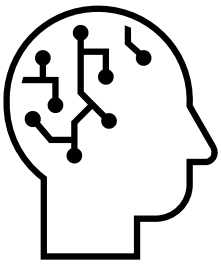
HANDBOOK:

Understanding The Economy as a Complex System

Thinking Circular®
Experts

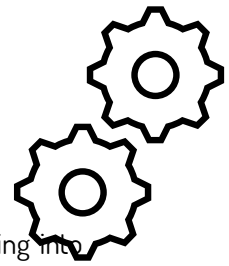
Content



Introduction

This handbook shall be a guide for managers who want to pave the way to a circular economy. Inspired by the Systems Innovation Network (SI), it delivers a description of the basic understanding of Systems Thinking that is needed to find one's way in the complex and everchanging world of economics.

As Thinking Circular® it is our mission to give orientation in the economic jungle of dysfunctional systems to make circular economy not only a vision but reality. Therefore, we have adopted and adapted SI tools with circular approaches. This handbook shall build a bridge from Systems Innovation to Circular Economy.



Overview

Economies as complex systems can't be described in one sentence. Looking into classrooms, students learn about economies as simple linear structures. They inhale demand and supply, production and consumer interests, money and currencies, prices and speculation. All that can easily be described by numbers and curves in a 2-dimensional or 3-dimensional math. Leaving the classroom, we come to notice: Economy is more. It is not 2-dimensional.

Especially the global economy - which evolved from cultivated assumptions and underlying paradigms - goes beyond that. How to emphasize the meaning of communication in economies? How to embed the history of countries or societies that differ as the two parts of this world: The Global North, much shaped by the industrial age, and the Global South, much shaped by exploitation and by running behind the paradigms of an industrial Global North? All of this makes the general idea of economy more complex than basic models taught us.

Complexity is part of the VUCA world. The term "VUCA" is made-up out of a necessary that we need new words to describe our economy. VUCA describes our economy as: volatile, uncertain, complex, and ambiguous.

Still, modern economic institutions adhere to the idea that we can manage economy in a simple manner. The direction is given by the power of profit. But: Theory makers must notice that economy has some new players on board. Not a single economy can be run without nature stabilizing the basis of all life and of all our resources that we manage. Nature laws and systems rules can't be ignored. Climate crisis has shown us that economy needs to inherit systems thinking. The planet itself has become a player on the field. This is where circular economy comes into play. It offers an opportunity to see economy as it really is - as part of a complex system.

This paper is designed to help readers better understand this system. We will look on the limits of the system and explain why they are **open** instead of closed. We will make clear why complexity is adding up to **non-zero sums** and why **behavioral economics** can't be missing to understand this. Reasons will show why **economic development** works different in complex systems and how **value** and **impact** interact. Based on a new value concept, we also need to look at the role of humans in this system. The **Homo Circularis** will be introduced as counterpart idea to the Homo Economicus. We will analyze what this all means for **organizations** and **institutions** to adapt to reality and how resources must be **allocated** in the future. The difference between **simple and complex** systems will become clear as well as the difference between **complex and complicated** systems. Complexity itself will be brought down to a level of understanding by zooming in and out of the system. Because this is what systems thinking means to understand **structural changes**. We need to zoom in to look at the individual **parts which are moving to form a system**, but we also need to zoom out to understand the system picture as a whole. We will clarify why this picture is not static. System changes from **linear to nonlinear** and **centralized to distributed** are evolutionary. All in all, the paper will describe this **evolutionary** process.

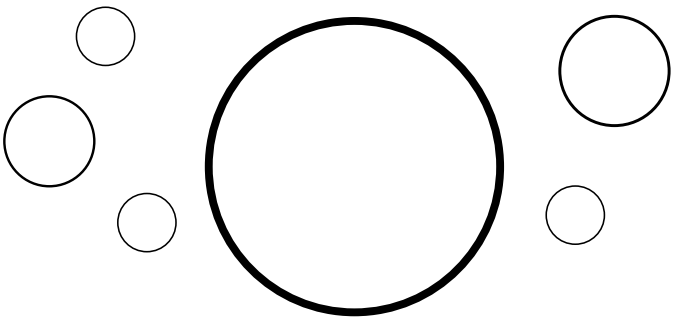
Open Economy

Whereas traditional economy is only focused on economic players, other players that interact with the economy come into focus when looking from a systemic perspective: the planet and the people.

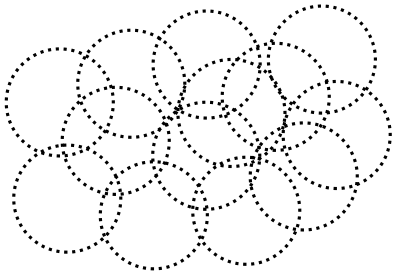
The sustainability movement has identified these three parts of a system a long time ago, which is why sustainability is often described as being based on three domains: the social domain (people), the ecological domain (planet) and the economic domain (profit).

Beyond these, economy may have even more players to interact with. Unlike the simple economic model of a closed system tells us, it is not closed at all. It's dynamic and moving. It can't be considered as isolated. Other systems are involved and flow into and out of the economic system. It is an open economy with open borders. Economy is only part of a bigger whole.

We may have viewed economy like a big "everything our lives move around" with some other things around, which are more or less important. Each of them an individual closed system on its own:



But we need to use open system models. The picture could and should look different. It may look like this:



It may also look different. Shapes and forms are changing just as systems do. The economy may only be one component interacting with other systems within its environment. There is a constant input and output of energy and matter.

This is characteristic of nonlinear systems. The thinking that our economy is a linear system with a one-direction input (resources) and output (waste) is no longer appropriate.

It does not mean that complex systems are too random to understand. It just means that dynamics are different. This is why "zooming in" becomes important. We need to look at the local rules under which the elements operate and how these rules interact to understand its outcomes.

Typically, this is done through computer simulation. When using this framework, we are interested in understanding the overall patterns. Because patterns can be translated into codes which can run computer models in order to get a simulation of the system's behavior over time. Complexity can be solved: We are defining simple rules and then use the computer to repeat these rules to give us nonlinear interactions and feedback that will generate a realistic representation of complex real-world economic phenomena.

Non-Zero Sum

Since we have an open model embedded in a real environment, we are able to recognize the complexity of the real world. To do this, we can consider experiences that we encounter individually in real life. Take humans, for example. What guides humans in decision-making situations? What are assumptions for these decision-making processes in neo-classical models in difference to complexity models?

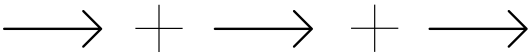
Neo-classical models assume that humans as intelligent beings in a simple economy are confronted with simple situations. Complexity theory assumes the opposite: a human is, despite his intelligence, confronted with difficult situations due to the complexity of the economy. His decision-making ability is limited by external and internal factors: lack of information, lack of time, as well as cognitive limits of the mind. We at Thinking Circular® are also convinced that humans are not only pure rational beings, as described in classical economics in the theory of Homo Economicus. We are convinced that humans are also guided by emotions, beyond their ratiocination. Emotions as influencing factor can't be missing in a systemic view. We therefore describe this in the chapter "Homo Circularis". Behavioral economics is a concept that can't be missing for understanding complex economic systems.

Whereas neo-classical models assume simple calculations, open and complex systems start from other assumptions. Situations can complement and accumulate in the sum. A Homo Circularis lacking a piece of information and a Homo Circularis lacking time can come to a different result in a complex decision situation than two Homo Economicus, who are confronted with a simple situation in a simply modeled economic system with closed borders. In theory, these two must be able to solve the situation based only on their ratio and their intelligence. This would mean, decisions and outcomes would always be the same.

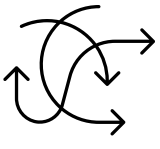
The outcomes in an open system differ. Each interaction can add or subtract value from the system and be non-zero in sum. Relationships are non-additive because the system is non-linear.

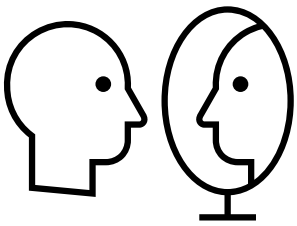
In a closed, linear system, there can only be additive relationships, because one action can only occur after another.

Linear:



Nonlinear:





Behavioral Economics

Behavioral economics studies the effects of psychological, social, cognitive, and emotional factors on the economic decisions of individuals. This gives us a much wider and more realistic conception of motives that are guiding individuals.

Classic economic theory describes how individuals pursue the outcome striving for as efficient as possible. But in difference to how it is described in classical theory, the outcomes may be other than profit. In a complex set of motives, this may also result in outcomes which are hugely non-optimal economic solutions.

This leads to the questions: What, if not profit, is the value out of this non-linear modeled framework?

Taking into consideration that the nonlinear model is an open model that interacts with other systems which flow into and out of the economic system, it becomes clear that the value must not lie within the economy only.

Since we have viewed the economy as a closed system for a long time ago, it was only possible to give value to anything that is inside of the system. For example, ecological capital can only be a value as part of the mining or agricultural industries. It can't have value independently from the economic system.

What we can see now using non-linear models is that it CAN have an alone standing value outside the economy. Because ecology and economy are interconnected, an intact ecosystem will translate into direct value for the economic system.

Using this approach, we can begin to reason about how to create a metric for translating between the different domains of the system, incorporating both, extrinsic economic value that is a direct outcome within the economy and intrinsic value outside the economy that results in indirect economic value.

This shows us: Economic systems are rather more complex than simple. Individuals can be driven by intrinsic motives coming out of other systemic domains, e.g., social or ecological motives to deliver purpose-driven value for these domains. Value can have different forms and is not determined by a single market price. It is heterogeneous, a network of different interacting variables. Anyhow, information technology can be a helpful tool to make this value tangible.

Economic Development

We can observe how the VUCA world is evolving. It is an evolutionary process. Change is a mechanism that is deeply rooted in complex economic theory. It is leading to ever new situations that lead to more complexity through diversification and growth. Technological innovation, new business models and many other developments lead to creative destruction processes that on the one hand eliminate parts of the economy which we know and on the other hand bring up new opportunities.

Growth itself gets a new perspective: It may not reduce to gross output as we know growth in the traditional sense. It may also have other definitions like qualitative structural transformation.

Unlike standard economic theory, the complexity theory has understood and considered this mechanism in its models. It therefore doesn't focus on achieving a market equilibrium, like standard economic theory does. Change in a qualitative way is then defined as economic development.

Value and Impact

Economic action describes how things are produced, exchanged, and consumed. The professional actions taken are described as management of organizations that handle production or exchange. In today's economic systems we can see people in different roles as managers, as consumers or as prosumers that produce and consume. The allocation of resources and goods and the estimation or definition of their value in price systems is the very heartbeat of any economy because it is driven by needs, demands and opportunities. Value is defined to the regard that something is held to deserve, its usefulness, its importance or worth. Prices arise by the expenditures of resources to achieve what is a manifest or observable value.

In classic economic theories the idea that people will strive for the things they value at the lowest cost is dominant. And value differs, as individuals or society and culture differs.

In these times, when we realize that the Anthropocene is already part of the past and climate change will dominate life on earth the question of positive impact on livelihoods arose. The Sustainable Development Goals define the societal global aims and values to create livelihoods for the people on planet Earth. Value has been given an ecologic, a social and an economic dimension. Positive impact as a value for sustaining human life on Earth must be expressed in price and tax systems. Governments, policy makers, society and the economy are addressed to rebuild economy systems that were driven by myths of growth and greed to acknowledge terrestrial boundaries. The strive for the lowest costs must be adjusted to global essential human needs to survive and solve the climate crisis.

Sustainable Development Goals by United Nations

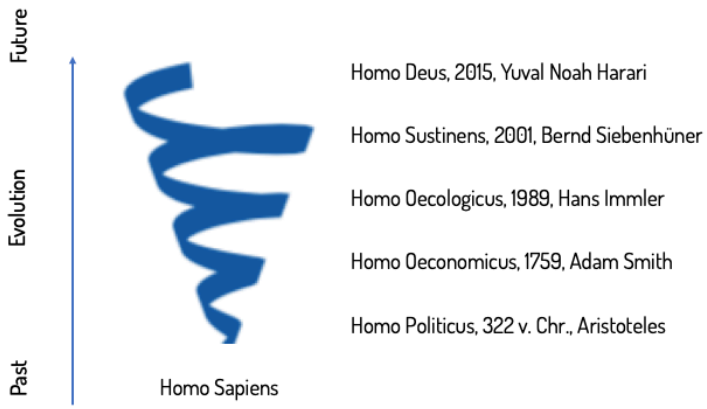
Homo Circularis

The Circular Economy already offers some answers to the question of how the economy could be in the future. However, the theory is not complete. It still lacks an idea how we as humans are described in this new world. How would people have to be or act if the theory of the Circular Economy were to become reality? We attempt a formulation that – following the Circular Economy – we call Homo Circularis.

But before we describe this idea of man, let's take a look at other ideas of man that were basis for other economic theories or social models. They allow us to draw a distinction. And to place it in a historical context and thus also embed it into the changing paradigms of today's VUCA world.

The starting point for our idea was Yuval Noah Harari. In his book "A Brief History of Mankind" published in 2015, he describes the development from Homo Sapiens to Homo Deus.

Harari explains how the human species was able to conquer the earth and how the age of the Anthropocene came into being. The Homo Deus described therein possesses quasi godlike abilities, which he not only uses creatively, but also destructively. Harari rightly places the question where the religions and humanism have remained in all the creative power of Homo Deus. Are we still capable of believing in something good in order to also act well? The question is as fundamental as it is provocative, as general and old as it is challenging. And the description of Homo Deus offers a basis for delimiting our actions and turn the image of humanity into a new narrative.



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The series of ideas of man that have already been formulated helps us to develop the new description. Homo Politicus was described by Aristotle. Researchers such as Wolfgang Kullmann interpret this idea of man from ancient Greece as a social being that interacts in community. People can form communities on their own. Other researchers and interpreters of Aristotle's

work emphasize the human ability to think politically. Against the background of two social classes prevalent in Greece at that time, there was the challenge of bridging the differences of rights, opportunities, life possibilities and conflicts. The question of justice was a political one. Forming just structures became the object and has been a political one in nature ever since.

The image of Homo Economicus developed by Adam Smith assumes that people act and decide with a focus on utility. People act rationally; this has also been a result of the Enlightenment. Morality forms a context and framework in which the action takes place. This conception of man is criticized by alternative economists, since it excludes economic decisions oriented to the common good, although it is proven that humans have always decided in the sense of the common good. This was already stated by Aristotle, because political action is oriented towards the common good as well.

Industrial ecology gave rise to Homo Oecologicus, which described the idea of a perfectly ecologically acting person but did not imply economic motivation and justice. Against this background, Homo Sustinens emerged. In this idea of man, moral responsibility is as significant as social learning, altruism, cooperation and communication. Ecology, social issues and justice are interrelated, form the sustainability triangle and are thus linked to this idea.

On our way to Homo Circularis, we want to consider how paradigms are currently changing. Paradigms describe beliefs of various relations in systems such as the relation of human to nature, human to human, human to technology, and identity issues.

Forgetting nature

In the Anthropocene, now that we are becoming aware of the connection of human actions to climate change, it is becoming clear that we cannot see nature just as a resource to be exploited, as described for Homo Deus. Science can lead us back to nature and a new understanding. We are currently learning that animals have all the characteristics that were assigned only to humans in the old ideas of man. Animals act socially, they have feelings, express themselves and they are rational – therefore they act strategically, and they communicate. Furthermore, we recognize that every living being, no matter how small, has a function in maintaining the biological cycles that form our basis of life. These findings prove that humans and animals are fellow creatures on the planetary spaceship Earth. For this the term earthling was already established. Homo Circularis understand themselves as fellow creatures, as earthlings.

Technology and digitalization

Our relationship to technology is also changing, at the same time becoming more intense and bringing in new dependencies as people connect with it more and more, even physically. The individualized cell

phone is a metaphor here for what we still see: People carry technical spare parts inside themselves, like pacemakers or hearing or optic nerve implants. People are turning themselves into human-technology hybrids, implanting keys or payment chips in their limbs. There is certainly room for interpretation as to how this physical connection is to be seen. Is technology an end in itself or a tool to make our lives easier? The field for answering this question is open. We stipulate here that Homo Circularis recognize and use technology as a tool.

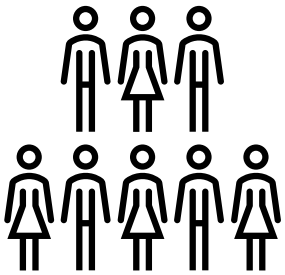
Identity

Our daily actions gave and give us an identity. We are what we do. Rehearsed behaviors, tradition from religions, tied to space and time, shaped us for centuries. Rapid changes in our environment and behavioral adaptations from living in other places, in other cultures change our self-image. "Who am I?" This question arises for every person who changes. Every time we change, also forced by changes in our environment, we need a redefinition of our self. This is something that everyone can only find for him- or herself. Psychologists can confirm this for us. And it is the "I-narrative", the individualized, own narrative, that defines us. The importance of narratives becomes easier for psychologists to observe and use therapeutically in times of social media. And we can also use this insight for the self-narrative of a Homo Circularis, who also narrates himself individually, but also sees himself as a social collective interacting with his fellow creatures.

There are more changing paradigms, e.g., gender issues, family images, democracy development. Homo Circularis do not see themselves as predominant, but in a diverse society as an element of social systems, as system theory can also depict. Communication among the elements is an elementary link and is also expressed in Hartmut Rosa's theory on the need for resonance in human beings.

Changing paradigms

Object relationship	Traditional	New
Identity	Connected with habitus, region, space, time	History of "I"
Human-Nature	Nature as a resource	Nature as partner
Human-Human	Bourgeois nuclear family, the fellow human being as competitor	New gender roles, fellow human as partner
Human-Technology (AI)	Technology as an end in itself and a bringer of salvation	Technology as a tool
Society	Order to be established by the leadership	Communication, society has the ability to self-order
Culture	Identity	Habit



We hold on to what helps us with changing paradigms from the knowledge of earlier ideas of man:

- Humans are social and political – we learn this from Homo Politicus.
- Humans are rational and use this for (economic) survival – we learn this from Homo Economicus.
- Humans also want to respect nature – we learn this from Homo Oecologicus.
- Humans try to live the harmony of social, ecological and economic goals and to behave morally – we learn this from Homo Sustinens.

What is missing?

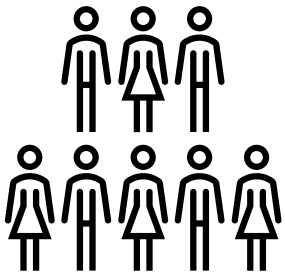
Man's striving for perfection in the respective ideas raises questions about the Good Life. What happens to a society that is constantly stuck in rate race ending up in depression, stress, cynicism, and frustration and that forgets to be happy due to sheer survival perfection? Can Homo Circularis be oriented to the above-mentioned human ideas with regard to the results of human striving? This is not what we can see. And the question about the "good life" about what is really important has already been asked.

As reflective and systems-thinking subjects, Homo Circularis will always ask themselves the question of what is really important. Especially when we lose something. Climate change will cause losses: people will lose their homes because they are no longer habitable, they will lose their possessions, they will lose people they love. Possessions will then take on a new meaning. Thus, the Homo Circularis makes himself more and more the steward of everything what offers him a basis of life: of things, of nature, of people. He will use possessions, but they will no longer matter to him. Possessions do neither per se justify survival nor a good life. This will be a new experience.

Homo Circularis have to adapt quickly to new environments, so their only option is rapid lifelong learning. And if they want to ensure the survival of their children, they have to pass on their knowledge quickly. While we're talking about children: What about love and feeling? The preceding pictures of human beings almost completely ignore this, and yet it is part of our emotional intelligence. We learn primarily from emotional experiences. Homo Circularis is emotionally intelligent.

What will Homo Circularis look for if they want to survive? They are looking for development opportunities. These result from social, ecological and economic opportunities, offers of help and use options. So, opportunities are what matter. Homo Circularis will look for them.

We will see that Homo Circularis in their quest for the good life, will act as stewards and yet do what Homo Sapiens have always done: Love, learn, teach, and act quickly for survival. To prove themselves resilient.



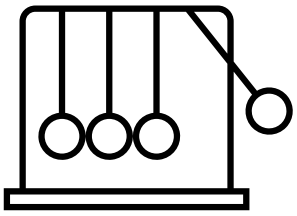
Who benefits from the image of Homo Circularis?

In demarcation to Homo Economicus it is certainly useful for the own reassurance of worried thinkers and alternative economists. Because our current program for higher, faster, stronger has overshot our save operating space on earth. Otherwise, the Anthropocene would have not existed.

If we ask, "Who benefits from climate change?", then it is clear that it does not benefit us humans, it threatens our existence. But perhaps the knowledge about climate change could be of some use to us after all?

This includes recognizing that the Darwinian paradigm is a cause of the climate change. Because in the idea of the STRONGER will be always winning, Homo Deus offered a legitimation for avarice, greed and narcissism, in the exploitation of our planet. There is no such thing as THE STRONGER. However, there are systems that are planetary in scale. Neither do we humans know the rules of the planet, nor can we control them, nor should we presume to attempt what Homo Deus attempts. Man is only one element in these systems.

It's time to finally say goodbye to Darwin's paradigm. In climate change, those who survive will be those who are good at cooperating, learning quickly, and proving emotionally and socially resilient. Perhaps it will be the Homo Circularis who adapts to the new and survives.



Organizations

Imagine you are baking a cake. For this cake, you need different ingredients and tools. And only if the ingredients and the tools are working hand-in-hand, the recipe will work out. If the cake turns out to be flat, the yeast may not have worked. If it turns out to be only half-baked, maybe time was too short that we have calculated for the baking process. So, if the result is not what we expected, we need to have a look at the ingredients and tools to find out what may have gone wrong. They are part of the "Baking-a-cake"-system.

To understand the complex system of economy, we have to look at the parts as well. Organizations are one of the major parts of an economy. And they are working just as a whole bakery for us: They take up the resources (which are the ingredients for whatever people could imagine on this planet), mix them and follow a specific production process in order to deliver the cake. This cake can be food, mobility, water systems, as well as anything else our comfortable world includes. Organizations are delivering values. And comfort is not the only value. With their products and services, organizations deliver security, health, wellbeing, efficiency, modern life, emotions, survival. As already described, these values don't need to be sheer monetary. They can also result into the conservation of our ecosystems or in social aspects.

And as the limits of our ecosystems have shown us, the ingredients for our cakes are finite. This is why in a complex economic system that takes up this consideration, we need organizations that don't only produce faster, more and further, but organizations that work effective and efficiently in allocating resources. They have to conserve demands on resources while maximizing the generation of the desired outcome.

This is why in complex economy organizations need to take a closer look on how to realize effectiveness and efficiency. In a circular economy, effectiveness is most important. But for working processes, efficiency is necessary.

Efficient means not wasting time, energy or money. Efficiency refers to a special production factor. But it does not necessarily cause positive impact! It might even drive negative impact. Industrial production in linear systems causes waste, like carbon in the atmosphere. It may be efficient, but it does not have a positive impact on the overall system. This is why we need to be effective, before we try to be efficient.

Effectiveness refers to more than one element in the system. Within the system the cause of effectiveness can be described as useful, suitable, convenient, advisable, and even efficient. It causes positive impact on the system's environment. An effective strategy avoids negative rebound effects!

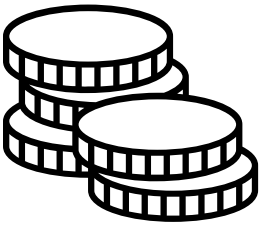
This is the same for the smallest of organizations such as households as for the global economy as a whole. An economy is the sum of all these systems of organization.

Institutions

From the complexity perspective, people are interconnected. Institutions are fundamental networks within the economy. People are embedded in these networks and resources flow through these networks.

For the effective and efficient allocation of these resources, the structure of the networks is important. We need to consider that these networks are part of an open system. That means, things can flow in and out. Allocating decisions are therefore characterized through input and output of the system, components of networks, the network's structure and through what is flowing through the network. The distribution of resources across the network can be different from time to time and may remain in a non-equilibrium state indefinitely.

Whereas the organization's success of an output (baking the cake was successful) depends on effectiveness and efficiency within the economy, the overall success of an organization in the economy (the cake delivers value) is dependent on this interaction between these networks. From this perspective, there are actually no efficient markets that allocate resources in an optimal way. This shows that in complexity theory, there are decisions we can influence and where effectiveness and efficiency need to come into play, and there are decisions which are controlled by a greater power.



Allocation

After discussing how organizations, effectiveness, efficiency, institutions and the overall allocation of resources within a complex system is interconnected, it makes sense to zoom in again to understand how allocation is working on the microlevel. We will take a look on how individual people, households, businesses and whole societies choose to allocate their limited available resources.

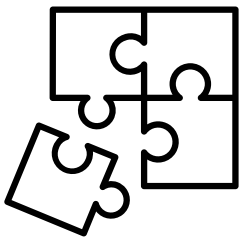
Actually, there are just two things we can do with our available resources: We can either choose to use them for consumption or to use them for investment. Consumption is hereby defined as finite outcome with no use for the future. It means we are using resources to generate an outcome which is not productive in the future anymore. It can't be used as resource again. This model of consumption is one that is cultivated in standard linear economy. As long as we produce waste that can't be food to another lifecycle but ends up as carbon in the atmosphere, we are consuming our resources without conserving them.

The other option is to invest resources. Investments mean to allocate resources in such a way that future value will result. For example, when we are able to turn waste into resources again, we will create value. This is what circular economy is about.

Just as we know from monetary investments in financial markets, investments always accumulate over time. Productive assets become more. This is basis for economic development in complex economic system. Consumption on the other hand will not create increases in returns. The organization may even decrease in value.

To sum up, organizations succeed when they have the intelligence to invest. They fail when resources are misallocated or over consumed.

Systems – Complex vs. Simple



It becomes clear that putting all parts together (resources, inputs, outputs, flows, economic development, values, impact, people, behavior, organizations, institutions, relationships, technologies, allocation mechanisms and much more) delivers a picture of systems dynamics. This picture explains the complexity that lies in it. It is a moving organism without equilibrium that is changing and transforming.

Which difference can we draw to simple linear systems?

The first difference is that simple systems only consist of a few elements. These elements can offer only a number of limited connections which are linear. Cause and effect are clearly traceable through feedback loops. One thing is directly causing another thing.

This means, and here we come to the second difference, simple linear systems can be easily controlled. Power can be centralized. Typically, these systems are characterized through hierarchical management. In hierarchical organizations, strategy, controlling and management are concentrated at the center. Decisions are pushed to the mass of organizational members.

We need to understand that every system combines both: There are economic organizations that are relatively simple. And there are organizations that are complex.

The fundamental differences between them need to be understood to effectively manage them.

Complex vs. Complicated

Everything in our universe started simple and has evolved over time to become more complex. Societies started as small tribes with simple economies. Technologies started as simple hand tools. Only through emphasis on their development, they have become complex within an evolutionary process.

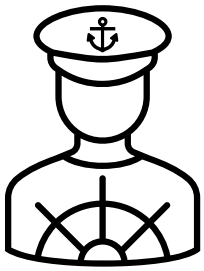
The making up of new words like "VUCA" is showing us that complexity is no individual feeling. It is for a good reason that the saying "We are living in an increasingly complex world" has become part of business and individual life. The complexity theory gives us a starting point to keep up with understanding 21st-century economic development.

The sheerly most important to thing to know about "complex" is that it is not the same as "complicated". Things get complicated when there is no correlation existing between many different parts. Parts are not interconnected. Coordination becomes random.

Complex systems also exist of different parts and are characterized through many connections and interdependencies between these parts. But coordination and organization become manageable to a degree because connections and interplaying mechanisms become traceable and tangible. On this basis, it is possible to make decisions.

A good example may be multicultural societies. Of course, situations in these society can become complicated. But the overall society is not complicated, it is complex because society is consisting of many different individuals with different cultural backgrounds that are interconnected and interdependent.

Another example may be the global financial system. It is complex in its form as well as it consists of many different institutions and individuals. But there is a clear difference to complicated.



Structural Changes

It is not long ago that standard economic theory had a profound right to be THE theory to be taught and to believe in. Economy was not always complex. The simple linear system was one that delivered real value. But though cause and effect were simple mathematics back then, what was not included were future projections and rebound effects.

Since about 200 years, we are experienced exponential growth in almost all fields we can think of: population growth, economic growth, consumption growth, mobility growth, production growth, trade growth, information growth, and much more.

Within the blink of an eye compared to evolutionary history, world has undergone a fundamental change. Today, we can find us in a global economy that went from linear to nonlinear and which is simply not simple anymore. It furthermore has become clear that this transformation is not sustainable.

What we can see is taking place is a transformation of systemic structures. We try to give this new economy a new name: It is already called information economy, network economy or also post-industrial economy. No matter which names we are giving to this child. It has become a complex system, and this is what we need to deal with.

In this process of structural transformation, we can identify a number of vectors which are fundamental characteristics to this change:

- We can see that parts developed to a system.
- We can see that the system developed from linear to nonlinear.
- We can see that the system developed from centralized to distributed.
- And we can see that the system developed from static to evolutionary.

From Parts to Systems

Before we experienced the structural changes described, economy was characterized through boundaries, e.g., national boundaries. Business was more regionally focused and within national economies, trade was characterized through competition.

Since our world has become more globalized, these boundaries have shifted and somehow disappeared. The information technology played a major role in this shift. Businesses are facing other sorts of competition. They need to be agile and resilient which is becoming more and more complicated than only complex due to rebound effects which were disregarded for a long time, e.g., finite resources, climate change, financial crises, ...

To survive and to keep up their right to exist, businesses need more and more to shift from competition to cooperation. The interdependence between them has become too strong to remain a single part, a lone fighter. Parts are emerging into one system.

This shift from parts to systems is affecting all levels of business. One example is the Sustainable Development Goals. Only if governments, organizations, networks, businesses, individuals as well as all other parts of the system are working together, we can achieve them. And we need to achieve them for merely survival which goes much beyond the economic system.

Of course, we can only achieve them if we incorporate the openness of the system. It must be clear that boundaries are not fixed anymore. Things flow in and out of the system. So does impact. Businesses can impact our ecosystems. This has become clear and needs to no longer be disregarded.

We can also see other parts moving into the system. Digitization is leading to open-source technology, the Internet of Things and many other applications of interconnectedness. Value chains are opening up for collaboration. Products develop into service structures. End-users become prosumers. Producer responsibility gets extended.

This development, the shift from parts to systems and from competition to cooperation, creates a very different dynamic to the one we have been used to. On the one hand, business is about retaining identity, uniqueness, value and autonomy. On the other hand, cooperation is needed remain in the market.

From Linear to Nonlinear

When parts start to grow as a system, another changing vector comes into play: Processes are no longer underlying cause-and-effect logic. Parts become a whole network of connections. Linear patterns get lost. Instead, the system is working nonlinear.

The circular economy is such an example. The model of the circular economy is deeply rooted in the understanding that our old system which was linear is not working. We can see it in climate change and other global issues that lead back to the linearity of the economy. In a complex system, it does not work anymore. We can't no longer put resources as much as we want into processing to get things - which we may desire but maybe don't really need - to produce waste we can't handle either. Waste is overgrowing us. The rebound effects are too big. We can see it in climate change. Carbon is nothing else than waste in the atmosphere which is unwieldy. How do we get this under control if we do business-as-usual?

In a complex system with nonlinear feedback loops, one cause may have different effects which means that the probability of rebound effects is growing exponentially.

We have to draw the consequences. And this is where circular economy comes into play. The model solves the issue of worthless and unwieldy outcomes. It gives the end-product of waste value again by implying that loops get closed so that waste can become a resource for a second life again. The end of end-of-life is the beginning of the Cradle-to-Cradle principle by Dr. Michael Braungart where we separate technical and biological cycle. It's the beginning of a new economy which aim it is to keep products and materials in the lifecycle as long as possible. The RESOLVE-principle by Martin Stuchtey which we also know from the Ellen MacArthur Foundation adheres to this. The principle stands for:

RE – Reduce, Regenerate, Reuse, Refurbish, Recycle

S – Share

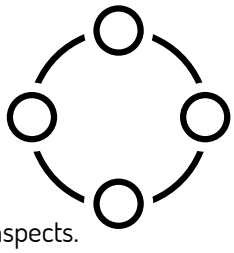
O – Optimize

L – Loop

V – Virtualize

E – Exchange

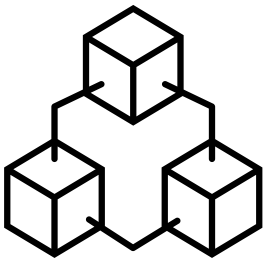
By closing resource loops, we are maximizing product use and are using resources effectively. This restoration of natural capital is real value and basis for economic development within environmental boundaries. To organize circularity digitally helps to accelerate economic development and to create smart solutions through collaborating, sharing knowledge, and building networks for circular systems.



This logic is not only reduced to circular economy and its environmental aspects. As parts develop into a system, we have many different feedback loops which are nonlinear: Technological, social, financial and other parts of the system become interconnected into global systems. We need to either take up responsibility and design them – otherwise they come back to us as disaster.

We can see this kind of butterfly effects for instance in the global financial crisis. But it's not only large organizations and governments which are producing large results. Through social media, grass rooting effects have become stronger as well. Today, very small organizations or even individuals can set up posts which go viral and affect whole markets. Same for hackers: One individual can turn down whole infrastructure systems.

New business models already know about this network effect and come to use it. Tech startups know about the power of scalability when using the network effect. Circular business models are about connecting to design cyclical processes where resources can be used and reused to deliver increased functionality by making resources go round in circles.



From Centralized to Distributed

In complex systems, centralized management doesn't work anymore. There are just too many parts to take control of.

It is not only harder to install a centralized management in a complex system, but also easier to distribute management because the system possesses the tools to do so. Information technology is such a tool. It does not only provide access to information, but also reduces transaction costs. Therefore, it becomes easier for organizations to set up their own networks. On the one hand, it is no longer necessary to define a centralized organization in a hierarchical structure with fixed roles and relations between the parts. On the other hand, such an organization would become way too expensive due to all of the overhead costs in comparison to agile distribution. Moreover, such organizations are no longer able to take advantage of scale. Deep-rooted bottlenecks constrain their effective scaling.

Out of this necessity, we can see new forms of networked organizations emerge, that are built on open platforms. Organizations are able to manage supply and demand between distributed producers and consumers through IT platforms. They are able to do so because distributed parts become cheaper to connect. New technologies make it possible. This allows the emergence of solutions in response to demand.

This is why foresight is seeing ever more traditional structures move into networking organizations in the future. Aggregating distributed capabilities on demand is better suited to complex systems.

From Static to Evolution

VUCA is defined by volatility, uncertainty, complexity and ambiguity. Fast-paced change, non-routine events and systemic shocks occur through exponential change and make the economy not only complex but also complicated from time to time as we still adhere to the system we know from the last centuries. But simple economic structures were relatively stable. There was an economic routine to follow, and effects were somehow predictable. Flexibility and diversity are not really needed. The focus of such a system lies on scale, output, and efficiency.

The pace of change that we are now confronted with has greatly increased in the past few decades. It has become a race with fast-paced evolutionary change through rapid iteration.

Whereas we know how to achieve economies of scale through larger input and mass production, we are now moving into a completely new chapter where economy is no longer about materialization. This dematerialized economy is about services, information and knowledge. It does not longer require large physical assets. This major shift comes along with the requirement to also shift focus away from competitive mass production models to innovative models where value can be created differently. This also means that design and organization of systems need to be agile to keep up with disruption. Through information technology, disruption may come from the other side of the world.

Organizations need to operate in real time with latest information to respond to current events. Static inert structures within centralized systems only lead to incompetence. Today, it is all about information. Those who don't respond to disruptive models, are paced out. We can see this for instance in the media industries which business models were completely disrupted by digital media. It's no longer about physical newspaper. But it's still about information, so that organizations have the chance to adapt, knowing that competition is growing stronger as nearly everybody can set up information portals on the internet at almost zero cost. This is a good example to show how drastically markets can be changing in a short time.

Private-room-sharing platforms in comparison to traditional business models of hotels is another example for agility and new business models. Whereas hotels adhere to all sorts of physical constraints and inventory, private-room-sharing platforms have already realized economic scale through renting models that are based on information technology, shared business models and cooperation instead of competition.

In an economic environment which new identity is systemic transformation, solidarity, agility, resilience, diversity and evolution become more important than from scale through linear physical accumulation.

Conclusion

During the process of industrialization, a system evolved that was manageable like a simple machine. For a few centuries, the system did what a machine is there for: It processed input into output in a linear way. Based on the assumption, that this is what economy is all about, we established our institutions which follow the centralized structure. The idea of controlling economic organizations in a top-down approach worked because there was a systemic fit to this structure and available technologies that supported it.

Today, we can find us in a world in which this set of assumptions and organizational structures are tumbling down. Evolutionary and fast-paced change is taking us into a VUCA world where complexity is the new authority. New institutions are built on new assumptions. Networks are evolving that are communication through new information technology. Organizations are collaborating. New business models grow based on ideas such as circularity, sharing or information technology. Cause and effect are no longer linear but nonlinear. To take up design, control mechanisms move from centralized to distributed. Agility is presumption to react in real-time to dynamic evolutionary processes.

We recognize the economy as a complex system which is not the same as a complicated system. It is not about getting lost. It is about understanding interconnectedness, openness and transformation.

About the Authors

About the multiverse of Thinking Circular®

At Thinking Circular®, we're creating a multiverse for green progress by helping green innovation to prosper. We use the concept of a circular economy and the Cradle-to-Cradle (C2C) design principle to support business, science and politics on the path to a more sustainable society. Consultancy, networking, partners, political positioning, events, expert advice, influencers, speakers – Thinking Circular offers all of this and much more. This is where ideas for securing the future are forged: We develop green innovations and make them a reality.

About Eveline Lemke

Eveline Lemke

As Minister O.D., Eveline Lemke is the linchpin and the face of Thinking Circular. She brings her networks and expertise to the table and builds gateways and bridges between the different dimensions of the circular economy. Thanks to her extensive experience of over 30 years in the field of circular economy, she has a keen understanding not only of the political necessities in this field but also the needs of business and society. Together with her competent team of circular economy experts, she helps to make change happen. This is how we are paving the way for an economy that allows everyone to live well and sustainably.

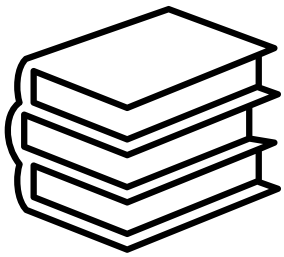
About Charléne Nessel

Charléne Nessel

For the economist and project manager at Thinking Circular®, commitment to a sustainable future and a green transformation in business and society is a vision to realize. After studying International Economics and Trade in Hangzhou, China, and at Hanover University of Applied Sciences and Arts, Germany, she earned her master's degree in Strategic Business Development. Circular Economy means to her putting sustainability into practice.

What we mean by circular economy

Thinking Circular® operates on the basis of a broad, holistic understanding of the circular economy. The cultural understanding of the circular economy in central European societies is often limited to waste management. However, waste as we define and produce it in our societies does not occur naturally in the environment. This means that the more consciously and harmoniously we interact with nature, the less waste will be produced. Waste as a product of excess and unfair distribution is attributable to the mismanagement of our economic systems. As long as we fail to produce and consume goods in such a way that they are compatible with and cause no harm to humans and the natural environment, we will need to use green technologies to compensate for the flaws in our system. Treating and decontaminating our air, water and soil will remain a necessity until the green transformation is brought to a successful conclusion. Until then, we need to aim to 'close the loop' by making materials and products flow in cycles so that they can be reused to the greatest possible extent. There is much ground left to cover and every step of the way is a learning experience.



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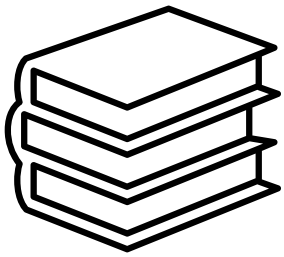

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