

SYSTEMS ENGINEERING

Systems Analysis & Design

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2025-I



Outline

- 1 Basic Concepts |
- 2 Human Activities |
- 3 Cibernetics and Technology)
- 4 Teams-Based Structure as a System |



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What is Systems Engineering?

- **Systems Engineering** is a discipline that studies the design, implementation, and maintenance of complex systems.
- This discipline is based on interdisciplinary fields, such as control engineering, industrial engineering, software engineering, mechanical engineering, electrical engineering, organizational studies, project management, and others.
- **Systems Engineering** is a holistic approach to engineering that focuses on how to design and manage complex systems over their lifecycle.



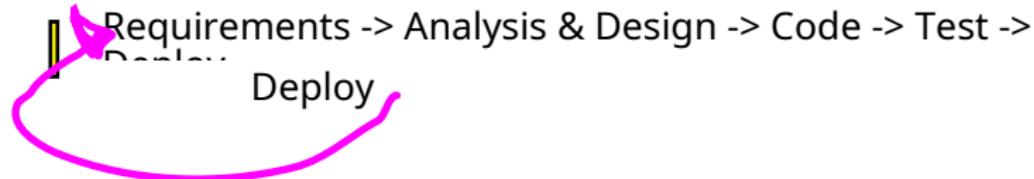
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Systems Engineer as a Professional

- A **Systems Engineer** is a professional who is responsible for **designing, implementing, and maintaining complex systems.**
- A **Systems Engineer** must have a broad understanding of engineering, mathematics, science, and technology.
- A **Systems Engineer** must be able to analyze and solve problems in a systematic and holistic way.



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Xerox



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Human Activities

- Human activities are complex systems that involve multiple components, interactions, and feedback loops.
- Systems Engineering can be applied to understand, analyze, and improve human activities.
- Systems Engineering can help us design and manage complex systems such as organizations, cities, economies, and societies.



live - 3 → live
live < 3 → dead
> 3 → dead
dead → 3 → live



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7 1000 0.1
7:05 0. 0.3

Algorithmic
Trading



Human Activities: Complexity

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- Interactions are key to understanding and improving human activities.
- Organizations are complex systems that involve multiple departments, teams, and individuals.



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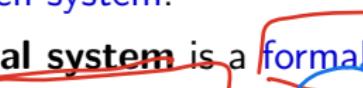


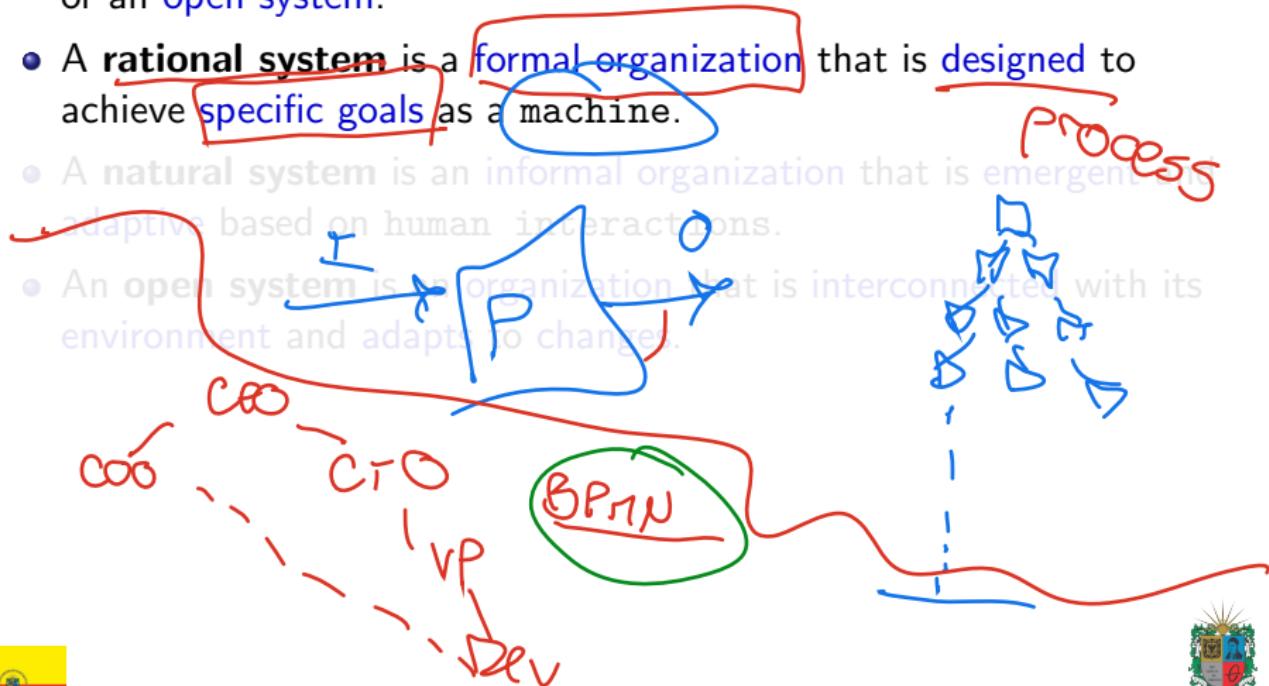
Organizations as Systems

- **Organizations** can be viewed as: a rational system, a natural system, or an open system.
- A **rational system** is a formal organization that is designed to achieve specific goals as a machine.
- A **natural system** is an informal organization that is emergent and adaptive based on human interactions.
- An **open system** is an organization that is interconnected with its environment and adapts to changes.



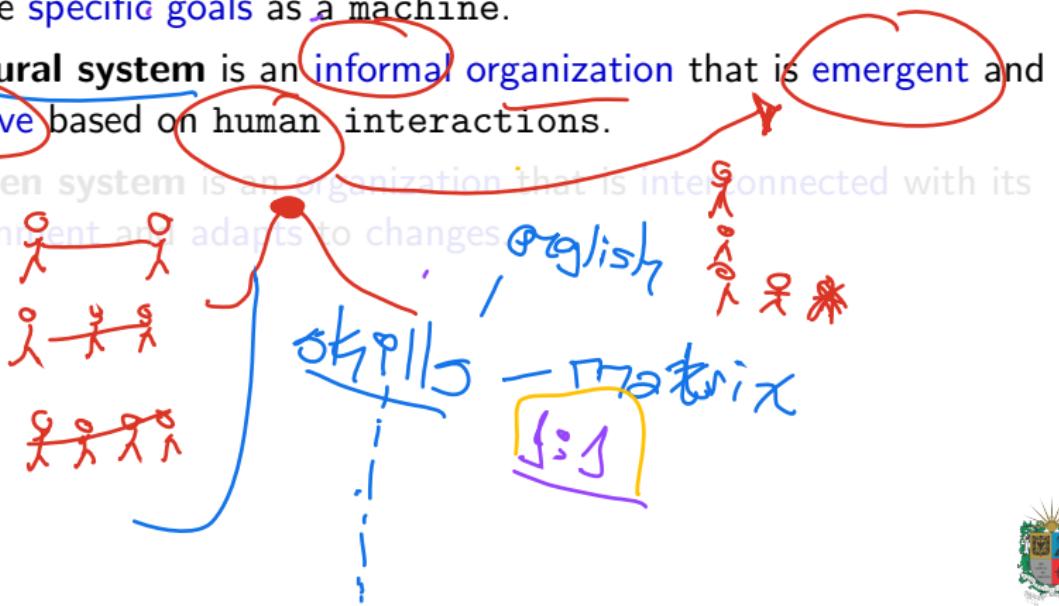
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Ψ - 3000



Sinergy

- **Sinergy** is a simple but powerful concept: the aim of the parts is more than the parts itself.

- It means the interactions would boost the capabilities of the parts of the system. Also, it lets both understand emergent behaviors and define improvements in systems.

- One of the main concepts is the theory of computation.
Based on graphs, you could define a computational machine.

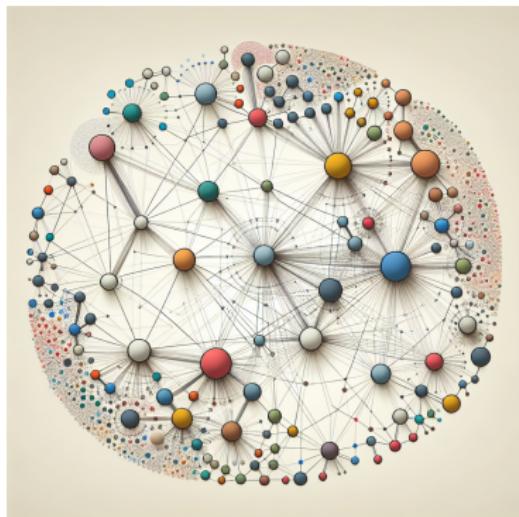


Figure: Prompt: Define a draw of clusters in social networks.



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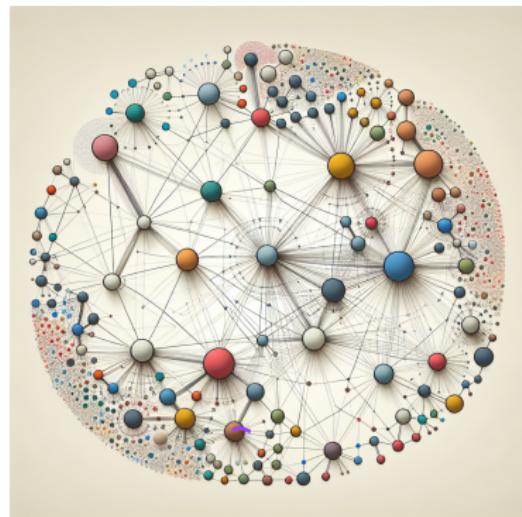


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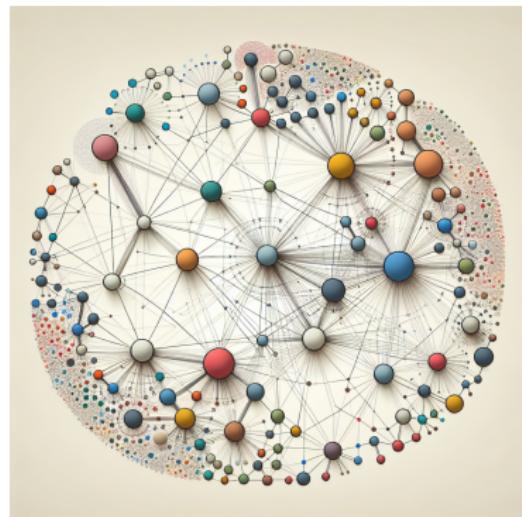


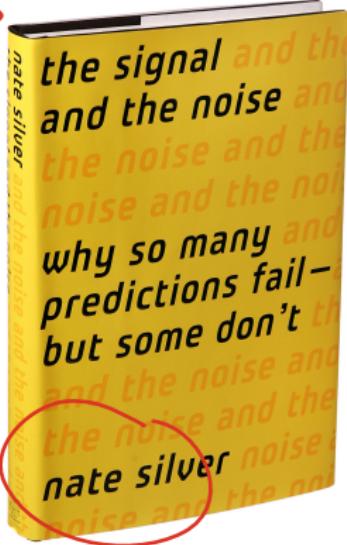
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Synergy: Money Ball

A child's drawing of a basketball court. The court is outlined in blue ink. A large circle at the top left contains the word "Athletics" in red and "S-T-G" in blue. A large circle at the bottom right contains the letters "T-H-E". There are several stick figures: one in a circle on the left, one near the top center, one in a circle on the right, one on the far right, and one near the bottom center. A large circle on the right side contains a stick figure and the letters "J-H-S".

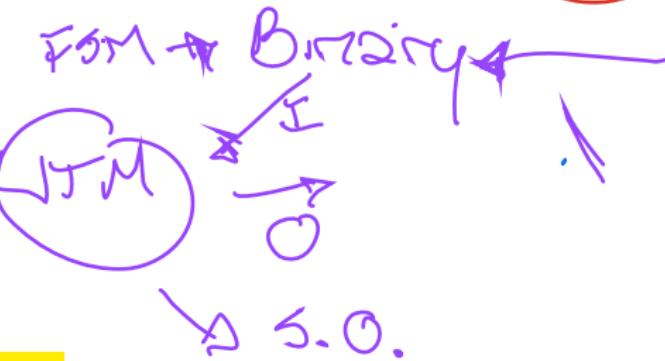
The Outliers



Talking with Machines!

Alongzo Chomsky (-18-26)

- ↳ Babbage Machine
- ↳ State Machine



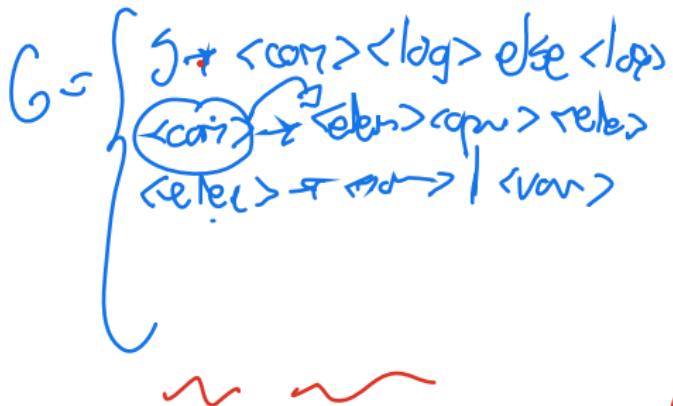
- Alan Turing proposed a hundred years ago an Universal Machine, capable of take any algorithm defined as a state machine, and process it in a binary language.

- Following after Noam Chomsky proposed the CFG based on generative grammars. Here is where the high-level programming languages appear.

Algorithm → FGM
Machine



Talking with Machines!



- Alan Turing proposed a hundred years ago an Universal Machine, capable of take any algorithm defined as a state machine, and process it in a binary language.
- Forty years after, Noam Chomsky proposed the formal languages based on generative grammars. Here is where the high-level programming languages appear.



Programming Languages

- Programming Languages with more capabilities, easier comprehension had been created. Also, more people start to code into specific domain programming languages.
 - Andrej Kaparty, hero in Tesla Company and now in Open.AI said: nowadays, english is the more important programming language.
 >> 03

~~C++ / Java~~

8-17

C++ / Java

$x > 5 ? \text{True} : \text{False};$

Python

true, if $x > 5$ else false

maternal language



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2023
copilot → codex



Applications of Systems Engineering



IPv6

- Systems Engineering can be applied to understand, analyze, and improve complex systems.
- Systems Engineering can be applied to design and manage complex systems such as organizations, cities, economies, and societies.
- Systems Engineering can be applied to design and manage complex systems such as software, hardware, and networks

Optimization

- * Genetic algorithm
- * Reinforcement learning

shutterstock

Vision

math

algorithms

soon

Rust

COSA

5G

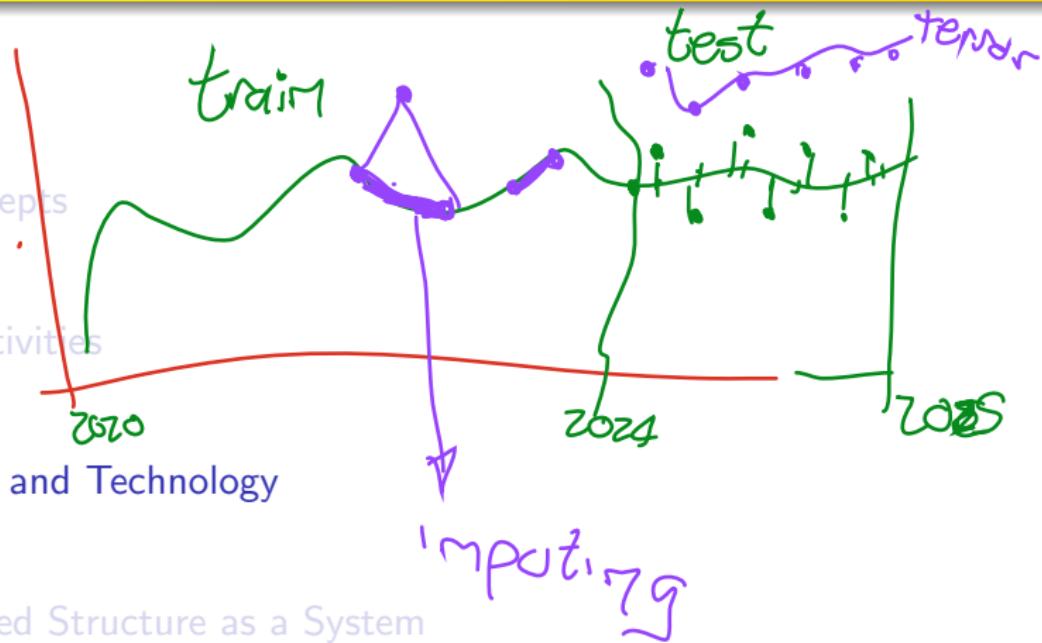
Huawei

Quantum Computer



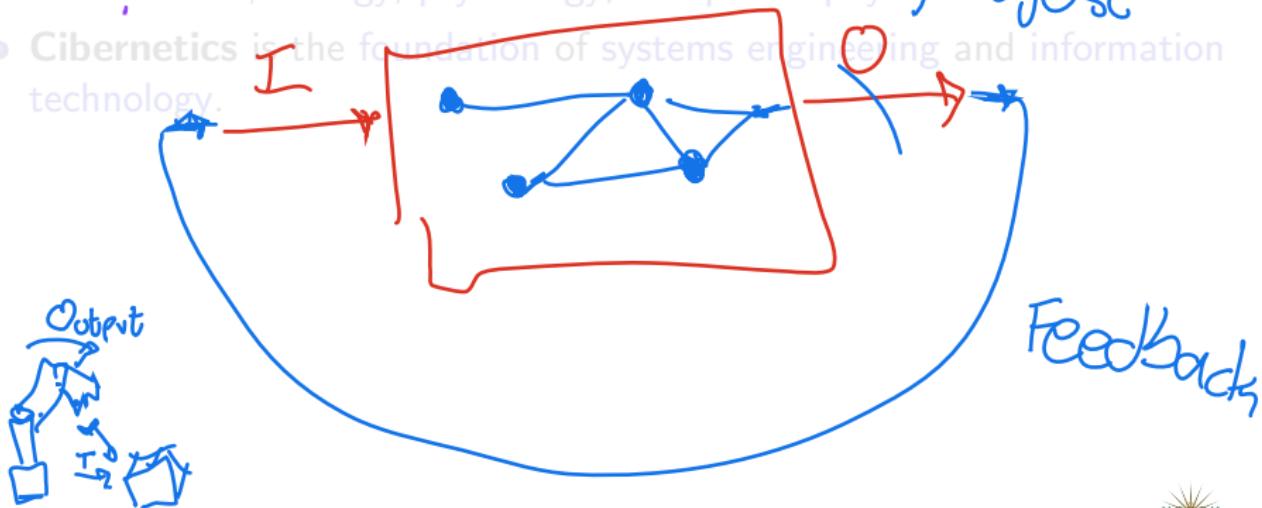
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Cibernetics → Robots

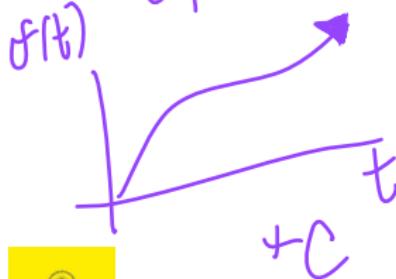
- **Cibernetics** is the study of systems, control, and communication in animals, machines, and organizations.
 - Cibernetics is a transdisciplinary field that combines engineering, mathematics, biology, psychology, and philosophy. *Adjust*
 - Cibernetics is the foundation of systems engineering and information technology. *I*



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derivatives
differential equations



bio-inspirations
robots

kid
learning
less errors

Control
mechanic
electronic
system

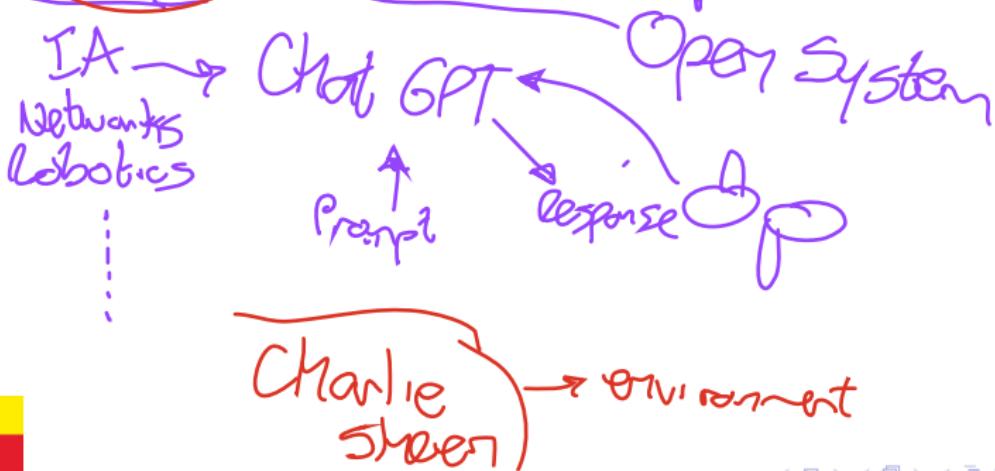
Yarn to
Cotton
Kangaroo



Cibernetics

• Accuracy

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Technology



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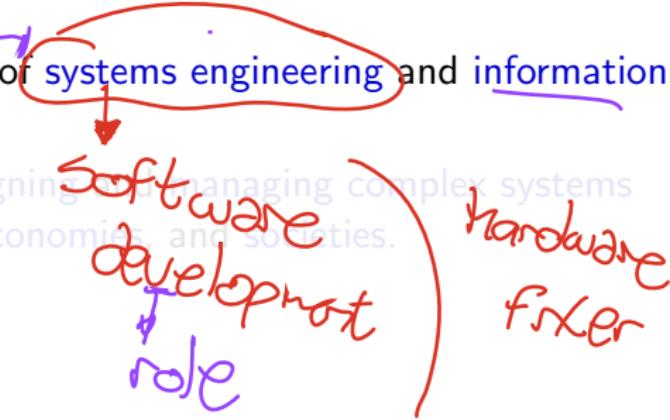
Wall-e *Memory* *weak*

system → multi-objective

sleep 8 hours,
grades ≥ 4.5
eat at lunch
less gap between classes



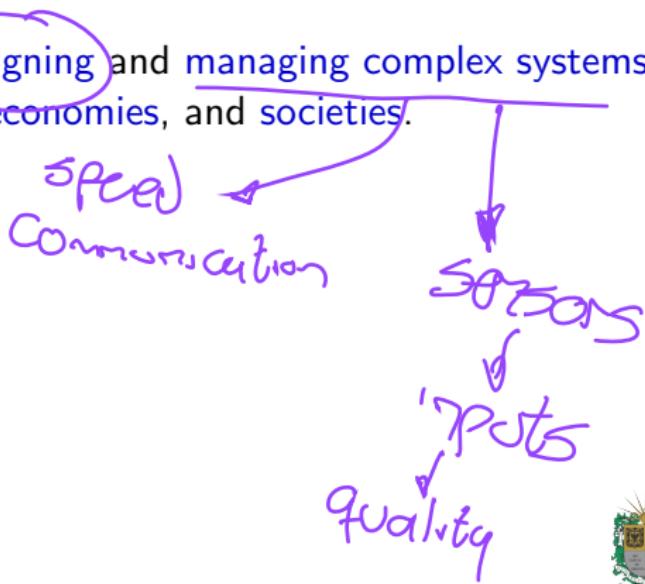
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cell phones
internet
- 



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Technology: AI

Agents

- Artificial Intelligence is a field of computer science that studies how to design and implement intelligent agents.

- Artificial Intelligence is the key to designing and preparing complex systems such as smart-organizations, smart-cities, smart-economies, and smart-societies.

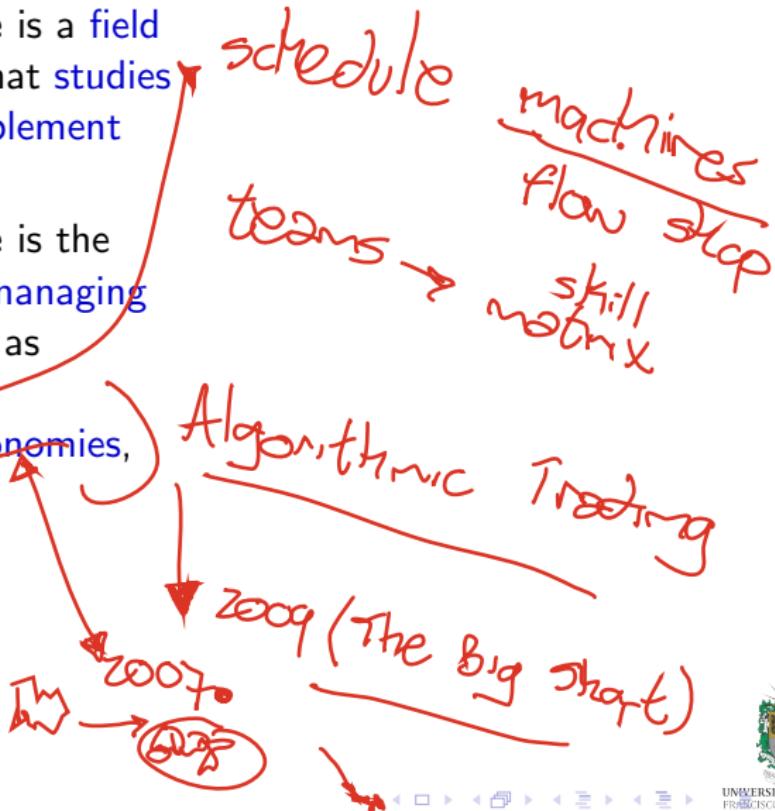


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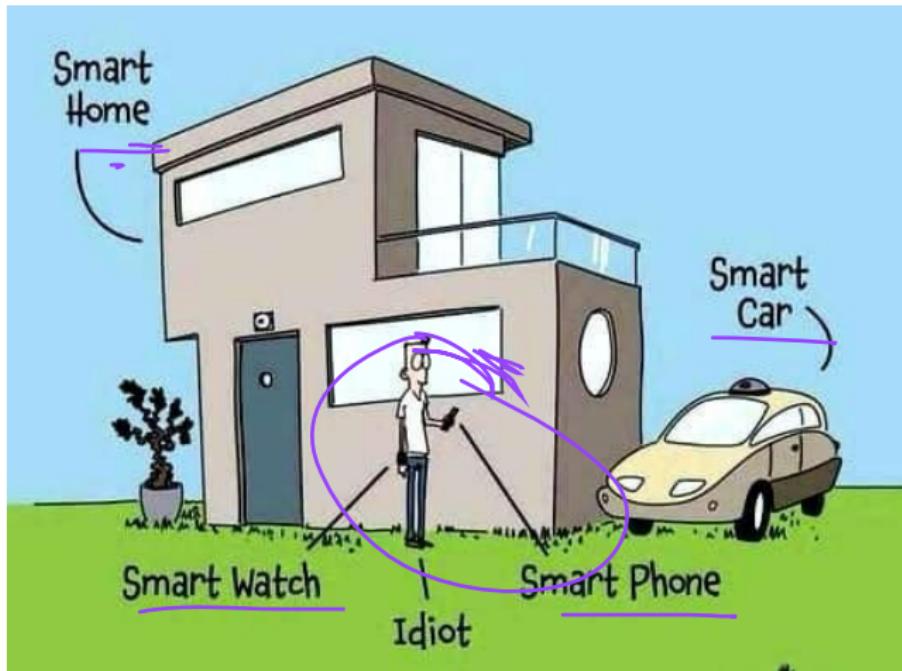
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~~roadway
lights smart~~



Artificial Intelligence **not** as a System

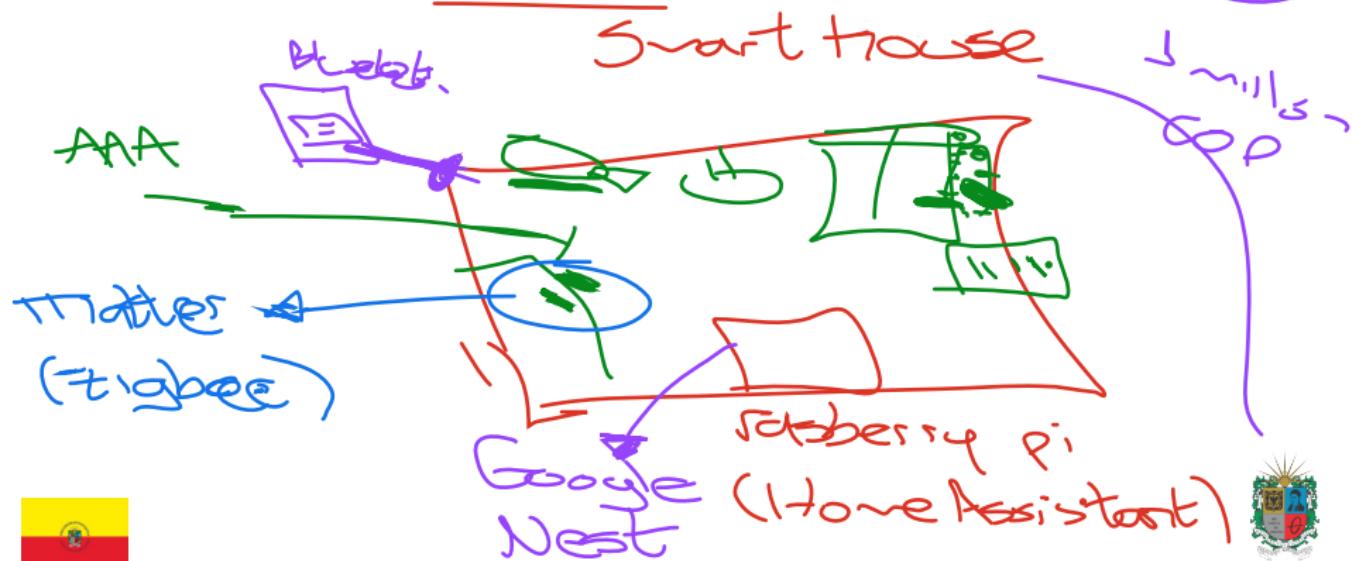


Cibernetics & Technology in Systems Context

Feedback

- **Cibernetics** and **technology** are the foundation of **systems** engineering and **information technology**.
 - **Cibernetics** and **technology** are the foundation of **artificial intelligence** and **smart systems**.

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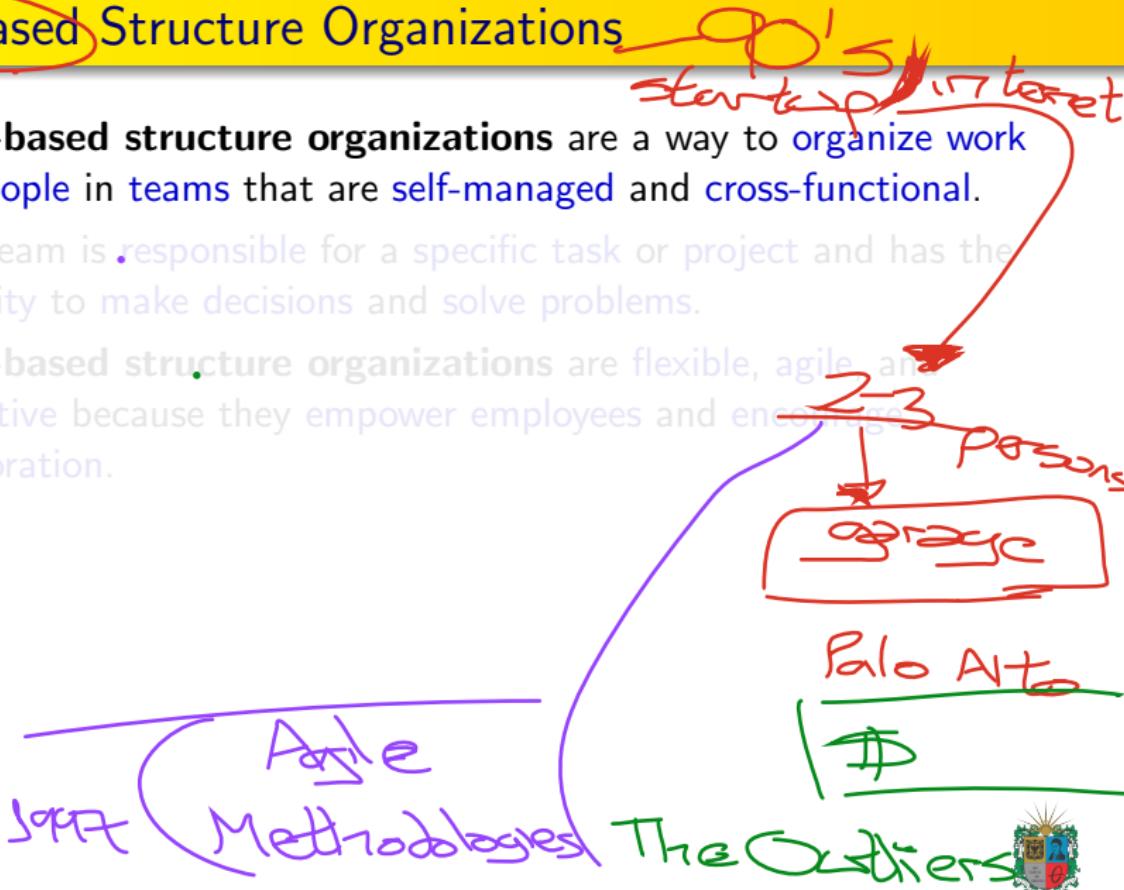
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Team-Based Structure Organizations

- Team-based structure organizations are a way to organize work and people in teams that are self-managed and cross-functional.
- Each team is responsible for a specific task or project and has the authority to make decisions and solve problems.
- Team-based structure organizations are flexible, agile and innovative because they empower employees and encourage collaboration.



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Teams as a System

- **Teams** are a **system** where collaboration (**synergy**) and communication are **key** to **success**.
- Define and automate the processes and procedures in the **team** is a challenge to improve the **team** performance.
- **Teams** are like **a pieces** in a **puzzle**, where each **piece** has a specific role and **responsibility**.



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Soft Skills

- **Soft skills** are **personal attributes** that enable someone to interact effectively and harmoniously with other **people**.
- Typical Soft Skills:
 - Communication skills (verbal and written).
 - Teamwork and collaboration.
 - Problem-solving and critical thinking.
 - Adaptability and flexibility.
 - Time management and organization.
 - Leadership and management.
 - Emotional intelligence.
 - Creativity and innovation.
 - Conflict resolution.
 - Networking and relationship building.
 - Customer service and client management.



Computer Analyst

• Skills:

- Business process modeling and documentation.
- Data analysis and interpretation.
- Requirements gathering and management.
- Stakeholder management.

• Responsibilities:

- Analyzing business processes and identifying areas for improvement.
- Gathering and documenting business requirements.
- Collaborating with stakeholders to define project scope and objectives.
- Creating and maintaining project documentation, such as functional specifications and use cases.
- Facilitating communication between business users and technical teams.
- Participating in system testing and user acceptance testing.
- Providing support and training to end users.



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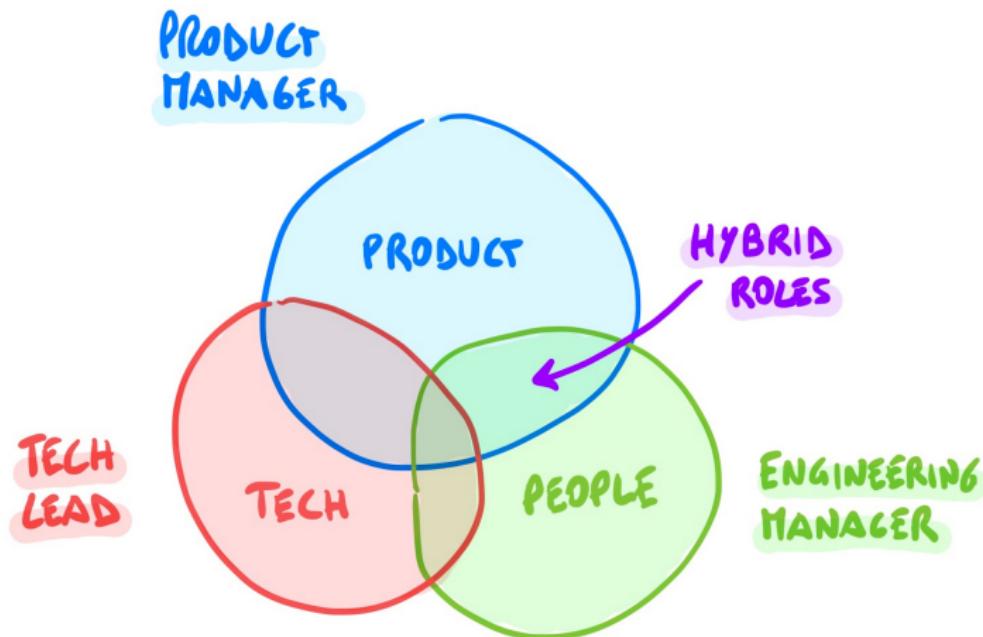
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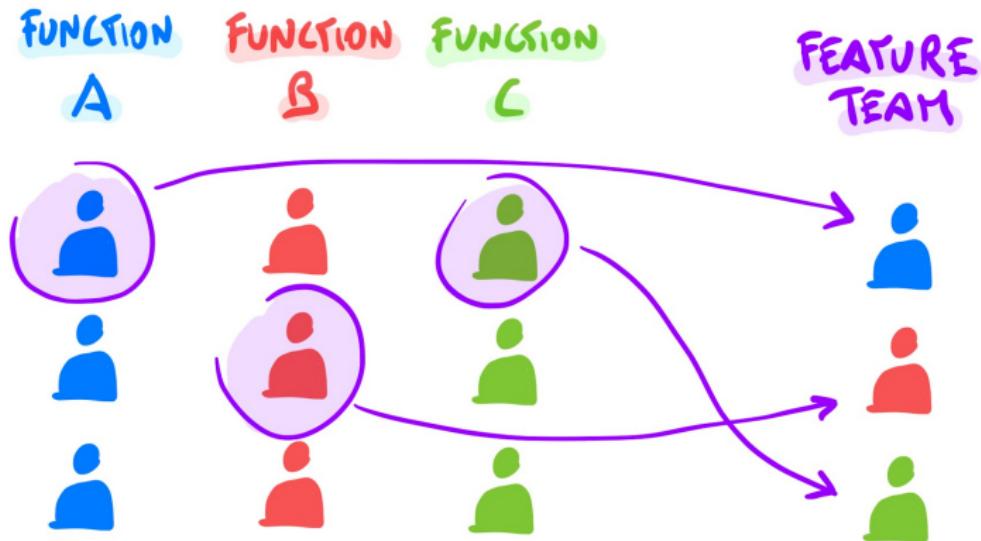
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Tech Company Typical Structure



Feature Teams



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- **Leading** a team is not a **role**. It is a decision, you could be a **leader** anytime and anywhere.
- Teamwork culture is pretty **important**. It creates habits, open communication, safety spaces for inclusion.
- **Psychological safety** is a key point to have an effective team. You could develop *technical skills*, but **it is not enough**.
- **Hierarchy** is very important. Anarchism tends to fail. Hierarchy exists by **status and power**.
- In a hierarchy **experts lead** to make better decisions. However, anyone must be careful to not leave people behind.



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What is to be a leader? II

- With **crystal-clear communications** and clarity about **business goals** and achievements, people feel **more comfortable** pursuing the same **goals as a team**.
- A **good leader** should focus on **outcomes** rather than **outputs**. This helps bring **business value** rather than just complete tasks.
- Failure** is always an option. Learn how to **deal** with setbacks; do not punish — just fix and learn.
- Some believe you're born a leader, while others think that a leader can be developed over time. Either way, **context** and **the desire** for self-growth are vital.
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What is to be a leader? III

- It is important to maintain **psychological well-being**. You will be **stronger**, better able to **help** people, and have a better **perspective** on everything.
- A good leader builds **trust relationships** and has the **emotional intelligence** to communicate effectively and understand others.
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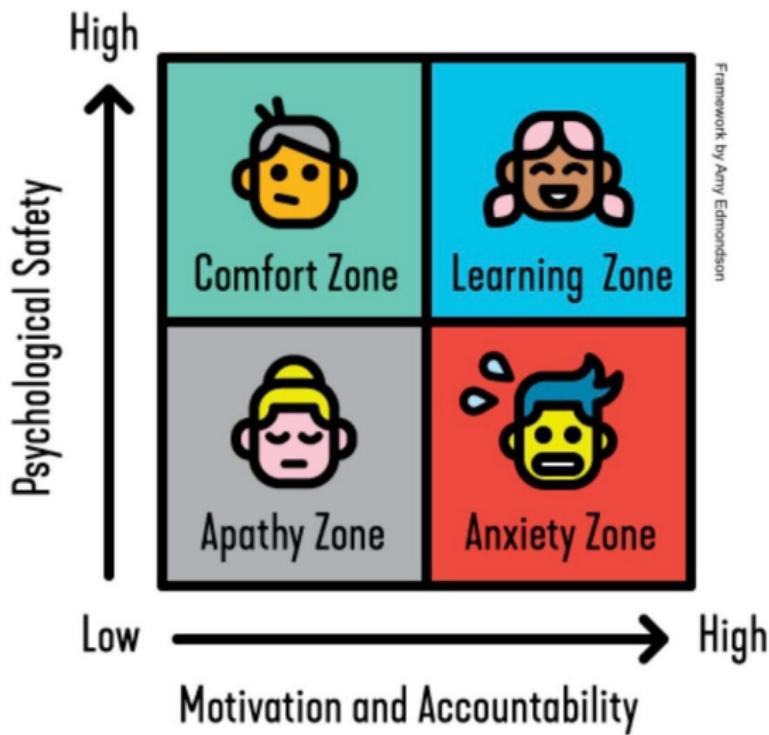


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Working Zones



Framework by Amy Edmondson



Outline

- 1 Basic Concepts
- 2 Human Activities
- 3 Cibernetics and Technology
- 4 Teams-Based Structure as a System



Thanks!

Questions?



Repo: <https://github.com/EngAndres/ud-public/tree/main/courses/systems-analysis>

