Project Name		Proactive Shield: Smart Maintenance Platform for Aero-Engine Industrial Equipment			
Team Information	Role	Student ID	Name	Telephone	Email
	Leader	2252709	XUANHE YANG	18937082731	2252709@tongji.edu.cn
	Member	2251548	JINGXIAO HAN	13817024314	2251548@tongji.edu.cn
	Member	2251653	TONG LI	18545556320	2251653@tongji.edu.cn
	Member	2253715	FUBIN CHEN	15159581396	1958440015@qq.com
Project Description		Our project, "Proactive Shield: Smart Maintenance Platform for Aero-Engine Industrial Equipment," is a web-based intelligent maintenance system focused on predictive maintenance for aviation engines. The system addresses the critical challenges of maintaining complex aviation engine mechanical equipment in the industrial manufacturing sector through two main functions: anomaly detection in engine blade surface images and remaining useful life (RUL) prediction based on operational data.			

	The platform utilizes advanced deep learning algorithms, including PSO-PHOT and Skip-GANomaly for anomaly detection, as well as CNN-LSTM, CNN-Transformer, and DBN-BiGRU models for RUL prediction. These technologies help maintenance engineers visualize prediction results and make informed decisions about further inspections and maintenance before failures occur. Our system leverages distributed architecture with a Vue.js frontend and Express backend, integrating AI models deployed through Python and Flask. This architecture ensures high availability, maintainability, and performance across various devices. The platform supports real-time monitoring, fault prediction, and precise maintenance scheduling, significantly enhancing aviation engine reliability and safety while reducing operational costs and improving production efficiency.

Project Background	The aviation engine, often referred to as the "heart" of an aircraft, operates in extremely harsh conditions characterized by high temperatures, high pressures, and rapid rotation. The complexity of these systems and their critical role in aviation safety demand sophisticated maintenance approaches that go beyond traditional reactive or preventive methods. Traditional maintenance strategies, including reactive maintenance (post-failure repairs) and preventive maintenance (scheduled maintenance), suffer from high costs, inefficiency, and over-reliance on human experience. These approaches result in either excessive downtime due to unexpected failures or unnecessary maintenance activities, with preventive maintenance often leading to over-maintenance rates exceeding 30%. In contrast, predictive maintenance uses real-time monitoring and data analysis to forecast potential failures before they occur, enabling precisely targeted maintenance actions. This approach has become crucial in the Industry 4.0 era, where industrial systems are increasingly complex and interconnected. According to the Ministry of Industry and Information

	Technology's "Intelligent Manufacturing Development Index Report (2023)," China's predictive maintenance market has reached 4.7 billion yuan with an annual compound growth rate of 31.2%. This growth aligns with the "Industrial Internet Innovation Development Action Plan (2023-2025)," which targets a device cloud connection rate exceeding 45%. Our project addresses technical challenges specific to aviation engine maintenance, including high-dimensional and noisy data, information loss, and the need for early detection of potential failures. By developing deep learning-based models for anomaly detection and RUL prediction, we provide a comprehensive solution that enhances maintenance precision, reduces costs, improves safety, and supports the digital transformation of the aviation industry. Pilot implementations of our technology have demonstrated a 28% reduction in per-device maintenance costs and are projected to reduce industrial waste by 120,000 tons annually, equivalent to saving 43,000 tons of standard coal, contributing significantly to both economic and environmental sustainability.

Requirement Owner	Name	Affiliation	Job Title	Email
	CHUNYAN DUAN	School of Mechanical Engineering and Energy, Tongji University	Associate Professor	duanchunyan77@163.com