



The Institution of Engineers (India)
U.P. State Centre, Lucknow



Celebrating “World Engineering Day for Sustainable Development”

Smart Engineering for a Sustainable Future

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Agenda

- ✓ **Engineering?**
- ✓ **First Engineer**
- ✓ **Historical Perspective of Engineering**
- ✓ **Traditional Engineering**
- ✓ **Challenges at Present**
- ✓ **Understanding Smart Engineering**
- ✓ **AI and SDG**
- ✓ **AI for Sustainable Future**
- ✓ **Conclusion and Future Aspects**

Engineering??

“Engineering is the art of turning scientific knowledge into practical solutions that improve the quality of human life.”



First Engineer

The words *engine* and *ingenious* are **derived** from the same Latin root, ***ingenerare***, which means “**to create.**”



Imhotep reading a Papyrus Roll (detail of a Sculpture) in the Egyptian Museum, Berlin.



Builder of the **Step Pyramid** at Şaqqārah, Egypt, probably about 2550 BC

Historical Perspective of Engineering

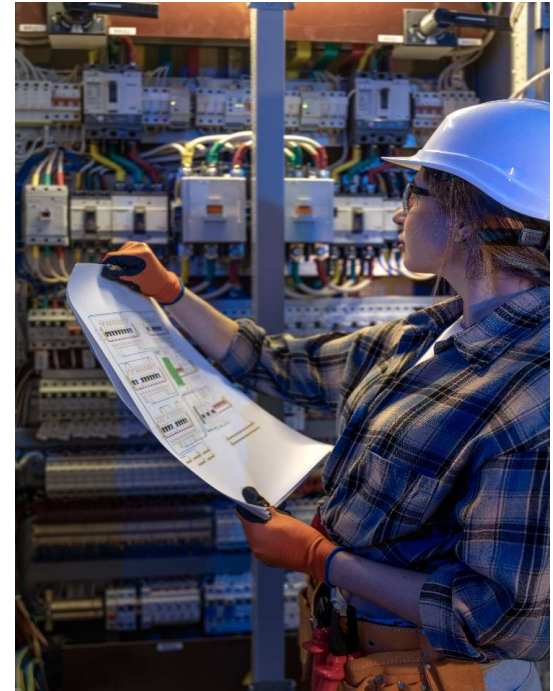
Time Period	Engineering Field / Development	Major Contributions / Technologies	Example
3000 BCE – 500	Civil Engineering	Construction, irrigation systems, roads, urban planning	Cities of Indus Valley Civilization, Great Pyramid of Giza
500 – 1500	Structural & Military Engineering	Fortifications, water mills, windmills, defensive structures	Great Wall of China
1700 – 1850	Mechanical Engineering	Steam engines, industrial machines, manufacturing	Steam engine improvements by James Watt
1800 – 1950	Electrical Engineering	Electric power generation, motors, lighting systems	Light bulb by Thomas Edison
1940 – 1980	Electronics Engineering	Transistors, integrated circuits, communication systems	Development of semiconductor devices
1980 – 2000	Computer Engineering	Personal computers, software systems, internet	Growth of digital computing
2000 – Present	Smart & Intelligent Engineering	Artificial Intelligence, Machine Learning, smart systems	Smart cities, autonomous systems

Traditional Engineering

Traditional engineering focuses on solving technical problems using established engineering principles such as **mechanics, electrical systems, civil structures, and manufacturing processes**.

Key Characteristics

1. Based on **manual design** and **conventional technologies**
2. Focus mainly on **functionality and performance**
3. Limited use of real-time data
4. Less integration between different systems



Traditional Engineering

Examples

1. Conventional power plants
2. Traditional transportation systems
3. Standard building construction
4. Manual manufacturing processes

Traditional engineering has played a critical role in building modern infrastructure such as **roads, bridges, industries, and power systems.**

However, it often **did not fully consider environmental impact, energy efficiency, or long-term sustainability.**



Challenges at Present

Today humanity faces unprecedented challenges:

- **Climate change**
- **Rapid urbanization**
- **Energy crises**
- **Water scarcity**
- **Environmental degradation**



To address these challenges, **traditional engineering alone is not sufficient.**

We must adopt **Smart Engineering** — engineering powered by **digital intelligence, sustainability, and innovation.**



Understanding Smart Engineering

Smart Engineering refers to the integration of advanced digital and physical technologies such as:

1. **Artificial Intelligence (AI)**
2. **Internet of Things (IoT)**
3. **Big Data Analytics**
4. **Automation and Robotics**
5. **Smart Materials**
6. **Sustainable and Green Design**
7. **Cloud Computing**
8. **Edge Computing**
9. **Digital Twins**
10. **Cyber-Physical Systems**
11. **Blockchain Technology**
12. **Advanced Sensors and Embedded Systems**
13. **Additive Manufacturing (3D Printing)**
14. **Augmented Reality (AR) and Virtual Reality (VR)**

to design and develop **efficient, intelligent, adaptive, and environmentally sustainable engineering systems** capable of addressing complex challenges in modern society.

Smart engineering focuses on three key principles:

1. Efficiency

Reducing energy consumption and resource wastage.

2. Intelligence

Using data and technology to optimize systems.

3. Sustainability

Designing systems that meet present needs without compromising future generations.

This approach aligns with the **United Nations Sustainable Development Goals (SDGs)**.

AI and SDG

Numbers in the SDG Framework

- 17 Goals
- 169 Targets
- 231 Global Indicators

SUSTAINABLE DEVELOPMENT GOALS



AI and SDG

17 Sustainable Development Goals (SDGs)

Goal No.	Goal Title	Description
SDG 1	No Poverty	End poverty in all its forms everywhere.
SDG 2	Zero Hunger	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
SDG 3	Good Health and Well-being	Ensure healthy lives and promote well-being for all at all ages.
SDG 4	Quality Education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
SDG 5	Gender Equality	Achieve gender equality and empower all women and girls.
SDG 6	Clean Water and Sanitation	Ensure availability and sustainable management of water and sanitation for all.
SDG 7	Affordable and Clean Energy	Ensure access to affordable, reliable, sustainable, and modern energy for all.
SDG 8	Decent Work and Economic Growth	Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.
SDG 9	Industry, Innovation and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

Goal No.	Goal Title	Description
SDG 10	Reduced Inequalities	Reduce inequality within and among countries.
SDG 11	Sustainable Cities and Communities	Make cities and human settlements inclusive, safe, resilient, and sustainable.
SDG 12	Responsible Consumption and Production	Ensure sustainable consumption and production patterns.
SDG 13	Climate Action	Take urgent action to combat climate change and its impacts.
SDG 14	Life Below Water	Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
SDG 15	Life on Land	Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss.
SDG 16	Peace, Justice and Strong Institutions	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels.
SDG 17	Partnerships for the Goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development.

AI for Sustainable Future

Urgency of AI

Why Now?

AI offers the **fastest route to scale innovation**, optimize resources, and address deep-rooted development gaps.

Global Crises and Smart Solutions

Challenge	AI Application
Poverty & Hunger	AI-powered crop prediction, precision agriculture, microcredit scoring
Healthcare Gaps	Early diagnostics, health informatics, telemedicine
Climate Crisis	Energy optimization, disaster forecasting, carbon tracking
Education Inequality	Personalized learning, language translation, edtech reach
Urban Overload	Smart city planning, waste & water management, traffic control

AI for Sustainable Future

AI and the SDGs – Mapping Synergies

AI & SDG Mapping: Synergies Across All 17 Goals

SDG	Goal Title	How AI Contributes
SDG 1	No Poverty	Predictive analytics for poverty hotspots, microfinance access
SDG 2	Zero Hunger	Precision agriculture, yield prediction, pest detection
SDG 3	Good Health & Well-being	Early disease detection, drug discovery, health bots
SDG 4	Quality Education	Adaptive learning, automated tutoring, NLP for literacy
SDG 5	Gender Equality	Bias detection, gender-inclusive analytics, protection apps
SDG 6	Clean Water & Sanitation	Smart water management, leakage prediction
SDG 7	Affordable & Clean Energy	Grid optimization, demand forecasting, renewables integration

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AI and the SDGs – Mapping Synergies

AI & SDG Mapping: Synergies Across All 17 Goals

SDG	Goal Title	How AI Contributes
SDG 8	Decent Work & Economic Growth	Labor market insights, gig economy platforms, skill mapping
SDG 9	Industry, Innovation & Infrastructure	Intelligent manufacturing, predictive maintenance
SDG 10	Reduced Inequalities	Inclusion analytics, bias audits, accessible tech
SDG 11	Sustainable Cities	Traffic optimization, pollution monitoring, urban planning
SDG 12	Responsible Consumption	Supply chain traceability, waste management
SDG 13	Climate Action	Emission forecasting, climate modeling, carbon tracking
SDG 14	Life Below Water	Marine life monitoring, illegal fishing detection

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AI and the SDGs – Mapping Synergies

AI & SDG Mapping: Synergies Across All 17 Goals

SDG	Goal Title	How AI Contributes
SDG 15	Life on Land	Deforestation tracking, species identification
SDG 16	Peace, Justice & Institutions	Fake news detection, justice analytics, cybercrime prevention
SDG 17	Partnerships	Data interoperability, multilingual models, knowledge sharing

AI for Sustainable Future

AI and the SDGs – Mapping Synergies

Cross Cutting Synergies and Challenges

Cross-Cutting Synergies

- 1. AI + Big Data** Enables real-time SDG progress tracking.
- 2. AI + IoT:** Empowers smart agriculture, clean energy, and urban sustainability.
- 3. AI + Blockchain:** Secures fair trade, land rights, and financial transparency.
- 4. AI + Robotics:** Revolutionizes healthcare, disaster response, and elder care.

and many other possibilities.

AI for Sustainable Future

AI Innovations & Inventions in the Global South

Notable AI Startups & Projects (Global South)

Country	AI Innovation	Description
India	Wadhvani AI	AI for cotton pest prediction, newborn risk detection
Kenya	Twiga Foods	AI supply chain for farmers to reduce food waste
Rwanda	Zipline AI Drones	Medical supplies delivered via AI-controlled drones
Nigeria	Releaf	AI for automating palm oil processing for small farmers
Brazil	Sinai Technologies	AI for carbon tracking and emissions forecasting in cities
Bangladesh	AI4BD	AI-driven Bangla speech recognition and text analytics
Philippines	Salarium	AI for payroll and worker financial analytics in SMEs

AI for Sustainable Future

Data, Ethics and AI Biases

Data: The Fuel of AI

What is Data in AI?

AI models learn from **data sets** that include images, text, numbers, audio, or other real-world inputs.

Types of Data:

Training Data – Used to teach the model (e.g., labeled images)

Validation/Test Data – Used to check performance

Why Data Matters?

Garbage in, garbage out: Biased or incomplete data leads to flawed outcomes.

Data quality, diversity, and representativeness directly affect the accuracy and fairness of AI predictions.

AI for Sustainable Future

Data, Ethics and AI Biases

AI Ethics: Principles for Responsible Use

Ethics in AI ensures that systems are designed and deployed **fairly, safely, and transparently**, with **human values and dignity** at the core.

Key Ethical Principles

Principle	Description
Transparency	How AI decisions are made should be explainable
Privacy	Personal data must be protected and used responsibly
Fairness	AI should not discriminate based on gender, race, geography, etc.
Accountability	Developers and users must take responsibility for AI outcomes
Inclusivity	AI must be accessible and beneficial to all, including marginalized groups
Human Control	Humans must remain in control of critical decisions

AI for Sustainable Future

Data, Ethics and AI Biases

AI Biases: When Machines Inherit Human Prejudices

What is AI Bias?

Bias in AI refers to **systematic errors** in predictions or decisions that **disproportionately affect certain groups** due to skewed data or flawed design.

Types of Bias

Type	Description	Example
Data Bias	Data is unbalanced or not representative	Healthcare AI trained mostly on white patients underperforms on others
Labeling Bias	Human annotators introduce subjective views	Mislabeling dialects as slang or informal
Algorithmic Bias	Model structure reinforces unwanted patterns	Resume screening AI favors male-dominated profiles
Historical Bias	Past inequality is reflected in training data	Credit scoring reflects past discrimination against minorities
Deployment Bias	Context of use differs from training	Predictive policing AI used differently than intended

Conclusion and Future Scope

Conclusion

- Integration of technologies like **Artificial Intelligence** is transforming engineering solutions.
- Smart Engineering enables **efficient, intelligent, and sustainable systems**.
- Modern engineering must align with the **Sustainable Development Goals (SDGs)**.

Future Scope

- Development of **smart cities, smart infrastructure, and intelligent transportation systems**.
- Sustainable energy systems** and climate-resilient infrastructure.
- Use of **data-driven engineering** for efficient resource management.
- Engineering innovations supporting global sustainability goals and societal well-being.

THANK YOU

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