

Terrestrial Outfitting Approaches and Key Technologies

LSIC E&C Monthly Meeting

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Agenda

- Company Background
- Healthcare Construction in CA
- Outfitting Systems Required in Healthcare Construction
- Outfitting Construction Phases in a project
- Current Trend in Construction: Pre-fabrication
- Common Challenges
- Current and Upcoming Technologies
- Thoughts on Lunar Construction
- Q&A

Company Background – Herrero Builders

- Commercial general contractor, operating in the San Francisco Bay Area since 1955.
- Projects range from new construction, seismic upgrades, and tenant improvements in healthcare, education, commercial, retail, historic, and hospitality.
- Adopted innovative construction processes by implementing Lean, Integrated Project Delivery methodologies, and Virtual Design and Construction software.



Healthcare Construction in CA

- Healthcare construction projects could range from an interior renovation in a clinic, expansion buildings for an existing facility or a ground up hospital.
- HCAI (Health Care Access and Information) regulates the design and construction of healthcare facilities in CA to ensure they are safe and capable of providing services to the public.
- Collaborative effort between healthcare providers, patients, and construction builders and designers to create facilities that serve our communities.



Outfitting Systems required in Healthcare Construction



- **Mechanical:** HVAC, airborne infection control and fire smoke control.
- **Plumbing:** non-potable, potable and sterilized water.
- **Medical Gas**
 - **Oxygen:** required in every healthcare setting and is used for resuscitation and inhalation therapy.
 - **Nitrogen:** primarily used for powering surgical tools and other equipment.
 - **Medical Air:** Used in the ICU and NICU areas, medical air is supplied by a specific air compressor to patient care areas.
 - **Carbon Dioxide:** Used for less invasive surgeries.
 - **Nitrous Oxide:** used in numerous surgical procedures as both an anesthetic and analgesic.

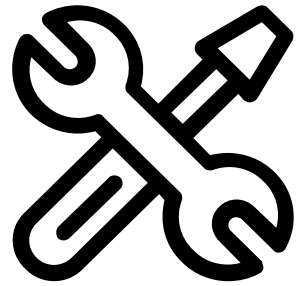


Outfitting Systems required in Healthcare Construction

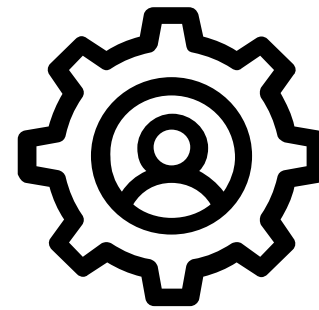
- **Electrical:** To power up anything from convenience outlets to critical MEP equipment and life safety systems.
 - Fire Alarm: Auditory and visual alarms during emergency.
- **Fire Protection:** Life Safety system needed against fire hazards
- **Conveyance Systems**
 - **Pneumatic Tube:** For easiness of transportation of blood samples and medicine.
 - **Elevators:** For transportation of people and tools/equipment/medication.
- **IT:** Wi-Fi, cellular connection and Real Time Location Tracking (RTLS).



Outfitting Phases in a Construction Project



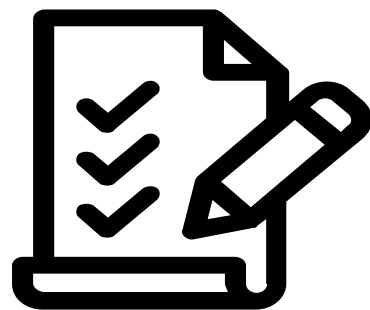
Installation of MEP Systems



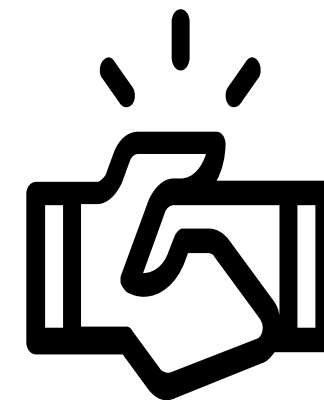
Testing/Troubleshooting



Insulation and waterproofing



Finishes and closures



Commissioning

Pre-Fabrication

- Act of making building components in a manufacturing location better suited to their construction, and then transporting these components to the final site.
- Once they arrive, they are set in place, secured, tied into utilities, and handed off to the owners.
- Unique complicated systems – we aim to design consistent and standard modular outfitting racks for ease of installation (i.e. patient bathrooms and sinks, exterior panels, MEP racks, etc.).



Common Challenges in the Construction Phase

- **Poor scheduling:** Since most physical construction occurs linearly; one construction team can be waiting for another team to complete their part of the project.
- **Drawing Revisions:** due to incomplete information during design and unique field or unforeseen conditions create rework in installation.
- **Integration of Systems:** All systems are independent and it's hard to combine multiple systems at the same time. Need to test one at a time and integration is limited due to proprietary rights. Currently, a room with all equipment controls is built, operators still have to go from one panel to the next. A solution could be the formation of digital twins.
- **Safety:** construction is dangerous. Projects that put more safety protocols end up being more successful. Safety culture is important. #1 cause of deaths in construction is fall accidents.



Technology Used in Construction



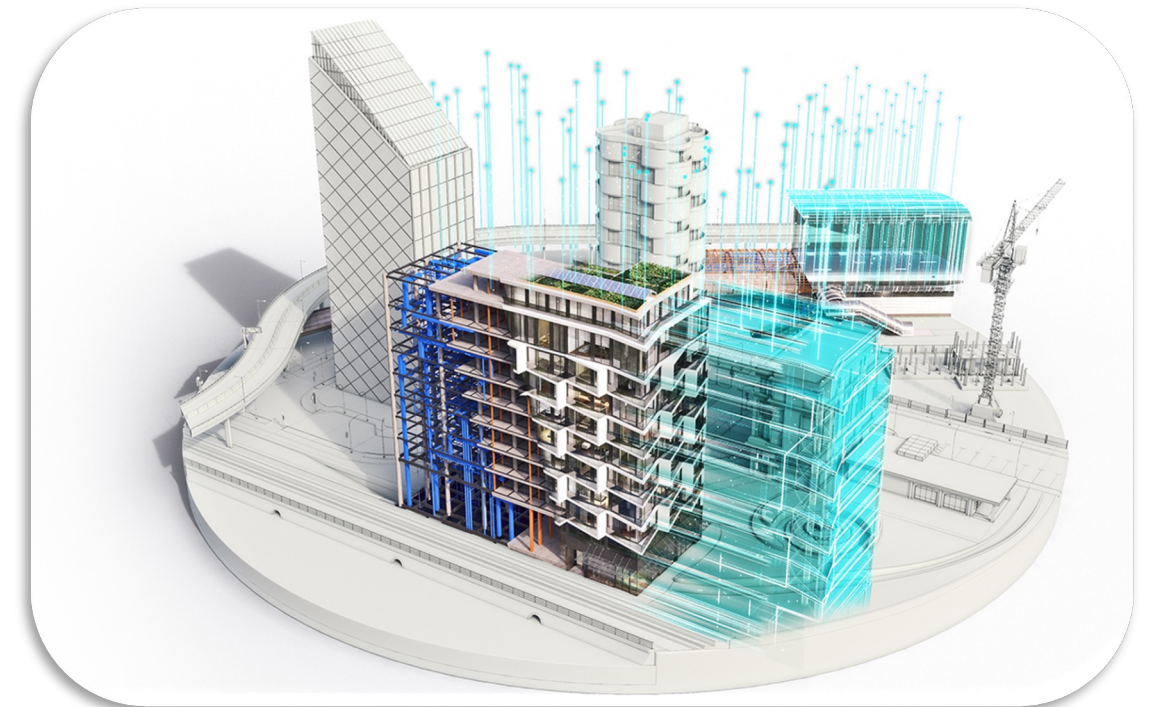
Building Information Modelling + 360-degree images



Robots



AR/VR



Digital Twins

Thoughts on Lunar Construction

- Outfitting in terrestrial construction could easily count for 50%+ of every single project
- Ways to test and troubleshoot systems + QA/QC
- Specialized Equipment (i.e. cooling towers, AHUs, Pumps, Chillers, etc.).
- How will the commissioning of a lunar habitat be done?
- Aerospace industry could use proven tech to facilitate the construction of extra-terrestrial habitats.
- Lunar Construction enthusiasts should look into healthcare construction more closely. A Lunar habitat is very similar to a hospital (i.e. specialized equipment and systems are needed)





THANK YOU

QUESTIONS?