Perrin Conferences
National Construction Defect Conference

A Brave New World – Risk and Liability in 3D Printed Construction

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PRECEDENCE RESEARCH
3D PRINTING CONSTRUCTION MARKET SIZE, 2023 TO 2032 (USD BILLION)
$ 3.42
$ 5.65
$ 9.34
$ 15.43
$ 25.51
$ 42.15
$ 69.66
$ 115.11
$ 190.22
$ 314.36
$ 519.49
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
Source: www.precedenceresearch.com

The 3D Printing Trend

- Dubai plans on having 25% of all buildings built via 3D prining by 2030
- Austin, TX is home to the first 3D printed homes for sales in the US
- In August 2022, Montana became the first state to approve 3D printed walls as a replacement for CMU

What Are The Practical Applications?

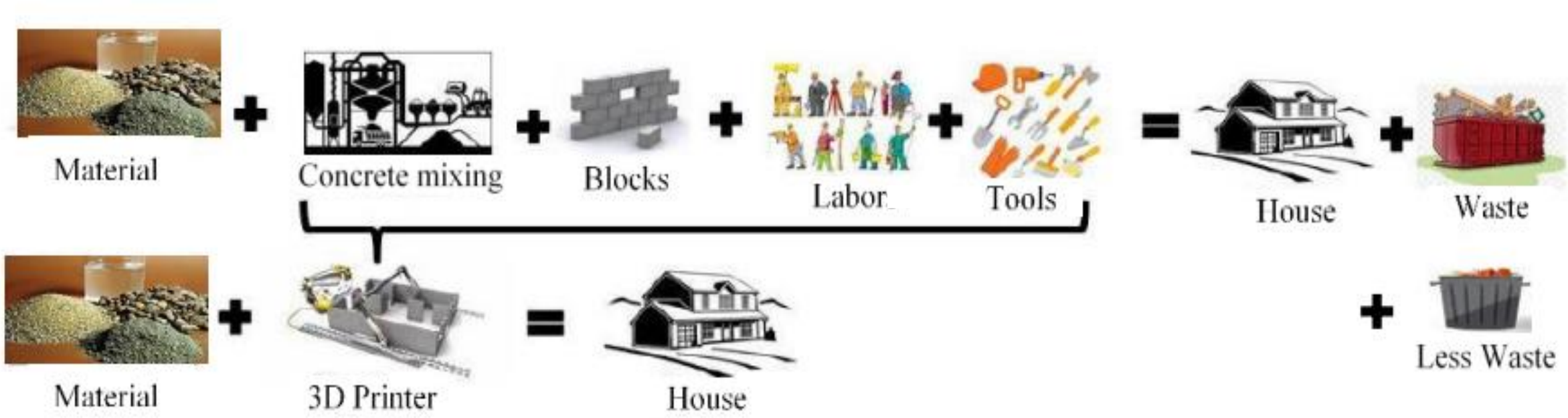
- 1. Architectural Models
- 2. Prototypes
- 3. Formwork Solutions
- 4. Buildings
- 5. Structural Components

People will come to love their oppression, to adore the technologies that undo their capacities to think.

- Aldous Huxley

Workforce Labor VS. 3DP

- **Top Row** - Conventional construction processes with the 3DP construction.



On the contrary, 3D printing is mostly automated that prints buildings from a computer-aided design (3D-CAD) with less involvement of human resources and without any need of tooling, dies/formwork, and fixtures.

3DP and its Benefits and Disadvantages

Additive manufacturing (AM) — more commonly known as 3D printing (3DP) — is the practice of constructing objects using computer-aided drawings (CADs) and 3D printers to create materials that can be used in constructing buildings.

Benefits:

- Can contribute to affordable housing, buildings, and versitility
- Time, Cost and Material Savings
- Reduce Labor force & labor related mistakes
- Positive Environmental & Economical Impacts

Disadvantages:

- No current Building Codes for 3DP
- Challenges in Construction Defect Disputes
- Size of Printers & Material Durability still in early stages
- Warranty Implications

Totally outside Building Code and Safety

ICC (International Code Council)

No material requirements or applications for building a wood, concrete, or steel structure. With 3DP, the use of non-traditional construction materials and methods, there are no requirements in these codes to date. There is only a UL reference in the Code found in appendix (UL 3401-19)

NFPA (National Fire Protection Agency)

The use of combustible powders or metals, the use of an inert gas supply, or the creation of a hazardous electrical classification with *non-industrial additive manufacturing*. The *non-industrial additive manufacturing* operations are only permitted to use plastic filament production materials that are listed with the 3D printer and that are identified in the manufacturer's instructions.

AHJ (Agencies Having Jurisdiction)

For AHJs, one of the biggest concerns surrounding 3D-printed construction lies in the fact that things can change at any moment, specifically methodology. The blends of materials being extruded by the printers, which are often proprietary and adapted to local conditions and not to extreme climates (Freeze, Heat, Humidity, Rain etc.) which is very important to be considered when it comes to the eventual deterioration of the products.

OSHA (Occupational Safety and Health Administration)

There currently is not a printer manufactured, whether it is manufactured in America or Germany that complies with the OSHA and EPA standards. Every machine on the market and utilized on projects do not have adequate safety engineering controls and the dust particles it generates in a non-industrial setting to produce 3D printed building materials are typically unsafe during the printing process and require additional PPE measures and medical monitoring.

Potential Contract Claims and Challenges with 3DP

- If the defect is the result of the printer's malfunction, the contractor will have warranty and indemnity claims against the manufacturer arising out of privity from purchasing or leasing the 3D printer.
- If the defect is the result of a software malfunction, that could open the developer to negligence and warranty claims for the value of the defects on the project.
- If there is an independent technician, acting as a subcontractor, feeding the plans into the 3D printer could also be open it to liability if the defect was the result of improperly uploading those plans or operating the 3D printer.
- The owner could also have claims against the manufacturer or software developer for economic loss, even in the absence of direct privity, if the owner can show the damage to his property caused by the 3D printer was foreseeable.

Types of Defects and Warranty Issues with 3DP

Potential Construction Defects and Warranty issues:

- **Layering defects:** 3D printing technology builds objects layer by layer. If there are defects in the layering process, such as uneven layer thickness or gaps between layers, it can affect the structural integrity of the home. This also adds the potential for moisture management failure, vapor transmission and eventual water intrusion.
- **Material defects:** The quality of the material used in 3D printing can also affect the structural integrity of the home. Inferior materials may not be able to withstand the stresses and strains of everyday use. This is especially important in extreme climates like snow, heat, and tropical climates with consistent rain throughout the year.

Types of Defects and Warranty Issues with 3DP

Potential Construction Defects and Warranty issues:

- **Design flaws:** 3D printing allows for complex and intricate designs, but if these designs are not properly tested and validated, they may result in weak spots or other flaws in the structure. This can potentially cause water intrusion, and structural defects can produce a situation where the structure will not be safe to be inhabited. Corrections to these issues are very difficult as in most cases the printing machine cannot "re-print" the area again.

- **The long-term durability of 3D printed homes has yet to be fully determined.** While some materials used in 3D printing are known to be durable, it remains to be seen how well these structures will hold up over time. This makes it very difficult to warranty certain items, especially components that are installed after the fact or over 3D printed walls and ceilings.

Types of Defects and Warranty Issues with 3DP

Potential Construction Defects and Warranty issues:

- **Lack of durability:** The long-term durability of 3D printed homes has yet to be fully determined. While some materials used in 3D printing are known to be durable, it remains to be seen how well these structures will hold up over time. This makes it very difficult to warranty certain items, especially components that are installed after the fact or over 3D printed walls and ceilings.

- **Regulatory challenges:** Many countries have yet to establish proper building codes and regulations for 3D printed homes, which could lead to safety issues and potential defects.

How to mitigate Construction Claims with 3DP

- To protect against possible construction defects, contractors should:

First

Implement strong quality controls to ensure traditional and 3D-printed building materials will function together as intended. Avoid using materials if there are no instructions specific to 3D-printed projects. If specifications do exist, the costs associated with installation, labor, and timelines (including testing materials on mockups) should be considered in project planning.

Second

Review craftsmanship to confirm that moisture intrusion does not occur after installation, as synthetic materials could prove problematic in areas with extreme weather conditions.

Last

Review plans and drawings with all parties, including subcontractors, using checklists and signoff/on to ensure proper usage and installation. Any testing results should be kept in the project file, per jurisdictional document-retention requirements.

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Thank You!