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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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.

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- **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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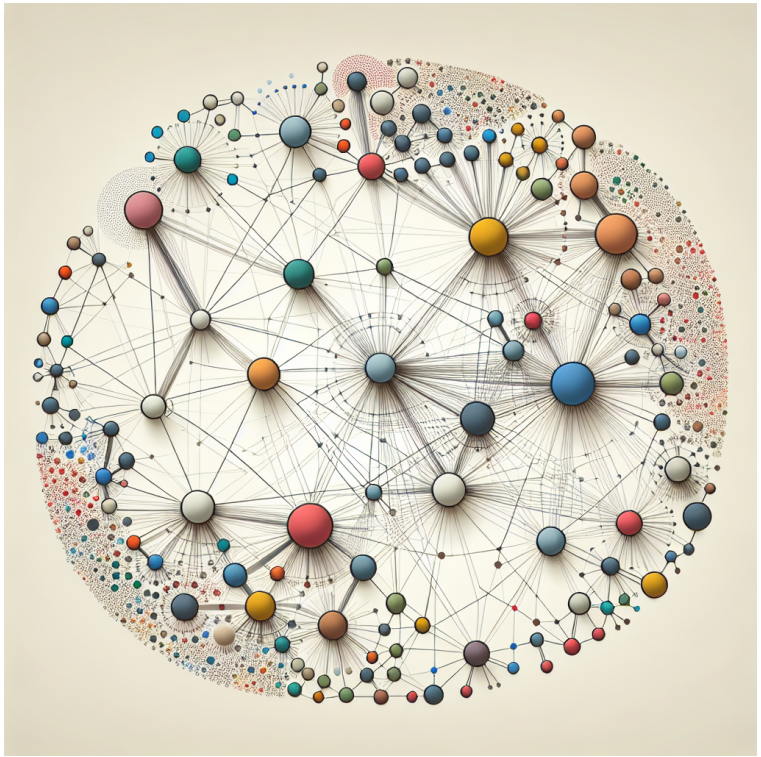
Synergy

- **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.



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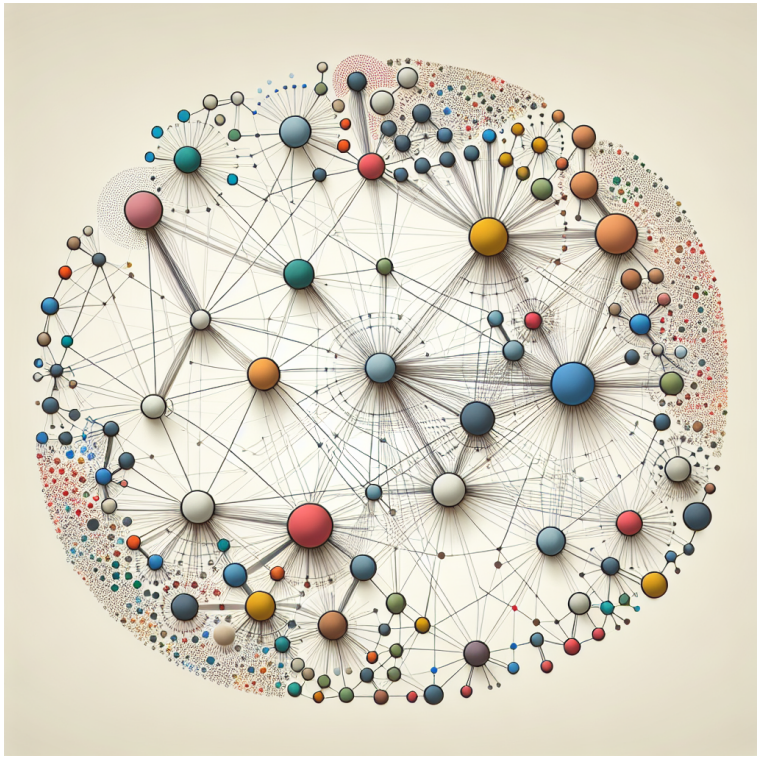

Real Madrid Galácticos: Systems Engineering Case Study

- **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.
- **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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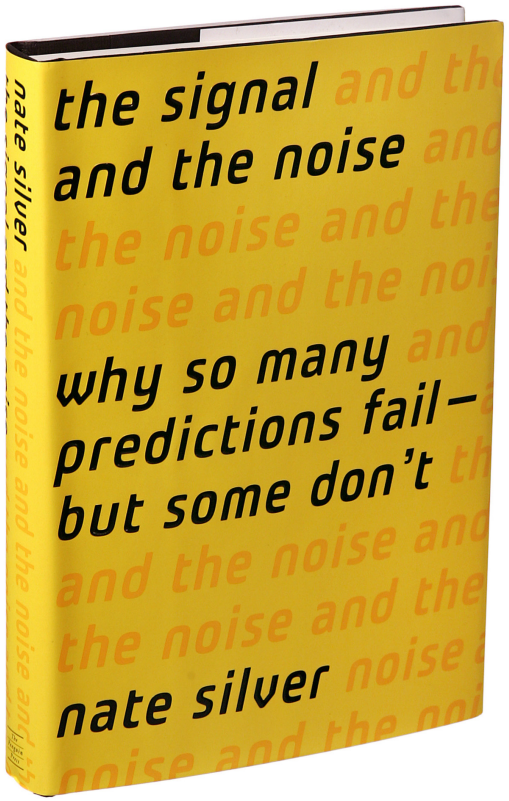
Synergy: **Money Ball**



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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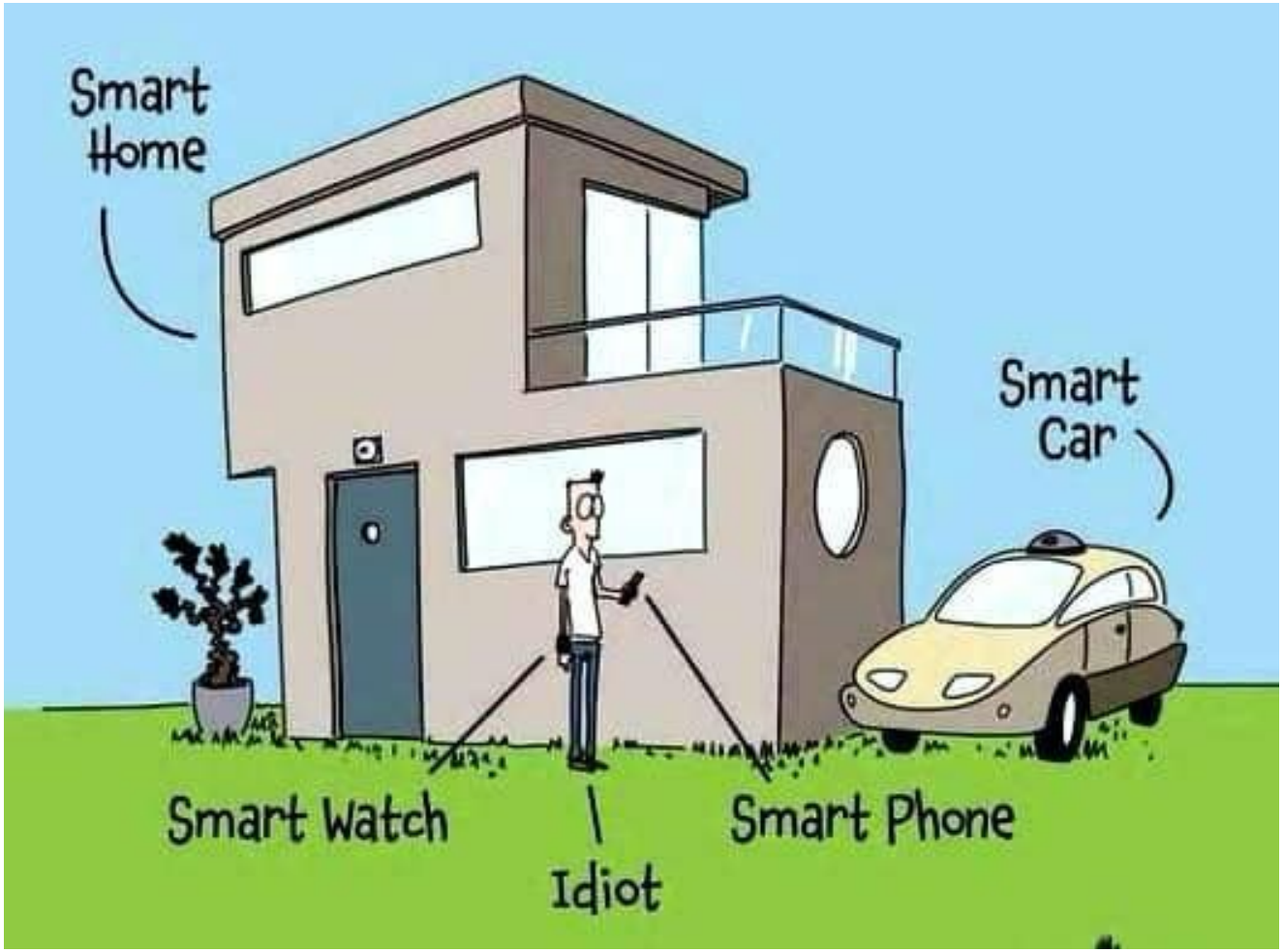
Artificial Intelligence **not** as a System



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.r

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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.

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"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.

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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.
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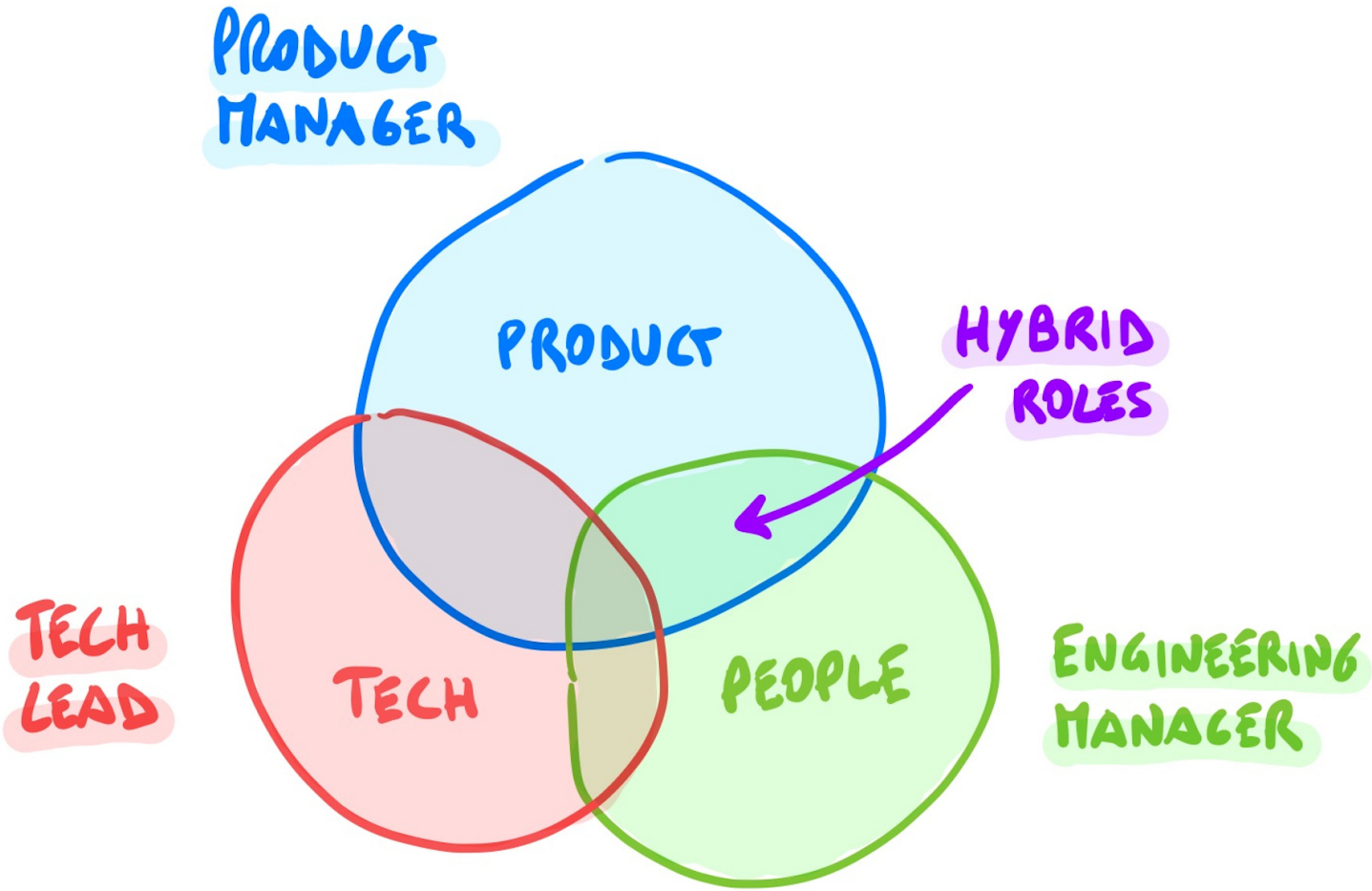
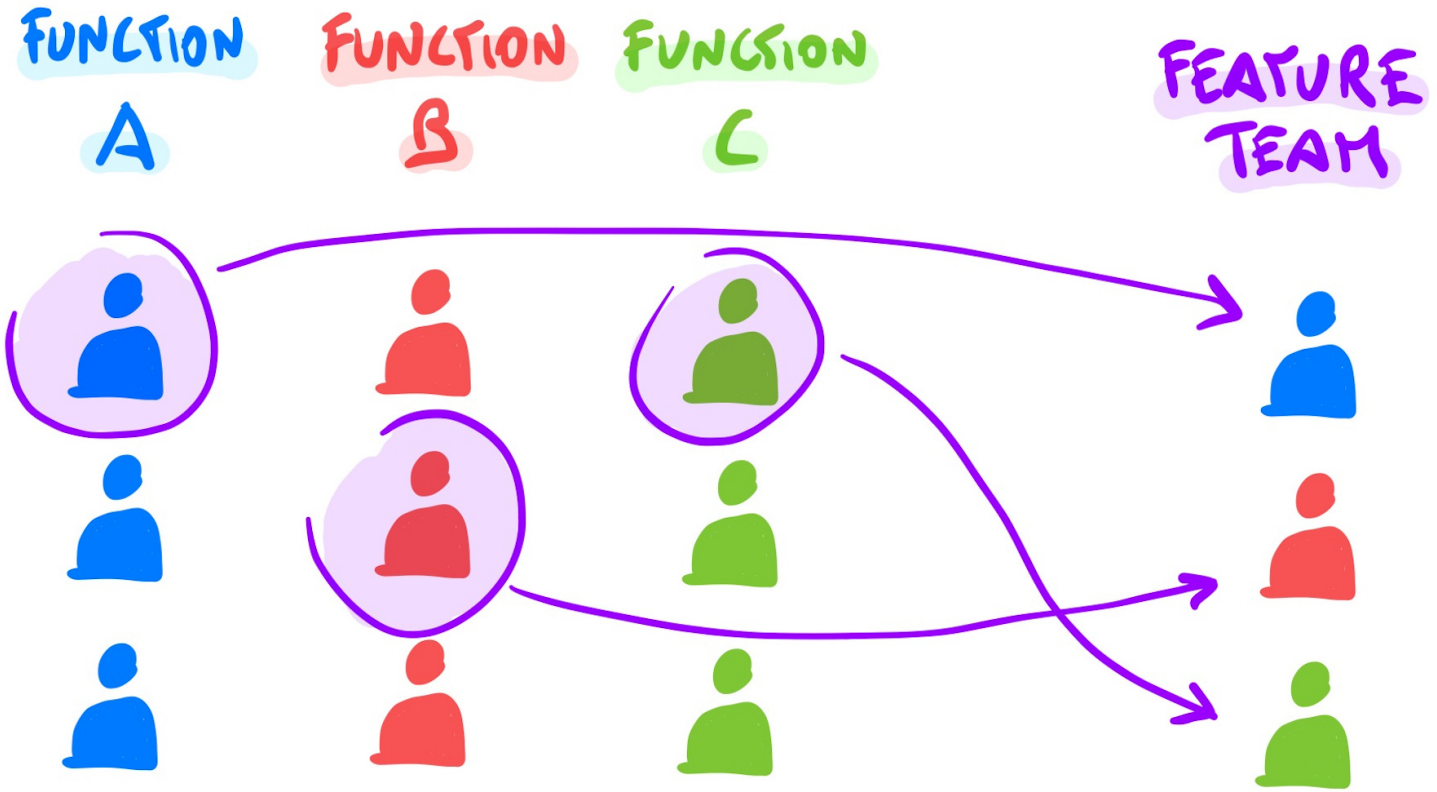
Technical Team Typical Structure



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.
- Making **ethical decisions** is key; it leads to taking the right and **better actions**.

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What does it mean 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.
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- To develop as a leader, follow the **three C's**: Curiosity, Courage, and Commitment.

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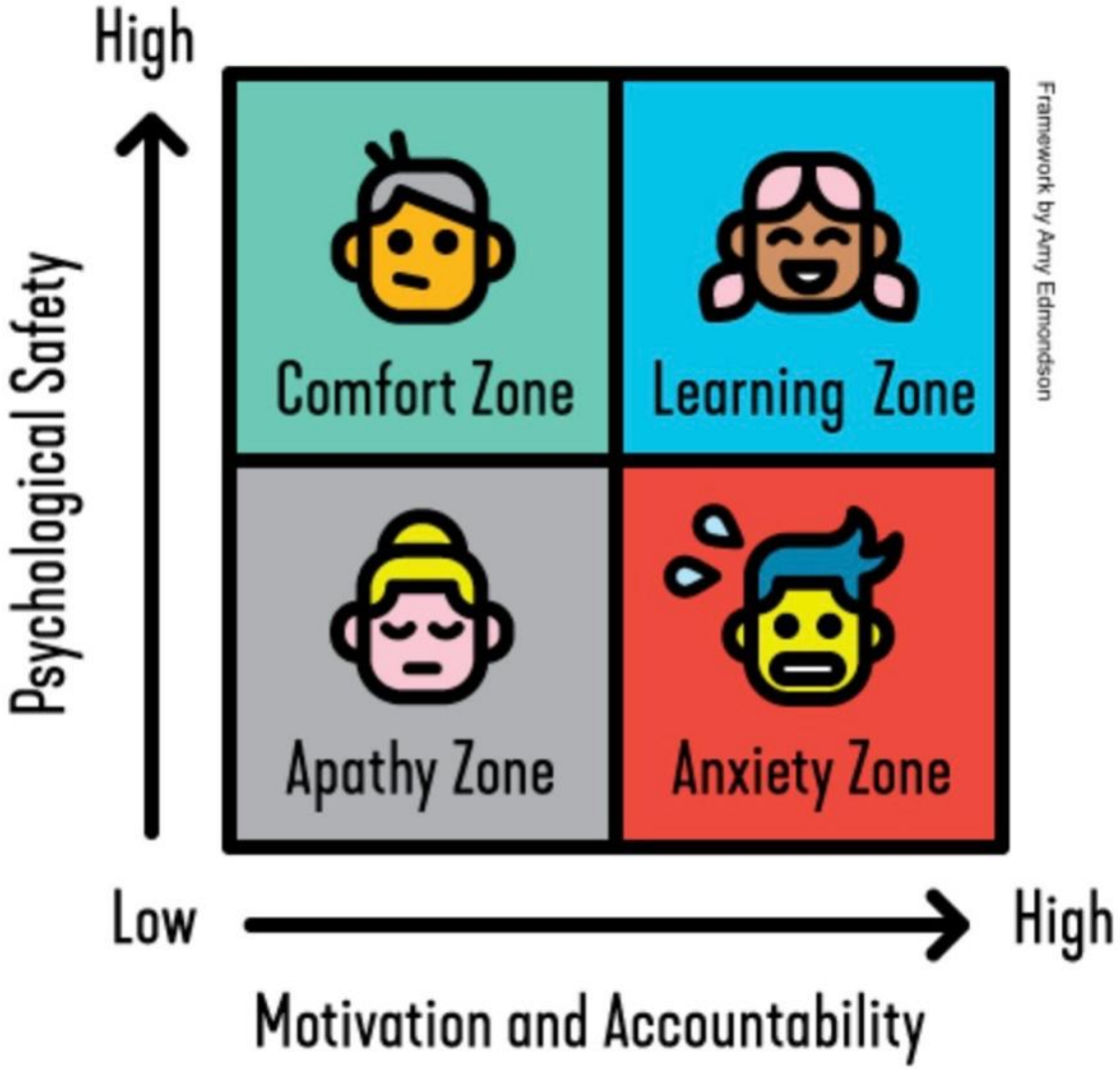
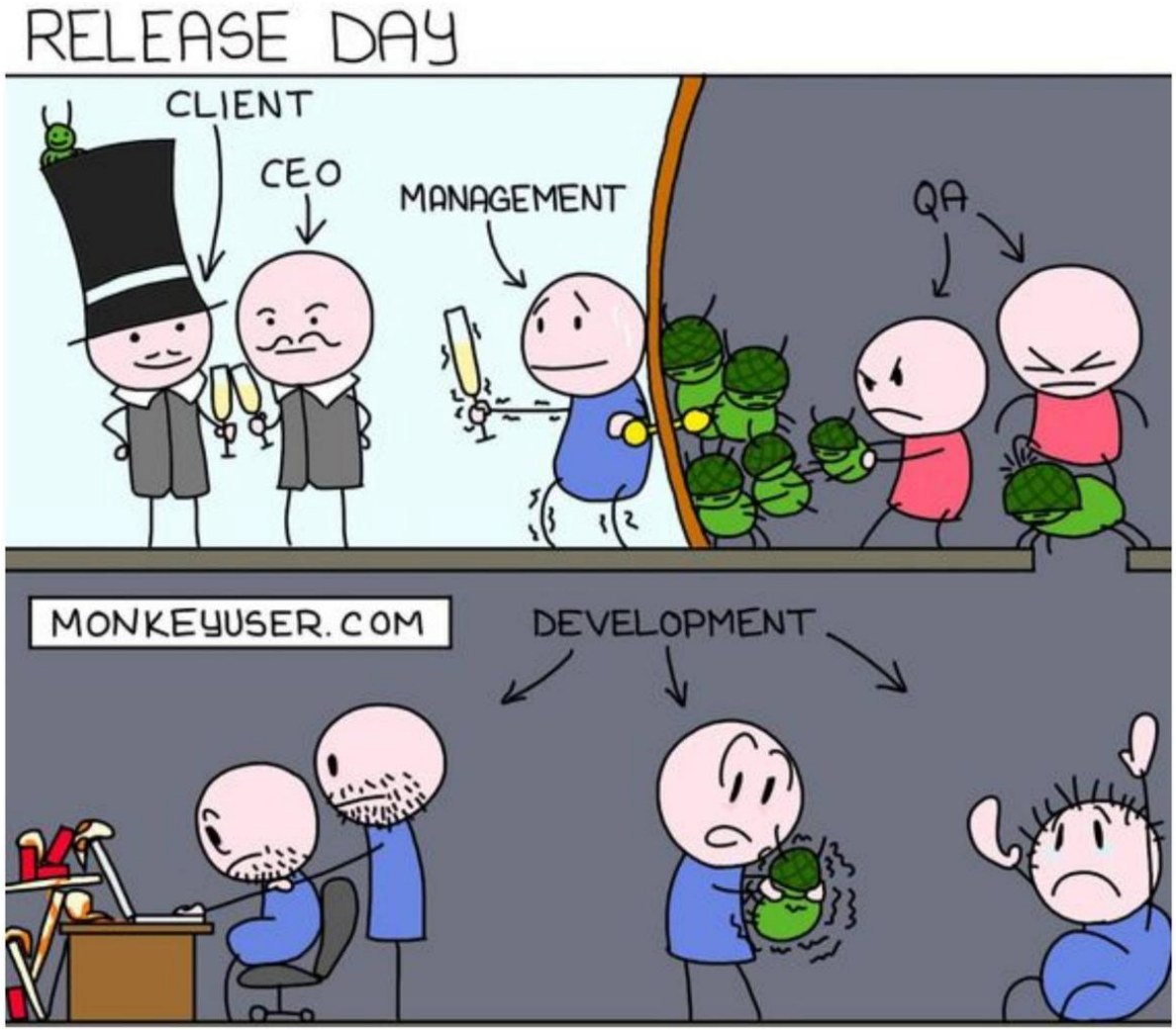
Working Zones



Real World!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Thanks!

Questions?

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