Sculptura

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June 20th, 2023

Société d'habitation du Québec
1425, Boulevard René-Lévesque O
Bureau 600
Montréal (Québec) H3G 1T7

Dear Mr. Claude Foster,

In response to the housing crisis in Montreal that has been happening for a long time and worsened these past few years because of COVID-19, Sculptura and its associate have completed a detailed analysis of the situation and came up with an innovative & sustainable solution. The report attached contains evidence that the crisis needs to be taken seriously and we cannot afford to repeat the same mistake as in previous years. Hence, Sculptura is proposing to let go of the traditional way of building houses and switch to 3D printing.

As you might have noticed on the media, the housing crisis in Montreal has been increasing at a fast pace especially since summer is approaching, tenants are receiving eviction notices from their landlords. This is because of the illegal platform *Airbnb* that grew in popularity. Let's not forgot the rise in population these last few years, because after all Montreal is one of the best cities in North America to settle in. The demand for housing has increased, but the availability remained somewhat the same, which causes an increase in the price. The short labour in construction also affects the situation because projects are conducted at a slow pace and some of them are even abandoned. Sculptura's approach to the situation is to start using 3D printing technology as a tool to diminish the housing crisis in Montreal. We are asking your permission to allow us to start this project on the island of Montreal and to dedicate a specific land for this project to flourish.

Scupltura would be pleased to answer your concerns and comments about this project. You can reach the team through Sculptura.team@sclptr.ca. We look forward to discussing with you on this project.

Sincerely,

Sculptura Team

Enclosure: Montreal's Housing Crisis: The Urging Need For Affordable Accommodation And Innovative Solutions

Montreal's Housing Crisis: The Urgent Need For Affordable Accommodation And Innovative Solutions

Proposal for
3D Printed Houses

Prepared for
Société d'habitation du Québec

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June 20th, 2023

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Problem Statement

Living in Montreal, like any other city, has disadvantages as well. Despite having a vibrant society, beautiful architecture, and an energetic creative environment, some people may discover a few issues such as high rent and difficulty to find affordable houses. Fortunately, a 3D printer for houses might be utilised to solve those problems. [1]

Proposed Solution

A 3D printed home is a residential structure created using 3D printing technology. By progressively printing the material in layers, the 3D printer constructs a physical structure based on a converted blueprint or CAD design. This printer uses material like concrete and clay to print the houses.[2]

Benefits

A 3D house printer introduces a new world of opportunities that traditional construction methods cannot deliver. Such as versatility in design and the ability to execute complicated designs, cheaper material and labour costs, and fewer building site mistakes due to automated operations. Which results a more efficient constructing market. [2]

Final Thoughts and Next Steps

Incorporating a 3D construction printer as a new method to build houses will allow people to live a more affordable life without escaping the city.

Introduction

There are many pros and cons of living in Montreal City. The cultural diversity, the accessible public transport, the amazing view, and more are an invitation to establish yourself in this city. [3] However, since Covid-19, Montreal citizens happened to be victims of a housing crisis that doesn't end. The housing market and the difficulty to find accommodation in Montreal had increased enormously in the short run. The augmentation of rental costs and the decline in the availability of rental properties worsen the housing crisis. [4] As a result, many families, young couples, and newcomers cannot afford to put a roof over their heads. Introducing a 3D printer in the residential construction industry will lessen the housing crisis in the Montreal area. Montreal is the ideal location to implement this innovation because of the struggle of getting accommodations. 3D printing is "a process of making three-dimensional solid objects from a digital file." [5] Printing the walls of a house is the same process as printing any object with a 3D printer. But the material used to print is different. In our, case concrete is used to print the walls. This method of producing houses is cost-effective, faster than the traditional method, and sustainable. Even if this technology only prints walls, it's still an advancement in the construction process. In the long run, this will bring a new era of construction. With the right investment, team, and planning, it will be possible to give back affordable accommodation to the population of Montreal.

Statement of Problem

A major housing issue is now plaguing Montreal, a vibrant metropolis with a diversified population. This situation has been worsened by factors including the rising use of short-term rental websites like Airbnb, rising eviction rates, an escalating population, and exorbitant

increasing housing costs, as seen in *Figure 1* . Additionally, the lack of construction workers makes the problem worse. It is crucial to investigate cutting-edge solutions to this urgent problem.

The Impact of Airbnb and Evictions

The popularity of short-term rentals, made possible by websites like Airbnb, is one of the main causes of Montreal's housing issue [6]. Since many landlords prefer to rent to vacationers rather than to long-term residents, there are less and fewer inexpensive housing options available [7]. This is because the cost of life has been increasing at such a high rate, but the salary has not. This forces people to find alternative solutions to their main source of income to continue a certain standard of living [8]. As a result, it becomes difficult for people and families to obtain stable housing options [9]. Additionally, converting residential homes into short-term rentals sometimes results in evictions, which dispenses with long-time inhabitants and exacerbates the lack of affordable housing [10]. (As seen in *Figure 1*)

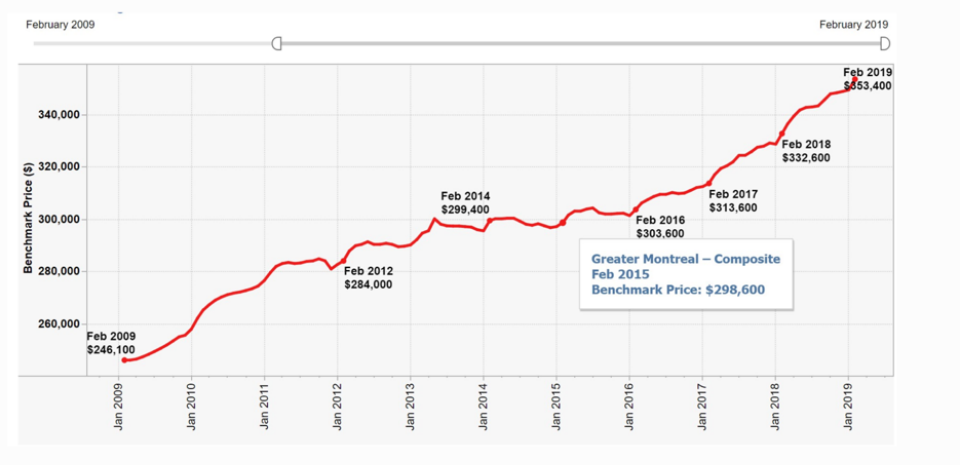

Figure 1: Montreal house prices increasing over the years [11]

Rising Population and Escalating Housing Prices

The number of people living in Montreal has significantly increased because of the city's attractiveness as a destination for immigrants, skilled workers, and international students [11]. The

housing market in the city, nevertheless, has not kept up with this expansion, creating an imbalance between supply and demand [12]. As a result, housing costs have increased, making it difficult for many Montrealers to find affordable housing. The lack of affordable housing options puts additional stress on vulnerable groups, escalating social inequality and poverty [13].

Shortage of Construction Workers and Its Impact on Housing Prices

Another significant aspect causing the housing issue in Montreal is the lack of construction employees [10]. Due to the city's building industry's difficulty in meeting the demand for new housing, projects have been delayed and costs have increased. Due to the labor shortage and rising construction prices, it has become harder to offer inexpensive home options [11]. Without enough trained labourers, the building sector will have a difficult time efficiently solving the housing issue. Investigating novel approaches that help hasten the development of affordable housing units is essential to resolving Montreal's housing crisis[14]. This issue needs to be taken seriously and an innovative solution must be applied as soon as possible. The government need to get involved and stop the illegal activity with Airbnb which decrease the eviction rate [9]. High food and energy prices scare policymakers, while growing property values are hailed as proof of a robust economy [12].

Cooperation among stakeholders is crucial to ensure the availability of affordable housing and ease the financial burden prohibiting individuals and families from buying homes and starting families in Montreal.

Potential Solutions

Montreal’s 2023 Budget

The budget for housing in the year 2023 was focused on building new affordable housing. In other words, $1 billion dollars is going to the improvement of housing affordability, where 1,500

affordable will be built over the course of five years. Moreover, affordable housing means a housing unit that is an inexpensive housing options that cater more to middle-class demands and are priced at what the market deems to be an affordable level. However, Valérie Plante, Montreal's mayor criticizes the new budget saying it will not be enough to solve the housing crisis. However, she claims the budget covered for most growing costs, such as inflation and building costs, on several social housing projects that the city is currently working on but does not cover projects for new social housing. In addition, Montreal's mayor criticizes the CAQ for not acting on the situation and investing on social affordable housing. [15]

Non-profit Housing Groups

Many non-profit organizations invest exists and want to provide lower incomes to buy a house. For example, housing units are bought or built by organizations like SHAPEM and are transformed into more affordable solutions taking them off the speculative market. Furthermore, thanks to seven organizations (SHAPEM, SOLIDES, UTILE, interloge, *Bâtir son quartier,* Acceuil Bonneau and *Brique par brique),* around 23,800 housing units were built over the last three decades and having 6,200 more planned in the future. On the other hand, the number of people on the waiting list for social and affordable housing goes up to 40,000 people. In contrast, the high cost of construction and the need for funding may intervene with pursuing the mission of these organizations: provide affordable housing. [16]

Coalition of Housing Committees and Tenants Association of Quebec

This association mandate is to speak on behalf of renters politically, especially for low-income households, and to protect their rights. They want to mobilize the population by educating them on their housing rights and through public awareness campaigns. By promoting their rights, tenants are aware of the legal, political, and social information concerning the housing market. [17] One

of the causes they fight against is the implementation of bill 31. Briefly, this new law prevents tenants from ending their lease. In other words, landlords can refuse a tenant's demand to assign their lease. [18]

3D Printed Housing

The solution to fight against the housing crisis is to build houses with the help of 3D printers. This technology has been on the market for the past few years, but it is gaining popularity thanks to its advantages. The main one being the price of the houses being sold are more affordable. Requiring minimum labor and low-priced materials, it is a reliable solution to help those who cannot afford a house. [19]

In addition, 3D-printed houses have been proven to be more sustainable, cost-effective, and customizable compared to traditional constructing procedures. Moreover, this revolutionary technology is estimated to grow at a rate of 20.8 percent from 2022 to 2030. It has been recognized that 3D-printed houses are better for the environment compared to traditional houses. For instance, the use of material is minimized, and the houses are made of recycled materials organic, and natural materials. Giving flexibility to the design and allowing a balance between the aesthetic and the function, this alternative is known to be high in efficiency and productivity with its low rates of errors and injuries. [20]

The Proposed Plan

Here is our plan to introduce 3D-printed houses to the Montreal housing market:

Implementation of the 3D house printer

Sculptura intends to start the project by printing 30 homes in the neighborhood of Ahunstic-Cartierville (as seen in *Figure 2).* Due to its convenient location, which includes being close to two highways, two metro lines, and several services including parks, hospitals, schools, and colleges, this neighbourhood is perfect to establish newcomers and families. After great thought is given to finding and securing the proper land, the project is scheduled to start in 2024 (as seen in *Table 1)*. The residences will be finished by July 1st, 2026, allowing people to move in. The business will use the cutting-edge and effective technique of 3D building to meet this ambitious deadline, guaranteeing quick development without sacrificing quality.

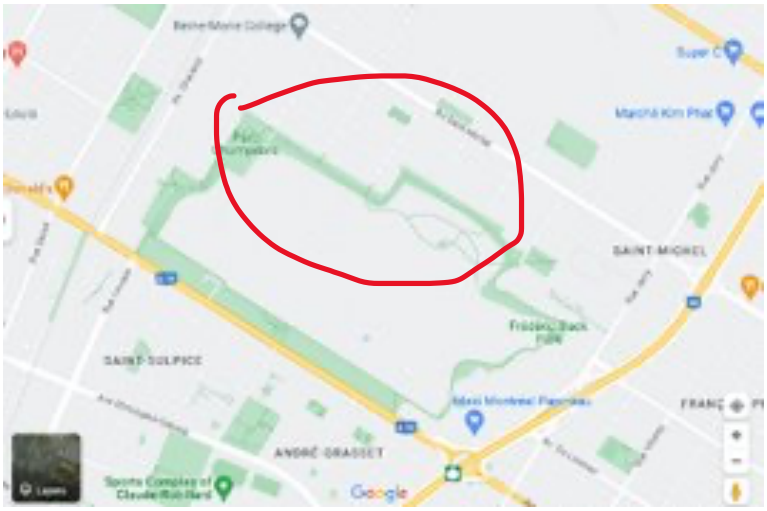

Figure 2: Ahunstic-Cartierville neighborhood [21]

Proposed Schedule

We have estimated the duration of our project to be two years (as seen in *Figure 3* and *Figure 4)*. It will start at the beginning of March 2024 and end at the beginning of July 2026. This schedule is divided into five main steps.

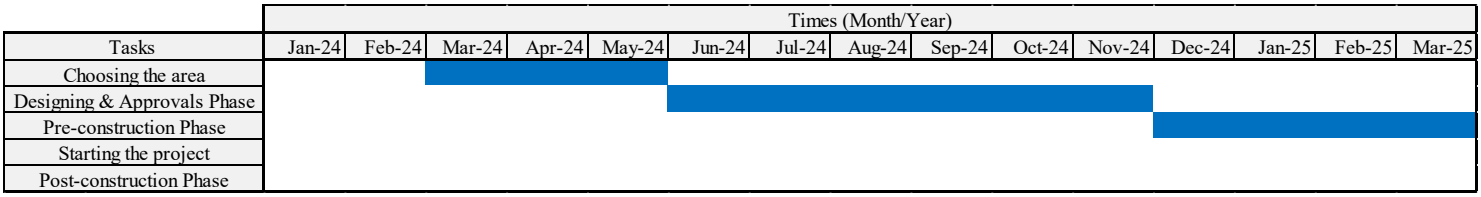

Figure 3 Gantt Chart schedule January 2024 to March 2025

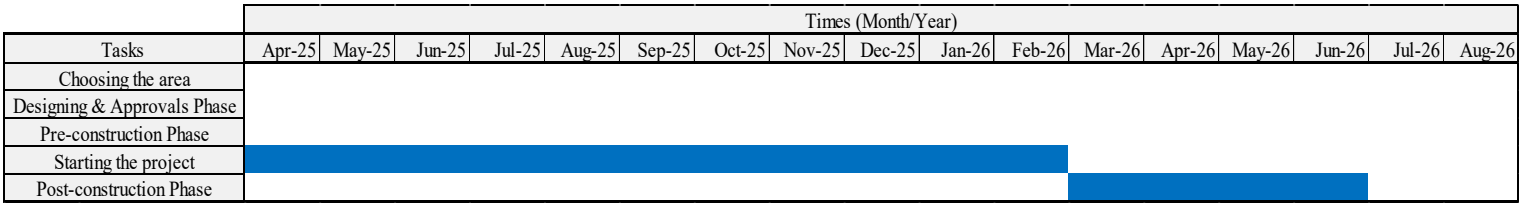

Figure 4 Gantt Chart schedule April 2025 to August 2026

As seen in *Table 1*, the first step is to choose and obtain the area where we will build our houses. It should take one to two months to be done. The second step is the design and approval phase which consist of finishing the designs, obtaining permits from the city and to employ contractors. It will take an approximative of six months to be done. The third step is pre-construction phase, it includes scheduling, financing, establishment of a team and buying the materials needed. It will last three to four months. The fourth step is starting the project and finish it. Preparation of the site, construction of the houses and quality control is made during this step. The last step is the post-construction phase were obtaining certificates of occupancy and selling the units are the main goals. [22]

Tasks	Proposed Outcome	Times
Choosing the area	• Worksite	March 30, 2024 – May 30, 2024
Designing & Approvals Phase	• Construction designs. • Permits & approvals from authorities. • Procurement of consultants and contractors.	June 1, 2024 – November 30, 2024
Pre-construction Phase	• Project schedule and budget. • Financing • Establishment of a project team and roles. • Materials	Decembre 1, 2024 – March 1, 2025
Starting the project	• Site preparation • Foundation and structural work • Building envelope construction	April 1, 2025 – March 1, 2026

	• Interior construction • Installation of utilities • Quality control and inspections	
Post-construction Phase	• Final inspection and obtaining certificates of occupancy. • Selling the units	March 10, 2026 – July 1, 2026

Table 1: Proposed schedule between 2024-2026

Bod Townhome printer

After conducting extensive research, Sculptra has successfully found a company, Nidus 3D, located in Kingston, Canada, that sells three types of 3D printers for residential use [23]. (As seen in *Table 2*)

	Modules	Dimensions (m)	Printable area (m)	Total Printing Area m^2	Perks
Bod Research	2 x 2x 2	7.45 x 5.05 x 5.05	4.52 x 4.55 x 3.09	20.56	Ideal for material testing centers, universities, and component printing.

Bod Home	5 x 5 x 3	15.03 x 12.63 x 11.6	12.10 x 12.13 x 8.14	293	Ideal for a two-story single-family home.
Bod Townhome	5 x 8 x 4	15.03 x 20.21 x 11.60	12.10 x 19.7 x 8.14	715	Ideal for three-story semi-detached homes.

Table 2: The Three Types of 3D House Printers

Sculptura decided to buy the Bod Townhome (as seen in *Figure 5*) printer for the project, which is roughly estimated to be worth two and a half to three million Canadian dollars [23]. This printer is the perfect fit for our project because you can always shrink the size of the house depending on the dimensions of your needs.

Figure 5: Bod Townhome Printer [23]

Budget

Setting a project's budget is essential to its execution success. Regarding our project, we have set aside a budget of $10 million. A sizeable chunk of this expenditure, between two and a half and three million dollars, will be used to buy the 3D printer machine. This device will be essential to improving the accuracy and efficiency of our construction process. We can optimize resource use and lower costs over time by utilizing this cutting-edge technology.

Preparing the land

After that, about a million dollars will be used to prepare the land to ensure a strong foundation for the project, the site must first undergo extensive excavation work. To support the project's operating requirements, it is also necessary to establish and integrate complicated electrical wiring systems, which calls for specialised knowledge and top-notch materials. In addition, the construction of a hydro aqueduct is an essential element that requires a substantial investment to guarantee an effective and long-lasting water supply. Setting up the project for success will depend in large part on how these funds are allocated.

Building

Additionally, a major chunk of the budget, roughly six to seven million dollars, will be devoted to the building of houses. Sculptura’s goal is to construct 30 houses on Montreal's lovely to meet the needs of newcomers and families wishing to buy a house in this thriving community. This investment not only meets the need for affordable housing but also helps the neighbourhood thrive and develop. The plan is to promote a feeling of community and ease the transition for immigrants to the neighbourhood by giving people and families additional possibilities to settle in Montreal.

Finalisation and Selling

The finalisation and the selling task (as seen in *Table 3)* does not require money from the dedicated budget because our team of specialists will manage them effectively. While the marketing campaign, which begins a year before completion, will promote the sale of the homes in the price range of $350,000 to $400,000, allowing potential buyers to visit and confirm their purchase decisions, our team of experts will handle the finalisation process, ensuring the houses are secure for occupancy. This well-planned scheduling will enable potential buyers to learn more about the project, visit the location, and confirm their purchase choices, resulting in a smooth transition for new tenants.

Task	Proposed Outcome	Time	Cost (CAD)
Research	Buy 3D Printer and prepare the blueprint	December 2024- March 2025	$ 2.5-3 millions
Preparing	Preparing the land	April 2025- June 2025	$ 1 million
Building	Building the houses	July 2025- March 2026	$ 6 millions
Finalisation	Preparing for new residents	April 2026- June 2026	N/A
Selling	Settling people	July 2026	N/A

Table 3: Distribution of the budget for the project

Comparing Prices

The table below demonstrates the differences in dimensions and costs between traditional houses and 3D printed houses in Virginia, California, and New York. In Virginia, a traditional house with a size of 1280 square feet costs approximately $384K, while a 3D printed house of the same size is priced at $235K, resulting in a significant difference of $149K. Moving to California, the dimensions vary between 864 and 1440 square feet. The cost range for traditional houses is from $253K to $864K, whereas 3D printed houses are priced at around $190K, leading to a difference of $63K to $674K. In New York, houses with a size of 1500 square feet have traditional house costs ranging from $450K to $1.2M, while 3D printed houses cost around $300K, resulting in a difference of $150K to $900K [24]. (As seen in *Table 4)* These figures demonstrate the potential cost savings associated with choosing a 3D printed house compared to a traditional one in these respective locations.

	Virginia	California	New York
Dimensions (sq.ft)	1280	864-1440	1500
Cost for Traditional Houses ($)	384K	253K-864K	450K-1.2M
Cost 3D Printed	235K	190K	300K
Difference ($)	149	63K-674K	150K-900K

Table 4: Difference of Cost Between Traditional Method and 3D Printed Houses [24]

House Market in Montreal in the Last Six Years

Interesting trends (as seen in *Figure 3)* showing Montreal housing prices from 2017 to 2022. The pace of increase showed a continuous increasing tendency from 2017 to 2020, remaining comparatively stable. The COVID-19 pandemic's arrival in 2020, however, caused a substantial

disruption in the trend. In comparison to prior years, the increase in home prices between 2020 and 2021 was much bigger, which was a result of the pandemic's effects on the real estate market.

Similar to that, the pattern persisted in 2022, when home prices took another significant jump. This accelerated surge in Montreal's property prices was caused by the pandemic's continuing effects as well as ongoing market forces.

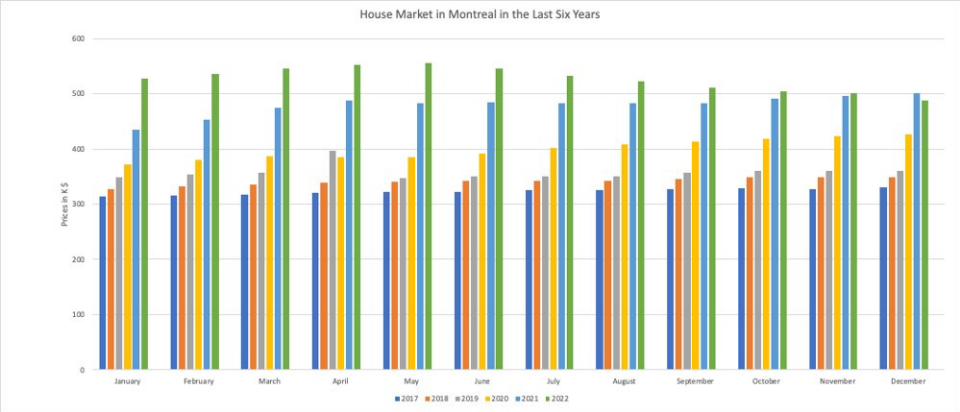

Figure 6: House6 Market in Montreal in the last six years [25]

Team Qualifications

Our team is comprised of highly experienced and capable individuals who possess the necessary expertise to successfully complete the proposed project. Allow us to introduce our team members and highlight their relevant experience.

Amal Benzaïd:

- Bachelor's in building engineering from Concordia University.
- Master of Architecture from Carleton University.
- MBA from HEC Montréal.

- Role in the project: Amal will contribute her architectural and engineering background, as well as her business acumen, to ensure the project's success.

Samantha Ruiz Vazquez:

- Bachelor's in building engineering from Concordia University.
- Master of Architecture from Milano University.
- Certification in the restoration of historical buildings.
- Role in the project: Samantha's expertise in building engineering, coupled with her architectural knowledge and experience in historical restoration, will be invaluable for the project's execution.

Mathilde Dumais:

- Bachelor's in building engineering from Concordia University.
- Master's degree in BIM field.
- Ph.D. in sustainable envelope.
- Role in the project: Mathilde's expertise in building engineering, particularly in BIM and sustainable design, will be instrumental in implementing cutting-edge technologies and ensuring environmentally conscious solutions.

Christen Halaka:

- Bachelor's in building Engineering from Concordia University.
- Master’s degree in architecture from the University of Melbourne.
- Ph.D. in Mathematics.
- Role in the project: Christen's combination of architectural and mathematical expertise will enable her to contribute to the project's design and technical aspects with precision and accuracy.

Each team member brings a unique skill set and a wealth of knowledge in their respective fields. With their diverse backgrounds in building engineering, architecture, and advanced degrees, our team is well-equipped to handle the complexities of the proposed project. We are confident in our abilities to deliver exceptional results.

Conclusion

The enormous augmentation of rent costs, the decline of vacancy unit rates and the shortage of construction workers increase the effect of the housing crisis in Montreal City. Our proposed solution will lessen the construction cost of building a two-story house or a building apartment. As a result, the selling prices will be lower and affordable to people with less income. The process of building a house with a 3D printer requires less time than the traditional process. It allows us to deliver accommodation in a limited time. To operate a 3D printer and print walls, you need fewer workers than in the traditional process of building walls. The shortage of construction workers will not be a problem for our project because fewer people are needed.

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