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REVIEW ARTICLE

Artificial Intelligence in SOLIDWORKS: Applications and Impacts

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ABSTRACT:

The integration of Artificial Intelligence (AI) and Machine Learning (ML) into SOLIDWORKS has revolutionized mechanical engineering workflows, enabling unprecedented efficiency, creativity, and precision in product design. This paper explores SOLIDWORKS' AI-driven tools, their applications, and their transformative impact on the field. SOLIDWORKS 2025 introduces Aura AI, a context-aware assistant embedded directly into the CAD environment. Aura automates repetitive tasks, generates design alternatives, and provides real-time regulatory compliance insights, allowing engineers to focus on innovation. AI reduces repetitive tasks, allowing engineers to dedicate 40% more time to creative problem-solving. However, human oversight remains critical. SOLIDWORKS aims to expand industry-specific AI customization, particularly for aerospace and medical devices, while improving predictive maintenance algorithms using IoT sensor data. This synergy positions SOLIDWORKS as a leader in smart manufacturing, driving innovation while maintaining the critical role of engineering expertise.

KEYWORDS: Non-Newtonian fluid, speed breaker, road safety, traffic control, vehicle speed, adaptive resistance, sustainable design.

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1. INTRODUCTION

Artificial Intelligence (AI) has become one of the most influential technologies driving digital transformation across engineering and manufacturing industries. Rapid advances in machine learning, deep learning, cloud computing, and big data analytics have enabled engineering software to evolve from conventional computer-aided drafting tools into intelligent design environments capable of learning from historical data, automating repetitive operations, and supporting complex engineering decisions.[1–3]

Computer-Aided Design (CAD) systems are fundamental to modern product development because they facilitate three-dimensional modelling, engineering analysis, manufacturing planning, and product lifecycle management. Traditionally, CAD software relied entirely on user inputs for geometry creation, design modification, and simulation. However, increasing product complexity and shorter development cycles have created a demand for intelligent CAD platforms capable of improving design efficiency while minimizing engineering effort.[4,5]

Among the leading commercial CAD platforms, **SOLIDWORKS**, developed by Dassault Systèmes, has established itself as one of the most widely used

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engineering design environments owing to its comprehensive capabilities in parametric modelling, finite element analysis, computational fluid dynamics, sheet metal design, assembly modelling, manufacturing planning, and product data management. Recent versions of SOLIDWORKS have progressively incorporated Artificial Intelligence (AI) and Machine Learning (ML) technologies to enhance engineering productivity and support intelligent product development.[6]

One of the most significant developments is the introduction of AI-powered assistants such as **Aura AI**, which provide context-aware engineering assistance directly within the CAD environment. These intelligent systems analyze user behaviour, recognize design intent, automate repetitive modelling operations, recommend optimal design modifications, generate documentation, and assist engineers in complying with manufacturing standards and regulatory requirements. Consequently, engineers spend less time performing repetitive CAD operations and more time focusing on innovation and product optimization.[7]

Another important application of AI within SOLIDWORKS is **generative design**, where optimization algorithms automatically generate multiple feasible design alternatives based on predefined objectives and engineering constraints. Instead of manually iterating through numerous design concepts, engineers specify loading conditions, material properties, manufacturing constraints, and optimization objectives, allowing AI algorithms to produce lightweight yet structurally efficient solutions. This capability has become increasingly important in aerospace, automotive, biomedical, and additive manufacturing industries where weight reduction and material efficiency are primary design objectives.[8]

Artificial Intelligence also enhances engineering simulations by improving finite element analysis (FEA), computational fluid dynamics (CFD), topology optimization, and manufacturing process planning. Machine learning algorithms can predict simulation outcomes, identify potential design failures, optimize mesh generation, and recommend design modifications before physical prototyping. These capabilities reduce computational costs while accelerating product development.[9]

The emergence of **Industry 4.0** has further expanded the role of AI in engineering design. Integration of SOLIDWORKS with cloud computing, digital twins, Industrial Internet of Things (IIoT), and smart manufacturing systems enables continuous communication between virtual models and physical products. Data collected from sensors embedded in manufactured products can be analysed using AI algorithms to improve future designs, predict equipment failures, and optimize manufacturing operations throughout the product lifecycle.[10]

Despite these technological advancements, widespread adoption of AI-assisted engineering also introduces several challenges. The effectiveness of AI models depends heavily on high-quality engineering datasets, while issues concerning cybersecurity, data privacy, computational resources, algorithm transparency, and engineer confidence remain active research topics. Furthermore, AI should be regarded as an engineering support tool rather than a replacement for professional judgement because successful product development continues to require creativity, practical experience, and multidisciplinary decision-making.[11]

The objective of this review is to examine recent developments in Artificial Intelligence applications within SOLIDWORKS and evaluate their impact on engineering design, simulation, manufacturing, and product lifecycle management. The review discusses current AI-driven tools, major industrial applications, benefits, limitations, and future research directions associated with intelligent CAD systems.

2. EVOLUTION OF ARTIFICIAL INTELLIGENCE IN CAD

Artificial Intelligence has transformed CAD systems from simple geometric modelling software into intelligent engineering platforms capable of learning from previous designs, optimizing geometry, automating workflows, and assisting decision-making. Early CAD software primarily supported two-dimensional drafting and three-dimensional

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parametric modelling, requiring engineers to manually perform almost every modelling operation.[12]

The introduction of knowledge-based engineering (KBE) represented the first step toward intelligent CAD by allowing predefined design rules and engineering knowledge to automate repetitive modelling tasks. Although effective, KBE systems remained limited because they depended entirely on manually programmed rules. The emergence of machine learning enabled CAD software to learn from historical engineering datasets, identify design patterns, and continuously improve prediction accuracy without explicit programming.[13]

Recent developments in deep learning, natural language processing, and cloud computing have accelerated AI integration into commercial CAD software. Modern SOLIDWORKS platforms now incorporate AI for feature recognition, intelligent modelling assistance, automated documentation, topology optimization, simulation acceleration, and collaborative cloud-based product development. These capabilities significantly reduce engineering effort while improving design quality and manufacturing readiness.[14],[15]

2.1 AI-Powered Design Assistant (Aura AI)

One of the most significant advancements in recent versions of SOLIDWORKS is the integration of **Aura AI**, an intelligent engineering assistant designed to simplify product development by providing context-aware recommendations during the design process. Aura AI utilizes natural language processing (NLP), machine learning, and cloud-based engineering knowledge to understand user intent and assist designers in real time.[16]

Unlike traditional CAD software that requires manual execution of repetitive modelling commands, Aura AI continuously analyzes modelling history, feature dependencies, assembly relationships, and engineering constraints to recommend appropriate modelling operations. Engineers can interact with the assistant using conversational language, allowing rapid execution of complex CAD operations without extensive command searching.

Major functions include:

- Intelligent feature recommendation
- Automatic dimension generation
- Design intent recognition
- Assembly error detection
- Automatic documentation
- Manufacturing recommendations
- Regulatory compliance assistance

These capabilities significantly reduce modelling time while improving consistency and minimizing human errors during product development.[17]

2.2 Intelligent Parametric Modelling

Traditional parametric CAD requires engineers to manually create sketches, constraints, dimensions, and feature relationships. AI-assisted parametric modelling automates many of these operations by recognizing geometric patterns and predicting user intentions based on previous modelling behaviour.[18]

Machine learning algorithms analyze thousands of previously designed components to recommend:

- Appropriate feature dimensions
- Standard design practices
- Hole placement
- Rib locations
- Fillet selection
- Draft angles
- Sheet metal bend parameters

Consequently, engineers spend less time creating repetitive features while maintaining high design accuracy.

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2.3 Generative Design

Generative Design represents one of the most powerful AI-driven capabilities integrated with SOLIDWORKS. Instead of manually modifying designs, engineers define:

- Design space
- Material
- Loading conditions
- Manufacturing constraints
- Safety factor
- Optimization objectives

Artificial Intelligence then automatically generates hundreds of feasible design alternatives using topology optimization algorithms.[19]

The optimization objective is commonly expressed as

$$\min C(\rho)=U^{T}KU$$

subject to

$$V(\rho)\le V_0$$

where

- C=structural compliance
- U=displacement vector
- K=stiffness matrix
- V=material volume

The generated designs are evaluated according to:

- Weight
- Structural stiffness
- Manufacturability
- Cost
- Material utilization

Generative design is extensively applied in aerospace, automotive, biomedical implants, and additive manufacturing for developing lightweight yet mechanically robust components.[20]

2.4 AI-Assisted Simulation

Artificial Intelligence has significantly enhanced engineering simulations performed within SOLIDWORKS Simulation.

Machine learning algorithms improve:

- Mesh generation
- Boundary condition prediction
- Material selection
- Stress prediction
- Fatigue estimation
- Failure probability analysis

Rather than executing numerous computationally expensive finite element analyses, AI predicts approximate stress distributions using trained neural networks, thereby reducing computational time without substantially compromising accuracy.[21]

Engineers can rapidly identify potential failure regions before performing detailed simulations.

2.5 Topology Optimization

Topology optimization has become a standard AI-assisted design methodology within SOLIDWORKS for minimizing component weight while maintaining mechanical performance.

The optimization process removes inefficient material from low-stress regions while preserving structural integrity.

Applications include:

- Automotive chassis

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- Suspension systems
- Aircraft brackets
- Robotic arms
- Heat exchangers
- Biomedical implants

Weight reductions of **30–70%** have been reported without compromising stiffness or safety.[22]

2.6 AI-Based Manufacturing Assistance

Artificial Intelligence also supports manufacturing planning by automatically evaluating manufacturability during product design.

AI algorithms identify:

- Thin walls
- Undercuts
- Sharp corners
- Tool accessibility
- Machining complexity
- Injection moulding defects
- Additive manufacturing constraints

Real-time Design for Manufacturing (DFM) feedback enables engineers to correct potential manufacturing problems before production begins.

3. APPLICATIONS OF AI IN SOLIDWORKS

3.1 Mechanical Product Design

Mechanical engineering represents the largest application area of SOLIDWORKS AI technologies.

AI assists engineers by:

- Automating CAD modelling
- Optimizing assemblies
- Detecting interferences
- Suggesting standardized components
- Performing tolerance analysis
- Predicting structural failures

These capabilities reduce product development time while improving engineering accuracy.[23]

3.2 Additive Manufacturing

Artificial Intelligence has become increasingly important in additive manufacturing.

AI supports:

- Build orientation optimization
- Support structure generation
- Layer thickness optimization
- Distortion prediction
- Print failure detection
- Material consumption estimation

Topology optimized geometries generated by AI are particularly suitable for additive manufacturing because of their complex lightweight structures that are difficult to fabricate using conventional machining.[24]

3.3 Digital Twin Technology

Digital Twin technology creates virtual replicas of physical products throughout their lifecycle.

SOLIDWORKS integrates AI with Digital Twins to:

- Monitor product performance
- Predict equipment failures
- Optimize maintenance schedules

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- Improve future designs
- Analyze operational behaviour

Sensor data collected from operating products continuously updates the virtual model, enabling predictive engineering and real-time decision making.[25]

3.4 Predictive Maintenance

Artificial Intelligence analyzes operational sensor data collected through Industrial Internet of Things (IIoT) devices to predict equipment failures before breakdown occurs.

Machine learning algorithms monitor:

- Vibration
- Temperature
- Stress
- Fatigue
- Bearing wear
- Lubrication condition

Predictive maintenance significantly reduces downtime and maintenance costs while increasing equipment reliability.[26]

3.5 Smart Manufacturing and Industry 4.0

AI-integrated SOLIDWORKS plays an important role in Industry 4.0 by connecting design, manufacturing, quality control, and product lifecycle management within a unified digital ecosystem.

Major applications include:

- Cloud-based collaboration
- Automated process planning
- Intelligent robotics
- Production scheduling
- Supply chain optimization
- Quality inspection
- Digital manufacturing

The integration of AI enables manufacturers to achieve faster product development, reduced production costs, and improved operational efficiency.[27]

Table 1. Major AI Applications in SOLIDWORKS

Application	**AI Contribution**
CAD Modelling	Feature prediction
Simulation	Intelligent FEA
Topology Optimization	Lightweight structures
Additive Manufacturing	Print optimization
Digital Twin	Real-time monitoring
Manufacturing	Process optimization
Quality Control	Automated inspection

4. BENEFITS OF AI IN SOLIDWORKS

Artificial Intelligence has fundamentally transformed engineering design workflows by enabling intelligent automation, improving engineering accuracy, and accelerating product development. AI-assisted SOLIDWORKS provides numerous technical and economic advantages across the entire product lifecycle.

4.1 Improved Design Productivity

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One of the primary benefits of AI integration is the significant reduction in repetitive modelling tasks. Intelligent design assistants automatically recognize user intent, suggest modelling features, generate dimensions, repair modelling errors, and automate documentation. Consequently, engineers can devote more time to innovation and engineering decision-making rather than routine CAD operations. Studies indicate that AI-assisted workflows can reduce design time by **30–40%**, particularly for repetitive components and assemblies.[31]

4.2 Enhanced Design Optimization

AI-driven topology optimization and generative design enable engineers to develop lightweight yet structurally efficient products. By automatically evaluating hundreds of feasible design alternatives under specified loading and manufacturing constraints, AI significantly improves structural performance while minimizing material consumption. Such optimization is particularly valuable in aerospace, automotive, biomedical, and additive manufacturing applications where weight reduction directly influences operational efficiency.[32]

4.3 Improved Simulation Accuracy

Machine learning algorithms assist finite element simulations by predicting stress distributions, identifying probable failure locations, optimizing mesh quality, and reducing computational time. AI also accelerates computational fluid dynamics (CFD), thermal simulations, and fatigue analyses by providing intelligent approximations that reduce the number of expensive numerical iterations required for convergence.[33]

4.4 Smart Manufacturing Integration

Integration of SOLIDWORKS with Artificial Intelligence supports the objectives of Industry 4.0 by connecting product design with manufacturing systems, robotics, Industrial Internet of Things (IIoT), and cloud computing. AI assists engineers in evaluating manufacturability, identifying production constraints, minimizing machining complexity, and optimizing manufacturing sequences before production begins.[34]

4.5 Product Lifecycle Management

AI enhances Product Lifecycle Management (PLM) through intelligent data management, automated engineering change tracking, predictive maintenance, and Digital Twin technologies. Continuous analysis of operational sensor data enables designers to improve future product generations while reducing maintenance costs and improving product reliability throughout the operational lifecycle.[35]

Table 2. Benefits of AI Integration in SOLIDWORKS

Feature	**Engineering Benefit**
Aura AI	Automated CAD assistance
Generative Design	Lightweight structures
AI Simulation	Faster engineering analysis
Predictive Maintenance	Reduced downtime
Digital Twin	Continuous product monitoring
Cloud Collaboration	Improved engineering teamwork

5. CHALLENGES AND LIMITATIONS

Despite its considerable advantages, Artificial Intelligence integration within SOLIDWORKS presents several technical and organizational challenges that require careful consideration.

5.1 Data Quality

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Machine learning models depend heavily on large quantities of accurate engineering data. Incomplete or inconsistent CAD datasets may reduce prediction accuracy and lead to suboptimal design recommendations.[36]

5.2 Computational Requirements

Advanced AI algorithms, topology optimization, and cloud-based simulations require substantial computational resources and reliable internet connectivity. Small and medium-sized enterprises may encounter financial and technical barriers when implementing these technologies.

5.3 Cybersecurity

Cloud-based engineering platforms increase concerns regarding intellectual property protection, cybersecurity, and unauthorized access to confidential engineering data. Secure encryption, authentication mechanisms, and compliance with international cybersecurity standards remain essential for protecting digital engineering assets.[37]

5.4 Explainability of AI Models

Many deep learning algorithms operate as "black-box" models, making it difficult for engineers to understand how specific design recommendations are generated. Explainable Artificial Intelligence (XAI) is therefore becoming increasingly important to improve confidence, transparency, and regulatory acceptance of AI-assisted engineering decisions.[38]

5.5 Human Expertise Remains Essential

Although AI substantially improves productivity, it cannot replace engineering creativity, practical experience, ethical judgment, or multidisciplinary decision-making. Human engineers remain responsible for validating AI-generated designs, ensuring safety, and considering manufacturing, economic, and regulatory constraints.

6. FUTURE PERSPECTIVES

Artificial Intelligence is expected to play an increasingly central role in future SOLIDWORKS development. Emerging technologies such as large language models, autonomous CAD systems, explainable AI, reinforcement learning, cloud-native engineering platforms, and generative engineering will further transform product development.

Future research is anticipated to focus on:

- Autonomous CAD modelling using natural language instructions.
- AI-driven optimization for additive manufacturing.
- Integration with Digital Twin ecosystems.
- Real-time IoT-enabled product monitoring.
- Sustainable material selection using AI.
- Automated tolerance analysis and manufacturing planning.
- AI-assisted multidisciplinary optimization.
- Cloud-native collaborative engineering environments.

The convergence of AI, cloud computing, Digital Twins, and Industry 5.0 will enable intelligent engineering systems capable of continuous learning and autonomous optimization throughout the product lifecycle.[39]

7. CONCLUSION

Artificial Intelligence has emerged as a transformative technology in modern computer-aided engineering, significantly enhancing the capabilities of SOLIDWORKS in design automation, simulation, optimization, and manufacturing. AI-driven tools such as Aura AI, generative design, topology optimization, and intelligent simulation reduce

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repetitive engineering tasks, improve design quality, and accelerate product development while supporting Industry 4.0 initiatives. Integration with Digital Twins, cloud computing, and Industrial Internet of Things technologies further strengthens predictive engineering and lifecycle management. Although challenges related to data quality, computational resources, cybersecurity, and model transparency remain, AI should be regarded as a powerful engineering support tool rather than a replacement for human expertise. Future developments in explainable AI, autonomous CAD, and cloud-native engineering are expected to further revolutionize intelligent product design and smart manufacturing. Overall, AI-enabled SOLIDWORKS represents a major advancement toward sustainable, efficient, and innovation-driven mechanical engineering.

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