Rodolfo Alcazar Portillo

THEORY OF INTERACTION

the foundations

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Everything
is a system, even fire.

Natural systems are open, even rocks, which react in different ways to different forms of energy and matter. Math approaches few dimensions and nature is hyperdimensional, such as water can be understood in different ways by different entities. Natural entities show diverse sets of capacities that allow them to process dimensional properties of matter, like a rock can filter water. Matter is exchanged between systems, as evaporated water from the soil can form clouds in the atmosphere. Matter has subjective dimensional values for each system, as water is a mean of transport for salt or the same water can act as a solidifier for magma in contact. Entities in nature, living and non-living *interact* interdimensionally, such as light is the start of a process that begins with photosynthesis and generates oxygen, among other products, which in turn keep an stable environment for trees, so trees can receive sunlight, closing the loop. Interactions can establish solid relationships between systems in nature, as bees need flowers and flowers needs bees to exist. Therefore *interaction* is existence. Non-living entities *interact* with the same rules as living entities, as chemical reactions can form very stable compounds, or a family can establish solid emotional bounds. The fractal *interaction* of fundamental particles and elements is the essence of existence on higher system scales; in consequence thermodynamical *interactions* are the basis of each movement our body performs. Nature *interacts* in a set of entirely different dimensions from those used in classic mathematics, as love or economy follows the same rules than molecular *interactions*. Mathematics is just one form of *interaction* between dimensions: the free fall equation is just an *interactive* transformation between the time and positional dimensions. Non destructive contents free in nature generate order and environmental stability, exactly as generosity generates a sane life, a sane income and a sane effect on the planet. *Interaction* creates attraction, such as the attraction of Maria and Pierre or the gravitational attraction. As the attraction you feel for that song. The rules are the same.

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Nomenclature

GST	General Systems Theory. Focuses on the system, the whole and permanent relations.
TOI	Theory of Interaction. Focuses on interactions: fleeting events between couples of entities.
YDOR	Graphical representation of an interaction instance.
Chaos	Lack of interaction between entities.
Content	Value (on ideal systems) or matter (in nature) that is transferred from one entity to another in order to interact.
Dimension	Approach of contents processing.
Interaction	Exchange of contents between two entities.
Order	Dimensional arrangement that exists due to interaction. No interaction means no order.
Perstability	Dynamic state that causes a system to persist continuously along time. The comprehensive meaning of the word life which includes all natural entities that persist along time.
Relation	Interaction that has reached a permanent repetitive state.
System	Group of parts that hold relations and perform together.
Dissipation	Decrease of order in dimensional scale.
Organization	Increment of dimensional scale order.
Development	One of the two possible applications of a content ingestion: the content is incorporated to the structure of the system and starts interacting with it.

Processing	The second possible application of a content ingestion: Contents are transformed and will not be incorporated as part of the structure.
LFR	Local (for the local entity) Final (after the end of the interaction) Result (integration of all dimensional values).
Intelligence	Mechanism that directs the performance of the system towards perstability.
Nonlinearity	Distinctive feature of interactions as a difference to relations.
Subjectivity	Feature of a system that allows it to assess the value of a content regarding its internal set of capabilities.
Synergy	Aggregate of the interactions between two or more systems performing together plus the interactions of each system.
Time Row	Subjective assessment of a system regarding the sequence of an interaction.
Horizontal Interaction	Interaction with systems on the same dimensional scale of existence.
Vertical Interaction	Interaction with systems on a different dimensional scale of existence: supra or subsystems. Also fractal interaction.
Pull interaction	Type of interaction where the reaction to stimulus is performed by adding chaos to the outmost higher scale of existence.
Push interaction	Type of interaction where the reaction to stimulus is performed by applying internal capabilities.
Pull competition	Competition focused on the best LFR for the contender. Powerful chaos generator. Controls overpopulation by generating chaos on excedent entities.
Push competition	Competition focused on the best LFR for the group. Powerful population generator. Controls underpopulation by generating development of lacking entities.

Contents

Foreword

Everything is a system, even fire. Natural systems are open, even rocks, which react in different ways to different forms of energy and matter. Math approaches few dimensions and nature is hyperdimensional, such as water can be *understood* in different ways by different entities. Natural entities show diverse sets of capacities that allow them to process dimensional properties of matter, like a rock can filter water. Matter is exchanged between systems, as evaporated water from the soil can form clouds in the atmosphere. Matter has subjective dimensional values for each system, as water is a mean of transport for salt or the same water can act as a solidifier for magma in contact. Entities in nature, living and non-living *interact* interdimensionally, such as light is the start of a process that begins with photosynthesis and generates oxygen, among other products, which in turn keep an stable environment for trees, so trees can receive sunlight, closing the loop. *Interactions* can establish solid relationships between systems in nature, as bees need flowers and flowers needs bees to exist. Therefore interaction is existence. Non-living entities interact with the same rules as living entities, as chemical reactions can form very stable compounds, or a family can establish solid emotional bounds. The fractal interaction of fundamental particles and elements is the essence of existence on higher system scales; in consequence thermodynamical interactions are the basis of each movement our body performs. Nature interacts in a set of entirely different dimensions from those used in classic mathematics, as love or economy follows the same rules than molecular interactions. Mathematics is just one form of interaction between dimensions: the free fall equation is just an *interactive* transformation between the time and positional dimensions. Non destructive contents free in nature generate order and environmental stability, exactly as generosity generates a sane life, a sane income and a sane effect on the planet. *Interaction* creates attraction, such as the attraction of Maria and Pierre or the gravitational attraction. As the attraction you feel for that song. The rules are the same.

Weird? Yes. *Interactions* are so obvious to our life that they were never strictly

observed.

For many years we have had the means to study interaction. But we didn't made it because we relied excessively on mathematics. Mathematics does not apply to all to nature for this type of understanding. There are three main problems of using classical math to describe interactions.

First, mathematical models are able to describe *closed systems*[1], and interactions essentially require a complete understanding of natural entities as *open systems*. The formulations of the general relativity and quantum physics theories enforced our blind trust on using math as a closed system to describe nature. Interactions analysis requires a paradigm shift before starting to gather knowledge about nature.

Second, equations provide an incomplete view of nature by eliminating the time row. Until now, our way of making science was to search natural hidden relations, the deeper innings of the universe. We use to call relations to stable and repetitive interactions on isolated dimensions. An example relation is mass that can be converted to energy and vice versa. An interaction is converting liquid to gas. They are equivalent, but there is always a direction and a sequence: liquid to gas or the other. The relation expresses both in a single and timeless assertion. To describe nature, the essential element, interaction, is fundamental.

We have thought of interactions as fugacious, dimensionally fuzzy, *sequential*, chaotic and non representative behaviors, therefore we didn't look for formal means to approach them. Well, we were totally wrong. It is relations —the stable, unidimensional behaviors between systems— which are uncommon in nature. Interactions are the most common feature in nature, not relations. Paradoxically, math is based on relations, despite it has means to approach interactions.

And third, math approaches preferentially isolated groups of dimensions. Interactions, on the contrary, are the main natural bridge between huge numbers of dimensions... on each interaction. If math can relate dimensions, nature has its own tool: interaction. Interaction is the natural mechanism to convert contents across complex sets of dimensions. For example, a cow is a machine that converts grass and other inputs into... milk! How many pages do we need to write a formula for that? Will that formula be able to describe the chaotic disposition of germs on the final milk? No. Not even using interactive diagrams. But the

[1] In the system {a=b, c=d}, a change in b does not affect c. But this happens in nature due to chaos and the hyperdimensional nature of matter, as described by Edward N. Lorenz on his paper "Predictability; Does the Flap of a Butterfly's wings in Brazil Set Off a Tornado in Texas?"; this behavior is called *sensitivity to initial conditions*. See http://eaps4.mit.edu/research/Lorenz/Butterfly_1972.pdf and http://necsi.edu/guide/concepts/butterflyeffect.html

knowledge of the principles of interaction can help the study of the transformation process by describing the rules of each action and reaction.

A study of the interaction principles provides answers for a huge number of questions. Probably the most amazing answer is that living and non-living entities behave exactly the same way and follow the same rules to exist and persist. So, the term *life* is not applicable only to biological life: all natural entities that persist in time are alive. Our definition of life will be called *perstability*. If Darwinism holds that men descended from apes, the interaction principles suggest that men descended naturally from rocks. Another remarkable fact is that nature evolved to the point of reaching life. Instead of destroying the environment, humans have the option to continue the road, just by understanding the natural rules. It is also amazing to understand that humans interact in an unhealthy way that can be easily changed. Learning to interact provides not only multiple benefits to life, society and the environment, but is an enjoyable process. Of course, interacting healthy is just following nature rules: enforce life in all dimensions.

Having a proper context (hyperdimensionality, chaos influence, time row) and tools (an appropriate language and approaching rules), the study of interaction and the definition of its principles can be easily achieved. Each conclusion obtained on the relevant dimensional space of interaction can then be converted to fundamental physics to be tested and dissected. That is out of the scope of this theory, but it is encouraged. The top-down level conversion is easy, like on informatic programming languages. Programming languages are easily converted to machine language, but the opposite is practically impossible. Converting physical events to interactions may be challenging. The top level of analysis is interaction.

The study of interactions will also descend to the roots of some disciplines and cause the finding of new definitions of synergy, information, dimension, relation and entity. Definitions of chaos and order are proposed here because they belong to the interactional field, not to thermodynamics or mathematics. For example, two entities are in relative *chaos* if they don't interact; the *order* of a system is the ratio of possible couplings to the total on a time period, because existence implies time. *Synergy* is the sum of the internal interactions of two systems added to the interactions between both systems. Entropy has no stronger meaning on the interactions discipline: this property is just a consequence of certain interdimensional interactions. *Entropy may be a big conceptual error*: by focusing closed systems, entropy excludes the trend to organization that follows dissipation. Entities in nature tend to exist by getting order.

Part 1 introduces the notions and concepts of interaction by describing it on

two different disciplines: communication and thermodynamics. *Part 2* presents the principles of interaction. *Part 3* approaches some interaction examples on nature and mostly on the macroscopic world; specifically on individuals and society. Detailed descriptions from the interactional focus are provided for many phenomena of human life: job, love, family, economy, human organizations, etc. I firmly believe that this principles may provide solutions to multiple socioeconomic problems. Further analysis is left for any concerned reader.

There is a reason for including a whole part dedicated to applied interaction on nature and human behavior: the ecological disbalance created by men is leading humanity to extinction due to a misuse of our intelligence. Maybe this is a natural consequence of an excessive and highly accelerated development of human capabilities. But extinction may be prevented. The argument and the many possible solutions are explained at the end of the book.

The main conclusion of this analysis is this: *generosity is more profitable than egoism*. The human problem lies on the millions and millions of unhealthy atomic interactions performed at each instant. The knowledge of interaction should be deepened and this theory requires to evolve (see *Conclusions: Future*). The application of this knowledge can prove to increase the quality of interactions on all disciplines, from love to economy. Since this is the first approach to interaction, this theory will probably evolve. Any conceptual mistake should be corrected, you are encouraged to participate by contacting the author.

Society prefers generous people, but TV teaches that selfishness provide easy benefits, including money. All our laws, our literature, our culture, our knowledge reflect human's natural instinct to be generous. But schools and universities teach and formalize the TV message and we think this is fine. Sane interactions at the human level not only produce ecological economic earnings: they provide welfare and increase of life quality.

This book is a formalization of my father's courageous thinking: "*no matter the circumstances, even in front of dead, one should be honest*". I've started to study interactions to prove this and I may have found the proof: honesty is the root of fine interaction, therefore a powerful generator of perstability —life, in other words—. Moreover, I think this book is the formalization of the global requirement to save the planet. We can, we just don't know how. It should not be difficult.

This book will not be revised for various reasons. English is not my mother tongue, so I apologize for the errors to all genuinely interested readers. I think you will find a lot of ideas, questions and fun on this text. If you want errors to be corrected, or contents to be changed, please do and send me your suggestions

to r@ydor.org so I can include your changes if appropriate, with the proper reference, on further editions.

Generosity is highly more profitable than egoism. Most social problems lie on people's misunderstanding of the interaction mechanism. Money making is the opposite of interaction, but interaction generates money. Healthy interaction provides development at all levels: emotions, health, ideas, opinions. Egoism reduce probabilities of existence. The worst human error is to use intelligence to twist the truth on an egoist direction. This is what the *Theory of Interaction* says.

Part I

Notions

Chapter 1

Presentation

> *"In modern science, dynamic interaction is the basic problem in all fields, and its general principles will have to be formulated in general General Systems Theory."*
> —Ludwig von Bertalanffy, 1968, General Systems Theory.

The General Systems Theory (GST) is a wide subject of study that approaches a number of basic and constant features of systems. The main idea that the GST has provided is that systems behave as part of a whole, and each one itself is a whole for other internal and smaller subsystems. The GST provides a view focused on the whole instead of the details. The GST defines a system as a combination of parts interacting together for some purpose. Viewing a system as a whole allows to concentrate focus on the global behavior.

The GST approach demands a strong delimitation of systems based on language and relations. Language, basically supported by the *universe of discourse* paradigm, idealizes systems. Relations permit also the modelization of ideal behaviors. Why? to apply logic and mathematics. If the model would not be idealized, it will no be static, and therefore it will be impossible to formulate formally, on paper, with a language. Details, unstable behaviors, exceptions, temporary conditions or collateral effects are to be neglected in order to understand the hidden deep natural principles. By removing all undesired behaviors, chaos is completely set aside. Neither math nor the GST are able to face chaos and chaotic behaviors. The more variables are ignored, the more idealized and unnatural becomes a model. The only elements allowing isolation, dimensions, are all set aside. For example, a thermodynamic system is modeled as an ideal gas on a perfectly closed system, so few dimensions are to be analyzed: time, pressure, heat, etc. The rest, chaos, admits no possible analysis under this model formulation.

The Theory Of Interaction (TOI), on the other side, provides the proper approach for considering the whole without isolating dimensions, at the expense of taking apart the holistic view, already provided by the GST. The interactive view forgets multiple relations and concentrates on the focused system and *one partner at a time*. It is basically an approach to the details and to the dynamic essence of systems, but not on the whole: only on each couple. The analysis of the whole corresponds to the GST. The approach of the interactional model is not to analyze small parts on isolated dimensions. Is to analyze small sequential operations on the whole dimensional set of a couple. The GST cannot model the relation between air pressure and musical chord quality, but the interactional model allows this type of dimensional analysis, even if one of the dimensions already includes the other. The GST concentrates its focus on system permanent relations to a whole, the TOI focuses on system fugacious interactions with casual couples. The GST idealizes systems, the TOI naturalizes systems.

Two model examples of interaction will be presented in this part to expose the elements of an interaction. The first model shows how language is built with the notions of interaction, and how humans create the interaction rules in the brain since conception. The second model contrasts the current thermodynamic physics model with the interactional one. As a conclusion, definitions of chaos, synergy and even a method of order measurement and the value of a system are proposed.

1.1 Definitions

From now on, the terms being, entity, system, object and element will be used indistinctly (the term system will encompass living entities and non-living objects). The reasons will prove to be be self-explanatory further on the text: basically every entity in nature behaves like a system and vice versa. *Thing* is a synonymous of *system* on this study.

Entities can exchange matter. Matter that is transferred from a system to another will be called *transferred content*. There is no thing such as information transfer: information is just one of multiple properties of a content, for example, a codification. A transference of contents between entities can be unidirectional or can have an answer, turning it into bidirectional. We will observe further that the answer to an stimulus matter transference will *always* come, normally with a delay.

A *dimension* is an approach of contents processing, therefore matter is *hyperdimensional*.

The concept of dimension is related to a process and a content. A size is an

approach of an spatial property (content) which is measurable (processing). This analysis expands the concept of dimension to all energy, matter or any conceptual object. Not only sizes and time can be understood as dimensions: any content that is exchanged between two systems (being them two organic cells or two variables on an equation) has multiple dimensions, depending on the processing. A color is an approach of a visual property (content) which is appreciable (process) by our eyes. If melted rock is solidified by water, the solidification is the process, and the melting degree can be the measurable content. Therefore, if a free fall equation is the system capable of converting *time* to *distance*, water is the system capable of converting *melted rock* into solid *rock*. Therefore, matter is said to be *hyperdimensional*, because infinite processes can be performed over any content. The definition of hyperdimensionality is central to this analysis and will be assessed in greater depth further on the text.

Hyperdimensionality is not conceptually coherent with thermodynamic entropy: the concept of entropy is based on the idea of thermodynamic dissipation, but thermodynamic dissipation is just one dimension of the thermodynamic process. *Thermodynamic dissipation* is not *general dissipation*, as most observers tend to think. During thermodynamic dissipation, other dimensions can generate or obtain order. The second law of thermodynamics formulation should be: *entropy tends to increase on a system... in limited sets of dimensions, while other sets can get order*. An example of the narrow approach of entropy are Bénard cells[1]. The interdimensional behavior is even more clear on open systems, which turn to be the majority in nature. The clear proof is this living planet.

The only physical content that can be transferred between systems is in essence matter (or energy, which comes to be the same). Anything that is contained on the physical transfer can be *processed*, *accepted*, *interpreted*, *transformed* or *used* as a different type of content depending on the dimensional processing (for example, a transferred content can hold some information just by holding determined organization over some elements of the content). Therefore any encoded message is just a dimension of the content. For example, a number of atoms can be organized as organic living tissue. Matter is subjectively encoded by the sender and also subjectively decoded by the receiver.

The reader is encouraged to avoid the usage and comparison with mathematical essential dimensions: the three spatial dimensions, or time, mass, etc. The essential dimensions are no more than mathematical concepts. Natural living entities can measure, weigh, calculate values using diverse subjective scales and processes, probably equivalent to human hunger, desire, smell, etc. Non-living entities do the same but in a passive way. Two different rocks that start to

[1] See http://www.mis.mpg.de/applan/research/rayleigh.html

fall from the same spot, can arrive to different places, depending on each one's subjective properties and dimensional processes.

Subjectivity is essential in the matter assessment performed by entities on each interaction. A scientist can *understand* an organic tissue as a combination of cells. Another individual can *understand* the same matter as dead, useless tissue. A third one can *understand* the same matter as excellent food. An environment can *understand* the very same tissue as the basis of a petrified rock. The word *understand* is occasionally used on the text to express the instinctive idea of a subjective processing approach of a content by an entity.

In many cases it is very useful to differentiate two entities that interact. The local entity is noted by *Y*, and the remote entity is noted by *O* (from *other*). The content transferred from *Y* to *O* is called *d* (from *delivered* content). The content transferred from *O* to *Y* is noted by *r* (from *received* content). This is the meaning of the YDOR acronym on this book. The loop name intentionally starts on the local entity *Y*, to expose nature's perfect sequence to order, existence and creation.

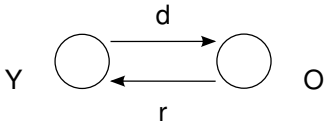


Figure 1.1: One basic interaction is expressed by a diagram called the YDOR cycle.

An interaction is the mechanism of matter exchange between two entities, for once. Entity *Y* sends some content to entity *O*, and in response, entity *O* sends a different content to entity *Y*. An interaction can be simplified as a temporary link or relation between two entities. The YDOR cycle represents one interaction loop. Interactions can loop permanently under certain conditions, and that is the essence of existence.

Chapter 2

In Language

> *How is it possible that mathematics, a product of human thought that is independent of experience, fits so excellently the objects of reality?*
> —Albert Einstein

Language is the first mechanism to be studied in order to analyze the principles of interaction. At multiple levels, language applies cause-consequence structures that follow the interactional *YDOR* cycle structure and all the principles of interaction to be studied afterwards. This structures are the basis of communication by means of a language. They are expressions of internal brain interactions and they serve to the purpose of transmitting structured ideas. Language could be the better example of human interaction means.

Models appear to be the mind's atomic elements of thinking. The brain may create modeled representations of perceptions and may imprint them on neurons. Mental models are built as the brain develops, assisted by the information collected from the five senses and the brain itself. The mind is capable of assess shapes, sounds, time, feelings, impulses, things, movements, reality and fiction, ideas and a lot of highly complex mental features and store them as models. Mental models permits approaching a knowledge from a suitable dimensional approach.

Brain models obey a causal structure: a constant logic of action and reaction. This mean that a model is not just a picture of an observed object. The pictorial representation is associated always with at least another model. For example, the natural reaction of the brain after observing an unknown object is to search relations that can provide clues of what can the object used for, what the object is. If we think on a blue sky, the idea triggers relations with other personal

experiences on the brain.

Human language follow the same logic as brain models. Language elements take the form of causal models to represent objects or ideas, adopting the cause-consequence logic. Sentences (or phrases, paragraphs, discourses, etc.) are essentially a construction or a description of causes and consequences. Spoken or written language permits expressing affirmations in the form of causes and consequences. For example, the sentence *"it will rain"* has a big load of dimensional messages codified inside. Depending on the context, it can mean *"I have read the weather forecast* [cause] *and therefore it says that it will rain* [consequence]". Or else it can mean that *"It will rain*[cause] *and therefore it should be considered before any action outdoors* [consequence]". There is no correct sentence that holds no causes and consequences.

Causes and consequences have a sequential development, a *time row*. Previous to the consequence, raises the cause, that is the natural sequence. Any cause triggers some consequence, and consequences are just the result of causes, in spite this sounding redundant.

Ideas and language structures can be modeled trivially:

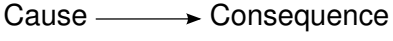


Figure 2.1: The basic language structure

What about mathematics? As we previously analyzed, mathematics provide two main uses: it is a *language* and it is an *formal tool of analysis*. The linguistic side follows the same causal structure as human language. But the analytic side has an unexpected and not-so-desirable feature.

Relations in math commonly force the cause-consequence sequence to behave symmetrically in time, generating a consequence-cause reflection. This is essential to apply the mathematical reasoning. But by creating a reflection of causes and consequences, time disappears of the formulation and affirmations become eternal, static in time.

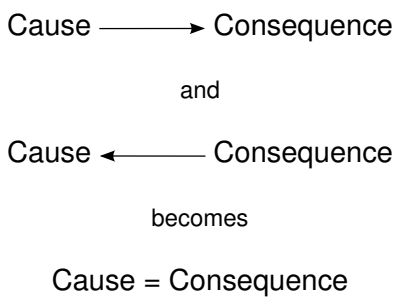


Figure 2.2: Mirroring language structure generates an equality.

This oversimplification has helped us to develop most of the current formal scientific knowledge. It is even used to express causal developments, taking adequate care of remembering that the structure is not reflexive.

But no absolute equalities exist in nature, no asymptotes, no exact limits, no stability, no permanence. The difference of both affirmations on the last figure is equivalent to equating exactitude to limited dimensionality, chaos to predictability, instance to permanence. In short, fuzziness is turned to definition due to a mathematical artifact. This works quite well with some systems (mostly all featured on physics books), but not with all systems in nature.

This simplification is possible only in limited sets of dimensions of value. For example, time and space can be related with a formula. But nature features infinite sets of dimensions of value (a natural cooperative association allows little fishes to approach big ones by offering a cleaning aid in exchange of food; an equation that would try to express this would be very limited).

As a consequence, we will represent the original causal form in this book with simple rows (⟶), and of course, continue to use the equal sign (=) when required. Rows indicate a directional sequence.

2.1 The Interaction Cycle

We're still not finished with language. As said, mind models and language constructs are based on the following structure:

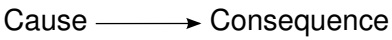


Figure 2.3: *The basic mental logic structure.*

This sequence is a representation of two actions on the physical world: the cause and the consequence. But the consequence is not just the end of the phrase. The consequence is a reaction triggered by something: a *reactive system*. If we touch something, we feel something. If we hit something, it breaks. If we push something, it moves. That *something* is precisely the *reactive system*. Our mind knows the world rules and just uses causes to calculate consequences. For mental logic, that internal *something* is reason.

Both cause and consequence are performed over an entity. This will be called *O*, the "*object*" system, over which the cause is applied. Later, a consequence is triggered from it. More precisely:

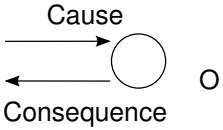


Figure 2.4: *Cause and consequence through a reactive system.*

To precise even more, a referential system is required on the representation, the main interactor, the originator of the cause. This local iterator system will be called Y. This entity plays the cause and is subject to the consequence.

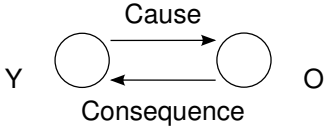


Figure 2.5: *A causal action triggered by a local entity have a consequential reaction triggered by another entity.*

This graph is precisely the YDOR cycle already exposed in the last section, which depicts one interaction cycle. So we can see that language structures are just expressions of interaction. The interactional structure is constant and easy

to find in sentences, paragraphs or complete discourses. Complex messages can include more inputs and outputs on both entities.

The cycle is always composed of both actions, cause and consequence, no more, no less. There is no action without reaction and viceversa, and the loop can repeat. The duet cause-consequence is also called *action-reaction*.

The causal action can start from the *O* entity, regardless of any naming issue, and the local entity *Y* will be the one that answers. Therefore, to generalize the model, the couple of transferences will be also called deliver-receive when observed from any entity's point of view.

Entities are represented on uppercase, contents on lowercase. In equivalence to what was earlier observed, actions are equivalent to transferences of content.

2.2 Cycle Features

Some properties of the interaction cycle are to be highlighted before formulating them as principles.

First, the inclusion of the *time row*. The interaction mechanism follows a sequence easy to display and analyze. Periods may be defined and action and reaction can overlap. This is accepted. But perfect simultaneous action and reaction do not follow the cause-consequence form, so this type of usage is discouraged. Nature follows the sequential principle of action and further reaction. The process may be extremely fast, such as fundamental interactions. But it is not simultaneous. Simultaneous events should be treated as simultaneous reactions to some action behaving as a trigger.

Second, any type of nonlinearity is allowed and encouraged to be represented in the interaction cycle. The causal transference can be faster, bigger, heavier, richer or more valuable than the consequential one and vice versa. Each one can be composed by any number of content components. A zero sized reaction is even accepted: it may represent a closed system or a buffering process. A third system can act as a time or matter buffer for a transference. A causal transference can be directed to one entity and the consequential can come from many other entities. The analysis to be performed will delimitate the set of entities participating in a action-reaction transference.

Third, the correlation of multiple dimensions. Equations can correlate stable related dimensions. The interaction cycle can correlate unstable, fuzzy, dynamic and subjective sets of dimensions.

Two essential definitions must be formalized to keep coherence with the systems theory: *relations* and *interactions*.

For the purposes of this text, a *relation* is a stable, persistent and correlated exchange of contents. The term relation expresses a stable link between two entities. Nature features diverse examples of stable relations, for example matter and energy. But most relations are limited between certain ranges. Energy and matter could show alterations on their relations when pushed to extreme limits. Stability is not a natural feature.

A relation is a proper representation of interactions within ideal systems, due to they are closed, do not require proximity or continuity to exist and perform.

Two, an interaction is an occasional exchange of contents, following the form of one *YDOR cycle*. It doesn't matter where does it begin and end, how long does it take for the cycle to close, if it is symmetric or not, if one of the exchanges is small in comparison to the other. Conversely to relations on few ideal dimensions, nature preferences interactions on multiple physical dimensions. Dynamicity is an essential natural characteristic. Two interactions can show absolutely different results despite having occurred under the same circumstances.

An interaction is a close representation of real systems behavior. Real systems, unlike ideal systems, require proximity to interact; they are open *par excellence*, so they are subject to losses, earnings, development or dissipation. Content channels require energy to allow flow. Processing does not just converts inputs into outputs: it requires energy for itself. Real systems require means to keep continuity, or else they dissipate into chaos.

Chapter 3

In Thermodynamics

> *It is an experience common to all men to find that, on any special occasion, such as the production of a magical effect for the first time in public, everything that can go wrong will go wrong. Whether we must attribute this to the malignity of matter or to the total depravity of inanimate things, whether the exciting cause is hurry, worry, or what not, the fact remains.*
>
> — Also known as Murphy's law, Nevil Maskelyne, 1908, British magician.

The second application of the interaction principles is related to thermodynamics. The topics covered in this chapter are an evidence of how does many mathematical problems correspond to the interactional discipline. For example, the definitions of chaos, synergy and order are not possible without basing them on the interaction principles. This chapter does not enter in deep into thermodynamics, it rather deals with some conceptual facts related to interaction on thermodynamic systems. Here we will create a limited dimensional model and present it as an analogy to classical thermodynamic models of ideal gases. Afterwards, we will observe how the lack of the dimension concept and the bridge between dimensions —interactions— causes the second law of thermodynamics to be inconsistent with entropy.

3.1 Chaos

Some definitions before starting: interactions, for now, can be understood as temporary polydimensional links between entities. Further on the text, an interaction will be defined as an exchange of polydimensional contents between

systems. Remember that relations are just stable and permanent interactional behaviors.

Imagine an infinite line with a zero point value somewhere. Let's put a big number of points in the line, by creating random guesses that represent the distance from each point to point 0 (rational or irrational, no matter). Now, remove the point 0.

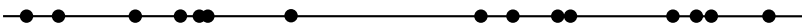


Figure 3.1: Points arranged in a chaotic 1-dimensional disposition

Points will form a fuzzy composition on the line. There is probably no definition or a visible pattern on the line. If the random number generation algorithm is perfect (no patterns), this is pure mathematical chaos in one dimension. If the line is infinite and we have no reference points, not even the measurement of distances is possible.

What is chaos? For now we don't have a definition of order. But order should be related to organization, the existence of patterns, forms, shapes. In sum, order should measure relations between entities. But no permanent relations are required to have order: order can be dynamic. So, order is related to interactions.

In the dotted line there are no interactions between points. Our definition of chaos will oppose chaos and interaction:

Chaos is the lack of interaction between entities.

This notion is consistent with all current definitions of chaos, the GST principles and the linguistic conception of chaos. Therefore, two systems isolated one from the other can be said to be in a chaotic disposition.

3.2 Dimensionality

Before starting we need the concept of dimension: a dimension is an approach of contents processing. A three-dimensional measure means three different measurements (processing) of three different sizes (contents). Dimensions depend on the processing. The same content can be processed in multiple forms, therefore contents are said to be *hyperdimensional*.

Following the definition of chaos, you may have remembered that ideal particles bouncing on tanks on classical thermodynamic models are considered to have

entropy, despite they are interacting, bouncing. Well, yes and no.

On one hand, particles have some measure of disorder, that is clear. For example, the position of all particles is chaotic:

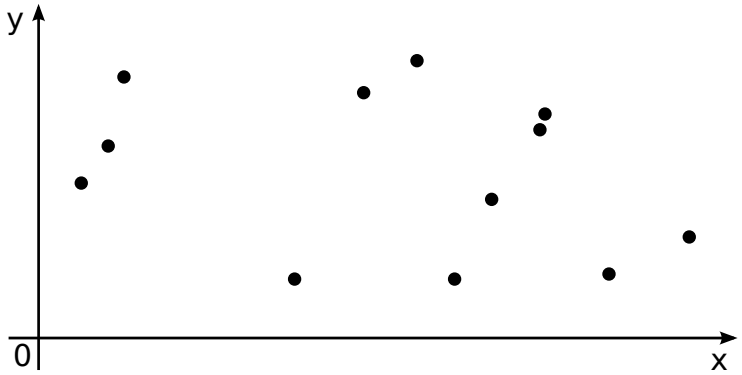


Figure 3.2: Particles of an ideal gas in a tank show chaotic positions.

But as particles are in movement, they are interacting on each bounce. Therefore they should get some level of order. Of course: while positions show chaotic behaviors, other dimensions as kinetic energy or acceleration are almost constant for all particles after some time:

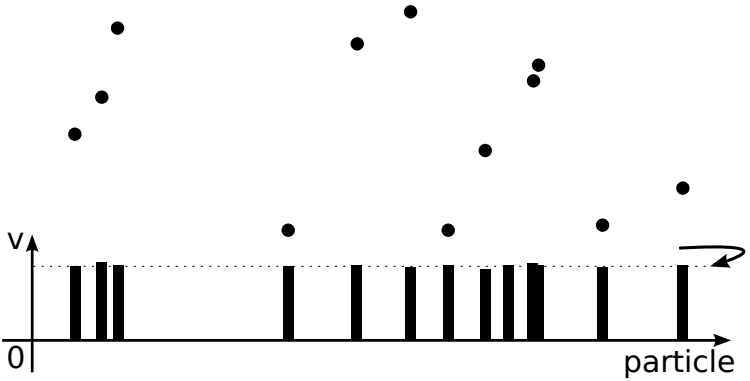


Figure 3.3: Particles show order on other dimensions as speed.
Speeds are not chaotic, they tend to a constant speed as pointed by the example row.

Therefore *the same set of particles have order in some dimensions while increasing chaos on other dimensions*.

Physical issues (volume, mass) cause particles to interact on a gas. But only at certain dimensions like speed value. Positions are completely independent, when no collisions occur. On this thermodynamic model *speeds are not chaotic*: after some number of interactions, the speed of all particles tend to a common value. So chaos only exist in specific dimensions of systems where no interactions are produced.

An interesting example is the positional interactions of particles in a solid (phonons). A small change in position of one particle will cause neighboring particles to move, but the system will remain in order even after absorbing or releasing energy. This does not occur in gases. On the positional dimension, chaos raises.

Interactions generate order in physical nature and mathematics. The more contents present in an interaction, more possible patterns of order that may appear. But physical limitations can also prevent entities to interact and therefore get order.

On common thermodynamic models, order is represented like over any other mathematical model, that is, only on relevant dimensions. Order and chaos are subject to the influence of dimensional properties of each type of matter. There is time-chaos, space-chaos, size-chaos, contact-chaos, etc. Order can raise in any dimension, independently of the simultaneous existence of chaos in other dimensions.

Chaos can contain order or vice versa. Chaos in one dimension can be absolutely compatible with order in other dimensions. Chaos in one dimension can cause order in other dimensions (Ilya Prigogine[1]*)* —of course, if interdimensional interactions exist—. *Order can raise from interactions.*

On a closed thermodynamic system with two tanks of gases at different energy, we say that entropy tends to grow when a door is opened between two tanks. But this is partially true due to it is a simplified approach. Chaos and order can raise independently in different dimensions.

If we open a door between two tanks containing ideal gases at different temperatures or pressures, the energetic values will start to change and tend to one value, which depends on proportions. After some time, particles arrive to a state of energetic order. So, on the energetic dimension, *entropy tends to decrease*. The positional dimension depends on the energetic dimension, particles elasticity, size, shape, etc. So, we can't say that positional entropy increase. Perhaps it continues to be the same, because the positions change

[1] *Order Out of Chaos: Man's New Dialogue with Nature by Ilya Prigogine, Ph.D.*

between limits (the tank walls). But the entropy of speed, which is proportional to energy, tends to decrease.

What about other dimensions? Does mass change? not really, because is related to energy. Weight? Not on the level of a tank in relation to earth, but variations on trajectories can be caused due to gravitational attraction within particles, stronger when distances decrease. Does the volume of each particle change? This is interesting: volumes can change momentarily, due to elasticity. Electrical charge? Charges can generate trajectory modifications in real physical systems. Spin? That is difficult to say, it depends on the particles structure. If they interact physically, they can generate other dimensions of order and chaos.

3.3 Synergy

There is no formal definition of synergy but "the total is greater than the sum of the parts".

$$\left\{ \begin{array}{c} a = x; \\ b = y; \\ a + b > x + y \end{array} \right\}?$$

The sum $1 + 1$ will always be 2 in a lineal dimension. But on the physical world, two flexible sticks can provide more resistance than the sum of each one isolated. This is real synergy. The sum of sticks is 2. But the resistance has increased due to an additional interaction between the sticks that causes the resistance to increase.

This is of course, an additional interaction over other physical dimension. We can say that if the number of internal interactions while holding a weight on a stick is n, the interactions of the two sticks is $2n$ and the interactions of a system composed of two sticks is $2n+a$, where a is the number of interactions between both systems.

Therefore *synergy is the result of the increase of interactions that occurs when many systems act together*.

In consequence, the added value of a number n of isolated systems should be less or equal the value of a system with n components. The exponential grow of the number of interactions and the value of a system will be analyzed on the subsection *Value Measurement*.

3.4 Order

Let's get back to the original model of particles over an infinite line.

If we add an additional dimension to form an infinite plane, the visible result will be an ideal fuzzy disposition of points. This is chaos in two dimensions. Since we have no referential distances, no measure of distances is possible between dots. The same fact applies to all possible dimensions: chaos exists in all dimensions on this idea.

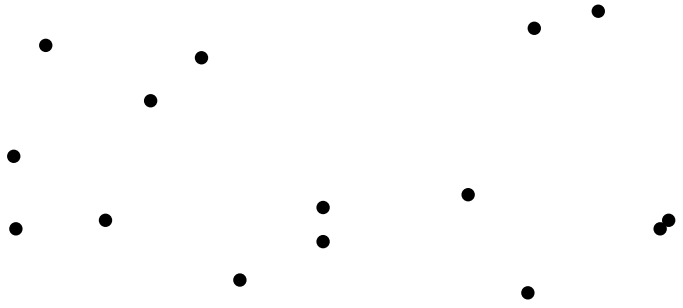


Figure 3.4: Points arranged in a chaotic 2-dimensional disposition

Let's create a border that limits the plane. Outside of the border no points are allowable. A limit for the plane space has been created. The idea of a limitation is essential to physical interactions.

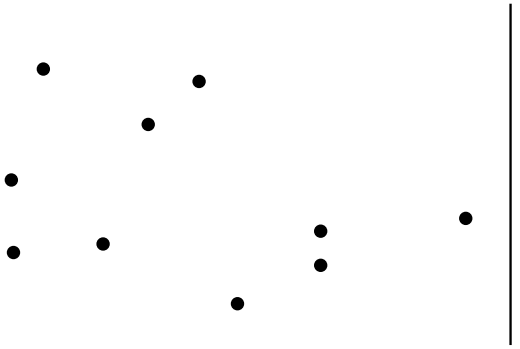


Figure 3.5: Points arranged in a chaotic 2-dimensional disposition.

In the infinite model, points do not follow any pattern. On the finite model, points can form patterns. For example, points may have a minimal distance to the border.

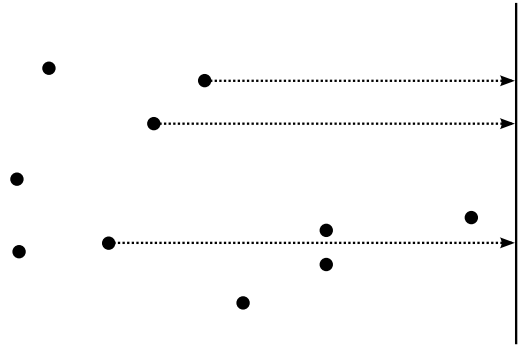


Figure 3.6: Interactions between points and an entity: the border.

The border limitation generates a possible interaction: a line which forms a right angle with the border. Now, all points follow this pattern: They share a same directional value to the border. Order appears again!

Interactions will cause patterns to appear. Therefore interactions can produce order.

Note that if the plane is huge, the points far from the border will appear to have no interaction because the border is too far to be used as a reference. This is an example of how physical limitations work. Mathematically, the distance to the border has no impact on interactions. But physically, it can prevent interactions. The closer the points get to the border, the more possibilities of interaction.

Physical limitations create constraints for interactions. Physical interaction requires proximity. Distance prevent interactions.

Let's add more dimensions. Imagine points attract between them with a force that is lineal to the distance and that particles have a punctual mass. Now, the vectors of attraction have values.

With time, particles will start to move and try to reach a mass center. But as they have mass and no size, they will not enter in contact and the movement of each particle will just be a set of irregular loops around a center. Order appears again.

If we add size (a circular shape), some degree of elasticity and viscosity, parti-

cles will finish by grouping. This is pure mathematical order: a group of particles that share one pattern: the distance to the groupal mass center is the minimum possible.

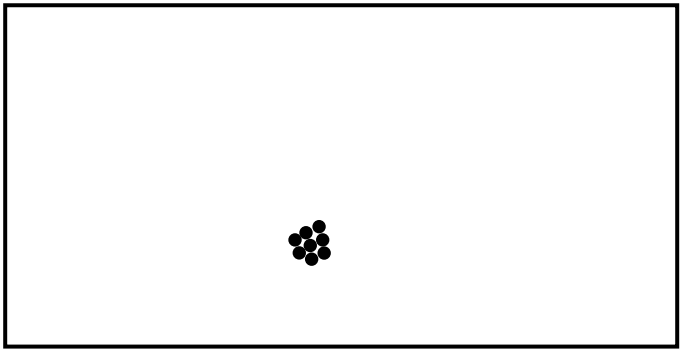


Figure 3.7: Gravity on a limited 2-dimentional space.

If we remove the plane size constraint, converting the plane to an infinite size and removing the borders, massive groups of particles will appear at distances that can acquire a pattern (in the following picture, groups have been created emulating gravitational attraction; this can be equivalent to the disposition of matter inside a universe for some period of time).

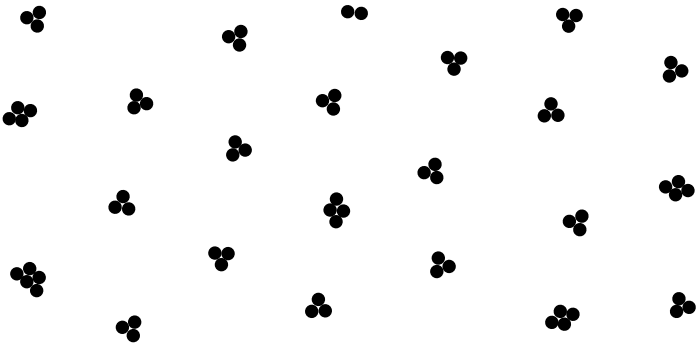


Figure 3.8: Gravity on an illimited 2-dimentional space.

Again, interactions generate order patterns, whereas dimensions are easier to

appreciate. Our definition of order will be this:

The order of a system is the proportion of couples from the total, that interact during a period of time.

To increase its meaning, order can be calculated over an objective dimensional subset when possible.

Entities can be pictured instantly. But transactions require to be assessed on a time period. So, this is a consistent definition with our purposes: time is required to be included because interactions can't be measured without it. Physical interactions occur through the time row. A highly remarkable conclusion is to be noted here: Existence is time dependent. Nothing exists on the instant. Time is an essential condition to existence.

Order causes existence.

Organization and Dissipation

Due to interactions provide order, an interaction between two systems in a lower dimensional scale causes the existence of a new system in a bigger dimensional scale.

Organization is an order increment in dimensional scale. Dissipation is a decrease of order in dimensional scale.

Natural entities tend to interact in order to keep existence. Entities exist by interacting each one using a limited set of capabilities. When interactions exceed the set of capabilities, entities get chaotic: they dissipate into lower scales of existence until further reorganization. This appears to be the natural *cycle of existence*.

This cycle of existence is in open contradiction with the concept of entropy, which suggests that chaos increases permanently. In fact, dimensions of existence of entities and contents are independent, therefore an increment of chaos on one dimension can increase order in other dimensions inside a system. Dimensional chaos increment is compensated with matter hyperdimensionality (see *Statics: Hyperdimensionality*). Apparently, order prevails in nature. Entropy can be a very limited approach of order and chaos. Chaos and order cannot be assessed in isolated sets of dimensions.

Absolute dissipation is apparently not possible. Energy does not dissapear, it just transforms.

Order measurement

This is a simple example of how order can be measured. The concepts exposed here are intuitive, to represent those used on our daily language. The value of order can have many meanings and can have different dimensional approaches on each discipline.

This are the premises:

- Order is related to interaction. Two entities that do not interact are in a chaotic organization. The number of possible interactive connections on a network is given by the triangular number, $i = \frac{n(n-1)}{2}$, where *n* is the number of nodes and *i* is equivalent to the number of interactions.
- Order is independent from isolated dimensions, but dependent on the whole dimensional set. Two systems are in order if they interact in at least one dimension. Order can be calculated regarding a particular subset of dimensions, which can yield a more representative value, depending on the analysis. For example, finished electrical connections on a circuit can be considered as interactions, despite no current flows on the cables. Then, a circuit can be in order if all parts are connected, independently of the current flowing through it. On the contrary, connections can be excluded from the dimensional set and current flow can be the measure of interactions, rendering a different value of order, for this different set of dimensions.
- Order is related to time. Two systems that don't interact during a period of time can be considered as chaotic. Despite connected, if no current flows through an electronic circuit, the circuit has the same behavior as if would have no connections. It's equivalent to say that the system does not exist.
- Order is related to a scale. Only systems on the outermost scale should be focused to calculate the best value of order. Smaller scales can hold chaotic content, but order is assessed on bigger scales, due to interactions of small scale systems with chaotic content can provide order to higher scales. For an electronic circuit, order is measured at the scale of its components (diodes, inductances, resistors...), not at the scale of its subsystems (electrons can behave chaotically —or not— on the liquid inside the capacitors, but that does not matter for the circuit: the liquid is part of one system, a capacitor).

Let's consider a value of order of 0 for a chaotic system and 1 for an ordered system to keep coherence with language. If there are three subsystems, only

two couples (a,b) and (b,c) interact and the couple (a,c) does not interact in any dimension, the proposed order will be 2/3. If only one couple interacts, the order will be 1/3. This is an intentional example of how the zeroth law of thermodynamics is an expression of the order required to assess thermodynamic equilibrium. If the measure of order of three thermodynamic subsystems is at least 2/3, the zeroth law says that thermodynamical equilibrium exists and that order can be considered as 1.

In conclusion, a measure of the order on a system can be assessed by calculating the ratio of interactions to the total of possible interaction couples during a time period:

$$o = \frac{2i}{n(n-1)}$$

Example 1

For the system of equations:

$$\left\{ \begin{array}{c} a = b \\ c = d \end{array} \right\}$$

There are four entities *a, b, c, d*, and two interactions, the equalities. Therefore, $o = \frac{2\times2}{4\times3} = 0.33$. If the equation *a=d* is proposed, all entities can interact by means of mathematical relations, in the same way as the zeroth law of thermodynamics. Therefore the order of the system will be *1*. On mathematical systems, if the order is other than *1*, some elements should be considered to be not in order, to behave chaotically from the rest. Time can be neglected on mathematical systems, not because interactions are counted over a time period, but because ideal mathematical interactions are permanent. Therefore time has no impact on most mathematical systems: they don't evolve with time.

Example 2

On a 5-entities system, there are $o = \frac{n(n-1)}{2} = 10$ possible couples, therefore if the system performed interactions on 7 couples during a time period, the order of the system is $o = \frac{14}{20} = 0.7$. A value of *1* means that a system is completely ordered: all parts interact within each other. Pay attention to the last *Example 1*: some interactions can be transitive, despite they are physical. Related interactions between non-contiguous elements may exist, therefore the value of order can easily reach *1*.

Chapter 6

Perstability

6.1 Evolution

While the GST view focuses on the system structure and consequent functions, evolutionism has remarked —beyond the scope of the systemic discipline— that living systems essential functions are those which permit the system to adapt and persist within dynamic environments.

This pattern can be extrapolated to non-living systems. The essential functions of an atom are those that provide not only internal stability but persistence along time. For a group of atoms to become a stable molecule, the functions require not only to ensure internal stability and persistence along time, but providing stability and persistence to the whole. A cell repeats the same pattern: by acquiring stability and providing stability to its neighbor cells, it remains alive and persists along time. On animals, human beings, social organizations, ecosystems, this pattern is the same.

As the environment and entities are highly dynamic and subject to change, entities should adapt to continue existing. Therefore stability is not enough to face dynamicity, for living and non-living entities. There is a difference between stability and the local time-variating state that allows the system and the suprasystem to persist along time. This will be called *perstability*. *Perstability is the dynamic state that causes a system to persist continuously along time.*

6.2 Life

The next principles are the essential axioms of *existence* and *life.*

Principle of Interaction:
Natural systems interact to exist.

Natural systems interact: only interactive entities can exist. Interaction provides existence. Without interaction, entities dissipate. Natural systems, therefore, need to be open. Closed systems cannot exist in nature. Entities on small scales interact providing existence to higher scales and vice versa. The cause of this principle is difficult to find on our current state of knowledge. Energy may tend to concentrate on the fundamental level —as diametrically opposed to the concept of entropy, which can be just a misinterpretation due to dimensional isolation of thermodynamic systems—. If so, elemental energy packets —*superstrings*?— require to interact to continue existing. Bigger scales of existence will be fractally provided by interactions on small scales (see *Thermodynamics: Order: Organization and Dissipation*).

Regarding the interaction partners, there are two types of interactions: *horizontal* interactions (interactions with couples on the same scale of existence) or *vertical* interactions (interactions with couples on different scales of existence, as subsystems or the suprasystem). The *Principle of Interaction* works the same for both types:

Principle of Order:
Interaction causes order that propagates horizontally and vertically.

Each interaction in nature is subject to compliance of a particular set of physical dimensional constraints. As long as constraints remain, no interaction exists, and therefore no order exists. When all constraints are met, the interaction takes place. Order between entities raises during the interaction. Lack of order means lack of interaction.

An interaction is a triggering mechanism for other multiple interactions. Order propagates horizontally and vertically on open systems after physical interactions have place. Entities in chaos can interact generating order for systems on bigger scales. Interaction in bigger scales cause transferences of content that get into systems triggering interactions between subsystems.

Order is not permanent on physical nature. Two entities can behave as closed systems after an interaction. Or else, an interaction may produce negative internal results for one or both interactors, so in many cases at least one member of the couple is destroyed in nature. If no member receive a negative interaction result and both continue behaving as open systems, it can repeat.

> Principle of Relationship:
> *Repetitive interactions provide existence along time and space on the scale of interaction.*

But couples of entities that hold relations —repetitive interactions— can still dissipate in chaos. Two systems that have reached stability by interacting repeatedly can have it at the expenses of other neighboring systems. This will ultimately cause the ecosystem to lose stability and dissipate, destroying the couple. Broadly, stability by means of isolated *horizontal* interactions or *vertical* interactions is not enough for a system to face changes on dynamic environments.

This *Principle of Relationship* is coherent with the GST meaning of a relationship.

> Principle of Perstability:
> *A system generates perstability for the environment when all its interactions (vertical and horizontal) tend to permanent repetition.*

Systems that show perstability can be said to be *alive*. This is the continuum of life:

> *Entities interact, interaction generates order, relationships provide existence and perstability generates life*.

Despite perstability is the proper and precise meaning of the term *life* on this TOI, it is not used on this book as such, due to the biological meaning of life is required to address biologically non-living and living entities. The term perstability is used instead. *Perstability can be considered as synonym of life*.

Chapter 7

Statics

7.1 Codification

> Principle of Codification:
> *All systems and contents in nature are essentially energy codified in different forms.*

Contents are *packed* and transferred between entities essentially in the form of energy codified by interactions. Physical structures can be codified in multiple forms, for example, as physical matter. But what is finally transferred is codified energy. The same happens with information over a carrier: information is a form of codification of the message, but essentially is energy what is transferred.

Codification is the result of an instance of organization (see *Thermodynamics: Order: Organization and Dissipation*).

Basic contents can be packed to obtain perstability due to physical natural constraints. If not, they may be unstable and can easily dissipate, therefore they will not arrive to destination.

Packing provide additional properties to the matter. Matter packed in the form of a stable content to be transferred acquire more properties, due to structures are able to be processed in multiple forms. Receivers can take advantage of some properties and therefore exploit the content depending on its capabilities.

Codification causes capabilities —mechanisms of triggering actions or reactions to external stimulus— and properties —messages codified in matter: hyperdimensional values— to be encoded in the structure. The more the complexity of the packed message, the more the capabilities and properties of the content. When capabilities are not enough to react to an stimulus, interactions

cause entities to dissipate until further reorganization. Hyperdimensional values cause matter to be valuable as a content for processing.

In this book, energy is considered as the fundamental block of interaction, being it equivalent to matter. Both concepts are used indistinctly.

7.2 Hyperdimensionality

> Principle of Hyperdimensionality:
> *Packing of matter provide it of vast quantities of dimensional values.*

Contents show hyperdimensional physical properties when approached by natural entities. The dimensional set of values is subjectively assessed by each entity that processes a content.

Systems have heterogeneous properties and capabilities. Each system "*understands*" matter in completely different forms. What is dissolving water for a system —as for proteins or a salt pebble—, can be solidifying water for others, —as for rocks by petrification or for igneous rock by cooling—. The hyperdimensional approach of systems allows them to process a content by using their sets of capabilities. For an artist, a rock can be converted in a work of art. For a caveman, a rock can represent a weapon.

How does hyperdimensionality works for mathematical entities? A point in a plane can be referenced as a pair of coordinates... in infinite ways, with four values or with hundreds. Is not common to represent a point with four coordinates, but of course, it is possible and absolutely logical; for example a point can be the plane representation of a cartesian position added to a polar position: four coordinates. A number of fractals are drawn with this approach [1]. Any type of coordinates can be used, cartesian, polar, logarithmic, intersectional, transformational, etc. A point can be referenced by looking a precise point on the paper.

Why such a strange idea?

We are used to reference a point by cartesian coordinates, X and Y, and to think that water has no dimensions except those found in books (volume, weight, color, temperature, phase of matter, heat capacity, etc.). But natural entities have no rules to approach matter (natural entities do not read books, in fact, a book can be *understood* as food for some entities, as fuel or a source of fiber

[1] For example, the Barnsley Fern fractal tree is drawn by making a line from a cartesian coordinate to some polar coordinate and create two smaller lines since this point by repeating the same mechanism. The exact same pattern can be observed on natural fern leafs.

for other entities). Contents can be interpreted in multiple weird ways (*interpretation is to mathematics as processing is to physical dimension*s). We are used to apply the simplest interpretation, but nature does precisely the opposite: creates original, strange and complex methods of processing-interpreting matter.

Let's explore the dimensions idea on the abstract and physical planes in deep.

Mathematical systems are ideal models that basically establish relations between dimensions. A linear function is a mathematical system that converts values in one dimensional space to another. Physical systems perform exactly the same type of conversion. On physical systems, entities (which can be conceptualized as black boxes) convert inputs in a dimensional space of contents to outputs on another.

What does a dimension and a dimensional value represents? On ideal systems, *a dimension is an entity's approach of content processing. A dimensional value is the weighing of the magnitude to be processed with a selected approach*.

On physical systems, the concept is identical: a dimension is an approach of contents processing. A unique content can be processed in multiple ways.

For example, there are three basic process types to convert glucose into energy: aerobic, anaerobic and by fermentation. In all cases, the input is the same, but depending on the set of capabilities of the processor system, one method will be used. This means one approach to process the content will be used: the content will be approached on one specific dimension. On high level systems, a bird could swallow a pebble of rock to literally chew food in its stomach. The same pebble can also be used by an insect to protect the entry to its nest. The pebble can be interpreted as a container of multiple different dimensional values.

DNA is basically a number of atoms, therefore it is at last pure energy. But energy is organized in fundamental entities, then in atoms, then in molecules. Living beings have the capability of generate, deliver, receive and process subjective sets of dimensional properties for any content.

Back to ideal models, a point on a line can be measured in infinite ways —from using traditional resources as a ruler, the hand, the eyes, etc. to any imaginable process of measure, as complex as those used by animals—. Systems in limited spaces can be associated with an infinite number of dimensions.

Mathematics use common simple dimensions, dimensions to which we have become accustomed. Nature does not follow the same conventions. Nature applies specific dimensional assessments to trigger interactions. When we are able to focus the dimensional approach, the analysis of a relation or interaction

is easier.

A consequence of this principle is that *mathematical systems are closed*. Mathematics only accept limited dimensional sets. On the other hand, *natural systems tend to be open in order to persist along time.*

7.3 Polymorphism

> Principle of Polymorphism:
> *Entities can behave as contents, and contents can behave as entities.*

Polymorphism is just a consequence of hyperdimensionality.

In order to analyze interactions, contents and entities should be clearly identified, because they are easy to misplace. The rule of discrimination between systems and contents is this:

> Rule of systems and contents discrimination*:*
> *If it tends to interact, it is better to consider it as a system. If it tends to chaos, then it should be considered as content*.

Contents can be obtained from the chaos: *natural entities are able to obtain order from chaos* (despite chaos is the opposite of order and existence, it does not imply that chaos is emptiness: chaos is the lack of interaction). Therefore chaotic contents can provide entities of order. On the other hand, matter itself can contain multiple dimensional values, including other subsystems. That means that a content transference can be formed of systems.

Systems do not interact against contents. As natural processes can be very fuzzy to observe and analyze, this definition should be carefully taken into account. If a content interacts, the conception of the model can be wrong: the real content should be found, and the interacting entity should be conceptualized as a system.

For example, it is intuitive that the interaction between zebras and lions consists on the procurement of food for lions. For one side, this is a destructive interaction (lions force zebras to deliver their bodies), lions just want the meat, they don't want other dimensions of the zebra, but as soon as the zebra dies, all their other dimensional contents starts to dissipate. But this can also be conceptualized as an interaction between lions and the environment, being the environment the meat provider, and the zebra can be conceptualized just as a content. The apparent interaction (persecution, hunting, attack) can be just the

dimensional processing. Nature has just provided lions with excellent tools to process zebra meat. Therefore the conceptualization depends on the type of analysis.

In computers, groups of bits of any size are stored in RAM memory chunks. The processor takes the decision to use memory chunks as data or as a program following strict rules. For example, if the value stored in memory is the hexadecimal *0x90*, an x86 CPU could use it as a program by executing the command NOP or as data by converting it to decimal 144. Matter is exactly the same. Entities decide to use the same matter as interactors —equivalent to computer programs— or contents —equivalent to computer data—.

7.4 Processing Capabilities

> Principle of Capabilities:
> *Each open system have a limited set of capabilities to approach contents.*

A dimension is an approach of contents *processing*. The *processing* capability of an entity are referred exactly to this conceptual idea. Systems are open due to the fact of having capabilities to approach contents. If a system has no capabilities to approach a content, it behaves as closed for the entity that generates the actual content.

A capability is a feature that allows a system to process an input in a dimensional set and generate an output in a different dimensional set. Any system can perform certain number of transformations, depending on its capabilities. Capabilities are multiplied by matter properties and cause the hyperdimensional approach of contents.

For example, a rock has the capability of transforming work in the form of potential energy (pressure on one side) into kinetic energy (the rock moves constantly in one direction). That, if the rock floats in free space. But if the rock is in contact with another rock, it will transform the initial work from one side into work on the other side of the rock (pressure for the second rock). Despite this properties appear to be absolutely trivial, they are essential to natural systems.

A rock has also other capabilities: It can demineralize water, as it does during petrification. It can protect the soil against wind erosion. It can provide a stable and humid environment for plants behind it. Rocks have multiple capabilities to approach the hyperdimensionality of different types of matter.

Capabilities define entities. Two entities can be considered functionally identical if they have the same set of capabilities (this is not common in nature for differ-

ent types of entities). Similar entities can hold enormous differences between their capabilities sets.

Chapter 8

Dynamics

8.1 Reactivity

Almost all systems in nature are open. It is actually difficult to find examples of closed systems in nature. Maybe outer space is the best approximation to a closed system. There are no possible reactions from emptiness in most cases. Any stimulus performed to space is normally dissipated without getting a reaction. But not always.

Matter —and energy— fundamental blocks that are free in space tend to concentrate in banks of diverse forms (being them fundamental particles, rocks or planets), probably due to the attraction of interactive fundamental forces[1]. Grouped matter forms packets of simple interacting entities.

Packets of interacting matter persist when they behave open and interact. Behaving as closed systems may lead entities to be fragile to external stimulus and dissipate. *Fundamental entities may exist because of their open behavior*. As soon as basic interacting entities group in more complex shapes, new forms of entities and contents may raise. This means that new types of stimulus *will* appear. So, in order to exist, entities should be able to react to new types of stimulus. All entities not having this capability will dissipate into fundamental blocks until reorganization. *Natural entities loop in a cycle of dissipation and reorganization to face change, universal dynamics*. Natural entities exist because they behave open to *all types of possible stimulus*.

> Principle of Reactivity:
> *Every stimulus action over a natural system triggers a reaction.*

[1] See https://www.learner.org/courses/physics/unit/pdfs/unit2.pdf

This is the most remarkable principle, a generalization of Newton's Third Law of Motion. Absolutely all stimulus cause a reaction, despite it can be delayed (see *Kinematics: Buffering And Delay*).

But do not get confused: the lack of an answer when speaking to a rock doesn't mean that it behaves as a closed system. It just means that rocks have not the capability of decrypting spoken messages (See *Statics: Processing Capabilities*). In other words, rocks are not able to process the vocal dimension of a content (See *Kinetics: Interdimensional Transformation*). All stimulus provided by the action will obtain a reaction. Air vibrations over the surface will cause molecules to bounce (to perform reactions) following Newton's Laws of Motion: motional action and reaction. Air humidity from the lungs will condensate and perform chemical reactions that will affect the structure of the rock and the environment after some time. Transferred temperature will cause internal vibrations to come back affecting the exterior side after time. And so on. All stimulus cause reactions that will affect the external side of the system after some time.

Reactions to an stimulus will get back to the stimulator (maybe by different channels and normally with a delay, see *Kinematics: Buffering And Delay*). If no reaction would be produced following an increase of temperature, that is, if a rock would behave as a closed system, temperature energy will accumulate inside and cause the rock to dissipate. Only open systems persist in nature. In order to persist, open systems must absorb stimulus, process contents and output the results.

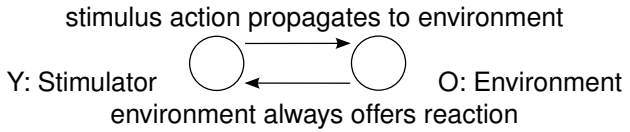


Figure 8.1: The YDOR cycle represents one *interaction.*

The total energy of reactions is subject to the First Law Of Thermodynamics: As all systems tend to keep their integrity, the sum of inputs tend to be the sum of outputs, therefore all energy that gets into the system finishes by coming out of it. Therefore an action stimulus to a system triggers a chain of reactions that keep almost the same energy as the input. This mechanism propagates through all the systems involved in the interaction. Finally, all the energy comes back to the original system.

There is no linear relation between the magnitudes of isolated actions and reactions. Thermodynamics suggests they should be equivalent, but reality shows

the opposite (this can be logical: thermodynamics approach is ideal, that is, dimensionally limited). Since a system is subject to multiple simultaneous interactions, a multiple number of reactions can result from a number of actions. There is no direct relation between them in number or magnitude, stimulus and reactions normally behave nonlinearly.

Reactions depend on capabilities. Stimulus are transformed according to each system's capabilities and reactions come out through available channels. That's why the proportions of stimulus and reactions are nonlinear.

The total input energy of a system should be equivalent to the total output energy, with two exceptions: temporary storage or buffering and permanent incorporation or development (see *Kinematics: Buffering And Delay* and *Kinematics: Development*). Destruction is another option, but not common on natural systems.

8.2 Subjectivity and Relativity

> Principle of Subjectivity:
> *Different entities can process one unique content in different forms.*

As entities have different sets of capabilities, one content can be transformed in different ways by different entities. This is something very easy to observe in nature. Every entity approaches the same content in different ways, so contents are said to have a subjective value for each entity.

This complex idea may be easier to understand by observing the macroscopic world. For example, a seed has different values depending on the entity that processes it. If the seed is transported within the reach of a bird, its values come to be those of the nutrients that provide perstability to the bird. If the seed falls into wet soil, it has the potential value of becoming a plant and providing perstability to the soil. In both cases one seed provides perstability and is exploited by transformer systems in different ways.

The value is said to be subjective because it depends on the transforming capability of the entity. A seed has a high value as food for a bird but it has a low value as food for a carnivorous predator.

Even the same type of creatures are subject to provide subjective values to one content. For example, a bird may try eating the seed because of hungry, in this case the main value is the seed as a food mitigator. But if there is a competing bird nearby —that has no hungry—, it may try to eat the seed only to prove that it is the owner of the territory. In this case the exact same seed is assigned a different subjective value: the seed is a proof of territorial domain.

The value is said to be polydimensional because it is not only evaluated in one dimension. For a bird, a seed has multiple values: it has one food value amount because it reduces hungry, it has one developmental value because it provides nutrients that help the body's development, it is valuable as a competitive prize because it provides a competitive advantage against other creatures, etc.

Relativity

Subjectivity is to interactions what relativity is to systems in motion. But this works not only for matter. The process time row is subjective to each entity, therefore time is a local representation of a sequence of interactions. Time is always relative to each entity.

8.3 Push And Pull

If contents are to be liberated on the environment, they tend to dissipate and become chaotic and therefore become useless to interact. Hence perstable pushing entities organize contents and directs them to interactors. Pushing content means making content available for neighbours to interact. Pushed contents take the form of the initial action that stimulates possible neighbors to perform a reaction. Stimulated entities receive contents and process them using their sets of *capabilities*. Pushing interactions are mostly order generators. Pushing contents is stimulating natural interaction. In general, stimulators obtain perstability from pushing interactions.

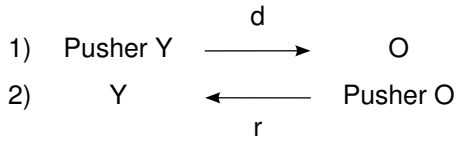


Figure 8.2: Pushing interaction starts by generating content. The interactor reacts naturally to the stimulus.

A content pulling is a stimulation that cannot be answered by any means within the set of system capabilities. Pulling contents is causing a stimulation over a system that has no way of behaving open to it. Therefore it affects the structure of the system.

Pulling content means causing an entity to react in a manner which does not influence its capabilities but its integrity. This is a natural behavior which normally causes one entity (the puller one) to obtain a positive result and the other

entity (the pulled one) to increase internal chaos, therefore to obtain a negative result. The pulled entity's integrity is affected: it will change. It can mutate, can be broken or can completely dissipate. Pulling contents is mostly generating chaos, therefore stimulators can potentially damage the environment, causing its own destruction. In other words, destructive stimulus can potentially cause destructive reactions. Pulling interactions may demand more energy to interact due to common sets of capabilities for a dimensional scale normally cover reactions to most types of stimulus. On vertical interactions this is regular. This is why big animals eat small ones with ease.

> Push and Pull Principle:
> *Any entity can start the interaction either by pulling or pushing contents. The other entity reacts with the same type of answer.*

Pulling interactions are powerful chaos generators, therefore pulling interactions can be called *counterinteractions* or *destructive interactions*. Pulling content means forcing an entity to interact. Pulling interactors control focuses of excessive interaction by generating chaos. Therefore pullers have great chances of dissapearing. The word pull is used due to the similarity of the action to a pulling or a ripping of part of a body, which is an exact representation of a pulling stimulus. Pulling interactions are represented with a row in direction to the puller.

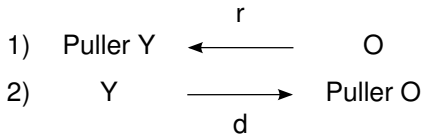


Figure 8.3: Pulling interaction is represented in the opposite sense, starts by aggressing the structure of O. The entity O can be damaged after step 1.
** damage is represented as brackets*

Performing an interaction from the outside means stimulating a local entity to react. If the local entity has the capabilities to react to the external stimulus, the interaction takes the push-push form and the LFR can be positive or negative. When the local entity has not the capabilities to react to an stimulus, the interaction takes the pull-pull form and adds chaos to the local entity. Therefore only pushing interactions may produce positive results for both members, and pull-pull will cause negative results always on one. On systems of high complexity, pulling interactions may appear to generate positive LFRs, but this is just an ap-

pearance. It's very difficult for pulled contents to be compatible with excretable matter, which does not form part of the system's structure. In other words, it's difficult for an external entity to force the excretion of internal contents without excreting part of the internal system's structure.

Pushing and pulling is not the same as pushing or pulling a rock: In this example, pushing a rock is related to direction changes (dimensional answer depending on capabilities). Pull is related to integrity changes (dimensional answer depending on structure). If a rock is hitted on one side, it will move, that is a push-push interaction. If is hitted with excessive energy, it will disintegrate and will produce byproducts. This is a pulling interaction. Pull will also cause an equivalent reaction, which will affect the puller's structure.

Stimulus actions *always* cause reactions on entities. Open entities that tend to keep integrity will always react. If a content is pushed to another entity, the other entity will respond by pushing some other content. This takes the form of a *push-push* interaction. If content is pulled from the other entity, it will react the same way regardless of the differences in dimensional proportions. This is a *pull-pull* interaction. Both push-pull and its opposite form represent only one of both flows, which should be expressed in one direction, and the reciprocal flow should be found. Normally a *push-pull* o *pull-push* is just a *pull-pull* interaction, pulling tends to prevail due to it deals with the subset of capabilities.

Push and pull interactions are not compatible on a single interaction. An interaction works either by push or pulling methods, because original action and response are just consequences of the *principle of reactivity* (see *Reactivity*). If repetition is produced, the interaction push or pull mechanism repeats on each loop. Despite this incompatibility, pull and push can exist simultaneously at different scales (see *Fractal Chaining*). An pull interaction on a system does not mean that all involved subsystems will interact by pulling (a predator can *pull* content from a prey, but that does not mean that the internal subsystems of each animal are not *pushing* contents inside their bodies during the interaction on the big scale).

Pull behaviors are more common on living entities than non-living entities due to certain living entities can get excessive levels of development —order— which can cause the environment to lose balance. Therefore pullers help quickly-developing groups by generating controlled levels of chaos.

8.4 Attraction, Proximity and Grouping

Principle of Attraction:
Entities may change dimensional positions in order to increase pos-

sibilities of interaction.

Successful interactions tend to generate dimensional attraction. When negative final results are obtained, dimensional repulsion is produced.

Attraction is the effect of one system over another that causes change of a dimensional distance until a region which maximizes the probability of interactions. Repulsion is the equivalent causing increment of a dimensional distance. We can say that an entity can *move* when attraction exists, despite movement is not always motion. Systems may grow in the attractive direction, may flow, or may dissipate into chaos and reorganize closer to the attractor. The movement is always local (the *Y* entity moves towards or away the interaction *foci*), and it depends on the result of past interactions.

The set of capabilities of each entity determine the LFR that can be obtained *after* the interaction —so, even if the content is positive, repulsion can be produced, see *Kinematics: LFR*—. So, the local entity performs the displacement. Apparently, entities can *follow* contents, but it is actually not the content what generates attraction or repulsion. It is the LFR. Entities approach contents based on past results —the structure of the entity determines its behavior—. So, *contents provide dimensional directions based on past LFRs*.

Physical effects of one system over another are limited by distance. *Proximity* is the physical property that makes each type of interaction possible when it is dimensionally appropriate to interact —flying ducks in V formation keep a precise distance to maximize the synergic effect of the interaction: the best interaction is not achieved in contact, but at a certain distance—. The concept of *contact* in our daily language is exactly the same, except that it is normally used to mean physical distances of values next to zero, or neglectable. Physically, a distance of zero would mean the integration of two systems. Strictly, there is no difference between proximity and contact, but is useful to conceptualize contact as the minimum distance possible between two entities without merging.

Proximity provides opportunities of interaction. Entities that get close after an interaction increment probabilities of repeating the loop. Even in spite of destructive interaction, proximity compensates destructive interaction effects. For example, people live on dense cities to increase interaction. The more the density, the more the possibilities of interaction. Highly destructive situations in big cities can be wrongly interpreted as economic prosperity.

Two attracted entities produce double attraction, two repelled entities produce double repulsion. If one entity causes attraction and the other causes repulsion, the outcome will depend on the situation, dimensional distance, power of the attraction, etc. Normally this case will lead to a pulling interaction.

Attraction or repulsion should not be confused with push and pull (see *Dynamics: Push and Pull*). Push and pull are related to partners capabilities and do not cause direct movement. They are related to the LFR (local final result of an interaction), and the LFR is the criteria to *move*.

Chapter 9

Kinematics

9.1 Interdimensional Transformation

> Principle of Transformation:
> *Interaction is the natural mechanism to perform interdimensional transformation.*

A very remarkable role of entities in nature is that most of them are able to make some processing that converts an input on on certain dimension set to an output on a different dimension set.

This is so natural to our knowledge that is difficult to observe at first sight. For example, a fluid pipe seems to be a system that takes an input on one side and the absolute exact output is generated on the other side, without any transformation. But in fact, the pipe does a huge transformation: it absorbs water from one position and delivers it to a different position in space. The conversion is a three-dimensional transformation. If we put a filter in the middle of the pipe, the input dimension can be dirty fluid and the output can be clean fluid. If the pipe is strong enough, it has the capability of keeping the same pressure on both sides.

Even a rock in formation can be observed as a transformer. Inputs can be a piece of soft matter (for example, animal tissue) and the water with minerals that are absorbed and performs chemical reactions. The output is a heavy mineral piece that provides stability to the soil. So, the input dimensions are organic and mineral molecules, water molecules. The output dimension is a increment on soil stability. A rock can also act as a transformer in a smaller time dimension: it can change the chemical properties of water.

This is easier to observe on macroscopic systems. For example, on photosynthesis a plant converts light energy, CO_2 and soil nutrients into oxygen and chemical energy in the form of glucose. A cow can be said to be a system that converts pasture into milk. An oven converts a mix of ingredients and some gas into a tasty cake.

Despite the total amount of matter and energy don't change through transformations (the matter-energy dimensional value does not change), interdimensional changes occur. A transformation is therefore a change in one set of polydimensional values into a set of different dimensional values.

Transformation is essential to perstability —*life*—. When complementary transformers get in contact and combine properties, they can increase their perstability. A group having this feature is a good environment for other transformers to join in.

Intradimensional pure transformation is physically not possible: a machine that converts *10j* of energy into *20j* cannot exist in nature. But a machine that makes interdimensional transformation is always possible. An amplifier can increase the amount of an input on the output, but by transforming other inputs.

9.2 LFR or Local Final Result

> *LFR* Principle:
> *After completing an interaction, each entity gets a local final result (LFR) which represents an increase or decrease of internal order.*

After interacting, entities get or lose *order*. In other words, entities get an increase or decrease of internal interactions after an external interaction. If the interaction produces internal order —an increase of internal interactions—, the *LFR* is positive. If the interaction causes a order decrease, the LFR is negative.

The local value is internal ("Local") and it is not related to the environment, therefore it is not related to perstability. An interaction can be destructive for the environment while being constructive for the entity. So, *an interaction can be positive for a couple, but negative for the environment*.

An interaction is said to be *positive* if the LFR is positive and vice versa. If the interaction is positive for an entity, local modifications will lead the entity to a state of accepting new interactions if they are available.

Local values are independent and subjective for both participants of the interaction. Both entities can lose, both can win, any can win while the other loses. All combinations are possible.

As perceptions are subjective on macrosystems, the LFR can be wrongly assessed and cause destruction. There is no relation between the perceived value and the received value. This is mostly visible on living entities. For example, narcotics apparent to be highly positive for the consumer. But they are destructive due to the final value is always negative: the continuous interaction cycle causes death.

LFRs assessment should be done in relation to the long term due to interaction delays can cause results to arrive with time (see *Kinematics: Buffering and Delay*).

9.3 Fractal Chaining

> Principle of Fractal Chaining:
> *Interactions chain fractally through scales of systems and subsystems.*

This is a direct consequence of the *Principle of Interaction* for *vertical*[1] interactions. Systems interactions are processed by the next smaller scale of subsystems until the point of converting pure contents of high complexity to pure energy and back to different complex contents in higher scales.

Simple entities convert energy directly into basic contents: fundamental entities at quantum level will produce perstable atoms (for example *C, H, O, N*) that can be part of perstable molecules (for example, *ADN*) and matter (for example, tissues). Basic and perstable matter can be part of complex organs (liver, heart, lungs) and make up living human beings. But at a fundamental level, this is just a chain of interactions until reaching the basic energy-matter elemental input. So, trees or storms process contents (input and output) that is basically composed by fundamental elements of matter: light, charges, electromagnetic fields, etc.

From the systemic point of view there is also a chaining of interactions. Systems interact with couples. Inside each system, the same process occurs at a lower scale, until reaching fundamental entities.

A question to formulate here is this: Is there any interest in creating perpetual machines? What is the interest in trying to demonstrate that converting energy does not need additional energy? There are big amounts of free energy available in nature. Probably a more interesting thing to do is to create machines

[1] *horizontal* interactions are interactions with couples on the same scale of existence; *vertical* interactions are interactions with couples on different scales of existence, as subsystems or the suprasystem. See *Perstability: Life.*

that can perform perstably, that can imitate life, not by not wasting energy but by using it in perstable reaction chains.

A remark about the classic GST: as the GST approaches systems with a limited dimensional point of view (size, type of relations, functionality, etc.), limits are dimensional. But as systems have hyperdimensional behavior, real limits are fractal.

Dissipation is just a scale decrease of existence. After matter has dissipated, it tends to reorganize, to acquire order, by means of interaction (see *Thermodynamics: Order: Organization and Dissipation*).

Apparently there is no absolute dissipation: energy does not dissapear, it is just transformed. Nature destroys entities that have not enough capabilities of interaction by performing pulling interactions over them. This destruction is just a decrease on the scale of existence until reorganization of matter. If new reorganized matter is able to deal with the environmental set of interactions, it will persist, it has achieved perstability.

9.4 Buffering And Delay:

> Principle of Buffering:
> *Actions can be buffered inside entities causing delayed reactions.*

After a content has been ingested, a system processes it using its capabilities (see *Statics: Processing Capabilities*). Therefore a system acts as a buffer for the content, during the time it is processed. Not all inputs arrive at the same time for being processed. Contents arrive after interactions. So the system requires to store obtained contents until they can be processed. So, a delay between ingestion and excretion is produced.

Afterwards, the content is processed and used in two possible ways: First, the entity can integrate it —or part of it— to the whole, causing the content to become part of the system. (*development*). Second, the content can be excreted, commonly as useful content for further interactions.

For example, hitting a side of a rock with a finger will cause it to move. The impact does not end with a deformated rock. On an infinitesimal and microscopical level, the amount of pressure is absorbed and transmitted in cascade by molecules that gain energy until reaching the opposite side of the rock. This causes the opposite side of the impact to pull. Then the rock has moved. Between the pushing, deformation, energy transference and actual movement, the impact is buffered as an increase of internal pressure and energy. On a macroscopic level, this is almost impossible to observe. Common matter in nature

shows elasticity, this is a condition of organized matter to exist (see *Dynamics: Reactivity*). If rocks had not even an infinitesimal value of elasticity, even a soft impact would deform and crash them.

As a consequence of this principle, *a set of simultaneous interactions of an entity during a period of time can be splitted into a sequence*. If an entity performs an interaction to O_1 to obtain the matter A, and simultaneously performs an interaction with O_2 to obtain B, while simultaneously transforming A and B to C to perform a third interaction, each couple can be analyzed separately.

9.5 Development

> Principle of Development:
> *Energy in a chain of interactions between open systems can be lost only if it is stored as order inside a system of the chain.*

All energy that enters an open system leaves it; with two exceptions: first, the *Buffering And Delay Principle* describes a behavior of temporary storage of contents for processing; second, this *Development Principle* describes a behavior of permanent storage of contents: *development*. Systems can ingest contents, process them to a storable dimensional value and make them part of the system's structure.

Contents become part of the structure of a system when they start to interact with it. That is, when contents increase the order of the system.

All energy that enters to a open system will eventually came out of it. If we propagate this behavior to an environment full of open systems, all stimulus will come back to the stimulator due to the propagation mechanism. This can take time, as the *Buffering And Delay Principle* affirm, but the answer will finally arrive. If some energy is lost, that means that some system on the propagation chain has obtained order by incorporating the ingested content and developing.

9.6 Simultaneity And Multiple Connectivity

> Principle of Simultaneity:
> *Every interaction on the set of interactions of a system can be analyzed independently from the others.*

Systems can hold many simultaneous interactions with multiple other systems at a given instant. This can cause observation to be difficult to perform and missing the relation between inputs and outputs. But the complex network of

interactions is negligible from the entity's subjective point of view. All interactions provide inputs to the system to process outputs. So, each interaction can be focused independently. As most natural entities are capable of buffering (see *Kinematics: Buffering and Delay*), all the network of interactions that a particular system *Y* performs can be analyzed separately.

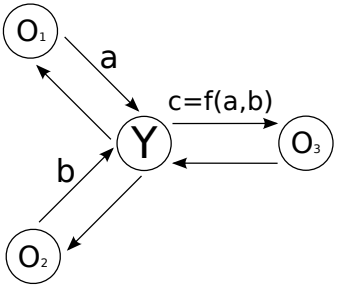
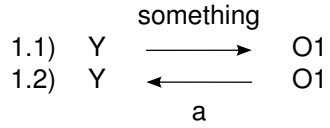


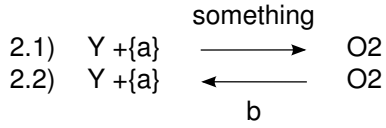
Figure 9.1: A group of simultaneous interactions

The three interactions on the example are completely independent one of the others. As the *Y* entity is able to buffer contents, the interaction with the entity *O3* can be observed separately, as any other. This interaction can be splitted as:

First interaction:



Second interaction:



Third interaction:

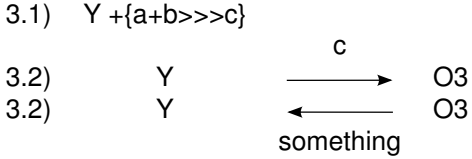


Figure 9.2: Splitting interactions from the previous Figure is trivial, but permits analyzing the process in deep

** the brackets {} represent the buffer,*

** the processing is represented by the symbol '>>>'*

Another interesting consequence is that some actions and reactions appear to be simultaneous. But in fact, they are just instances of smaller interactions, which depend on the buffer size.

9.7 Repetition

Principle of Repetition:
Interaction repetition increase perstability.

After an interaction, each entity gets a LFR. If both LFRs are positive and both entities are in conditions to repeat the interaction, the interaction will loop again, normally with similar results. Therefore the effects are amplified.

Due to interaction generates temporary order, looping repetition creates persistent order. That means existence on the scale of the interaction. A permanently repetitive interaction is called a relation. So, *relations provide existence*.

For each entity, there are two main and consecutive facts —among others— that would cause proximity and therefore increment of the probability of repetition: first, existence of the entity. If the entity has suffered destructive damages after the last interaction, then, despite a possible tendency of repeating the interaction, the repetition will not be possible. Second, LFR. If the LFR is positive, normally an entity will tend to increase dimensional proximity with the partner and increase the probabilities of repetition. There are other less important factors that can influence on the repetition and the impact of all factors on each case should be considered specifically. They will be analyzed on the next sections.

Therefore, *only push interactions are compatible with permanent repetition*. Pulling entities may repeat interactions for some time, but due to its destructive nature, one entity on the couple gets increasing chaos until dissipation. Pulling repetition is never perstable. As discussed previously, pulling interactions are just interactions where one —or both— members cannot perform a reaction due to a lack of capabilities of handling the actual content. Therefore at least one entity increases its internal chaos and its probabilities of dissipation after a pulling interaction.

Preconditions

> Rule of Repetition:
> *If at least one member obtains a positive final result after a pushing interaction, repetition may occur.*

After an interaction has finished, a new interaction can occur, due to the conditions can be met again. Preconditions are multiple: existence (both entities should continue to exist), dimensional proximity (if the initial interaction was positive, the distance should have decreased) and predisposition (entities should be ready to interact) and others.

Existence: Entities should have integrity to interact properly. Push flows tend to keep integrity of both entities. Perstable entities tend to reject destructive content, and destructive contents can remain on the suprasystem until some other entity can profit of it and obtain a positive result from it. Pull flows, on the other hand, tend to decrease entities integrity if they are destructive. Any entity that has not enough energy to reject a destructive pull will be damaged, absorbed or dissipated. Pulling destructive entities can control an overpopulated environment, so they nullify the predisposition to repeat.

Proximity: physical entities require dimensional proximity to interact, on the adequate dimension of the transfer (light require a visual line, electricity require contact with both ends of a conductive mean, etc., physical distance has almost no relevance on small scales, a 10m cable flow is almost the same as a flow over a 1m cable, conductive distance should be zero). Dimensional proximity is determinant on the physical dimension.

Predisposition: Obviously, before each interaction, entities should met the necessary conditions to interact, have buffered content to expel, have some lack of content that could be satisfied by the external transfer, remain open, have dimensional compatibility, etc.

Triggering: Active stimulators have certain control of the interaction by triggering stimulus to proper interactors. On the other hand, passive entities —entities that just react to stimulus— depend on stimulators to perform interactions. Therefore repetition can be controlled by triggering entities. *Triggers may gain control of their environment*.

Chapter 10

Conclusions

Natural entities tend to interact and interaction provides order. Order provides existence if interaction tends to repeat on push interactions. If no interactions are pull and most interactions tend to repetition, they provide entities of perstability, which is the same as life. Order in lower scale levels provide existence to higher scales.

Interactions are easy elements to isolate and analyze. Due to the *Principle of Simultaneity*, a network of interactions can be analyzed by splitting many interactions and approaching them independently. And due to the *Principle of Reactivity*, an stimulus propagates until reaching the stimulator. So, the YDOR cycle can be used as the essential analytic element of natural behavior. Analysis of natural systems based on the interaction cycle provides a wide point of view of any complex mechanism and a proper tool to split systems working in networks.

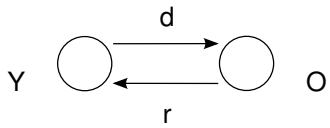


Figure 10.1: An interaction is represented by the YDOR cycle and forms the basic block of analysis of nature.

Interaction follows simple rules. All actions get a reaction. Using individual sets of capabilities, systems act as interdimensional matter transformers and useless codified outputs become required inputs for other systems in nature. So,

matter has hyperdimensional and subjective values for natural entities. Interaction provides of required inputs to be processed by systems, inputs that either a) are stored permanently as development b) stored temporarily in buffers for further processing or c) destroy the entity on pull-pull interactions. Contents stimulus cannot be avoided.

Another remarkable conclusion refers to humans and the environment. Natural entities have evolved until reaching life and human intelligence. Suddenly, human behavior has started to act against the natural process causing a nocive effect on life and the planet, although we believe following the natural mechanisms of competition. Human intelligence has followed a path non compatible with perstability. Thus, social behavior has become incompatible with nature rules and causes diverse issues at many levels, which finally degrade our life quality and our environment. Probably by incorporating the interactional knowledge to our lives, perstability is still possible to reach before the natural interactional cycle of the environment expels us from the planet until further reorganization.

The only thing humans require to restore ecological balance is to behave as perstable entities. The actions to follow are easy —incorporating the knowledge of interactions in our daily actions—, the effects of sane interaction can be observed on the short term and they are more pronounced on the long term.

Applied to human life, the basic interaction principles say that entities with the highest probabilities to acquire perstability are those who increase and maximize pushing interactions while minimizing pulling interactions; develop original sets of capabilities; valuate resources using LFRs as the comparative mean; behave creative and generative; behave open; increase proximity to pushing partners; support pushing partners, etc. Many actions can be taken in order to include the principles of perstability to human life.

As a personal remark, I would say that interaction rules itself are difficult to teach. Strong opposition of the reason to the general principles is natural. That is because each person has experienced a huge number of interactions through life. Everyone has a strong set of interaction rules which can be tough to change. As other psychological processes, learning to interact properly requires courage and intelligence to change.

Some examples of the current state and examples of evolution towards sane interaction will be observed on the following *Part 3*.

10.1 Future

This TOI, the *Theory of Interaction*, is at its very early stages. It requires to grow and develop on each field, to solidify its own bases. If its principles are true, part of the current scientific knowledge may be impacted. Nevertheless, this superficial observation still have potentials:

The TOI may be compatible with most other disciplines of knowledge: *Newton Law's of Motion* are a consequence of the TOI when applied to the motional dimension (the three Newton's motion laws interactional equivalents are respectively: *perstability*, *interdimensional transformation* and *reactivity*). The TOI is a coherent complement to the *GST*, the *General Systems Theory*. *General Relativity* may have a strong relation with the *principle of subjectivity* —not yet assessed—. The *Quantum Theory* and the *Supersymmetric Strings Theory* may explain the *Principle of Interaction* in a near future: why does natural entities tend to interact? The TOI is a principles superset for the *Theory of Evolution*. The evolutionary principles are compatible with the TOI's ones therefore they apply to all natural systems: mutation, natural selection and all genetic phenomena. Most *economic theories* are an extension to the TOI, and specifically, the subjective measurement of value is essential to the TOI. The TOI is the essence of atomic transactions at macro and microeconomic levels. *Sociopolitical disciplines* also are just extensions of the TOI. Most are simple to approach as common interactions. Many *ecological theories* benefit from the TOI: it provides a comprehensive understanding of the direct relation between human behavior and the ecological impact. It also suggests the strongest approach to reduce the ecological damage produced by man. The TOI principles may be universal, but not only to all disciplines in science: to all type of natural interactions.

On the other side, a number of definitions on the TOI require to be clarified an compatibilized with current knowledge. This exposition of the TOI is an empiric observation and relies on the idea that energy is the atomic essence of entities and contents; that interaction is performed by two entities and has two possible states that occur sequentially in the time row. The *Quantum Physics Theory* can modify this understanding, the concepts of order, chaos and existence. *General Relativity* may modify the principles related to time and space, and mainly the *Principle of Subjectivity*. The hyperdimensionality concept exposed among the *Statics* principles also require to be refined on the mathematical field. The *Dimensional Analysis* discipline of mathematics requires to grow, specially for interdimensional continuity, something that may exist in nature but is not currently possible to express mathematically. Maybe the answer of why does natural entities tend to interact lies in the properties of the essential dimensions of the universe.

Part III

Applications

Chapter 11

Nature

> *Knowledge comes by taking things apart: analysis. But wisdom comes by putting things together.*
> — John A. Morrison

This third part is an applied analysis of the TOI principles over several disciplines..

11.1 Newton's Laws

Newton's Laws of Motion are an application of the TOI for solids interacting on the dimension of motion.

> *First Law of Motion: Every object remains in uniform motion unless an external force is applied to it.*

The first law describes inertia and was formulated for one reason: at the time Newton's Laws were enunciated, objects were supposed to move only as long as forces are applied to them. This can be just a special case of the second law for perstable entities. It may be interpreted from the interactional point of view as this: there are no changes in dimensional order if there is no interaction. If no stimulus force is applied to a perstable entity, it will experience no energy changes.

> *Second Law of Motion:* $F = ma$

This rule describes how dimensional transformation is done, how a force is converted to mass acceleration by natural solids (see *Kinetics: Interdimensional*

Transformation). It represents only the *right side* of an interaction, the transformer entity *O*, who is able to convert a force into movement.

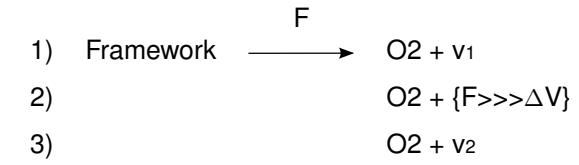


Figure 11.1: A force coming from an external framework is converted to movement.
** the brackets {} represent the buffer,*
** the processing is represented by the symbol '>>>'.*

As seen before, each entity have a set of capabilities that allows proper reactions to stimulus (see *Statics: Processing Capabilities*). In this case, certain solids have the capability of converting forces to movement changes, but not all objects react the same way. For example, if a magnetic field is applied for some time over a metallic ball, the force is converted to a variation in movement following the second law. The same force cannot be converted to movement if the ball is made of wood. Therefore, some solids can act as transformers of magnetic force into variations in movement. This law is commonly assessed with contact energy, which can be processed by a wider range of objects.

A vectorial force represents an energy transfer, the initial part of an interaction. Magnetic energy can be buffered in the form of kinetic energy —movement— of entities capable of processing it. The whole interaction is approached by the third law:

> *Third Law of Motion: For every action there is an equal and opposite reaction.*

This rule describes a full interaction cycle. This is a consequence of the *Principle of Reactivity* (see *Dynamics: Reactivity*) for perstable entities. A stimulus force directed to an entity causes an equivalent force from the entity, but on the opposite vectorial direction. Two objects that collide exert forces in opposite directions: one force represents the action and the other the interaction. Their directions represent the type of energy transfer. While one absorbs energy and buffers it into movement in one direction, the other loses it from its movement buffer on the same direction, that is, it absorbs movement energy on the opposite direction. The vectors are opposite because they represent the energy transformation: energy can be converted to a negative force on the first object,

which loses speed, then this force is transferred to the second object which gains it as positive force and gains speed.

This law assumes the existence of capabilities to interact (wood has the capability to react to magnetism by avoiding it, metal reacts processing it). If the capability of reacting to a certain force don't exist, it will cause dissipation.

11.2 Non-living entities

As observed before, fundamental packets tend to group by means of interaction (see *Life: Principle of Interaction*) and become subsystems of bigger scale systems. Elementary systems persist by using sets of capabilities to perform reactions in order to persist. If capabilities are not enough to face the dynamics of basic packet groups, systems dissipate and reorganize multiple times until required capabilities become part of the structure, no matter the shape or codification acquired (see *Statics: Codification*).

For example, if three particles organized in a triangle are capable to resist the effects of proximity of other particles keeping the form of a triangle, particles will start by grouping in pairs and disintegrate due to external influences on the structure, until groups of three raise. Triangles have perstability on this model. What is the next level? Maybe triangles that join single particles are not perstable. Maybe the next level of perstability are octahedrons of two triangles. And so on. But maybe icosidodecahedrons of octahedrons destroy triangles easily. Then the population of triangles reduce near icosidodecahedrons. Triangles destruction become a pulling interaction, which generate the imperative chaos that eventually becomes reorganization. This new mechanism increases hiperdimensionality providing opportunities for new entities to develop depending on spatial regions.

The basic question remains, why do natural entities tend to interact? *After interaction raises, the rest is just time.* My personal self-consistent conjecture is this: *energy interacts to exist*.

For non-living entities to persist in nature, open behavior is required. That means that having capabilities of reaction to stimulus is essential to keeping order and existence. Or else, common interactions are processed as pull mechanisms and entities dissipate. Entities behave open when they have capabilities to react to the environment. Openness allow systems to exist, persist in time and enforce perstability.

In case of a rock, persistence along time means keeping structure, organization, cohesion, continuity, adhesion, etc. In case of an atom, it means keeping a stable structure of its components —elementary particles— within external

influences. Atom require to be organized and to reach some particular equilibrium in order to persist. So, non-living entities tend to keep their internal properties by applying sets of capabilities oriented to persist. Remember that capabilities are used to perform pushing interactions.

Living and non-living entities interact identically with the environment. But each one show distinctive features. The major difference between non-living and living entities is that non-living entities passively use its capabilities to persist. If capabilities are not enough to persist, non-living entities disintegrate and reorganize eventually. On the other hand, living entities can assess their role against the environment and behave —even mutate voluntarily— to increase its internal order and to persist. Living entities can actively develop their applied capabilities, discard those who are not used and create new ones that may even contribute to the suprasystem. But the difference can be fuzzy: as higher the scale of organization, more advanced sets of capabilities are developed, which means that mechanisms grow in complexity towards intelligence.

The definition of intelligence has been always controversial. Most possible reactions of a rock in nature —to pressure, to water, to acceleration, to wind, to heat, to humidity, etc.— lead to keep its existence, therefore intelligence may not be solely a capability of humans. A proper definition may be this: *intelligence is the capability of performing towards perstability*.

11.3 Living entities

As observed on the last section, the first systems in nature have probably raised from fundamental entities just by following the basic laws of interaction: acting and reacting; increasing proximity and order; providing existence fractally to upper scale systems; organizing and dissipating until capabilities are able to cope with environment dynamics having push interactions and decreasing pulling events; incorporating contents to develop rich and polydimensional structures; etc. Elementary particles are the essential systems capable of holding fundamental interactions and respond accordingly.

In consequence, nearby fundamental entities interacted causing stable proximity: order in a number of dimensions kept by constant interaction cycles —existence—. Foci of perstability incorporated more particles causing physical size increase, which in turn is capable of attracting more and more fundamental systems. This may cause an exponential growth of the dimensional space (while the physical space grows slowly). Those are the cells of universe.

A theoretical gravitational attraction between particles on an finite plane should cause particles to group around a central point after time has passed. An infinite plane of interacting groups will cause a lattice of banks formed by entities

(see *Notions: In Thermodynamics*). That's the TOI's interpretation of how stars raised on the real universe, after a probable big-bang.

The lattice phenomenon —simultaneous for different dimensional groups— is exactly what causes the grouping of fundamental cells. After that, the mechanism of interaction repeats horizontally and vertically. Interaction propagates fractally. Order on lower dimensional scales provide existence to higher scales by means of vertical interactions, and higher scales provide perstable environments to lower scale entities.

While the evolution theory cannot explain how do the first forms of life on earth arose, the TOI arguments that they should have raised from foci of high perstability that raised from non-living matter. The principles of perstability suggest that biological life is a natural consequence of fractal interaction and intelligence —as defined on the previous section—.

11.4 Competition and Collaboration

This two concepts are commonly understand as opposites. Competition is associated with an egocentric behavior and collaboration with a groupal oriented behavior. Competitors focus on the resource and collaborators on the group. The opposition of this concepts is just a wrong humanization of behaviors on different dimensions.

Wherever there is an insufficient dimensional resource for a number of entities there is a competition. Wherever some taken action benefits the group there is a collaboration. Both behaviors are compatible and can coexist on different dimensions. For example, trees can compete for sunlight while they collaborate in keeping soil humidity.

This confusing view can be better explained from the interactional point of view.

A competitive behavior is related to three entities: one resource provider that provides limited resources and two competitors that try to obtain the limited resource. Collaboration is related to two entities that push content for the other to profit. Therefore they can't be opposites due to they represent different models of behavior.

Collaboration

A win-win push interaction causes dimensional attraction and repetition. This type of interaction is the most common in nature. So, common natural entities are collaborative. This is not an exceptional behavior. The following graphic shows an example of collaborative behavior: O_1 generates a content, Y accepts it and profits of it. Both obtain positive LFRs.

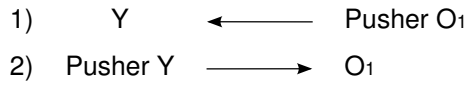


Figure 11.2: Most natural interactions can be said to be collaborative behaviors.

Due to only two entities participate on the interaction, this is the unique form of collaborative behavior.

Push Competition

Not only collaboration exists in nature. Competition is also a common mechanism, but it mostly keeps the push mechanism. In the following graphic, two generator entities O_1 and O_2 on opposite ends offer contents to Y. If the central entity Y detects content that can cause benefit in different directions, it will simply choose one, probably the one that causes the best LFR.

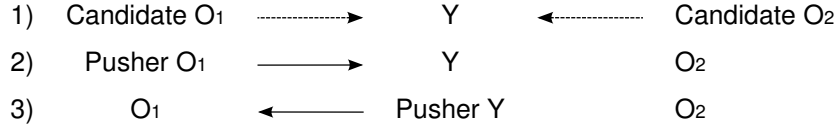


Figure 11.3: Push competition causes all entities to obtain the best LFR

The isolated entity O_2 does not interact, then it does not obtain resources due to the lack of an interaction reaction. But it does not die. *Contents are not expelled without interaction* —that would be a different interaction with other entity—. Contents are not transferred until actual interaction. So, after the interaction, both O_1 and O_2 continue existing. Both O_1 and Y obtain a positive LFR and O_2 does not die. Y has a high possibility of development and eventually increasing population due to the abundance of resources, and O_2 persist the interaction coupling failed attempt. This is a natural population balancing mechanism, that can lead to enormous groupal development. Most entities winning and no destruction is the common result of pushing competition.

Pull Competition

Conversely, if entities O_1 and O_2 use *pull* mechanisms, the result is completely different.

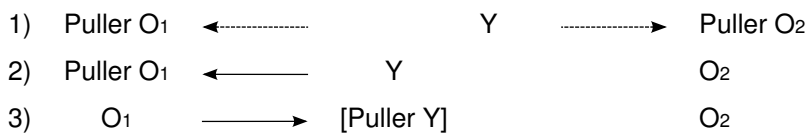


Figure 11.4: Pull competition causes only one entity to obtain the best LFR, damages Y, isolates competitor.

** damage is represented as brackets*

In this case the *Y* entity has no opportunity of choosing the best interaction. It is forced to interact, therefore *Y* is subject to a high risk of disintegration. The O_1 entity which gets the content is chosen by a *selection mechanism*. The losing O_2 entity has also a risk of disintegration: on pushing competition, the losing entity does not interact but remains alive and keeps the content useful to interact, whereas on pulling competition, the losing entity has lost the content. The pushing loser is able to cause attraction after losing the competition, but the pulling loser is rejected. This is another natural population control mechanism that prevents huge population increments (which is the case for living beings). The selector mechanism plays a decisive role. The normal result is only one entity assuring a positive LFR and two entities normally getting a negative LFR.

So, on pushing interactions the competitive decision is taken by *Y* and it is based on the LFR. Pushing content entities have the best chances of perstability. On pulling interactions the competitive decisions are taken by *Os* and depend on a *selector mechanism,* which is completely irrelevant to the best LFR. Pulling interactions are destructive.

Pulling competition is a population controlling method for pushing entities (*Y* in the graphic). An excess of *Y* will cause an increment of *O*, which in turn will quickly decrease the amount of *Y* entities. This will cause *O* entities quantity to decrease, which in turn will cause an increment of *Y* entities, looping the behavior. So, for this mechanism to work in a stable manner, (i.e. the proportions of both become stable), there must be a precise *limiting factor*. If there no limiting factor, *O* entities quickly end up with *Y*. If the limitation is excessive, *O* entities perish by not reaching *Ys* and causing an *Y* overcrowding.

The *limiting factor* is the ability of repellency of the *Y* entity. This mechanism does not then work with thinking *O* beings because limitations may be exceeded by intelligence of *O* entities. Then means other mechanisms are also applied on the competition, such as aggressivity to decrease the population of *O*. Advanced intelligence provides abilities to overcome limiting factors, and also to

eliminate competition.

Pushing competition is focused on the best LFR for the group and it is a powerful population generator. Pushing competition controls underpopulation by generating development of lacking entities. *Pulling competition is focused on the best LFR for the contender*. It is a powerful chaos generator. It can control overpopulation by generating chaos on exceeding entities.

Interfering Pulling Competition

On pulling competition, competing interactors do not interact between themselves. They can do so on interfering competition. The purpose of an interferent interaction is to cause a positive own LFR and a negative LFR for the rival As the rival is not able to deal with the interference, this is represented as an additional pulling interaction. This behavior is considered because is common in living beings.

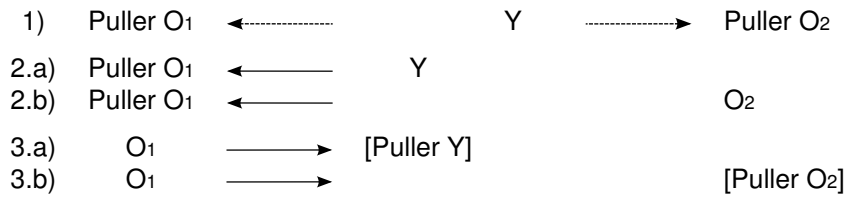


Figure 11.5: Pull destructive competition causes one entity to obtain the best LFR, damages Y, damages competitor.

** damage is represented as brackets*

Both interactions are performed by both *O* competitors, absorbing and interfering. This mechanism works faster than pure competition, creates more destruction and therefore more chaos, and helps decreasing the population of competitors when the population of *Y* is decreasing.

11.5 Generosity and Egoism

Generosity —also *generativity*— and egoism can be easily expressed in terms of pulling or pushing interactions. Generosity as an interactional behavior has the exact same shape as collaboration, a push-push interaction cycle.

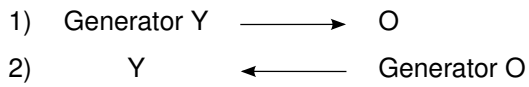


Figure 11.6: *Generosity is just a common push-push interaction.*

Egoism is also a two entities mechanism, and can be associated with the pulling mechanism.

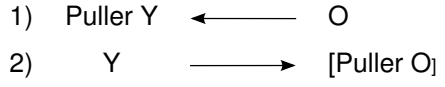


Figure 11.7: *Egoism is a pull-pull interaction.*
** damage is represented as brackets*

And this is exactly the interactional portion of the pulling competitive behavior, which was observed to cause only one LFR. Egoist individuals behave as pulling competitors. The interaction can also be pulling-interferent: selfish individuals may not only pursue benefit but also destruction of others —or even the environment—.

Pulling entities depend on overpopulated environments to survive. Therefore pullers are highly unstable.

On living entities, pull behaviors allow quick and easy short-term —but highly unstable— benefits. Push behaviors allow stable and long term benefits. On humans in particular, the permanent exercise of push (generativity) and the elimination of pull (selfish interactivity), cause a rapid increase in the chances of positive interactions.

The mixing of push and pull behaviors appears to increase the interactions number, this is an extended idea on economy. This is true, but commonly this appearance hides the enforcing of single-loop interactions at the expense of repeating interactions. After the time enough for repetition, pulling interactions will show small rates of repetition. Moreover, they tend to stop repeating and rather cause isolation (the social ecosystem learns what kind of interactors it is dealing with). If pushing interactions are the dominant behaviors, the ecosystem creates a different paradigm of the interactor and therefore it tends to interact more, with more stably, with repetitive loops.

The *balanced* mix of push an pull interactions is the current social model of interaction taught on the formal education system. Schools and universities

background teaching purpose is this: *to increase the number of interactions, neglecting long-term repetition and collateral effects*. This guideline allows the application of destructive interactions. Scientists are considered to have the responsibility of fixing the damage this teaching causes on our ecosystem. Current societies interact guided by a big misinformation set of rules. Mass media is the most confusing source; universities and schools are included as a constitutive part of the misinformators. This can be easily reverted on the education system.

11.6 Complex Systems

This section expresses a personal opinion about the discipline of complex systems. The field of *Complex Systems* that is currently promoted by many scholars has no reason to be. This is a simplified set of characteristics taken from a lecture[1] of Michel Baranger, which expresses some common ideas of the complex systems discipline.

1. *Complex systems contain many constituents interacting nonlinearly.*

Non-complex systems also interact nonlinearly, this is natural and common of all systems (see *Dynamics: Reactivity*). But may appear startling when small sets of dimensions are approached. For example, on the thermodynamics field, the idea of entropy dictates that chaos should increase: it does on certain dimensions. But when we apply the idea of hyperdimensionality (see *Statics: Hyperdimensionality*) to models, huge numbers of layers of chaos (vertical and horizontal) can naturally coexist with multiple layers of order. Layer values cannot be added; how can life be added to the mass of an animal? A living system seems to behave nonlinearly, but is just the effect of order on different dimensions. Mass is just a different dimension of order (see *In Thermodynamics: Dimensionality*).

2. *The constituents of a complex system are interdependent.*

All systems in nature are interdependent (normally all open systems are subject to the *Butterfly Effect*[2]). Mathematical systems are independent and perhaps this is the root of this misinterpretation. Common mathematical systems are closed —math isolates to analyze—, so they are not interdependent. Closed systems cannot be used to describe nature.

[1] Chaos, Complexity and Entropy, Michel Baranger, http://necsi.edu/projects/baranger/cce.pdf
[2] http://www.stsci.edu/~lbradley/seminar/butterfly.html

Index