RECENT ADVANCEMENT IN CONSTRUCTION INDUSTRY

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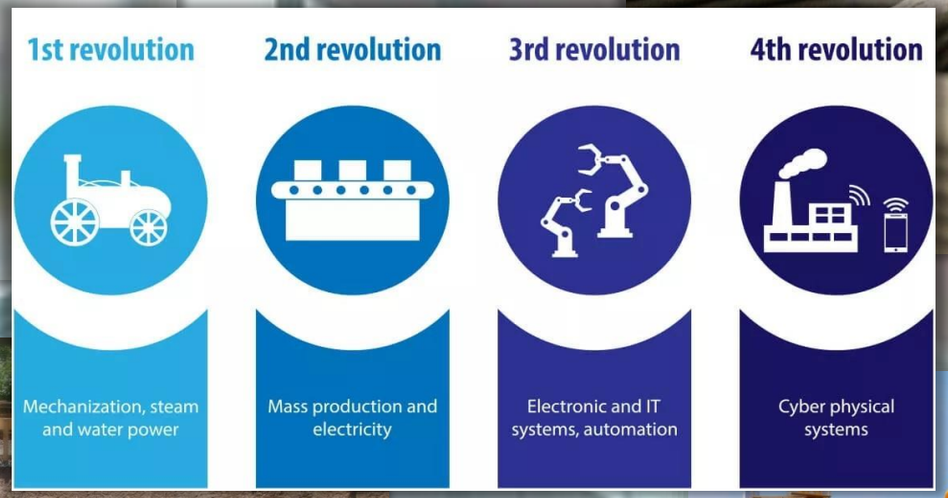
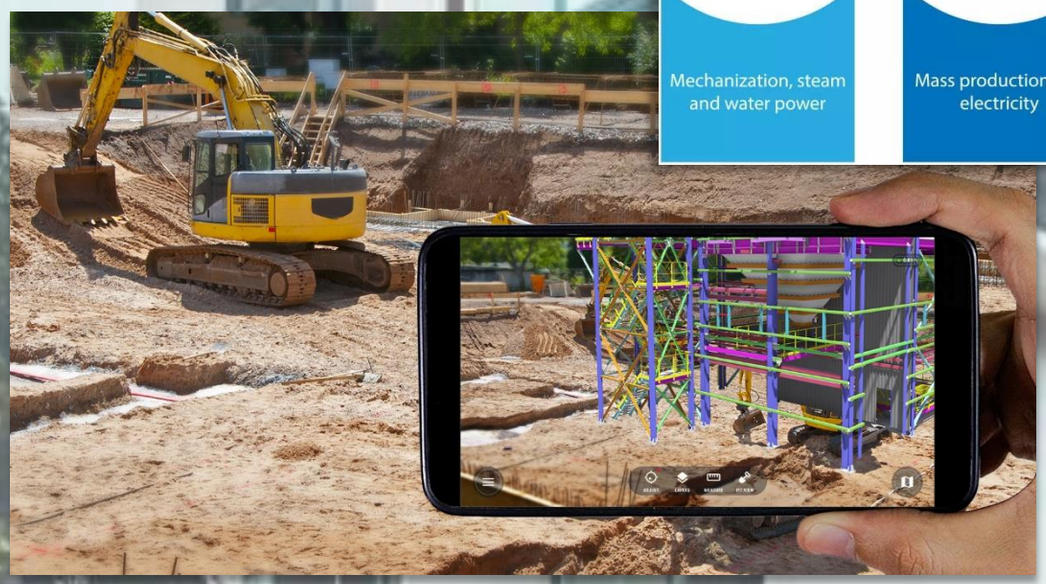




June 2024

"**COVID -19** will likely be known as the trigger that changed the way the world sees and carries out business"

(Ozguler, 2020)
PM World Journal (ISSN: 2330-4880)

- During the Pandemic (COVID-19) era, the engineering and Construction companies faced unprecedented downturn.

- The COVID-19 pandemic has introduced new challenges such as distancing on job sites, travel restrictions for project engineers, site safety and security, labor shortages, supply chains, unanticipated and prolonged delays, reduced productivity and cost overruns.

- It was not clear how the construction industries will adopt once the RECOVERY AND REBUILDING PHASE BEGINS.

Doi:10.20944/preprints202104.0383.v1

- The Engineering and Construction Industry stepped out of the pandemic crisis in a better state despite all odds.

- That’s happened because of the allowance for sustainable growth and the use of new technology in construction made it all possible

- This growth of industry has been on uptrend, which results from some key developments in the industry.

Doi:10.20944/preprints202104.0383.v1

- Some of these developments include construction methods, technology and software innovations and prevailing market conditions.

- Investments in infrastructure, energy and utility sectors, which continue to be significant drivers of the increase in total construction production, were also associated with other market trend.

https://www.intellectsoft.net/blog/8-emerging-construction-technology-trends

CONSTRUCTION MARKET OVERVIEW

"China, US and India will account for 57% of all global growth in the construction and engineering market by 2030 – underpinning the future economic development of the three countries that account for over a third of the world's population and economic output".

Global Construction Perspectives and Oxford Economics, the Global Construction 2030;

$ 17.5 trln

by 85%

The global construction market is set to grow by US$8 trillion by 2030, reaching a total size of $US17.5 trillion, up by 85% to 2030.

DEVELOPMENTS IN CONSTRUCTION INDUSTRY

- Benefits of adoption of emerging technologies
  - ✓ economic growth
  - ✓ increased productivity opportunities
  - ✓ reduce jobsite hazards and construction costs
  - ✓ improve profitability, affordability and financial sustainability
  - ✓ improve communication and information sharing between stakeholders
  - ✓ improve the industry's overall performance, enhance its reputation and increase profits.

https://www.intellectsoft.net/blog/8-emerging-construction-technology-trends

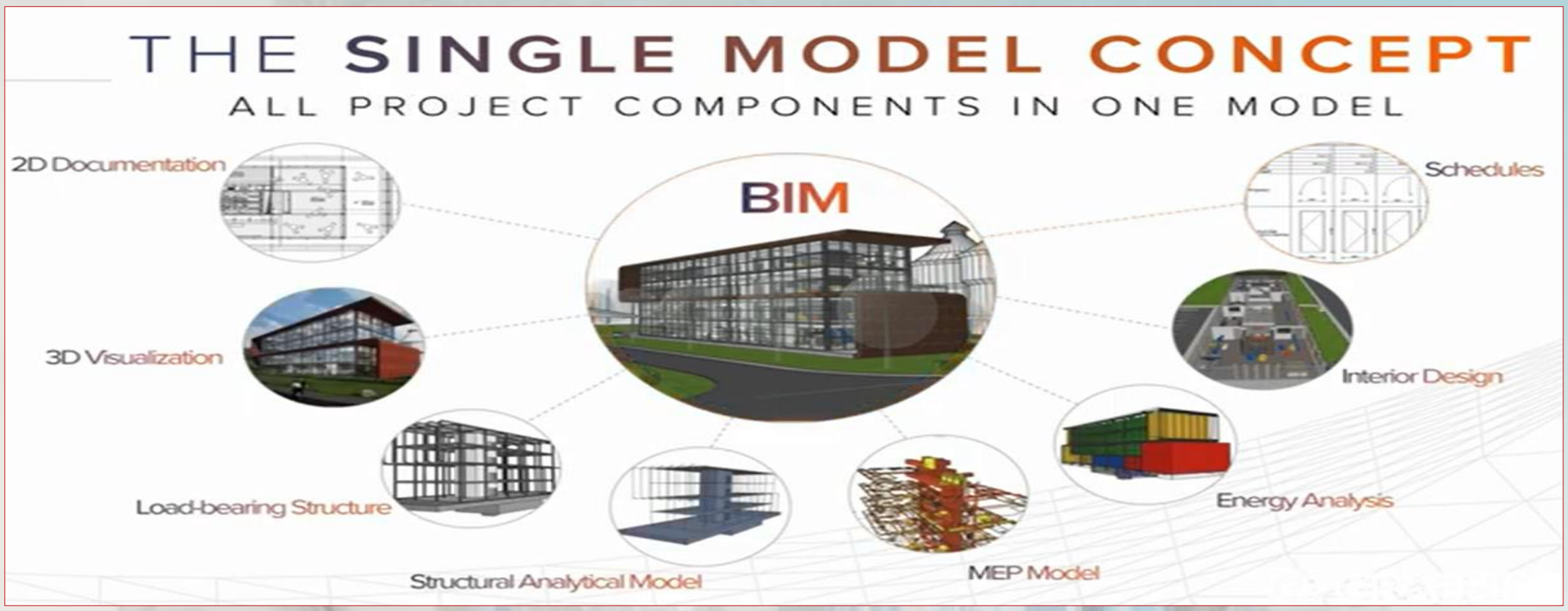
DEVELOPMENTS IN CONSTRUCTION INDUSTRY

The technologies being discussed are;

- ✓ 5D BIM (5D Building Information Modelling)
- ✓ AI and IoT (Internet of things) or Intelligent Build Environment
- ✓ Augmented Reality/ Virtual Reality assisted Buildings
- ✓ Construction Drones
- ✓ Construction Robotics
- ✓ Advance Building Materials
- ✓ 3D Construction Printing
- ✓ Modular Construction

https://www.intellectsoft.net/blog/8-emerging-construction-technology-trends

5D BIM (5D BUILDING INFORMATION MODELLING)



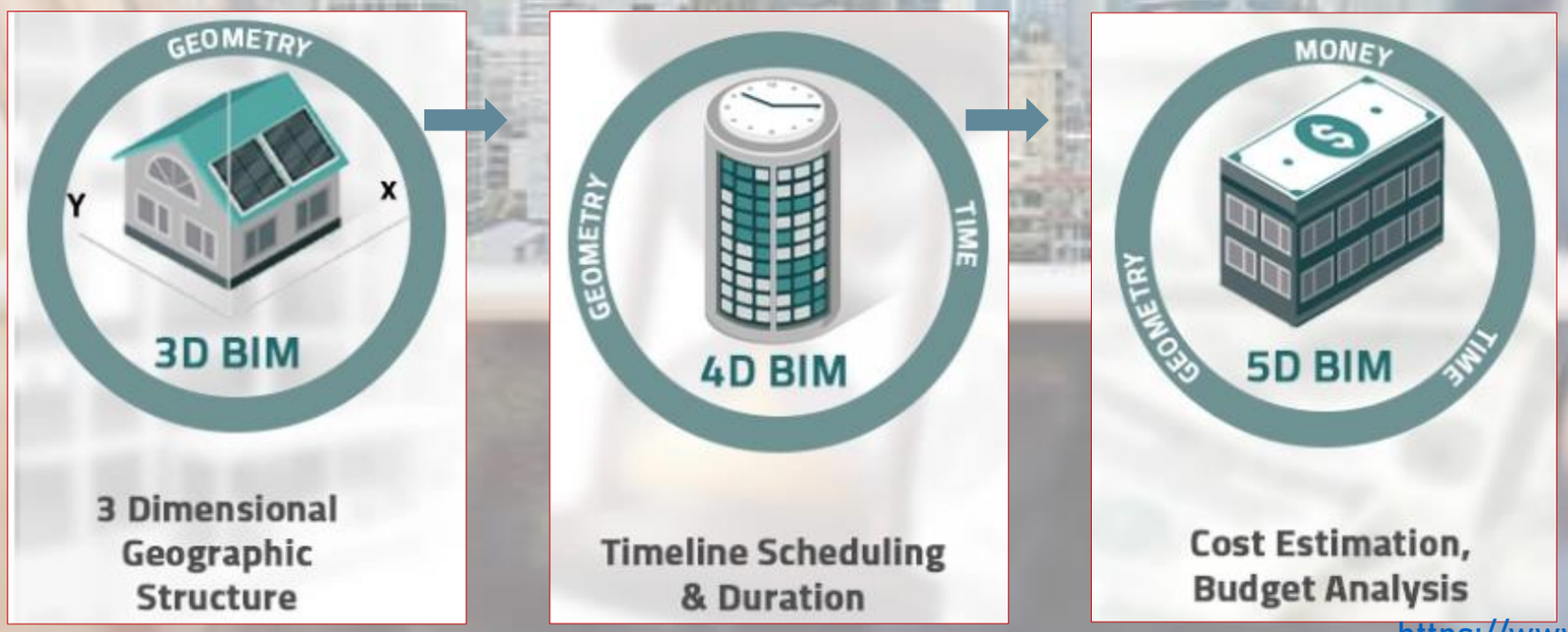
- Building Information Modeling also known as BIM
- Also mentioned as Virtual Design and Construction (VDC)
- An Abstract model with object-based style
- BIM in construction has significantly grown over the last 10 to 15 years

BUILDING INFORMATION MODELLING (BIM)

BIM 5D provides the key attributes of a construction project.

(5D BIM)

- It is an advanced approach
- Extends the capabilities of traditional BIM
- Fifth Dimension adds cost to the model
- 5D BIM combines the visual representation of the design with project management, scheduling, and cost analysis



(5D BIM) – KEY POINTS

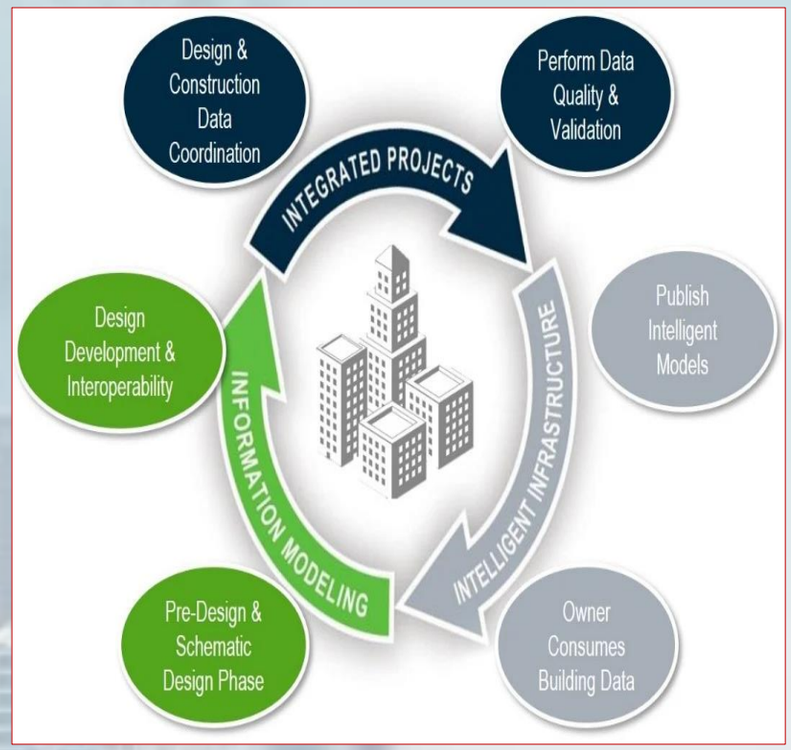
Collaboration:

Enables collaboration among clients, project managers, builders, and subcontractors by integrating their expertise into the design model.

Risk Assessment:

By linking cost data to model elements, 5D BIM becomes a powerful risk-assessment tool.

Communication:



The detailed model, combined with cost information, facilitates communication and troubleshooting across the entire project team.

https://www.technostructacademy.com/blog/what-is-5d-bim-cost-estimation-in-bim/

(5D BIM) – BENEFITS

- Accurate and Real-Time Cost Estimation
- Enhanced Collaboration and Coordination
- Improved Time and Resource Management
- Enhanced Risk Mitigation

Artificial intelligence & IOT

- As construction technology continues to evolve, several future directions are anticipated.

- These include the further integration of Internet of Things (IoT) devices, advanced analytics and Artificial Intelligence (AI) for predictive maintenance and project management, and the utilization of sustainable and eco-friendly materials.

AUGMENTED REALITY/VIRTUAL REALITY ASSISTED BUILDINGS

AUGMENTED REALITY / VIRTUAL REALITY ASSISTED BUILDINGS

- USE of digital innovation within the industry generally refers to Fourth Industrial Revolution, or Industry 4.0

- The construction industry is slowly shifting from years of the wait-and-watch stance to adopting digital technologies to improve the overall project life cycle from conceptual design to construction.

- In the architecture, engineering, and construction (AEC) industry, XR's (extended reality) potential is both massive and relatively untapped

doi: 10.3389/fbuil.2022.730094

AUGMENTED REALITY / VIRTUAL REALITY ASSISTED BUILDINGS

XR or extended reality has two sub categories

- ✓ Augmented Reality
- ✓ Virtual Reality

The two technologies that could extensively assist the construction Industry in ;

- ✓ Enhancing its workflows
- ✓ Fostering better coordination
- ✓ Offering effective training methods.

AUGMENTED REALITY / VIRTUAL REALITY ASSISTED BUILDINGS

- Augmented Reality [AR] displays allow to view and test a building's 'digital twin' before construction work begins.

- Data can be captured, analyzed and stored ahead of a build, - speeding up processes and resulting in higher performance structures. AR is preferred as a site extension of BIM.

- Virtual Reality [VR] is an environment that is artificially created using various types of hardware and software. VR is an image created in 3D which is viewed using a computer or devices such as haptic devices, wearable devices, and warble display screens

PRACTICAL EXAMPLES

https://www.youtube.com/watch?v=ao-q7Ln70sg

PRACTICAL EXAMPLES

CONSTRUCTION DRONES

CONSTRUCTION DRONES

- Construction drones have emerged as game changers, redefining the way, construction projects are planned, executed, and maintained. Equipped with sophisticated sensors, cameras and GPS technology, drones offer unparalleled capabilities to capture real-time data, generate accurate 3Dmodels, and conduct remote inspections.

- Overall integration of Construction Drones yields transformative advancements across all phases of construction projects. As technology continues to advance, drones are expected to play an increasingly critical role in shaping the future of the Construction Industry.

https://doi.org/10.3390/drones7080515

WHAT ARE CONSTRUCTION DRONES?

Construction drones are unmanned aerial vehicles (UAVs) or unmanned aircraft system(UAS). The role of these gadgets includes surveying and monitoring as well as imaging the area from above for further analysis.

Key Features are;

- GPS (geographical positioning system)
- Thermal Sensor
- Camera
- Software

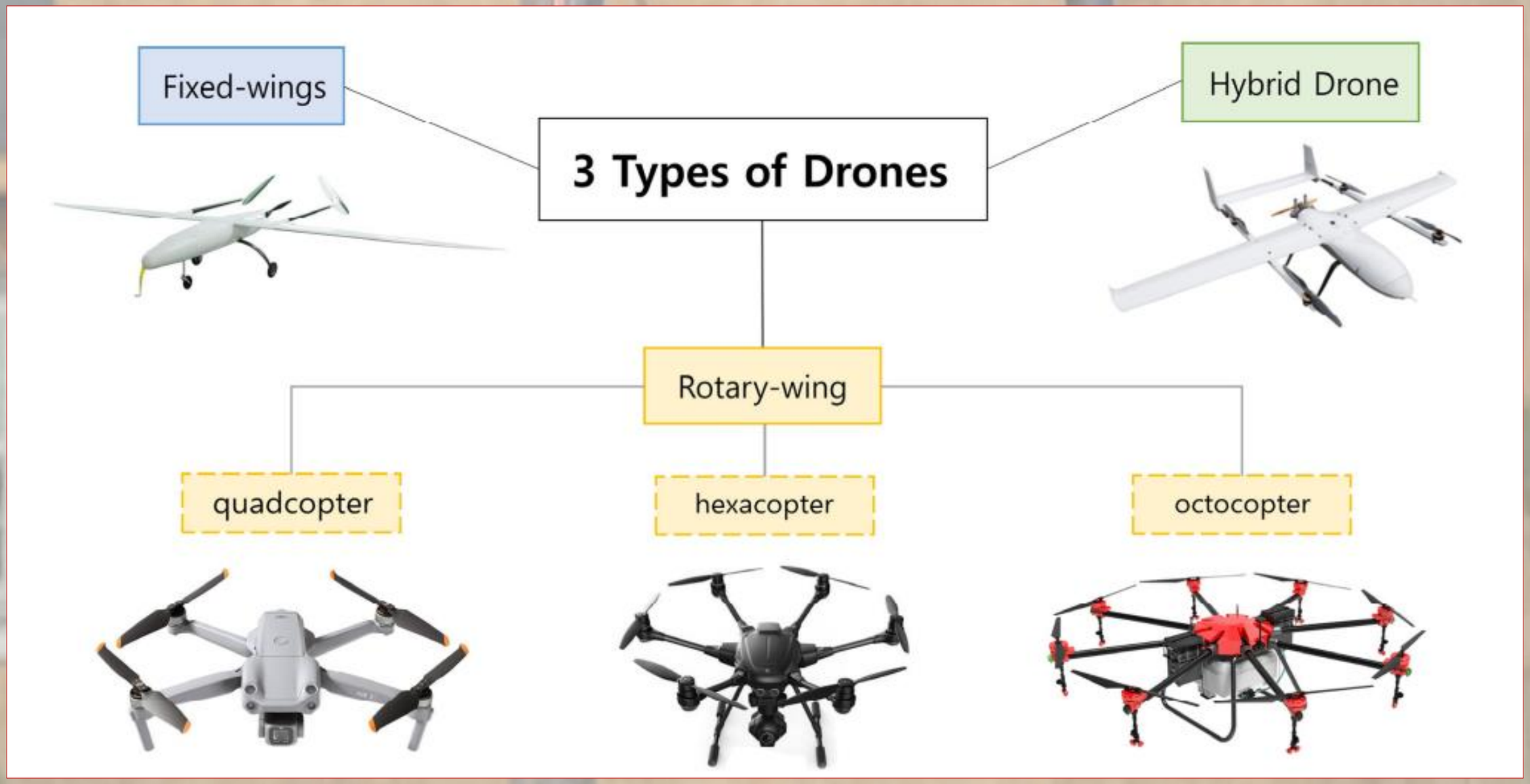
https://aerologix.com/drones-in-construction-why-they-are-useful-and-how-to-use-them/
https://www.bigrentz.com/blog/drones-construction

USES OF CONSTRUCTION DRONES

- Topographic Mapping and Land Surveys
- Equipment Tracking
- Progress Monitoring
- Security Surveillance
- Personnel Safety
- Structure Inspection and Photography

https://www.bigrentz.com/blog/drones-construction

CONSTRUCTION DRONES TYPES



CONSTRUCTION ROBOTICS

Robotics and automation expedite the numerous repetitive and time consuming tasks;

Robotics Solutions extend to

- Automating heavy equipment and fleets for excavation, transportation, load lifting, concrete works, and demolition, enhancing worker safety and cutting down operational time.

- Advance Construction Robotics is a startup developing re-bar Tying robots to automate rebar installation. The use of AI and computer vision in the startups, TyBot and IronBot eliminates the need for manual mapping and calibration by auto-locating, auto-positioning and tying upto 110 rebar intersection per hour.

- Singaporean startup, Weston Robot provides autonomous heavy equipment for load lifting, logistics, patrolling, inspection and disinfection.

ADVANCED BUILDING MATERIALS

- Advanced building materials are becoming integral to new construction practices. Innovative and sustainable materials like 3D-printed concrete and basalt are replacing traditional ores.
- Self-healing concrete, utilizing bacteria, exemplifies materials derived from living organisms.
- Another category of cutting-edge materials includes aerogel, graphene, carbon composites, hydroceramics, and nanomaterials, known for their lightness and high water-holding capacity.
- Spanish startup, Graphenglass develops graphen-based construction materials. The graphene-based architectural products include solar protection and wind facades. The compact graphene features properties such as flame-retardant, color consistency for outdoor exposition, and mechanical strength.

3D CONSTRUCTION PRINTING

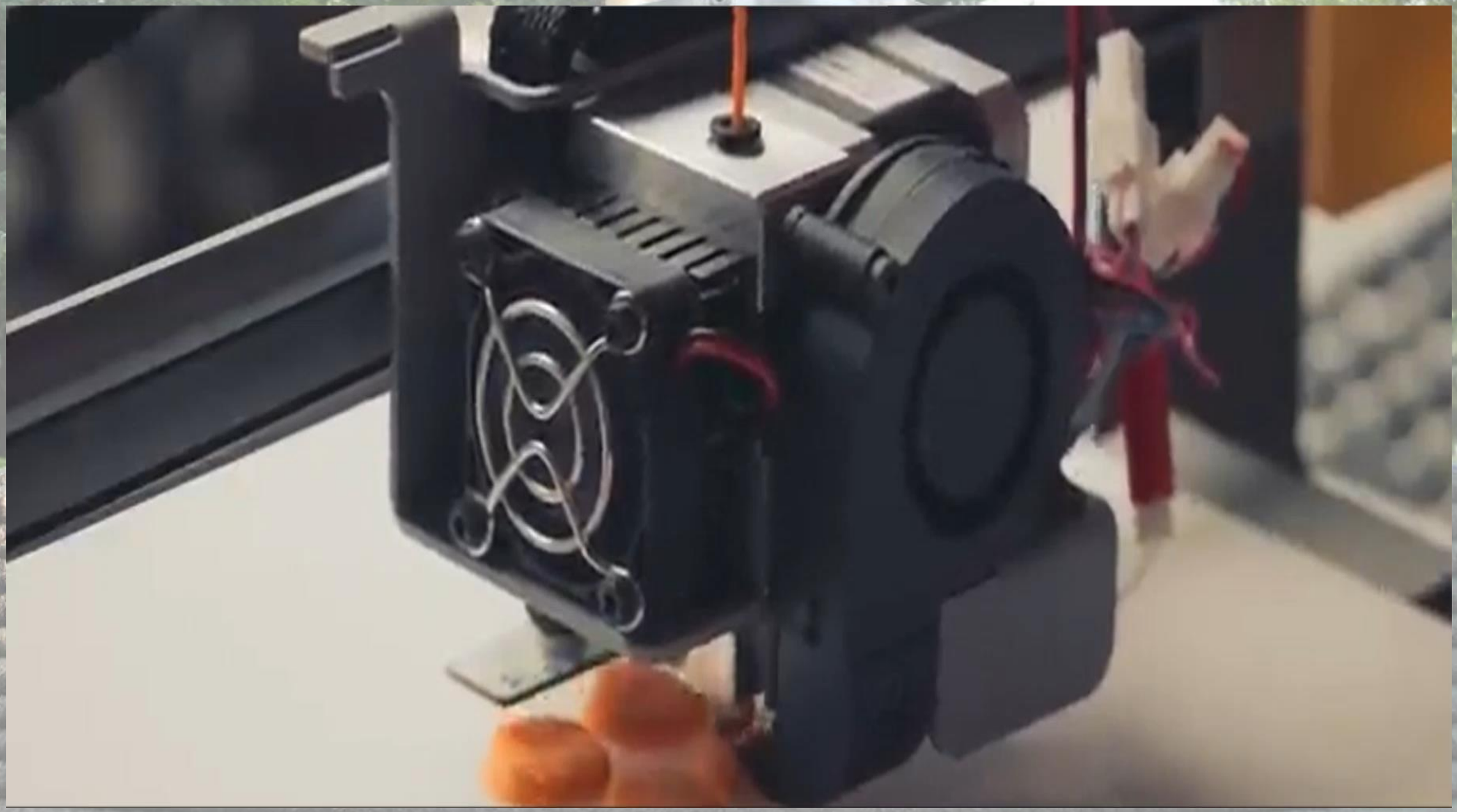
NEED FOR 3D CONSTRUCTION PRINTING

- Building and construction (B&C) industry have been facing several issues
  - ✓ Skilled Labor
  - ✓ Cumbersome Formwork
  - ✓ Automation and Safety Issues
  - ✓ Efficiency
  - ✓ Difficulty in meeting the targeted demand

- 3D printing (3DP) seems to be a promising technology that can build complex 3-dimensional (3D) structures without the need of formwork and human intervention. It is an innovation that contributes to automation in civil engineering and offers benefits in design, greenness, and efficiency

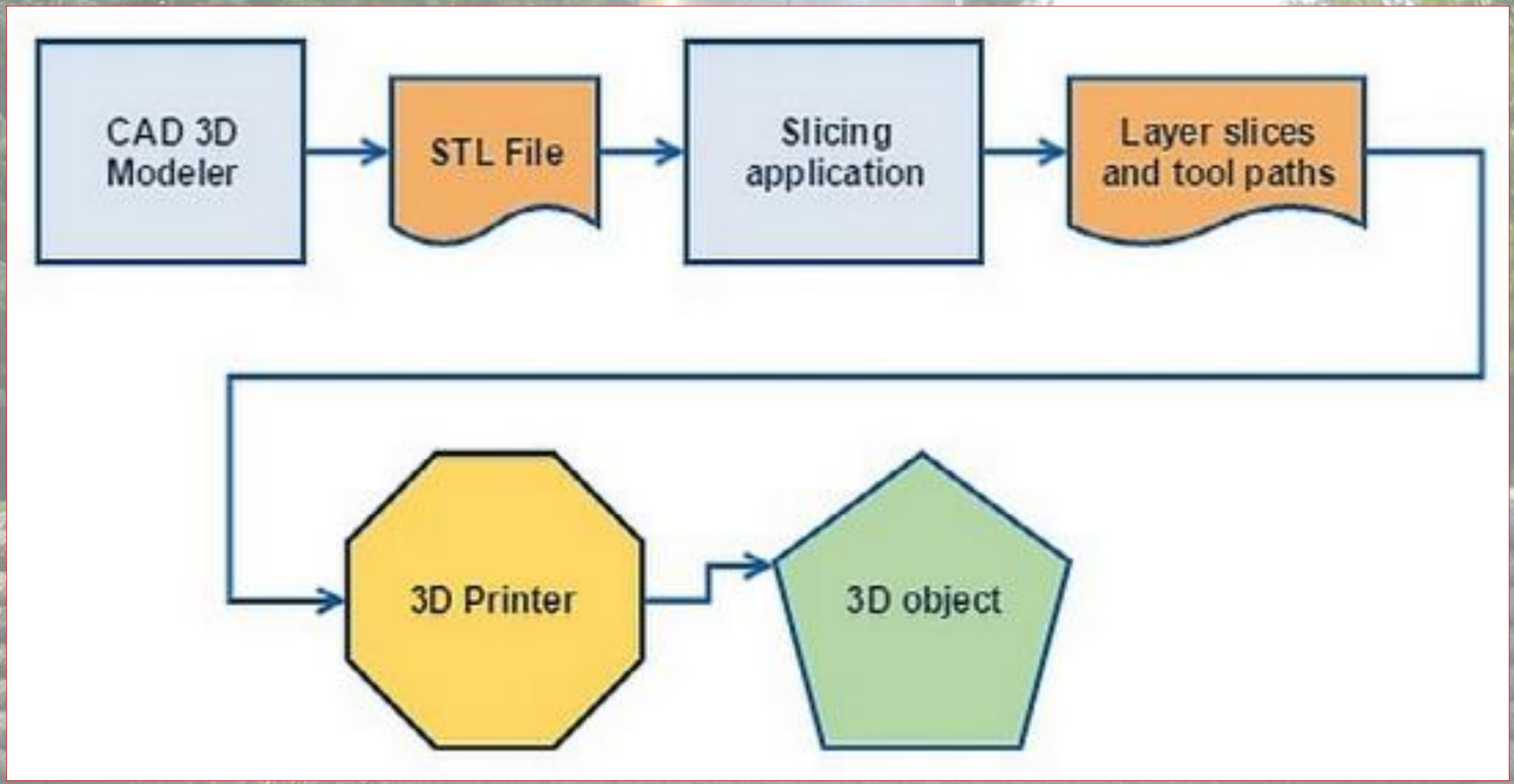
WHAT IS 3D Printing (3DP)?

Three-dimensional (3D) printing, also known as additive manufacturing (AM) is a layered material joining process that is based on 3D model data to manufacture various structures and complex geometric shapes without using any tooling, dies, or fixtures.



https://www.youtube.com/watch?v=2Q-l1TRRZJ8

3D Printing Process FLOW



Generalized Additive Manufacturing Process

3D CONSTRUCTION PRINTING TYPES
D-SHAPE (Off-site In situ Gantry based)

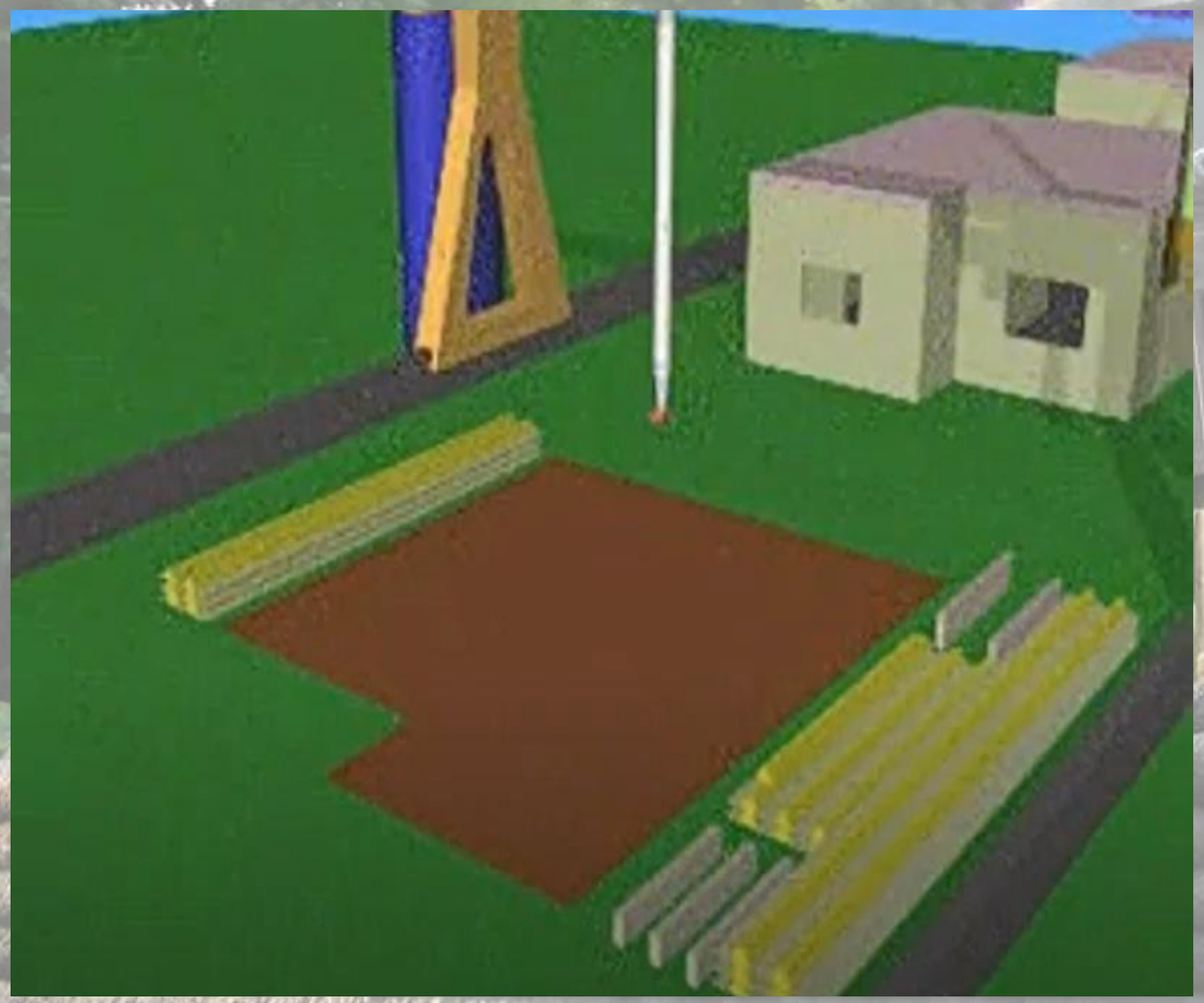
The technology works by depositing alternating layers of Powder of granular matter like sand or aggregate, and specially formulated binding “ink” that fuses the grains together. This enables printing of solid structures from the ground up, wall by wall, layer by layer

3D CONSTRUCTION PRINTING TYPES
CONCRETE PRINTING
(Off-site In situ Gantry based)

Concrete Printing is another large-scale 3D construction process. It uses a single spool nozzle which moves along a pre-programmed path and continuously extrudes the concrete materials.

https://www.researchgate.net/publication/333673859

CONTOUR CRAFTING
(On-site In situ Gantry based)



Contour Crafting (CC) is a mega-scale fabrication process that enables additive fabrication of large-scale objects directly from computer models. In this process, an extruder nozzle attached to a gantry crane is used to apply a concrete mixture.

The crane or extruder nozzle travels along a digital floor plan of the building object and places layers of concrete on top of each other – to a certain extent simiar to the FDM process.

https://www.researchgate.net/publication/333673859

CHALLENGES AND OPPORTUNITIES

1. Standards Required to be developed
    a. Guidelines

    b. Quality Control methods and tools

2. Development of Ink: It is one of the most active areas of research on 3-D printing of concrete. Ink formulations include:
    - ordinary portland cement,

    - alternate binder materials, including sulfur-based cements, limestone calcined clay cements, calcium aluminate cements, geo-polymers, and magnesium potassium phosphate cements blended with fly ash.

    - suitable flowability, extrudability, buildability, set rapidly

3. Incorporating Reinforcement Steel

EXAMPLES

- Two-story municipality building in Dubai by Apis Cor
- Community village in Austin by ICON
- Vehicle-hiding concrete arches in California by U.S. Marines Corps
- Houses by COBOD and Peri Group in Berlin
- River revetment wall in Suzhou by Winsun
- Prestressed bicycle bridge at Eindhoven
- Pedestrian arch bridge at Shanghai
- Optimized-reinforced concrete beams at Ghent and Naples

MODULAR CONSTRUCTION

WHAT IS MODULAR CONSTRUCTION

- Buildings that are made up of repeated and standardised sections, known as Modules.
- It is technically a form of Prefabrication.
- Modules are constructed in an off-site factory setting under controlled conditions.
- Design is according to Building Codes and regulations
- The finished structure is transported to Site for assembly.
- Only excavation, laying of foundation and module installation are performed at Construction Site.

BENEFITS

- Economy of Scale through repetitive manufacture
- Rapid Installation on Site (6-8 units/day)
- High level of quality control in factory production
- Reduced Construction Time
- Limited disruption in the vicinity of construction site
- Adaptable for future extensions
- Cost Effective and Energy efficient
- Potential for reuse and repurposing as they are portable

APPLICATIONS

- Private, Social and Shelter Housing
- Apartments and mixed-use buildings
- Educational sector and student residences
- Key worker accommodation
- Public sector buildings
- Health sector buildings

RISK INVOLVED

- Continuous Supply chain of modular construction
- Transportation require special vehicle
- Financial Constraints
- Lack of equipment and skilled labor
- Limited Expertise

THANK YOU