Software Engineering Lab: Directed Energy Weapons (DEWs) Energy Demand Assessment

Lab Overview:

In this lab, you will work in teams to assess energy storage and generation requirements for directed energy weapons aboard SHARKS. You will follow Agile principles to self-organize, gather data, and work through initial designs. Your project will focus on identifying the power requirements for disabling drones and determining breaking points for directed energy weapons under various scenarios. You'll also engage with your professor as a stakeholder, refining your approach based on their feedback.

Objectives:

- Understand and apply **Agile principles** in team settings.
- Collaborate to gather and analyze data related to energy storage for directed energy weapons.
- Design a solution for integrating energy storage configurations aboard Navy ships with pulse power systems.
- Interact with the stakeholder (your professor) to confirm project requirements and direction.

Lab Instructions:

Part 1: Sprint Planning and Requirements Gathering

Goal: Organize into teams, define roles, and gather initial requirements for the project.

1. **Form Teams & Assign Roles** (30 minutes):
    - Divide into **two self-organizing teams**. Each team should assign the following roles:
        - **Scrum Master**: Responsible for keeping the team on task and resolving issues.
        - **Domain Expert**: The go-to person for knowledge about directed energy weapons and Navy ship power systems.
        - **Developers**: Gather data, conduct analysis, and design solutions.
        - **Verifier/Tester**: Ensures the accuracy and quality of the work, and checks for any design issues.
2. **Understand the Problem** (20 minutes):
    - Read through the project background and summary:
      You are tasked with assessing energy demands and storage requirements for

directed energy weapons aboard amphibious assault ships. These ships need to defend against aerial and surface drones using directed energy weapons that generate pulse power loads. Your task is to determine the typical size of drones, how much power is needed to disable a drone, and how long it takes to recharge these energy weapons. Using this information, you'll identify breaking points where the weapon systems might fail to keep up with drone attacks.

3. **Stakeholder Interaction** (30 minutes):
   - Meet with your professor, acting as the **stakeholder**, to ensure you understand the project requirements.
     - Ask clarifying questions about the **drones**, **recharge times**, and **power needs** for directed energy weapons.
     - Confirm your team's data collection approach and focus areas.
     - Revise your problem statement based on feedback from the stakeholder.
4. **Sprint Planning** (30 minutes):
   - Create a **sprint backlog** listing the tasks your team will work on before the next session.
   - Define your sprint goal: **collect relevant data, perform an initial analysis**, and **begin designing** a system to assess energy storage needs.
   - Example backlog tasks:
     - Research drone sizes used in recent military operations.
     - Gather data on the power required to disable drones using directed energy weapons.
     - Identify recharge times for the energy weapon systems.
     - Begin drafting the design for a system that integrates energy storage to support pulse power demands.

Deliverables for Part 1:

- A sprint backlog with clearly defined tasks for each team member.
- A document outlining your understanding of the project, the data you plan to collect, and the approach your team will take.

Part 2: Design & Initial Analysis

Goal: Collect data, analyze it, and refine your initial design for energy storage and weapon configurations.

1. **Data Collection and Analysis** (45 minutes):
   - Using your backlog from Part 1, work on **gathering data** related to:
     - Typical **drone sizes**.
     - The **power required** to disable a drone with directed energy weapons.

        - **Recharge times** for these weapon systems.
    - Remember to bring creativity into your scenarios (don't forget the **sharks with laser beams**!). Consider both **land-based systems (army grunts)** and **shipboard systems** when analyzing data.
2. **Design Review** (30 minutes):
    - Using the data you've gathered, create a **draft design** for an energy storage system that could support the pulse power demands aboard Navy ships.
        - Focus on identifying **breaking points**: How many drones can the system handle before failing? How fast can the energy weapons recharge?
    - Meet with the **stakeholder** (your professor) to review your initial design. Get feedback and make any necessary revisions to your design.
3. **Sprint Retrospective** (15 minutes):
    - Hold a **retrospective** with your team to discuss:
        - What went well during the sprint?
        - What could have gone better?
        - How can you improve your Agile process for future sprints?

Deliverables for Part 2:

- A **technical design document** outlining:
    - Data collected (drone sizes, power requirements, recharge times).
    - Your proposed energy storage system configuration.
    - Identified breaking points (e.g., number of drones that can be taken down before failure, recharge time issues).
- A **retrospective report** detailing what your team learned and areas for improvement.

Background Information:

Scenario Context:

- You are evaluating energy storage needs aboard **amphibious assault ships** to support directed energy weapons that defend against **drones**.
- The **Wasp-class ships** use steam-powered systems with multiple turbines for shipboard power, but new energy weapon systems are generating **pulse power loads** that current power systems may not support.
- Your goal is to **model energy demands** and identify where the ship's energy systems may fail under operational scenarios (e.g., number of attacking drones, recharge times for the energy weapons).

References your domain experts:

- Sylvester, Jeremy E. "Power systems and energy storage modeling for directed energy weapons." Master’s Thesis, Naval Postgraduate School, Monterey, CA, 2014.
- Gattozzi, A. L., J. D. Herbst, R. E. Hebner, J. A. Blau, K. R. Cohn, W. B. Colson, J. E. Sylvester, and M. A. Woehrman. "Power system and energy storage models for laser integration on naval platforms." In 2015 IEEE Electric Ship Technologies Symposium (ESTS), pp. 173-180. IEEE, 2015.
- Auld, Sean, Daniel Camp, Paul Kylander, Nathan Vey, and Jerald Willis. "Battery Usage in the Future Fleet." Master’s Thesis, Naval Postgraduate School, Monterey, CA, 2022.
- Oriti, Giovanna, Alexander L. Julian, Matthew P. Storm, Daniel P. DeToma, and Norma Anglani. "Shipboard Control System Supported by Energy Storage Sizing to Meet the MIL-STD-1399 Limits for Pulsed Power Loads." IEEE Open Journal of Industry Applications (2023).
- Lashway, Christopher R., Ahmed T. Elsayed, and Osama A. Mohammed. "Hybrid energy storage management in ship power systems with multiple pulsed loads." Electric Power Systems Research 141 (2016): 50-62.
- Michnewich, Daniel A. "Modeling Energy Storage Requirements For High-Energy Lasers On Navy Ships." Master’s Thesis, Naval Postgraduate School, Monterey, CA, 2018.
- Woehrman, Lt. Cmdr. Michael A. “Power Systems Analysis of a Directed Energy Weapon System for Naval Platforms.” Master’s Thesis, Naval Postgraduate School, Monterey, CA, 2013.
- Department of Defense Interface Standard, MIL-STD-1399, Section 300, Part 1 Low Voltage Electric Power, Alternating Current, MIL-STD-1399, Sep. 25, 2018.
- Gildemeyer, Scott J., Dale B. Hager, Dean Liensdorf, Adrien C. Malone, Kelly A. Mugerditchian, and Bonnie W. Johnson. " Analysis of shipboard effects and coverage for the integration of a high-energy laser on a LPD 17,” Master’s Thesis, Naval Postgraduate School, Monterey, CA, 2018.