Decentralized and Open Thinking

Part 1

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Publishing Information

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Foreword

- This is Part 1 of the slidedeck for the Decentralized and Open Thinking micro-course.
- The micro-course is divided into 3 parts:
    1. Cooperativism and Platforms
    2. Drivers of Platform Cooperativism
    3. The Platform Cooperativism Movement and Future Industries
- There are no assignments included with this micro-course. If you would like an assignment for your personal use or for use in a course, please send an email to **ledgerback@gmail.com**.
- Thank you to Systems Innovation (SI) for offering free educational materials and resources that helped serve as the basis for this micro-course
- If you would like to make ***updates*** or report the need for ***corrections*** to this slidedeck, please do so by sending an email to **ledgerback@gmail.com**.

Outline

- Learning Objectives
- Topic Schedule
- Materials
- Prerequisites
- Topics
  - Mindset
  - Thinking Modals
  - Systems Thinking
  - Modelling
  - Design Thinking
- Supplementary Materials

Learning Objectives

- To have a basic understanding of thinking modals that will aid in understanding, defining, promoting, and designing solutions and systems (i.e., helping with problem-solving) that can cause systemic change and aid in transitioning to new systems and relational dynamics that rethink society's relationship with science and technology, and how individuals interact with each other, institutions and society at large.

Topic Schedule

1. Mindset
2. Critical Thinking
3. Basic Logic
4. Decentralized Thinking
5. Open Thinking
6. Systems Thinking

Materials Needed

1. A personal computer
2. An internet connection

Prerequisites

- **None**

1. Mindset

1.1. Open Mind

- From Merriam Webster's Online Dictionary, an open mind is defined as "a willingness to listen to or accept different ideas or opinions".
    - However, being open minded does not mean blindly accepting any idea that is presented to you. Rather, it is about the willingness to hear new ideas *and then applying your critical thinking skills and other thinking skills to parse through the idea.*
- Why is it important to have an open mind?
    - It will be easier for you to challenge your own ideas and thinking, and work towards finding the best outcome rather than validating any preconceived notions or ideas
    - To be willing to hear and assess new ideas, regardless of how outrageous they are, and determine whether they have any merit to them.

1.2. Critical Thinking

- **Definition**: Critical thinking is the ability to objectively evaluate the premises that lead to a conclusion through sound reasoning
- **When to Use**: At all times when determining the validity of a conclusion (or argument in general)
- **Purpose**: To help improve your own thinking processes
- **Benefits**: Improve the way you understand how you and others process information to reach conclusions
- **Helpful Tips**:
    - **Reflective Skepticism**: Suspending judgment about claims until there is enough evidence, even in the face of uncertainty or, social or other pressures
- **Needs**:
    - Deductive Reasoning
    - Inductive Reasoning
    - Open Mind
    - Reflective Skepticism
- **How to improve**: Refer to 1.3. Logic Basics

1.3.1. What is Logic?

- Logic is the science (with a focus on analytic skill of constructing and deconstructing abstract arguments) of reasoning. Logic focuses on distinguishing correct reasoning from incorrect reasoning.
- Logic concerns *how to reason*, not *how we actually reason in practice*
- In this mini-course, we will go over some of the basic terminology and analytical skills of Logic
- Logic often concerns the analytical skill of constructing and deconstructing abstract arguments

1.3.2.1. What are Propositions, Inferences and Arguments?

- **Terminology**:
    - **Inference**: drawing conclusions from premises.
    - **Argument**: collection of statements, of which one or more is a premise, and one which is a conclusion. A statement is a declarative sentence that is capable of being false or true.
    - **Proposition**: a statement that is capable of being true or false.
    - **Premise**: a factual statement (i.e., can be proven to be true or false) that is used as evidence for a conclusion. You can also think of a premise as *data*, *information*, etc.
    - **Conclusion**: a statement that is supported by one or more premises
- **Argument Structure**:
    - Generally, an argument will be comprised of 2 elements:
        i. (>= 1) Premise
        ii. Conclusion

1.3.2.2. What are Propositions, Inferences and Arguments?

- **What is not a proposition?**
  - Any statement that does not turn on its truth or falsity
- **Examples**
  - A question
  - A command
  - Expressions of feelings

1.3.2.3. What are Propositions, Inferences and Arguments?

- Indicators of premises and conclusions
  - **Premise**:
    - Since
    - For
    - Because
    - Given that
  - **Conclusion**:
    - Therefore,
    - Thus,
    - Hence

1.3.2.4. Exercise break

1. Please identify the premises and conclusions of each argument below.
    a. Since the ground is wet, therefore it rained earlier.
    b. Jack always goes to the deli on Tuesdays. Since today is Tuesday, Jack went to the deli.
    c. The box has wires. The only items that have wires are telephones. The box is a telephone.

1.3.2.5.1. Premises -> Conclusions

- The premises of an argument may be dependent (“joint inference”) or independent (“independent inference”) of each other in determining the validity of the conclusion.
- **Dependent Examples**:
  - *Premise 1*: Jack is taller than Ted (1). *Premise 2*: Ted is taller than Fred (2). *Conclusion*: Jack is taller than Fred (3).
    - 1 + 2 |-> 3
  - *Premise 1*: A snake is a reptile (1). *Premise 2*: A reptile is an animal. *Conclusion*: A snake is an animal
    - 1 + 2 |-> 3

1.3.2.5.2. Premises -> Conclusions

- **Independent Example**:
  - Soccer is a sport played with your feet.
  - FIFA defines soccer as a sport
    - 1 -> 3
    - 2 -> 3

1.3.3. Fallacies

- **Fallacy**: an error of reasoning that makes an argument flawed.
- **Informal fallacies**: fallacies that do not require a formal or abstract analysis of argument patterns
- **Formal fallacies**: fallacies that do require a formal or abstract analysis of argument patterns
- For examples of informal and formal fallacies, please refer to https://brewminate.com/an-introduction-to-basic-logic/

1.3.4. Propositional Logic/Arguments

- **Propositional Logic**: an approach to constructing arguments that fit valid argument forms
- Example Form:
    - *Premise 1*: *If A = B*
    - *Premise 2*: *And B = C*
    - *Conclusion*: *Then A = C*
- Propositional logic uses special language and often combines multiple propositions into a single proposition.

1.3.5. Complex Propositions and Connectives

- The four basic logical connectives of propositional logic
  a. Conjunctive (and)
  b. Disjunctive (or)
  c. Negation (not)
  d. Conditional (if-then)
- We often use the letters P, Q, and R as placeholders for propositions in an argument.
- Nested Logical Connectives: combinations of basic logical connectives
  a. Examples:
     - If P, then (Q and R)
     - If (not P), then (Q or R)

1.3.6.1. Valid Argument Forms

- **Valid Argument**: An argument that follows a valid argument form
- Four examples of valid argument forms:
  - Modus ponens
  - Modus Tollens
  - Disjunctive Syllogism
  - Hypothetical Syllogism

1.3.6.2. Modus Ponens

- Premise 1: If P, then Q
- Premise 2: P
- Conclusion: Therefore, Q

1.3.6.3. Modus Tollens

- Premise 1: if P then Q
- Premise 2: not Q
- Conclusion: therefore, not P

1.3.6.4. Disjunctive Syllogism

- Premise 1: P or Q
- Premise 2: not P
- Conclusion: therefore, Q

1.3.6.5. Hypothetical Syllogism

- Premise 1: if P then Q
- Premise 2: if Q then R
- Conclusion: therefore, if P then R

1.3.6.6. Fallacious Versions of the Valid Argument Forms

- Here are a couple examples of fallacious versions of the earlier described valid argument forms.

1.3.6.7. Fallacious Modus Ponens

- **Fallacious Modus Ponens**: fallacy of affirming the consequent
  - Premise 1: If P, then Q
  - Premise 2: Q
  - Conclusion: Therefore, P

1.3.6.8. Fallacious Modus Tollens

- **Fallacious Modus Tollens:** fallacy of denying the antecedent
    - Premise 1: if P then Q
    - Premise 2: not P
    - Conclusion: therefore, not Q

1.3.6.9. Fallacious Disjunctive Syllogism

- **Fallacious Disjunctive Syllogism:** fallacy of asserting an alternative
    - Premise 1: P or Q
    - Premise 2: P
    - Conclusion: therefore, not Q

1.4.1. Form v. Content

- The form of a statement is distinct from the content of a statement.
- **Content (i.e., descriptive terms)**: refers to the validity of premises in an argument
- **Form (i.e., logical terms)**: refers to the logical order of the argument
- An argument may have good form, good content, or both.
- Generally, an argument with good content is considered factually correct (contains only factually true premises), but the conclusion may not draw from the premises (premises can be factually incorrect).

1.5. Sound v. Unsound Arguments

- **Sound argument**: an argument that has a valid form and factually correct content. In other words, if the premises are true, the conclusion would necessarily need to be true.
- **Unsound argument**: is an argument that has a valid form but a factually incorrect content, or vice versa.

1.6. Deductive v. Inductive Logic

- **Deductive Logic**: an “argument whose conclusion follows necessarily from its basic premises.”
  - The prior logical forms and arguments we have been dealing with are all considered deductive arguments
  - Deductive arguments are concerned with the validity or invalidity of an argument (there is no in-between here, everything is black and white)
- **Inductive Logic**: an “argument in which the premises provide reasons supporting the probable truth of the conclusion.”
  - You can consider inductive logic to be probabilistic thinking
  - Inductive logic is concerned with the probability of a conclusion, rather than the validity of a conclusion.

1.7.1. Inductive Logic

- Inductive logic relies on inductive probability, “ which is the degree to which a conclusion is probable given the truth of the premises.”
- There are different strengths to inductive probability based on how strong or weak the conclusion is based on the premises
    - The critical matter with inductive logic is whether the conclusion moves too far away from the premises
- For more information on inductive logic, please refer to a course on probability and statistics

1.7.2.1. Inductive Logic Argument Forms

- Here are a couple examples of inductive logic argument forms
  - Statistical syllogism
  - Statistical induction
  - Analogy

1.7.2.2. Statistical Syllogism

- **Statistical Syllogism**: drawing a conclusion about an individual based on the population as a whole. Below is the formula for this argument, and example of it, and the fallacy associated with it:
- Form:
  - Premise 1: n percentage of a population has attribute A
  - Premise 2: x is a member of that population
  - Conclusion: Therefore, there is an n probability that x has A

1.7.2.3. Statistical Induction

- **Statistical Induction**: drawing a conclusion about a population based on a sample. Here are the details of this:
- Form:
    - Premise 1: *n* percent of a sample has attribute A
    - Conclusion: Therefore, n percent of a population probably has attribute A

1.7.2.4. Analogy

- **Analogy**: drawing a conclusion about one individual based on its similarities with another individual. The following are the details
- Form:
    - Premise 1: Objects *x* and *y* each have attributes A, B and C.
    - Premise 2: Object *x* has an additional attribute D
    - Conclusion: Therefore, object *y* probably also has attribute D

1.8. Different Levels of logic

- Surface Level
  - Syllogistic logic
    - In the case of syllogistic logic, the logical terms include only the following: ‘all’, ‘some’, ‘no’, ‘not’, and ‘is/are’.
  - Sentential logic
    - In the case of sentential logic, the logical terms include only sentential connectives (e.g., ‘and’, ‘or’, ‘if…then’, ‘only if’).
- Deep Level
  - Predicate logic
    - In the case of predicate logic, the logical terms include the logical terms of both syllogistic logic and sentential logic.

1.9. Subjective v. Objective

- **Objective**: independent from the particularities of a specific instance or individual
- **Subjective**: conditional on the particularities of the individual
- Difference between objective and subjective:
    - An objective statement can be proven true or false (similar to a proposition) through generally accepted methods for validity (e.g., utilizing valid argument forms)
    - A subjective statement cannot be proven true or false through generally accepted methods for validity
- Examples:
    - Subjective: opinions, expressions of feelings, beliefs
        - “My favorite burger is the whopper from Burger King”
    - Objective: true or false
        - “It rained yesterday”

1.10.1. Causality

- **Causality**: The relationship between two or more things where the change in one or more things provides the conditions for or causes a change in some other one or more things (i.e., the relationship between cause and effect)
- **Axiom of Causality**: proposition that everything in the universe has a cause and is thus an effect of that cause. This means that if a given event occurs, then it is the result of a previous, related event.
- Generally in scientific experiments, determining whether the independent variable has a causal relationship with the development variable (effect)
- **Establishing Causality:** Two general approaches: 1) Linear and 2) Non-linear
- **Linear Causality (A -> B)**: Sequential, direct relationship (bottom-up approach only; lower-level phenomena are seen to cause higher-level events.)
    - **Correspondence**: is there a relationship between the independent and dependent variables?
        - E.g., looking for a correlation
    - **Time precedence**: Did A occur before B?
        - Cause must come before the effect
    - **Non-spuriousness**: eliminating the possibility that the relationship between the independent and dependent variables is caused or influenced by a third or more variables

1.10.2. Causality

- **Nonlinear Causality (A <-> B)**: Bidirectional or multidirectional relationship (e.g., loops)
  - **Cyclical process**: A effects B, and B affects A
    - Although this chain of events leading to feedback may be mediated through several events or over a prolonged period
  - **Lack of Time-precedence**: future events may be causes for present actions
  - **Possibility of Spuriousness**: Effects can be the product of many causes (i.e., multiple variables)
  - It is the relationship between variables that causes effects, rather than one variable acting on another variable

1.11. Abstraction

- **Abstraction**: the process of removing layers of detail such that only the bare essential features of the object that are generic to all entities of that kind are captured. (i.e., making a compact representation of an object or instance)
    - Can use inductive reasoning in abstraction to Identify common attributes and generalize those attributes to all objects of that kind
- **Abstract Thinking**: Applying abstraction to objects and events in the world .
- **Synthesis**: Identifying similarities between objects and associating these objects with an abstraction type
- **Final Abstraction**: a compression of the prior information, thus there should be less information than the original set of objects or instances it is designed to represent
- **Reification**: making something real or concrete (Abstraction also requires retification to make abstraction apply to the real-world)
- **Example**:
    - General features of a dog: Abstraction
    - Specific features of a breed of dog (e.g., rottweiler, golden retriever): Reification

2. Thinking Modals

2.1. Thinking Modals

1. Decentralized Thinking
2. Open Thinking
3. Systems Thinking
4. Design Thinking

2.2.1. Decentralized Thinking

1. What does it mean to be decentralized?
    a. What is permissionless?
    b. What is decentralized thinking?
2. Similar modals to decentralized thinking
    a. Blockchain Thinking
    b. Relational Thinking
    c. Process Thinking

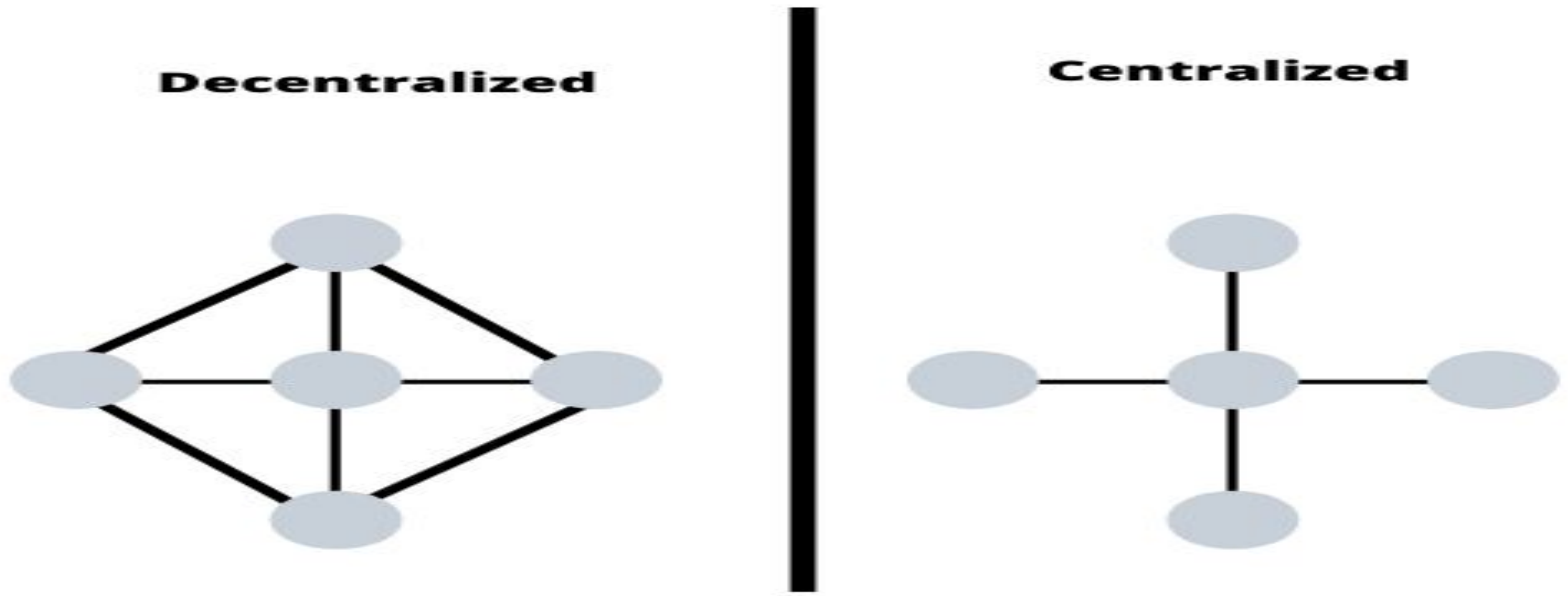
2.2.2.1. What does it mean to decentralize?

- There is not a clear cut definition of decentralization, so for that reason, we will rely on the definition of decentralization from systems theory.
- **Decentralize**: the delegation of authority and decision-making power among multiple agents in a system.
    - **Alternative Definition**: the lack of central control or processing by a centralized authority concerning the decision-making power of multiple agents in which the agents are highly connected to one another and self-organize.
- **Centralize**: the concentration of authority and decision-making power in one or few agents in a system
- Applying this definition (and refer to the slide on abstraction), we can find decentralization in multiple contexts:
    - For example, political decentralization can refer to the movement of giving greater decision-making power to government subdivisions, everyday citizens and their representatives in public affairs (e.g., a representative democracy), while economic decentralization can refer to privatization of goods and services and deregulation of markets (i.e., closer to a free market).

2.2.2.2. What does it mean to decentralize?

- **What are the goals of decentralizing?** Curbing or eliminating the issues caused by centralization
- **What are the general objectives of decentralizing?**
  - Increase agent participation in the decision-making of the system
  - Increase the diversity of agents in the system
  - Increase efficiency of agent actions in the system
  - Improve conflict resolution and address inequities among agents
- **Similar concepts**
  - Peer-to-Peer (P2P) processes
  - Permissionless

What does it mean to be decentralized?



2.2.3. Permissionless

- Once again, we rely on a definition based on systems theory and abstraction for application.
- **Permissionless**: A permissionless system is one in which an agent does not need to be granted access to:
    - 1) enter and leave the system; and
    - 2) implement actions in or cause changes to the system.
- **Permissioned**: A permissioned system is a system where an agent needs:
    - 1) access to enter and leave the system;
    - 2) implement actions in or cause changes to the system; or
    - 3) both

2.2.4. Blockchain

- Blockchain is not only a disruptive technology, it is also a way of thinking that subverts traditionally held notions of our relational dynamics that pushes us towards decentralizing.
- We take our definition of blockchain thinking from the **GiZ Blockchain Lab**.
- **Blockchain Thinking**: “questioning established institutions, cutting out traditional intermediaries and gatekeepers, decentralising and crowdsourcing to the maximum, [and] considering incentives and market mechanisms, in order to find new, more decentralised solutions.”

2.2.5.1. Relational Thinking

- **Relational Thinking**: Focusing on the relations and connectivity between entities, rather than seeing the entities as discrete objects and accompanying properties, (i.e., an object is only meaningful based on its relation to other objects)
  - The relation itself is important, and can serve as the basis for the existence of certain features and properties of the entities
- Two divergent, but needed approaches are the analytic approach and the synthetic approach:
- **Analytic Approach**: examining the entities' properties with disregard to their relations (i.e., reductionist)
  - The relation itself cannot be the cause of phenomena (certain properties, features, and dynamics), instead it must come from the properties of a component part of the system

2.2.5.2. Relational Thinking

- **Synthetic Approach:** examining the entities' properties with regard to their relations (i.e., holistic)
  - The relation itself can be the cause of phenomena (certain properties, features, and dynamics)
- Synergies between entities can be positive or negative.
- **Positive synergy**: " constructive interaction between elements whereby they work together in some fashion to create a combined organization that is greater than a simple summation of the effects in isolation.
- **Negative synergy**: A destructive interaction between two or more elements where the parts work in a counteractive fashion to dampen down or destroy the effects of each other. Negative synergies are typically a product of components failing to coordinate or differentiate Effectively.

2.2.5.3. Relational Thinking

- **Types of relations**
    - Dependent
    - Co-dependent
    - Independent
    - Interdependent
- **Requirements**:
    - **Autonomy**: the elements are autonomous of from each other
    - **Differentiation**: elements differentiate their state or function with respect to each other
    - **Emergence**: “some combined organization that is greater than any of the parts,”

2.2.6. Open Thinking

- Open ("openness"), like decentralization, is an abstraction of model that can be applied in many different contexts.
- Once again for our definition, we shall lend ourselves to the systems perspective. Additionally, we shall also examine the open definition in terms of productive outputs
- **Open Systems**: A system that has external interactions (e.g., information sharing, energy transfer, materials, entities) with an external environment (permeable boundaries, allowing for inflows and/or outflows)
- **Open Content** (From the *Open Knowledge Foundation*): "'Open means anyone can freely access, use, modify, and share for any purpose (subject, at most, to requirements that preserve provenance and openness).'"
- **Common Characteristics of Openness**:
  - **Transparent**: Full information about the open thing
  - **Participatory**: Can meaningfully contribute to the open thing
  - **Free movement**: Can freely join and leave the open thing
  - **Access**: Can enter or view the open thing
  - **Inclusivity**: The more the merrier

Tool: Open and Decentralized Table

	Centralized	Decentralized
Open		
Closed		

You can use this table to help break down entities, actors, and contexts based on their openness and decentralization.

3. Systems Thinking

3.1. Systems Thinking

- Systems Paradigm
- Systems Theory
- Systems Models
- Linear v. nonlinear thinking
- Feedback loops
- Wicked problems

3.2. Systems Paradigm

- **Paradigm**: “A model, perspective, or set of assumptions that form a worldview underlying the theories and methodology of a particular domain.”
- The systems paradigm forms the worldview (basic concepts and axioms) or perspective underlying systems thinking
- **How does the systems paradigm differ from other paradigms?** Based on the holistic view (how parts of the system relate to the whole)
    - The whole or system is “the most appropriate frame of reference for understanding something.”
- **Why do we need a paradigm?** To answer the fundamental philosophical questions before we can engage in reasoning and scientific inquiry (Ultimately, the answers we can derive from the conceptual framework):
- **Systems theory**: Balance analytical and synthetic (holistic and reductionist) reasoning
- **Subjective v. Objective**: Traditional scientific paradigms are focused on objectivity with little to no regard for subjectivity. Systems thinking turns this on its head by also focusing on subjectivity, in addition to objectivity because all systems thinking sees knowledge as the product of interaction between the conceptual system by individuals and the objective phenomenon being observed

3.3. Holism v. Reductionism

- Holism and Reductionism are two paradigms about how to view, interpret and reason about the world
- **Holism**: understand the parts of the system in reference to the whole system
    - Common Features:
        - The properties of the parts cannot explain the properties of the whole
        - The whole has priority over the parts
    - **Synthetic reasoning**: Knowledge is derived from reference to the greater context, rather than the elementary components
        - “While synthesis means the combining of constituent elements into a single or unified entity.
    - **Nonlinear Causality** (downward causation): focus on how whole macro-level affects the constituent parts
- **Reductionism**: understand the parts of the system in reference to the elementary parts of the system
    - **Analytical reasoning**: Breaking down a complex entity into constituent elements
    - **Upward causation**: How the lower-level parts cause higher-level functioning
            - Refer to linear causality

3.4. Synthesis v. Analysis

- **Synthesis**: "Process of reasoning that describes an entity through the context of its relations and functioning within the whole system that it is a part of."
- **Key steps**
    - Environment: Identify the system the entity of interest is a part of
    - Functioning: How whole system functions through its network of connections
    - Interrelations: How the parts are interrelated and arranged to function within the system
    - Can form the basis for creative thinking (i.e., thinking outside of the box)
- **Analysis**: Refer to the slides on Abstraction
- **Key steps**
    - Isolate: Decompose into constituent parts in controlled environment
    - Properties: Determine the properties of the constituent parts
    - Combine : Recombine constituent parts into one system
- **Insights**
    - Analysis: Reveals the "structure of a system and how it works,"
    - Synthetic: "reveals why the system behaves as it does."

3.5. Emergence

- **Defined**: when novel features and properties arise that cannot be described solely from the parts of the system
- Form of nonlinear pattern formation
- **Patterns**: any form of correlation between the states of elements within a system.
- Systems theory is interested in the study of patterns more than the study of parts.
- **Robustness**: A function of the number of relations and the strength of the correlations between the elements.
    - When there is no correlation then the system is random.
    - If all the parts are interconnected and change exactly with all the others, then we have a strong or robust pattern.
- Emergence leads to the creation of order
    - Can be understood in terms of the correlations or symmetry between the parts.
    - It is easier to create ordered systems from symmetry because data can be compressed to a small set of data and transformation. Contrariwise for asymmetry.
- Complexity lies at the intersection of symmetry and asymmetry which “create[s] a pattern that has order but is also somewhat random and chaotic”

3.6. Types of systems

- **Simple System**: Symmetric (One or many symmetries)
- **Complicated System**: No symmetry
- **Complex System**: Interaction between symmetry and asymmetry
- **Autopoietic** (i.e., Self-creating): system that creates itself (parts maintain the pattern and constitute the elementary parts of the system)

3.7. Simple Rules

- Most complex systems are derived from simple rules
- Agents in complex systems act in accordance with basic rules
- Feedback loops help to create emergence by amplifying some local pattern or behavior by pushing the system into a particular configuration

3.8.1. Unpredictability and Irreducibility

- Emergence is generally unpredictable because it comes from the feedback between the system and its environment
- There are two (2) types of emergence: Weak and Strong
- **Weak Emergence**: any emergent process that given enough information, can theoretically be simulated by a computer.
    - Novel features and properties may emerge within a system that could not have been predicted a priori. However, once they have emerged it is possible, at least in theory, to derive them from underlying component parts.
- **Strong Emergence**: are ones that cannot be derived, even in theory, from a full understanding of the properties and interactions of the component parts on the lower level.
    - The higher-level emergent properties and features must then be understood as a whole in terms of the macro- level dynamics without referring to micro-level mechanics.
- **Irreducibility**: Emergent properties form synergies cannot be oversed in local subsystems, but only from global view of the system

3.8.2. Unpredictability and Irreducibility

- **Integrative Levels**: In such a way emergence creates a system with two or more distinct and irreducible patterns of organization
    - As components combine to produce a larger functional whole in hierarchical series, new properties emerge, and one cannot explain all of the properties at one level from an understanding of the components at the level below.
- Features of Integrative Levels
    - Higher levels depend on lower levels as building blocks
    - Number of elements is reduced as levels increase because of synthesis
    - Increasing sequence of levels leads to increased complexity
- New descriptive categories are necessary for the different levels when referring to phenomena that involve emergence.
    - As emergent macro-level phenomena cannot be described within the vocabulary applicable to the parts;
    - these emergent features require new terms and new concepts to categorize them.
- Optimal means of prediction is a computer simulation

3.9. Systems Hierarchy

- **Hierarchy in Systems Theory**: Describing emergent pattern where smaller subsystems form part of a larger system that forms a larger supra-system
  - Central to explain interaction between levels and their ordering (i.e., integrative levels)
- **Encapsulation**: How smaller subsystems are encapsulated or nested within larger structures
  - Hierarchical encapsulation
    - Achieved through abstraction
    - Central to structural design of complex systems
      - fundamental pattern of functioning ordered systems of complexity, as it works to distribute components out across different levels.

3.10. Micro-Macro Dynamic

- Stems from emergence and hierarchical structure
  - **Emergence**: New levels and structures that bound and constrain shape of the system
  - **Hierarchical structure**: Provide enabling structure (differentiated components to perform various structural and functional roles) for new levels to process resources .
- Complexity dynamic develops between the lower levels and higher levels
  - Macro (higher-levels) need to constrain and control the micro (lower-levels) in order to enable higher-level processes creates a complex dynamic between the micro and macro levels, as they become interdependent.

3.11. Feedback Loops

- **Feedback loops**: describe a relationship of interdependence over time, meaning what happens now is going to affect what happens in the future.
    - Focus on nonlinear causality
- **How this works in a linear system**:
    - Input -> Output
        - Output does not affect future input
            - Product of independence between states over time
- **How this works in a nonlinear system**:
    - Input <-> Output
        - Output does affect future input
            - States over time are interdependent

3.12. Process Thinking

- **Process Thinking**: interpreting events in terms of the processes of change that create them. It focuses on the nonlinear dynamics of change over time that create certain patterns out of which events emerge.
    - Considerations: Process thinking involves considering phenomena dynamically (concerning movement, activity, events, change and temporal evolution).
- **Process Philosophy**: based on the premise that *being* is dynamic and that the dynamic nature of *being* should be the primary focus of any comprehensive account of how the world works.
    - A view of reality in terms of ceaseless process, flux, and transformation rather than as a stable world of unchanging entities.
- **Food for thought**: Consider the lifecycle of a plastic bottle versus the end product at each stage of the life cycle (or simply, the plastic bottle itself)

3.13. State of Becoming

- Nonlinear system
  - Emergence:
    - Process through which new entities become formed
    - No clear endpoint or state of the system or object
  - No predetermined set of states. Current state sets the context for future states
- Linear System
  - Finite amount of interacting components
  - Predetermined set of states

3.14. Type of Change

- Nonlinear/Emergent processes
  - **Qualitative Change**: Change in the system arises from changes in structure and functioning of the whole which leads to qualitatively new behavior and features
    - Cannot quantify from the properties of the parts
    - Regime shifts change the structure and functioning of the whole which results in qualitatively new behavior and features.
- Linear Processes
  - **Quantitative Change**: Change is within the properties of the parts and is quantifiable

3.15.1. Integration v. Differentiation

- Integration and Differentiation represent two different stages of the evolution of a system
- **Differentiation**: process whereby an integrated system becomes divided up into more specialized, well-defined parts. Through differentiation, what was originally a homogenous system becomes a heterogeneous system.
    - **Specialization**: the formation of separate individual subsystems enables those components to focus more intensely on a particular function or activity. Thus allowing them to become more efficient at this activity than if they had to perform a large number of diverse activities.
    - **Adaptability**: as it allows for more variation within the system to respond to the variation in its environment.
- **Integration**: process whereby diverse elements become combined or synthesized into a whole system.
    - Those elements that are best suited to the whole system and the system's purpose are selected for by the environment as the system becomes reintegrated.
    - Bringing component subsystems into one system and ensuring the system achieves its intended purpose requires the development of new layers of abstraction that can accommodate the diversity of the differentiated components that are being interrelated; this however also works to reduce their autonomy, in order to align them with the functioning of the whole system.

3.15.2. Integration v. Differentiation

- **Dialectic Development**: interplay between differentiation and integration in the evolution of a system
    - Differentiation and integration enable and create each other
        - Integration can only take place when there are different parts, likewise, differentiation can only occur through integration into a larger organization because elements that remain autonomous are required to perform multiple functions to maintain themselves within their environment.

3.16.1. Wicked Problems

- **Wicked Problem**: a problem that lacks clarity in both aims and solutions because of many interdependent factors that are often incomplete, difficult to define, and in flux.
- These problems are subject to real-world constraints that prevent multiple and risk-free attempts at solving.
- **How to solve?** Use systems thinking, design thinking and a deep understanding of stakeholders to help develop interventions (solutions may not exist) to the caveat of issues that may arise from proposed solutions

3.16.2. Wicked Problems

1. The ten (10) characteristics of wicked problems as described by Horst Rittel and Melvin Webber in *Dilemmas in a General Theory of Planning*:
   a. “There is no definitive formula for a wicked problem.
   b. Wicked problems have no stopping rule, as in there’s no way to know your solution is final.
   c. Solutions to wicked problems are not true-or-false; they can only be good-or-bad.
   d. There is no immediate test of a solution to a wicked problem.
   e. Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.
   f. Wicked problems do not have a set number of potential solutions.
   g. Every wicked problem is essentially unique.
   h. Every wicked problem can be considered a symptom of another problem.
   i. There is always more than one explanation for a wicked problem because the explanations vary greatly depending on the individual perspective.
   j. Planners/designers have no right to be wrong and must be fully responsible for their actions”

4. Modelling

4.1.1. Models

- **Model**: a model is an abstract and compact representation of some phenomena that enables us to conceptualize and communicate its basic structure and dynamics in a coherent fashion
- **Purpose:** To better understand systems in the real world. Generally, real world systems are too complex to grasp as a whole and we often only interact with small subset of the subsystems of a system.
- **Modelling Process**: Abstraction to create simplified representation of real world phenomena
- **Perspectives**: How to interpret an entity
- **Why do models need perspectives?** An effective model must capture and integrate diverse information, perspectives and views of a particular phenomenon to give us a vision of the whole system and basic understanding of its primary constituent parts and relations
- **Are models facts?** Models are not facts, thus there are no correct or incorrect models. They are simply more or less useful opening on what they enable us to see and inhibit us from seeing An effective model balances simplicity from abstraction with the breadth and scope of the multitude of perspectives on the system.

4.1.2. Models

- **What makes an effective model?** This depends on the number of parameters we want to define. Nonetheless, an effective model should have explicit assumptions about phenomena since models only represent subsets of all possible phenomena and assumptions are needed for elements and systems outside of our focus of interest
- **What are the limitations of models?** Models constrain our perception so if a model is improperly or poorly developed such that it does not include all relevant perspectives and information, we can be blind to what should be obvious and necessary for success, and can even lead to nonsensical results.
- Incomplete models used in the world can “at best be partially successful, and at wrose, a potentially dangerous situation.”
- It is best to be explicit about the limitations of a model and work “to develop more robust models whose foundations are clearer, scope broader and better match the data”

Key Takeaway

- Finally, a key thing to remember when working with theories and models is that they are necessarily a 1-for-1 representation of the real world, they simply help us to better clarify and structure our thinking; to become aware of our assumptions and point of view, which itself is of huge value.

5. Design Thinking

5.1. Overview

- **Design Thinking**: A design methodology for problem-solving
- Helpful with complex problems, ill-defined or undefined problems
- The 5 steps of Design Thinking:
    a. Empathise,
    b. Define (the problem),
    c. Ideate,
    d. Prototype, and
    e. Test.

5.2. Empathise

- **Goal**: gain an empathic understanding of the problem you are trying to solve.
- Part of the process of empathizing requires you to engage with the people and the physical and social environment that is the area of concern, and consulting with experts in that area.
- This helps with finding your own personal biases and assumptions and finding insight into users and their need

5.3. Problem Statement

- **Goal**: Synthesise observations from the Empathise stage to define core problems.
- Preferably, problems should be defined in a human-centered manner
- Also consider ideas for features to solve the problems or help users resolve the issues themselves with minimum difficulty

5.4. Ideation

- **Goal**: Identify new solutions and alternative perspectives to the problem
- Can be achieved by using ideation techniques such as Brainstorm and Brainwrite
- Best to get as many ideas as possible.

5.5. Prototype

- The team will investigate the solutions developed in the previous step by implementing the solutions by prototyping inexpensive products.
- **Goal**: identify the best possible solution for each problem identified and how real users will interact with the end product and the constraints of the product
- The solutions implemented as prototypes are either accepted, improved and re-examined, or rejected on the basis of the users' experiences.

5.6. Test

- Designers rigorously test the complete product using the solutions identified during the prototyping phase in an iterative process
- During this testing phase, the results help redefine the problem(s) and inform the understanding of the users
- Alterations and refinements can still be done to rule out solutions and gin a deeper understanding of the product and its users.

5.7. Non-linear approach

- This five-step process is often carried out in a nonlinear fashion in practice.
- Additionally, the five steps are not necessarily sequential, and should be viewed as different modes that contribute to the project.

6. Supplementary Materials

6.1. Supplementary Materials

1. Prototyping the Ad Hoc Hotel & Casino