Large-scale 3D Printing
Past, Present and Future Prospect

Berok Khoshnevis

Founder CEO, Contour Crafting Corporation

Dean’s Professor, University of Southern California
My realizations in 1994

- 3D priming is too slow for large objects
- We have been 3D printing for several millennia in construction
SIS family of AM technologies

Invented by B. Khoshnevis
Invention of Contour Crafting

CC is an extrusion based a layered fabrication technology that builds objects with successive “thick” layers as it smoothens out external surfaces.
Small scale ceramic to large scale concrete
History chart of large scale 3D printing
PRESENT
Why construction needs a change

- Construction is the largest sector ($5.6T/year) of almost all economies
- Labor efficiency is alarmingly low
- Skilled workforce is vanishing
- Work quality is low
- Control of the construction site is insufficient and difficult
- Accident rate at construction sites is high (> 400,000 / year in US); 60,000 fatalities/year globally
- Waste and trims are high (3 to 7 tons per average home; 40% of all materials used worldwide are for construction)
- Low income housing and emergency shelters are critical
- All other products are fabricated automatically – construction is still largely a manual task
Current focus of construction 3D printing community is on Building Construction

**Residential:**
- Shortage of 800 million houses worldwide (UN statistics)
- Global Markets are Grossly Under-Served
  - Nearly 2 Billion people are homeless or live in slums
  - Annually 37 million people lose housing due to war and natural disasters

**Commercial:**
- Shortage of commercial and industrial buildings, especially in developing countries
Barriers against implementation

- Conservative industry
- Low profit margin
- Regulatory barrier
- Paradigm change requirement with respect to inspection
- Labor unions
- And most importantly, marginal impact of 3D printing (limited primarily to bldg. shell)
FUTURE
Infrastructure Construction

Application in automated wind turbine tower construction
Pylon construction _ Application in the Hyperloop project
The next stage after our Earth-bound civilization is the **Solar System Civilization** – and it is beginning
# Space mining companies

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<td>Astrobotic Technologies</td>
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Autonomous construction with **sulfur** concrete
NASA awarded Contour Crafting the Grand Prize among 1000+ globally competing technologies in the Create the Future Design Contest.
New Large-Scale AM Processes
A new large-scale powder-based 3D printing Technology
NASA awarded SSS the Grand Prize in the *International In-Situ Resource Based Fabrication Competition*.
Other research directions

• Process innovation and improvement
• Materials
• Impact on BIM and BIM integration
• IoT roles and synergies
Contour Crafting Corporation (CC Corp) - A New Journey

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