Ministry of Higher Education and Scientific Research, Tunisia

Institute of Technological Studies of Bizerte

License in Electrical Engineering

Computerized Maintenance Management System

&

SCADA System

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To my dear father and mother, this graduation report is dedicated to you.
Thank you for your endless love, guidance, and support.
Every step I took in my education was made possible by the strength and care you both have always given me.
Your encouragement helped me overcome challenges and reach new heights.
I am grateful for the lessons you taught me about hard work, honesty, and kindness.
I hope this work makes you as proud of me as I am proud to be your child.
Thank you for always believing in me.
This achievement is as much yours as it is mine.
I love you both ❤️ .

Acknowledgements

I would like to express my heartfelt gratitude to everyone who supported me throughout this project. I am deeply thankful to my supervisor, , for their invaluable guidance, insightful feedback, and encouragement. Your expertise and support were essential to my progress and learning.

I would also like to thank my professors and classmates at ISET Bizerte for their continuous motivation and collaboration. To my family and friends, your encouragement and understanding during this journey have meant everything to me. This project is a reflection of our shared dedication and hard work.

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General Introduction

Context & Motivations

In industrial environments, unplanned equipment failures and inefficient maintenance processes can lead to significant downtime, production losses, and increased operational costs. Traditional maintenance management often relies on manual fault reporting and reactive interventions, which result in delayed responses and ineffective resource allocation. To address these challenges, digital maintenance solutions have been increasingly adopted, combining SCADA systems with CMMS (GMAO) applications to provide real-time fault monitoring, automated reporting, and optimized maintenance workflows.

A SCADA (Supervisory Control and Data Acquisition) system enables real-time monitoring and control of industrial machines and processes. However, most SCADA systems lack a structured maintenance management component, making it difficult to track reported issues and ensure timely interventions. To overcome this limitation, this project focuses on developing an HMI-based fault reporting system integrated with a CMMS web application.

The goal is to create a seamless connection between fault detection (SCADA) and maintenance management (CMMS). This integration will allow operators to report faults directly from an HMI (Human-Machine Interface), automatically notify maintenance teams, and track issue resolution within the CMMS system. The motivation behind this project is to streamline maintenance operations, reduce equipment downtime, and improve the efficiency of industrial maintenance teams.

Project Objectives

This project is focusing on the following objectives:

1. Developing an HMI-based fault reporting system that allows operators to report machine faults with a simple interface.
2. Integrating the system with an S7-1200 PLC to collect fault data and trigger automated maintenance alerts.
3. Establishing a communication link between the SCADA system and the CMMS web application to log and manage reported faults.
4. Implementing a notification system that sends automated alerts (SMS) to maintenance personnel.
5. Providing real-time dashboards and historical records in the CMMS application for improved decision-making and maintenance planning.

Detailed Description

SCADA-Based HMI Fault Reporting System

The first component of this project is the SCADA-based fault reporting system, developed using WinCC Runtime Professional for the HMI, an S7-1200 PLC for signal processing, and a communication processor (CP) module for SMS notifications. The fault reporting process follows these steps:

1. Fault Detection & Reporting via HMI:
   - The operator selects the affected machine on the HMI interface.
   - A fault report form appears, allowing the operator to describe the issue.
   - The reported fault is logged into the system and sent to the PLC.

2. Automated Fault Notification:
   - The PLC processes the input and sends a command to the CP module.

- The CP module sends an SMS notification to the maintenance team.

3. Data Logging & Visualization:
   - All reported faults are stored in a centralized database.
   - The SCADA system provides real-time monitoring and displays fault trends.

CMMS (GMAO) Web Application & Integration

The second component of the project is the CMMS (GMAO) web application, which provides advanced maintenance management features.The CMMS system works as follows:

1. Automatic Fault Logging:
   - When an operator reports a fault on the HMI, it is automatically recorded in the CMMS database.
   - The maintenance team can view real-time fault alerts on the CMMS dashboard.

2. Work Order Generation & Assignment:
   - The CMMS system generates a work order for each reported fault.
   - The maintenance manager assigns the work order to a technician.

3. Maintenance Follow-Up & Resolution:
   - The technician updates the status of the fault (e.g., “In Progress”, “Resolved”).
   - Once the fault is resolved, the SCADA system updates the machine status.

4. Historical Data & Preventive Maintenance:
   - All maintenance actions are stored in the CMMS for future analysis.
     - The system generates reports for preventive maintenance planning.

By combining SCADA monitoring with CMMS-based maintenance racking, this project creates a complete maintenance solution that enhances industrial efficiency and reliability.

Chapter 1 This chapter introduces the company, outlines the project context, identifies the problem, and specifies the project requirements.

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Chapter 3 Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et.

1. Project Context

Introduction

in this chapter, we will present the company first, then we will present the project context,problem and the requirements of the project.

1.1. Lear company

Lear Corporation is a global leader in automotive seating and electrical systems, serving major automakers worldwide. With a history dating back over a century, the company has established itself as a crucial player in the automotive industry, continuously innovating to meet the evolving demands of modern vehicles.

Figure 1: LEAR Corporation logo

1.2. History of Lear Corporation

Lear Corporation was founded in 1917 as the American Metal Products Company in Detroit, Michigan. Initially, the company specialized in manufacturing tubular, welded, and stamped assemblies for the automotive and aircraft industries. Over the decades, Lear underwent several transformations, expanding its capabilities and diversifying its product portfolio.

Key milestones in Lear's history include:

Table 1: Lear's history timeline

1960s-1970s	Expansion into automotive seating and interior systems.
1988	Renamed Lear Corporation after a series of acquisitions and restructuring.
1994	Became a publicly traded company, listed on the New York Stock Exchange.
2000s	Strategic acquisitions, including United Technologies' Automotive unit, strengthened its position in electrical systems.
2010s-Present	Focused on innovation, sustainability, and intelligent seating technologies, with significant investments in research and development.

1.3. Products and Services

Lear Corporation operates under two major business segments: Seating and E-Systems.

1.3.1. Seating

Figure 2: Seat made by lear

Lear is one of the world's leading manufacturers of complete automotive seat systems and related components. The seating division focuses on:

- Seat Structures & Mechanisms: Development of durable and lightweight seat frames.
- Foam & Comfort Solutions: Advanced foam technologies for enhanced comfort.
- Trim & Surface Materials: High-quality leather, fabric, and synthetic materials.
- Seating Electronics: Integration of climate control, massage functions, and safety features.

1.3.2. E-System

Figure 3: E-system fo lear corporation

Lear's E-Systems division specializes in electrical and electronic components for vehicles, including:

- Wiring Harnesses: Advanced connectivity solutions for automotive electrical systems.
- Power Distribution Units: Smart distribution of electrical power within vehicles.
- Connectivity Solutions: Infotainment, communication modules, and cybersecurity systems.
- Battery Management Systems: Technology supporting electric and hybrid vehicle batteries.

1.4. Global Presence

Lear Corporation operates in 39 countries with more than 257 locations worldwide. Major production and engineering facilities are located in North America, Europe, and Asia, ensuring close collaboration with leading automakers.

Figure 4: LEAR implantation in the world

- United States: Headquarters in Southfield, Michigan, and several manufacturing plants.
- Mexico: A major production center for automotive seating and wiring systems.
- Germany & UK: European R&D and innovation centers.
- China & India: Growing markets for electric and connected vehicle technologies.

1.5. Lear Corporation in Tunisia

Tunisia has become an essential manufacturing hub for Lear Corporation, providing cost-effective production capabilities and a skilled workforce. Lear's operations in Tunisia are part of its broader strategy to strengthen its footprint in North Africa and Europe.

1.5.1. Tunisian Facilities

Lear Corporation has several facilities in Tunisia, including:

- Bir El Bey Facility: Specializes in electronic component production for automotive applications.
- Menzel Bourguiba Plant: Involved in assembly, wiring systems, and quality control.
- Bizerte Industrial Complex: Opened in 2023, this facility is expected to employ over 7,000 workers by 2027, focusing on advanced automotive technologies.

1.5.2. Economic Impact

Lear's investment in Tunisia has provided employment opportunities, skill development, and technology transfer. The company's presence has also contributed to the local economy by supporting suppliers, logistics companies, and infrastructure development.

1.6. Problem Statement

Since the Menzel Bourguiba plant is a new facility, it lacks an efficient maintenance management.

- Lack of Centralized Monitoring: Machines operate independently without a unified interface for tracking performance and errors.
- Delayed Fault Detection and Reporting: Maintenance personnel are often unaware of failures until they escalate into major issues.
- Manual Communication of Alerts: Machine errors are reported through inefficient methods, causing delays in intervention.
- Limited Data Analysis: There is no real-time access to historical maintenance data, making it difficult to optimize preventive and predictive maintenance strategies.
- Production Downtime: Unplanned machine failures result in costly production stoppages and inefficiencies.

1.7. Proposed Solution

To address these challenges, the project proposes a CMMS-SCADA integration that provides:

- A centralized digital platform for managing maintenance requests, work orders, and intervention history.
- SCADA system allowing operators and maintenance teams to visualize all the machines statuses on a single screen.

- Automated error alerts (SMS) sent to designated maintenance personnel when faults are detected.
- Historical data analysis and reporting, enabling predictive maintenance strategies and improved decision-making.
- Seamless integration with PLC systems (S7-1200) to ensure automated fault detection and quick response mechanisms.
- User-friendly HMI interfaces for operators to report faults and monitor machine statuses.

By implementing this system at Lear Corporation, the factory can significantly enhance its maintenance efficiency, reduce unplanned downtime, and improve overall operational performance.

Conclusion

This chapter establishes the foundation of the project by outlining Lear Corporation's background, identifying key maintenance challenges, and presenting the proposed CMMS-SCADA solution. The subsequent chapters will delve deeper into the design, implementation, and evaluation of the integrated system, highlighting its benefits and potential impact on Lear's operations.

2. Design Overview

Introduction

The main goal of this project's design is to create an organized and effective system that guarantees the smooth operation and integration of different parts. An overview of the system architecture, key elements, workflow, and technology is given in this chapter. In line with the project's goals, the design strategy seeks to achieve dependability, scalability, and usability.

2.1. System Architecture

The system consists of multiple interconnected modules that work together to achieve the desired functionality. It includes:

- Hardware Layer: Comprising industrial machines, CP-1242-7 V2(Communication module for the plc), and PLC(Programmable Logic Controllers) for automation and real-time data acquisition.
- Software Layer: A web-based GMAO (Gestion de Maintenance Assistée par Ordinateur) application built using Django.
- Database Layer: A PostgreSQL database to store and manage data efficiently.
- Communication Layer: A Cp module to send SMS to maintenance staff and a VB Script to send Data from the SCADA systeme to the Database.

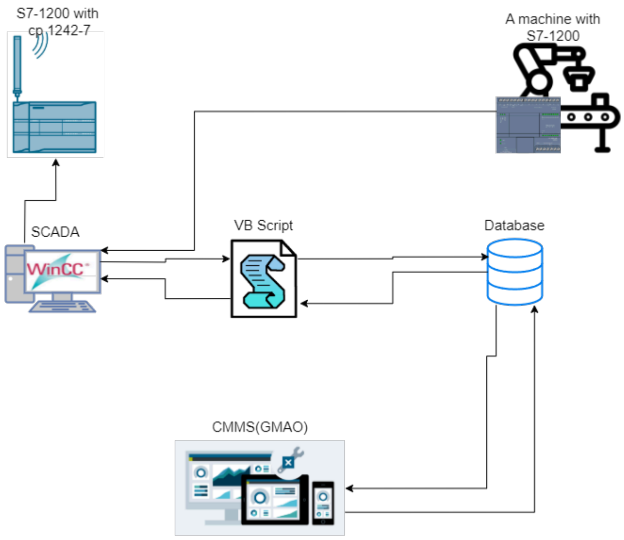

Figure 5: The interaction between the different modules

2.2. Main Components

- Frontend: A user-friendly interface developed using HTML, CSS, JavaScript, and Bootstrap, allowing operators to interact with the system.
- Backend: Implemented using Django to handle business logic, data processing, and authentication.
- Database: PostgreSQL is used to store user information, work orders, fault logs, and intervention records.
- SCADA Integration: The S7-1200 PLC handles the comunucation task, while WinCC Runtime Professional is used for SCADA visualization.

- PLC Integration: The S7-1200 PLC monitors machine states and detects faults in real time. These faults trigger data transmission via VBScript.
- Data Transmission Mechanism: VBScript is embedded within WinCC Runtime Professional to extract machine data and insert it directly into the PostgreSQL database. The script is triggered by events such as machine failures or specific operator actions.
- Fault Notification System: Once fault data is recorded in the database, the Django backend processes it and updates the web interface. This allows maintenance teams to respond promptly and resolve issues efficiently.

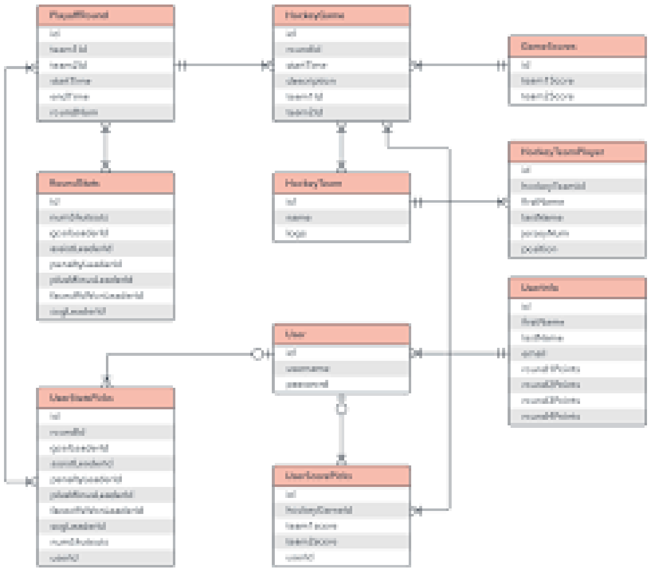

Figure 6: The ERD of the database

2.2.1. Workflow

The workflow of the system is designed to ensure seamless communication between the hardware and software components. The process can be summarized as follows:

1. Data Acquisition: The PLC continuously monitors the machines and detects any faults or anomalies.
2. Data Transmission: When a fault is detected, the VBScript embedded in WinCC Runtime Professional extracts relevant data and sends it to the PostgreSQL database.
3. Data Processing: The Django backend processes the incoming data, updating the database and notifying the frontend.
4. User Interaction: Operators can access the web interface to view real-time data, generate reports, and manage work orders.
5. Fault Notification: The system sends SMS notifications to maintenance staff, alerting them of any critical faults that require immediate attention.
6. Maintenance Management: The GMAO application allows maintenance teams to track work orders, log interventions, and analyze machine performance over time.
7. Reporting: The system generates reports based on the collected data, providing insights into machine performance, fault history, and maintenance activities.

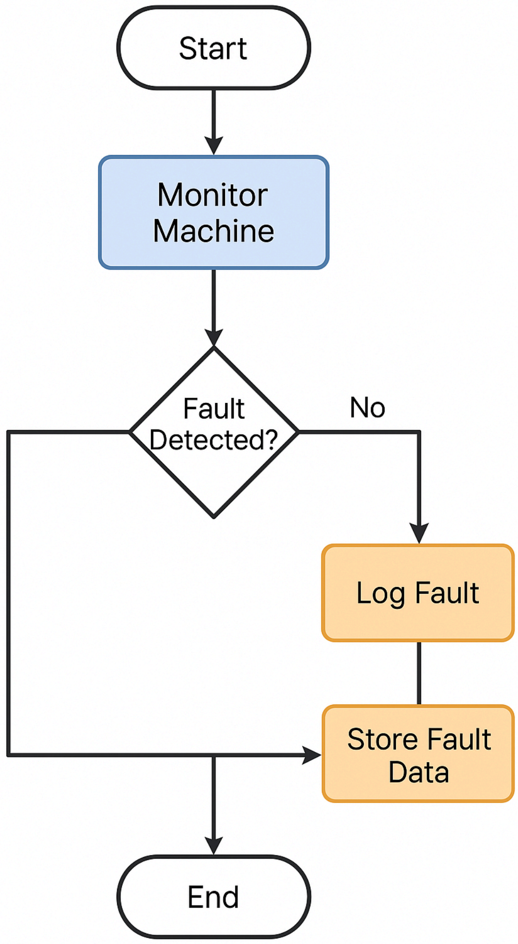

Figure 7: The workflow of the system

2.3. Technologies Used

- Frontend: HTML, CSS, JavaScript for an interactive user experience.
- Backend: Django (Python) for handling data logic and system processes.
- Database: PostgreSQL for structured and efficient data storage.
- Industrial Communication: VBScript within WinCC Runtime Professional to enable machine-to-database communication.
- SCADA: WinCC Runtime Professional for real-time machine monitoring and operator interaction.

Conclusion

This chapter provided a comprehensive analysis of the system's design, covering its architecture, components, data flow, and constraints. Figures such as the system architecture diagram, database schema, and fault detection workflow illustrate the working mechanisms in detail. The next chapter will delve into the implementation phase, explaining the technical aspects of development and integration.

3. Implementation

Introduction

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Figure 8: Typst logo

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Table 2: Some table

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Conclusion

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General Conclusion

Discussion

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Future Work

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