters, document, theory, etc.

A discrete entity is recognised by virtue of its relatively stable coherence over a period of time within definable boundaries that serve to differentiate it from its environment and to give it a distinct character of its own. The distinction and punctuation of a discrete entity is always relative to the viewpoint and intention of the observer. For example, a mountain may be considered as a discrete entity from our point of view at the present time. However, seen from a geological perspective, it is seen to be part of a larger mountain range without actual physical separation from it. Separation and boundaries exist purely in the mind of the observer, i.e. in the conceptual realm.

The substance of entities is a combination of mei, which may range from pure information, as in the case of an idea, to pure matter, as in the case of a brick. A book may be seen as information, matter or both, or even as energy if it is set alight or 'fires you up' to do something, depending on how it is viewed. In all instances, an underlying energetic dimension can be postulated for discrete entities. In fact, it is believed that ultimately everything revolves around different configurations of energy.

The concept of a discrete entity differs from a doublet in this sense, amongst others, that a doublet is a focalised field-like entity with a diffuse and potentially infinite boundary. However, it is similar to the concept of a core-body associated with a doublet. In some instances a discrete entity may in fact be the core-body associated with a particular doublet, e.g. the human body as part of the human doublet in the physical domain, or a document as the core-body of a field of knowledge in the conceptual realm. A collective discrete entity, such as a country, may represent the core-body of a nation-doublet. However, all discrete entities are not necessarily core-bodies associated with doublets. For instance, a chair is generally not considered to represent the core-body of a doublet (since a chair is not generally

considered to constitute a doublet per se), nor does a single concept or word, even though they both do participate in doublets. For instance, a chair may participate in a family doublet and a concept in an institutional doublet as part of a policy statement. Thus, ultimately, all discrete entities participate in at least one doublet, albeit not necessarily on the level of organisation associated with its core-body.

4.5.2 Notes on related viewpoints

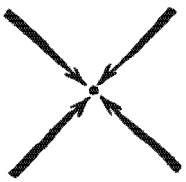
- The *objectivation of reality* argues "that reality is created as social forms through social acts of discourse which allow for the meaningful construction of objects" and "because we are taught to perceive entities such as cats as being discrete forms which exist separately from our perceptions of them, we rarely challenge this" (Davies 1992, p.606-607). Conversely, Husserlian *phenomenological reality* argues "that reality is to be explored through the exploration of transcendental experiences rather than through an exploration of a notionally objective reality" (Davies 1992, p.608).

4.6 Teleos

> Teleos refers to a state or outcome towards which a process (or system) tends to be directed, attracted or which it dynamically persists in.

4.6.1 Introduction

Teleos (Greek for 'end') is representative of a class or range of distinctions, including:



- a *generic outcome* associated with a process: i.e. a **function** (e.g. walking and talking);
- a *preferred future state*: i.e. a **goal** (e.g. aiming to arrive at a destination at a certain time) or an objective, ideal and vision.
- a *meta-attractor that connects and contextualises different teleoses* in conceptual space: i.e. a **purpose** (e.g. going to work in order to earn a living) or a mission.

Whenever a process or system exhibits any one of these properties it is said to be *teleos-related.* The term *teleonomic* in the context of the biomatrix simply means *teleos-related.* The aforementioned properties are generally interrelated and interchangeable, depending on the focus of the observer. The range may also be viewed as a *hierarchy of teleos* concepts, ranging from purpose through goal to function. The concept of a goal resides in the middle of the range and is thus 'fully' representative of the concept of teleos. The concepts of purpose and function overlap with those of ethos and action-pattern, respectively. The observer may choose to focus on a particular aspect of teleos within the range or class of concepts associated with it.

Teleos can also be further distinguished as either emergent or intended:

Emergent teleos occurs as a result of interactions within the system. It is not explicitly associated with sentient intent and no intention can be ascribed. In these instances the observer abstracts teleos from a system by observing its dynamic organisation over a period of time under different conditions. If the system tends towards or away from a particular state, it is abstracted as an associated teleos. Examples of emergent teleos are the tendency of water to flow towards the lowest point of gravity causing the flow of a river, and the emergence of patterns of behaviour within families as unintentional coping mechanisms.

Intended teleos is intended by a sentient being (system) and projected onto itself or onto another system. It is associated with all planned activities in the biological, psychological and social realm. All processes and associated structures which are designed by man are examples of intended teleos.

4.6.2 Action pattern vis-à-vis teleos-related actions

Teleos-related action refers to a specific end-state reached by the system irrespective of the pattern or 'route' it has followed in reaching this state. Teleos-related action is associated with plasticity, which means the system may pursue different routes or patterns in reaching its preferred end-state. This perspective focuses on a punctuated end-state, i.e. a 'pattern' of preferred end-states. The action-pattern perspective focuses on discernible patterns of change in the state of a system over time. For example, my actions of going to work every day may be considered to be teleos-related in the sense that I always pursue a specific end-state, which is reaching the location of my office. This may however be associated with a variety of action-patterns, in the sense that somedays I may travel there by train, by car or even choose to walk (bearing in mind that each one of these means of commuting exhibits a distinct series of repetitive actions; i.e. an action-pattern).

4.6.3 Perspectives on teleos

The primary perspectives on teleos are:

- **contextual** perspective: i.e. a purposeful distinction;
- **preferred end-state** perspective: i.e. a goal-related distinction;
- **action pattern** and associated **outcome** perspective: i.e. a functional distinction.

4.6.4 Notes on related viewpoints

- "Many modern day treatments of teleology ... distinguish between teleomatic, teleonomic and teleological systems. Briefly, in this scheme teleomatic systems are classified as end-resulting, teleonomic systems are classified as end-directed, and teleological systems are end-seeking. These distinctions are broadly intended to capture the differences between inorganic, biological, and intelligent systems, but it is a moot point whether they do so in an informative way" (Christensen 1996, p.305). The biomatrix model essentially groups all these distinctions, amongst others, under the single term teleos.

4.7 Focalised field of teleos

A focalised field of teleos in conceptual space refers to an ensemble of teleoses associated with a single point of focus.

4.7.1 Introduction

It should be noted that the concept of a field of teleos exists entirely in conceptual space and provides a way to group, name and identify the associated teleoses of a system or process, its sub-systems and sub-processes.

The field is fractal-like or *self-similar*, i.e. repeating itself with ever larger, and ever smaller, groupings or clusters (Gleick 1987). Thus, each grouping may be collapsed into a single focal point; alternatively, each focal point may be expanded into a field of points, in their turn clustered around the expanded focal point. The individual teleoses are those of the sub-processes of the process under observation. These points become focal points for a whole ensemble of points surrounding them, which, again in their own right, become focal points for smaller clusters of points. The focalised point of the cluster represents the focal teleos, or is simply referred to as the teleos of the process under observation. The concept of a focalised field is somewhat similar to the physical structure of a galaxy: when viewed from afar, it appears to be a single point, but from closer up, it keeps on expanding into ever smaller clusters of stars, and planets clustered around the stars.

Educating, for example, may be viewed as a focal point of teleos, with teaching, learning, and managing, in their turn viewed as points in the associated field of teleos clustered around the main focal point. Similarly, learning may be viewed as a focal point in its own right, with reading, thinking, searching and memorising as its associated cluster of points (in conceptual teleos space). In some instances it may actually not be possible to name the focal point of teleos: it rather emerges out of an associated cluster of points that has been named or identified. This is somewhat similar to the concept in linguistics whereby a particular word derives its meaning from its *field of associated words*, which surrounds it in the conceptual space of language. More specifically: "the influence that determines meaning moves downward from the whole to the part, rather than upward (or outward) as associative field theory implies. The meaning of a word is determined by the field as a whole" (Paivio and Begg 1981, p.79).

4.8 Function

A function refers to a particular outcome or effect associated with a process or structure.

4.8.1 Introduction

By distinguishing a function, an observer chooses to focus on a specific outcome associated with the process or structure under consideration, which she then describes in terms of an activity. In simple terms one may say that it states what a process/structure is observed to 'do', or what it 'does'. For example, it is observed that the pumping of the heart results in the movement of blood around the body. It may thus be said that the function of the heart is to pump blood. Thus outcome is described in terms of an activity that is on a different level of abstraction from its associated process and structure. The concept of a function is considered to belong to the teleos-class of concepts in the sense that the associated process or structure is dynamically organised towards sustaining or having the effect of the outcome. However, as function focuses on outcome or effect described as an activity, it is rather a 'mix' of both the concepts of a process and a goal. While a process deals with a series of actions and a goal focuses on a preferred end-state associated with the process, a function concerns itself with associated outcomes. Focusing on function thus makes evident á role played by a process or structure in the context of a specific outcome.

It should be emphasised that the act of focusing on and ascribing a function does not necessarily account causally for the presence of the process or the structure to which a function is ascribed. It only makes explicit a specific effect by assuming that the particular process or structure must be present in order for the effect or outcome to come about (Nagel 1979). In the case of intended functions, e.g. in the psycho-social sphere, it may be possible to make a causal ascription, since the intention of a process may be explicitly known to the observer. For example, to state that the function of the marketing process is to enhance the image of a product and then also to assume that this function is causally linked to a particular need for it in the system, may not be incorrect. However, in the naturo-sphere it would be incorrect to make causal judgements (i.e. teleological assumptions) as to the presence of a particular outcome in a system. For instance, when it is stated that the function of the flapping of the wings of a bird is to fly it is simply implied that the actual outcome of flapping has the effect that the bird flies. This statement does not imply that the bird has necessarily evolved the function of flapping and the associated wings in order to fly, viz., flapping was not necessarily caused by a need to fly. Similarly, when it is stated that a function of the contraction of the heart muscles is to pump blood, it is not implied that the heart muscles contract in order to pump the blood. It simply means that an effect or outcome of the contraction of the heart muscles is that the blood gets pumped

through the body. Thus, a functional ascription, or perspective, does not necessarily imply a teleological ascription.

A functional view can mask other roles that a process or structure might have. For example, if one states that the function of the kidney is to cleanse blood, other important roles, such regulating concentration of substances in the body, regulating water balance, activating Vitamin D, controlling blood pressure and red blood cell production, might be overlooked. Different functions may be associated with the same process or structure, which is referred to as multi-functionality, or different processes or structures may be associated with the same function. Of course, the association is always subject to the focus of the observer and thus, depending on the context, the observer may focus on the one or the other outcome. For example, in the context of a working environment a person may be said to have the function of managing a department, whereas in the context of a family the same person may have the function of 'being a parent'.

The following generic functional distinctions can be identified in most biological and social systems (Járos, Belonje et al. 1988):

- **Input function (inputting)**: actions contributing to the movement of mei from the outer to the inner environment of a system (e.g. eating, acquisition of goods).
- **Output function (outputting)**: actions contributing to the movement of mei from the inner to the outer environment of a system (e.g. waste disposal, selling of goods).
- **Transportation function (transporting)**: actions contributing to the movement of mei in space (e.g. blood circulation, distribution of goods and information).
- **Storage function (storing)**: actions contributing to the storage/accumulation of mei, over a period of time, in an area in space (e.g. storage of information in a computer, or memory in the body, storage of goods, storage of fat in the body).
- **Transformation function (transforming)**: actions contributing to changing the structure of mei in a system (e.g. growth of a system, i.e. enlargement in size, psychological growth, assembling a product, rewriting an existing policy).
- **Structural integrity function**: actions contributing to the maintenance of stable spatial relationships between the entities and processes of a system, i.e. their configuration (e.g. support provided by the human skeleton, a chair, a building, an organisational matrix).
- **Governance function (governing)**: actions contributing to regulation, co-ordination, planning, decision-making in a process (e.g. the nucleus in the cell, the central nervous system in the body, all managerial processes, governing by government).

4.8.2 Notes on related viewpoints

- Miller's LST in a sense equates the concept of process with that of function. It analyses 20 subsystems, each of which is associated with a particular process (i.e. 'function'). These sub-

system distinctions are analogous to the functional distinctions of the biomatrix, except that it is a much more comprehensive list and based on a distinction between processes associated with matter-energy and those associated only with information (Miller 1978; Bailey 1993).

- Ackoff and Emery rejected the cybernetic definitions of teleology in favour of the *directive correlation* developed by Sommerhoff, based on the principles of set theory (Britton and McCallion 1994). A further distinction is made between *extrinsic* and *intrinsic* functions. In this framework a function essentially refers to a particular 'production' of objects or events associated with a particular structure or event. In addition different structures may be associated with a particular function and a particular structure may be associated with different functions (i.e. multi-functionality) (Gharajedaghi 1985, p.9). This is not unlike the definition of the biomatrix model.
- The biomatrix definition of a function could be considered as a type of normative functional analysis in which "the term 'function' is intended to provide some type of normative explanation of the causal process or object which is being described" and "for identifying particular effects of causal systems" (Christensen 1996, p.305). Christensen, on the other hand, uses the term function "in the highly general sense of an input-output map: $F = I \rightarrow O$ " and his analysis is referred to as "analytical functional analysis" (Christensen 1996, p.304).

4.9 Goal

A goal refers to a specific preferred-end-state which has not yet been realised.

4.9.1 Introduction

In the biomatrix approach, goals belong to the teleos class of concepts. A goal is a projection in time of a possible future outcome, or the maintenance of an already attained state. Being goal-related is a property of a system derived from the organisation of its parts. The goal is specified in terms of a series of variables. If the variables reach the specified state, it can be said that the goal has been reached. The goal may be quantified in terms of the outcomes and values of the relevant system variables (i.e. the preferred values), or may be expressed in qualitative terms, for example, reaching a specified level of fitness, aiming for a certain level of literacy in society, or spending 'quality time' at home with the family. A city may act as an attractor in the migration process. Thus the migration of people, whose goal (i.e. to reach the city), contributes to the urbanisation process. Systems do not always attain their goals. However, a goal always serves as an attractor directing a process towards a particular outcome, and even though it may never be attained its effect on the process can be considerable.

There are general conditions for goal-relatedness (Nagel 1979), irrespective of whether the goal is pursued by human agents, living systems incapable of intentions, or by inanimate systems:

- Goal related processes exhibit **plasticity**: i.e. the goal of such processes can generally be reached by the system following alternate paths or starting from different initial conditions (Nagel 1979).
- These processes also exhibit **persistence**: i.e. the system is maintained in its goal-relatedness by compensatory changes in the system in case of disturbances taking place (either within or external to the system). If these disturbances were not compensated for they would prevent the realisation of the goal (Nagel 1979).
- A state which is 'pursued' with plasticity and persistence over time, is identified as a **preferred-state**, and is referred to as the goal.
- In a dynamically regulated system, the present state of the system is continuously compared with its goal, which acts as a reference level for the desired end-state. Generally there is a time scale associated with a goal, which refers to the anticipated period of completion of the out-come. The time allowed to achieve the desired end-state must always be longer than the inherent *time constant* (i.e. the minimum time required to achieve the goal by virtue of the inherent properties of the system and the context) of the process (Gupta and Hasdorff 1970),

otherwise it would be impossible from the outset to achieve the goal within the intended time limit. If a process is repetitive, the goal is continuously reinstated as a future reference level (although it may be updated). A repetitive process may have a short time constant, together with a short term goal, in which instance the goal may virtually be achieved on a moment to moment basis. For example, body temperature and blood sugar levels are homeostatically regulated and maintained.

The following distinctions pertaining to a goal can be made:

- **Projected goal:** a goal which is projected onto the system (not necessarily intended). For instance, production targets may be projected by management on the production process.
- **Abstracted (observed) goal:** identified when the observed state of a system repeatedly and persistently appears to be attracted towards a particular (preferred) state in the presence of different prevailing conditions. An abstracted goal may be intended within a system or it may unintentionally emerge from within the system. For example, the lowest point of a bowl is observed to act as an attractor for a ball running down its sides. Similarly behavioural patterns of animals and human being may be observed and conclusions drawn about the apparent goals.
- **Intended goal:** a conscious expression or formulation pertaining to a desired future state of a system. It relates to the projection of a pre-determined intent which explicitly or knowingly predetermines desired outcome. Intended goals exist only in association with conscious sentient systems in which the observer can identify intent. All intended goal statements should ideally be formulated in a way which does not refer to the specific process, function or other means whereby a goal will be achieved. This is especially important during the design process, since it lends flexibility in the choice of associated actions and structures. A prematurely specified process generally removes creativity from the solution. For instance, one may specify the safe transport of individuals from one point to the next as a goal, without stating how it is to come about.
- **Emergent goal:** emerging out of the dynamic interaction of a system, and manifesting itself as a preferred-state over time. Emergent goals are always abstracted from a system by the observer. It refers to a retrospective interpretation of actual outcomes, giving rise to predicted future outcomes. The recognition of an emergent goal is based on an interpretation of previously occurring preferred outcomes. For example, preferred patterns in nature and unintended preferred patterns of human behaviour may be identified and associated with emergent goals.

The distinction between an intended and emergent goal is an important one that is often neglected in systems theories. It can be illustrated by the Ethos (**E**) - Teleos (**T**) - Process (**P**) - Structure (**S**) diagram (see Figure 45, page 100). An intended goal generally originates in the ethos (**E**) quadrant and evolves clockwise, whereas an emergent goal originates in the process (**P**) or structure (**S**)

quadrant and evolves in an anti-clockwise direction. Like many other distinctions in the biomatrix, there is a fuzzy overlap between intended and emergent goals. This is primarily due to the subjective nature of the process of observation, and limitations in our understanding of, or access to, the 'real' situation, or the 'truth'.

The concept of a "final-cause" relates to intended goals (Nagel 1979). Where the goal is intended and projected onto the system, and is governed accordingly, it pre-determines its outcome. When it emerges, it is not governed through intent, is 'free' to change in the future, and is not associated with a final cause, for example, Creationism posits an intended goal and Darwinism an emergent goal.

It is necessary to distinguish between the system under observation and the observer. What appears to be an emergent goal for the observer may in fact be an intended goal for the system and vice versa. For example, a pattern of behaviour that is observed in a family may either be the result of intent on the part of the family or may actually emerge as an unconscious pattern within it. On the other hand, as humans we sometimes tend to project intent onto the naturo-sphere (i.e. anthropomorphism), where there may be no intent but only an emergence of preferred outcomes.

Apart from the distinction between intended, emergent, projected and abstracted goals, other distinctions can also be made. This depends largely on the observer, the system under observation and the intent of the exercise. In some instances the system observes itself in which case the observer and the system are the same thing, for example, an individual or business organisation reflecting on persistent patterns in the past, or future goals pertaining to itself. The following additional distinctions between goals may prove to be useful:

- **Explicit** (stated or formulated) and **implicit** (not expressed or stated).
- **Extrinsic** (originating from outside the system) and **intrinsic** (originating from within the system).

4.9.2 Notes on related viewpoints

- According to Miller's LST, living systems act in accordance with *purposes* and *goals* that are derived from its *template* and modified by learning. Purposes are *preferred internal steady state values*; goals are *preferred external states or relationships*. For instance, "an amoeba has the purpose of maintaining adequate energy levels, and therefore it has the goal of ingesting a bacterium" (Miller 1978, p.39).
- In the words of von Bertalanffy: "you cannot conceive of a living organism, not to speak of behavior and human society, without taking into account what variously and rather loosely is called adaptiveness, purposiveness, goal-seeking and the like" (von Bertalanffy 1968, p.45). He defines *equifinality* as "the tendency towards a characteristic final state from different initial states and in different ways, based upon dynamic interaction in an open system attain-

ing a steady state" and the concept of feedback as "the homeostatic maintenance of a characteristic state or the seeking of a goal, based upon circular causal chains and mechanisms monitoring back information on deviations from the state to be maintained or the goal to be reached" (von Bertalanffy 1968, p.46).

- Ackoff views a *goal* as an intermediate intended outcome that is attainable under the prevailing conditions. An *objective* is a long-range intended outcome, which is a desired outcome that is not attainable in the time period being considered, but attainable at a later time, with progress towards it in the period concerned. An *ideal* is an ultimate intended outcome that can never be attained but can be approached and approximated within limits. Although an ideal can never be attained it is still meaningful to define its pursuit (Ackoff and Emery 1972).

4.10 Purpose

A purpose is the meaningful contextualisation of teleos, relative to the ethos of the observer.

4.10.1 Introduction

A purpose ascription provides a meaningful explanation or reason as to why a process or entity performs a particular function or pursues a particular goal. It focuses on the context of a particular entity, process or system, and explores the meaningful interaction or coupling of a system with other systems in the web, i.e. the biomatrix. A purpose is always ascribed relative to the ethos of the observer and in the context of other systems (i.e. both the inner as well as outer environment of the system under focus). It essentially answers the question why a particular function is performed as seen against the background of an inner and outer context. It is related to the "final cause" found in Aristotle's writings and as such answers the question: "for the sake of which ?" (Barnes 1982, p.54).

Notes on purpose:

- Based on the pattern of interaction, it highlights, interprets or intends a continuity, or 'flow' of teleos within the biomatrix.
- It is a subjective interpretation and meaningful explanation, relative to the ethos of the observer.
- It can either be intended and projected on, or abstracted and interpreted from, a system.
- The existence of the system under observation is considered to be subservient to its ascribed purpose.
- The concept of purpose is considered to belong to the teleos class of concepts in the biomatrix.

Examples of purposeful ascriptions:

- The purpose of the sun could be interpreted as the provision of energy and light to planet earth, or to serve as a god for the ancient Egyptians.
- The purpose of a river could be interpreted as the circulation of water and the provision of an environment for organisms, or as an area for human recreation, or as a means to navigate.
- The purpose of trees could be the creation of an aesthetically pleasing and shady environment for human beings (i.e. intended and projected), or a source of oxygen (abstracted and interpreted).
- The purpose of the heart could be interpreted as: to pump and circulate blood throughout the body, or as the seat of the mind for the Buddhist.

- The purpose of a chair could be to provide comfortable seating and to be aesthetically pleasing for the user, or as a means to match the height of hands to a working surface.
- The purpose of the process of eating could be to feed my body and soul, to socialise with friends, or to settle a business deal.
- The purpose of an individual's life process (intended or abstracted) could be to serve himself/herself and his/her fellow beings, or as a service to God.
- The purpose of a business company could be to serve its employees, its shareholders and the larger community in which it participates.
- The purpose of government may be to govern society in a way that is beneficial to the individual, the group and the environment, or as a means to gain and hold power.

4.10.2 Perspectives on purpose

Purposeful ascriptions are primarily guided by the following perspectives:

- an ethos perspective (albeit implicit).
- a teleos perspective: i.e. an intended or abstracted *continuity of teleos* between interacting systems.

For example, the purpose (i.e. intended) of the *education process* (i.e. the system under observation) could be to *transfer and integrate knowledge* (i.e. functions), in order to deliver *productive* (i.e. a goal), and *self-actualised* (i.e. a goal) *individuals* (i.e. coupling of the education process with individuals as systems) in *society* (i.e. coupling of the education process with society as a system), by providing the individual with an opportunity for *self-actualisation* (i.e. a function).

This interpretation is seen against the background of a particular ethos as held by the observer. The education process may, however, also be interpreted as a means to endorse a particular ideology in society, which, of course, pertains to a different ethos and gives rise to a different purpose.

4.10.3 Notes on related viewpoints

- According to Ackoff and Gharajedaghi "purpose" is a matter of *choice*: "An entity is purposeful if it can produce (1) the same functionally defined outcome in different ways in the same environment , and (2) functionally different outcomes in the same and different environments. Although the ability to make choices is necessary for purposefulness, it is not sufficient. An entity that can behave differently but produce only one outcome in any one set of different environments is goal-seeking, not purposeful. Servo-mechanisms are goal-seeking. In contrast, people are obviously purposeful systems, and so are certain types of social groups." (Ackoff and Gharajedaghi 1996, p.13). They go further and distinguish between: *deterministic systems* in which neither the parts nor the whole are purposeful, *animated systems* in which the whole is purposeful but not the parts and *social systems* in which both the parts and the whole are

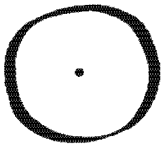
purposeful (Ackoff and Gharajedaghi 1996). The concept of "purpose" as described by these authors is more closely related to the concept of intent or *intended organisation* (i.e. governance) in the biomatrix model.

- According to Miller's Living Systems Theory, living systems act in accordance with *purposes* and *goals* that are derived from their *template* and modified by learning. Purposes are *preferred internal steady state values*; goals are *preferred external states or relationships*. For instance, "an amoeba has the purpose of maintaining adequate energy levels, and therefore it has the goal of ingesting a bacterium" (Miller 1978, p.39). Underlying these purposes and goals is a *hierarchy of values* that permits the system to establish decision rules. These rules come into play when needs of the system are in conflict, that is, when the system is unable to act to fulfil all its requirements simultaneously or immediately.

4.11 Ethos

Ethos refers to the field of organisational principles guiding a system.

4.11.1 Introduction



Ethos serves as a reference for what is considered to be 'right' or 'wrong', 'good' or 'bad', 'important' or 'not important' and 'desirable' or 'not desirable' for the system in relation to itself, to its inner environment and to its outer environment. Ethos is manifested in different ways on the different levels of the biomatrix:

- **Physico-chemical:** 'laws' of nature relative to aspects that support congruent states and dynamic equilibrium within a system.
- **Biological sphere:** mutually evolved organisational principles relative to a congruent co-existence and co-emergence of organisms.
- **Psycho-social:** aesthetics, ethics, value systems, systems of justice, systems of belief, ideologies, morals and attitudes.

Ethos, as a field of principles, represents the contextualisation of different possible dynamic states of a system and serves as a reference for the prioritisation of these states. Such a field generally contains clusters of principles organised in a hierarchical order of priority and importance, which always evolve relative to others and are placed in the context of the system itself, its inner environment and its outer environment. The organisational principles associated with the concept of ethos are considered to exist primarily as a field in the spatial domain (see Figure 44: The generic systems aspects in the context of a double distinction of spatial vis-à-vis temporal and physical vis-à-vis conceptual, p.94).

The field of ethos impacts on all the generic aspects of a system. However, the main influence of the field of ethos will be on the teleos of the system (**E→T**) as it generally serves as a standard according to which possible outcomes are evaluated and ultimately selected. For example, the ideals, visions and goals of an individual are greatly influenced by his values. In addition, however, ethos has an impact on the other generic aspects as well (**E→P** and **E→S**). Once a goal has been identified, it has to be implemented in the form of processes and structures, which must also be done according to the dictates of the ethos. For example, an individual may have set the goal of obtaining a safe home environment for her family, since she values the family as a social and personal institution (i.e. **E→T**). Furthermore, ethos will influence the process of obtaining a house, e.g. through honest or dishonest means (i.e. **E→P**) and actually building a home that conforms to some aesthetic norms (i.e. **E→S**).

Two principles which may be antagonistic to each other on a particular level of organisation, can be reconciled in the context of a higher level principle. For example, shareholders in a company may stand firm on their right of getting a return on their investments, whereas employees may insist on their right to increased wages, without either of them giving way. This apparent deadlock may be transcended by judging the demands against the higher level principles of social responsibility and the free-market principles of capitalism. These, in turn may be seen as being transcended by the principles of 'brotherhood' or by what may be considered to be 'just' towards fellow citizens of the state. In the case of an apparent contradiction in the law, it is resolved relative to the higher level principles as contained in the bill of rights (if these exist). In the case of the psycho-social sphere the field of ethos is largely subjective, although, in a coherent society there may be a wide-ranging inter-subjective agreement on many issues.

The concept of wisdom is closely related to that of ethos, that is to say without an operationalised ethos we can not be wise or act 'wisely'. Strijbos identifies the three components of wisdom as follows: correct insight into the situation, correct insight into what needs to be done, and finally, the appropriate action (Strijbos 1995). He warns that we should be alert to the risk that we mould our ethics into the dominating scientific-technological framework. As far as the relationship between wisdom and intuition is concerned he argues that "behind intuition lies the wisdom of the heart. The wisdom of the heart forms the deepest stratum of being human and gives direction to the whole of human existence, and thus also to intuition, which it guides and nourishes" (Strijbos 1997, p.452).

The principle of balance between the exo-, centro- and endo-fields of a doublet, postulated in the body of this thesis, resides in the domain of ethos. It is considered to be a fundamental principle that holds true for all levels of organisation and all spheres of being. However, different criteria will come into play when these aspects are considered in the various spheres of being. In the naturo-sphere these criteria will be seen as having essentially evolved as part of the process of evolution and thus as well established through millions of years of interaction and 'experimentation' between different principles of organisation. However, in the socio-sphere these criteria are often of a subjective and experimental nature. If the subjective components of ethos are not recognised as such the field of ethos may become rigid and not open to revision. In this case ethos might become dogma. One of the greatest challenges of the next century will be the evolution and establishment of a sustainable ethos on the planet as a whole.

Some examples of ethos at different levels of organisation are:

- On the atomic level the principle of attraction and repulsion between particles, and symmetry in sub-atomic particles, give rise to evermore complex structures of a certain kind. The universe is apparently 'valuing' an increase in a select type of order.

- On the cellular level the genetic code contains guiding principles for the interaction between, and prioritisation of, intra- and inter-cellular processes.
- On the level of the organism the autonomic nervous system of an individual contains a set of pre-programmed rules which pertains to its organisation as an integrated whole (i.e. relative to its inner and outer environment).
- On the level of the individual person a set of values can be recognised, e.g. being selfless as opposed to being selfish.
- On the level of the business organisation, an organisational ethics can be recognised, e.g. competitiveness as an important principle in its organisation.
- On the societal level a Bill of rights and Constitution represent the ethos of the nation state.

4.11.2 Notes on related viewpoints

- Miller defines a system's *values* as the totality of the *strains* within a system. The *hierarchy of values* represents the relative *urgency* of reducing each strain. "There is a range of stability for each of numerous variables in all living systems. It is that range within which the state of correction of deviations is minimal or zero, and beyond which correction occurs. An input or output of either matter-energy or information which, by lack or excess of some characteristic, forces the variables beyond the range of stability, constitutes stress and produces strain (or strains) within the system" (Miller 1978, p.34).
- Giddens refers to "virtual rules" embodied in the process of "structuration" in society (Mingers 1996, p.476). In the context of the biomatrix model this may be viewed as the societal ethos.
- 'Ethics' may be viewed as the highest level of abstraction within the concept of ethos: "...what ethics does is to set up the culture of dialogue between the organization and its various stakeholders. ... The effectiveness of the organization would be reflected in the way the organization copes with the varied objectives and synthesizes all these values" (Ramakrishnan 1995, p.311).
- Munro argues that "it is only in terms of a particular practice and its associated telos that the value of that practice can be properly understood" (Munro 1995, p.268). He also suggests that "although the soft and critical approaches can enrich our understanding of the human condition through democratic struggle, at present this remains founded on an impoverished understanding of value". Furthermore: ".. analysis of purposeful systems is somewhat neglectful of the historical and material conditions through which people come to value particular purposes and way of living" (Munro 1997, p.579). Finally, "systems methodologies must be reframed to ask questions about those aspects of the system (rules, activities) which have a value in and of themselves, emerging from a way of life, its narrative unity and its telos" (Munro 1997, p.580).

- Hall, in his *values-based relational systems approach* to organisational development suggests that "values are ideals that give significance to our lives through the priorities we live by" (Hall 1995, p.37).
- Banathy argues "our third order of business is to restore the system's accountability for the 'bigger scheme of things'. In precognitive, one-dimensional systems, this is not an issue. The systems either successfully negotiate a meaningful basis for participation or become extinct. In postcognitive, multidimensional systems, we can use power or competence in one dimension to subsidize lack of efficacy in the others. While such an arrangement may be acceptable, we need to make explicit provisions for the resolution of conflict between the multidimensions. We need to provide explicitly for the ethical dimension" (Banathy 1997, p.82).
- Singer et al argue for the incorporation of social and ethical concerns into traditional operations research (OR) techniques and game theory (GT). They claim that elementary forms of decision analysis can readily be augmented, using ethical theory, in ways that include ethical issues (Singer and Singer 1997).
- Minati proposes a list of practical rules for companies in a process named *ethical quality measurement* (Minati 1995).
- Kant's aesthetics is interpreted by van Gigch as follows:

  "A definition of what is 'good' can originate in a framework which uses the hierarchy of inquiring systems. It incorporates meta-ethics, normative ethics and morality as follows:

  (1) The inquiring system at the metalevel is concerned with *meta-ethics* where the definition of values is made. This inquiring system is also concerned with the cognitive functions involved in producing ethical judgements.

  Example: An action is 'good' if it never causes any physical or emotional harm to an individual and if it never causes the individual to be deprived of his or her rights (we assume that 'rights' are socially bound).

  (2) The inquiring system at the object level is concerned with *normative ethics* where norms are set. A 'norm' is a standard which is used for comparison purposes. At this level, laws and rules and procedures which will be used at the lower inquiring level are set.

  Example: The action of battering a spouse causes physical and emotional harm and therefore is considered 'bad'.

  (3) The inquiring system at the lower level is concerned with morality, i.e. the determination whether a certain action or a certain behavior deviates from the norm established by the inquiring system at the normative ethics level.

  Example: Given the standard of behavior for a spouse which was established earlier, the *actual behavior* of a particular individual can now be judged to be ethical or not" (van Gigch 1997, p.41).

For Kant an *aesthetic* judgement is to be contrasted to a *logical* judgement. Furthermore, the cognitive state upon which the aesthetic judgement is based relies on the harmonious play between *imagination* and *understanding*; and the harmonious state between the two is revealed by *feeling* (van Gigch 1997).

4.12 Congruency

Systems, processes and structures are said to be congruent if they are in harmony, are mutually supportive or are in agreement, relative to their ethos, teleos, process, structure, substance or dynamic organisation.

4.12.1 Introduction

Systems, processes and structures interact with one another by the very nature of their openness. The concept of congruency refers to a harmonious or mutually supportive interaction between the two or more systems, relative to particular aspects of the systems. The concept of congruency in the biomatrix was originally inspired by its use by Edwards (Edwards 1996). Interaction between systems may be beneficial to all participating systems, useful to only one of them (as is the case for a parasite) or detrimental to all of them (as is the case for most instances of war). Thus, systems are not necessarily congruent in all respects, although they may exhibit congruency in one or more aspects. Systems may only share a common ethos, for example two business organisations may have the same value of serving the interests of the community and the shareholder, but they may have completely different goals, functions and structures. These two systems are thus congruent in their ethos. Alternatively systems may share a common goal (e.g. motor cars travelling towards a common destination), but have different values (e.g. cautious versus reckless driving), utilise different processes (e.g. automatic versus manual driving; continuous versus interrupted driving), and different structures (e.g. different model motor cars).

Congruency is not always a necessary requirement, and may in some instances even be disadvantageous within a particular context. Incongruency may, for instance, create a favourable environment for creativity, innovation and evolutionary advancement. It should be noted that congruency and incongruency are relative to the perspective and focus of the observer. Two nations at war may be considered to be incongruent from a survival and quality of life perspective but may in fact exhibit a congruency in terms of their respective weapons industries and advancement-of-technology processes.

4.12.2 Perspectives on congruency

Congruency or incongruency may be viewed relative to the generic systems aspects. These aspects are interrelated and hence the distinctions may often overlap.

- **Ethos**: A congruency of ethos implies an agreement in principle. For example, members of a society may be congruent relative to a mutual respect for life, held by its individuals. Two

institutions may be incongruent, e.g. an organisation which makes a profit at all cost, as opposed to an environmentally responsible organisation.

- **Teleos:** In the teleos domain, systems may be viewed as having mutually supportive 'ends'. For example, the process of *getting rid of waste products* is considered to be congruent with *collecting waste products for re-use*. *Maintaining a healthy diet*, on the other hand, may be incongruent with *a craving for sweets*.
- **Process:** A congruency relative to process may be viewed as a synchronous interaction between the respective processes, for example, providing a friend with assistance when it is actually needed. An example of incongruency would be 'meddling' in a process when it is not considered to be appropriate, for instance, watering or fertilising a plant when it should be allowed to rest (i.e. hibernate).
- **Structure**: Congruency relative to structure is seen as a fit in both a spatial (i.e. configuration) and temporal (i.e. action-pattern) sense, for example, engine parts fitting together or a mutually supportive organisational structure. In terms of action-patterns two individuals in an organisation may make an excellent team, because of the way they go about things. An example of incongruency would be a genetically incompatible organ transplant.
- **Substance**: Congruency relative to the substance may be seen as having the 'right mix' of mei. For example, it is a congruent use of water to extinguish a forest fire but perhaps not in cases of a chemical or electrical origin. Nutritious substances are considered to be congruent with the organism, whereas a poisonous substance is incongruent.
- **Dynamic organisation:** Two institutions or individuals are said to be congruent relative to their dynamic organisation if they share a common strategy. On the other hand, an autocratic management style imposed on a creative independent personality type may result in an incongruency between the manager and worker.

4.12.3 Notes on related viewpoints

- Maturana and Varela view *structural coupling* as a mutual relationship or correspondence between the structure of a unity and the structure of its environment (including other entities within the environment). This occurs when a unity undergoes recurrent interactions within its environment whilst maintaining its identity and therefore its organisation (Maturana and Varela 1992).
- Hall developed a values-based relational systems approach to organisational development named the "Holographic Organization" in which an organisation "is *holographic* to the degree to which it is operating on a healthy and congruent set of values that all employees hold minimally in common" (Hall 1995, p.35).

4.13 Continuity

Continuity refers to a congruent coupling, or interaction between a series of actions and structures, over a period of time and in space.

4.13.1 Introduction

In the biomatrix, actions are considered be continuous in both space and time, viz., to have an uninterrupted or congruent extension of action-segments in space as well as an uninterrupted or congruent extension of the phases over time. In other words, appropriate actions must be executed at the right time and place, with consideration of the requirements of the generic systems aspects: i.e. ethos, teleos, process, structure, substance, dynamic organisation.

For example, a message travelling along a communication network implies that there is a continuity of information content as well as of energy flow. The energy and the message carried by it are transformed from vibrations in the air (i.e. an auditory signal), to an electrical impulse in a wire or electro-magnetic wave in the air, and eventually back into an auditory signal again. However, there is not necessarily a continuity in teleos or ethos with respect to the interacting parties. For instance, there may be a continuity in the flow of information in a company, but no congruency relative to the teleos, i.e. a great deal of information is passed on, or flows within the organisation, but is not mutually beneficial to the respective parties. It may in fact even waste valuable time and resources.

A continuity of teleos in a particular action chain may also be referred to as a 'flow', or procession, of teleos along the chain. In reality the teleos of course does not flow, it is merely matched by a congruent teleos on the other side of the segment and so forth along the line. In a sense it is analogous to a travelling wave on the water, where the water does not actually flow in the direction of the propagation of the wave, but there is in actual fact a transfer of energy along that direction. Thus, the teleos, or ethos, may be matched on both sides, and in that sense, get 'passed on' or 'flow' along the chain of events. To talk about a procession of teleos, or ethos, is perhaps more correct.

4.13.2 Perspectives on continuity

Continuity may be viewed from a temporal or spatial perspective:

- **Temporal continuity**: congruency between the individual phases of an action-focused series as perceived over time.
- **Spatial continuity**: congruency between the individual segments of a thread-like action-focused series as perceived in space.

Continuity may also be viewed from the perspective of one or more of the generic systems aspects, i.e.:

- **Ethos**: e.g. workers on a production line sharing an ethos of 'doing their best' at all times.
- **Teleos**: e.g. a company aiming at providing a particular service, coupled to the customers in search of that particular service.
- **Process**: mutually supportive coupling of actions in the series of actions (or coupling of process). For example, the action of a crying baby, because it is hungry, should be met by the responsive action of feeding, rather than the action of soothing the baby with a loving touch. Similarly, the phases of the digestive tract exhibit a continuity, i.e. the one phase pursues the digesting and metabolising action from where the previous segment and phase left off.
- **Structure**: e.g. a matrix organisational structure can be continuous in the sense that it focuses on *throughput*, i.e. the segments and phases of production. The parts of a machine or 'parts' of a biological organism are also considered to be structurally continuous, for example, the various segments in the digestive tract of an organism.
- **Substance**: mutually supportive exchange of mei between the respective actions. For example, the substance of an advertising campaign (i.e. the product image) must match the substance of the production process (i.e. the actual product). In the case of an ecological food chain, production chain or information exchange there should be an uninterrupted and congruent flow of mei. For instance, in an ecological food chain the mei is considered to be continuous, since it couples and gets transformed from one organism to the next. The observer may not necessarily claim a continuity of teleos, though. For instance, we may not claim that the function or purpose of the plankton is to feed the whale. In the socio-sphere, however, it may be appropriate. For example, it is correct to state that the purpose of the cattle breeding process (and by implication of the cattle) is to feed the human consumer. In that context it is an appropriate observation, since it goes hand in hand with known human intent.
- **Dynamic organisation**: e.g. the conception, planning and implementation of the various phases of a project in an uninterrupted manner (both in time and in space).

Concluding remarks

This conludes Part 4 of the thesis. It explored a series of concepts in a linear and reductionistic manner, starting from what is considered to be the more fundamental concepts and culminating in the secondary concepts of the model. Some essential concepts of the biomatrix model were excluded, e.g. dynamic organisation and telentropy, however, these concepts are considered to have been analysed in sufficient depth in Part 3. The reader is referred to Appendix A for a complete list of definitions of all the essential concepts in the biomatrix model.

5. Part 5: A linear perspective on Teleons and Doublets

Part 5 deals with the two classes of systems in biomatrix theory, namely teleons and doublets, presented here as two chapters. Teleons and doublets comprise an integration of all the preceding concepts and as a result their subject matter is more extensive and is dealt with at much greater length. These two concepts are in a sense a culmination of all the concepts defined in the preceding part.

Metaphorically speaking the preceding concepts constitute the roots of the biomatrix theory, giving rise to its two main trunks, namely the concepts of the teleon and doublet respectively. The branches of the tree may be viewed as the multiple perspectives and distinctions to be drawn within the biomatrix by the observer. This conceptual tree or map holds the promise of throwing some light on, and bearing some fruit in our quest for greater insight and understanding of the world in which we participate. The structure of the two chapters are similar to that of the concepts dealt with in part 4, except that their format is much more elaborate.

The introduction of the teleon and the doublet in Part 3 of the thesis and their analysis here, invariably lead to some repetition. However, for the sake of completeness some sections were included, as a revisiting and summary of ideas. Those sections are intended to 're-open' ideas within a new context and thus presents the opportunity for new insights and greater depth of understanding. In this regard it should be noted that the thesis traces a spiral of recuring concepts and understanding is intended to arise by means of its "*internalization*" through a "*contemplative process of holistic meditation*" (Muller-Merbach 1994, p.24), accompanied by an "*emerging change of consciousness*" (Murthy 1994, p.463).

The sections addressing the *generic systems perspectives* on the teleon and doublet share the same structure and may at first glance appear to have a similar content. However, rigorously viewing both the teleon and doublet from all these perspectives serves to illustrate subtle, and in some instances profound, relationships in terms of their differences and similarities.

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5.1 The Teleon

This chapter analyses the teleon under the headings as listed below.

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5.1.1 Introduction

> A teleon is a process-based, thread-like-entity, extending in time and space in relation to a focalised teleos-field.

More specifically:

- A teleon comprises an integrated web of processes (in physical and /or conceptual space), dynamically and collectively organised towards, or "aimed at", a focalised teleos-field.
- The focalised teleos-field serves to cohere, integrate and demarcate its associated processes into a distinct entity.
- The integrated web of processes can be viewed as a teleos-based vector, or "arrow", in conceptual space.
- It originates within, and is associated with at least one doublet of origin.
- The teleon (and by implication its associated web of processes) interacts with, and connects at least two doublets (generally more).
- It manifests an apparent continuity of teleos across all participating doublets and their associated levels of organisation. This gives rise to a teleos-coupled chain of processes, extending both in space and time.

The biomatrix model postulates and assumes that the universe comprises a web of activities spanning all levels of a natural holarchy. The threads represent teleons (directed channels of activity or flux of mei) and the nodes stand for doublets (points in space where the threads interact and cohere into focalised-field-like-entities). This web, called the biomatrix, can be observed from various perspectives. A novel perspective introduced by the biomatrix approach is the teleonic or *teleonomic perspective* or simply *teleonics* (Cloete and Járos 1989; Járos and Cloete 1993; Járos, Dostal et al. 1993; Cloete and Járos 1994). Teleonics introduces the notion of extended thread-like systems (in the space-time continuum) into systems theory, i.e. a 'wave' or field perspective as opposed to a 'particle' perspective on being.

5.1.2 The thread-like entities

Recognising the systemic nature of the strings of mei flux in both time and space elevates these channels of mei flux to systems in their own right. This is in contrast to focusing on point-like-entities (i.e. discrete entities) and their respective interactions. In short, the focus is on the thread-like, flux-based nature of these systems in the space-time continuum, as opposed to the spatially focalised, or point-like systems (i.e. the knots in the web).

The thread-like nature of these channels of mei flux in space is essentially derived from a continuity, or congruent chain of teleos across levels of organisation. In other words from a teleos perspective these channels comprise a series of congruent segments and phases of activity. The thread-like chain of events thus couples in such a way that there is an apparent continuity of function, goal or purpose across the levels of organisation spanned by the thread-like system. Continuity in teleos may either be by design (i.e. intended) or may have emerged as such through the dynamic organisation of systems over time (i.e. the process of evolution).

These teleos-related, thread-like systems, spanning different levels of organisation, are referred to as teleons in the biomatrix model (Cloete and Járos 1989; Járos and Cloete 1990). The "tele-" prefix is derived from the Greek, meaning to reach or stretch far ahead in space and to be attracted towards a preferred end-state, whereas the "-on" suffix refers to the thread as an autonomous unit or system in its own right.

From a mathematical perspective teleons as systems are analogous to vectors in a vector field (Boas 1966), and the focalised-field-like systems (i.e. the doublets) are analogous to areas of densification and transformation in the field (of activity).

An essential difference between a process and a teleon is that a teleon makes explicit the ***extended continuity of teleos in space***, i.e. its thread-like nature. This spatial distinction is in addition to mere change over time or the consecutive phases of action (more conventionally associated with a process). A teleon is thus essentially a ***procession of processes in space***, which combine into a congruent chain or segments in space, complemented by its phases in time. This is in contrast to the concept of a process which is in general primarily associated with change over time. Change associated with a process may, and often does, happen at a focalised point in space. The spatial extension of a process is generally only implied in its interactions with other discrete entities over time and then only regarded as a secondary phenomenon. Admittedly, some processes are viewed as an extension in space, e.g. travelling from point A to point B. However, the emphasis is not necessarily placed on the continuity of teleos in space. Equating a process with a teleon may thus lead to confusion or misunderstanding. What may appear to be a subtle difference could result in major differences in the way a system is ultimately perceived and defined. The more subtle a distinction appears to our minds the greater the danger of unknowingly, and quite happily, going off on a different track. To prevent this from happening and to serve as a reminder of the necessary shift in our perception towards a thread-like, teleos-based systemic entity, it was deemed necessary to introduce the concept of a teleon. The distinction between a more conventional approach of focusing on interaction between entities vis-à-vis focusing on teleons in their own right is depicted in Figure 57.

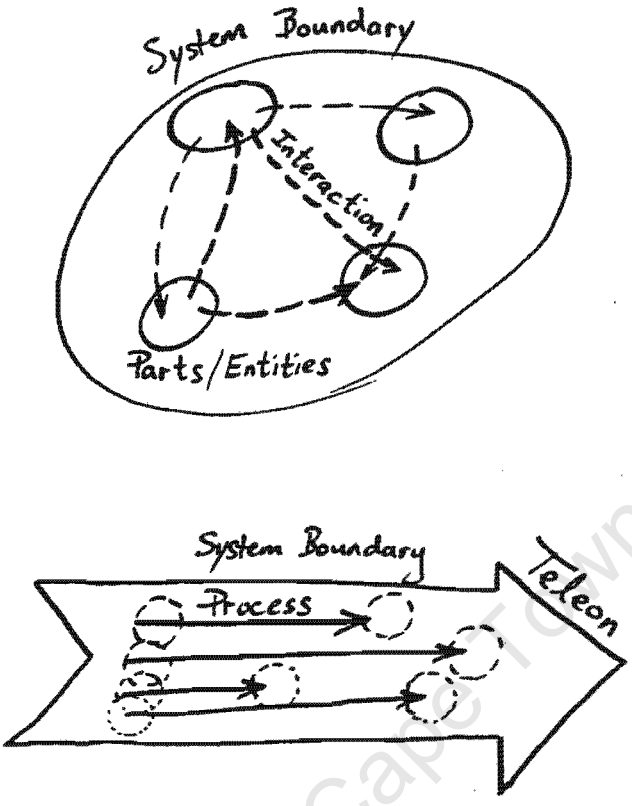

Figure 57: Focusing on interactions between entities vis-à-vis a focus on thread-like-processes

The physical boundaries of a teleon are diffuse in the sense that the individual processes which comprise the teleon are spread out as a network in physical space (without necessarily having clearly defined end-points). The boundaries of a teleon are in the first instance determined in conceptual space by its focalised teleos and is then projected onto its associated processes in physical space. In other words the boundaries are primarily defined in the conceptual (i.e. information) domain and then projected onto the physical domain. This renders a rather diffuse web of processes, all contributing to a conceptually focalised and shared field of teleos. Depending on its level of contribution to the shared teleos, a process or sub-teleon may belong to a greater or lesser degree to the teleon under observation. It may also, at any given moment in time, belong to, or be associated with, more than one teleon.

The participating units of a teleon comprise both sub-teleons and doublets. In other words viewing the teleon from close up reveals an even finer web with its own knots (i.e. participating doublets) and threads (sub-teleons). What appears on one level of observation as a singular thread or teleon thus 'dissolves' into yet another web when 'teased out' with its own sub-teleons and participating doublets. This fractal interplay (Gleick 1987) within both teleons and doublets, as well as a

'zigzagging' (Keeney 1983; Bateson 1985) between teleons and doublets manifests on all levels of organisation in the holarchy of the biomatrix.

As stated before, the dual nature of being, viz. thread-like being as opposed to focalised-field-like being of systems, is considered to be analogous to the wave/particle duality in the physico-sphere (i.e. in particle physics) (Gribbin 1984). A teleon as a thread-like system is thus analogous to the wave-like being of reality. It should be noted that the transformation of a particle may be viewed as a process (e.g. changing from one elementary particle into another), but this perspective does not necessarily lead to the wave-perspective of being. It takes a qualitative shift in our perception and means of observation to observe the wave-like being of reality; *it requires more than simply focusing on process or change over time.* As an analogy it can be stated that focusing on the up-down process of movement of a cork (i.e. an entity) in a pond (i.e. an environment), is qualitatively different from focusing on the *associated wave pattern as a web of process-threads* (see Figure 58). One may take the analogy a step further and investigate the interference pattern between waves associated with different objects or entities. The *interference pattern* is possibly an even better analogy for the concept of a teleon, or more correctly *a web of teleons* in the biomatrix. Thus, focusing on process or having a 'process-based' approach of systems does not necessarily and invariably lead to a thread-like and field-like perspective of being. The concept of process is common to both the wave and particle perspective and should not be confused with the concept of a wave (or analogously the teleon). It is envisaged that the concept of a teleon will introduce the reality of thread-like being complementary to point-like being into systems theory.

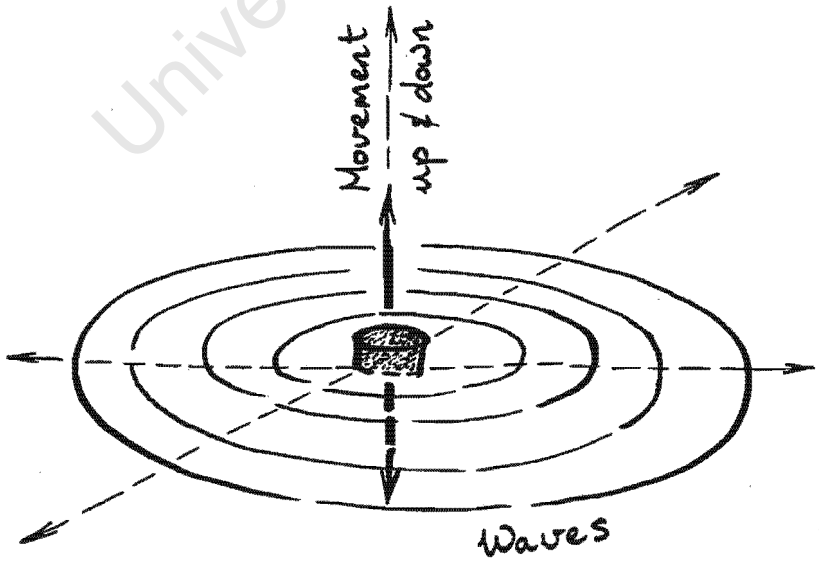

Figure 58: Waves associated with the up-down movement of a cork in a pond

The teleon as a system in its own right is inclusive of all the generic systems aspects: ethos, teleos, process (mei flux), structure, substance and dynamic organisation. The teleon is made up of a cluster of processes with participating doublets, which in their turn cluster into sub-teleons, collectively organised towards the focal teleos of the teleon. In other words the processes all contribute towards the collective teleos. The autonomy of the teleon essentially originates from its collective dynamic organisation towards a focalised field of teleos.

5.1.3 Teleons as fields of sub-teleons

All teleons which are considered by the observer to be participating in and contributing towards the focalised field of teleos under observation are considered to be sub-teleons of that field (i.e. of the teleon of focus). In other words, associated with the focalised teleos is a field of related teleoses (refer to the field-of-teleos concept), with their associated teleons (referred to as the sub-teleons). These teleons are all 'aimed' at the field surrounding the focalised point of teleos, i.e. the point of focus considered to represent the teleon under observation.

It is noteworthy that sub-teleons are not distinguished by their relative level of organisation, but rather by their relative position in the focalised field of teleos. A sub-teleon may either be one of many phases in the overall teleon (i.e. a serial sub-unit) or one of many parallel sub-teleons. The boundaries of the teleos field are not discrete but are of a fuzzy nature. Consequently, in fuzzy logic terminology, a specific sub-teleon is considered to participate to a greater or lesser extent in the teleon of focus. The degree of its membership is judged by the observer on the basis of its level of contribution to the teleon of focus. This is opposed to the more traditional classification of 'all or none'. Thus, the sub-teleons considered to comprise a particular teleon are distinguished by the degree to which they are considered to participate in the teleos-field, i.e. their conceptual closeness to the focal point of teleos. Furthermore, since there is an overlap of fields in the teleos space, a sub-teleon may belong to more than one teleon in the biomatrix.

For example, the production-teleon of a vehicle manufacturing plant may be considered to comprise the following sub-teleons: procurement of materials and resources, manufacturing of components, assembling of units, quality control, and management of the overall production process. Research and development may not be considered to be part of the production teleon in this instance, but where the product is of a one-off nature, and each product requires a new solution, it may be included as a sub-teleon in the production teleon.

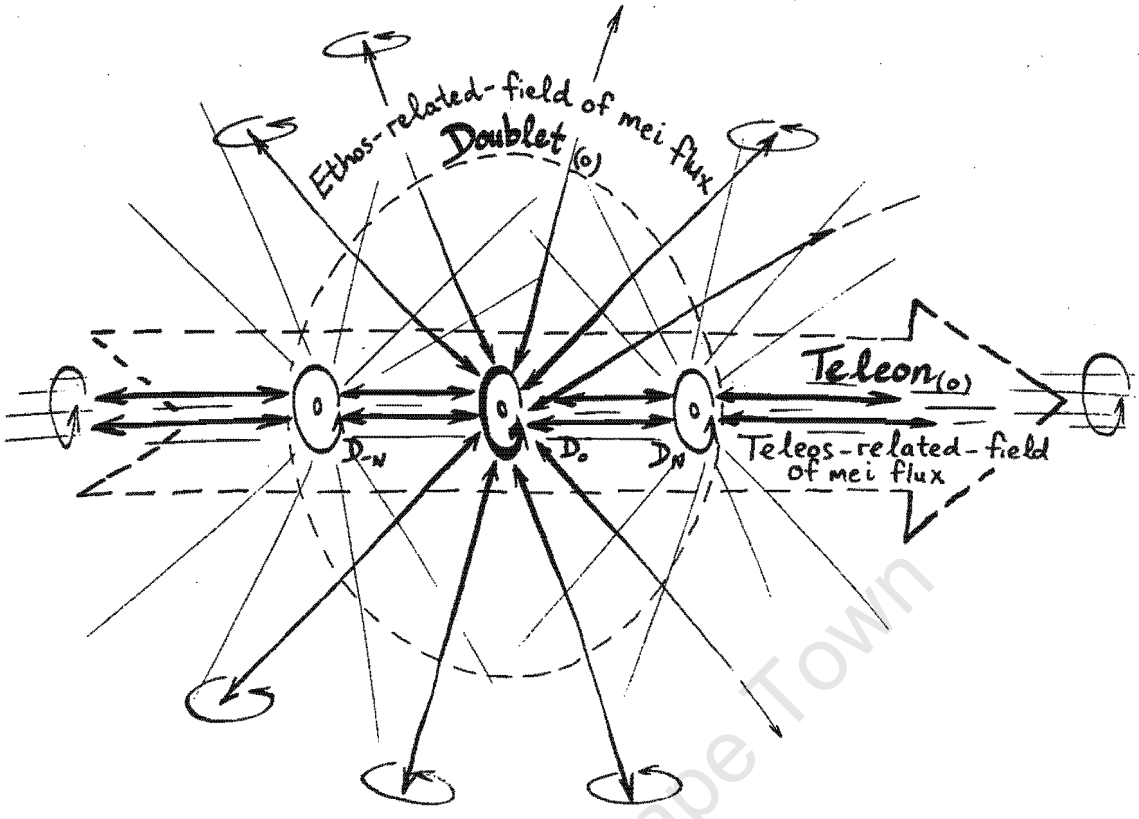

Figure 59: A complementary field-like perspective on reality: i.e. teleons and doublets

5.1.4 Teleons and Doublets: a complementary duality

The teleon and the doublet are analogous to the wave/particle duality in physics in constituting a complementary manifestation of being. These two modes of being co-create each other in a mutually interdependent way. This duality also bears similarity to the interdependence and "zigzag" interplay between "process" and "structure" as suggested by Bateson (Bateson 1985). It should be noted though that the teleon and the doublet both manifest aspects of process and structure, the difference being that a teleon manifests process and structure in a thread-like manner, with teleos-related-process-threads being the observer's point of departure, whereas a doublet manifests process and structure as a field-like-node as point of departure. The difference in these two perspectives is depicted in Figure 59.

However, the two modes of being do not exclude each other. From a causal perspective they are considered to co-create each other. Nodes of 'densification' in the field signify areas of interaction and transformation of teleons. This results in the emergence of doublets, albeit on other levels of organisation and abstraction. For example, the underlying flux and coupling of mei (i.e. teleons) on the sub-atomic level are considered to give rise to the atom as a persistent structure and entity in space (i.e. a doublet) (Capra 1976; Bohm 1980). Similarly, the interaction of teleons within a focalised area, with its associated mei such as people and goods, may give rise to the emergence of a company or city

as a focalised-field-like entity (i.e. a doublet). Conversely, it is also true that the interaction between individuals as doublets gives rise to teleons (e.g. a communication teleon between two people). Similarly, on a sub-atomic level the interaction between particles (i.e. doublets) emerges as force fields (i.e. teleons) (Feynman 1985).

5.1.5 Participating / co-acting doublets

All those doublets which are considered by the observer to be participating in the teleon under observation and by implication its sub-teleons, are considered to be participating, or co-acting doublets. Teleons typically connect different levels of organisation, and it is thus to be expected that the participating doublets will be on different levels of organisation in the biomatrix. If the teleon is directed outwards or upwards in the holarchy, it typically connects doublets on ever higher levels of organisation, whereas if it is directed inwards, the opposite is true. For example, the nutrition teleon is considered to originate within the societal doublet (e.g. agriculture), running all the way down through the farming doublets, processing and distribution companies, the family, the individual, eventually to enter the cellular doublet. The mei flux continues outside the cellular doublet, e.g. radiation of energy towards the environment and the excretion of waste products, in this way turning outwards again. Not all teleons necessarily comprise long chains of processes or sub-teleons. The 'shortest' teleon is when only two doublets co-act, that is, the doublet from which the teleon is considered to originate and the doublet at which the teleon is considered to be directed.

In some instances it may be useful to distinguish between the doublet of origin, the receiving doublet (i.e. at which the teleos is considered to be directed), and the intermediate doublet(s) (see Figure 60).

5.1.5.1 Doublet of origin

A teleon always originates within a particular doublet or in some instances a group of doublets. It never 'starts off' or originates in 'thin air'. This is because doublets serve as points of focus and transformation of mei in the biomatrix. Consequently, whenever a teleon comes about in the field of mei flux, it can be traced back to at least one of these focal points (i.e. a doublet). For example, in the naturo-sphere *functions* are generally associated with *doublets*, e.g. the *radiation of energy* can be traced back to a *particle*, or *respiration* to a *plant*. In the socio-sphere and psycho-sphere, teleons may be intended within a particular doublet(s) which is referred to as the doublet(s) of origin.

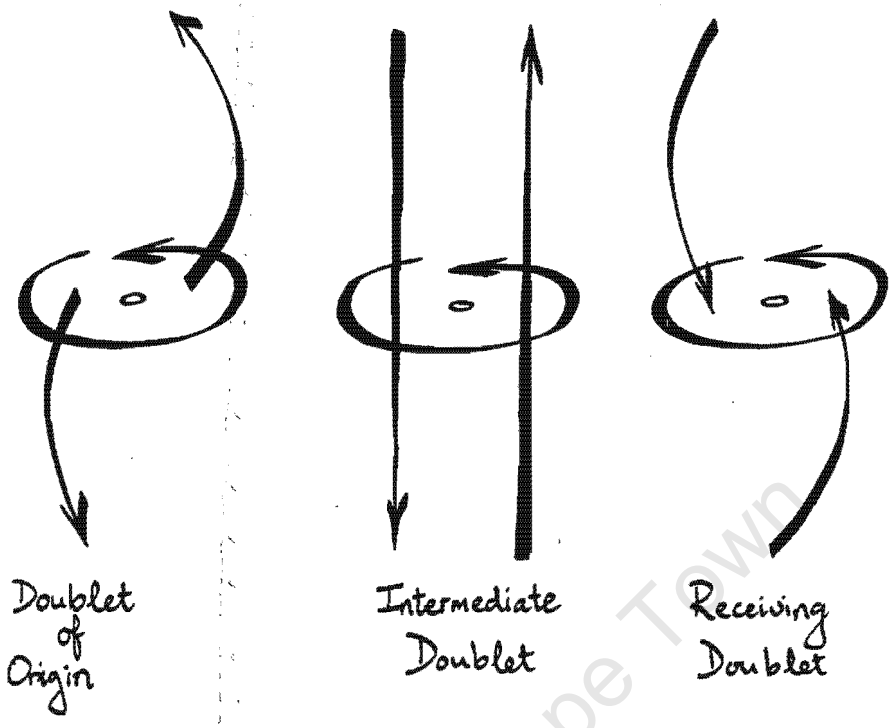

Figure 60: Receiving doublet, intermediate doublet and doublet of origin

5.1.5.2 Intermediate doublet(s)

The intermediate doublet(s) are all those doublet(s) participating in the main teleon, but which are not directly associated with the teleon's origin or aim. For example, the education teleon may be considered to originate within the education department (i.e. doublet of origin) and to be directed at the individual scholar (i.e. receiving doublet). The schools and teachers are therefore considered to be intermediate doublets. Depending on exactly which teleon is under focus, the classification of the doublet may change. For instance, if we were to focus on the teaching teleon, the teacher may be considered to be the doublet of origin.

5.1.5.3 Receiving doublet(s)

The receiving doublet(s) are those doublet(s) at which the teleos is considered to be directed, even if only in potential. The receiving doublet can actively engage with a teleon in its field; however, even if it does not actively tap into the teleon it still remains a receiving doublet because the teleon permeates its field. For instance, an individual can choose whether or not to tap into the education teleon in society, but at least she has the opportunity to do so. Thus the individual is considered to be a receiving doublet relative to the education teleon in society.

Admittedly the distinctions between the doublet of origin, intermediate doublets and receiving doublets is not always clear-cut, especially in the case of functional teleons (as discussed later).

5.1.6 Generic systems perspectives on the teleon

This section focuses on the generic systems perspectives relative to the teleon: i.e. ethos, teleos, process, structure, substance and dynamic organisation perspectives.

5.1.6.1 Ethos perspective

The ethos of a teleon is derived from its doublet of origin. In those instances where a chain of processes connects to form an extended teleon, the ethos may in fact change from the one segment to the next. In other words there is not necessarily a continuity of ethos between the segments of a teleon. The only aspect which is considered to be continuous in the teleon is its associated teleos. This continuity of teleos demarcates it as a distinct entity in teleos space, whereas a doublet is demarcated by its shared ethos. As we trace the mei flux along the segments of a teleon (i.e. its sub-teleons) the ethos may change, but there is always a congruent coupling of teleos. For example, the ethos of a marketing teleon is not necessarily congruent with the ethos of the purchasing teleon. However, in some instances it is quite possible that the customer and the producer may for ethical reasons, demand a congruency of ethos as well. For instance, a weapons manufacturer may decide only to sell its products to customers who share its ethos (more specifically its political and ideological beliefs). Similarly, a customer may demand that the producer share its ethos of ecological awareness.

5.1.6.2 Teleos perspective

This section focuses on the teleos aspect of a teleon. The teleos is considered to be the determining factor in the identification of a teleon as a distinct entity.

a. A hierarchy of teleos

A *hierarchy of teleos* may be distinguished with regard to the teleos associated with a teleon. A teleon may be associated with only one or a combination of different classes of teleos (e.g. function, goal, purpose). The hierarchy is inclusive, though, i.e. the more 'advanced' levels include the preceding classes of teleos. Whether a teleon is considered to belong to any one or a combination of these categories of teleos, is influenced by the perspective of the observer. The concepts of a functional teleon, goal-related teleon and purposeful teleon all exist on different levels of abstraction, but are related through the hierarchical nature of their respective associated teleoses.

a.i. Functional teleons

A teleon associated with a function is referred to as a functional teleon. This is considered to be the most elementary type of teleon from a teleos perspective. It focuses on a continuity between the

generic outcomes associated with the respective interacting processes or sub-teleons. A functional teleon is not necessarily associated with a particular goal or purpose. Hence it does not pertain to a specific end-state in terms of the system variables, and also does not contextualise the teleos in terms of their relative meaning (i.e. the purpose). In fact, the vast majority of teleons in the physico-sphere are of this type, as are some teleons in the bio-, psycho- and socio-spheres.

A few examples of functional teleons are: *evaporation* of water from the sea, *transportation* of the gaseous water in the clouds inland, *condensation* and *rain*, and water *flowing* back to the sea. All these couple in a functional sense, that is to say each process 'ensures' as part of its generic outcome the availability of mei (i.e. water in whatever state) for the next process in this chain of circulation of water on the planet. While this is considered a functional teleon, the description does not make any claims with regard to the respective goals and purposes of each process. For instance, the observer need not assume that the evaporation of water is regulated to match the needs of a particular mass of clouds inland (i.e. matching of goals), or that water is transported inland in the clouds in order to ensure rain over inland regions (i.e. a purpose).

A further example would be the *release* of oxygen as a result of *respiration in plants* (i.e. a generic outcome associated with that process) and the *uptake* of carbon dioxide in the same process, coupled with the *uptake* of oxygen and *release* of carbon dioxide associated with the process of *respiration in animals*. These two processes are considered to couple in a congruent manner from a functional perspective, and as such constitute a functional teleon. However, this does not make any claims regarding a specific goal or purpose associated with the teleon. In other words, plants are not considered to specifically regulate their process of respiration to match that of the animals, and vice versa. In both instances the regulation is considered to be aimed at their respective inner environments. Thus, from a functional perspective these processes happen to be continuous, and that is all the observer claims.

Similarly, I may dispose of my refuse by putting it out in front of my house with the intention that it will be collected by the waste disposal workers. However, parts of it may be collected by a scavenging process. These two processes are then considered to couple in terms of their respective functions, thereby giving rise to a functional teleon. My disposing of the waste, together with the scavenger removing it constitutes the functional teleon. Neither of these processes is regulated to match a mutual goal or purpose. Of course I may decide to intentionally take this into account, e.g. by sorting my refuse beforehand. In addition to the coupling of functions a congruency with regard to the respective goals and purposes may also arise.

a.ii. Goal-related teleons

A teleon associated with a goal is referred to as a goal related teleon. It means the outcome of the teleon is organised towards a preferred end-state which is described in terms of a set of specific values. It should be noted that the entire segment or cluster of sub-teleons is considered to support the goal. The goal generally comprises a focalised field of teleos (in this instance goals). Some sub-teleons may contribute more to the point of focus than others. Goal-related teleons are in general associated with an ensemble of functions, i.e. generally the goal is reached through the support of a cluster of functions. It may be considered that the goal is aimed in a certain direction in the holarchy, e.g. inwards or outwards. This perceived direction may be relative to the focus of the observer.

For example, in the naturo-sphere the concentration of gases in the atmosphere of the planet appears to be regulated within narrow boundaries (i.e. the emergent goals) (Lovelock 1979). This may be perceived as a goal-related teleon aimed at regulating the gas concentration in the atmosphere, with a myriad of supporting processes and functions, e.g. the absorption, transformation and release of atmospheric gases by organisms, complemented by non-biological chemical processes in the environment. Together these processes give rise to an emergent goal on a planetary scale. Depending on the viewpoint of the observer this goal can be seen to emerge from the interaction of the various processes or as the governed organisation originating from a higher level of organisation (Markos 1995). Whatever the case may be, the fact is there appears to be a definite goal associated with the gas levels on a planetary scale. This goal and all its associated processes may be viewed as a goal-related teleon.

A further example is the sales teleon of a company setting the goal of selling x amount of units per annum. It is thus viewed as a goal-related teleon of selling with its associated goal of selling x number of units by the end of the year. The associated sub-teleons are: marketing, manufacturing, distribution and so forth. These are all functions which ideally should share the focalised goal of selling x number of units. While these functions may have their own priorities and do not necessarily fully share the selling teleon's goal they do support it as a function or generic outcome. For instance, although the functional teleon of marketing is not necessarily aimed at specifically marketing the product towards selling x number of units, it does support the selling of the product in a generic sense.

Another example would be an individual establishing the goal of obtaining a particular qualification in x number of years. Let us call this the education teleon with a goal as mentioned. The functional teleons supporting this education teleon are typically: teaching, learning, reading, writing and so forth. These functional teleons may not all *share* the specific educational goal but they do support it. For instance, the teaching teleon may make the required resources and knowledge for learning available. The decision of what the student wishes to learn and when she wants to complete her goal may be flexible and left up to her. It does, however, support the chosen goal of the education teleon as chosen

by the student. Alternatively the teaching process may be much more rigid with uniform goals shared by all students, i.e. the goals as established by the teaching function are imposed on the respective education teleons of the students.

If the observer chooses to focus on a particular teleon, its goal becomes the point of focus. The supportive teleons are then viewed against the context of the field of teleos under focus. They may share the goal or may only support the goal in a functional sense. If the focus happens to shift to one of the sub-teleons, another field of teleos becomes the area of focus and the roles of goal-related teleon, sub-teleon and functional teleon may all shift relative to a different field of teleos. Teaching may be viewed as a functional sub-teleon of the goal-related education teleon as chosen by the student. By the same token, if viewed from the perspective of the teacher, education of the individual may be seen as a functional sub-teleon contributing to the goal-related teaching teleon. In the latter case the goal may be to achieve a particular pass rate in the group and education is a function in which the group participates.

a.iii. Purposeful teleons

Purposeful teleons are all those teleons which have an explicit purpose associated with them. It should be remembered that purpose is only associated with those teleons where there is a clearly identifiable intent. Purpose is generally associated with sentient systems or may be projected onto a non-sentient system by a sentient system. From a teleos perspective purposeful teleons are intentionally aimed in a specific direction in the holarchy. As is the case for the previous classes of teleos, purpose is also associated with a focalised field of teleos or more specifically, a focalised field of purpose. Furthermore, a singular function (or functional teleon) may be associated with multiple purposes (or purposeful teleons). Each purpose is associated with a particular teleon, although all purposes may share a single function. In those instances the respective purposeful teleons should be regulated according to their own individual purposes, even though they share the same function. In practice this would mean that the organisation of a functional teleon is done in such a way that it supports all the required purposes of its associated purposeful teleons.

For example, a purpose of the eating teleon (a functional teleon) may be to provide nutritious food to the cells or alternatively to share a sociable event with friends or both. In some instances it may also serve a sacred purpose. The eating function or functional teleon may thus be associated with multiple purposes and should be regulated accordingly. It is important that the observer recognises the existence of the separate purposeful teleons as systems in their own right although they all share and are supported by the eating teleon. Admittedly purposeful teleons exist on a different level of abstraction from functional teleons, but that certainly does not make them less real. This is an extremely important aspect of the field-like and teleos-based approach of the biomatrix. It acknowledges the existence of teleons as systems recognised by their dynamic organisation in the

teleos domain. The dynamic organisation of the teleon associated with social eating is certainly just as real as eating for nutritional purposes. The acute observer will notice that the organisation of the eating process is steered by different intended outcomes or purposes. Purpose manifests itself in a very real sense through the observed organisation of all the teleons and doublets of the eating process.

Confusing or not recognising the existence of functions, goals, or purposes may lead to ineffective or non-existent governance of the respective teleons. It is essentially in the domain of organisation of the mei flux that teleons are regulated, and therefore it is within this realm that their respective roles may be obscured. Ultimately we are faced with mei in flux; the challenge is to organise or govern it in such a way that the mei flux supports the particular functions, goals or purposes. This generally translates into an interdependent but not identical web of mei flux associated with each one of these levels of teleos, or classes of teleons. The challenge and art is to clearly separate these webs of mei flux associated with their respective fields of teleos, but at the same time to recognise their interdependence or areas of shared mei flux.

b. Spatial continuity of teleos (i.e. a series of segments)

The *continuity of teleos* across different processes in space and time is one of the primary characteristics of a teleon. Processes tend to cohere or couple relative to a congruent teleos. These process chains form extended segments in space, giving rise to a teleon spanning different levels of organisation in the holarchy of mei flux. In a sense it may be viewed as threads of vertical connection across levels in the mei field of flux, the levels in their turn being demarcated by the points of focus, i.e. the doublets. This is what is meant by the field of thread-like processes. Not all teleons extend across more than one level but many do.

For example, in the physico-sphere there appears to be a functional continuity of mei flux across levels of organisation, i.e. sub-atomic particles couple with atoms, and atoms couple with molecules and vice versa. There is also a coupling between the biosphere and the physico-sphere in the sense that living organisms tend to synthesise ever more complex levels of matter (e.g. photosynthesis and protein synthesis). This 'upward coupling' is in its turn counteracted by the second law of thermodynamics, i.e. the degradation of matter into ever 'lower' forms of organisation, or in simple terms the 'decay' of mei. In the socio-sphere there are many examples of teleons stretching across levels. Virtually all social institutions or teleons stretch across many levels of organisation. These can be intended and designed by humans (the 'architects' of social institutions). Education, agriculture, health care and technological development are but a few examples of spatially extended teleons. A simplified version of the formal education teleon is depicted in Figure 61 as a case in point (segments of sub-teleons are depicted in teleos-space at a given moment).

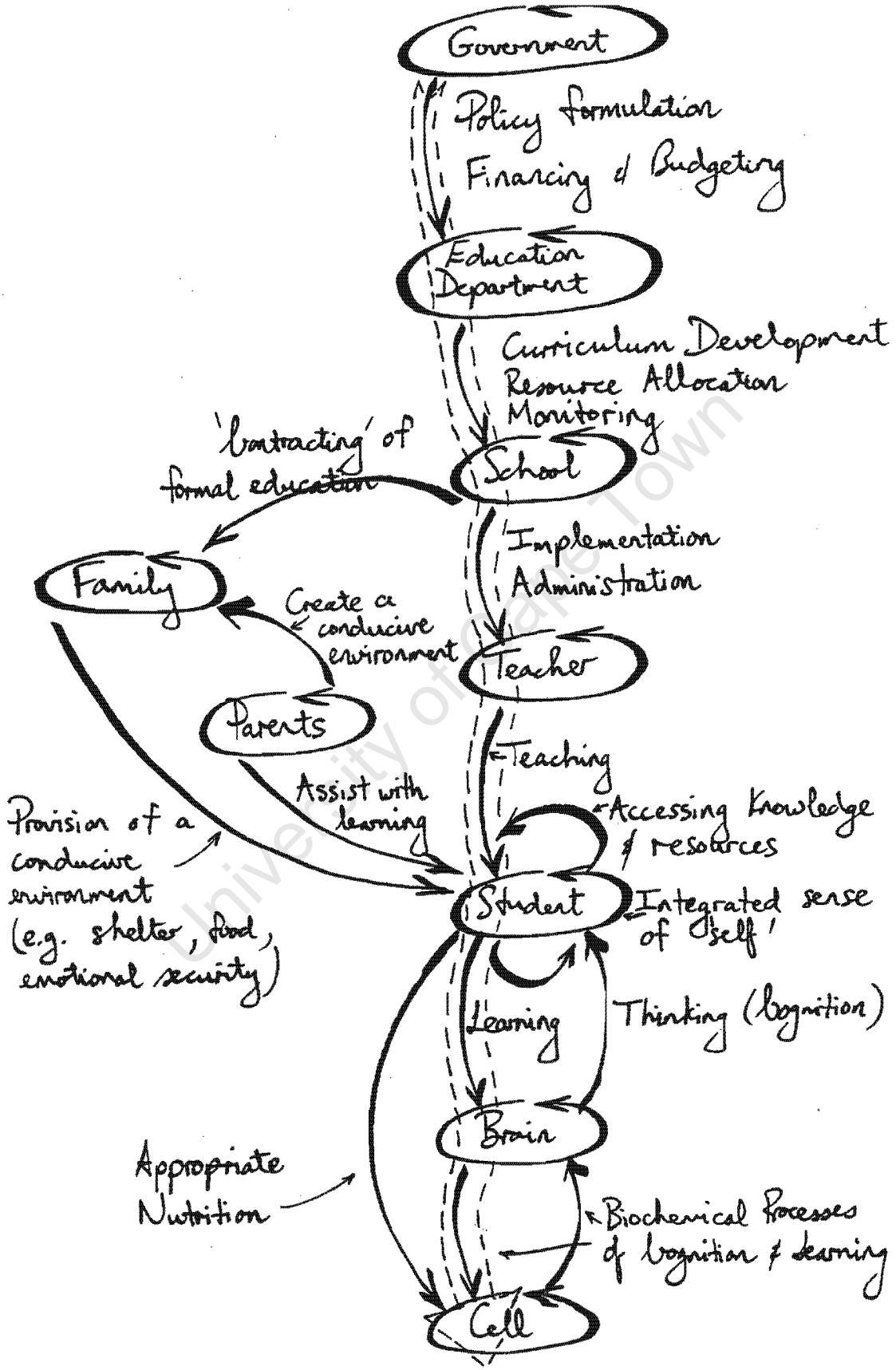

Figure 61: A simplified version of the formal-education teleon

c. Temporal and sequential continuity of teleos (i.e. a series of phases)

The temporal continuity of teleons is what gives rise to the apparent unfolding of events in the different spheres of being. In the physico-sphere we observe the progression of cosmology, i.e. the unfolding of the material and energetic universe. This unfolding appears to be continuous in time, i.e. there is a natural progression of events over time, starting with the big-bang, the formation of stars, the formation of more complex forms of matter within the stars, and so forth. In the biosphere we observe the teleon of evolution which appears to be directed at the formation of ever more complex wholes or living systems (Smuts 1987). In the socio-sphere we observe the unfolding of civilisation, entailing the progression from a hunting, agricultural to an industrial and information-based society. All the aforementioned teleons manifest an apparent continuity of teleos in time which contributes to our 'sense of history'. Some of these teleons are intended and others are considered to emerge. Whether there is intent outside the socio-sphere becomes a philosophical and theological question. This debate need not be resolved in order to accept the fact that there is an apparent temporal continuity in teleos, whatever the nature of its origin.

The phases of a teleon are depicted in Figure 63 and a simplified version of the phases of the formal-education teleon are depicted in Figure 62.

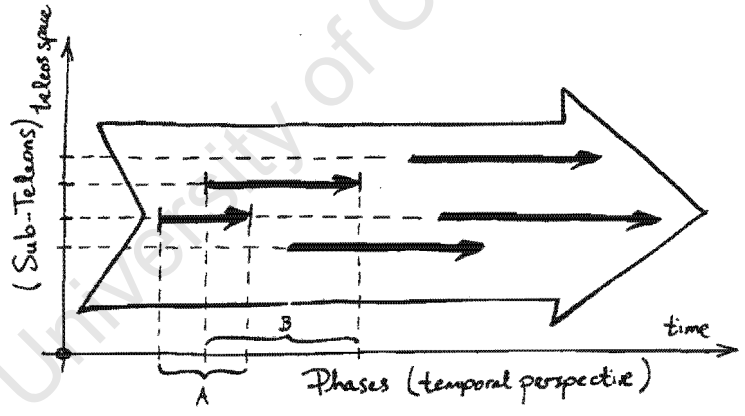

Figure 63: The phases of a teleon (i.e. a temporal perspective)

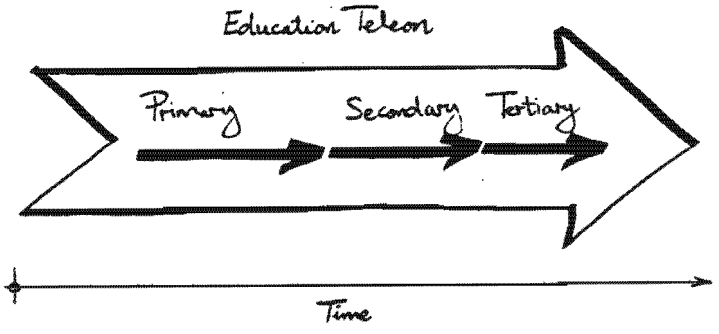

Figure 62: Phases of the formal-education teleon (i.e. a temporal perspective on education)

d. Generic teleons in the biomatrix

The generic distinctions between teleons in the biomatrix were postulated at the very outset of the studies into the biomatrix approach. Initially two types were distinguished, viz. endodynamic and exodynamic processes, the goals of which were related to the interior and exterior environment respectively (Járos, Coleman et al. 1979; Járos, Guyton et al. 1980). These distinctions were thus based on the apparent direction of their associated teleoses in conceptual space which led to the name doublet (a doublet utilises both kinds of teleons to react with the two environments). When teleos-related processes were renamed teleons, endo- and exodynamic processes were changed to endo- and exo-teleons respectively. It was soon realised that there is a further group of teleons, which are reflexive in nature regarding the direction of their teleos. This means that their teleos is directed at the same level from where the teleons originate. These 'self serving' teleons are the centro and tapping-teleons.

By definition, generic teleons exist on all levels and in all spheres of being, which means that their presence creates a meta-pattern of teleos in the biomatrix. They are always seen in the context of the networks of doublets, as their existence is essentially derived relative to the focal points created by the doublets. The existence of these generic distinctions renders a context within which all teleonic mei flux may be analysed and synthesised relative to the doublets of focus. The generic teleons also give meaning to the notion of 'balance' within a doublet. If one considers the fisherman's web analogy, any knot will stay in a stationary state if the resultant of all forces in the strings pulling on it is zero. Similarly the teleons acting in different directions on a doublet should be in balance to ensure a steady state for the doublet.

It should be noted that these teleons are not defined on the basis of the direction of mei flux associated with them (e.g. input / output), but rather on the direction of their associated teleos as perceived by the observer. A process associated with the input or uptake of mei does not necessarily imply it is an endo-teleon. Similarly the outward flux of mei is not necessarily associated with an exo-teleon.

In the following sections examples are provided which relate to the naturo-, bio-, psycho- and socio-spheres. When considering these examples it must be born in mind that the exo-, centro-, endo-tapping distinctions are always made relative to the doublet of focus and its inner or outer environment. Many of these processes may also have other teleonic components associated with them, but in these examples a particular teleonic component is emphasised.

d.i. Exo-teleon

> An exo-teleon is a teleon with an associated teleos which is considered by the observer to be directed towards the external environment of its doublet of origin (i.e. outwards relative to the reference level of organisation).

For example, in particle physics the doublets (i.e. the particles) interact with their outer environment through fields of force permeating its surrounding space. Each field in its turn comprises a flux of force-carrying units, radiating from the particle of focus, e.g. gravitons in the case of the gravity field, and photons in the case of an electromagnetic field.

The function of propulsion by the amoeba is presumably directed at its outer environment, since it appears to be dynamically organised towards 'searching' for nutrients, and avoiding unfavourable conditions relative to its outer environment. It also clearly originates from and is organised within the amoeba (i.e. the doublet of focus). It may also be argued that the contraction of the muscle cell in a multicellular organism, the excretion of hormones by the glandular cell, and the electrical conduction of the nerve cell, are all of an exo-teleonic nature relative to the cell (i.e. the doublet of focus) and the organism.

In the individual the function of talking to a friend is an example of an exo-teleon in the human doublet. Walking with the aim of reaching a particular destination (in the external environment) is considered a functional exo-teleon. In fact all movement considered to be directed at the outer environment is exo-teleonic, e.g. manufacturing and building processes. When research is expressed as a contribution to a greater field of knowledge it is considered to be exo-teleonic. This is complementary to research for personal satisfaction which is considered to be centro-teleonic. If an individual family member contributes to the welfare of the family these efforts are considered exo-teleonic in nature. Similarly an employee doing a 'good job' within a business is considered to make an exo-teleonic contribution.

The processes of production and marketing within a company (doublet of focus) are generally considered to be aimed at its outer environment and are thus exo-teleons, whereas on a national level of organisation (i.e. the doublet of focus is the government) all processes associated with foreign affairs, external trade and commerce, international communication, international transportation, international law and contractual agreements are of an exo-teleonic nature.

d.ii. Centro-teleon

A centro-teleon is a teleon with an associated teleos which is considered to be referring back to the reference level of organisation of its doublet of origin (i.e. self-referring to the reference level of organisation).

Centro-teleons are generally associated with maintaining the integrity and autonomy of the doublet of reference, relative to its outer and inner environment. They are also responsible for maintaining a balance and co-ordination between the exo- and endo-teleonic fields of the doublet of reference.

For example, although the chemical properties of an atom and its volume in space are by and large determined by its configuration of electrons, ultimately the integrity and structure of the atom as a whole is determined by the structure of its nucleus. The electromagnetic forces emanating from the nucleus and the intra-nuclear forces responsible for maintaining its integrity give rise to a unique atomic structure (Eisberg and Resnick 1974). This comes about through the processes of attracting, repelling and thereby determining the configuration of electrons in their associated electron 'shells'. These forces may be viewed as centro-teleonic relative to the atom as a doublet. In more simple terms, one may strip the nucleus of its electrons and be left with an ion which remains a potential atom, or a potentially complete doublet (i.e. the potential for electrons or their 'holes' seems to remain). On the other hand, if we take away the nucleus and leave the electrons, we are left with 'no-thing', i.e. only the free-moving electrons with no overall or emerging structure.

On the level of the cell it may be argued that some processes originating from the nucleus are of a centro-teleonic nature, for example, the process of DNA replication (thereby maintaining the unique identity of the cell and its genetic material), as well as those processes responsible for regulating and maintaining a balance between the various intra-cellular organelles.

From a biological perspective the autonomic nervous system of the human doublet and its associated processes may be considered to be centro-teleonic (i.e. the human doublet is the doublet of focus). These processes are typically responsible for regulating the physiological processes within the body for the good of the organism as a whole. For example, the 'flight or fight' response is regulated in order to preserve the integrity of the organism as a whole. Similarly, where the body is exposed to extreme cold it may 'decide' to cut off the blood supply to the extremities in order to preserve the heat for the vital internal organs. This is done in the context of the survival of the whole or centro-level of organisation. The centro-teleonic field includes all processes considered to be for personal benefit, for example, going for a walk because it creates a sense of joy, eating food because it creates an enjoyable sensual experience, making love because it is enjoyable. From a psychological perspective processes maintaining or supporting the ego, or the sense of self, are typically considered to be of a

centro-teleonic nature. The self is considered to arise from a recursive self-organising process and "may be understood as a gradual process of 'self self-organisation' " (Tschacher and Rossler 1996, p.1015).

On the institutional level centro-teleons are typically associated with the processes of establishing the identity of the institution, e.g. the process of policy formulation and registering of the Founding Act of a company (i.e. its legal identity). Centro-teleons also include processes responsible for maintaining its identity and general organisational stability. These include the allocation of resources to the various departments or functions, as well as all co-ordinating processes between the departments, thus all processes that focus on the interest of the whole and not on the interest of a particular function within the whole.

On the national level, from a judiciary and political perspective the unique identity of the nation is expressed by the enactment of its constitution and bill of rights. In order to maintain these ideals the office of the president (including members of the cabinet or senate) is responsible for ensuring a balance and co-ordinating between the various functions of government. The allocation of resources through the process of budgeting is typically of a centro-teleonic nature, since it has to balance the interests and needs of the whole field of teleons associated with the societal doublet. This is opposed to focusing on a particular function (institution) or teleon in society.

d.iii. Endo-teleon

> An endo-teleon is a teleon with an associated teleos which is considered to be directed towards the internal environment of its doublet of origin (i.e. inwards relative to the reference level of organisation).

For example, the emergent forces between the atoms comprising a molecule (i.e. doublet of focus) may be viewed as endo-processes aimed at holding the atom together, thereby maintaining the inner environment of the molecule. These forces are typically described in terms of quantum mechanical principles.

The inner environment of the cell (i.e. doublet of focus) is regulated through active and passive transport processes across its selectively permeable membrane. Furthermore, metabolising processes within the cell ensure a favourable concentration of substances for the functioning of the cellular organelles and its associated functions. These are all considered to be endo-teleonic by nature.

On the level of the organism or human doublet all physiological processes responsible for maintaining a favourable environment for the cells are considered to be of an endo-teleonic nature. These include the processes of nutrition, respiration, regulation of body temperature, blood-sugar level, as well as

the immune responses. For example, the individual may be considered to eat, digest, and metabolise food (i.e. sub-teleons) in order to maintain a favourable environment for the cells. These sub-teleons would then all form part of the nutrition teleon considered to be directed towards the inner environment of the human doublet. Similarly, the expiration of carbon dioxide and the inhalation of oxygen are sub-teleons of the respiration teleon. The respiration teleon is dynamically organised towards maintaining favourable gas levels in the inner environment (i.e. the blood). From a psychological perspective the processes of learning, memorising, visualisation and imagination may be seen to contribute to the maintenance of the intra-psychic environment of the individual.

In an institution all supportive and maintenance processes are typically associated with the endo-teleonic field, for example, the training and development of personnel, creating a favourable working environment, remuneration of staff, provision and maintenance of the infrastructure (e.g. offices and all technological aids) and the acquisition of materials as required for the process of production.

On the national level the following processes are typically associated with the endo-teleonic field: agriculture (if aimed at local consumption), maintaining internal security (i.e. police and defence processes), judiciary processes aimed at the citizens, creating and maintaining an infrastructure (e.g. roads, telecommunication network, public buildings and houses), health care and social welfare processes, environmentally related processes (e.g. conservation, pollution control and recreation), processes of production and commerce (if aimed at the local market) and last but not the least the process of education. This list is not meant to be complete but only serves as an example of an endo-teleon in a nation as a doublet.

Comparing the endo-teleonic and exo-teleonic field on the level of the nation, it seems that we tend to focus more on creating a favourable national, or inner, environment, as opposed to creating and sustaining a favourable international, i.e. planetary, environment. This is hopefully something that will be corrected in the future.

d.iv. Tapping-teleons

> A tapping-teleon is a teleon considered to perform the function of coupling teleons from the inner and outer environment with the doublet of focus.

It is essentially this innate tendency of doublets towards an integration of their outer and inner environment which is responsible for the phenomenon of continuity of mei flux, and on another level of abstraction, the continuity of teleos within the biomatrix. In other words there is a tendency towards the formation of long chains or segments of mei flux, as well as for teleons to cross different levels of organisation and connect the different spheres of being. In fact it is the search for these

apparently continuous threads of teleos-related mei flux (i.e. teleons), which is one of the main concerns of the biomatrix approach. It is furthermore assumed that all doublets to a greater or lesser extent exhibit this tendency, i.e. *are open systems both inwards and outwards.*

From a teleos perspective these 'chains' of mei flux exhibit the properties of plasticity and persistence. Consequently, although these extended chains may be considered by some to be of a purely "abstracted" nature, in the sense as defined by Miller (Miller 1978, p.19), it should be noted that within the biomatrix these teleons are considered to be very real systems (i.e. having an objective existence). Teleons are identified on the basis of an observable continuity of teleos which may be agreed upon through the process of inter-subjective agreement and subjecting the system to measurements under different prevailing conditions. The fact that they do not manifest as focalised entities in space should not detract from their reality.

It should be noted that the function of tapping may come about in an implicit and passive sense. For example, the phenomenon of resonance in the physico-sphere is a case in point. It is by virtue of the mutual attunement of two systems that an exchange of mei (in this instance energy) comes about. It is not always a case of actively reaching outwards or inwards in order to couple with the fields in the environment: the coupling often comes about as a result of the innate structure of a system. This is related to the concept of "structural coupling" of a system with its external environment as proposed by Maturana and Varela (Maturana and Varela 1992). In short, 'tapping' may either be intended and governed or it may emerge through the dynamic organisation and innate structure of the interacting fields.

Exo-tapping-teleon

> An exo-tapping-teleon is a teleon considered to perform the function of coupling teleons from the outer environment with the doublet of focus.

For example, the human doublet reaches out in a variety of ways to tap into its external environment. The sensory functions integrate information from the external environment into the teleonic field of the human doublet (voluntary or involuntary). There are also functions responsible for the integration of matter and energy, e.g. the selection of food substances (voluntary) and the breathing of air (involuntary). All functions associated with inter-personal relationships have a tapping aspect associated with them. For instance, we actively search for and engage in companionship relative to our external environments. One may also argue that processes associated with the notion of a super-ego in psycho-analytical theory are representative of an exo-tapping function relative to the ego. In terms of the education process the human doublet intentionally searches for and chooses between the information or knowledge on offer in its external environment. Similarly we choose to link up with an

employer in order to engage in the process of production. The institutional doublet typically taps into its environmental resources through the functions of acquisition of goods and technology, as well as the procurement of personnel.

Centro-tapping-teleon

> A centro-tapping-teleon is a teleon considered to perform the function of re-integrating teleons originating from the doublet of focus, back into the doublet itself.

Centro-tapping functions are typically of a self-referring, self-reflecting and self-replicating nature. For instance, on the molecular level one may argue that the ability of a crystal to maintain its integrity and to grow in size is largely due to a centro-tapping function, i.e. its structural integrity is largely derived from the mutually stable configuration of the whole, that is to say the whole sustains the whole. Should it grow in size the matrix of the whole serves as reference for its growth. On the cellular level the process of cell division may be seen as a process whereby from an organisational perspective the whole serves as reference for the new, that is to say it taps into the dynamic organisation of the reference level in order to re-create a replica of itself. The process of autopoiesis as defined by Maturana and Varela (Maturana and Varela 1992) has a centro-teleonic component associated with it, in the sense that the dynamic organisation of the level of reference is tapped into in order to sustain and reproduce itself. In the human doublet the process of self-reflection is typical of a centro-tapping teleon, i.e. the whole taps into the dynamic organisation of itself or the level of reference and 'mirrors' it, in order to reflect on it. The notion of the ego and the processes associated with it in psycho-analytical theory may be seen as the outcome of centro-tapping functions in the human doublet. One may also argue that the phenomenon of self-consciousness is to some extent the outcome of a centro-tapping function. On the institutional level senior management or the directorate typically expresses processes of self-reflection. This is an essential part of the processes of appreciating and evaluating the institution as an entity in its own right, or as an autonomous whole. Like a living organism, an institution may grow in size as a result of a centro-tapping function. In other words institutional growth comes about relative to itself without referring to its outer environment (e.g. customers) or its inner environment (e.g. employees). It grows because it has the innate ability and tendency to grow of its own accord, i.e. by tapping into or simply allowing the innate dynamic organisational tendencies towards growth to flourish. This is typical of a bureaucracy.

Endo-tapping-teleon

> An endo-tapping-teleon is a teleon considered to perform the function of coupling teleons from the inner environment with the doublet of focus.

For example, on the level of the organism (e.g. the human doublet) processes associated with inner or lower levels of organisation are tapped into, or activated from the level of focus. For instance, we intentionally tap into, or activate the process of muscular contraction (i.e. on the cellular level) in order to walk. In general the biological endo-tapping functions in the human doublet are dynamically organised through the intervention of nervous and hormonal signals. These are governed by the central nervous system (including reflex functions in the spinal column), which is organised in such a way that it 'serves' the doublet as a whole. From a consciousness perspective we 'tap into' our brain, e.g. through the reticular activating system we activate certain areas of the brain. Without this function the human psyche remains in a state of unconsciousness or sleep (Jordaan and Jordaan 1984). One may also argue that the function of endo-tapping gives rise to the notion of the "id" (as defined in psycho-analytical theory). On the institutional level it is essential to tap into resources, e.g. human and technology, in order to integrate what is 'on offer' on these lower levels of organisation into the functioning of the institution as a whole. For instance, the manager of a production process should take note of suggestions made by all participants, and he should also ensure that the productive potential of an individual or technological aid is maximised relative to the institutional requirements. Ideally on the national level endo-tapping functions should be in place with the explicit aim of integrating all citizens and resources into society at large. This should hold for all spheres, e.g. cultural, economic and political. For example, in the political sphere the opinions of citizens are tapped through the function of voting by all eligible members of a democracy.

e. Relativity of the direction of teleons in the holarchy

It should be noted that the direction of the teleos associated with a teleon is not necessarily always pointed in one of the generic directions as defined by the exo-, centro- and endo-fields of teleons. These directions should be seen as the three generic or universal directions in teleos space, and all teleons may be viewed as comprising components in each one of these generic directions. It may turn out that a specific teleon is predominantly aimed at one of the generic directions, but in many instances components of its teleos may be aimed at a combination of the directions. From a mathematical perspective teleons may be seen as vectors in a vector space, with the generic directions of exo, centro and endo being analogous to the unit vectors.

It does, however, remain useful to distinguish all teleons relative to these generic directions, since it provides the observer with a means whereby a sense of balance can be obtained within the doublet.

This assumes that the generic directions in teleos space hold true for all doublets. The configuration of these generic directions gives rise to a meta-pattern of teleos within the biomatrix.

On the level of the human doublet, for example, most functional teleons may be associated with any one of the generic teleons. The walking-teleon, for instance, may be aimed at exercising the body as a whole and maintaining its state of health, which may be viewed as having a centro-teleonic component as well as an endo-teleonic component. On the other hand, the walking-teleon may be aimed at reaching a specific destination in order to interact with a friend, in which case it has predominantly an exo-teleonic component, although there may also be a centro-teleonic component, in the sense that some personal joy is anticipated in meeting a friend. Focusing on the department of finance (i.e. one of the government doublets) and its associated financing-teleon, it soon becomes evident that the financing-teleon 'split ups' in different directions in teleos-space. For example, the procurement of taxes constitutes an exo-teleon for the department (i.e. activities are aimed at its outer environment), alternatively, when looked at from the perspective of the societal doublet, the procurement of taxes constitutes an endo-tapping teleon, since it 'taps' into the inner environment of the state (i.e. its members). From the perspective of the government as a whole, the budgeting process constitutes a centro-teleon (i.e. being aimed at balancing the various teleons of government), whereas from the perspective of the department of finance it constitutes an exo-teleon, i.e. one of the services rendered to government (its outer environment).

In short, the functional, goal-related and purposeful teleons do not necessarily map onto the generic teleonic directions within the holarchy on a one-to-one basis. However, the process whereby the observer distinguishes the generic components of a teleon enables comparison to be made between teleons. This comparison is made possible through the grouping of classes of activities of a similar teleonomic nature within a group of teleons, i.e. comparing apples with apples.[10] The meta-pattern emerging as a result of the generic distinctions also **serves as a framework to ensure that all the teleonomic components are represented and in place when analysing a particular system.**

5.1.6.3 Process perspective (mei flux)

Associated with any teleon is a web of processes or mei flux, which is considered to be associated with the field of teleos, albeit in an implicit sense. By focusing on the mei flux associated with a teleon, the observer merely observes the flow and transformation of mei in time and space. In

[10] This is similar to the mathematical concept of unit vectors in a vector space, which enables one to perform algebraic calculations on a group of vectors .

instances where the teleos emerges out of the interaction between various processes, it may not always be clear exactly which processes should be considered to participate in its emergence. In those instances there may be areas of uncertainty in the mei flux perspective, where some areas of mei flux are considered to have a greater or smaller probability of being associated with the teleon under focus. On the other hand, if a teleon is governed on all its levels of organisation, the associated mei flux and its exact contribution towards the teleon of focus becomes clear. Ultimately all teleons are a combination of the outcome between governed and emergent organisation, i.e. dynamic organisation; consequently all teleons have diffuse boundaries pertaining to their associated processes or mei flux. Thus the web of mei flux considered to give rise to the preferred outcome of a particular field of teleos cannot be clearly demarcated, parts of the web being more certain than others (see Figure 64).

In short, the extent of the web of mei flux giving rise to a teleos-related outcome can in general not be exactly defined by the observer.

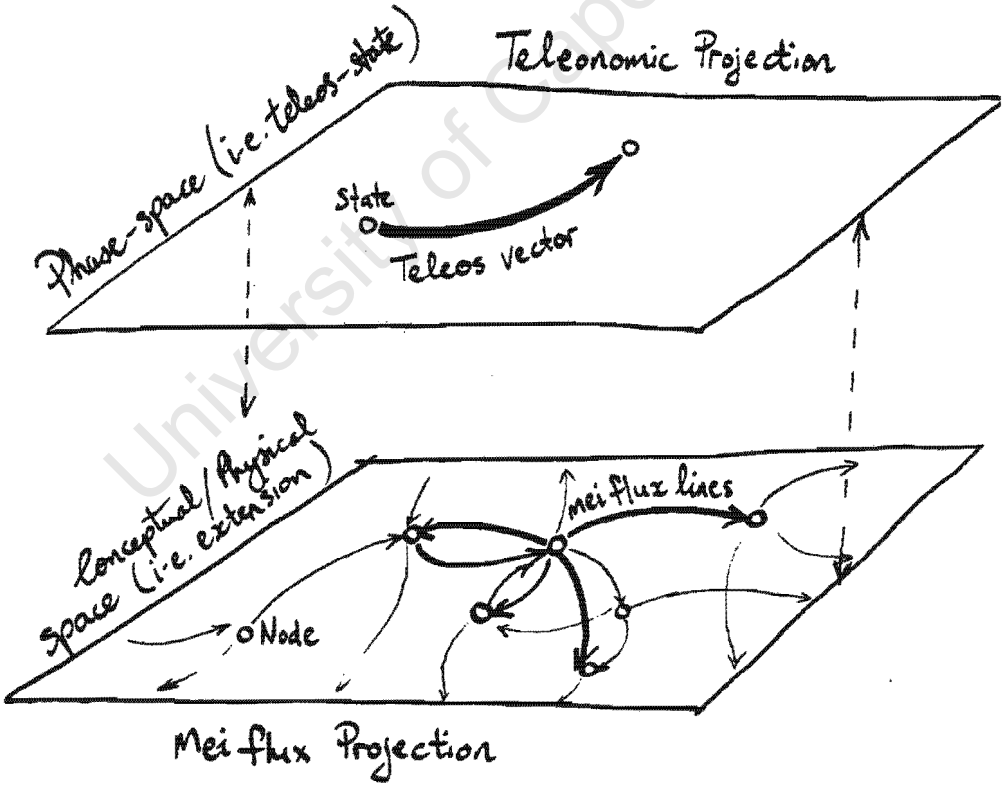

Figure 64: The relationship between the mei flux and teleonomic projection in the biomatrix

5.1.6.4 Structure perspective

Observing the web of teleons within the biomatrix from a structural perspective gives rise to distinctions similar to those of a structure perspective on process, except that in this instance the focus is on the continuity of teleos and not mei flux (please refer to the structure perspective on a *process* for more detail, page 153).

The following structural distinctions on teleons may be useful:

- **internal** sub-teleon couplings (co-action);
  - **serial** sub-teleon couplings (phases and segments);
  - **parallel** sub-teleon couplings;
- **external** teleon couplings (interaction);
  - **preceding** teleons;
  - **successive** teleons.

5.1.6.5 Substance (mei components) perspective

Apart from merely focusing on the state of mei at a particular point in time and space within a teleon, the observer may also distinguish between the following types of mei components: input/output, transformer/actor and supportive.

a. Input/output mei components

The input/output distinction refers to those components which are considered to flow into as well as out of the teleon, i.e. they are associated with the *throughput of mei* relative to the teleon. Typically these entities also get transformed as part of the process.

The actual mei flux can be traced through the network of associated processes, for example, the flow of information in the process of communication between two individuals or the flow of food substances in the nutrition process.

These components may be transformed (or reconfigured) into a different substance. For example, in the process of communication, information may be transformed as it flows from one person and is re-interpreted by another individual; or in the case of the process of nutrition, the food substances are broken down into more basic units (ultimately converted into energy) when cooked, digested and eventually metabolised.

b. Transformer / actor mei components

These components are considered to be involved in the transformation of, or acting upon, other components in the context of the teleon. For example, the heart may be considered to be an actor component in the circulatory teleon of the human doublet. Typically all employees are trans-

former/actor components in the different teleons associated with an institutional doublet. The distinction between input/output components and transformer/actor components within a teleon is analogous to the distinction between the subject and object in a sentence; with the verb corresponding to the process of transformation.

c. Supportive mei components

The supportive components are all those components participating in the teleon which are not considered to flow through the teleon, or to be involved in the transformation of other entities. They are considered to be associated with a supportive function in the context of the teleon. In the institutional doublet the physical buildings and some of the technology, as well as background information, may be considered to be of a supportive nature. Of course, if a machine is directly associated with a production process, it may be considered to be a transformer entity as opposed to, perhaps, the communication network.

The distinction between transformer/actor and supportive entities or components is not always an exact one. This always remains relative to the intention and focus of the observer.

5.1.6.6 Dynamic organisation perspective

From a dynamic organisation perspective a distinction can be made between a teleon that is governed towards its associated teleos and a teleon which emerges out of the interaction of its associated mei flux. In practice both these types of organisation are present within a particular teleon, albeit to a greater or lesser extent.

a. Emergent organisation

In the case of an emergent organisation a teleon may be seen as a process which evolves out of the interaction of its associated mei flux. Its teleos and structure is seen as an emergent outcome of the associated mei flux, or the interaction between its associated processes.

b. Governance

In those instances where a teleon is intended, planned and projected onto a web of mei flux, it goes through a rather different process of evolution. It essentially starts off with a definition of its teleos, followed by identifying its supportive processes, ultimately leading to its teleos-related outcome.

The following additional distinctions can be made with regard to the governance of a teleon:

- **Teleos-setting**

Focusing on teleos from a governance perspective, one may distinguish the governance process of teleos-setting, i.e. defining the purpose, function or goal of a teleon. Typically the purpose of a teleon

is derived from its relation to a larger context, i.e. it does not depend solely on the teleon itself. Purpose is thus something which derives from a context. On the other hand goals may either originate from within or from without the teleon of focus.

For example, the production teleon within an institution derives its purpose (i.e. the production of goods) from the context of its doublet of origin (i.e. the institution to which it belongs and in which it participates), whereas its goals may be established by senior management (i.e. the centro-level), or defined by the production teleon itself (i.e. set from within).

- **Regulation**

The process of regulation refers to the organisation of a teleon towards its pre-determined teleos, e.g. its goals.

Preferably the process of regulation should originate entirely within the teleon itself. In other words the teleon should enact its own regulation. It is within the teleon itself that the necessary information exists in order to make appropriate decisions from moment to moment. In those instances where regulation is enacted from outside the teleon, it may lead to inappropriate interference or telentropy within the system. The process of regulation generally entails some form of feedforward and feedback. A diagram of the cybernetic perspective on regulation is presented in Figure 65.

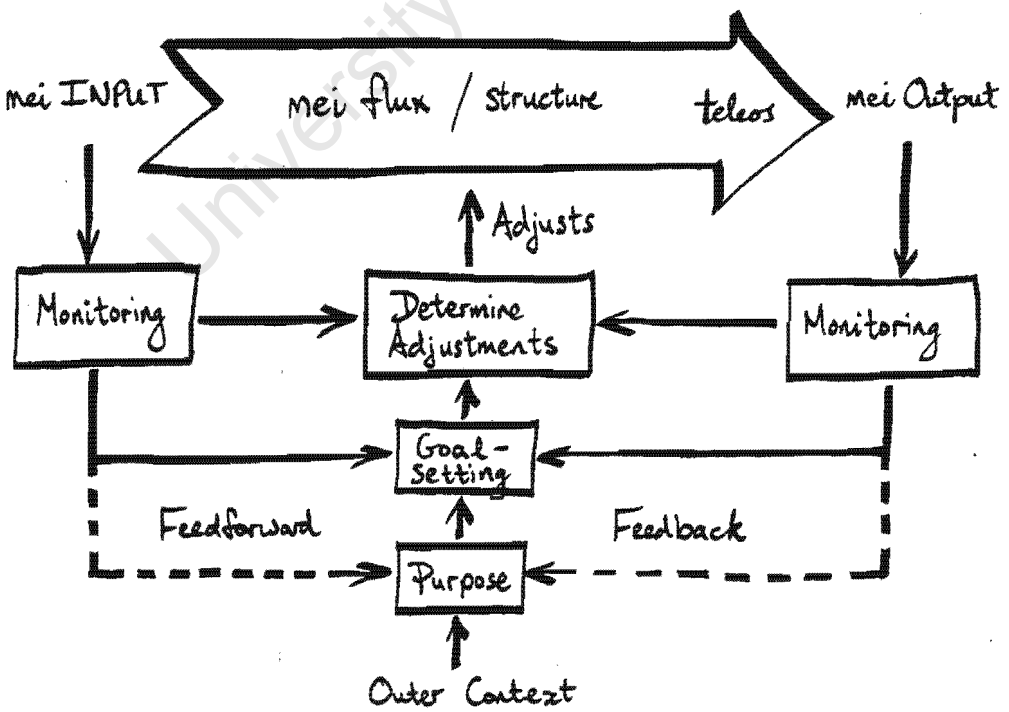

Figure 65: A cybernetic perspective on the process of regulation

5.1.7 Notes on related viewpoints

- Miller's LST maintains that "the units of abstracted systems are relationships abstracted or selected by an observer in the light of his interests, theoretical viewpoint, or philosophical bias. Some relationships may be empirically determinable by some operation carried out by the observer, but others are not, being only his concepts" (Miller 1978, p.19). However, "the relationships mentioned above are observed to inhere and interact in concrete, usually living, systems. In a sense, then, these concrete systems are the relationships of abstracted systems." Furthermore, "since abstracted systems are oriented toward relationships rather than toward the concrete systems which have those relationships, spatial arrangements are not usually emphasized. Consequently their physical limits often do not coincide spatially with the boundaries of any concrete system, although they may" (Miller 1978, p.19).
- "Soft systems methodology (SSM) began to make progress when it was realised that all real-world problem situations were characterized by people trying to take purposeful action. A set of activities, linked together so that the set was purposeful, was treated as a new kind of system concept (a 'human activity system')." (Tsouvalis and Checkland 1996, p.37). The "human activity systems" of SSM were also referred to as "holons", a term originally introduced by Koestler (Tsouvalis and Checkland 1996).
- For Parsons the conceptual unit of the social system is the *role*. "The social system is made up of the actions of individuals. The actions which constitute the social system are also the same actions which make up the personality systems of the individual actors" (Parsons in: Bailey 1990). Bailey in *social entropy theory* concludes that "both roles and their incumbents are proper - indeed necessary - objects for sociological analysis. They must be studied simultaneously. To eschew the study of either would greatly hamper the task of sociological explanation" (Bailey 1990, p41).
- Gharadejhaghi states "I rediscovered Russell Ackoff and his key concept of purposeful systems. This exciting conception opened up a whole new vision. But before I could begin to understand its real implications I had to do a lot of unlearning. In addition, Boulding's concept of 'image' combined with Walter Buckley's 'complex adaptive systems' provided me with the insight to distinguish between 'information-bonded' and 'energy-bonded' systems. Subsequently, the synthesis of *purposefulness* with information *bondedness* became the core of the social systems model presented in this work" (Gharajedaghi 1985, p. v).
- Espejo states that "a system is first of all a way of looking at the world. It is a mental construct of a whole, for which it is possible to establish a set of interrelated parts that make up the perceived whole". He also maintains that the concept of a *holon* (as used by Checkland) refers to whenever the construct of a system "is offered only as an idea about relevant situations and the emphasis is on creating new distinctions or possibilities. Even if the holon appears to have a reference situation in the real world, its purpose is not to bring forth the complexity of real-

world interactions but to offer an idea to be used to think more creatively about the world" (Espejo 1994, p.202-203).

- The concepts of centro- and exo-tapping-teleons in the biomatrix are related the notion of self-reference in systems theory. Luhmann's theory of self-reference, for instance distinguishes between self-reference to the system itself, referred to as *auto-reference* and self-reference *through its environment*, referred to as *hetero-reference* (Bailey 1997).

5.2 The Doublet

This chapter analyses the doublet under the headings as listed below.

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5.2.1 Introduction

> A doublet is a focalised-field-like-entity; it emerges from a composite field of teleons which is dynamically focused around an attractor or nucleus, in which its ethos resides.

A doublet is essentially a composite field of teleons and as such it is a field-like process-system, rather than a concrete entity system, even though it is often associated with such an entity. From a theoretical perspective, it should thus be viewed as a special class of system, the concept of which emerges out of a recursive description of the following four levels of abstraction or logical typing (Keeney 1983):

- The nucleus and its associated field of centro-teleons.
- The dual field of exo- and endo-teleons.
- The distinction of the centro-body or core-body.
- The inner- and outer environment.

While reality should ideally be considered to be a complex and indivisible "whole" as advocated by holists (Smuts 1987), the only way to handle its complexity for the sake of study or discussion is to regard its 'parts' as smaller 'wholes' themselves. Anything smaller than the greater whole must always have a dual description of "part-whole" that should be considered in context of the greater whole. To highlight this double description, Arthur Koestler called these part-whole entities "holons", highlighting their "Janus-facedness" as "self-assertive and integrative" tendencies (Koestler and Smythies 1968; Koestler 1978). David Bohm referred to wholes as "centres" or "foci" (Laszlo 1972) and Gerard called them "orgs" (Gerard 1957). The dual nature of these wholes was appreciated by all these authors, although they emphasised different aspects of duality. Laszlo, for example, referred to "self-stabilising" and "self-organising" properties, which stresses the importance of the requirements of maintenance and growth in living systems. Koestler's duality highlights the requirements that any system should look after itself as well as contribute to the larger system to which it belongs. However, these dualities do not cover the teleonic duality presented by the doublet. Both Koestler's and Laszlo's dualities refer to the system itself on the one hand, which includes the entire holarchy of subsystems within it, and the environment that includes the entire suprasystem holarchy. The duality of the doublet is the result of a *symmetrical field of teleons* (in teleonomic space) relative to the level of focus.

Because of the difference between the dual descriptions represented by the holons and orgs, on the one hand, and the duality that dual-field-like systems stood for, it was decided to give the latter a special name, viz. "doublet" (Járos and Cloete 1987). The decision was not taken lightly, considering

the present day explosion of neologies. The term was intended to describe the tendency of all systems to comprise a bipolar field of processes or two clusters of processes, viz. those teleonomically aimed at its inner environment (the endo-dynamic processes) and those aimed at its outer environment (the exo-dynamic processes). The teleos-related endo- and exodynamic processes were later renamed endo- and exo-teleons, and it was realised that apart from these two types of teleons there were two others, viz. centro- and tapping teleons, which respectively contribute to the maintenance of the doublet's integrity and its coupling with its environment. However, as far as the interaction between the inner and outer environment of the doublet is concerned, the original duality still holds and thus the name "doublet" is still appropriate. It is obvious also that the highlighting of the special duality in no way diminishes the dualities identified by Koestler and Laszlo. In fact, the biomatrix approach complements these distinctions in complex systems.

One important point made by Smuts (Smuts 1987), who can rightly be considered as the father of holism, may have been missed by some of his proponents. For Smuts, the concept that "the whole is greater than its parts" was important. This means that newly emergent properties will be added to the whole which are not explainable from a knowledge of the parts. However, he also stressed that in the process of forming a greater whole, the parts themselves change considerably. There is thus *emergence in the parts as well as in the wholes*. This obviously would cause great problems to those scientific reductionists who believe that from a knowledge of the parts one can simply reconstruct the whole. Not only can one not reconstruct the whole, but one also has to reconsider the parts. When this thesis was written, for example, first the whole message was considered, then the parts were written. However, on recreating the whole the parts had to be changed in order to achieve a good fit between the whole and the parts. This process had to be repeated several times until some convergence was achieved.

5.2.2 The doublet as a composite field of teleons

The doublet comprises a composite field of teleons, and a distinction is made between three generic classes of teleonic fields. This distinction is based on the nature of its associated teleos:

- the *exo-field* with the associated teleos *directed outwards* at the associated exo-doublets;
- the *centro-field* with the associated teleos *directed at itself*, i.e. the centro-level of organisation;
- the *endo-field* with the teleos associated *directed inwards* at the associated endo-doublets.

5.2.2.1 A field-like entity as opposed to a discrete entity

Traditionally, we tend to focus on discrete entities as being constructed of smaller and smaller similar entities, as follows:

- human beings, comprising living cells;

- business organisations, comprising human beings and artefacts;
- cities, comprising human beings and other living and non-living entities;
- motor vehicles, comprising mechanical parts;
- atoms, comprising sub-atomic particles;
- languages, comprising discrete words or concepts.

This preference for discrete entities can be ascribed to the fact that the eye, being probably the most powerful sensory aspect of human beings, is the main source of information concerning the world around us. We believe what we can see with our own eyes. We have readily extended this to things perceived through our other senses and even to concepts that are conceived or 'seen in our mind's eye'. Language, being the main medium of our communication, is also the main vehicle of our thinking processes. Through language we have strengthened the status of tangible entities by giving them prominent positions in the units of our thinking process, viz. in sentences. The entities are given position number one as subjects of a sentence and, especially in an analytical language such as English, are placed at the beginning of the sentence. It is thus not surprising that the entity-based view of the universe gets ingrained in all that we think and do.

We are obviously aware of processes in the world, but we tend to perceive them as something related to the passage of time that results from an interaction between entities or from a change within discrete entities. In a typical sentence the predicate (represented by a verb) is usually an action that someone performs; it can simply not stand alone. The biomatrix approach, through its teleonic perspective, firmly places process at the centre of the field of description and analysis. This is not to say that discrete entities are regarded as irrelevant, but they should be used together with a teleonic perspective to arrive at a more complete picture.

Because one is talking about modes of perception, changes in perception are obviously required to move from our focus from discrete entities to field-like process entities. To illustrate this, let us observe the beehive as a metaphor for a field-like process entity manifested in time and space. If we take a long-exposure photo (i.e. explicitly incorporating the time dimension) of the hive and its bees, what we see on the photo are series of lines or threads spreading in all directions from the hive each representing the flight paths of individual bees into the surroundings of the hive. The totality of the lines is a field of pathways, representing the total activity of the bees flying in and out of the hive. In our mind's eye we can see that each thread extends into the inner environment of the hive and represents the movement of a bee within the hive. We could photograph these internal pathways and prove that there exists a set of lines within the hive, another field of pathways representing the total activity of the bees within the confines of their hive. Although the physical wooden structure was provided by men, the actual core body of the hive was constructed by the bees themselves though the totality of their actions represented by the field lines outside and inside the hive. The 'nucleus' within the hive around which all activity is centred and which gives the entire field of activity its direction is

the large-sized stationary queen bee. From this perspective, the 'bee hive' comprises not only a physical hive, a wax structure and individual bees, but also a field of threads extending into the inner and outer environment forming a core body and having a nucleus in the form of a queen bee. The dual thread-like-field represents 'lines of action' over time in space and extends the system far into the outer environment, including the flowers, water points etc., as well as into the inner environment, including the compartments within the core body and the nucleus or queen bee. The difference between looking at the hive as a composition of processes on the one hand and discrete entities on the other is considerable. The former entails seeing it as a field of processes extending to its outer and inner environment confluent into a core body, as compared with seeing a concrete hive with concrete bees interacting with the environment. From a casual perspective, the core body emerges out of the co-action of the field of processes (i.e. activity of the bees), organised around the nucleus (i.e. the queen bee). The simple lumping of a vast number of bees together is certainly not going to make a hive. In reality, it is the activity or field of processes which actually gives the hive its living existence. In other words, a hive exists ultimately as a field of processes, as does a house, which can be viewed as the result of the designing, building and maintenance processes. The concrete building is the result of the processes and not the cause of the processes.

One must be very careful not to regard the primacy of process as the only truth. Processes do emanate from existing structures or discrete entities. In fact, there is a reciprocity between process and structure, the one giving rise to the other in a continuous ever repeating cycle. This is the well known "zig-zag" arrangement of Bateson (Bateson 1985). Unfortunately, classical science does not always allow for this recursive pattern, and presents the materialistic reality as the exclusive or primary one. The primary focus of a doublet is the field of 'lines of action' in both time and space, giving rise to the living hive. The individual bees that are the discrete entities in space, only come into focus later, when details are considered. Similarly, families and business organisations are seen as composite fields of thread-like-process-entities (i.e. teleons) in a time-space continuum in which discrete entities participate and not simply as groupings of discrete entities, such as family members or employees. The lines of fields are confluent within the doublets of the family, the organisation and the family members. As the lines interact with one another, they all undergo a change. This means that all the doublets change as the result of the interaction. This explains why the formation of wholes actually changes all the parts, as was so well observed by Smuts many years ago (Smuts 1987)

A tree with its branches, main trunk and roots could serve as a further metaphor to understand the basic structure of this type of system (see Figure 66). The branches and roots represent interactions with other doublets or systems on different levels of organisation in the holarchy of life. The trunk is representative of the core body or level of reference, that can be identified as the system under observation. The bifurcation points of the branches and roots in their turn represent different levels of organisation in the holarchy. As part of a holarchy, each bifurcation point is actually representative of

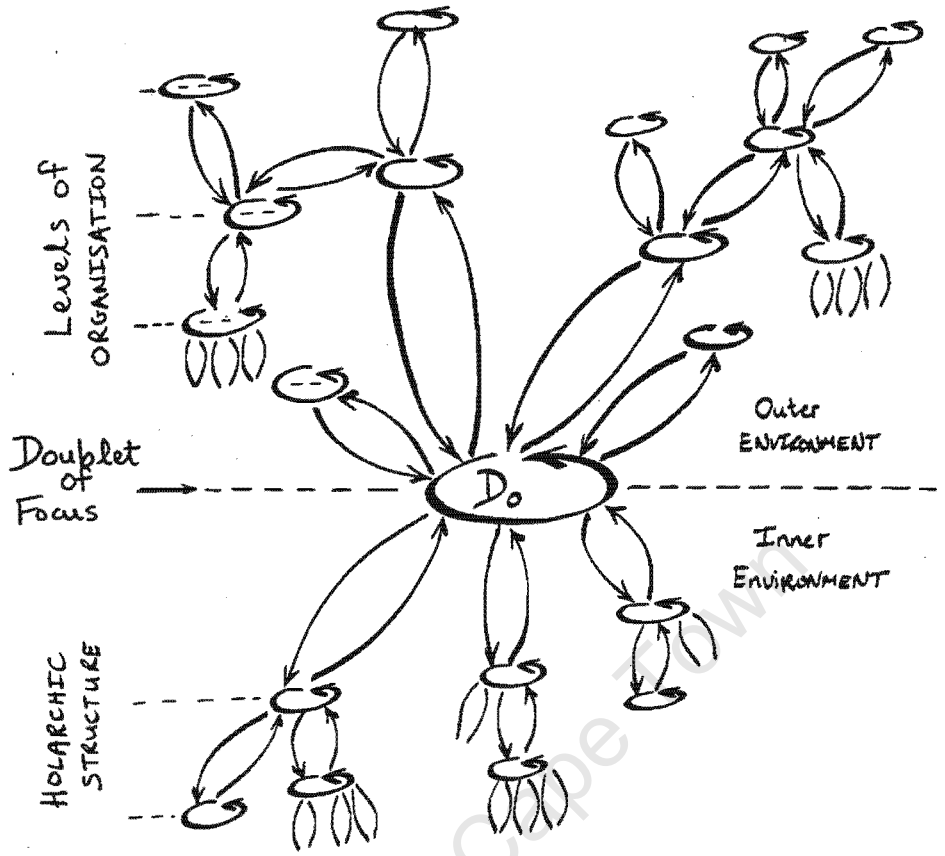

Figure 66: The tree as metaphor for the doublet as a holarchic field of teleons

a new doublet with its own branches and roots. In other words, a new doublet exists at each splitting point of the branches and roots, each with its own set of branches and roots, thus forming a fractal-like structure.

Another useful metaphor is that of the doublet as a cluster of stalks seen as a dual sheath with some stalks pointing upward and others downward. The grasping of the sheath is representative of the nucleus or attractor of the doublet i.e. that aspect which binds the various stalks into a single cluster or core body.

5.2.2.2 The endo-field and exo-field belong equally

Both the exo- and endo-fields originate from the central nucleus and are considered to be part of the doublet on an equal level of abstraction and organisation. The difference is that the exo-field is directed towards the outer environment and the endo-field towards the inner environment. Thus the roots and branches of the tree are both considered to belong to the same tree and are on the same level of abstraction, the only difference being their direction in teleos space. This view represents a major, if not radical, shift in the perception of systems. This can be elucidated by using the human being, or human doublet, as a case in point.

Classically, a human being is viewed as a system that comprises a grouping of interacting cells and organs that are all situated within distinct physical boundaries of the human being as a system. Together these units or parts are considered to constitute the system. All entities outside the body are considered to be part of the environment and not *to belong to* the system. Furthermore, there is a hierarchical grouping of entities into ever larger wholes residing on subsequent levels of organisation representing atoms, molecules, cells, organs, human beings, families, societies, etc.

In the case of the doublet as a composite field of teleons, the process-units or 'process-parts' of the system extend over at least three levels of organisation as a cluster of threads with its focal point on and originating from the centro-level. This is as opposed to the classical view with the system under observation residing on a single level of organisation, e.g. the human being as an autonomous system. In the case of a human being as a doublet, the exo-field typically comprises activities like having a conversation, walking somewhere and eating. Conversely the endo-field typically comprises activities like digestion of food, transportation of oxygen and CO_2 in the blood and maintaining appropriate levels of chemical substances in the blood. Although part of the activity belonging to a field may actually take part outside the body, it is still considered to be a part of the human doublet. For example, conversation typically extends outside the core body or physical body, i.e. from one human being to another. However in the field-like-process approach, the conversation teleon is considered to be just as much within the boundaries of the human doublet as would be the digestion teleon.

Admittedly the doublets towards which the fields of teleons are directed are still considered to be separate from the doublet of focus. This holds whether these doublets are inside or outside the doublet of focus. For example, a single cell within the stomach is considered to be inside the human doublet, whereas another human being with whom conversation is made is considered to be outside the human doublet as a system. However, in both instances the fields which originate from the doublet of focus and which permeate the outer and inner doublets, are considered to belong mutually to the doublet as a field. These outer and inner fields are considered to be on the same level of abstraction and organisation relative to the doublet of focus.

The concept of a doublet as a field of activities is a departure from the traditional position where those entities 'inside' the system are considered more important from a causal point of view. Traditionally the human being is considered to emerge out of the interaction between its cells and organs. From a teleonic perspective the doublet of focus is seen to emerge as a result of a mutual contribution of both its inner and outer fields of teleons. For example, both the teleonic field of conversation between myself and a second person, and the teleonic field associated with my cellular activities are considered to participate mutually in the emergence of the doublet of focus (i.e. myself).

As a further case in point, it is true to state that a cell within my lung and the plankton cell within the ocean from where I derive my constant flow of oxygen are both 'part of' the same activity-field that permeates both these discrete entities. More specifically, the latter two doublets participate equally in and are considered to belong equally to the human doublet as a field-like system. Thus, the emergence of the human doublet as a complete autonomous system is due to both the cell in the lung and the plankton cell in the sea. Such an approach represents a balance between a 'bottom-up' and a 'top-down' approach as opposed to the traditional 'bottom-up' approach which views a system and all its interacting parts as being inside the boundaries of the system (see Figure 67).

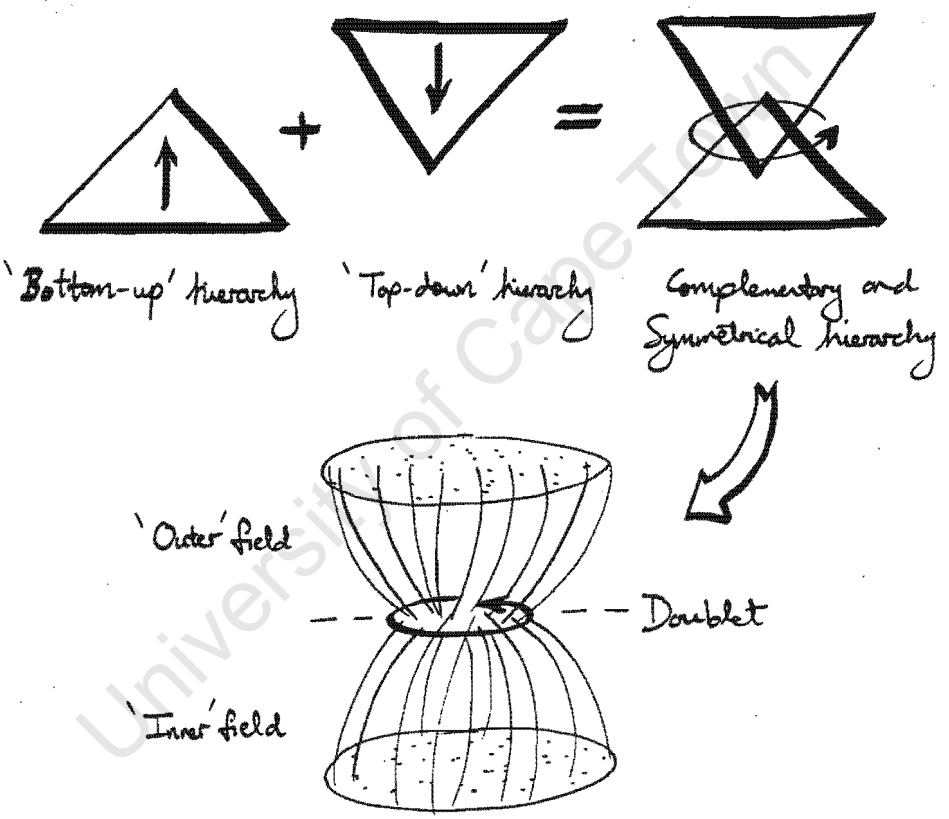

Figure 67: The doublet as a symmetrical and complementary hierarchy of fields

This shift from the traditional view can be attributed to the fact that the doublet as a system is considered to comprise a field of teleons that extends over at least three levels of organisation in the holarchy, with a level of reference situated in the middle level.

5.2.2.3 Qualifications for membership of the field

This section explores the basis on which a process-thread or teleon is considered to be a member or 'part' of a particular doublet, in other words which teleons are considered to fall within the

'boundaries' of a doublet-system. Essentially the main qualifier is related to the dynamic organisation of the process-thread in question.

- If the dynamic organisation of a teleon originates within, or can be attributed to the core body or nucleus of a particular doublet, it is considered to be a member of the teleonic-field of that doublet.
- The organisation of the process-thread in question should be derived from the ethos of the doublet of focus (the ethos of a doublet resides in its nucleus). Thus ultimately ***a doublet is ethos-bound***. In other words its boundaries are determined by its ethos, which in the mei flux domain translates into an associated dynamic organisation.
- It follows that the mei flux of the process in question is linked with the core body or nucleus of the doublet. This is a necessary but not a sufficient requirement (unless the process actually originates from the nucleus).
- Furthermore, in its co-action with other member teleons, it must directly contribute to the dynamic state of the doublet, i.e. its creation, emergence as an identity or whole, its maintenance, 'destruction' or transformation into something different.

In many instances the dynamic organisation of a particular process can be traced back to more than one doublet and as such is considered to be a member of more than one doublet. The extent to which a particular teleon belongs to a particular doublet may also vary, depending on the degree to which it meets the aforementioned requirements. A fuzzy classification system can be employed to determine the degree of membership of a teleon. In practice membership is often not a yes-or-no situation, but rather a matter of degree relative to the context.

For example, if somebody were to talk to me as a human doublet, the process of talking is generally not considered to be part of my doublet or process-field. This is because although the talking interacts with my field, this process primarily originates within the other person. On the other hand, if I were to have a conversation with this person, the organisation clearly originates in both doublets and is considered to be a member of both fields. Interaction with the core body and its field is thus not a sufficient requirement for membership of that particular doublet. For instance, the radiation of the sun's rays on my skin, or the generation of sounds in my immediate environment, is clearly not part of my human doublet. On the other hand, the process of sun-bathing is, and so is the process of listening. In both these instances the dynamic organisation of these processes can be traced back to myself (i.e. the nucleus of the personal doublet). Similarly the processes of marketing and manufacturing are clearly part of the business-organisation-doublet, but the processes of buying and consuming the finished product are not; they belong to the individual consumer-doublets. Management processes within the company may be considered to belong to both the company-doublet (i.e. originating within the collective company ethos or policy) as well as the individual employee-doublet (i.e. originating within the worker's personal ethos). The management process is, thus,

generally co-organised by the company as a whole, as well as the individuals involved with management (a difference in company and worker ethos obviously creates a risk of conflict and ineffective management).

5.2.3 The nucleus or attractor

The doublet as a field spans at least three levels of organisation in the holarchy (comprising a field of processes giving rise to the focalised discrete entities). The focal point of the doublet resides on the level of reference, referred to as the centro-level of organisation. It is at this level that the nucleus of the doublet resides. The nucleus serves as an attractor (in physical and/or conceptual space) for the field of processes. It essentially organises the field into an autonomous and integrated focalised-field-like-entity (or system). As an attractor, it gives rise to a 'densification' or focalisation of processes and thus to the appearance of a core-body which is maintained in a state of dynamic equilibrium in time and space. The metaphor of a seed well illustrates the role of the nucleus within the doublet. Conceptually the nucleus embodies the ethos of the doublet, in other words it acts as a reference for the values and organisational principles shared by the doublet as an integrated whole. It is the one 'thing' which all the teleons within the doublet share, i.e. a common value system, or more correctly, a focalised ethos-field in the conceptual ethos domain. Harmonisation and resolution of conflict between the individual teleons in the doublet-field are enacted relative to the shared ethos embodied in the nucleus. It thus serves as a reference for the autonomous identity of the doublet.

The nucleus does not necessarily manifest as an entity in physical space, but rather as a conceptual entity or attractor in the dynamic organisation domain. In the words of Varela: "by identity I intend here a unitary quality, a coherence of some kind. It is not meant as a static structural description (it is a process), nor as carrying mentalistic or psychological connotations (it is identity in a generalized not a personalistic sense)"; and also "it is this operationalized closure which gives rise to an emergent or global coherence, without the need of a 'central controller', hence the identity I have in mind here is nonsubstantially localized, and yet perfectly able to generate interactions" (Varela 1997, p.73).

5.2.4 The centro-body/core-body

The core-body of the doublet is an area where there is a densification or concentration of processes around the nucleus, as previously explained. It emerges as a relatively *stable and focalised spatial configuration* as a result of an underlying action-pattern. In other words it emerges out of the focalised dynamic organisation of all the participating processes in the doublet-field. It is generally perceived as a *discrete entity* in space (conceptual and/or physical).

The centro-body is the part of the doublet which an entity-based systems approach would generally refer to as the system; more specifically, it would serve as the primary distinctive factor for identifying the boundaries of the system under observation. In the case of a human being as a doublet

the core body is the physical body, and in the case of a cell it would be the cell structure defined by the boundaries of its membrane. Doublets do not always have a clearly distinguishable core body in physical space, but certainly in conceptual space. For instance, a family and business organisation, as a doublet, do not exhibit clearly distinguishable core bodies in physical space, although they do in conceptual space. Thus, although their boundaries are not necessarily distinct in physical space, they are always perceived as distinct entities by the observer. For example, we refer to a mountain as if it existed as a distinct entity, but were one to draw its boundaries it would soon become clear that they are not distinct at all. However, it does not withhold us from referring to the mountain as a distinct entity; albeit in conceptual space.

In general the core body has not got clear-cut boundaries (as is the case for a human being and other living organisms), but is rather an area of densification of the field where the boundaries are nebulous and are drawn by the observer relative to her vantage point. This is certainly true for social 'organisms' or doublets, and is also the case for the very small physical systems, i.e. atomic- and sub-atomic systems. Clearly distinguishable boundaries for core bodies as discrete entities only exist for a mid-range of systems in the evolutionary ladder, e.g. biological organisms and macro-physical objects. Outside this margin 'things' *dissolve into a field of processes without discrete boundaries*.

5.2.5 The associated endo-doublets, exo-doublets and supra-doublets

The distinction between the associated exo-doublets and endo-doublets goes hand in hand with the distinction between the endo-field and exo-field of the reference doublet. In order to avoid a circular logic in the definition of these two types of distinctions it is essential not to base the distinction between the exo- and endo-doublets on the associated exo- and endo-fields. The criterion on which the distinction between exo- and endo-doublets is based is essentially one of dynamic organisation.

The 'centro-doublet' is generally referred to as the *reference doublet*, the *doublet of focus* or simply the doublet.

5.2.5.1 Endo-doublets (sub-doublets)

The class of doublets referred to as *endo-doublets* or *sub-doublets*, relative to a reference doublet, all share the following characteristics:

- They all appear to be dynamically organised relative to, or in observance of, the single field of ethos associated with the centro-level of organisation (of the reference doublet).
- The field of interaction with a particular endo-doublet is considered to reside in the inner environment of the reference doublet; this is a necessary requirement, but not a sufficient one. Doublets may, and often do, 'invade' the reference doublet and do not share its common ethos. Furthermore, some may naturally 'reside' in the inner environment, but not couple with it in a congruent way, relative to an ethos, for example, those doublets within an institution

which behave in a 'criminal' way, i.e. not in line with the ethos of reference, or, in a biological context, all internal parasites.

- Endo-doublets are considered to be on a lower level of organisation than the reference doublet. It is not always that simple to judge the level of organisation of a system relative to others, especially in social systems. Thus we refer to a holarchy of organisation as opposed to a hierarchy.

In other words in respect of its own organisation an endo-doublet appears to explicitly share the ethos of the reference doublet associated with the centro-level of organisation. Thus, in terms of the dynamic organisation there is an 'intimate' or interdependent organisational link between endo-doublets and the doublet of reference. It also follows that endo-doublets amongst themselves all share a common class of organisational principles, and are considered to be 'coupled' or mutually dependent in terms of their organisation.

In other words, in line with Miller's definition of a system (Miller 1978, p.16), endo-doublets are constrained by, conditioned by, or dependent on the state of other endo-doublets. In the context of the doublet this is considered to be an outcome of the fact that all endo-doublets share the common ethos of the reference doublet. It should also be noted that the reference doublet is considered to *emerge out of the interaction of both its endo- as well as its exo-fields*. This differs from the view, as held by Miller and all traditional entity-based systems theories (Laszlo 1972), that the system emerges out of the interaction between its 'inner components' or parts, i.e. the endo-doublets (as opposed to the composite field-based approach of the biomatrix model).

5.2.5.2 Exo-doublets

The class of doublets referred to as *exo-doublets* relative to the reference doublet all share the following characteristics:

- The field of interaction between the reference doublet and an exo-doublet is considered to be congruent in terms of a shared teleos. In other words, an exo-doublet exhibits a continuity of teleos relative to the reference doublet, but generally not a continuity of ethos.
- In general exo-doublets as a class do not share a particular teleos with the reference doublet.
- In general exo-doublets as a class do not share a common class of organisational principles. Thus there is no shared ethos. In other words they interact with the reference doublet without necessarily being bound by a common ethos.
- The field of interaction between an exo-doublet and the reference doublet is considered to reside in the outer environment of the reference doublet.
- In general exo-doublets need not reside on the same level of organisation.

For example, the family as a doublet interacts with family friends, with a school, with employees and other institutions in society. These are all considered to be exo-doublets of the family doublet. These doublets all share a particular continuity of teleos with the family doublet independent of each other, and in general, do not share a common ethos amongst themselves. Similarly, the 'customers' of a business doublet as well as its suppliers of 'materials' are considered to be exo-doublets, each one interacting independently with the reference doublet, i.e. the business, although, from the perspective of the reference doublet, they all exhibit a continuity of teleos, albeit different in each instance. Furthermore, they are all considered to reside in the outer environment of the reference doublet.

5.2.5.3 Supra-doublets

The class of doublets referred to as *supra-doublets* relative to the reference doublet all share the following characteristics:

- The reference doublet is considered to be an endo-doublet (sub-doublet), relative to the supra-doublet.
- The supra-doublets are considered to be on a higher level of organisation than the reference doublet.
- In general supra-doublets are not necessarily on the same level of organisation.

A doublet may, and generally does, participate in more than one supra-doublet. For example, a human doublet may participate in a family supra-doublet, in a business organisational supra-doublet, an education institutional supra-doublet and in a friends supra-doublet.

The distinction between endo-, exo-, and supra-doublets is depicted in Figure 68.

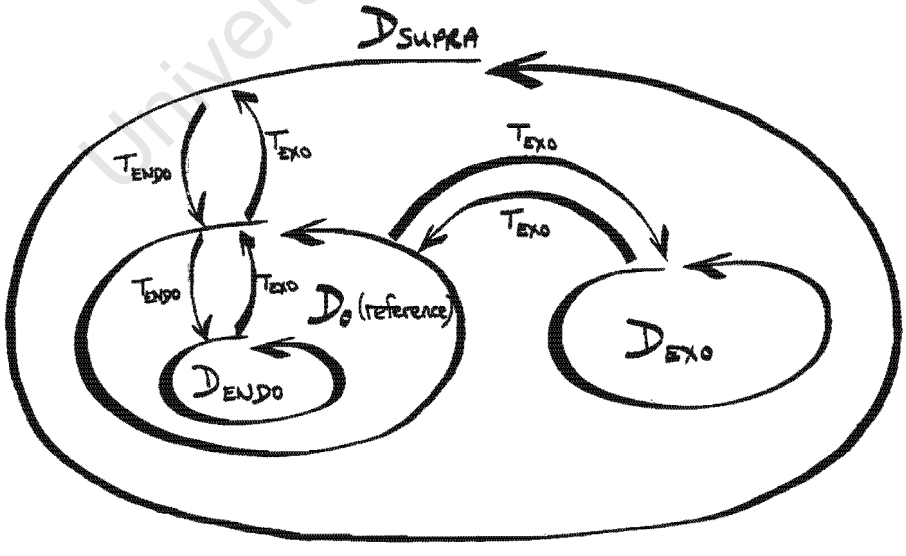

Figure 68: The relationship between the reference (centro), endo, exo and supra doublets

5.2.6 The outer and inner environment

A distinction is made between an inner and an outer environment of the reference doublet.

- **Inner environment**

  The inner environment is the field-like space (conceptual and/or physical) considered by the observer to be 'contained by' or 'inside' the centro-level of organisation, or alternatively to be 'inside' the core-body. It includes all the interacting fields of the endo-doublets as well as other doublet-fields which are considered to be 'inside', but not belonging to the class of endo-doublets.

- **Outer environment**

  The outer environment is the field-like space (conceptual and/or physical) considered by the observer to be 'outside' the centro-level of organisation or alternatively, to be 'outside' the core-body. It includes all the interacting fields of the exo-doublets as well as other doublet-fields which are considered to be 'outside', but not belonging to the class of exo-doublets.

The concept of an environment is *a field-like concept and as such is not entity-based.*

The exo-environment for instance includes the total field of all exo-doublets, other doublets which are considered to be 'outside' but not interacting with the reference doublet, as well as those components of the fields of endo-doublets which are considered to directly permeate the outer environment.

As a human doublet I may, for example, interact as part of my exo-field with a friend who would be an exo-doublet relative to me; my friend in her turn interacts with her family as part of her exo-field. The interaction of my friend with her family thus forms part of my exo-environment but not my exo-field, whereas my personal interaction with her forms part of both my exo-field as well as my exo-environment.

Furthermore, my body as a doublet may be invaded by a non-congruent or 'foreign' doublet, e.g. a 'malignant' bacterium. In this case the bacterium is considered to be part of my inner environment but not part of my endo-field. In fact it is this class of doublets that the immune system is aimed at. The immune system identifies teleonomic incongruencies associated with processes occurring in these 'foreign' doublets.

This is a first-order approximation of the concept of exo-environment, i.e. only those doublets with which there is direct interaction are included. It is also possible to have a second-order, third-order, etc., approximation depending on the number of intermediate doublets. One may argue that ultimately all doublets are at some stage, directly or indirectly, interacting with all other doublets and thus by implication should be considered as part of the environment. However, in practice it is useful to

distinguish on the basis of the 'directness' or 'remoteness' of the nature of interaction within the complex web or field of processes.

The same principles applying to the exo-environment hold true for the endo-environment. For example, an employee is considered an endo-doublet of a business organisation (the reference doublet). The interaction between the company and the employee (e.g. remuneration, training, production) is considered to be part of the company doublet's endo-field as well as its inner environment. The employee, however, also has numerous other teleons within his doublet-field, e.g. interacting with his family, personal recreation activities, nutrition etc. These activities form part neither of the company's endo-field nor of its inner environment.

The distinction between an endo/exo-field and an endo/exo-environment-field is actually more significant than it may appear at first glance. It acknowledges the fact that all the activities of the endo/exo-doublets of the reference doublet do not necessarily contribute to the emergence and organisation of the reference doublet. This is due to the explicit distinction that is made between the discrete entities and the field of activities associated with each one of them.

Looking at the endo-field versus endo-environment distinction it is not a simple matter of a system emerging out of the interaction of its parts, with the parts being fully 'embedded' or 'part of' the emerging system. It is rather a matter of some activities of the 'discrete parts' giving rise to the emergent system and some of their other activities giving rise to other emerging systems. Focusing on discrete entities may inadvertently lead to a false and simplified view of parts interacting to give rise to a larger whole, with the wholes in their turn interacting. This viewpoint leads to a conceptualisation of a hierarchy of systems, with the discrete entities serving as reference points of ever larger or more complex wholes.

A field-based focus on process, on the other hand, leads to a much more intermingled, more 'open' and less linear hierarchy of organisation. The discrete entities are considered to 'wear many hats' or participate in a variety of other doublet-field systems, even on diverse levels of organisation. Furthermore the environment is not only something which is 'out there'; it is truly just as much 'in here'. The environment actually intermingles and 'flows within' the system under observation. It yet again emphasises the equal and mirror-like ontological base that is granted to the exo- and endo-poles of the doublet, and the inner and outer levels of its existence.[11]

[11] For the mathematically-minded, it may be added that the potential for complexity is equal with respect to the inner and outer environment. Generally the observer tends to consider the outer environment to be much more

Footnote continued on next page.

5.2.7 The field of tapping teleons

Tapping teleons are the special class of exo-, endo-, and centro-teleons. These teleons are concerned with the integration of what is 'on offer' or accessible in the outer and inner environment, into the field of the reference doublet. This is essentially a functional distinction of teleos. These teleons have the function of integrating relevant aspects of the fields originating from other doublets into the field of the reference doublet. These teleons thus 'tap into', or couple with, fields originating from other doublets but permeating the field of the reference doublet. Teleologically these teleons 'fold back' to the reference doublet in an act of self-referral, thereby integrating selected aspects of the 'foreign' fields with the field of reference.

This additional class of exo-, endo-, and centro-teleons has been distinguished in order to emphasise its importance in the functioning of all open systems. The mere overlap of fields does not guarantee an interaction; furthermore the interaction needs to be modulated in order to ensure a congruent coupling between fields. This is done through selective tapping into the outer and inner environment.

The special case of tapping into its own field is referred to as centro-tapping. This implies a process of 'self-reflection' or a re-integration of the field of reference.

5.2.8 A three-level distinction

Apart from looking at a doublet as a focalised field of teleons, it should also be viewed as a field-like entity which permeates at least three different levels of holarchical organisation. Levels of organisation are distinguished by focusing on the core bodies or nuclei of doublets residing on different levels. In other words the respective core-bodies or nuclei of doublets reside on a particular level of organisation and serve as points of reference for different levels in the holarchy.

A doublet's field extends from its core body or nucleus towards its outer environment, which is on an outer level of organisation, as well as to its inner environment, which is on an inner level of organisation. A doublet, therefore, always permeates at least three levels of organisation within the living holarchy, with its core body and nucleus being the middle reference level. Whenever a doublet

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complex than the inner environment, mainly as a result of the much bigger and infinite space associated with it. On the other hand, the space of the inner environment is considered to be limited and finite, and likewise its capacity for complexity. This is an erroneous conclusion. Geometrically it has been shown that the field of two-dimensional lines traversing an enclosed and finite three dimensional space is infinite. Similarly, the number of rational numbers within a finite range of integer numbers is infinite. In other words there is *an infinite series* of rational numbers within the finite two-dimensional space of, for instance, the numbers 1 and 2.

is analysed or depicted it is done with at least three levels of organisation in mind. This is referred to as the three-level perspective of systems (i.e. doublets) in the biomatrix. Consequently the biomatrix approach insists that the observer should always consider at least three organisational levels with reference to any doublet (as a system).

An example of a three-level distinction pertaining to the human doublet would be the cell, the human organism and the family. These are viewed as three doublets with their core bodies on different levels of organisation. Let us take the middle one of the above levels as the level of reference. The field of the human doublet extends from its core body towards its outer environment , viz., the family, and towards the inner environment, viz. the cells.

5.2.9 Boundaries of the doublet

The boundaries of doublets are not discrete like those of discrete point-like entities, but fuzzy, and consist of an intricate demarcation of field-lines. A tree, for example, should not be seen as a closed spherical volume, but as a fractal-like web of branches and roots blending with the outer and inner environments. A doublet is not demarcated by drawing a circle around it, or putting it in a 'box', but rather through the exercise of tracing the finest of all the 'branches' and 'roots' in both directions of conceptual space. Thus, the boundaries of fields are not defined in the classical sense as a dividing surface between the inside and the outside, but rather as a complex, fractal-like, inner and outer demarcation of fields (see Figure 69).

Figure 69: The doublet as a fractal-like field of mei flux

5.2.10 'Incomplete' Doublets

All doublets are focalised in space, sometimes with an emergent core-body that can be viewed as a discrete entity. However, all discrete entities are not necessarily doublets. The degree to which a discrete entity is considered to be a doublet depends on the level of focus and the perspective of the observer. For example, we may not consider the organs in the body, or a department in an institution, or an artefact to be a doublet.

The following characteristics of doublets may serve as a means of distinction between a doublet-like and a non-doublet-like discrete entity:

- A doublet is an *autonomous entity*, i.e. it exhibits the properties of *organisational closure* (Maturana and Varela 1992). This is essentially achieved through its tapping and centro-teleons.
- A doublet is *self-referring* in terms of some of its processes. This is achieved through its tapping and centro-teleons relative to an attractor which resides in its nucleus.
- A doublet is *self-governing*, which is achieved through its centro-teleons.
- A doublet is *self-maintaining* and *may be self-reproducing*. Together this is referred to as autopoiesis by Maturana and Varela (Maturana and Varela 1992).

The distinction however, is not clear-cut and it may turn out that an entity is considered to be an 'incomplete' doublet. It may be in the process of evolving into a doublet, or even in the process of losing the properties of a doublet (i.e. in the process of surrendering its autonomy and sense of 'self').

5.2.11 Perspectives on the generic systems aspects

This section focuses on the doublet from the perspective of each of the generic aspects of a system: i.e. ethos, teleos, process, structure, substance and dynamic organisation.

5.2.11.1 Ethos perspective

The doublet is in the first instance ethos bound. Ethos gives the doublet an identity and serves as an attractor for the organisation of the teleonic field into an autonomous entity. The ethos serves as the ultimate field of reference in the co-ordination and balancing of the composite field of teleons and their respective fields of teleos.

5.2.11.2 Teleos perspective

The doublet comprises a composite field of teleons; in other words it is associated with multiple teleoses as opposed to its singular ethos.

a. Symmetrical and complementary pairs of teleos

The field of teleons may be viewed from the perspective of symmetrical and complementary pairs of teleos:

- exo-teleonic field vis-à-vis endo-teleonic field: i.e. outer environment vis-à-vis inner environment;
- centro-teleonic field vis-à-vis exo/endo-teleonic fields: i.e. 'self' vis-à-vis 'non-self';
- endo/exo-teleonic fields vis-à-vis endo/exo-tapping fields: i.e. 'give' vis-à-vis 'take'.

b. Holarchical distinctions

Alternatively a doublet may also be viewed from the perspective of the direction of its teleonic poles in the holarchy:

- exo-field: i.e. outwardly directed;
- centro-field: i.e. directed at itself;
- endo-field: i.e. inwardly directed.

c. Functional distinctions

A doublet may also be viewed from a functional perspective:

- a provision or giving function: i.e. its exo/endo-fields;
- a self-referral, balancing or co-ordinating function: i.e. its centro-field;
- a tapping, taking or integrating function: i.e. its exo/centro/endo-tapping-fields.

5.2.11.3 Process (mei flux) perspective

The process perspective on a doublet focuses on the flux of mei within and through the doublet. It represents a more fundamental level of abstraction or logical typing than that of the teleons. The observer essentially traces the flow and transformation of mei in space (conceptual and/or physical):

a. Mei flow perspective

The mei flow is not a simple case of input and output of mei to the system, as would be the case for the classical 'black box' approach of a cybernetic perspective. A three-level distinction is made for the doublet, i.e. an outer environment or exo-process-field, a centro-level or centro-process-field, and the inner environment or endo-process-field. These levels in their turn give rise to a mei flow from inside into the centro-level and vice versa, as well as a flow from outside into the centro-level and vice versa. In effect it explicitly adds another dimension of mei flux to all doublet systems.

The mei flow perspective does not explicitly make a teleological distinction; it simply focuses on the direction of mei flow in space. In this instance the endo-, exo-, and centro-prefix refers to the

direction of mei flow, and is not necessarily the same as the direction of its teleos in conceptual teleos space. It should be added that the flux of mei through the doublet is facilitated by the tapping teleons of the doublet field. The cell is an excellent case in point. It has a selectively permeable membrane giving rise to a 'tapped' or filtered two-way flow of mei from its outer to its inner environment and vice versa. It does, however, also hold true for non-living doublets, e.g. the planet and atom. For instance, the planet has a selectively permeable atmosphere which couples both with its outer environment (e.g. the solar and cosmic 'wind') as well as its inner environment (e.g. the radiation of heat and electromagnetic waves originating from its core-body).

a.i. Input/output between exo- and centro-process-field

This perspective refers to the two-way exchange of mei between the centro-level and the coupling of its exo-process-field with fields permeating its outer environment, i.e. those fields originating from exo-doublets. For example, a business organisation acquires information, finances and 'raw materials' (i.e. mei input) from its outer environment (i.e. its customers and service providers). At the same time it also makes available its products, by-products and other unintended, sometimes unwanted, outputs to its outer environment (i.e. mei output).

a.ii. Input/output between centro- and endo-process-field

This perspective refers to the two-way exchange of mei between the centro-level and the coupling of its endo-process-field with other fields permeating its inner environment (i.e. originating from endo-doublets). For example, in a business organisation there is a flow of mei from the employees to the centro-level in the form of their respective contributions towards the functioning of the organisation as a whole. Similarly there is a flow from the centro level to the employees in the form of instructions and remuneration.

b. Mei transformation perspective

The mei transformation perspective focuses on the transformation of mei within the doublet. Transformation may take place on the interfaces (i.e. as part of the coupling process) or may form an integral part of processes within the doublet. Transformation may also be viewed from the different aspects of the doublet. For example, mei may be transformed as part of a 'production' or *exo-process*, the *structure* of the core-body itself may be transformed, a particular *teleos* or even the *ethos* of the doublet may be transformed. Generally, if the structure or ethos of the doublet as a whole is transformed, we refer to it as a *transformation*. It should never be forgotten that the doublet as a field of mei flux is always in a state of *dynamic equilibrium*. Parts of this field are always evolving or being transformed into something else, even though we may not perceive or acknowledge this as such. There are no static structures in nature: "there is stability, but this stability is one of dynamic balance,

and the further we penetrate into matter the more we need to understand its dynamic nature to understand its patterns" (Rhee 1997, p.212).

5.2.11.4 Structure perspective (conceptual and physical)

The structure of a doublet manifests itself in its ethos or nucleus, the configuration and action-pattern of its associated processes, the meta-pattern of its field of teleons (i.e. its teleonomic poles) and in the spatial configuration of its core-body:

a. Nucleus (ethos)

The structure of the ethos associated with the nucleus exists in conceptual space and essentially refers to the pattern of organisational principles between processes and teleons in the doublet.

b. Process-field

Associated with all structured processes is an action-pattern, i.e. a series of actions which repeats itself in time. Focusing on these patterns enables the observer to understand the dynamics of the system, as well as the recursive relationship between process in time and its configuration in space.

c. Teleonic field

The structure of the teleonic field is abstracted from (analysed) or projected on (designed) a field of processes. The act of abstraction or projection in the teleonomic domain presents the observer with a pattern of teleos associated with a teleonomically-structured field of processes. From this pattern follows the abstraction or projection of the teleons. It should be noted that a particular process may to a greater or lesser extent participate in several teleons.

d. Centro/core-body

The structure of the core-body manifests itself as a spatial configuration of mei in physical or conceptual space. The core-body is traditionally associated with the physical structure of a 'concrete' system. In the case of a doublet as a composite field-like system, the core-body is only one of many aspects of its structure, and may not even exist as a discernible entity in physical space. For example, the core-body of a business organisation as a doublet need not exist in physical space. The observer may choose to associate the core-body with the actual business premises, which may turn out to be rather diffuse in physical space (e.g. the concept of the mobile office). On the other hand, the human doublet does indeed entail a physical body, i.e. its core body.

5.2.11.5 Substance (mei) perspective

Substance refers to all those separate 'entities' which 'embody' the doublet in conceptual and/or physical space. Substance makes the doublet perceptible to our senses, to our mind or our measuring

devices. Substance flows and interacts within the field of processes. In fact, it is the presence of substance that makes the processes perceptible and 'tangible'. Substance generally manifests on different levels of organisation within a doublet. On closer inspection some of the 'substances' may turn out to be doublets in their own right. In an entity-based systems approach the substance generally is that which is referred to as the parts of the systems. In the doublet it refers to all 'tangible' things (mei). In some instances they are considered to be doublets, e.g. endo-doublets or doublets flowing within the field of teleons, as would be the case for employees and clients of an institution. In other instances they are not considered to be doublets, e.g. food substances, technological parts or bits of information.

A functional distinction pertaining to substance within a doublet can be made as follows:

- input/output entities;
- transformer entities;
- supportive entities.

For example, in a school as a doublet the throughput (i.e. input/output) entities are the students, the teachers are the transformer entities, whereas all educational aids as well as the school building would be viewed as supportive entities.

5.2.11.6 Dynamic organisation perspective

This section explores a few aspects related to the dynamic organisation of a doublet as a focalised-field-like system.

a. Co-action of the teleonic fields

The doublet emerges from the dynamic organisation of and co-action between five poles in its teleonic field (exo, endo, centro, exo-tap and endo-tap). The following complementary pairs of teleons can be identified (it should be noted that the pairs also complement each other) (see Figure 70).

The complementary pair of '*giving*':

- directed at its inner environment (i.e. endo-pole);
- directed at its outer environment (i.e. exo-pole).

The complementary pair of '*taking*':

- tapping into the field permeating its inner environment (i.e. the endo-tapping-pole);
- tapping into the field permeating its outer environment (i.e. the exo-tapping-pole).

The organisationally closed *centro-pole* of '*individuation*':

- directed back at itself, i.e. the centro-level or the level of reference.

The teleons within a particular pole are said to co-act (e.g. within exo-pole or endo-pole). Essentially this implies that all teleons within the cluster or more specifically the pole, interact in such a way that they are congruent with a shared teleos field. There are sub-clusters within a major cluster of teleons associated with a pole with further distinctions of teleos associated with them. Ultimately all the clusters within a particular pole are dynamically organised in such a way that they are congruent and continuous with the overall pattern of teleos.

The doublet with its associated core-body is considered to emerge out of the co-action within, and interaction between these five teleonic poles.

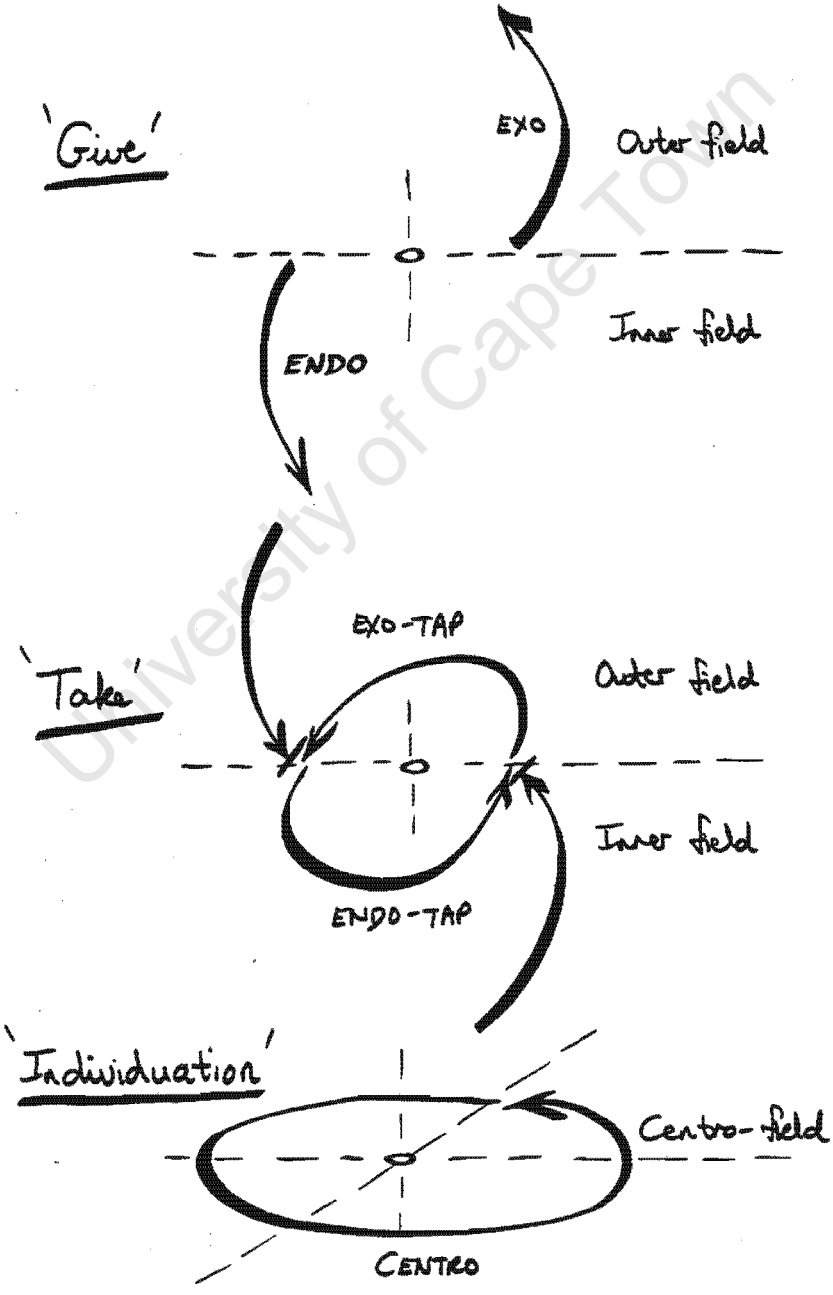


Figure 70: Complementary pairs of teleons in the doublet

b. Balancing/harmonising the teleonic poles

Apart from a balanced or congruent co-action between the clusters within a particular teleonic pole, it is also essential to achieve a balance or harmony between the respective poles.

Whereas an intra-polar balance is achieved through reference to a shared teleos, an inter-polar balance is achieved through reference to a shared ethos. In other words, congruency between the teleonic poles is relative to the single ethos associated with a doublet as a 'whole', or as a composite field of teleons. The dynamic organisation of this *act of inter-polar balancing* is mainly brought about by organisational teleons residing in the centro-pole. Thus, one of the functions associated with the centro-teleons is to ensure a congruent co-action between the respective teleonic poles of a doublet. It is a balance between 'being an introvert' (i.e. endo-pole) as opposed to 'being an extrovert' (i.e. exo-pole). This in its turn is balanced relative to a balance between 'being selfish'(i.e. centro-pole) as opposed to 'being unselfish' (i.e. exo/endo-pole).

c. The emergent middle

The reader may have noticed in the previous section that the 'self' is associated with the centro-pole, and both the endo-pole and exo-pole are associated with the 'non-self'. This is a direct result of the process- and field-based approach of a doublet as a system. This is such an essential concept that it justifies some further explanation, at the risk of unnecessary repetition.

For example, a more traditional systems approach would view the human-being as something which emerges out of the interaction of its cells. The cells are considered to be 'parts', components or units of the human system, and as a result all processes directed towards the cells or associated with the cells, are generally considered to belong to the system. Thus, with the more traditional approach the human body in its entirety would be considered to be the system under observation.

The doublet as a composite field of teleons results in a radically different viewpoint of what is considered to comprise the 'system', and what not. The focus is now on fields of processes with each pole exhibiting some emergent organisational properties. For instance, the human being as a field-like system exists on different levels of recursive abstraction, or logical typing: i.e. the nucleus, the exo/endo-pole in its process-field, the centro-pole in its process-field and the core-body. The endo-doublets (e.g. the cells) interact with the endo-pole of the doublet of focus, and the exo-doublets (e.g. family members) participate in the exo-pole. These two classes of interaction are considered to be of the same *logical type* (Roach and Bednar 1997). The only 'things' which are considered part of the system are the fields, the nucleus and the core-body (which is considered to be of secondary importance when it comes to identifying the system). The cells or endo-doublets are thus not considered to be part of the human doublet as a field-like system. They are considered to interact with

the system through the mediation of the endo-tapping pole. The exo-doublets are considered in a similar way.

Admittedly the endo-doublets or cells in this example are mainly responsible for the emergence of the core-body as a stable configuration in space. However, this is no reason to attribute to them the privileged position of being part of, or being 'within', the field-like system. Attributing to them alone this privileged position is, in our opinion, a fallacy which has its roots in an entity-based approach. In this instance the focus is exclusively and erroneously placed on those entities that are considered to reside within the system boundary. The boundary in its turn is based on the notion that the 'parts' are organisationally coupled in an 'intimate' way, resulting in the system as a whole. For instance, in the human organism (as an entity-based system) the mutually constrained interaction between all the cells (and organs) are considered to result in the human organism as a whole. A more accurate description, based on the biomatrix model, might be that *there exists a congruent and mutual coupling between the fields of activity originating from the cellular loci, and the fields of activity originating from the human organism as locus* (this description refers to the inner environment of the human doublet, the same is true for its outer environment). It leads to a three-level, field-based perspective on any system, with the locus of its fuzzy system boundaries residing on the 'middle level' (i.e. the level of focus).

To re-iterate, the doublet is a field extending into its inner and outer environment. Furthermore it is focused on the level of the centro-field. It is here that the 'self' or autonomous field-like entity is focused. The centro-field may be viewed as a thin 'layer', a layer of processes distinguished by its dynamic organisation, which is organisationally closed and self-referring relative to the nucleus.

This organisationally closed layer of processes is referred to as ***the emergent middle***. It emerges out of the interaction of the exo- and endo-fields with the outer and inner environment, with the centro-field residing in the middle (i.e. the relative level of organisation in the holarchy of field-like systems).

What implication does this have for our understanding of the human 'system'? It means that the human body is not the doublet or the system: it is only an aspect of it; more precisely it is the core-body. It also means that the cells residing in the inner environment, as well as all the people, institutions and other entities with which a human being interacts in its outer environment, do not comprise the doublet. These merely interact with the human doublet through their own associated fields. It is also true to say that from a physiological perspective the nucleus and centro-field reside in those processes associated with the central nervous system, whereas from a psychological perspective, the nucleus and centro-field reside in those processes associated with the ego or the self. From a spiritual perspective one may say that it resides in those processes associated with the notion of a 'soul' or a 'spirit'.

In the case of an institution the concept of the doublet becomes even clearer or easier to comprehend. Again, we may state that the employees do not comprise the organisation or institution. This is quite obvious, because we all know that only certain activities of the employees interact with the institution. Large portions of the employees' activity-fields fall outside the interest of the institution in which they participate, e.g. their family lives, nutritional activities, and so forth. Likewise, the customers and suppliers of resources do not comprise the institution; they merely interact with it in shared fields of activity. The exo-field would typically be the production and marketing processes, whereas the endo-field would typically be all support activities, e.g. procurement of resources, training and provision of an infra-structure. The nucleus and its associated centro-field is in the first instance associated with the organisational ethos. This is typically expressed in its policy documents, mission statement and also its founding act (the contents of which exist predominantly in conceptual space). From the perspective of physical space, the nucleus and its associated centro-field is associated with all processes of policy-formulation and decision-making, as well as the allocation of resources. These processes are typically associated with and reside on the level of the board of directors, the chief executive officer, or a senior executive committee.

d. Creation and evolution

There are essentially two ways in which a doublet may come into being. One is the 'intended' creation and projection of a nucleus into the field-like holarchy, referred to as governed organisation. The second is emergent organisation, which refers to the emergence of a nucleus out of at least two pre-existing interacting levels of organisation in the holarchy.

Thus, on the one hand a doublet may start off as a nucleus in the holarchic field of systems, gathering or attracting processes around it which are congruent with its ethos. Ultimately, this then produces a fully-fledged doublet, embedded between an associated outer- and inner field-like environment. Examples of this would be an institution which starts off as an idea in the mind of an individual, followed by a mission statement, policy document and founding act. Together these represent the nucleus of the potential organisation. At this point it may start to evolve as a fully-fledged institution with all the associated generic aspects of a doublet, e.g. its processes, teleons and structure. Another example would be the fertilised ovum of a human being. At this point it represents the nucleus of a potential human doublet. Within the environment of the uterus it evolves into an autonomous doublet or human being. Similarly the seed of a plant represents the nucleus of a potential doublet in the plant kingdom. Given the appropriate environment it evolves into a plant. In the physico-sphere the nucleus of an atom, stripped of all its electrons (e.g. the hydrogen ion), represents the potential for a fully-fledged atom. Similarly, a solar system is believed to evolve out of a point of gravitational focus embedded in a rotational plasma field.

Alternatively a doublet may emerge out of the interaction of pre-existing processes in a field-like environment. This is analogous to the process of spontaneous emergence of order out of an apparent chaos, as observed in non-linear, dynamic, thermodynamically dissipative systems (Prigogine and Stengers 1984). This emergent type of evolution effectively comes about in an area of flux between at least two pre-existing and interacting states of organisation (i.e. doublets). It is believed that within the context of the biomatrix this type of emergent evolution comes about when the teleonic fields, of at least two doublets, interact so as to create a new state of organisational closure (Maturana and Varela 1992). Furthermore, it is believed that the newly formed state of organisational closure is facilitated by the various tapping teleons of the interacting doublets. It is as if the act of tapping into their respective environments becomes interlinked or organisationally closed, giving rise to a new ethos and ultimately an attractor or nucleus. Metaphorically this may be seen as the interaction of two counter-currents or rivers of flux, producing turbulence out of which emerges a distinct area of 'circular closed flow', generally referred to as a vortex.

In reality these two types of organisation interact and impact on each other giving rise to a mutually recursive outcome. This combined outcome is referred to as dynamic organisation.

The following examples serve to clarify these two types of organisation. On the one hand the fertilised ovum presupposes a governed interaction of two pre-existing states of organisation, i.e. the act of procreation between the parents as doublets. On the other hand, out of the interaction between the two packets of genetic material emerges a non-determined new order. In its turn the newly born individual governs its interaction with its inner- and outer environment, which in its turn gives rise to a non-determined emergent 'selection' of the 'fittest' genetic material in future acts of governed pro-creation. Similarly a company may be created in an intended and governed act of formulating a mission and policy statement. In due course the newly created company interacts with its inner and outer environment, which invariably gives rise to unintended, non-determined changes in its processes and structure, i.e. an emergent organisation. These changes may impact on its ethos and policy document which in their turn may be formally incorporated as a governed and pre-determined process of re-structuring or transformation.

5.2.12 Notes on related viewpoints

- In the terminology of Living Systems Theory, the *units* of a doublet are processes (Miller 1978, p.16-19). However, Miller's LST emphasises the role of *concrete* systems, with concrete units, and by definition also their *boundaries* in physical space (Bailey 1995). According to Miller: "Theory which deals with concrete systems avoids two common sorts of confusion. One is the confusion of conceptualizations which seem to assume that information can be transmitted from system to system without markers to bear it. The other is the confusion of some social science theories which appear to assume that actions, roles, or relationships carry

on a life of their own, independent of other aspects of the people or other concrete systems whose processes they are" (Miller 1978, p.22). This quote serves to highlight some of the primary points that the biomatrix model tries to make. Firstly, although processes admittedly can not "carry on a life of their own", ***neither can discrete or focalised entities carry on a life of their own***. Secondly, the phrase "or other concrete systems whose processes they are" only deals with one perspective of reality, i.e. viewing process as the outcome of an interaction between entities, as opposed to ***also viewing entities as the outcome of an interaction between processes.*** Admittedly Miller may argue that no process can exist without a concrete entity or "marker". The biomatrix model is in agreement with this, but takes it one step further and also maintains that ***no discrete or focalised entity or "marker" can exist or come about without process.***

- The Gaia theory considers the planet earth as a superorganism (Markos 1995) and in that sense our planet may actually satisfy all the requirements of a doublet .
- The following extracts from Laszlo puts the concept of the doublet as a *field-like-activity-based system* in perspective (these extracts are presented in section 1.4, page 6, and are being repeated here):

> Attention in the contemporary natural sciences has shifted from the description and classification of individual entities to the theoretical explanation of classes of entities forming ordered structures or events. ... Thus classical physics gave us particular entities as the ultimate furnishings of this world, with classification serving the primary heuristic purpose of building theories for calculating their behaviour. ... The new physics deals with ordered sequences of events, forming wholes, which can only arbitrarily, and usually without success in formulating exact laws, be analysed to individual components. The general construct for these ordered wholes is field. (Laszlo 1972, p.23)
>
> Before Clerk Maxwell, people conceived of physical reality – insofar as it is supposed to represent events in nature – as material points, whose changes consist exclusively of motions...After Maxwell they conceived physical reality as represented by continuous fields, not mechanically explicable...This change in the conception of reality is the most profound and fruitful one that has come to physics since Newton. (Einstein in: Laszlo 1972, p.23)
>
> Physics' conception of nature as forming ordered fields with complex subsidiary patterns is reflected in the new chemistry, where molecules are viewed as complex dynamic patterns formed by the sharing of the outer electrons (conceptualizable both as waves and particles) between several nuclei. Further counterparts to these concepts are found in biology. There, organisms are no longer viewed as discrete entities made up of similarly

6.1 Contributions of this research process

The aim of this thesis is the formalisation and further development of the biomatrix model into a congruent and rigorously defined general systems model, rather than the proving or disproving of any particular hypothesis.

The complete model should be viewed as a rigorously defined proposition: it should not be evaluated on the basis of perceived relevance or applicability, but rather on the basis of *logical consistency*, *contextual congruency* and *soundness of endeavour*. The contributions of this research process should thus be seen in the context of the model as presented in this thesis document (see Appendix B for a synopsis of the most important concepts, principles and contributions of the biomatrix model and Appendix C for a critical response to some issues raised).

The biomatrix model makes several contributions to the field of systems science, the most insightful of which probably is the distinction between the *teleon* and the *doublet*, which constitute complementary classes of systems in the biomatrix. This distinction is based on the notion of a field-like, process-based, and holarchic organisation of the universe. The concept of a field of teleons explicitly acknowledges the existence of spatially extended and congruent chains of mei flux across conventional, 'entity-based' system boundaries. At the same time, the concept of the doublet as a focalised field of teleons also forces a change in our perception of 'entities' and challenges the traditional notion of a system boundary. These spatially focalised systems are considered to be the loci for fields of interacting teleons, i.e. mei flux-lines. Therefore, both classes of systems consist of fluxes of mei, the threads (teleons) being *teleos-bound* and the points of focus (doublets) *ethos-bound.* These concepts make a significant contribution in the sense that they represent a new way of abstracting and viewing systems, while also having an ontological basis. Therefore, they render a more complete approximation of a reality based on a fundamental duality, embedded in a field of mei in flux.

The notion of composite and complementary fields leads to the concept of the *emergent middle* and the necessity of taking at least three levels of organisation into consideration when focusing on any system. In this regard it contributes to our understanding of how 'things' come about and manage to persist as integrated but autonomous entities in the universe. In doing so, it proposes a truly complementary 'top-down', 'bottom-up' causality, with the nucleus serving as point of reference and acting as a locus for the spatially diffuse, field-based doublet (as a system). The rigorous definition of generic systems aspects into ethos, teleos, process, structure, substance and dynamic organisation, as well as their dynamic relationship, is meaningful. For instance, structure is explicitly defined as manifesting in *space* as well as in *time*, which in turn points to the fundamental unity of time and space as a logical outflow of the process-based perspective of reality. In terms of the organisation of a system, a clear distinction is made between emergent organisation and governed organisation, with

particular emphasis on the complementary role of these principles in the evolution of all systems. Classical systems thinking does not generally treat these distinctions in such an explicit manner. The distinction enables the tracing of the dynamic evolution of a system in phase-space, by looking at the contributions of different phases and generic systems aspects to the overall dynamic organisation of the system.

The precise definition of the concepts of congruency and continuity in the context of a teleonomically integrated field of processes, leading to the concept of *telentropy,* is also a meaningful contribution. These concepts provide a means whereby systemic creation and transfer of 'disorder' or 'stress' can be analysed, contextualised and communicated. Bearing in mind the balance between exo-, endo-, centro- and tapping-teleons, as viewed from the generic systems aspects, the concept of telentropy also makes a valuable contribution to our ability to recognise, predict and deal with systemic 'disorder'.

Finally it can be stated that the model makes a significant contribution to system sciences in the sense that it proposes an integrated, congruent and rigorously defined general system model, the fundamental premises and quintessential structure of which are 'deeply' embedded in a field- and process-based paradigm.

6.2 Suggestions and recommendations for future research

The future development of the biomatrix model is envisaged to centre around further validation of its usefulness in terms of its application to multi-disciplinary issues, as well as the further development of its content. It will be noted from the number of papers listed in the Biomatrix Bibliography that considerable work has already been done in this respect.

6.2.1 Application of the model

The future application of the model to the bio-, socio- and psycho-spheres is desirable. Its application to real-life issues by a diverse group of system practitioners would demonstrate the usefulness of the model beyond doubt, at the same time providing valuable feedback for its future development.

The model has a potential for application to all social institutions, as well as to the individual levels of organisation (e.g. in the fields of psychology and health). Its attractiveness lies in its ability to contextualise and integrate the different levels of organisation pertaining to the individual doublet, i.e. those levels considered to be within its outer environment (society at large), at the centro level (psychology), and its inner environment (biology). Pressing problems in the fields of health care and education deserve special mention, especially since they call for an integrated approach that considers all levels and spheres of organisation.

The benefits of a partnership between systems science and organisational theory are obvious (Galliers, Mingers et al. 1997), especially for applying systemic principles to the structuring and organisation of large business institutions. The biomatrix model has been found to be particularly useful in explaining the importance of systemic principles to business. To further enhance and facilitate this process the 'packaging' of the model for specific application to business management is suggested. This should include a contextualisation of key issues in management science as viewed from a biomatrix perspective. For example, the notion of a matrix organisational structure has already been touched upon (Dostal and Jaros 1994b; Dostal 1997; Jaros and Dostal, 1999). The identification of a series of generic structures or archetypes of dynamic processes that recur in diverse settings and that embody important management principles (Senge 1990; Lane and Smart 1996) will further extend the application of the biomatrix model.

6.2.2 Content of the theory

The ontological basis for the concepts of teleon and doublet justifies further research (Davies 1992). In the socio-sphere the existence of teleons is by and large an outcome of human intent. That is to say, we intentionally create teleologically continuous links of mei flux between levels of organisation and within society to serve our purposes. On the other hand, teleons in the naturo-sphere exhibit an apparent teleos that took millions of years to evolve. The different levels of organisation associated with ever larger entities in the physical world are obvious; but it is not easy to determine whether these entities are in actual fact linked through vertical channels of mei flux, and if so, the exact nature of these links.

When exactly an entity is considered to comply with all the characteristics of a doublet is not always that clear. This is in a sense similar to the problem associated with our distinction between animate and inanimate 'systems'. On the one hand life appears to be a continuous spectrum, ranging from inanimate systems to animate systems (with the virus on the interface between the two). On the other hand, we tend to have very specific ideas about what constitutes life, and what does not. In the context of the biomatrix, the point that needs further investigation concerns the properties that distinguish a doublet from the environment within which it emerges. Furthermore, it needs to be established whether these characteristics are really 'innate' properties, with an ontological basis, or whether they are mere abstractions in the mind of the observer. The posing as well as answering of these questions cuts to the heart of age-old philosophical debates which are not easily resolved. In fact, from a certain perspective, these questions may not even be meaningful questions to ask.

The notion of the *emergent middle* and its implications for the evolution of systems are also considered to justify further research. It essentially implies that all systems effectively evolve between two pre-existing levels of organisation. How this relates to the prevailing theories of evolution concerning biological systems and for that matter the entire universe, should provide fruitful ground for further research and may reveal some interesting insights in these fields.

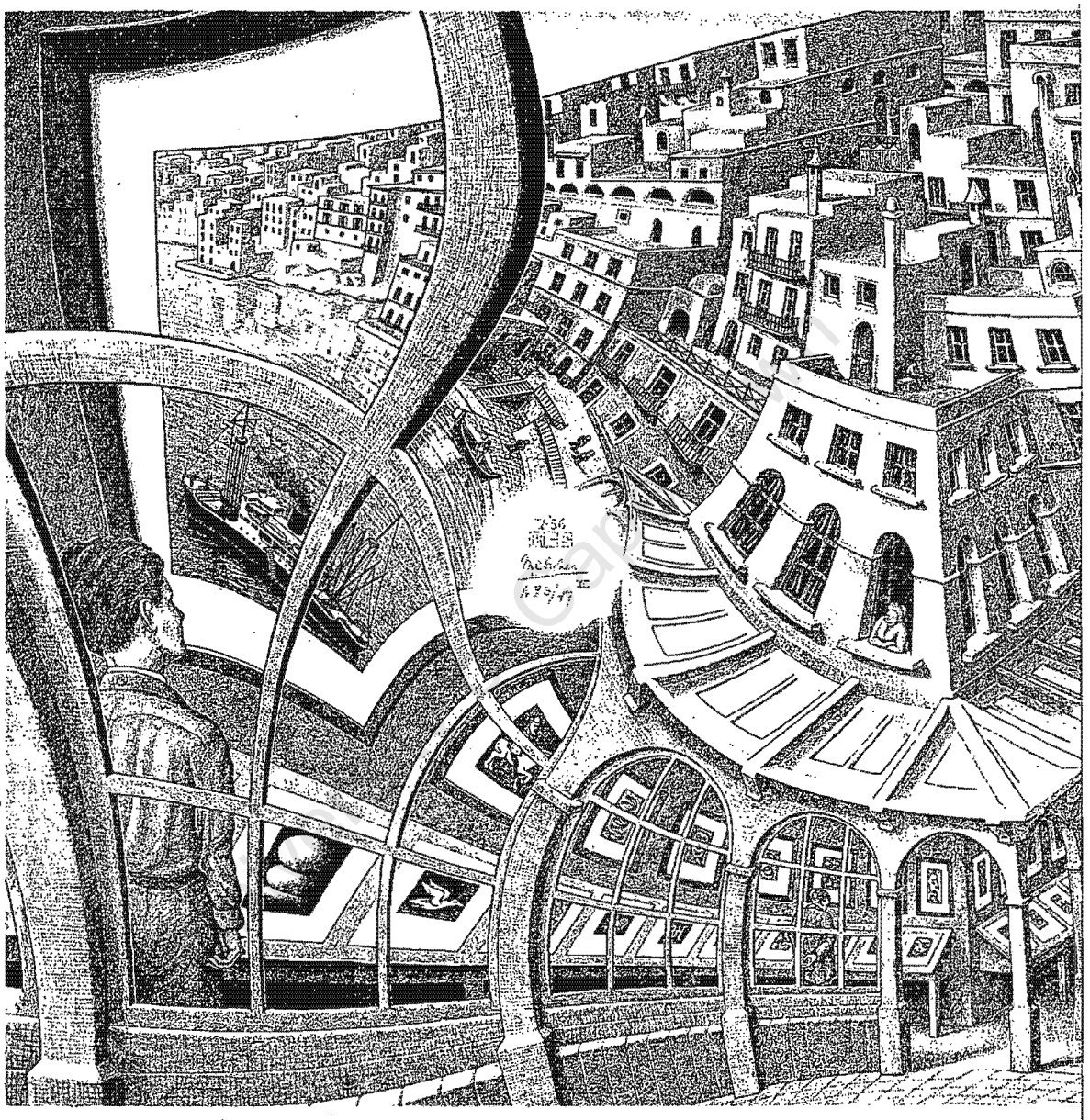
6.3 Conclusions

The biomatrix model has been formalised and developed, in agreement with the aim and research paradigm of this thesis, into a logically consistent and contextually congruent general systems model.

The biomatrix model has been presented in the form of a series of well-defined and integrated theoretical constructs, contextualised and set within the *process* and *field paradigm*. In some instances existing system concepts have been redefined, while a number of novel concepts, principles and approaches, which are consistent with our experience of reality have been introduced. The researcher trusts that the development and formalisation of the biomatrix model as undertaken and presented in this thesis will make a meaningful contribution to the field of systems theory and related sciences and that it will stimulate future research, application, validation and constructive evolution of the model itself. In our experience, not reported in this thesis, the model provides an integrated understanding of multi-levelled and multi-dimensional systems and serves as a means whereby inter-disciplinary studies and communication are facilitated.

Above all it is hoped that the research reported in this thesis will provide a comprehensive but relatively simple perspective on human beings and their world, thus making our fragmented information more available for the intelligent and, more importantly, compassionate conduct of life.

> *The best stories are those which stir people's minds, hearts and souls and by doing so give them insights into themselves, their problems, and their human condition. The challenge is to develop a human science that more fully serves this aim.* (Reason 1981a, p.50)



7. Appendix A: Alphabetical glossary of key concepts

7.1 Action

Action refers to a change of mei in time and space (conceptual or physical), as observed relative to the context and the period of observation.

Image / Metaphor

- **A dancer:** continuously changing shape and position.
- **The weather:** a combination of pre-determined patterns (i.e. seasons) as well as unpredictable chaotic changes.

Example

- moving.
- changing shape.
- talking.
- breathing.
- growing.

7.2 Biomatrix

The biomatrix refers to the universal web of holarchically organised process-threads (i.e. teleons) and focalised-field-like entities (i.e. doublets).

Image / Metaphor

- A fisherman's web with its knots (i.e. doublets) and threads (i.e. teleons).

7.3 Biomatrix space (BMS)

The space *described by* the biomatrix model is referred to as the biomatrix space (BMS). A distinction is made between *physical space* and *conceptual space* (i.e. in the mind of the observer).

7.4 Centro-tapping-teleon

A centro-tapping teleon is a teleon considered to perform the function of re-integrating teleons originating from the doublet of focus back into the doublet itself.

7.5 Centro-teleon

A centro-teleon is a teleon with an associated teleos which is considered to be referring back to the reference level of organisation of its doublet of origin (i.e. self-referring to the reference level of organisation).

7.6 Congruency

Systems, processes and structures are said to be congruent if they are in harmony, are mutually supportive or are in agreement, relative to their ethos, teleos, process, structure, substance or dynamic organisation.

Image / Metaphor

- A jig-saw puzzle.
- A dancing couple.

7.7 Continuity

Continuity refers to a congruent coupling, or interaction between a series of actions and structures, over a period of time and in space.

- **Temporal continuity**: congruency between the individual phases of an action-focused series as perceived over time.
- **Spatial continuity**: congruency between the individual segments of a thread-like-action-focused series as perceived in space.

Image / Metaphor

- A relay race.
- A road network.

Example

- The segments of the digestive tract (i.e. spatial continuity)
- The developmental phases of an individual (i.e. temporal continuity)
- The segments of a communication network (i.e. spatial continuity)
- The segments, or lines, of delegated responsibility in an organisational structure (i.e. spatial continuity).
- The phases and segments of a production process (i.e. temporal and spatial continuity)

7.8 Discrete entity

Discrete entities are spatial configurations of mei which are demarcated within real or conceptual space by distinct and finite boundaries.

Image / Metaphor

- An object.
- A concept.

Example

- A 'packet' of energy, referred to as a quantum.
- A rock.
- A chair.
- The physical human body.
- A gathering of people (e.g. spectators at an event).
- A 'packet' of information: i.e. a concept described by symbols (e.g. language).
- A document or book.
- A company as a distinct legal entity.
- A nation.

7.9 Doublet

A doublet is a focalised-field-like entity; it emerges from a composite field of teleons, dynamically organised around an attractor or nucleus, in which resides a focalised ethos.

More specifically, a doublet comprises:

- A *nucleus or attractor* (in conceptual space), associated with the centro-level of organisation, within which centres a focalised field of ethos (in conceptual space). The nucleus serves as an attractor for the field of teleons, and dynamically organises the doublet into an autonomous entity. It gives rise to an emergent centro-level of organisation (i.e. the level of reference). It also serves as a reference for the 'self', or 'whole', and gives rise to the doublet being an autonomous and integrated entity (or system).
- A *composite field of teleons*, producing, and considered to be part of, the doublet, comprising the following generic distinctions:
  - an *exo-field* of teleons, its teleos directed at its associated exo-doublets in the outer environment;
  - a *centro-field* of teleons, its teleos referring back to itself (i.e. of the reference doublet), or the centro-level of organisation;
  - an *endo-field* of teleons, its teleos directed at its associated endo-doublets in the inner environment.
- A *field of tapping teleons* which is superimposed on the above fields (as an additional distinction), comprising:
  - an *exo-tapping field* of teleons, its teleos directed at integrating what is on offer from the fields of the exo-doublets, into the field of the reference doublet;
  - a *centro-tapping field* of teleons, its teleos directed at re-integrating what is on offer from the centro-teleonic field into the field of the reference doublet;
  - an *endo-tapping field* of teleons, its teleos directed at integrating what is on offer from the fields of the endo-doublets into the field of the reference doublet.
- A *centro-body, or core-body*, emerging from the composite field of teleons. It manifests as a spatially (conceptual and/or physical) discrete and focalised structure, associated with the centro-level of organisation of the doublet.

An inner- and outer environment can be distinguished as follows:

- An *inner environment*, i.e. the field-like space (conceptual and/or physical), considered by the observer to fall 'inside' the centro-level of organisation.
- An *outer environment*, i.e. the field-like space (conceptual and/or physical), considered by the observer to fall 'outside' the centro-level of organisation.

The following types of dynamic-organisation originate from the centro-level:

- *Co-organisation* with reference to doublets in its *outer-environment* (i.e. its exo-teleonic-field).
- *Autonomous organisation* with reference to *itself* (i.e. its centro-teleonic-field).

- *Co-organisation* with reference to doublets in its *inner environment* (i.e. its endo-teleonic-field).

Image / Metaphor

- A tree with its roots (endo-field), main trunk (centro-body) and branches (exo-field).
- A cloud, having nebulous boundaries, and forever emerging, as a focalised-field-like-entity, in dynamic equilibrium.
- A beehive: the hive representing the core body, the flight patterns of bees representing the exo-field, the trails of the bees within the hive representing the endo-field, and the queen bee representing its nucleus.
- A spider's web: the spider (i.e. the nucleus) at its centre, and the web of threads (i.e. the field of teleons) emanating from it.

Example

- An atom.
- A living cell.
- A human being.
- A family.
- An organisation, e.g. business organisation, school, society, the 'world-wide-web'.
- A 'body' of knowledge.
- A government.
- The planet and the solar system.

7.10 Dynamic organisation

Dynamic organisation refers to the combined outcome of all the 'guiding forces' in a system, i.e. the combined outcome of the *emergent organisation* vis-à-vis the *intended organisation or governance* of a system.

7.11 Emergent organisation

Emergent organisation refers to the innate ability of a system to organise itself as a result of the interaction between its units.

7.12 Endo-tapping teleon

An endo-tapping-teleon is a teleon considered to perform the function of coupling teleons from the inner environment with the doublet of focus.

7.13 Endo-teleon

An endo-teleon is a teleon with an associated teleos which is considered to be directed towards the internal environment of its doublet of origin (i.e. inwards relative to the reference level of organisation).

7.14 Ethos

Ethos refers to the field of organisational principles guiding a system.

Ethos serves as a reference for what is 'preferred', 'the norm', 'right' or 'wrong', 'good' or 'bad', 'important' or 'not important' and 'desirable' or 'not desirable' for the system in relation to itself, to its inner environment and to its outer environment. Ethos is manifested in different ways on the different levels of the biomatrix:

- **physico-chemical:** 'laws' of nature relative to aspects that support congruent states and dynamic equilibrium within a system;
- **biological sphere:** mutually evolved organisational principles relative to a congruent co-existence and co-emergence of organisms;
- **psycho-social:** aesthetics, ethics, value system

Examples

- On the atomic level the principle of attraction and repulsion between particles, and symmetry in sub-atomic particles, give rise to evermore complex structures of a certain kind. The universe is apparently 'valuing' an increase in a select type of order.
- On the cellular level the genetic code contains guiding principles for the interaction between, and prioritisation of, intra- and inter-cellular processes.
- On the level of the organism the autonomic nervous system of an individual contains a set of pre-programmed rules which pertains to its organisation as an integrated whole (i.e. relative to its inner and outer environment).

- On the level of the individual person a set of values can be recognised, e.g. being selfless as opposed to being selfish.
- On the level of the business organisation, an organisational ethics can be recognised, e.g. competitiveness as an important principle in its organisation.
- On the societal level a Bill of rights and Constitution represent the ethos of the nation state.

7.15 Exo-tapping teleon

An exo-tapping teleon is a teleon considered to perform the function of coupling teleons from the outer environment with the doublet of focus.

7.16 Exo-teleon

An exo-teleon is a teleon with an associated teleos which is considered by the observer to be directed towards the external environment of its doublet of origin (i.e. outwards relative to the reference level of organisation).

7.17 Focalised field of teleos

A focalised field of teleos in conceptual space refers to an ensemble of teleoses associated with a single point of focus.

- Together, these points constitute a single focalised-field-of-teleos.
- The field is fractal-like, i.e. repeating itself with ever larger, and ever smaller, groupings or clusters. Thus, each grouping may be collapsed into a single focal point; alternatively, each focal point may be expanded into a field of points, in their turn clustered around the expanded focal point.

Image / Metaphor

- A Galaxy: viewed from afar, it appears to be a single point, from closer up, it keeps on expanding into ever smaller clusters of stars, and planets, clustered around the stars.
- A cross-section through a piece of string, i.e. ever finer threads twined around a central axis, or its focal point.

Example

- **Education:** education may be viewed as a focal point of teleos; with *teaching*, *learning*, and *managing*, in their turn, viewed as points in the associated field of teleos, clustered around the main focal point. Similarly, *learning* may be viewed as a focal point in its own right, with *reading*, *thinking*, *searching* and *memorising* as its associated cluster of points (in conceptual teleos space).

7.18 Function

A function refers to a particular outcome or effect associated with a process or structure.

- The concept of a function is considered to belong to the teleos-class of concepts, in the sense that the associated process/structure is dynamically organised towards sustaining, or having the effect of, the outcome.
- Different functions may be associated with the same process/structure, a phenomenon referred to as multifunctionality.
- Different processes/structures may be associated with the same function (i.e. different means to achieve the same outcome).

Example

- **Illumination**: a function of the radiation process of the sun, as opposed to also radiating heat as an outcome.
- **Pumping blood**: a function of the contraction processes of the heart muscle, as opposed to also generating heat as an outcome.
- **Acquiring goods**: a function of the acquisition process, as opposed to also having fun as an outcome.
- **Nutrition**: a function of the eating and drinking process, as opposed to spending time with family or friends as another outcome, which of course also becomes a function if so intended.
- **Providing support**: a function of a chair, as opposed to also taking up space, or being aesthetically pleasing, which are other possible functions.
- **Creating a desirable image of a product**: a function of the advertising proces, as opposed to perhaps also being entertaining, which may also become a function if so intended.

7.19 Goal

A goal refers to a specific preferred-end-state which has not yet been realised.

- **Intended goal**: an intended goal is a conscious expression of, or explicit formulation pertaining to, a desired future state of a system, prior to the future of the system.
- **Emergent goal**: an emergent goal emerges out of the dynamic interaction of a system, and manifests itself as a preferred-state over time. Emergent goals are always abstracted from a system by the observer.
- **Projected goal**: a projected goal is an intended goal which is projected onto a system by the observer.
- **Abstracted (observed) goal**: if the observed state of a system repeatedly and persistently appears to be attracted towards a particular state, in the presence of different prevailing conditions, then this **preferred-state** is referred to as an abstracted, or observed, goal of the system. An abstracted goal may be intended within the system, or it may emerge within the system, without any intention.

Image / Metaphor

- An arrow pointing at a mark.
- The top of a mountain, or the bottom of a well.

Example

- A specified level of fitness (intended and/or emergent; abstracted and/or projected).
- A particular destination to be reached at a point in time (intended and projected).
- 'Quality' time at home (intended and/or emergent; abstracted and/or projected).
- 'Good' interpersonal relations (intended and/or emergent).
- Specific production targets in an organisation (intended and projected).
- An acceptable level of inflation (intended and/or emergent; abstracted and/or projected).
- A literate population (intended, abstracted and/or projected).
- The lowest point in a bowl, which acts as an attractor: i.e. a ball running down the sides of a bowl always comes to rest at the lowest point, irrespective of where it is initially placed on the inner surface (emergent and abstracted).
- The centre of the valley, towards which flows all the water running down a catchment area (emergent and abstracted).
- A specific body temperature and blood sugar level, i.e. homeostatic levels maintained in the body (emergent and abstracted).

- Water and light sources, acting as attractors in plant growth (emergent and abstracted).
- A recurrent behavioural pattern, as observed over time, in a human being or family (intended and/or emergent and abstracted).
- A city, acting as an attractor for the migration of people, i.e. the urbanisation process (intended and/or emergent and abstracted).
- Increased size, i.e. growth, as a persistent tendency in some public service organisations, possibly even in the presence of a stated, and intended, policy for reducing its size (emergent and abstracted).

7.20 Governance

Governance or governed organisation refers to 'intended', planned, programmed or predetermined organisation of a system.

7.21 Process

A process is a series of actions over time leading towards an end-state relative to a particular period of observation.

Image / Metaphor

- **Evolution:** i.e. a series of actions leading to a transformed end-state.
- **A cinema picture**: i.e. a series of frames creating the impression of a successive flow of events.

Example

- **Energy transfer process:** e.g. absorption of energy→transformation of energy→radiation of energy.
- **Commuting process:** e.g. walking→driving→parking→walking→arriving at office.
- **Design process:** e.g. brainstorming→analysing→synthesising→design specification.
- **Transformation process:** e.g. re-designing→implementation or re-structuring→monitoring.
- **Nutrition process:** e.g. selection of food→preparing→eating→digesting→metabolising.

7.22 Purpose

A purpose is the meaningful contextualisation of teleos, relative to the ethos of the observer.

- Based on the pattern of interaction, it highlights, interprets or intends a continuity, or "flow" of teleos within the biomatrix.
- It is a subjective interpretation and meaningful explanation, relative to the ethos of the observer, in terms of what teleos is being served by a given system.
- It can either be intended and projected on, or abstracted and interpreted from, a system.
- The existence of the system under observation is considered to be subservient to its ascribed purpose.
- The concept of purpose is considered to belong to the teleos class of concepts in the biomatrix.

Purpose-related ascriptions of a system generally include reference to one or more of the following aspects:

- the **ethos of the observer** (albeit implicit);
- an apparent, or perceived, **continuity of teleos** (implicit or explicit reference to) with another system(s);
- a function(s);
- a goal(s).

Example

- The purpose of the sun could be interpreted as the provision of energy and light to planet earth, or to serve as a god for the ancient Egyptians.
- The purpose of a river could be interpreted as the circulation of water and the provision of an environment for organisms, or as an area for human recreation, or as a means to navigate.
- The purpose of trees could be the creation of an aesthetically pleasing and shady environment for human beings (i.e. intended and projected), or a source of oxygen (abstracted and interpreted).
- The purpose of the heart could be interpreted as: to pump and circulate blood throughout the body, or as the seat of the mind for the Buddhist.
- The purpose of a chair could be to provide comfortable seating and to be aesthetically pleasing for the user, or as a means to match the height of hands to a working surface.
- The purpose of the process of eating could be to feed my body and soul, to socialise with friends, or to settle a business deal.

- The purpose of an individual's life process (intended or abstracted) could be to serve himself/herself and his/her fellow beings, or as a service to God.
- The purpose of a business company could be to serve its employees, its shareholders and the larger community in which it participates.
- The purpose of government may be to govern society in a way that is beneficial to the individual, the group and the environment, or as a means to gain and hold power.

7.23 Structure

> Structure refers to those relationships between elements (e.g. discrete entities, actions or processes) which appear to remain constant relative to a particular period of observation and level of organisation as defined by the focus of the observer.

The following distinctions may be made pertaining to structure:

- **spatial configuration:** a structure considered to manifest primarily in the spatial domain (physical or conceptual);
- **action-pattern (temporal-structure):** a structure considered to manifest primarily in the temporal domain.

The following distinctions are of a different logical type:

- **conceptual structure:** a structure considered to manifest primarily in conceptual space;
- **physical structure:** a structure considered to manifest primarily in physical space.

Image / Metaphor

- A **tree:** a configuration in physical space.
- A **field of knowledge:** a configuration in conceptual space.
- A **whirlpool**: both an action-pattern and configuration in physical space.
- A **dance sequence:** an action-pattern manifesting both in conceptual and physical space.
- A **cloud**: both an action-pattern and configuration in physical space.

Example

- The spatial configuration or shape of a physical object(s): e.g. round, fork-like, densely scattered, human-shaped.
- An institutional structure: e.g. the relative configuration of different departments and functions in a business organisation.
- The pattern of traffic flow or migration of animals (i.e. action pattern).
- Behavioural patterns (i.e. action patterns).
- Cultural structures: e.g. values as relative configurations in conceptual space.

7.24 Substance

The substance of a system refers to all those separate 'entities' which embody a system (conceptual or physical), in other words, that which makes a system perceptible to our senses, to our mind, or our measuring devices.

7.25 Tapping-teleon

A tapping-teleon is a teleon considered to perform the function of coupling teleons from the inner and outer environment with the doublet of focus.

7.26 Telentropy

Telentropy at any moment in time can be defined as a measure of uncertainty associated with a teleon reaching its preferred teleos, given its present state. Put differently, the telentropy associated with a teleon is inversely proportional to the probability (at that moment in time) that it will reach its associated teleos, given its present state.

7.27 Teleon

A teleon is a process-based, thread-like-entity, extending in time and space in relation to a focalised teleos-field.

More specifically:

- A teleon comprises an integrated web of processes (in physical and /or conceptual space), dynamically and collectively organised towards, or 'aimed at', a focalised teleos-field.
- The focalised teleos-field serves to cohere, integrate and demarcate its associated processes into a distinct entity.
- The integrated web of processes can be viewed as a teleos-based vector, or "arrow", in conceptual space.
- It originates within, and is associated with at least one doublet of origin.
- The teleon (and by implication its associated web of processes) interacts with, and connects at least two doublets (generally more).

- It manifests an apparent continuity of teleos across all participating doublets and their associated levels of organisation. This gives rise to a teleos-coupled chain of processes, extending both in space and time.

Image / Metaphor

- A thread within a web (e.g. a fisherman's net).
- A ray of light in a field-like-space.
- The lines of force in an electromagnetic field.
- 'Functional chains' within society.

Example

- Radiation-of-energy teleon (e.g. from the sun).
- A transportation teleon (e.g. a road network with its associated vehicles).
- Oxygen-provision-to-the-cells teleon.
- Manufacturing-of-a-product teleon.
- An education teleon.

7.28 Teleos

Teleos refers to a state or outcome towards which a process (or system) tends to be directed, attracted or which it dynamically persists in.

- It either emerges from the system, and is observed (i.e. abstracted), or is intended (i.e. projected onto the system).
- A system is considered to be attracted towards a preferred state if it persists, under different prevailing conditions, in its present state, or persists in progressing towards a particular future-state (or end-state).
- Whenever a system exhibits the aforementioned properties it is said to be **teleos-related**.
- The overall concept of teleos is inclusive of, and depicts, a range of concepts in the same class, i.e. purpose, goal, and function.

Image / Metaphor

- A **target** being aimed at.
- The **sun** acting as an attractor (for the earth or a plant).
- A **habit** or **persistent pattern of organisation**.
- A **vision**.

Example

- A **function** as a generic outcome of interacting processes, e.g. walking and talking.
- An **emergent goal** as a **preferred outcome,** e.g. water flowing towards the sea, diffusion processes tending from high to low concentrations, and an organism persisting in a particular habit or behavioural pattern, e.g. migrating towards a nutrition-rich environment, or moving away from a 'dangerous' area.
- An intended **goal,** e.g. working towards a specified sales target.
- An **intended purpose,** e.g. pursuing a healthy diet in order to promote a state of health.

7.29 Time

Time refers to the observer's perception or measurement of the progression and duration of events.

Image / Metaphor

- The incessant flow of water down a river.
- The different phases of the moon.

Example

- The 'time' and date (i.e. progression of events).
- The time it takes to complete a task (i.e. duration).
- The birth, growth and inevitable ageing of living organisms (i.e. apparent flow of time).
- Time that seems to 'fly' when one is engaged in a pleasurable activity and 'drag' when one is bored (i.e. the subjective and relative nature of time).

8. Appendix B: Concepts, principles and contributions of the biomatrix model

This is a synopsis of the most important concepts, principles and contributions of the biomatrix model.

8.1 General aspects

- The biomatrix model proposes *a universal framework and meta-pattern of organisation* in all spheres and on all levels of being.
- The model makes *ontological statements* about the quintessential nature and organisation of all systems which may serve as a basis for future inquiry into the nature of reality (e.g. the field-like nature of localised entities, organisation as an interplay between intended and emergent outcomes, and evolution as an interplay between two pre-existing levels of organisation).
- The model puts forward a *conceptual framework* for both *reductionistic* and *'wholistic'* excursions by the *observer*, suggesting an improved *understanding* of, and *insight* into the field of focus.
- The strength of the model resides not only in the clarity of its *individual concepts* but also in the way these have been contextualised into a *congruent framework* supporting *different perspectives*. In this regard the numerous graphical representations of concepts and their relationships are considered to make a significant contribution.
- The model suggests an *overall context and language for discourse* (i.e. a meta-language) around which issues from a *wide range of disciplines* may be debated.

8.2 The biomatrix: a field of mei in flux

- The model is supportive of a *field-like* perspective on a reality which is underpinned by *process and flux*.
- The model introduces the concept of a *field of mei in flux* (referred to as the *biomatrix*) and suggests that all systems are field-like by their very nature.

8.3 Duality and symmetry

- The *teleon* and the *doublet* are defined as a *complementary pair* of systems, both representing a unique aspect of reality, but also co-producing each other. They are considered to constitute a fundamental *duality*, analogous to that of the wave and the particle in physics. The model thus suggests a *dual perspective on reality* as represented by these *two classes of systems*.

- The principles of *symmetry* and *complementarity* are proposed as fundamental to the organisation of the model (e.g. the *exo-* vis-à-vis *endo*-pole of the doublet, *inner* vis-à-vis *outer* environment of the doublet and *intended* vis-à-vis *emergent* organisation).

8.4 The teleon

- The biomatrix model views action per se as a specific class of system, viz. the teleon which is defined and *demarcated by its teleos*. The observer is encouraged to explicitly search for *teleonomic continuity in the mei flux*. This results in a *thread-like* or vector-like system of action *traversing different levels of organisation*.
- The teleon is regarded as *a thread of activity in both time and space* as opposed to the traditional concept of a process as activity in time (i.e. temporal change).
- By introducing the concept of a teleon, the model explicitly addresses the existence and nature of *vertical 'connections' within the holarchy* of organisation. These connections are essentially based on a teleonomic continuity, i.e. a '*flow of teleos*'.

8.5 The doublet

- The concept of a doublet is introduced as a *focalised-field-like system*, i.e. a densification or point of focus within the teleonic field. Whereas the teleon is teleos-bound, the doublet is considered to be *demarcated by its ethos*, i.e. its dynamic organisational principles.
- The doublet comprise an *exo-* and *endo-teleonic field*, respectively directed at its outer and inner environment.
- On another level of abstraction, there is the *centro-teleonic or self-referential field* directed at the doublet itself. The centro-teleonic field is considered to be responsible for maintaining the autonomy and integrity of the doublet within a space permeated by a multitude of interpenetrating fields.
- The concept of an attractor or *nucleus*, representative of the focal point and ethos of the doublet, is introduced. This point of focus is suggested to exist for all localised or focalised entities (albeit in conceptual phase-space).
- In some instances a *core-body* may emerge from the focalised field, giving rise to a *discrete entity*.
- All discrete entities are viewed as emerging from an underlying field of mei in flux, as opposed to viewing these entities as the primary foundation of reality.
- The concept of *tapping-teleons* implies that ultimately all systems are considered to be open systems embedded within a field of mei flux.
- This concept also stresses the fact that the act of coupling with the field 'on offer', *originates within the system itself* either as a voluntary or involuntary, a active or passive act.

- The distinction between exo- and endo-tapping postulates a *symmetrical arrangement between the inner and outer fields of the doublet from which emerges the middle or centro level.*
- The *centro-level,* in a self-referential manner, produces an autonomous identity, relative to the outer and inner fields within which the doublet is embedded.

8.6 A complementary inner and outer environment

- The inner and outer fields of the doublet are considered to be complementary and co-creating members of the teleonic field, giving rise to the doublet.
- The inner environmental field does not enjoy a privileged position compared to the outer environmental field, even when seen from a causal perspective and when focusing on the doublet as an emergent entity. The ontological implications of this statement are considered to be significant.

8.7 Boundaries and 'parts' of the doublet

- The doublet essentially redefines the classical notion of *parts of a system* (i.e. the notion of the *interaction between parts within the system boundaries* giving rise to an emergent whole and the whole in its turn interacting with the environment to produce a larger whole; i.e. a bottom up tree of emergence of ever larger wholes).
- The doublet is seen as a field of coupled processes extending both into its inner and outer environment, both of which have *diffuse and fractal-like boundaries*, as opposed to discrete parts organised within a discrete boundary.

8.8 The emergent middle and the three levels

- The concept of the '*emergent middle*' leads to an explicit focus on *at least three levels of organisation* in all instances (i.e. the inner, centro and outer fields of the system under observation).
- The centro-level of organisation of a doublet-system is thus viewed as something which emerges between an outer (or upper), and inner (or lower) level of organisation, as opposed to the more traditional one-sided 'bottom up' causal tree of systemic evolution.
- The evolution of systems is thus seen as something that *happens between two pre-existing levels of organisation. This distinction implies a primordial separation of two complementary poles of organisation.*

8.9 The teleonomic projection (teleonics)

- A *symmetrical meta-pattern of teleos* is suggested on the *teleonomic plane*. It is symmetrical in the sense that the field of teleons is considered to be directed towards both the inner and the outer levels of organisation of its associated doublet (i.e. endo- and exo-teleonic fields). It is a

meta-pattern in the sense that it postulates a universal network of symmetrical and complementary connections between all levels of organisation, as viewed on the teleonomic plane.

8.10 Generic systems aspects

- Aspects pertaining to all systems in the biomatrix are individually defined and interrelated as six classes of distinctions to be made (or perspectives to be held) by the observer. Together, they are referred to as the generic systems aspects, i.e. ***ethos, teleos, process, structure, substance (mei) and dynamic organisation***.

8.11 Dynamic organisation: emergent vis-à-vis governed organisation

- A distinction is made between *emergent organisation* and *governed organisation*. These two principles of organisation are considered to interact and give rise to a collective outcome, referred to as *dynamic organisation*.

8.12 Phases of evolution

- The evolution of a system as viewed from the perspective of its generic aspects is considered to *follow two complementary paths*.
- The respective phases of these two complementary modes of evolution have been generalised as a '*clockwise*' tendency from ethos through teleos and process, to structure, vis-à-vis the '*anti-clockwise*' tendency from structure through process and teleos to ethos.
- In practice these two tendencies interact and produce the *complex dance* of the trajectory in phase-space.

8.13 Time-space and structure

- Structure is seen as an aspect that manifests both in time (*action-pattern*) and space (*spatial configuration*). This alludes to the intimate ontological relationship between time and space and the unifying role that *structure* plays in the manifestation of systems in the space-time continuum.

8.14 Conceptual and physical space

- The biomatrix model suggests an intimate link between *conceptual* and *physical systems*, acknowledging the fact that all systems are associated with a perception in the mind of the observer (i.e. conceptual space). Conceptual and physical systems are considered to be *real* by virtue of an *inter-subjective agreement* on their existence.

8.15 Congruency and telentropy

- The concepts of *congruency*, *continuity* and *telentropy* are introduced as a means whereby order, disorder and uncertainty associated with a system may be understood relative to its generic aspects.

- These concepts postulate that *an apparent continuity of teleos manifests itself across the levels of organisation in the universe.* This, in its turn, produces the postulated meta-pattern of symmetrical connections on the teleonomic plane.
- The concept of telentropy is considered to be a useful vehicle to discuss and understand the spread of disorder across different levels of organisation.

9. Appendix C: A critical response

This is a critical response to the *systems paradigm*, the *biomatrix model* in general and this *thesis* in particular.

9.1 The general systems paradigm

The following are major points of criticism levelled at the general systems paradigm, and may therefore also apply to the biomatrix model (Dostal 1997):

Woodhill maintains that systems thinking involves the paradox of attempting to be holistic vis-à-vis our inability to grasp totality (Woodhill 1993).

This paradox is embedded in the limitations of the human mind. The multi-dimensional and multi-levelled framework of the biomatrix model provides a context which attempts to encompass the totality of life. It thus provides a means of contextualising a particular issue under focus, within the pre-given framework of the biomatrix model. By comparison, other general systems approaches identify the problem and build the environment around it, albeit based on systems principles. In that sense the biomatrix model is considered to provide a meta-pattern, or meta-framework for inquiry. Admittedly, this framework is ultimately grounded in its postulates.

The human mind has the ability to think in a linear and analytical manner as well as in a patterned synthetic mode. The latter enables us to perceive wholes in their totality. The synthetic mode refers to the wholistic, intuitive and patterned mode of thinking which is related to aesthetics. This thinking style is not accessible to the traditional requirements of empirical science. In this regard the biomatrix uses analogies and graphic depictions of its concepts that inspire and facilitate wholistic thinking while the clear definitions of its concepts invite the analytical mode of thinking. Thus, the model facilitates a balance between analytical versus synthetic and convergent versus divergent modes of inquiry.

"Systems thinking achieves its all-encompassing universality by its abstractness and by ignoring the concrete, specific and substantive" (Lilienfeld 1978, p.192).

While agreeing with the first part of the statement, the second part may be disputed. Any model or theory is an abstraction that only becomes concrete in its application. Numerous examples have been given in this thesis of how the model may be perceived in relation to reality. In addition, it has been applied by other researchers to different disciplines and shown to yield concrete suggestions and strategies pertaining to specific and substantive issues in the 'real' world.

One of the most widespread criticisms of systems theory in general concerns terminology, namely that systems thinkers are imprecise, ambiguous and often unclear in their use of concepts (Lilienfeld 1978; Robbins and Oliva 1982). At the same time the biomatrix model may be criticised within the systems field for the introduction of new terminology.

It was in response to the criticism of loose and imprecise terminology in the systems field, that the biomatrix model is described in terms of well-defined concepts. The creation of new terminology was deemed necessary, as some of the concepts introduced are new within the systems field, even though there are similarities with concepts used by other systems thinkers. For example, Gharajedaghi's (Gharajedaghi 1986) use of "function", and Checkland & Scholes' (Checkland and Scholes 1990) use of "human activity systems" are in some respects similar to the concept of the teleon, even though they do not make a similar distinction between doublets and teleons, amongst other issues. Thus, in the context of academic debate, the biomatrix terminology is considered useful because of its precise definition and the novel ideas it tries to convey. However, in the practical application of the model, it may complicate and confuse communication with people not familiar with these concepts. In those instances it may be acceptable to replace these terms with more descriptive approximations.

The criticism has been lodged that although the general systems paradigm aims to develop a common vocabulary to unify disciplines, different disciplines have their own intrinsic and fundamental conceptions of systems and their functioning. These may even be in conflict with each other. At the same time, many applications of systems thinking within a specific discipline are not adding new insights to the discipline but merely represent a replacement of vocabulary (Lilienfeld 1978).

The biomatrix model evolved from the efforts of an interdisciplinary research group and therefore addresses both issues. On the one hand, the concepts and organisational patterns associated with the biomatrix model can add new insights to various disciplines, or if not new, emphasise their universality across disciplines.

To date, the general systems paradigm does not "offer a conceptual space in which to visualise systemic ideas or any kind of conceptual map of how these ideas (i.e. various systems concepts) might relate to one another" (McNeil 1993, p.204).

One of the aims of the model is to integrate the primary general systems concepts as well as some new concepts into a logically coherent, mutually reinforcing and explanatory model or conceptual map of ideas. The various graphic representations of these ideas allow the visualisation of the conceptual map of the model and its related concepts. These 'maps' have been found useful as explanatory tools in working with people with no prior knowledge of the problem (Cloete 1994; Dostal and Járos 1996).

The general systems paradigm has been criticised for using selective evidence from various scientific disciplines, as well as for applying analogies of phenomena across different fields of knowledge, in its construction of concepts that claim to be applicable across disciplines (Lilienfeld 1978).

This is a criticism that also applies to the biomatrix model. The model was indeed conceived on the basis of cross-disciplinary information and analogies. However, the interdisciplinary composition of the biomatrix research group provided some cross-checking of the validity of comparisons on the basis of individual professional experience. Nevertheless, the various concepts and principles of the biomatrix model allow for vigorous testing within different disciplines. At this stage in its development the model may be regarded as being located at the *exploratory (i.e. heuristic) end of the research spectrum*, which guides the researcher, as opposed to the explanatory and descriptive end of the research spectrum.

Much of the criticism directed at the general systems paradigm, and potentially this model, refers to its obscurity. On the one hand it is perceived as too complex in its application, and on the other hand it is perceived as being simple and commonsensical.

In this regard it may be stated that the principle of requisite variety, as suggested by Ashby, dictates that the complexity in a system's environment calls for an equal level of complexity in the response of a system to its environment (Ashby 1958). The world that we live in is indeed complex, and in many instances appears to be obscure; in that sense a model of equal complexity is called for to guide our human process of inquiry.

Unfortunately common sense is, indeed, not that common. Thus, the model also *serves as a frame-work to remind us of some very 'common' principles.*

9.2 The biomatrix model

The following are some critical questions and comments that may be raised with regard to the biomatrix model in particular:

Admittedly, this is a rigorously constructed model, but is it actually true? In other words: is the emperor wearing any clothes?

The fact is that localised-entities do exist in our world. The question is: are they field-like? In the physical sphere particle physics certainly supports that premise. But is that also true for other spheres? Certainly, for social systems, the evidence does point in that direction. It makes sense to think in terms of a socially-constructed organisation as an extended field of activities, rather than as a discrete entity with enclosed boundaries and localised in space. Furthermore, congruent chains of mei flux, stretching across different levels of organisation, certainly have evolved and do exist in the bio-sphere. Anybody with a rudimentary knowledge of ecology will attest to that fact. Are these process-

fields really organised in terms of endo-, centro-, and exo-poles? This premise is certainly supported by the actual organisation of processes as witnessed in biological systems (e.g. organisms), the psycho-sphere (i.e. psychological processes) as well as the socio-sphere (e.g. the organisation of social institutions). In conclusion, one of the points which the biomatrix model makes is that we should not grant a position to discrete entities which is privileged above that of the congruent field of process-chains, merely because they seem to be more tangible. The biomatrix model argues that these two modes of manifestation point towards a fundamental duality embedded in reality, a duality which ultimately can be traced back to our distinction and appreciation of time and space, and to the way in which we perceive order or structure in these two modes. Observers who subscribe primarily to an entity-based reality may be unpleasantly surprised when they come to the realisation that their tangible physical reality vanishes into thin air when viewed from close up, or gets transformed into something completely different when viewed over time.

I find the concepts of the model obvious and trivial: virtually all the concepts, in one form or another, were already familiar to me in my field of expertise.

The concepts when viewed separately may very well be familiar, but the way they have been integrated and contextualised in the model may prove to be different. Although these differences may seem subtle, they may very well have profound effects. Furthermore, in itself, it is quite a remarkable proposition that those principles known to be true in a particular field of knowledge (excluding the systems field) are universally true.

I fail to see how the biomatrix model is different in a fundamental sense from some of the other existing systems models.

The biomatrix model encourages the observer to note certain aspects of a system that are not generally emphasised in other system models (see Appendix B). It essentially enables the observer to appreciate the multi-dimensional, field-like and flux-based nature of systems, and thus to relinquish some of his previously-held beliefs on the nature of reality.

I fail to see the relevance of the model.

The model presents the observer with a different view on reality; this view is so significantly different (see Appendix B and section 6.1) as actually to make a difference in terms of our participation in, and co-creation of, the world in which we live. To rephrase the above statement: is it a difference that makes a difference? This is a question that ultimately only the observer could answer for herself. However, before judgement is passed, she should actually be able to 'see' and internalise its fundamental points, complemented by the process of critical reflection on its application to the different spheres of her life. It requires time and effort, but even more importantly, it requires nothing less than a change in mind-set. If the reader does not subscribe to the fundamental premises of the

model, she may not necessarily appreciate the usefulness or relevance of the model either, simply because she subscribes to a different ontological viewpoint of what is 'really out there'. Niels Bohr once said: "anyone who is not shocked by quantum theory has not understood it" (Bohr in: Gribbin 1984, p.5).

Finally, a critic may state that he cannot see the relevance of the model, when what he really means is that he either *does not like it*, or *does not agree with it*. However, the model has been rigorously defined and constructed, and in order to engage in a constructive process of dialogue the critic needs to be equally precise and rigorous in his response.

9.3 The content of the thesis document

The following are some critical questions and comments that may be raised with regard to the content of the thesis document in particular:

Having read through the entire thesis, I still do not understand how the biomatrix model could and should be applied.

The focus of the thesis is the formalisation and development of a general systems model and not its application. It is essentially a *conceptual-theoretical study which describes* the model, and does not concern itself with the application of the model per se, apart from numerous short examples to clarify concepts, as well as some general guidelines for its application in chapter 3.6. The thesis may be compared to a physiology or anatomy textbook in the field of medicine. The studying of physiology or anatomy does not necessarily lead to an understanding of its application to medicine: they merely describe the functioning and structure of the healthy system (i.e. the human body).

It would have been helpful to have more in-depth examples (e.g. case studies) on the application of the model, thus actually illustrating how the model could be useful and revealing new insights in a particular context.

In order to retain the focus of the thesis a deliberate decision was made not to include in-depth examples or case studies. It should be noted that the application of the model has been dealt with extensively elsewhere (see the biomatrix bibliography).

I fail to see what this thesis actually proves.

The thesis does not set out to prove anything: *it proposes a model* in the form of a logically consistent, integrated and congruent set of theoretical concepts, in order that it can be validated and critically debated by interested parties.

I just don't 'get it'.

The response to this complaint is perhaps best framed with the help of an analogy. The reader is probably familiar with those printed pictures which when looked at appear to be a random two-dimensional pattern, repeated all over the page, but when looked at in a certain way 'jump' out of the page and present the viewer with an emergent and completely different three-dimensional picture. However, this does not simply happen: it requires a concerted effort to view the two-dimensional pattern in a particular way (e.g. focusing behind the picture and *at the same time relaxing the eyes, allowing for a new order to emerge*). It may take a while to see the three-dimensional image, but when seen once, it becomes much easier to regain the image. Likewise, the thesis sets out to guide the reader through a process of seeing the world differently, i.e. bringing about a change in mind-set. Making this mind-shift is not a linear process, it comes about rather suddenly, and can be lost just as abruptly, to be regained again with greater ease.

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