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Advanced Building Construction Methods

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OAK RIDGE National Laboratory
U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY
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Motivation

If you were not limited by traditional building materials or methods, what could you do? Are there aspects to how buildings are built today that are practical but result in missed opportunities for improving health, comfort, or environmental impact?

Background

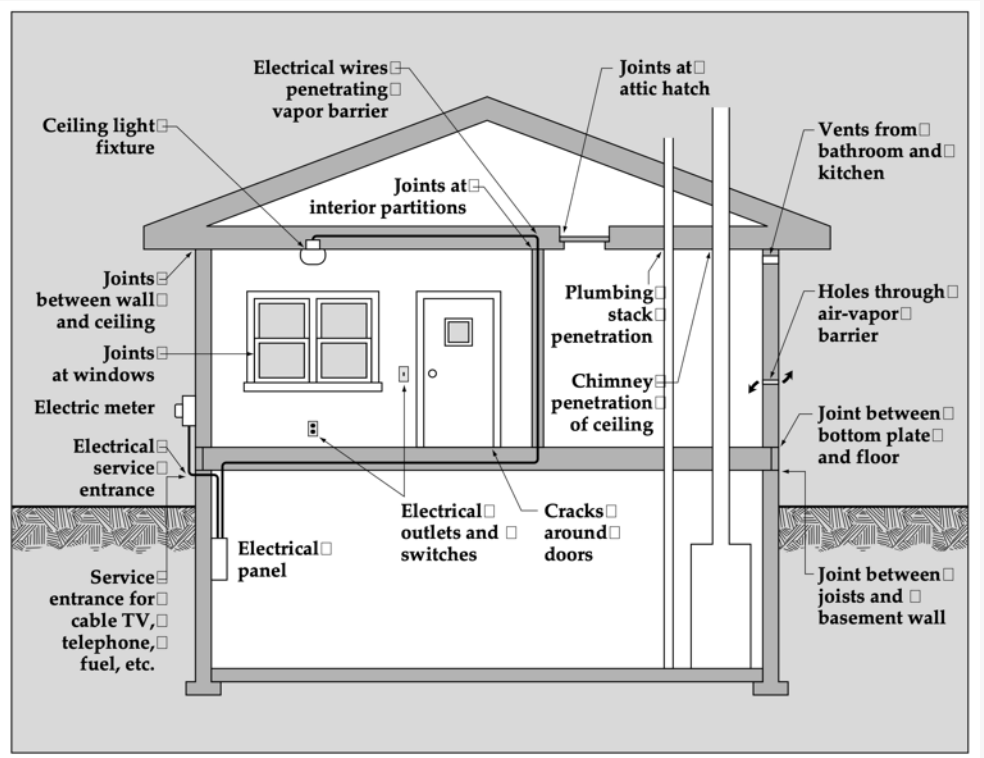
Source:https://upload.wikimedia.org/wikipedia/commons/thumb/a/ab/Menkaures_Pyramid_Giza_Egypt.jpg/800px-Menkaures_Pyramid_Giza_Egypt.jpg

Although some materials and techniques have evolved throughout human history, building construction methods have remained relatively the same: haul the building components to the site and piece them together.

Background

Although practical and proven, construction methods and/or materials often limit potential for maximizing benefits, including:

- Energy efficiency
- Indoor air quality
- Occupant comfort
- Flexible usage
- Rapid deployment.



Air leakage can occur in many places throughout a home.

Image From: https://www.nrel.gov/docs/fy00osti/27835.pdf

Background

DOE's Advanced Building Construction (ABC) Initiative is integrating energy efficiency into highly productive constructive practices through:

- Technology investments:
  - Robotics
  - Digitization
  - Materials
  - 3D printing
  - Off-site Manufacturing
- Stakeholder engagement.

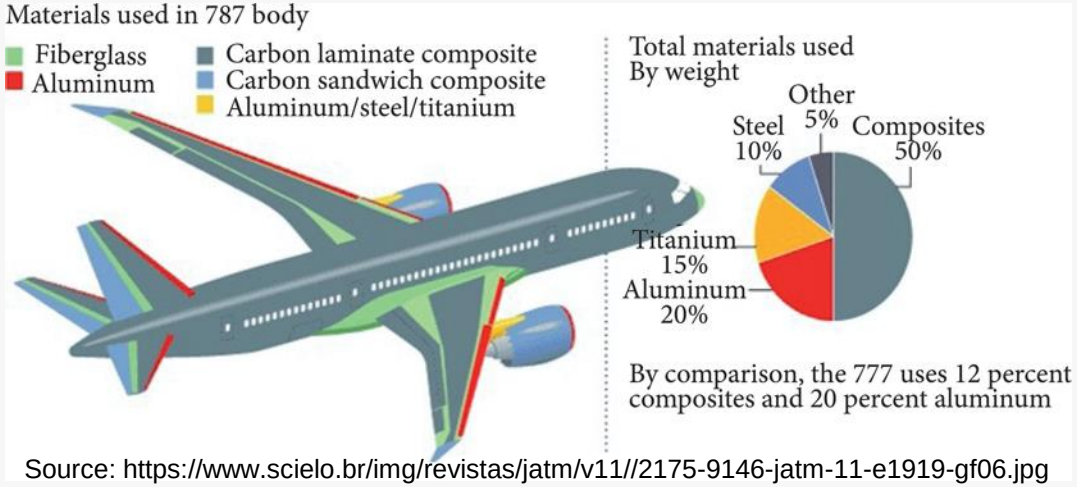
Source: https://www.energy.gov/sites/prod/files/styles/borealis_photo_gallery_large_respondxl2/public/2020/02/f71/bto-iUnit-What-is-ABC-020520.jpg?itok=O9v7W9zK

Background

Source: https://www.holmatro.com/sites/default/files/inline-images/Applications_car_manufacturing.jpg

Other industries have already looked for more efficient processes and materials, including:

- Vehicles
- Airlines.



Source: https://www.scielo.br/img/revistas/jatm/v11//2175-9146-jatm-11-e1919-gf06.jpg

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Hypothesis

Changing how buildings are built and what materials are used could lead to improvements in energy efficiency, occupant health, comfort, and cost, as well as more specific improvements in flexible usage or rapid on-site construction.

Recent Developments:
Modular Construction

Industry has seen companies modularizing the construction process in an assembly-line-style factory.

Benefits include:

- Indoor construction
- Automation
- Cost reduction (upwards of 20%)
- Energy improvements.

Source: https://www.chapmantaylor.com/uploads/Chapman-Taylor-Modular-Construction-LR1.JPG

Recent Developments:
Materials and Methods

3D printing and increasing the use of automation are examples of innovative methods that have been applied to buildings.

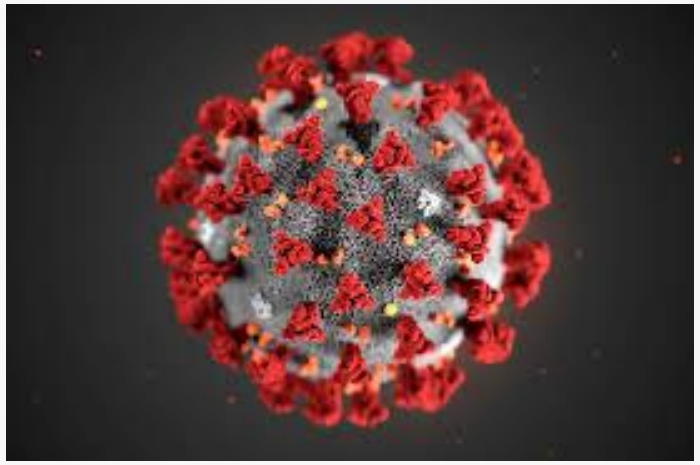
Benefits include:

- Energy improvements
- Durability
- Reduced construction time.

Source: https://www.chapmantaylor.com/uploads/Chapman-Taylor-Modular-Construction-LR1.JPG

Recent Developments:
Flexibility

The COVID-19 pandemic has forced us to rethink how offices should be configured, what meets the definition of a hospital, and even how our homes are used.



Source: https://encrypted-tbn0.gstatic.com/images?q=tbn%3AANd9GcRVd1653WyMe_s7YkQyg0SLWmHZ-e5FCpD2jg&usqp=CAU

- What could we do differently?
- Can we increase configurability of buildings or spaces?
- What about embedded infrastructure?

Recent Developments:
Temporary Housing

The Federal Emergency Management Agency often delivers trailers for temporary housing following disasters such as hurricanes or forest fires. Can we creatively improve:

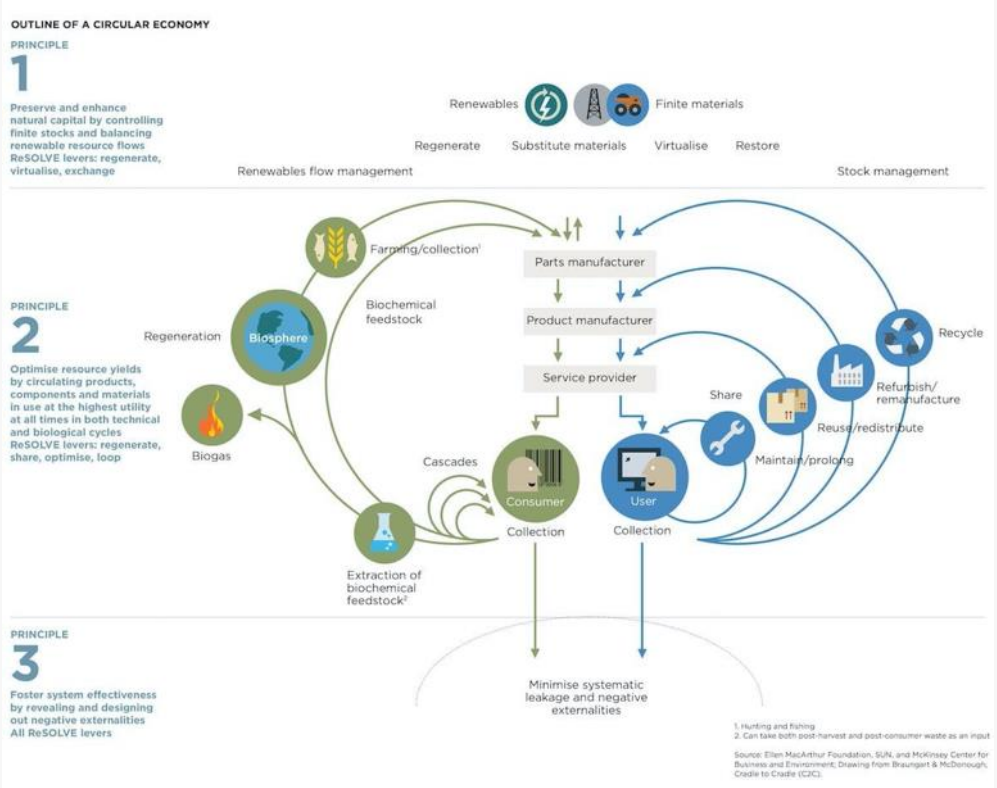
Source: https://www.chicoer.com/wp-content/uploads/2019/07/0801_NWS_CER-L-GRIDLEY.jpg

- Durability
- Energy efficiency
- Comfortability
- Deployment and deconstruction effort?

Recent Developments:
Circular Economy

How can building materials, construction processes, and design methods promote concepts of a circular economy, including:

- Keep resources in use
- Extract maximum value
- Recover and regenerate.



Source: https://www.ellenmacarthurfoundation.org/assets/images/circular-economy/System_diagram_cropped.jpg

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The Challenge

Develop an innovative solution incorporating substantial changes in building materials or construction methods, leading to significant benefits, including but not limited to, increased productivity, reduced construction time, reduced cost and waste, improvements to occupant comfort and health, reduced energy use, or building flexibility.

Additional Resources

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Department of Energy ABC Initiative Resources

- https://www.energy.gov/eere/buildings/what-advanced-building-construction-initiative

Energy Resources

- https://www.eia.gov

Modular Construction Resources

- https://www.modular.org/
- https://www.modx.network/mod-x
- http://modular.org/documents/document_publication/mckinsey-report-2019.pdf

Methods and Materials Resources

- https://www.businessinsider.com/3d-homes-that-take-24-hours-and-less-than-4000-to-print-2018-9
- https://www.ornl.gov/news/ornl-integrated-energy-demo-connects-3d-printed-building-vehicle
- https://esub.com/reshaping-the-construction-industry-automation-tools-and-technology/

Additional Resources

Impact of COVID-19 Resources

- https://www.washingtonpost.com/business/2020/04/23/offices-after-coronavirus/
- https://www.ashrae.org/technical-resources/resources

Temporary Housing Resources

- https://www.wlox.com/story/34416301/coast-company-developing-temporary-housing-alternative-to-fema-trailers/

Circular Economy Resources

- https://www.ellenmacarthurfoundation.org

Construction Cost Resources

- https://www.rsmeans.com/model-pages.aspx

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Questions or Comments?

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Thank You!