
INTERNET
OF THINGS
IOT
GIS

Role of ICT in Architecture

Presented By: Hafsa, Rehab, Eisha
Ayesha, Irza, Samad, Ali, Hassan

Evolution of Digital Planning in Architecture

- Digital planning revolutionized architectural design by replacing manual drafting with CAD (Computer-Aided Design) and BIM (Building Information Modeling).
- Architects now use software to simulate structural integrity, energy efficiency, and spatial dynamics before construction begins.
- This shift enhances precision, reduces errors, and accelerates project timelines.

Tools and Techonologies in Digital Planning

- Key tools include AutoCAD, Revit, Rhino, SketchUp, and parametric design platforms like Grasshopper.
- Technologies such as AI, AR/VR, and GIS are integrated for immersive visualization and site analysis.
- Cloud collaboration allows real-time updates across multidisciplinary teams.

Impact on Sustainability and Digital Design

- Digital planning supports eco-friendly architecture by modeling energy use, daylighting, and material impact.
- Urban planners use digital twins and GIS to design smart cities with efficient transport, green spaces, and resilient infrastructure.
- Data-driven decisions lead to more livable and adaptive environments.

FOR EXAMPLE

The Masdar City

The Masdar City

Masdar City in Abu Dhabi is a planned sustainable city developed using digital planning tools to minimize carbon footprint and maximize energy efficiency. Masdar City in Abu Dhabi is one of the world's most ambitious experiments in sustainable urban development, designed to be a model for future eco-cities

What Makes Masdar City Unique?

1. Digital Master Planning
2. Smart Infrastructure
3. Renewable Energy Integration
4. Green Building Standards
5. Traditional Meets Tech

Minecraft: A Digital Tool for Inclusive Urban Design

Loading…

GAME MODE

Overview

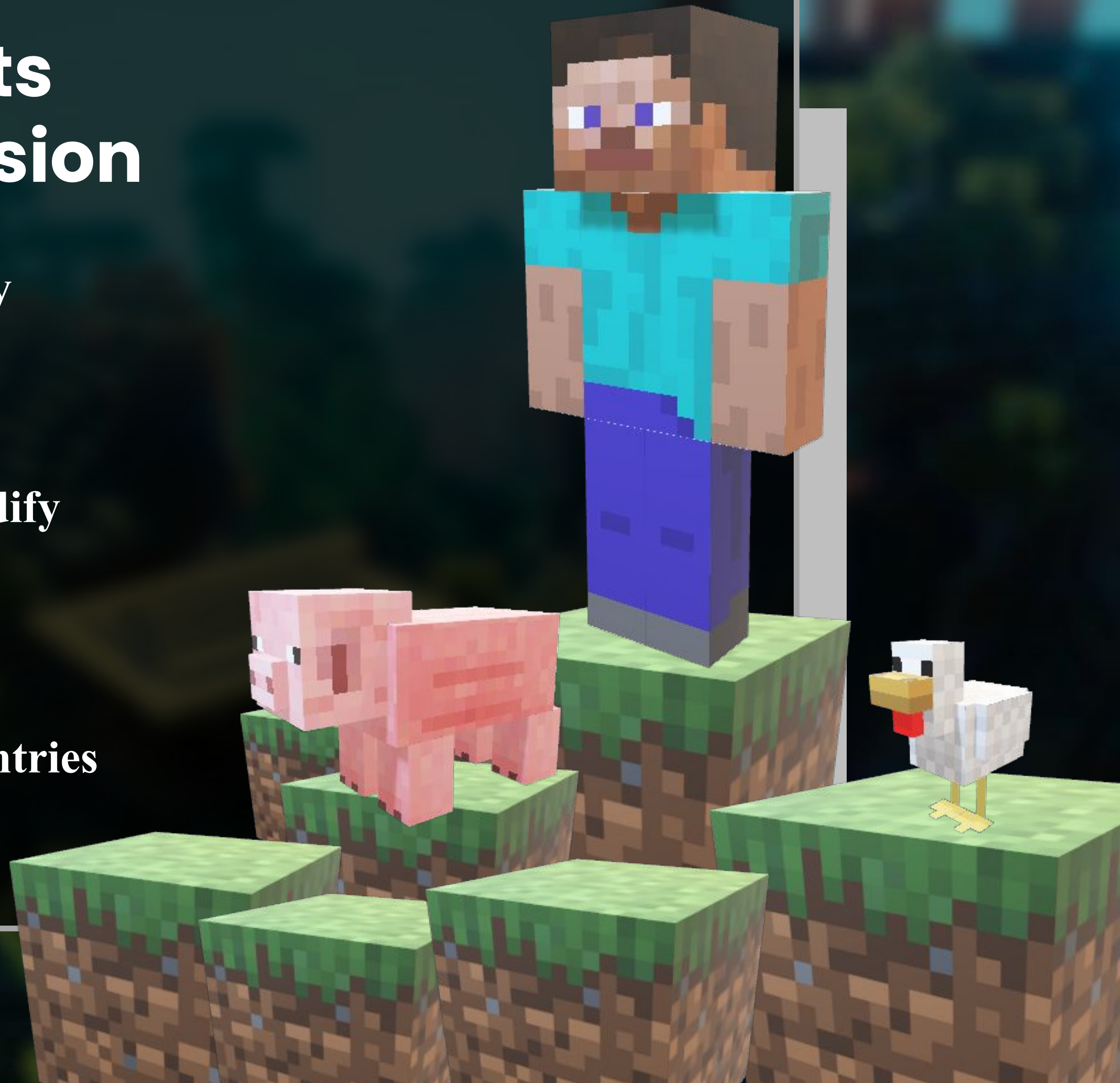
Our Creation

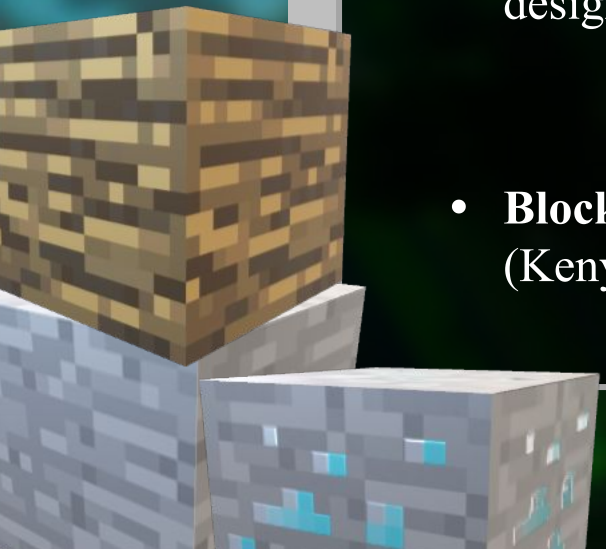
Simulation

Overview

Using Game Environments to Build Real-World Inclusion

- Used as a 3D platform for city and community planning
- Let's users **visualize, walk through, and modify** design ideas
- **Block by Block Initiative**: active in **30+ countries** (Kenya, Peru, Nepal, etc.)

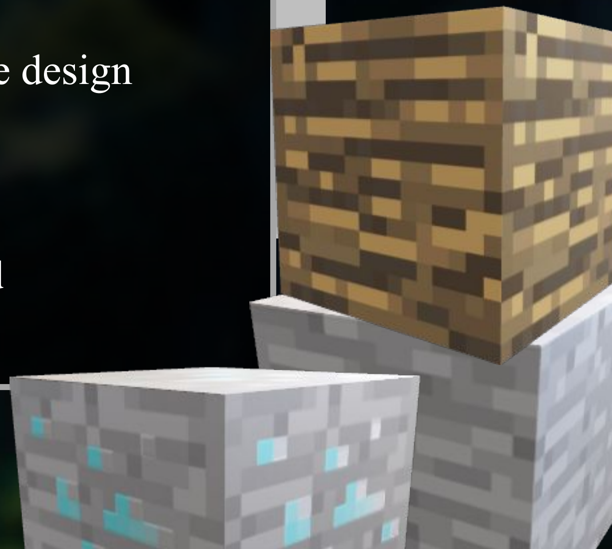




Overview

Using Game Environments to Build Real-World Inclusion

- Helps non-technical residents participate in planning
- Encourages **collaboration, creativity, and feedback** in real time
- Low-cost, accessible alternative to early-stage design software
- Used in education to teach **urban design and sustainability**

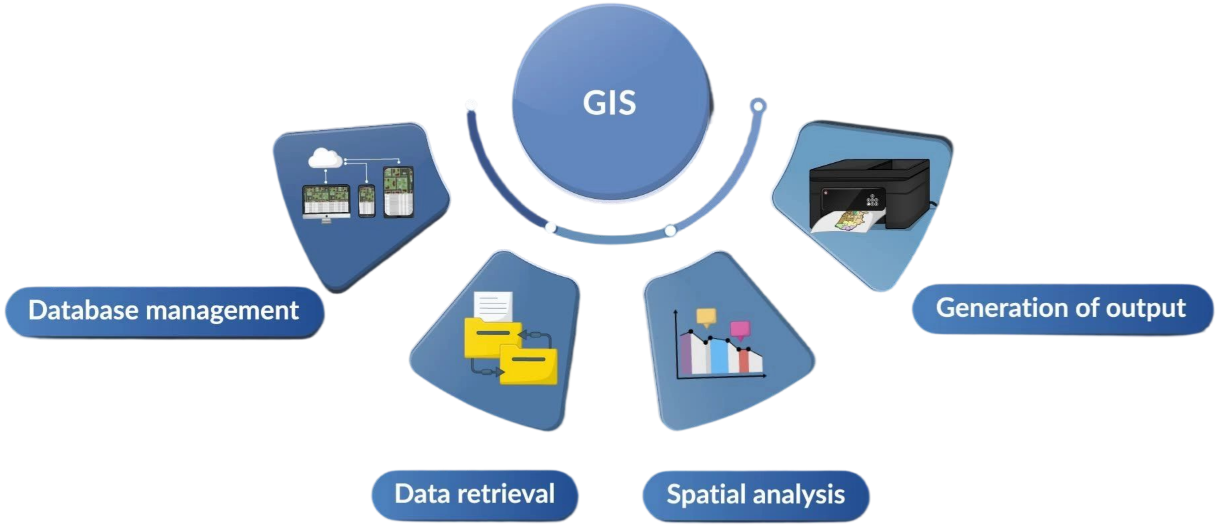



BACK

Introduction to Geographic Information System (GIS)

- **Definition:** A system to collect, analyze, and visualize spatial data.
- **Purpose:** Converts complex data into meaningful geographic insights.
- **Importance:**

1. Supports decision-making (urban planning, disaster response, environment).
2. Integrates technology with real-world problem solving



GIS in Urban Development & Architecture

Urban Development

- Visualizes land use, population, and infrastructure needs.
- Aids in sustainable and efficient city planning.
- Helps simulate and test urban growth scenarios.

Architecture

- Uses spatial data for design and site planning.
- Integrates real-time info (traffic, environment) for adaptive design.
- Enhances energy efficiency and sustainability.

GIS Applications & Case Studies

Key Applications

- **Site Analysis:** Cultural & physical context in design.
- **Sustainability:** Data-driven, eco-friendly design.
- **Disaster Resilience:** Risk-based architectural planning
- **3D Modeling:** Real-time visualization & stakeholder communication.

GIS Applications

Key Applications

- **Site Analysis:** Cultural & physical context in design.
- **Sustainability:** Data-driven, eco-friendly design.
- **Disaster Resilience:** Risk-based architectural planning
- **3D Modeling:** Real-time visualization & stakeholder communication.

The Use of GIS Across Various Architectural Disciplines.

Real World Examples

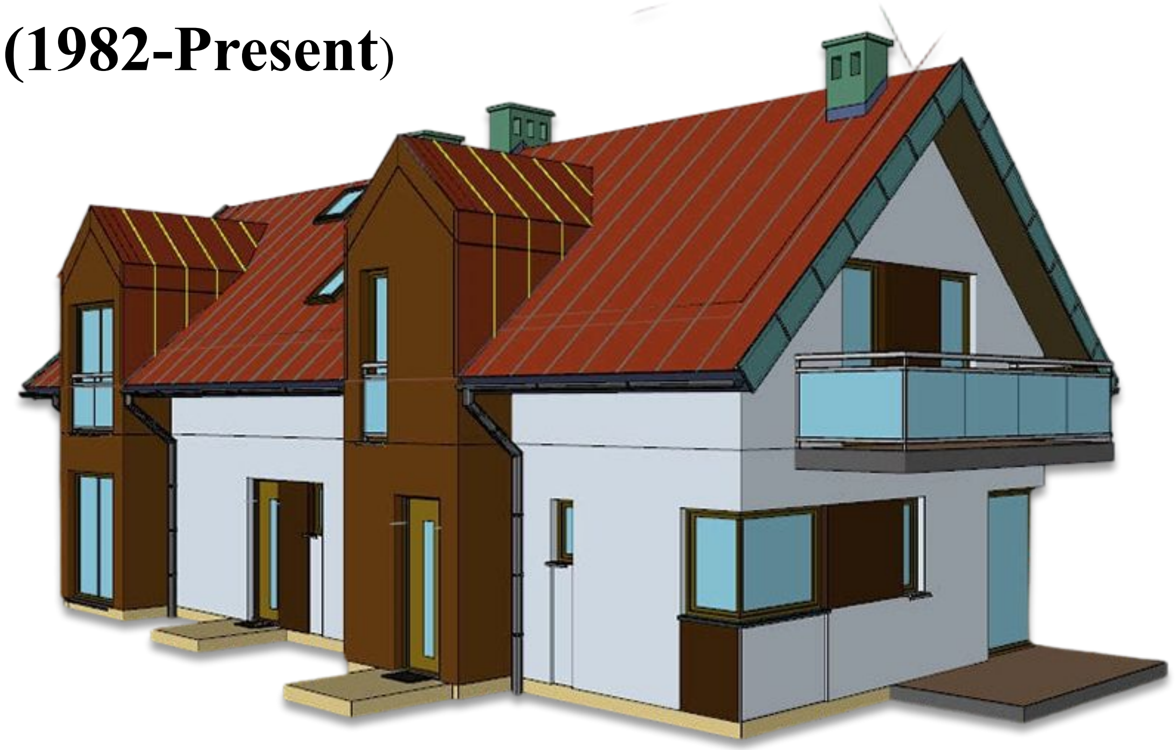
- **Ampang Jaya, Malaysia:** 3D GIS for urban design & growth visualization.
- **Cacak, Serbia:** GIS for sustainable land management.
- **Jinghong, China:** Ecological architecture via GIS & parametric design.

(Xishuangbanna, Jinghong District, China)

AutoCAD Evolution

From Drawing Boards to Digital Canvasses (1982-Present)

- Founded by Autodesk in 1982
- First affordable CAD at $1,000
- 31 versions over 35 years
- Became industry standard (DWG format)
- Revolutionized architectural workflow



(A House Model Made in CAD)

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BURJ KHALIFA

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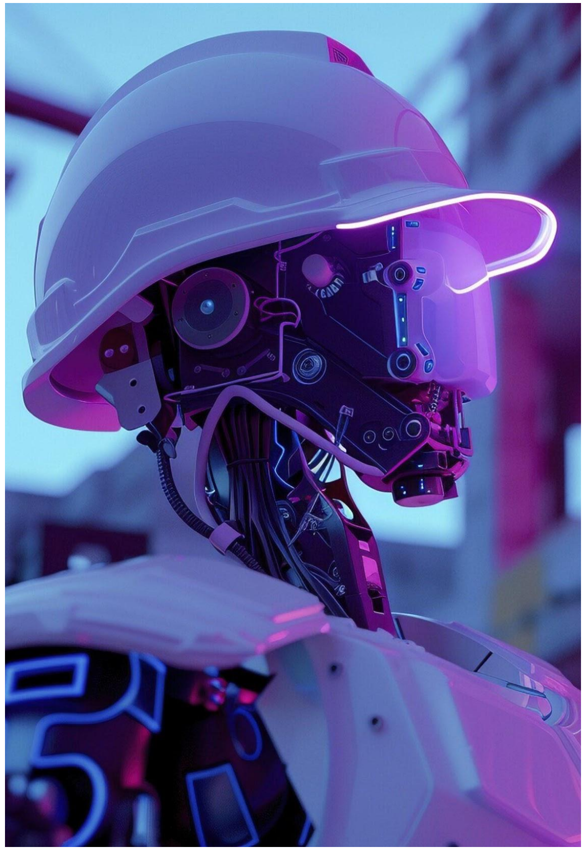

AUTOCAD ROLE

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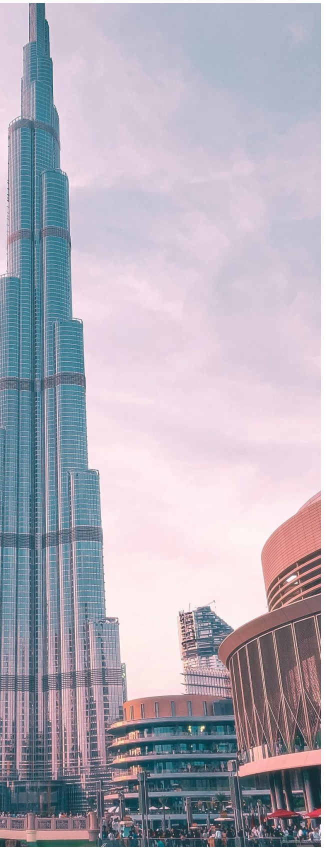

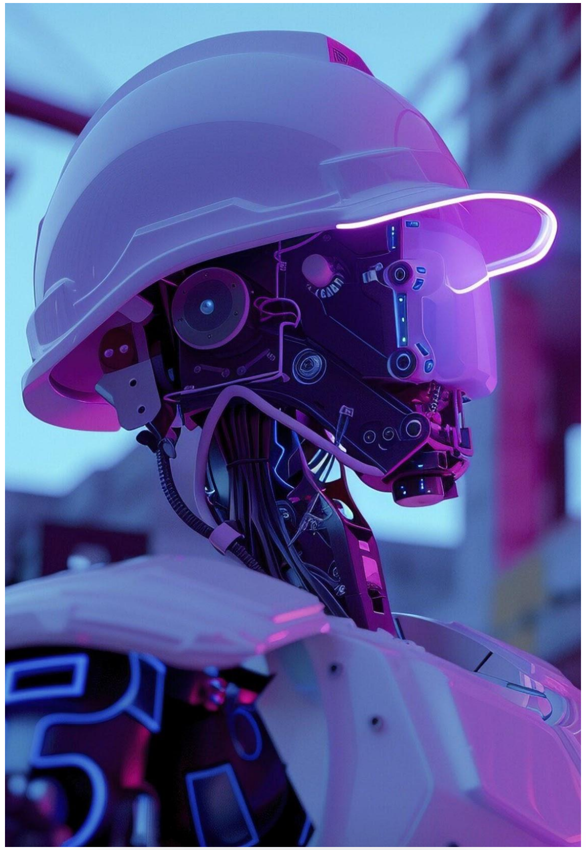

FUTURE

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SIMULATION

Burj Khalifa Overview

World's Tallest Building - 828m, 162 Floors

Design Challenges:

- Extreme wind loads at unprecedented height
- Complex Y-shaped geometry
- Coordinating thousands of contractors
- Desert climate conditions

Technologies Used:

- CAD for precise drafting and modeling
- BIM for construction coordination
- 3D simulation for risk assessment

BACK

AutoCAD's Role in Burj Khalifa

Making the Impossible Possible

- Precise geometry calculations for each floor
- Coordinated architectural, structural & MEP systems
- Managed thousands of construction drawings
- Linked with structural analysis software
- Enabled global team collaboration

BACK

Impact on Future Architecture

Building Tomorrow

- Enables complex geometries and ambitious designs
- Integration with AI and sustainability tools
- Global collaboration and cloud workflows
- CAD-driven prefabrication and automation
- Foundation for next-generation BIM platforms

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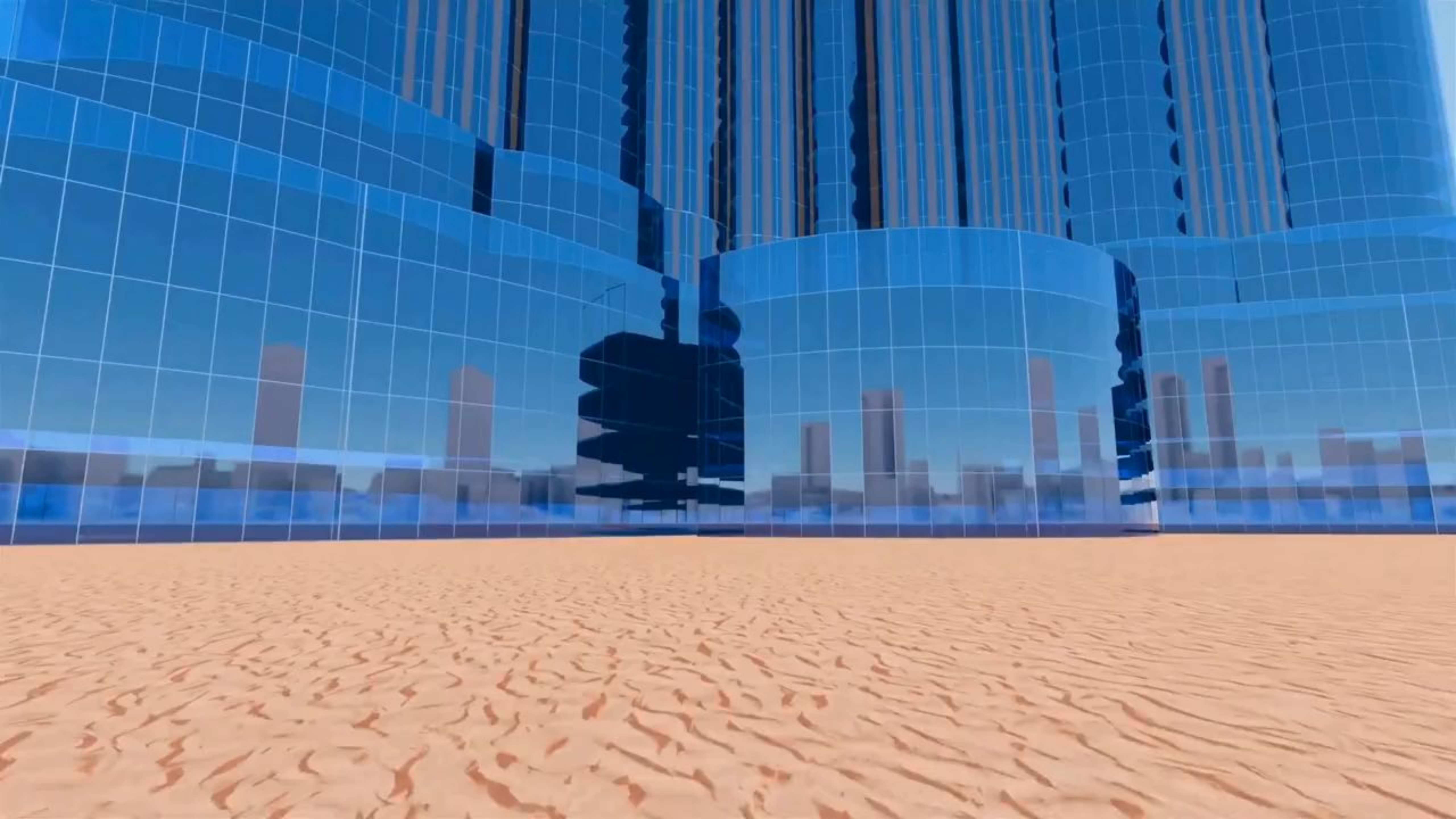


Introduction to BIM

What is Building Information Modeling (BIM)?

BIM is a **digital process** that creates intelligent 3D models for the **entire building lifecycle** — from design to operation.

- Unlike traditional CAD, BIM models are **"smart"** — they know what each element is, its properties, and how it connects to others.
- **Simple Definition:** A *digital twin* of a building containing all info for efficient design, construction, and management.

PHASES OF BIM

BIM consists of three main phases:

- Designing.
- Constructing.
- Operating.

PHASES OF BIM

BIM consists of three main phases:

- Designing.
- Constructing.
- Operating.

1. Design Phase

Architects and engineers create the building digitally.

Example: Detecting duct & wiring conflicts in a hospital.

2. Build Phase

Used for precise construction, cost tracking, 4D scheduling.

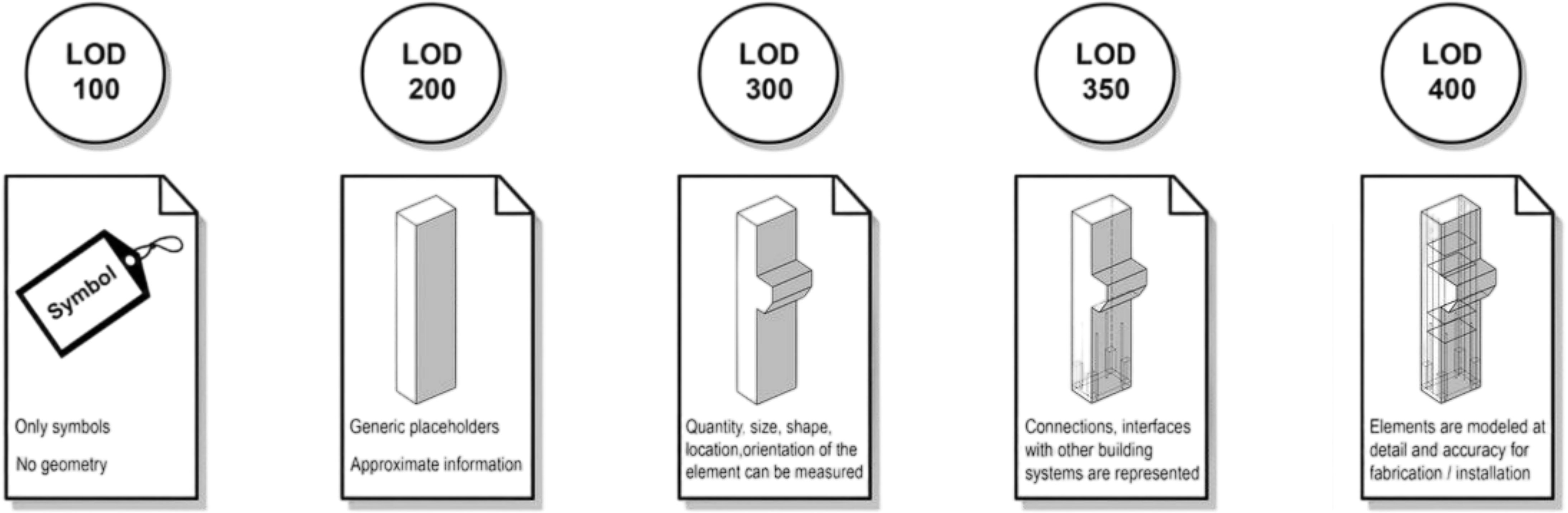
Example: Burj Khalifa coordinated 163 floors with BIM.

3. Operate Phase

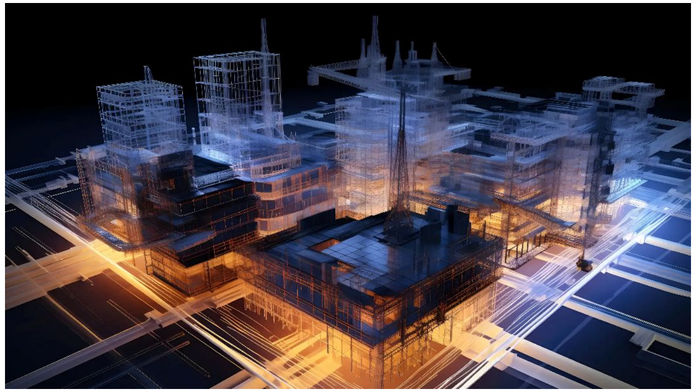
Used for facility management, predictive maintenance, energy optimization.

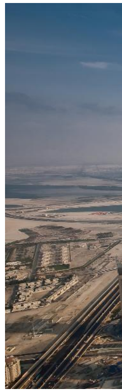
Example: The Edge, Amsterdam – 70% less energy use.

Levels of Development (BIM)



LOD 100: Concept **LOD 200:** Approximate design **LOD 300:** Precise elements **LOD 400:** Fabrication-ready **LOD 500:** As-built model



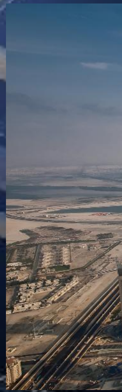


Advanced BIM Technologies

Modern Tools Enhancing BIM

- **Laser Scanning:** Converts real buildings into exact 3D data (e.g., Notre-Dame restoration).
- **Augmented Reality (AR):** View hidden pipes/wiring in real time on-site.
- **Mobile Integration:** Real-time updates, issue tracking, and team coordination.

These tools increase **accuracy, collaboration, and speed**.



Revit – The Core of BIM

Three Parts of Revit Software

- **Revit Architecture:** Design spaces, materials, and layouts (2D→3D auto generation).
- **Revit Structure:** Analyze loads, design beams, and reinforcement.
- **Revit MEP:** Create HVAC, electrical, and plumbing systems.
- *Example:* Designing a hospital—Revit MEP coordinates air, plumbing & power perfectly.

Real World BIM Success Stories

Famous Projects Using BIM

- **Burj Khalifa:** Coordinated 163 floors flawlessly.
- **London Olympics 2012:** BIM saved months via clash detection.
- **Changi Airport T5:** 30% less construction time using integrated digital twin.
- **Pentagon Renovation:** Used laser scanning for secure, phased construction.
- All examples show BIM improves **time, cost, and coordination**.

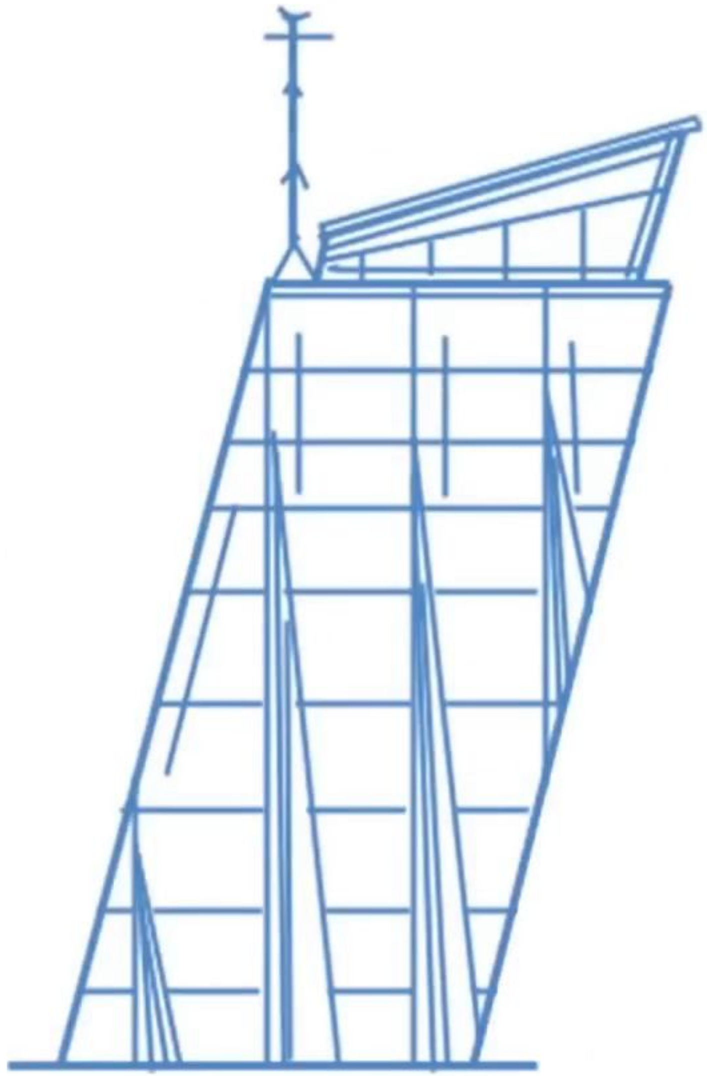
Future & Benefits of BIM

Why BIM is the Future of Construction

- **Quality:** Fewer errors, higher precision, better performance.
- **Quantity & Cost:** 10–15% cost reduction, accurate material estimates.
- **Future Trends:**
  - AI-driven design & digital twins
  - Robotics and blockchain integration

Cloud-based and mobile BIM

(Simulation Coming)

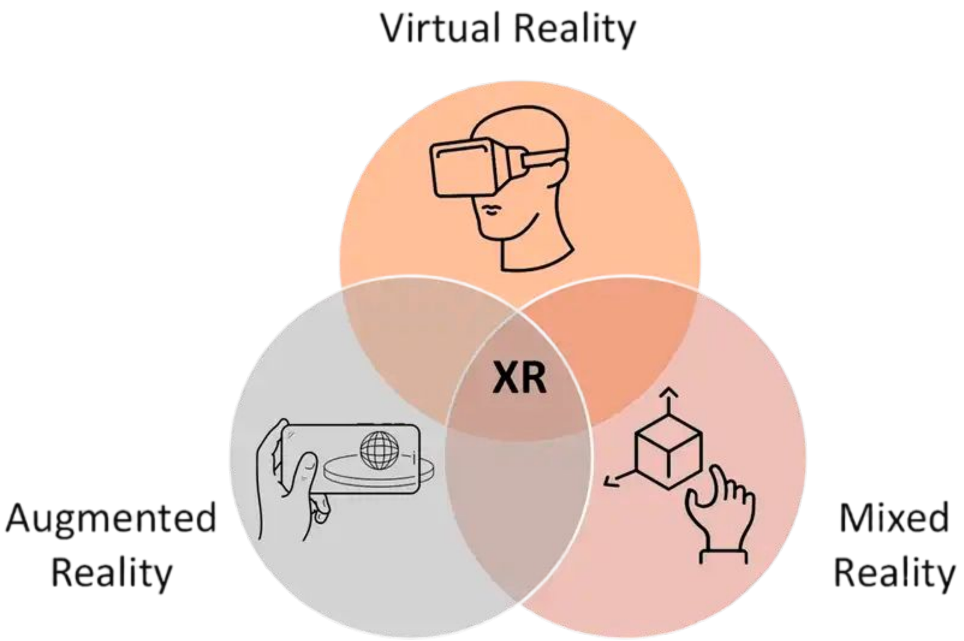


Integration of Immersive Technologies in Architecture

- Modern architecture now integrates Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) for advanced design and visualization.

- These technologies enable virtual exploration of structures before construction begins.

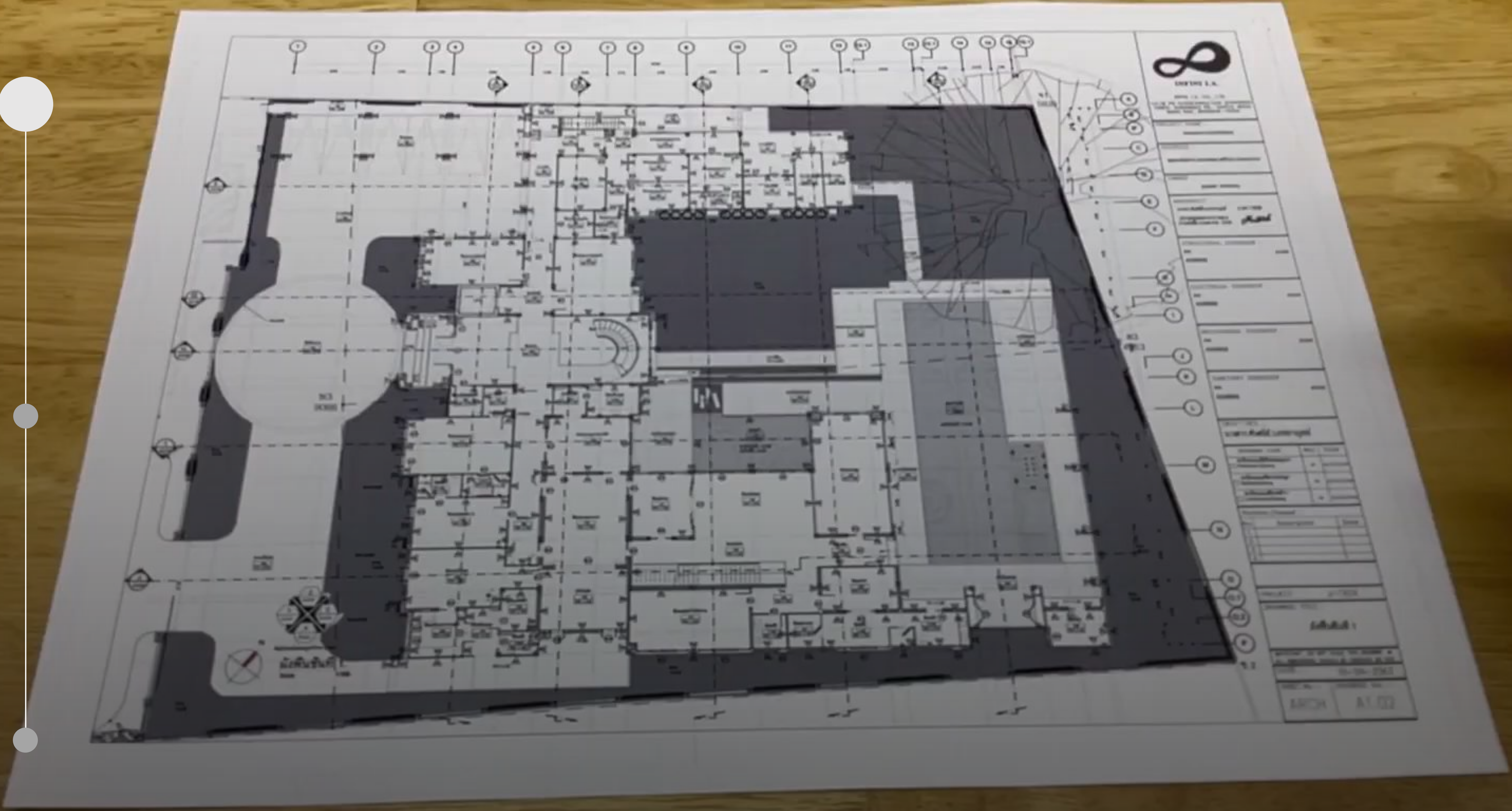
- They enhance design precision, client understanding, and overall project efficiency.



Augmented Reality (AR):

- Shows digital models on real sites.
- Helps visualize buildings in real surroundings.
- Useful for quick edits and construction planning.

(Simulation Coming)


ARCH

Virtual Reality (VR):

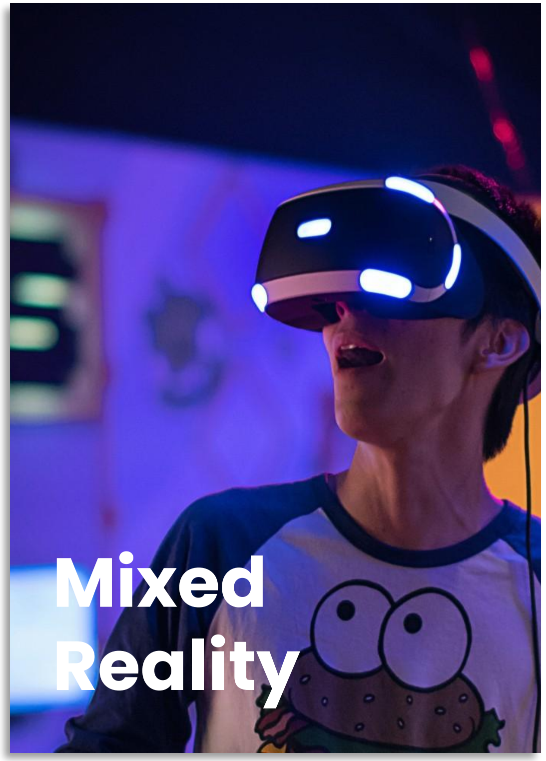
- Lets users walk inside 3D building designs.
- Tests space, lighting, and materials.
- Improves accuracy and finds design errors early.

(Simulation Coming)

Mixed Reality (MR):

- Blends real and virtual worlds.
- Allows interaction with 3D models in real space.
- Supports teamwork and live design updates.

(Simulation Coming)




Captured on Meta Quest Pro


Zaha Hadid Architects

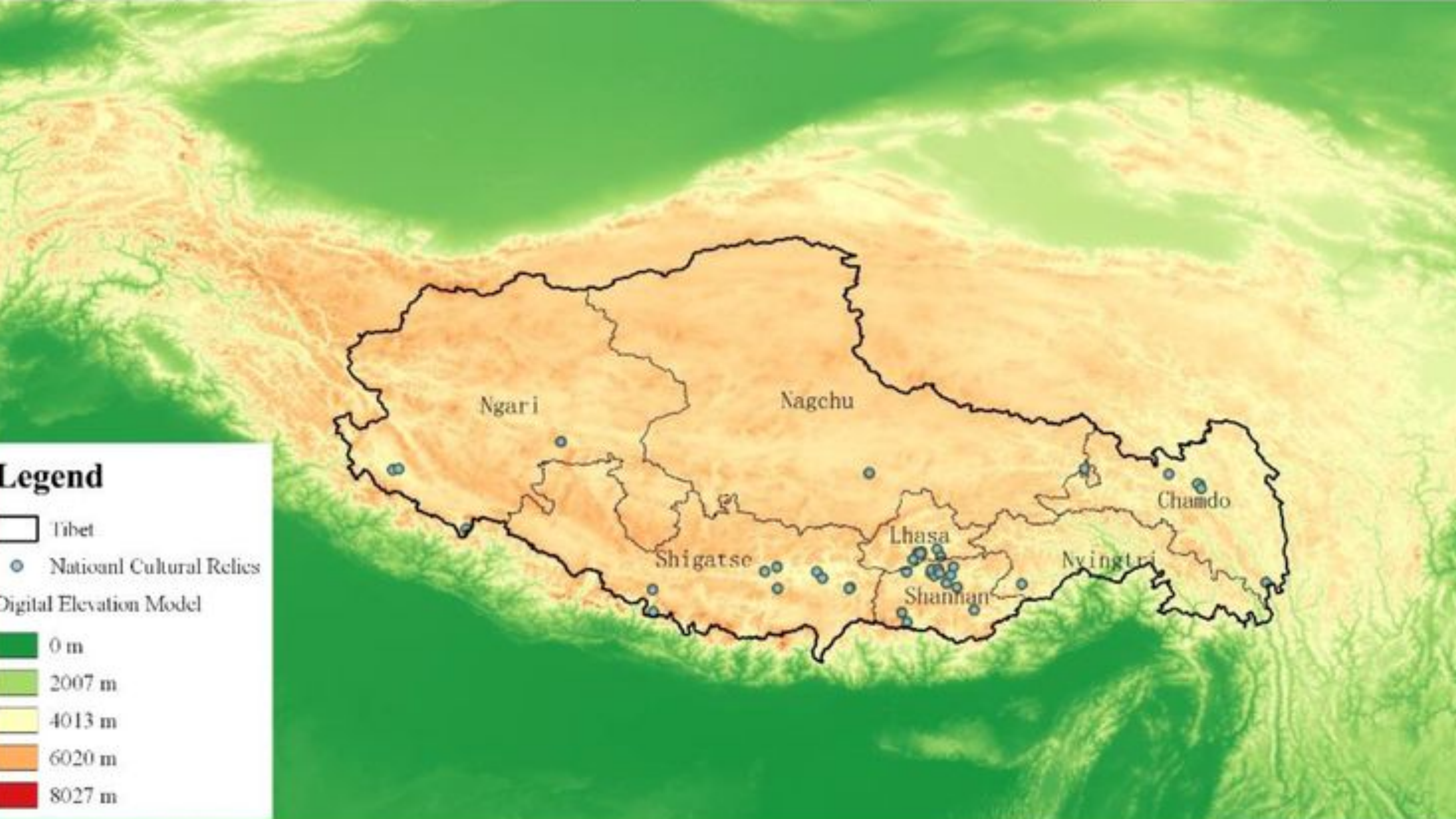
- Helps find mistakes early and saves time.
- Makes designs easy for clients to understand.
- Improves teamwork and supports creative ideas. Famous Examples :
  Zaha Hadid Architects used these technologies in:

  - BMW Central Building (Germany)
  - Guangzhou Opera House (China
- These projects show how technology helps create modern and beautiful buildings.

UAVs in Architecture

UAV's use in architecture

- Pilotless drones with AI & sensors.
- **Uses**: surveying, mapping, inspections, safety checks, project monitoring.
- **Types**: Fixed-wing, Multi-rotor (common), Single-rotor, VTOL.
- Examples: drones built a rope bridge; UAVs cooperatively built a wall (MBZIRC, 2020).


Ngari
Nagchu
Chamdo
Lhasa
Shigatse
Nyingtri
Shannan
Legend
Tibet
Natioanl Cultural Relics
Digital Elevation Model
0 m
2007 m
4013 m
6020 m
8027 m

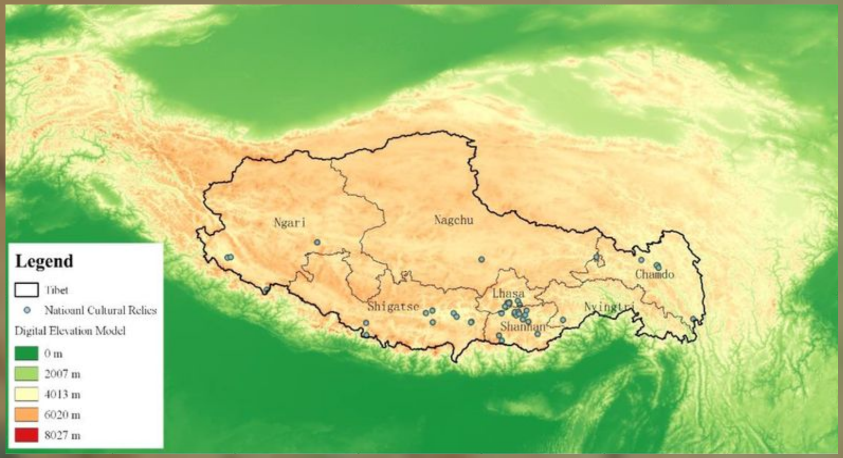
Using Drones for Tibetan Architectural Heritage

Background:

- Tibet’s high altitude (≈4900 m) and harsh terrain make traditional surveys difficult.
- There is a need for portable, low-cost, and accurate documentation techniques.

Objective:

- To evaluate the UAV + Structure from Motion (SfM) method for 3D architectural heritage documentation.
- Compare accuracy with Terrestrial Laser Scanning (TLS).



NEXT

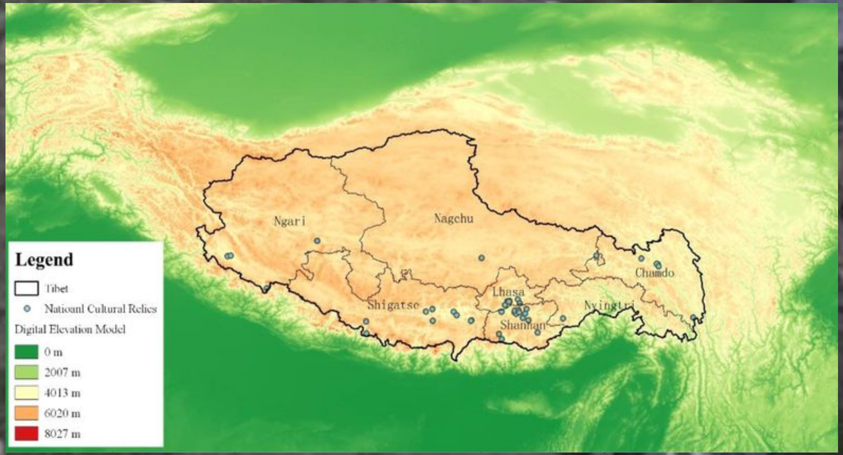
PREV

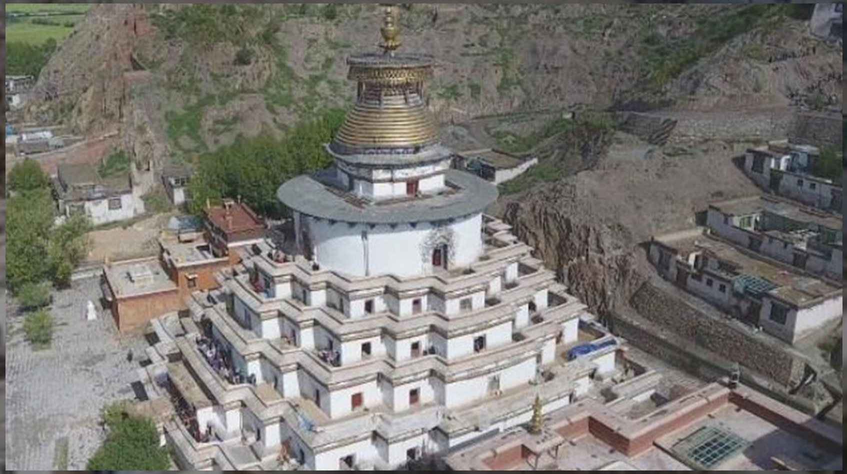
Case Study: Auspicious Multi-Door Stupa

Palcho Monastery, Gyantse, Tibet (built AD 1418–1436).

NEXT

PREV





Case Study: Auspicious Multi-Door Stupa

Methodology:

- **Drone:** DJI Phantom 4; 317 usable images captured during 6 manual flights.
- **Ground Control Points** (GCPs): 55 measured via total station.
- **Comparison**: UAV-SfM model vs. TLS (Leica C10) model.
- **Data Processing**: Agisoft PhotoScan; Bundle Adjustment used to improve accuracy.

NEXT
PREV

Findings:

UAV-SFM

- Achieved 2.05 cm RMSE (≈1/2500 accuracy).
- **Coverage:** >95% completeness vs. ≈40% by TLS.
- Demonstrated as low-cost, portable, and efficient for large heritage sites.

Applications:

- Supports Historic Building Information Modeling (HBIM).
- Enables structural deformation and settling analysis.
- Integrates with GIS for large-scale heritage management and visualization.

Internet of Things (IoT)

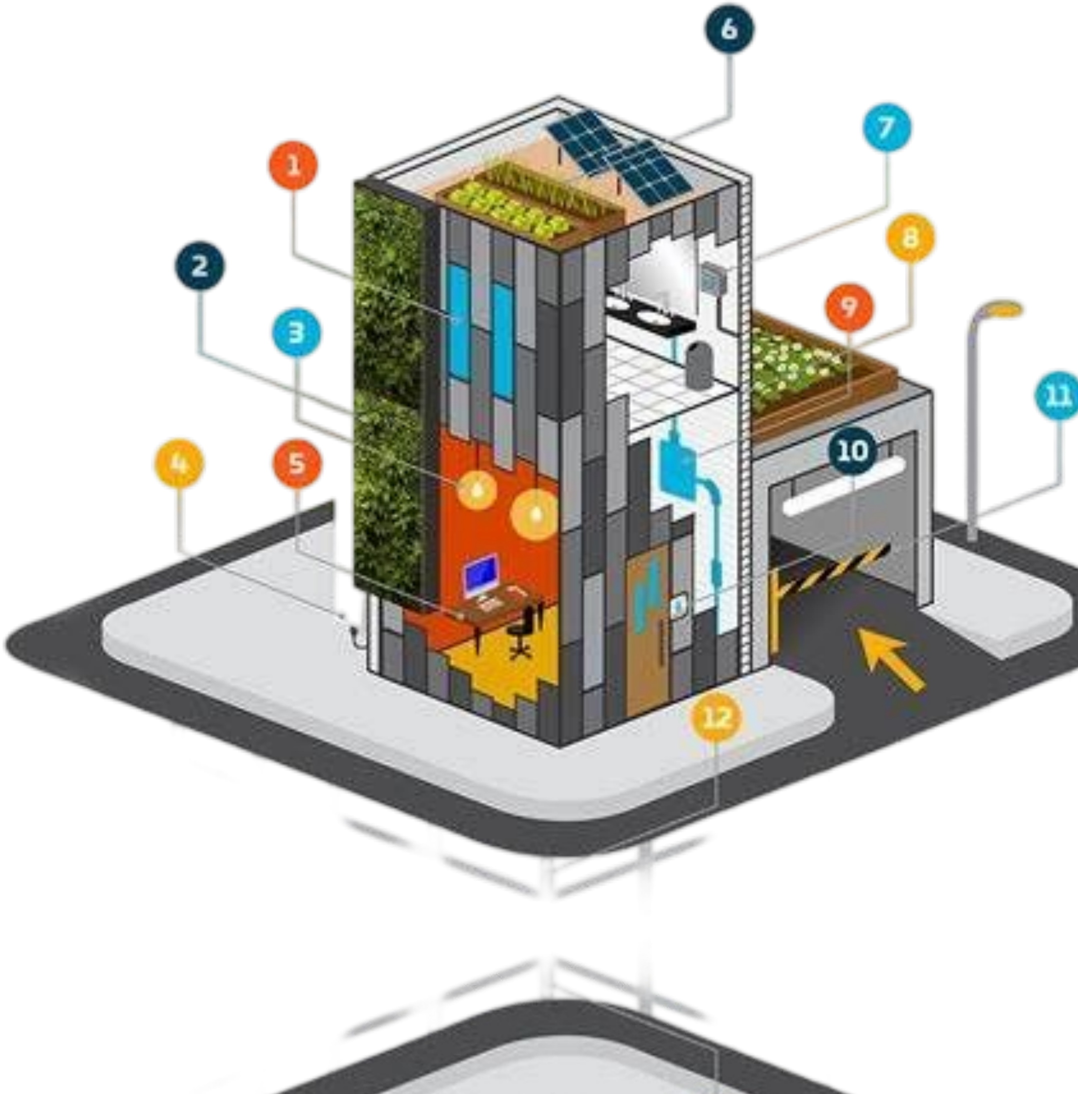
• Buildings use embedded sensors and connectivity for real-time monitoring and control.

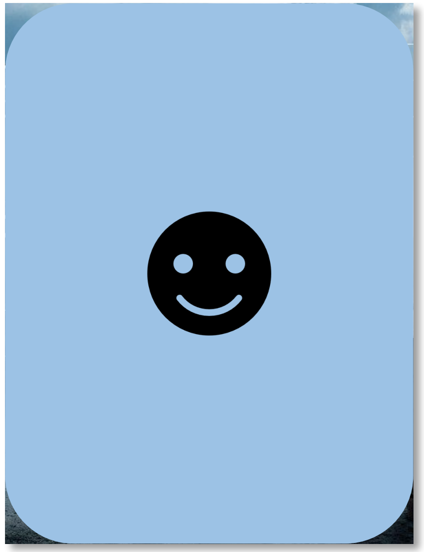
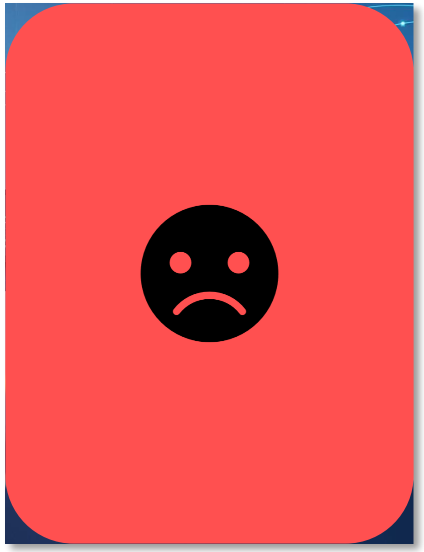
• IoT acts as the building's nervous system—tracking light, motion, air quality, and energy use.

• Enables automated HVAC, lighting, security, and access systems.

• Structures adapt to users and environment, shifting from static design to dynamic, responsive spaces.

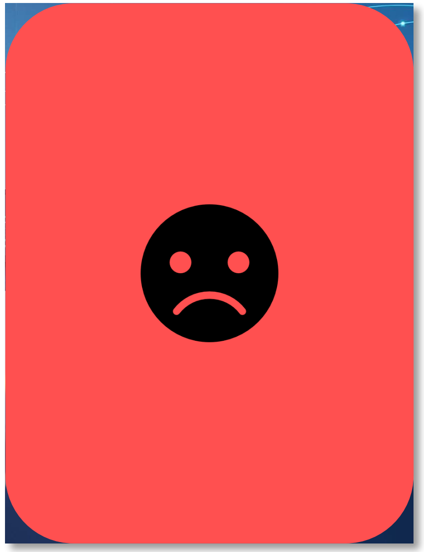
• Architecture becomes a living system that blends aesthetics, function, and interaction.



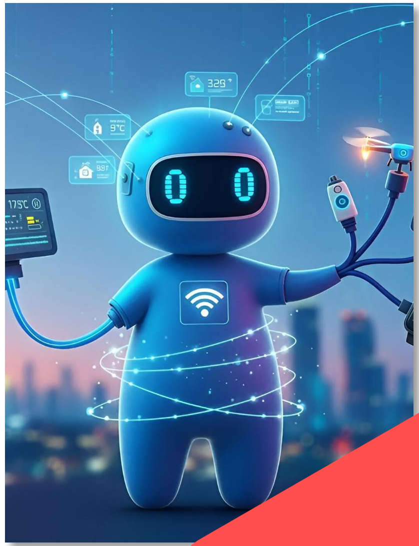

Benefits

Enhances energy efficiency, comfort, and sustainability, reduces costs through predictive maintenance, and improves overall building performance.



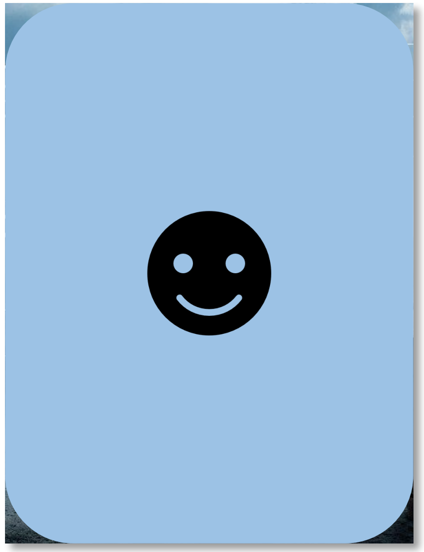
Challenges

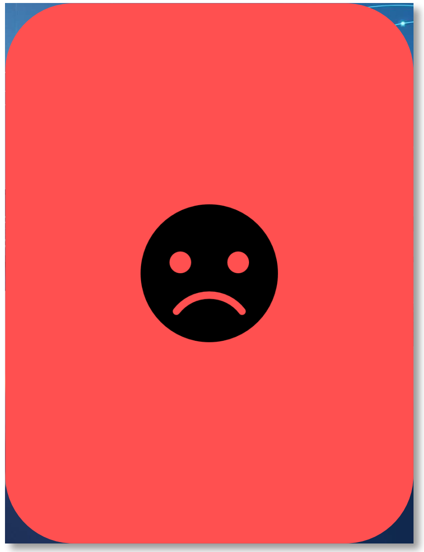
High setup costs, cybersecurity risks, technical complexity, and data management issues.



Mitigations

Use strong encryption, secure networks, regular updates, and comprehensive user training.






PALAZZO
FONTAINEBLEAU

THE LAS VEGAS SPHERE:

1. **Smart Environmental Control:** IoT sensors regulate temperature, humidity, and air quality to ensure optimal comfort for audiences.
2. **Dynamic LED Management:** Over 1.2 million IoT-connected LEDs synchronize in real-time to create immersive visual displays.
3. **Predictive Maintenance:** IoT systems monitor equipment performance, detecting faults early to reduce downtime.
4. **Seamless Visitor Experience:** Connected devices manage lighting, sound, and interactive elements to personalize audience engagement.

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Architecture Before ICT

Designing Before the Digital Era

MANUAL

hand-drawn blueprints, drafting tables, scale models

BASIC

plumb bobs, measuring ropes, theodolites, and drawing boards

PRE-DIGITAL

all revisions done by hand, often taking weeks

TIME

A medium-sized building (5–10 floors) could take 6–12 months just for planning

CONNECT

Communication relied on physical meetings and paper documentation

ERRORS

High error margins due to manual scaling and poor version control

PRECISION

Ancient precision achieved through astronomy, geometry, and practical surveying, not digital tools

EXAMPLE

Ancient precision achieved through astronomy, geometry, and practical surveying, not digital tools

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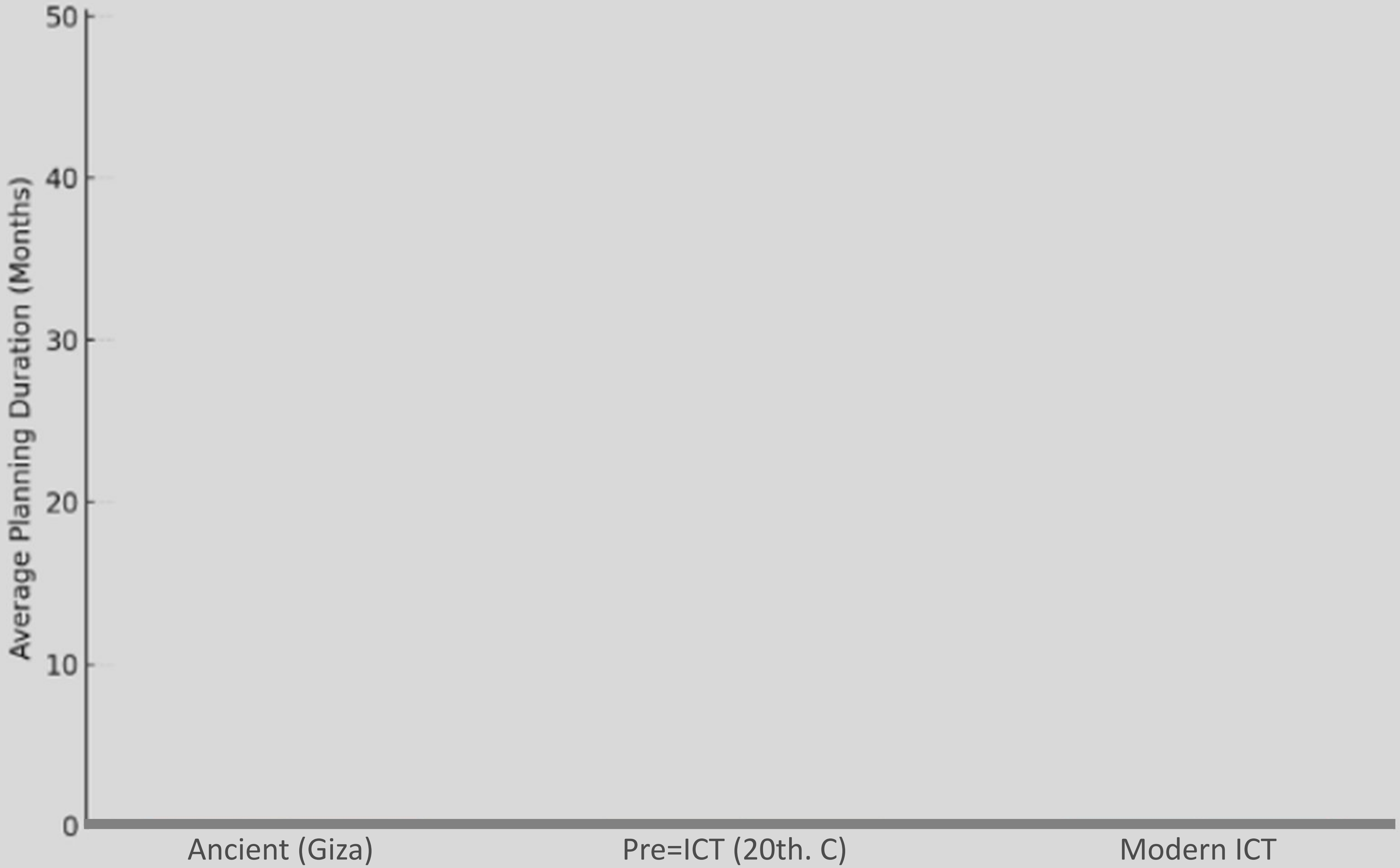
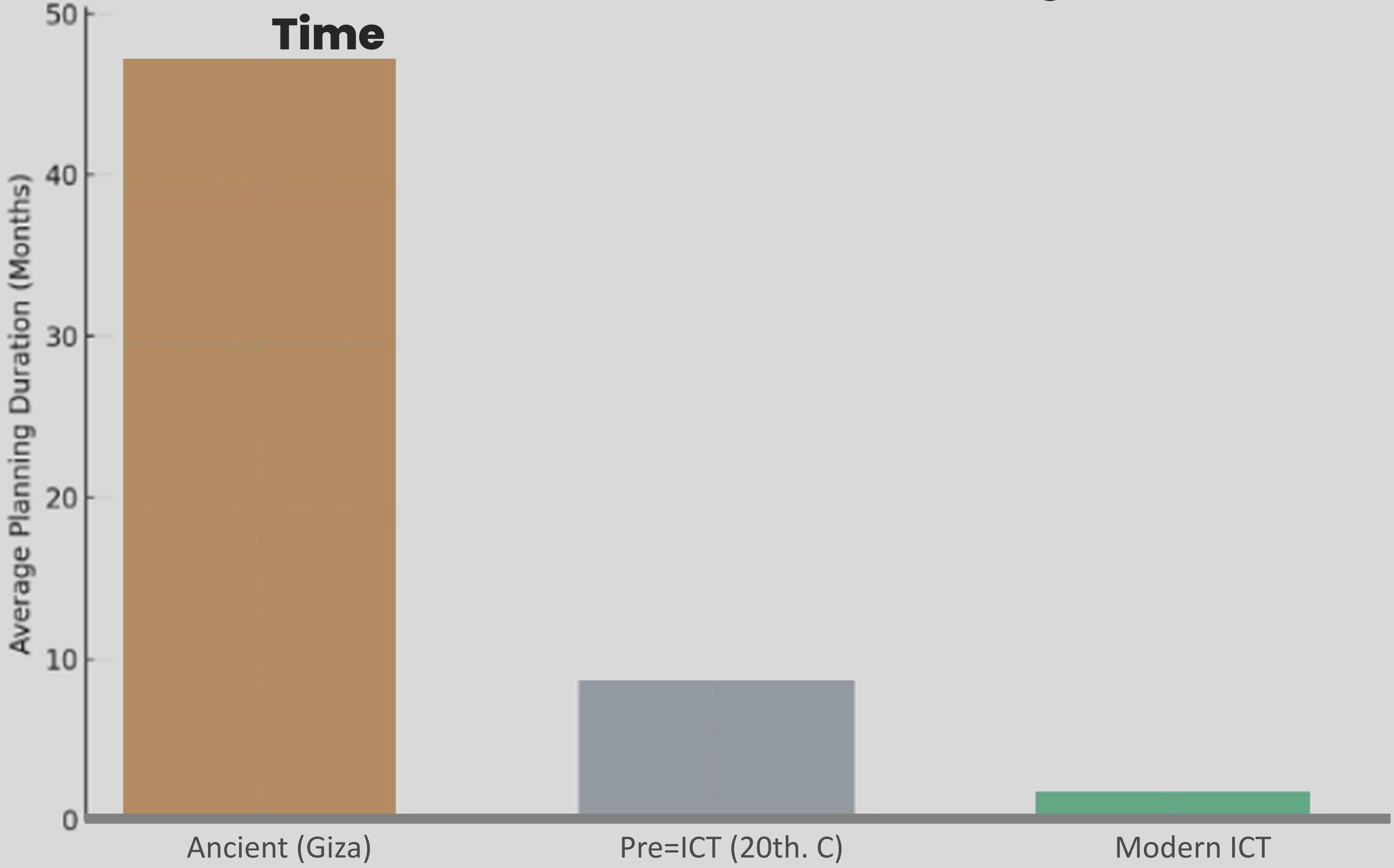

Average Planning Duration (Months)
50
40
30
20
10
0
Ancient (Giza)
Pre=ICT (20th. C)
Modern ICT

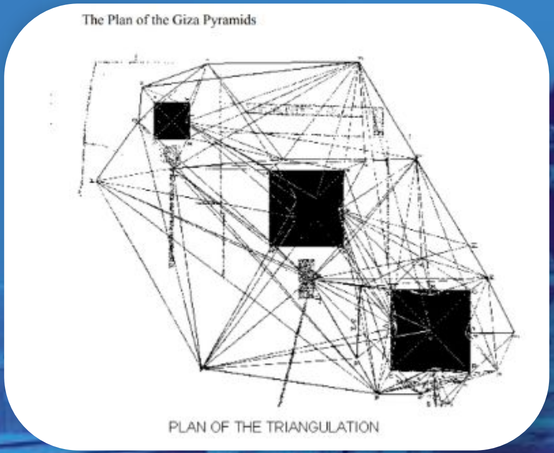
Evolution of Architectural Planning Time

BACK



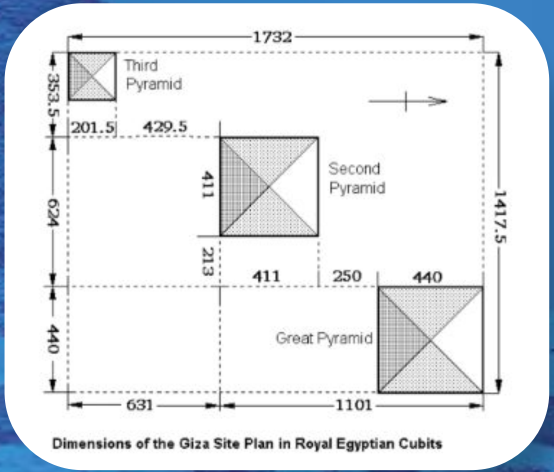
BACK

Precision Engineering Without Digital Tools (The Pyramids of Giza)



The Plan of Giza Pyramids

- Built by **skilled, paid workers** using ramps, sledges, and levers
- Aligned to **true north within ~0.05°** using Merkhet and Bay tools
- Base sides (230.4 m each) vary by **less than 20 cm**
- Used **grids, ropes, and pegging** for layout, early form of site mapping
- Hand-drawn plans on **papyrus and limestone flakes**
- Demonstrated **astronomical, mathematical, and surveying precision**
- Served as both **technological and symbolic monuments**



Dimensions of Giza Site

Digital Intelligence in Vertical Architecture

PLAN 1

DESIGN

- Designed using **BIM (Building Information Modeling)**
- Integrated all systems: architectural, structural, mechanical

PLAN 2

BENEFITS

- **20% reduction** in project time, **15% lower cost**
- Twisting form cut **wind load by 24%**, saving **25–32% material**

PLAN 3

LESS ERROR

50–60% fewer design errors, **40–50%** less rework

PLAN 4

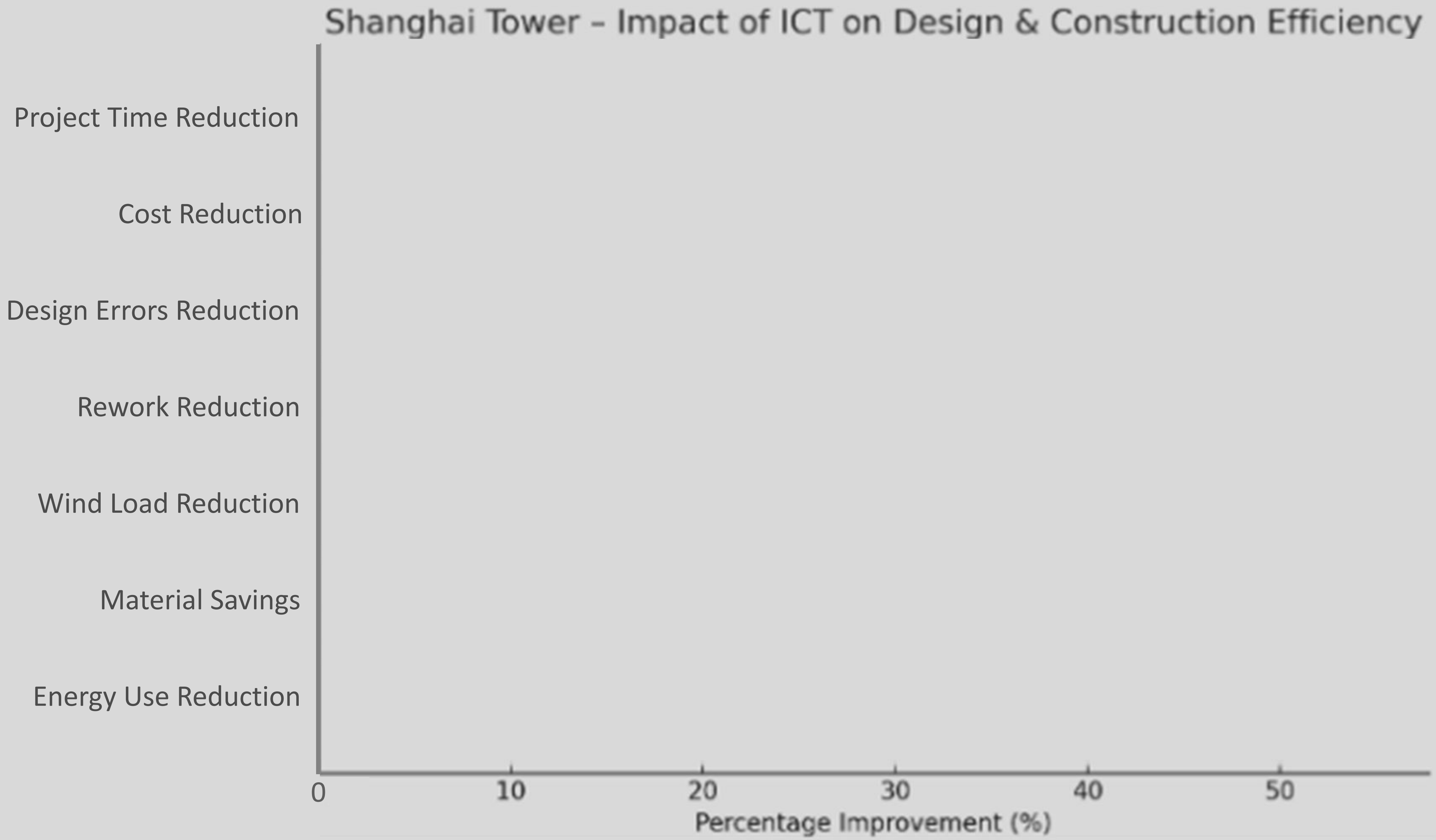
PERFOMANCE

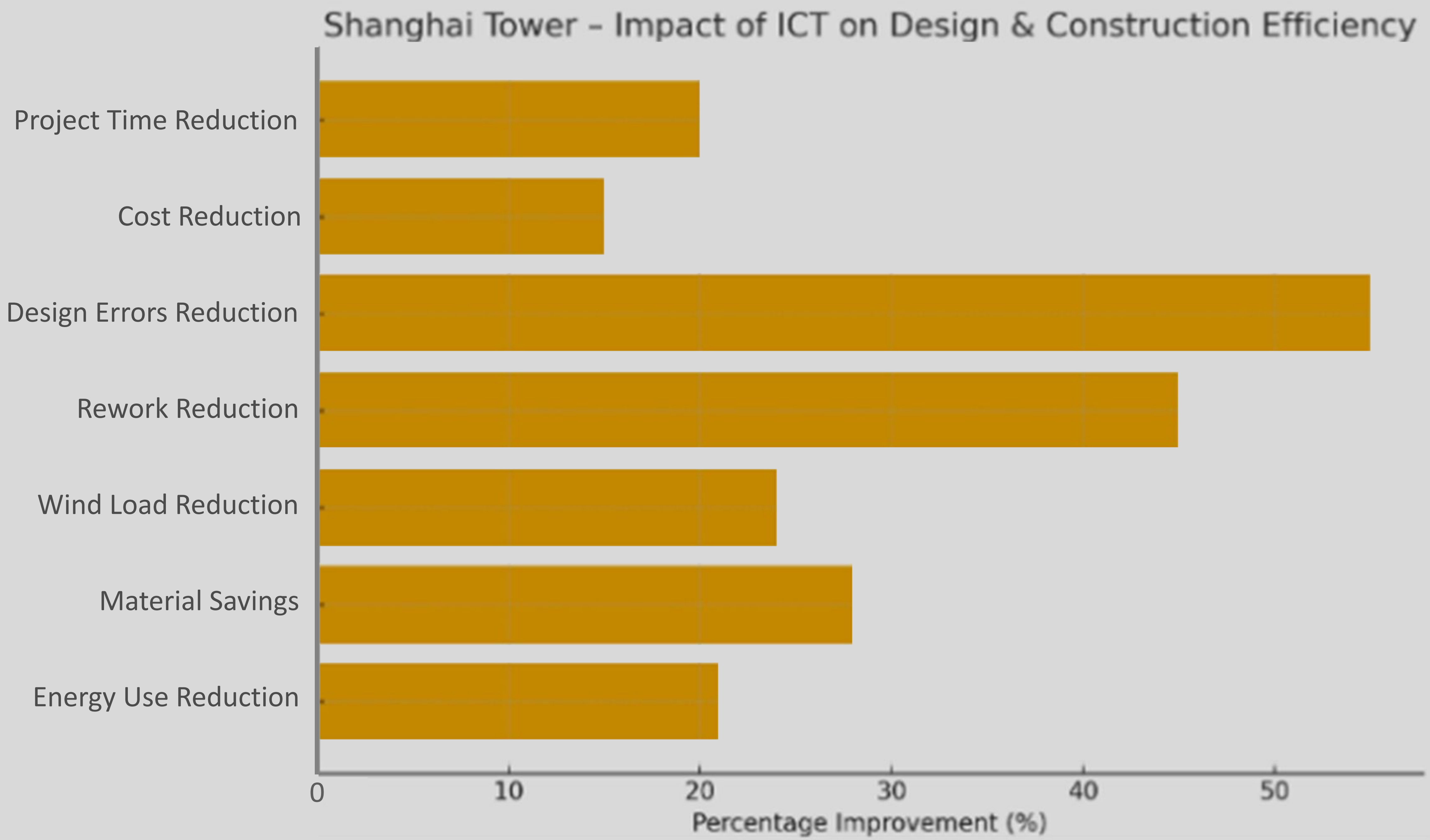
Equipped with **IoT sensors** for real-time performance monitoring

PLAN 5

SIMULATION

Used **VR/AR** for stakeholder visualization and safety training


Shanghai Tower – Impact of ICT on Design & Construction Efficiency
Project Time Reduction
Cost Reduction
Design Errors Reduction
Rework Reduction
Wind Load Reduction
Material Savings
Energy Use Reduction
0
10
20
30
40
50
Percentage Improvement (%)



Shanghai Tower – Impact of ICT on Design & Construction Efficiency
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Material Savings
Energy Use Reduction
0
10
20
30
40
50
Percentage Improvement (%)

(Shanghai Tower)


VS

The Pyramids of GIZA

ANCIENT

Planning Tools	Knowledge System
Merkhet, star alignment, grids	Oral tradition, symbolic sketches

Precision	Workforce	Symbolism
±0.05° alignment	Manual, specialized craftsmen	Divine order & permanence

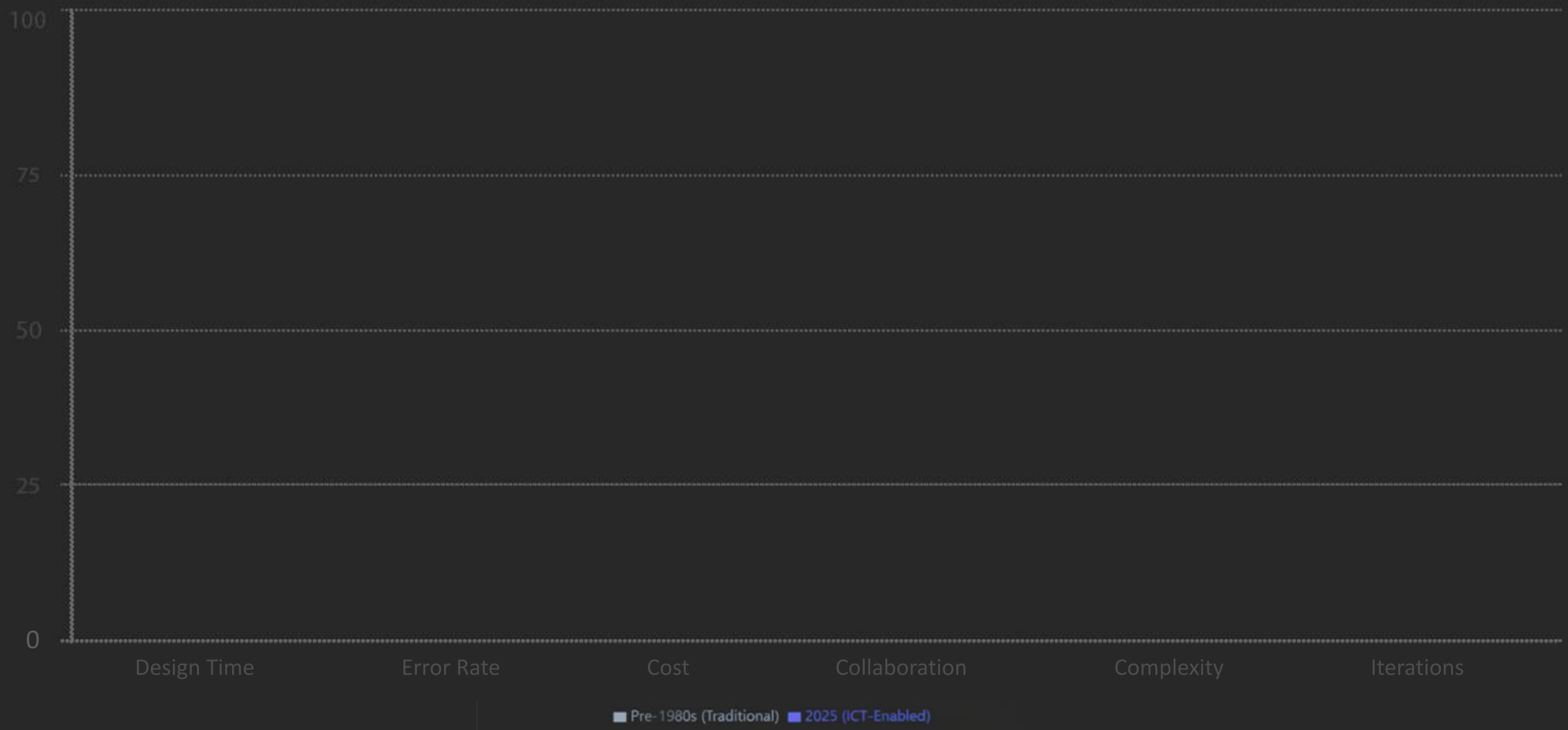
Shanghai Tower

MODERN

Planning Tools	Knowledge System
BIM, VR, parametric design	Digital twin, data-driven design

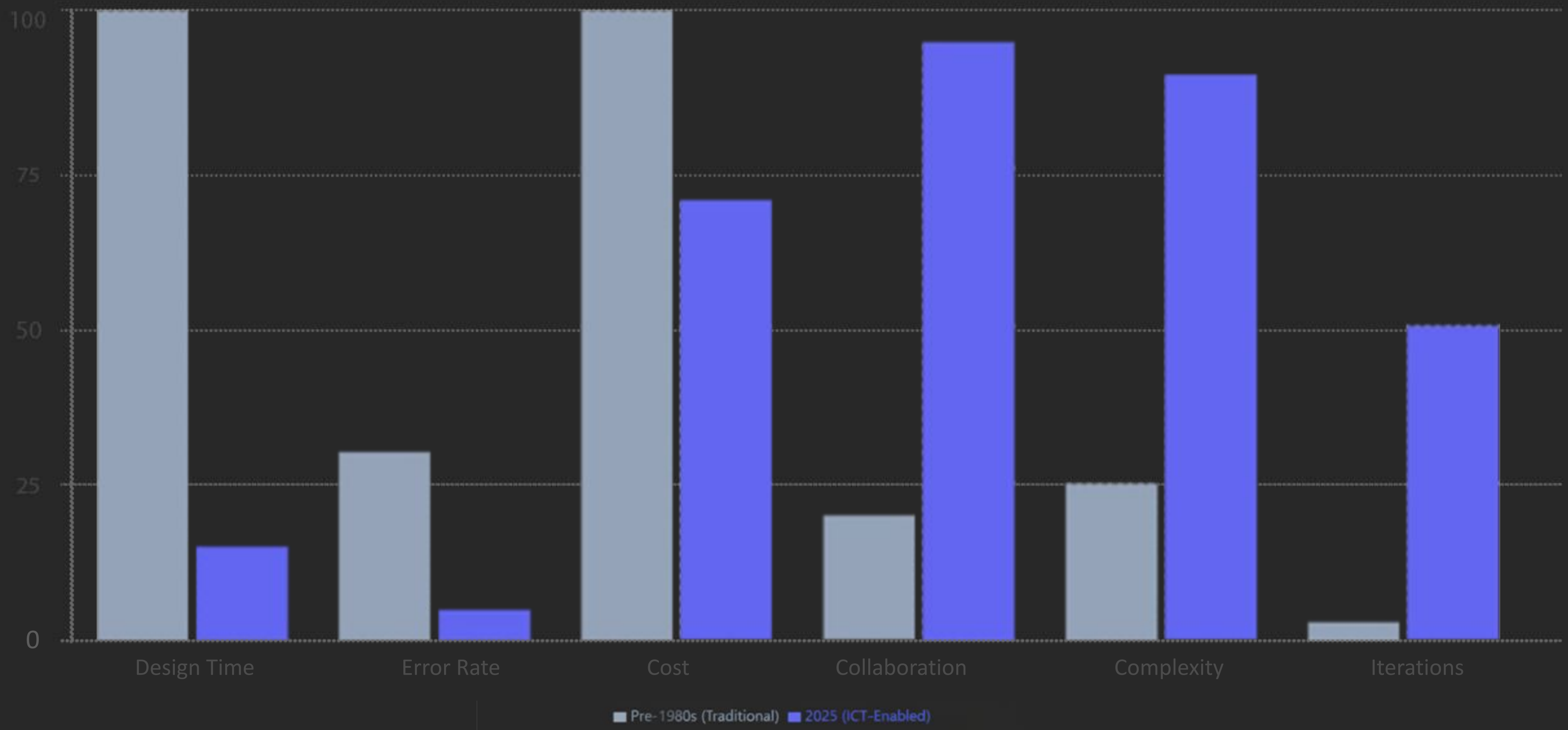
Precision	Workforce	Symbolism
Millimeter-level 3D accuracy	Global teams via ICT integration	Sustainability

Traditional vs ICT-Enabled Architecture



*Note: Lower is better for Design Time, Error Rate, and Cost. Higher is better for others.

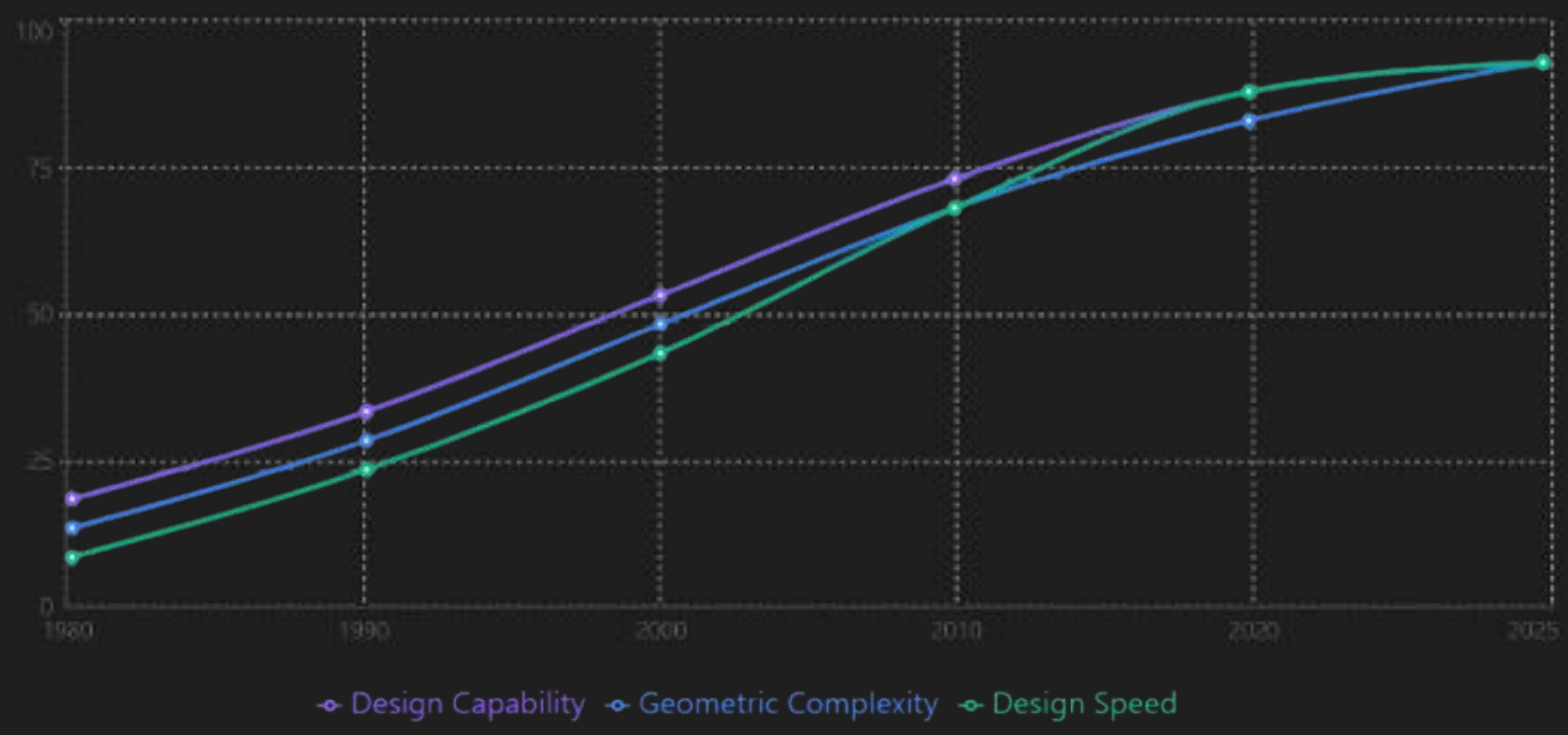
Traditional vs ICT-Enabled Architecture



*Note: Lower is better for Design Time, Error Rate, and Cost. Higher is better for others.

ICT Revolution in Architecture

Quantifying the Digital Transformation



Thank You