

Society as a Complex System

Evolutionary Sociology and Systems Theory

The theory of social organism perceives society as an organic entity similar to living organisms, emphasizing the parallels between biological and social mechanisms. This perspective emerged in sociology around the mid-19th century. Particularly, Spencer proposed concepts of "survival of the fittest" and "evolution" from a standpoint of social evolutionism even before Darwin's "On the Origin of Species" was published. The theory of social organism underwent significant development through Spencer's social evolutionism, leading to a leap forward. Since then, new biological ideas based on evolution theory have been extensively incorporated into sociology.

Spencer's theory of social evolution attempts to understand society through the analogy of organisms, based on a fundamental parallel between organisms and society. This approach did not involve a clear definition of systems

In response, Bertalanffy, who emerged in the early 20th century, proposed the holistic organism theory as a theoretical foundation for biology, aiming to capture biological phenomena with clear definitions of systems. Moreover, his generalized "General Systems Theory" indicated its applicability to human social systems as well.

The foundational concept in Bertalanffy's General Systems Theory is the concept of "organization." Living organisms are complexes formed by organic arrangement of their elements. This complex cannot be reduced to its individual elements. The

whole that is formed by the organization of parts is greater than the sum of its parts. Therefore, it cannot be reduced to its individual components. The essence of biological phenomena lies in the interaction among these parts, producing holistic qualities and forms that cannot be reduced to the parts themselves. In this way, a system is defined as a mechanism that produces more than its elements through interactions between them. Similarly, human societies, as self-forming entities shaped by interactions among their elements, also operate as systems governed by the same principles as life

General systems theory is an extension of social organism theory, which conceptualizes society as an organic entity similar to a living organism. However, unlike the social organism theory of the 19th century, this approach seeks to unify the understanding of both life and society under clear definitions related to systems. As a result, it has had a significant impact on sociology as well

Prigogine's theory of self-organization in the latter half of the twentieth century emerged from the exploration of new directions in natural science. However, it also provided a valuable paradigm for understanding human societies. As a result, it has had a significant impact on sociology as well.

According to Prigogine, if a system is an open system that exchanges matter, energy, and information with its surroundings, and moreover, if it is far from equilibrium, then order can emerge from chaos. In such cases, spontaneous self-organization occurs initially with small fluctuations within the system. These fluctuations amplify, and upon surpassing a certain threshold, the system rapidly creates new order. Due to this process of "order formation from fluctuations," the system can adapt to various environmental changes by altering its internal organization autonomously. Thus, the system can autonomously generate increasingly complex new structures.

Such phenomena are always observed in phase transition phenomena such as the bonding of atoms and molecules, the formation of crystals, and changes in the state of matter. However, the same phenomenon is also observed in biological processes such as the origin and evolution of life, and in social phenomena pursued by humans.

Human society, like the system of organisms, operates as an open system exchanging materials, energy, and information with the outside world. It exists in a constant state of imbalance, continuously receiving goods and knowledge from external sources. Consequently, society undergoes a process of complex order formation, moving from chaos to order. Moreover, society always harbors internal fluctuations, which amplify in response to environmental changes, perpetually generating new forms and structures. Thus, society, through these fluctuations, is a self-organizing system that creates new orders. Viewing it in this way, material, life, and society can all be understood through a unified theory.

The theory of autopoiesis proposed by Maturana and Varela, too, originates from natural sciences, particularly biology. This theory was also transplanted into sociological theory by Luhmann, yielding significant achievements.

The autopoiesis system is a system that continues to operate and create itself incessantly by producing its own components. This theory of autopoiesis originated from the study of animal nervous systems. The nervous system of animals is a closed system that is internally determined by the nervous system itself, rather than externally regulated. Therefore, such autopoietic systems continuously generate their own structures through a self-referential cycle of production and reproduction. However, precisely because these systems are self-referential and closed, they incorporate the external environment into themselves. Autopoietic systems create their own boundaries autonomously. Such autopoietic systems are not limited to nervous systems but are fundamental to life in general, including cellular systems that produce themselves.

According to Luhmann, who introduced the autopoiesis theory into sociology, a social system is a system that cyclically and recursively reproduces its constituent elements based on differences between the system and its environment. Such systems, particularly in society, are observed in communication. Therefore, Luhmann defines society as an autopoietic system with communication as its fundamental element. Indeed, communication reproduces communication itself. Thus, the social system as a communication system is an autopoietic system that self-referentially recurs back onto itself.

Science of Complex systems

However, whether in general systems theory, self-organization theory, or autopoiesis theory, the focus tends to be on the direction of order, often overlooking the direction of disorder. Interactions between elements not only create order but also generate disorder. Even slight movements in interactions can be amplified successively, leading to the collapse of the entire order. In processes of social change, fluctuations within can spread across the whole, sometimes leading to the disintegration of society. When fluctuations grow large and approach a critical point, whether they move towards order or towards chaos depends on the interactions of various elements at that moment and cannot be predetermined in advance.

Even if moving towards organization, the breakdown of the existing order is necessary, and in that process of collapse, disorder always emerges and chaos rears its head. Human societies not only tend towards order from chaos but also possess directions towards chaos from order simultaneously. Families, organizations, nations, the international community—all face crises of disintegration. In these situations, uncertainty increases, and people's anxieties grow ever stronger.

The science of complex systems that emerged at the end of the 20th century integrates both order and chaos. Complex systems refer to networks composed of

many elements that interact strongly with each other. In such systems, each element is constantly influenced by and reacts to other elements within the interaction field. Therefore, every element is always in motion and never fixed at any moment. This continuous interaction among elements leads to the constant generation and breakdown of order.

The science of complex systems is built on a synthesis of self-organization theory developed by Prigogine and others, and chaos theory primarily emerging from mathematics. Self-organization theory focuses on the generation of order, while chaos theory, conversely, emphasizes the aspect of order disintegration. Therefore, the science of complex systems, which is based on the synthesis of both, simultaneously considers "order from chaos" and "chaos from order".

The phenomenon highlighted by the theory of self-organization is that in systems far from equilibrium, fluctuations in the behavior of elements are amplified. Beyond a certain tipping point, elements cooperate to spontaneously form new order. Therefore, this theory emphasizes aspects of the order phase of complex systems.

The phenomenon highlighted by chaos theory involves the amplification of tiny discrepancies in the initial conditions of a system, eventually leading to a completely unpredictable change in its overall behavior. As is well known, this is metaphorically described by the example where a butterfly flapping its wings in Hong Kong can trigger a chain of events that results in a hurricane in America. This phenomenon is named the butterfly effect. The discovery of this <sensitivity to initial conditions> is the central feature of chaos theory. It can be seen as a heightened manifestation of the self-organizing phenomenon known as <order from fluctuations>.

In chaos theory, we observe states where order breaks down. Consequently, science loses the predictive ability about the future that it once prided itself on. Science enabled us to predict the future by identifying regularities within

phenomena. However, in chaotic phenomena, these regularities themselves cannot be established, shattering the deterministic worldview. Yet, it is precisely because of this that chaotic systems exhibit extremely free behavior, determining themselves, so to speak, through what could be called free will. Thus, while they may initially appear as disorderly chaos, they possess strong adaptive capabilities in reverse. Chaos theory emphasizes the unpredictability, irregularity, and non-determinism, particularly highlighting the chaotic aspects of complex systems.

The world, in reality, is in the midst where order and chaos intersect, continually undergoing generation and dissolution. It moves in a spiral intertwining chaos and order, transitioning from chaos to order, from order to chaos. Complex systems science conceptualizes this phenomenon of generative change in the midst of chaos and order as "the edge of chaos". This edge of chaos exists in the intermediate realm between excessive order and excessive chaos, delicately balancing both forces. Here, components are not completely fixed nor in total disarray; instead, they maintain a certain balance between the forces of order and disorder. When at the edge of chaos, the world spontaneously forms itself, adapts to circumstances, and behaves as a living entity.

The realm of the living involves active interaction among its elements internally, while also interacting with the environment in which it resides. Through this process, it adapts to both internal and external conditions, undergoing phase transitions and generating new structures. The special realm that enables such phase transitions lies in the interstice between chaos and order, known as the "edge of chaos". It is a region delicately balanced between the necessity of order and the demand for change, a place that maintains stability while harboring innovativeness, and serves as a arena of struggle and transformation. Approaching too closely to chaos risks dissipation and disintegration, while moving too far away leads to rigidity and uniformity. When poised at the subtle balance point between these two extremes, things thrive with vigor. The "edge of chaos" is precisely where self-formation of matter, manifestation of life, and evolution of organisms become possible. Moreover, it serves as the ground enabling human social activities—a place where creativity

springs forth in all things. Truly, the “edge of chaos” is nothing less than the crucible of creation.

Certainly, whether it's families, organizations, economies, politics, states, or the international community, human societies are networks formed by lively interactions between elements. These networks constantly undergo cycles of order generation and collapse, always changing. Societies, too, continually remake and evolve themselves on the edge between order and chaos, at the brink of chaos. Here, elements are always fluctuating, their oscillations often becoming significant and affecting the whole, sometimes plunging into unpredictable chaos. Yet, from this chaos, new orders also emerge.

When society adheres too closely to order, it becomes rigid and loses its adaptability to the environment. However, once it reaches such a state, fluctuations emerge and grow, leading to the breakdown of rigid structures. As this breakdown progresses and approaches a state of excessive disorder and chaos, new movements arise to bring about order from that chaos. Thus, society, like living organisms, evolves in the realm between chaos and order, on the edge of chaos. In this dynamic, there is order within chaos, chaos within order, and the intersection of order and chaos becomes the realm of generation and emergence.

“Emergence” as a concept

The concept of emergence was proposed by the psychologist Morgan in the first half of the 20th century, primarily as a concept capturing the emergence of mind from life. This idea influenced Bergson's notion of “creative evolution” and was accepted in Whitehead's philosophy of organism, becoming an established philosophical concept. “Emergence” refers to the emergence of a more complex new structure that was not present in its constituent elements, due to their tightly

interconnected interactions. This idea has been inherited in Bertalanffy's general systems theory and in Prigogine's theory of self-organization

Complex systems science also inherits this idea directly, calling complex systems "emergent science" at the edge of chaos and order. In complex systems science, the source of new structures emerging in living systems is seen in the tight interrelationships among their constituent elements and their interactions. Within such systems, interactions between elements give rise to both competition and cooperative relationships, resulting in coherent behaviors. These interactions are governed by extremely simple principles. However, from these simple principles of interaction, remarkably complex outcomes emerge. This is nothing other than the phenomenon known as emergence.

science of Complex systems acknowledges that the overall characteristics generated by global structures feedback into and influence the behaviors of their constituent elements. Such structures defy reductionism, which attempts to capture the whole by breaking it down into elements, as they constantly generate new possibilities and evolve spontaneously. Hence, each element constituting these systems changes in accordance with the overall system's evolution. What characterizes complex systems is their continuous innovation.

In such living systems, as has been argued since Bertalanffy, the whole is more than the sum of its parts. The emergent properties arising from relationships between parts cannot be reduced to those parts themselves. Therefore, upon one structure, more complex structures are continuously built up one after another. As a result, this system creates various hierarchies according to the degree of complexity, and these hierarchies constantly change and evolve."

The universe has a hierarchical structure consisting of superclusters, galaxies, stars, and planets. The material world also has a hierarchical structure, including

subatomic particles, atoms, molecules, and polymers. The biological world similarly exhibits a hierarchical structure: genes, cells, tissues, organs, organisms, and ecosystems. This reflects the process of generation in which the world continually creates new structures through interactions between its elements.

Human societies, as systems in which individuals interact with one another as relational entities, continuously generate new structures through these interactions. Countless individuals constituting society relate, influence, and connect with each other, forming networks of interaction. It is from these networks that new social structures emerge. We interact with one another exchanging goods, money, information, and actions, mutually relating, reacting, and evolving. The complex structures of economics, politics, and society also arise from these interactions. Society emerges from these active interconnections among people.

Each individual action affects others in interrelation, causing a chain of impacts where it, too, is influenced. Moreover, the effects of one action ripple through the whole, which in turn affects the original action. From such intricate interconnections of countless actions, something greater than the sum of these actions emerges. Furthermore, it differentiates into a society with increasingly complex functions, creating new structures layer by layer, from families and local communities to profit-driven societies, nations, and the international community. Higher-level structures emerge from interactions of lower-level elements, yet they cannot be reduced solely to these elements and possess structures beyond them. Such is the nature of society as a complex system.

Living Systems and the Environment

Complex systems possess flexible adaptability to the constantly fluctuating environment because they can continuously generate new structures in response to environmental changes. These systems are open to their environment and are in

constant interaction with it. Moreover, this interaction can have an unexpectedly profound impact on the emergence of new structures within the system. The interaction with the environment is incorporated into the generation of structures, which can synergistically influence the system and lead to a complete reorganization of its relationships. The phenomenon known as phase transition refers to such dramatic changes occurring within the system. Living systems interact with their environment and exist only within the context of this interaction.

The idea of viewing living systems as open systems and trying to understand life phenomena through their interaction with the environment was introduced by Ludwig von Bertalanffy. Indeed, living systems maintain their internal order fluidly while exchanging matter, energy, and information with their external environment. Living systems do not merely respond to external stimuli. Instead, they continuously reorganize their own structures while interpreting the external environment. Open systems, in general, possess not only the ability for self-maintenance but also the capacity for self-transformation. The ability to form order through interaction with the environment is what signifies being alive.

To interact with the environment, a living system must be simultaneously closed. By restricting itself to a specific closed domain, interaction becomes possible. For a system to be an open system, it must be closed. The concept of boundaries comes into existence at the intersection of openness and closure. A living system relates to the environment at this boundary interface. To be alive is also to maintain a boundary with the environment. Moreover, a living system creates this boundary itself. In fact, it is through the creation and establishment of this boundary that the self of the living system is defined. Only in this way can the environment permeate within the living system.

In this sense, the environment does not merely exist objectively in a physical and chemical manner. The environment becomes what it is only when it is selected and given meaning by living systems. It is not that systems are created by the environment; rather, the environment is defined by the systems.

Moreover, the environment is constantly changing. These changes are extremely complex, and it is impossible to predefine or predict what kind of changes will occur. For living systems, environmental fluctuations are filled with randomness. However,

living systems still strive to adapt and survive in the ever-changing environment. Homeostasis, a maintaining system that keeps the internal state constant while adjusting itself in response to external disturbances from environmental changes, is one form of adaptation to the environment. Furthermore, living systems also actively adapt to environmental changes by transforming their own structures. The existence of evolution in living systems is a result of this process

In complex systems theory, living systems with such capabilities are referred to as complex adaptive systems. A complex adaptive system adapts to environmental changes by interpreting these changes, referencing accumulated experiences, and reorganizing its internal mechanisms accordingly. This internal reorganization involves restructuring the relationships among elements based on new information. By reorganizing the relationships among elements using new information, a complex adaptive system creates a new order. As a result, it can adapt to new environments that it has not previously experienced. This flexibility in handling complex environmental changes is what enables living systems to respond effectively.

Biological organisms are a typical example of complex adaptive systems. Throughout Earth's long history, life has evolved from simple forms to more complex ones since its inception. This progression was possible because organisms could reconfigure their internal mechanisms in response to environmental fluctuations. Evolution is both transformation and emergence. It does not merely occur as a result of internal mutations being selected by external environments. Rather, evolution is the subjective self-transformation of organisms to adapt to environmental changes.

The intermediate domain between chaos and order discovered by the science of complex systems, known as the "edge of chaos," is where the ability for evolution is maximized. In this domain, a moderate level of order is maintained while new forms of order are actively generated. Living organisms adapt and evolve towards the edge of chaos. Here, countless elements interact dynamically with each other, competing and cooperating, and evolving together through their interactions.

In this way, organisms have unidirectionally and infinitely increased in complexity, evolving from simple to complex, from lower dimensions to higher dimensions, and from undifferentiated to differentiated states. This has occurred because organisms continuously remodel themselves and generate new structures through their

interactions with the ever-changing environment.

This complexity arises primarily through integration and symbiosis. Elements, while initially competing with each other, eventually cooperate, coexist, and establish division of labor, which in turn creates more advanced and intricate structures. Moreover, the formation of these more complex structures occurs in a manner similar to stacking building blocks, one on top of the other. As a result, a hierarchical order naturally emerges.

This complexity also arises through differentiation and diversification. Living organisms change and diversify a single common principle into infinite variations, creating boundless diversity. In this process, the direction in which differentiation occurs depends on the interaction of various elements at any given time. As a result, organisms are able to freely choose their own direction. The ability of living beings to adapt flexibly to their environment and survive is due to this kind of complexity.

Living systems are influenced by their environment and, in turn, influence their environment, shaping themselves through this interaction. Living systems change themselves in relation to their environment and, through this process, also alter the environment. In this way, they evolve synergistically through their interactions with the environment. The essence of a complex system is "self-formation through interaction." Here, interaction includes not only the interactions among elements within the self but also interactions with the environment. In living systems as complex systems, interactions with the environment and interactions among internal elements mutually affect each other, leading to increasing complexity and diversity.

Society as a Complex Adaptive System

Human societies are open systems that interact with their environments. They continuously engage with their surroundings by exchanging materials, people, and information, maintaining constant interaction with the environment. Furthermore, through this interaction, societies assimilate information from the external environment, develop new structures, and adapt to environmental changes. In this way, society is a dynamic, living system.

To enable interaction with the environment, society must also remain enclosed

within a certain domain. As Luhmann states, society becomes open by being closed. Every social system has boundaries for this reason. Through these boundaries, society connects with the environment. Society sets its own distinction between itself and the environment and determines its own attitude towards interacting with the environment. Living systems maintain the contradiction between openness and closedness at their boundaries.

Society, in turn, creates distinctions between itself and the environment, and conversely, defines the environment. Moreover, as Luhmann suggests, these boundaries are not merely spatial delimitations but are rather boundaries of meaning created through the differentiation between 'inside' and 'outside.' Social systems create such boundaries of meaning themselves while incorporating new information from the environment and actively transforming their own structure. Through this process, they adapt to the environment.

Society is a living system that actively reconstructs its own mechanisms and structures to adapt flexibly to the constantly changing environment and its uncertainties. Just like a living organism, society continues to persist by altering its own systems through interactions with the environment. Society is always in flux and does not remain static. It cannot be viewed in a static manner but must be understood as a dynamic process.

First, external factors prompt the movement of heterogeneous elements that quickly detect changes in the environment, leading to conflicts with the old structures of society. However, these conflicts stimulate change and create new structures. This can be understood as the formation of order through fluctuations. In this context, the focus is on individuals who cause change and their actions. Such practical actions lead to transformations in the structure of society.

From the perspective of complex systems science, the structural changes in society are nothing more than the inevitable behavior of complex adaptive systems. A complex adaptive system adapts to the randomness of environmental fluctuations by reorganizing its internal mechanisms. Similarly, society, as a complex adaptive system, can undergo internal structural transformations in response to environmental changes. Thus, society evolves from simpler forms to more complex ones, just like living organisms. The area where this evolutionary capacity reaches its peak is known as

the “edge of chaos.” In this region, a flexible and vigorous environmental adaptability is exhibited, leading to the active emergence of new orders from chaos.

In this context, many social systems are layered and formed, so a more comprehensive social system becomes the environment for a less comprehensive one. Consequently, fluctuations in the more comprehensive social system are perceived as environmental changes and trigger fluctuations in the less comprehensive social systems. Families constantly adapt their structures in response to changes in the surrounding society. Similarly, nations continuously reshape their own structures to survive by adapting to changes in the international community.

Furthermore, when one social system fluctuates, the social systems that were perceived as its environment also undergo changes. What is influenced by the environment simultaneously influences the environment itself. Moreover, society continuously shapes itself. In this regard, society, as a complex adaptive system, is similar to living organisms. In this sense, society is a kind of living entity.

Both society and living organisms are complex adaptive systems that adapt flexibly to environmental changes by reorganizing their own structures. If we understand them this way, then it is not inappropriate to view society as a constantly evolving system, based on the analogy with living organisms.

As society’s ability to adapt to the environment increases, its functions become more complex and differentiated, and accordingly, its structure also becomes more differentiated. In this way, society creates increasingly complex and hierarchical structures, such as families, kinship groups, tribes, interest groups, nations, and the international community, leading to the formation of a highly specialized and complex social order.

The phenomenon of various domains of social life that were once intertwined gradually differentiating is a trend toward increasing complexity. This is similar to the evolutionary process of living organisms. The history of human society evolving from hunter-gatherer societies to agricultural societies, from agricultural societies to urban societies, and from urban societies to modern industrial societies can be seen as an example of differentiation from simpler to more complex forms. At each stage of this social evolution, humanity has created more complex political structures, economic

organizations, and communication methods, thereby enhancing its ability to adapt to the environment.

Environment and Social Change

The tendency to adapt to environmental changes by restructuring one's internal mechanisms and creating new frameworks can be observed everywhere—whether in families, economic organizations, nations, or the international community. For example, when a company is struggling due to its inability to adapt to market trends and its performance is declining, the company will seek to address the issue by reforming its own organization. In doing so, the company evolves as well.

When a country faces a significant environmental change in the international community, such as modernization, it will actively incorporate modern methods of state governance from outside and address the situation by undergoing substantial structural transformation. By adopting new technologies and industries, establishing parliamentary systems, abolishing class systems, reforming the education system, and completely reinventing itself as a modern state, the country evolves and progresses.

For a country, changes in the international community are akin to environmental changes, and they have a significant impact on its survival. Nations engage in exchanges with other countries, sharing goods, human resources, capital, and information, thus interacting with the international environment. In response, they strive to form and maintain their own internal order. Moreover, the international relations surrounding a country are constantly evolving due to shifts in alliances between nations, fluctuations in national power, and changes in the country's international status. Therefore, a nation is a dynamic system that continually adapts and maintains itself through its interaction with the ever-changing external environment.

A nation, faced with the constantly changing international environment, cannot always address these challenges with outdated systems or mechanisms. When confronted with contradictions or disharmony with the external environment, it must actively reform its forms, functions, structures, and institutions to restore harmony with its environment and ensure its survival. A nation must flexibly respond to unpredictable changes in the international environment, quickly adapt to these

changes, and rebuild its own structure to regain harmony with its surroundings.

A nation, too, must find itself at the edge of chaos, balancing between disorder and order, in order to adapt flexibly to environmental changes. A nation is a living entity that actively alters its structure in response to changes in its environment and evolves; it is a complex adaptive system.

Society as a Nonlinear System

The society we engage in is constituted by interconnections. Society is a complex system that evolves and changes through interactions among its elements and between these elements and the environment. When one element fluctuates, other elements adjust in response, and as other elements fluctuate, they in turn affect the original element. When one social system changes, it causes changes in other social systems, and these altered social systems further induce changes in themselves. The creative evolution of society arises from such nonlinear interactions. Society is a self-organizing system that shapes itself through fluctuations in its elements and environment. Even minute fluctuations in elements or the environment can trigger significant outcomes. Moreover, the whole that is formed is always greater than the sum of its parts.

Social phenomena like trends are symbolic of a nonlinear society. Humans live amidst a tangle of conflicting desires: the desire to be different from others and the desire to be the same as others. Therefore, when someone adopts an unusual or distinctive style of clothing or behavior, it influences others and prompts them to conform. As more people begin to conform, a trend emerges. Once a trend is established, it automatically attracts more people, amplifying the trend phenomenon. However, when most people conform, the trend becomes banal. Consequently, some individuals will adopt different behaviors, creating the next wave of trends. In this way, the interplay between differentiation and conformity drives the emergence of trends.

Not only trends but, as Tarde argued, society in general is constituted by imitation. Social groups consist of entities that have relationships of imitation with each other, both directly and indirectly. Through the synergistic interactions of these many entities, a large wave of imitation in society is generated. Imitation is also a typical nonlinear phenomenon, where a small initial act of individual exhibitionism can be

amplified to produce significant results.

Not only in trends and imitation but also in economic phenomena, there are occurrences where prosperity begets a sense of prosperity, and this sense of prosperity further creates even more prosperity. This is a non-linear phenomenon similar to the one described. The economy is also shaped by the interrelated psychology of countless individuals.

The explosive spread of a new invention can be considered a nonlinear phenomenon, where technology is innovated and society undergoes a dramatic transformation. Initially, it may seem to have only a minor impact, residing in a corner of society. Nevertheless, it changes its surrounding environment and attracts followers. As it gradually becomes more widespread, it captures a certain market share, which in turn stimulates new demand. Today's vast industrial and technological civilization, for example, spread worldwide and transformed society because the water frame, invented in Britain at the end of the 18th century, was combined with the steam engine.

Whether it is the formation of agricultural societies through the discovery of cultivated plants or the creation of urban societies through the development of trade, these were nonlinear social transformations. Revolutionary social changes triggered by waves of new political movements are also nonlinear. Here, we must first focus on the creative power of a few exceptional individuals who bring about something new. It is through the context of markets or eras that these innovations are realized and lead to enormous results.

Such phenomena can also be observed in natural processes. A small fluctuation can be amplified, triggering cooperative phenomena among many elements, and when surpassing a certain critical point, revolutionary changes in structure can occur. This is known as a nonlinear phenomenon and is referred to as a phase transition. Both nature and society fluctuate and shape themselves through nonlinear interactions between elements.

self-reference

Whether in nature or society, nonlinear systems, at both the element level and the system level as a whole, not only influence others continuously with their own

movements but also constantly return to themselves. Through the repetition of this self-referential movement, the system transforms itself. A living system, in this way, self-referentially creates itself.

The theory of autopoiesis particularly focuses on the self-referential nature of living systems. According to the theory of autopoiesis, living systems are formed through a network of circular production and reproduction. In this context, the theory emphasizes the self-creation of the living system by focusing on the perspective within the living system itself. Here, the components produced by the system are recursively and circularly involved with itself, leading to its own reproduction. Self-referential systems generate meaningful information from within themselves and continuously create themselves.

In an autopoietic system, what is created by itself continuously returns to itself, allowing the system to perpetuate itself. By repeatedly engaging in this self-referential self-creation, an autopoietic system adapts itself to its environment.

Certainly, human societies are also self-referential autopoietic systems. In such systems, the actions and behaviors expressed by individuals, who are the components of the society, not only influence others but also result in effects that recursively and circularly return to the individuals themselves. Consequently, these effects become factors that alter the behavior of the individuals, thereby generating subsequent behaviors. In this way, the actions and behaviors of individuals are reproduced. Through this process, societies continuously create themselves in a self-referential manner, adapting to their environment. Moreover, societies inherently possess elements that reflect on their own situations and seek new ways of being. This capacity for self-referential transformation is what allows societies to evolve.

The self-catalysis phenomenon highlighted in Prigogine's theory of self-organization can also be seen as one of the simplest and most specific cases of self-reference. In the worlds of organic chemistry and biology, it has been discovered that when creating the same organic compound from an initial organic substance, that very substance itself can act as a catalyst to facilitate the reaction. This allows for the endless and rapid self-replication of the same organic compound from a small amount of the initial substance. The phenomenon where the substance produced during a generation process acts as a catalyst for the generation process itself is known as self-catalysis.

In this self-catalytic system, order naturally emerges from a state of disorder.

Self-catalytic phenomena are observed not only in natural self-formation processes but also in social phenomena. Examples include the way trends can trigger more trends, economic booms can lead to further booms, and technological innovations can spur additional innovations. In addition to these positive feedback loops, self-catalytic effects are also present in negative feedback loops, such as recessions triggering more recessions, stock sell-offs causing further sell-offs in panic, and economic crises. In these cases, the actions of one individual can prompt similar actions from others, and these actions, in turn, serve as a catalyst, amplifying similar behaviors. This self-catalytic phenomenon in society occurs because society is inherently nonlinear and is always influenced by self-referential systems.

In both natural and social systems, hierarchical structures emerge because they are self-referential systems. We recognize the formation of a hierarchy when something appears in a certain context, proliferates, or when similar entities aggregate to occupy a specific domain, maintaining stable persistence. The role of self-referential systems is significant in such hierarchical formation. In biological systems, hierarchies such as organelles, cells, tissues, organs, organisms, populations, and ecosystems are formed due to the functioning of self-referential systems. Similarly, in social systems, hierarchies such as individuals, families, local communities, interest groups, nations, and the international community are formed due to the presence of self-referential systems.

Self-Observation

Any self-referential system has the ability for self-observation. Originally, the universe itself is a self-observing system. This universe creates galaxies, stars, planets, and life, including animals and humans with the ability to recognize and observe the world. This represents the infinite self-formation of the universe.

What is important here is that the observer of this world is within the world, not outside of it. A conscious being is not a detached observer with no connection to the world but someone who exists within the world and perceives it. Therefore, this in-world perceiver disrupts the world through the act of perception and participates in the self-formation of the world.

The principle that made it possible to specifically incorporate this into the natural sciences and describe the world was the uncertainty principle of quantum mechanics. The uncertainty principle assumes that the observer is within the world being observed. Since the observer is within the observed world, the act of observation by the observer disturbs the behavior of the observed world. Consequently, the observed world becomes uncertain. In the quantum mechanical worldview, the objective being observed and the subjective observer are inseparable and cannot be separated. This is because the subjective observer is not outside the world but within it, forming an inseparable part of it.

In classical mechanics, the observer is positioned outside the world and describes it from that external perspective, with a clear separation between the observer and the observed, between subjectivity and objectivity. This is the standpoint of Newton and Descartes. However, this approach did not describe the real world, where the observer is actually within the observed world. Modern physics, which attempts to describe the world by connecting the subjective observer with the objective observed, can be said to have a better understanding of the real world.

However, the structure of the world discovered by modern physics is by no means something new. It was a phenomenon that has always been present in the realm of life beyond the material world. Whether observing living microorganisms, animal behavior, or measuring the brain, the act of observation itself always disturbs the phenomenon, making it impossible to see the phenomenon in its true state.

In human societies, this phenomenon is even more pronounced. In such contexts, the act of observing by an observer inherently influences the person being observed, making it impossible to observe the person in their natural state. For instance, consider a psychiatrist examining a mental health patient. The psychiatrist cannot objectively observe the patient because the act of observation disrupts the patient's consciousness, causing the patient to change. The psychiatrist's presence as an observer constitutes an intrusion by another person, which forces the patient to adopt a different attitude than their usual one. As a result, the psychiatrist is unable to fully grasp the patient's typical state in its pure form.

Society is a self-observing system. Society can only be observed from within itself.

As Luhmann states, it is impossible to grasp society from the outside; there can only be self-observation, self-description, and self-understanding as functions of society itself

In this context, the observer of society is also an actor within society. More accurately, observing and expressing it is itself an act. This act directly influences the self-formation of society within the interconnectedness of social relationships. Consequently, the impact of this act can also return to the observer, sometimes requiring them to change their own observations. Within this cyclical process, society generates new meanings continuously and shapes itself. The observer is not outside of society while observing but becomes a participant in the midst of social interactions through the act of observation. In society, the subjective observer and the objective observed cannot be separated.

Society describes itself, and through this self-description, it forms itself. The self-formed society then describes itself once more, and through this process, it continuously forms new versions of itself. Through this self-referential cycle, society transforms itself. Therefore, the self-description of society continues infinitely and never ends. Society is a world that reflects itself infinitely, like mirrors reflecting each other. In this world, parts reflect the whole, and the whole is contained within each part. A society that forms itself generates constantly new meanings and structures through its infinite capacity for reflection.

The self-portrayal of a society is not constant. Even when we talk about the self-portrayal of a society, it represents a variety of perspectives from the many individuals within that society. As a result, this portrayal allows for a diverse range of interpretations. A single society is reflected in various ways depending on the differences among its members. Each person has a different perspective, experiences, and past, leading to a variety of interpretations of society. However, it is from the interaction of these diverse interpretations that a new self-formation of the society emerges.

In other words, a society that does not allow for diverse interpretations cannot be considered a society with vibrant formative capabilities. A society that does not harbor many critics cannot be called a dynamic society. In this sense, self-reflective processes are indispensable for a society's self-transformation. Through self-

reflection, a society reexamines itself and envisions new directions. Observers can participate in the society's self-formation through their ability to evaluate and conceive such new directions.

Society moves forward by recognizing, judging, and evaluating its own state and circumstances, while also envisioning, predicting, and conceptualizing its future. This self-observation, self-evaluation, and self-prediction—essentially, self-reflective ability—is what enables society to continuously shape itself, never remaining static.

However, the predictions and plans presented through this self-reflective ability are conducted not outside of society, but within society itself. Therefore, since the setting of that future is an act within the current society, it disrupts the interconnections of the present society. As a result, in reality, the predicted future often does not turn out as anticipated.

The problem of "self-fulfilling prophecy," often discussed in social sciences, is exemplified by this specific issue. Even though it's called a prophecy, it disrupts the situation itself because it occurs in a specific social setting rather than outside of it. Since whether or not individuals choose to follow the prophecy is up to their own decision, it is natural that some people will not follow it. Consequently, the prophecy fails to come true due to its own inherent contradictions, or it may transform into something else.

Similarly, in order for a prophecy to be realized in the context of social reality, if many people agree with the prophecy and everyone starts to act in accordance with it, the prophecy may end up being realized beyond the prophet's original predictions. This phenomenon is known as the self-fulfilling prophecy. Whether it is a broken prophecy or a self-fulfilling one, it occurs because the prophecy itself is carried out not outside of society but within the interconnectedness of the actual social context.

improvisational theater model

To metaphorically understand the structure of such a society, the improvisational theater model is appropriate.

In improvisational theater, there is no pre-written script. Actors each create their own image of the play, set their own roles, and express themselves. Through the

interactions of these actors, the story of the play gradually takes shape. Then, the actors interpret the evolving story in their own way while continuing their self-expression. Here, the story of the play itself can change based on the words and actions expressed by an individual actor's unique interpretation. Therefore, how the play will ultimately conclude is unknown even to the actors themselves. Additionally, in improvisational theater, actors may present unexpected expressions or behaviors that differ from what many had envisioned for the story. This can lead to the story becoming fragmented or disordered. Nevertheless, even with such unforeseen expressions and behaviors, the play is often shaped into a coherent performance through the collective efforts of the actors.

In this context, an actor must be aware of what other actors have said and how they themselves have behaved before the current moment. Furthermore, looking into the future, they need to formulate their own hypotheses and quickly determine what kind of statements and behaviors they should adopt accordingly. At the same time, the actor must absorb the statements and behaviors of other actors, understand the ongoing situation, and perform accordingly. In other words, it is essential to grasp the past, set the future, and understand the present scene. With this foundation, the actor creates their role and the play in that moment. Through this process, the actor continuously generates and produces a new version of themselves.

Improvised theater has a self-referential structure. Each actor must not only hear and remember the lines they come up with themselves but also reference the past and align with the future they have set in order to produce the next line. In this way, the actor is engaging in a self-referential act of self-production.

Not only that, but actors must also take into account how their lines affect other actors and lead them to deliver their own lines. They must then bring these responses back to themselves and use them as a basis for their next lines. In this way, actors limit themselves through the story they create and continue to shape their next selves. Actors, in a self-referential manner, position themselves within their own history while constantly forming a new self.

Moreover, considering the entire play, it generates a self-referential self through the interpretations of each actor performed within it. It is a drama that narrates a new self by observing, reflecting upon, and evaluating the self through itself. In this respect,

the play can be said to be alive. It is a self-referential expression of the self, both in its entirety and individually.

In this context, the whole is always within the individual parts. Each actor, while performing alongside others and exchanging lines, immerses themselves into the whole through the creation of a common play. Each actor is distinct individually, yet experiences a self that extends beyond the boundaries of their individual self into the whole. Naturally, this forms a space shared with others. By inhabiting this whole space within themselves, individuals are able to express themselves appropriately. There is both individuality within the space and space within the individuality. There is both individuality within the whole and the whole within individuality. The society is also an improvisational play formed by many members.

Contingency and Indeterminacy

A society is a complex system that is constantly evolving and shaping itself through the interaction of countless elements. As a result, society always contains internal fluctuations, and, much like our own lives, it can sometimes be uncertain about which direction to take at critical junctures. In such moments, the role of contingency is significant in determining which direction society will choose. The self-formation of society is governed by contingency. In a society, small contingent events can be amplified and expanded, often leading to significant changes. Influenced by random occurrences, society can experience a breaking of symmetry towards a particular direction. Once symmetry is broken, self-formation tends to occur in a self-amplifying manner in that direction

For example, Brian Arthur, who contributed to the establishment of complexity science from the field of economics, noted that economic phenomena we engage in exhibit a phenomenon known as <increasing returns> that never reaches equilibrium, and provided many examples. In the mid-1970s video development competition between the β and VHS formats, VHS was technically inferior to β . Nevertheless, VHS manufacturers were fortuitously favored by early sales success. As a result, the VHS format gained a significant advantage, and video technology was rapidly locked into the VHS format. Examples of increasing returns like this are countless. Each case begins with a minor, accidental event and leads to significant, historically irreversible outcomes.

The formation of society is full of contingency. However, that is precisely why society can also be said to be free. The history of society does not follow any inevitable laws. Instead, society, like our own lives, creates and changes its own forms and structures while surrendering to contingency, and this process is ongoing. The forms and structures that society can take are determined by the interactions of various elements at any given time. Therefore, they cannot be predicted or predetermined. In this, there is both contingency and freedom.

In this sense, society can also be considered non-deterministic. According to self-organizing theory, when fluctuations are amplified and reach a certain bifurcation point, the system's solutions become multiple, and it becomes impossible to determine in advance which direction will be chosen. Furthermore, chaos theory shows that even with infinitesimal errors in initial conditions, the resulting errors can become infinitely large, making it impossible to predict the outcome in advance. In such cases, the scientific prediction based on the establishment of laws becomes unfeasible. In systems where countless elements are interconnected and interact with each other, the results cannot be determined solely by the initial conditions. Society, too, is a non-deterministic system in this way. Therefore, it is neither certain nor predictable how any given society will create new orders.

Society does not operate according to predetermined laws or plans. The social world, shaped by human activities, determines its own form and structure based on the unpredictable changes in the environment and the unpredictable responses to these changes. Thus, society is a prime example of a non-deterministic world.

Whether in the universe, the material world, the realm of life, or human society, everything is fundamentally a complex system composed of an infinite number of interconnected elements. Consequently, it is indeterminate. Since everything is interconnected and interacts with everything else, no event can be determined in isolation. All events are determined solely through their connections with all other events, thus the future cannot be predicted.

In classical science of the 17th and 18th centuries, the establishment of laws and predictive ability were considered the greatest characteristics of science, and it was believed that everything could be determined by initial conditions. In the world of

classical science, it was assumed that the past, present, and future were all already determined by these laws. Even in social sciences, the influence of classical science was significant, and it was once thought that the societies and histories created by humans also followed deterministic laws. However, today it is understood that even including the natural scientific world, the infinitely interacting world is considered to lack inherent laws. We must now understand that prediction and law establishment are no longer the essence of science.

Collapse of Causality

Furthermore, society is a complex system that forms itself through the interactions of countless elements. In this context, the classical notion of causality, where a single cause corresponds to a single effect, collapses. Instead, it is a world where many causes lead to many effects. As a result, society is in a constant state of flux and change.

In social sciences, for example, the historical materialism that reduces all social change to economic factors was once popular under the influence of classical scientific views, such as the theory of dominant or single causes. However, this oversimplifies the issue too much and must be considered incorrect. Society changes due to the interplay of countless elements, so it cannot be explained by a single cause. A social phenomenon involves many factors, and there are also interdependencies and interactions among these various factors.

Society is a complex system made up of countless interrelated elements. In this context, every element is interconnected with every other element, and it is difficult to clearly distinguish between cause and effect. In fact, social phenomena, much like biological phenomena, often arise through cycles where it is frequently impossible to clearly determine which is the cause and which is the effect. Instead, a cyclical interaction prevails, where each element can be both a cause and an effect for each other. In this cyclical process, the chain of cause and effect eventually loops back to itself. In such self-referential cycles, the effect feeds back into its cause, continuously generating itself. Processes based on cyclical causality cannot be reduced to isolated causal relationships.

Complex systems are generally those that can only be understood through dynamic

many-to-many relationships, and cannot be grasped through simple cause-and-effect relations. In complex systems, phenomena cannot be decomposed into independently simple elements. Rather, it is crucial to focus on the interconnections among various elements and to perceive the complexity as it is.

Time, Space, and Generation

As a complex system, society continuously forms itself through interactions among its elements, thereby generating time and space. Rather than unfolding itself under a time-space schema, society defines its own domain, determines its environment, and fluctuates through its own development. In this process, space and time manifest. Society expresses the interconnections among its elements as human collectives, boundaries, structures, road and communication networks, flags, and symbols, creating its own domain and environment. Like living organisms, its members continually change, replace each other, and modify their forms and structures without rest. Society is an organization that seeks to express itself both spatially and temporally. At any given moment, society is never in a static state but is constantly fluctuating. Thus, society transitions from one state to another while simultaneously encompassing both past and future states within the present.

Society is expressed spatially as forms and structures and temporally as continuous change and formation, but these dimensions of space and time are always intertwined. The phenomenon of social evolution also emerges from the encounter between these spatial and temporal aspects. Through spatial interactions, society actively reshapes and evolves its own forms and structures over time. Since the environment itself also changes over time, society constantly creates new forms to adapt to these changes. Therefore, social evolution arises from the intersection of temporality and spatiality.

Social systems, as complex systems, continuously generate new forms and structures. Consequently, the time manifested in such systems is irreversible. When one social state is reorganized and a new social state emerges, there is always some degree of leap or change, accompanied by accumulation and increase in experience. Therefore, nothing is ever repeated exactly the same way, nor is there any possibility of reversal. Even if identical conditions are recreated, it is impossible for the same things to recur in the same manner. Social phenomena, like living phenomena, are dynamic processes of generation, change, and development, and thus are one-time

phenomena that cannot be reversed or exactly replicated.

Social phenomena, much like biological phenomena, cannot be captured by the mechanistic schemas of classical science that assume reversible time. The time of social phenomena is one-way, and it cannot be reversed or have the past and future swapped. Society undergoes an irreversible development process, always being formative and creative. The unpredictability of how social development will progress and what new forms it will produce in the future is also a result of the irreversibility and uniqueness of the time of social phenomena.

Society as a complex system is constituted by the interconnectedness of countless elements. It forms and evolves through these interactions. Self-formation through interactions is the essence of society as a complex system. In a complex societal system, countless elements continuously change their combinations, resulting in fluid transformation. Society is not a static entity; rather, it is a part of a world that is perpetually generating and changing. In this context, each element exists and changes only through relationships. It is a world of infinite transformation and generation. The world itself is a fluid realm of continuous generation and change within interconnectedness. Human society is one expression of this. Society is a process, a continuous generation and change, and an endeavor to create something new incessantly. It is a dynamic and evolving entity that is always fluctuating and changing moment by moment.