

SYSTEMS ENGINEERING

Systems Analysis & Design

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Outline

1 Basic Concepts



2 Systems Engineering



3 Cybernetics 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.



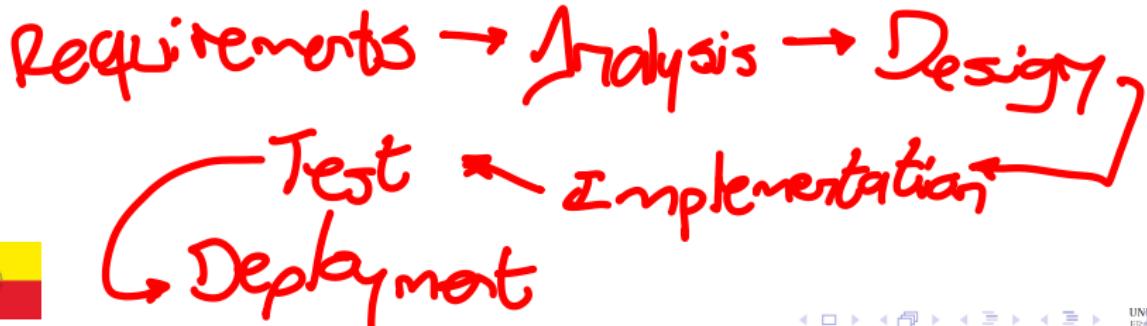
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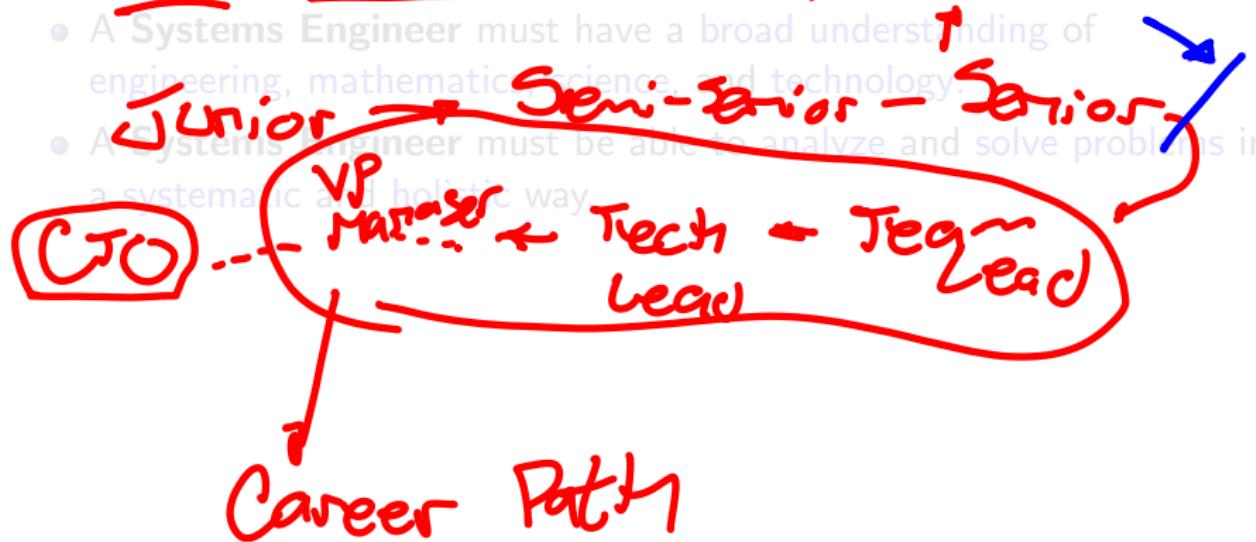
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Systems Engineer as a Professional

- 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.



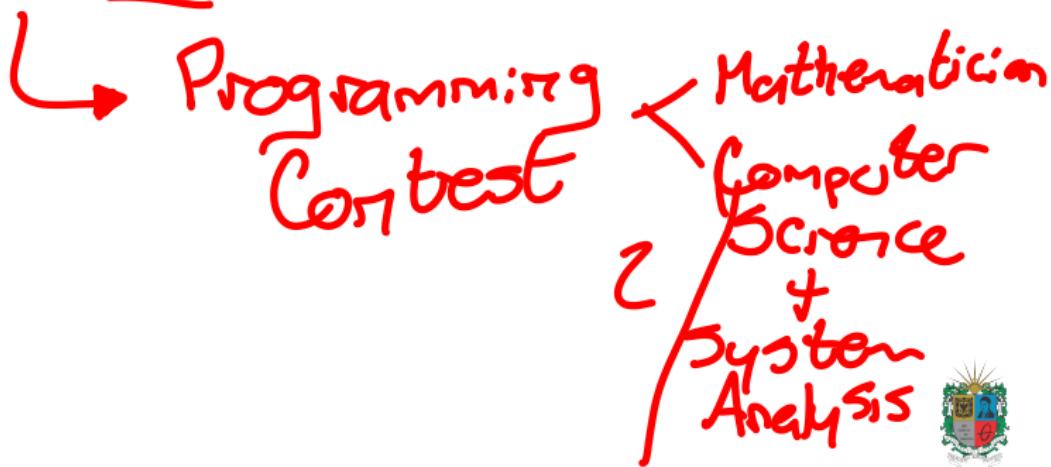
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Human Activities

- 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.

- Interactions are key to understanding and improving human activities.

- For example, organizations are complex systems that involve multiple departments, teams, and individuals.

P.T.O.
Paid Time-off



Human Activities

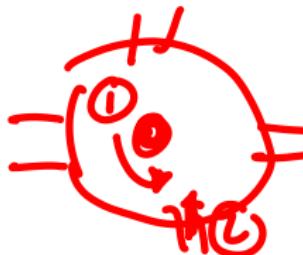
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CTO
CEO



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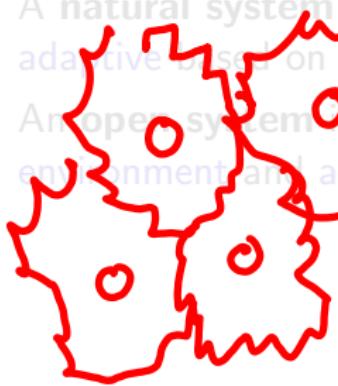
Organizations as Systems

- **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.
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classical

*persons as
an object*



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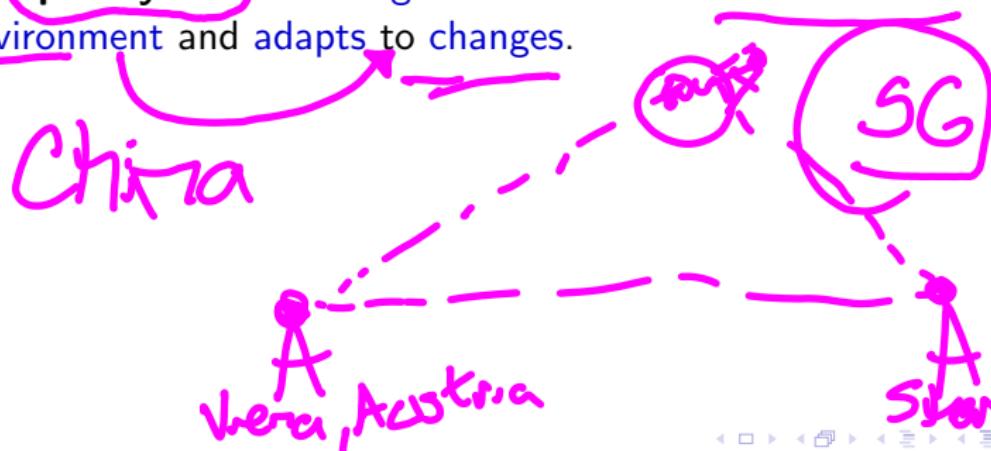
- ↳ remote
- ↳ ideas + innovation

Human Talents → career path
people@empresa.co



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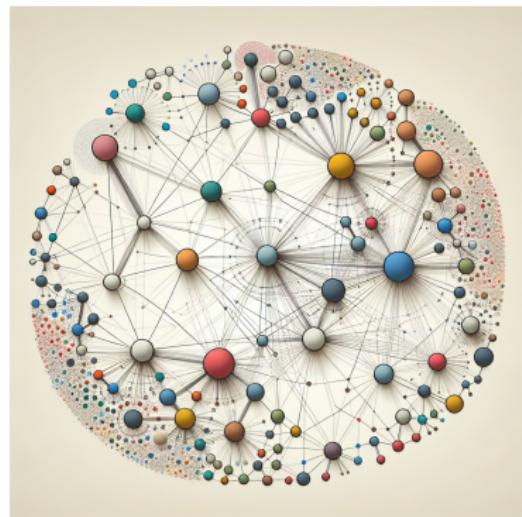
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Synergy

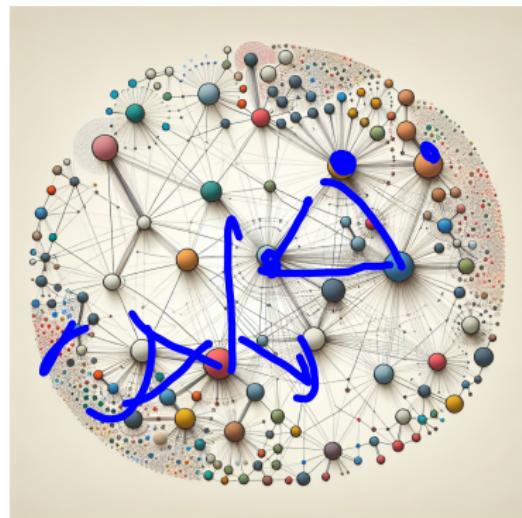
- Synergy is a simple but powerful concept: the whole is greater than the sum of its parts.
- It means the interactions can boost the capabilities of the parts of the system. Also, it allows both understanding emergent behaviors and defining improvements in systems.
- One of the main concepts is the theory of computation. Based on graphs, you can define a computational machine.

→ interactions



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Real Madrid Galácticos: Systems Engineering Case Study

- **Galácticos Era** (2000 — 2006): Real Madrid assembled the most expensive and talented individual players in football history.
- **Star Players:** Zinedine Zidane, Robinho, David Beckham, Luís Figo, Ronaldo, Kaká, Roberto Carlos, ... each a world-class individual performer.
Raul, Guti, Diana
- **Expected Result:** With the best components, success should be guaranteed, right? Watch this video.
- **Real Result:** Only one Champions League in six years, two La Liga titles, but multiple early Champions League exits. Poor team chemistry and lack of system integration despite massive investment.
- **Systems Lesson:** A collection of excellent parts does not automatically create an excellent system. Synergy and integration matter more than individual talent.

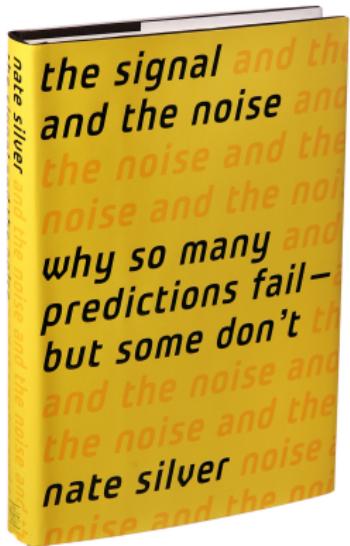


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Synergy: Money Ball



Talking with Machines!

- **Alan Turing** proposed a century ago a **Universal Machine**, capable of taking any **algorithm** defined as a **state machine**, and processing it in a **binary language**.
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Programming Languages

- **Programming Languages** with more **capabilities** and easier **comprehension** have been created. Also, more people started to **code** in specific domain programming languages.

Demo time!

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Applications of Systems Engineering

- **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.



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Cybernetics

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



Technology

- **Technology** is the *application* of scientific knowledge to **solve problems** and **improve systems**.
- **Technology** is the **key** to **designing** and **managing** complex systems such as organizations, cities, economies, and societies.



Technology: AI

- **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 *managing* complex systems such as smart-organizations, smart-cities, smart-economies, and smart-societies.

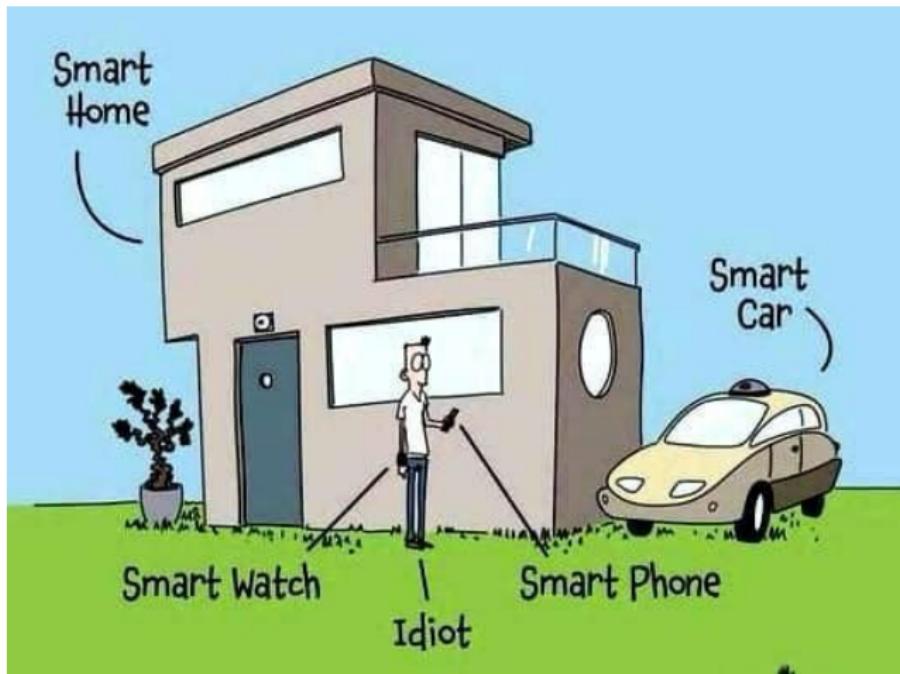


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Artificial Intelligence **not** as a System



Cybernetics & Technology in Systems Context

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



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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**.
- Defining and automating the **processes** and **procedures** within the **team** is a **challenge** to **improve team** performance.
- **Teams** are like **pieces** in a **puzzle**, where each **piece** has a **specific role** and **responsibility**.



"Soft Skills" in Engineering

- **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 — Technical Skills & Responsibilities

• 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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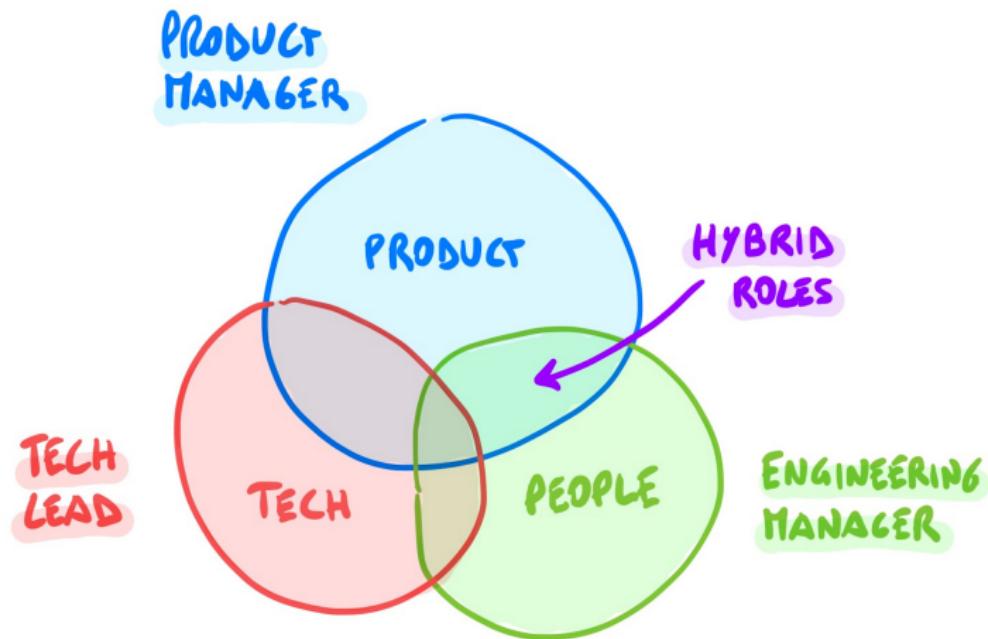
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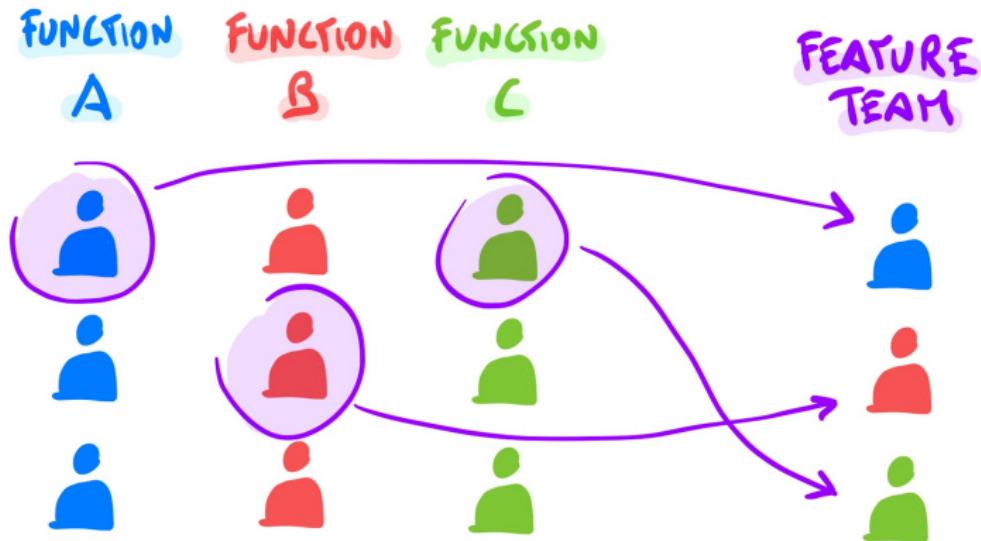
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Technical Team Typical Structure



Feature Teams



What does it mean to be a leader? I

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



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What does it mean to be a leader? II

- With **crystal-clear communication** 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 completing 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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- To develop as a leader, follow the **three C's**: Curiosity, Courage, and Commitment.



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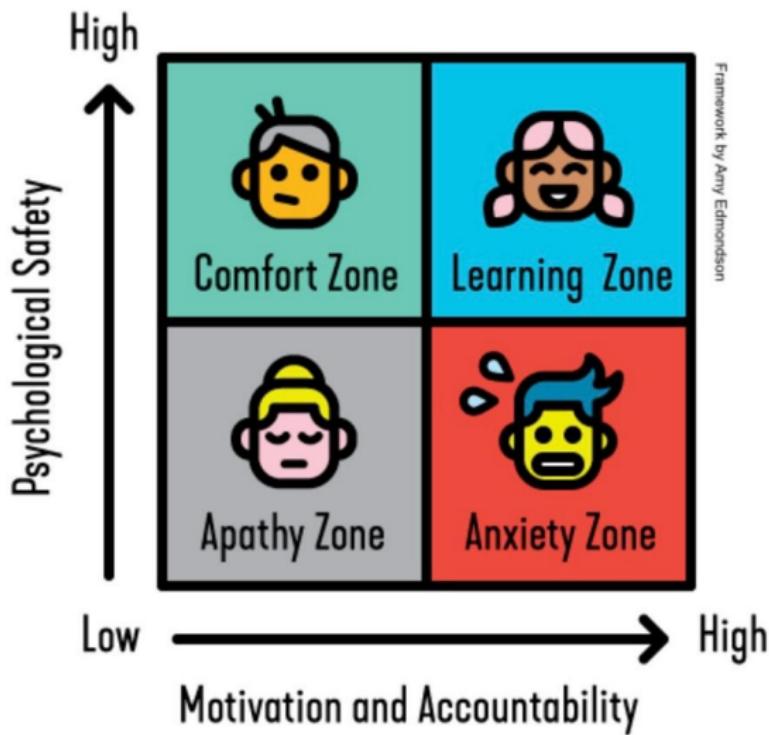


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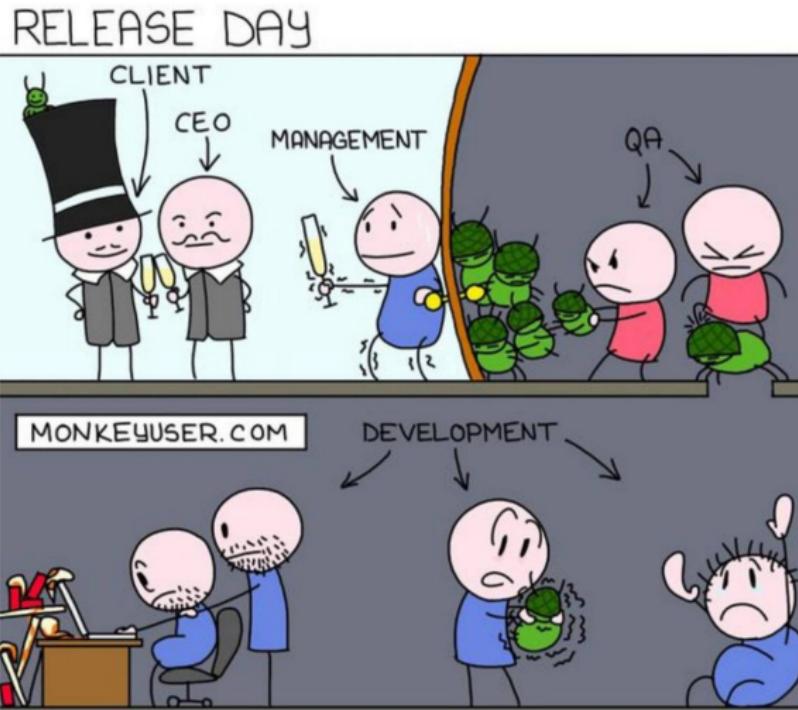
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Working Zones



Real World!



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

