The Third Space
Market Analysis

This project takes place on the unceded traditional territories of the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and səlilwətaɬ (Tsleil-Waututh) Nations.

Contents

Market Analysis

Housing unaffordability is not unique to Vancouver, however the severity is unparalleled when contrasted to other major cities. For the average household in Vancouver making $82,000 CAD ($60,210 USD), there is no scenario where a buying a home is affordable.

The affordability crisis is deep and systemic.

To put this crisis into perspective, the following is an example of the affordability of previous Build Challenge in Vancouver's economic

SPARC House in Vancouver

2020 build challenge winners CU Boulder (SPARC House) were able to develop a house that was attainable for those with a household income of 63,000 USD (86,500 CAD).

CU Boulder's construction cost, factoring in for land cost and their proposed garage is $739,704 CAD ($543,316 USD) or $629 PSF CAD ($461 PSF USD), bringing the i

Construction cost statistics show that there is a significant premium when building in Vancouver compared to Denver; about 30% higher. This comes from comparing the cost PSF CAD to build standard detached housing in Vancouver ($260 PSF) and Denver ($200 PSF) (Statista & Estimations QS).

Th CU Boulder team completed their house in 2021; with 2 years of price inflation factored at an average annualized rate of 6.3% (Statistics Canada).

Vancouver zoning with a 0.7 floor space ratio requirement results in a required lot size of 1,680 sq. ft.

The resulted expected monthly payments for CU Boulder's home are $7,746 CAD ($5,688 USD) (Figure 1). In order for a household to afford this home, the annual income requirements are $270,000 CAD ($198,270 USD) per annum – significantly higher than the $86,500 CAD ($63,519 USD) proposed. Although this income requirement is less than that of Third Space Commons (387,440 CAD/$284,507 USD), this is a result of our building being 814 sq. ft. larger. Comparing cost per sq. ft. directly, our project is cheaper by $298 PSF CAD ($218 PSF USD). Based on the Median HH income in Vancouver of $82,000 CAD ($60,210 USD), Third Space Commons would have a Price/Income Ratio of 26.27 and SPARC House would be 19.79.

SPARC House in Vancouver	
Original Cost PSF	$629 CAD
Assumptions	
Average Annual Inflation Rate	6.30%
Construction Cost Multiple (Vancouver to Denver)	1.30 X
Vancouver Land Cost (PSF)	$319
House (Sq. Ft.)	1,176
Land Required (Sq. Ft.)	1,680
Costs	
Construction Cost	$1,086,595
Land Cost	$535,920
Total Cost	**$1,622,515**
Total Cost PSF	**$1,380 PSF**
Operating Costs	
Property tax	$298
Insurance	$125
Utilities	$290
Maintenance	$270
Mortgage (30 year, interest @4.74%, 20% down)	$6,763
Total Monthly Cost	**$7,746**
Required HH Income	**$270,520**

Figure 1- Financial Break Down of SPARC House by CU Boulder 2021 if Built in Vancouver

Third Space Commons in Denver, Colorado

To look at this through a different lens, we'll consider the scenario in which Third Space Commons is built in Denver. Figure 2 flips the assumptions and shows a 23% construction cost savings in addition to drastically reduced land cost, at only $34 PSF CAD ($25 PSF USD). The subject site is in a S-SU-D Zone that requires a minimum lot size of 6,000 sq. ft – bringing the land cost to $201,240 CAD ($147,776 USD) and a full project cost of $1,161,992 CAD ($853,228 USD). Within the section of "Affordability and Cost Effectiveness", we explore how the income required to afford Third Space Commons in Vancouver is around $390,000 CAD ($286,387 USD). By constructing the exact same house but in Denver, the income requirement drops by over half to $174,499 CAD ($128,139 USD). Similar to the last example, the income requirement is greater than that of the CU Boulder team, however; this is a result of our building being larger. Using the same land cost and assuming both projects were built at the same time, our project is $129 PSF CAD ($95 USD) cheaper than the CU Boulder team (based on $439,000 USD base + $100,000 USD garage + 147,932 USD land value ($24.66 USD *6,000 sq. ft.) / 1178 sq. ft.). Based on the Median HH income in Denver of $106,582 CAD ($78,265 USD), Third Space Commons would have a Price/Income Ratio of 9.87 and SPARC House would be 8.77.

Original Cost PSF	$627 CAD
Assumptions	
Average Annual Inflation Rate (Minus 2 years)	6.30%
Construction Cost Multiple (Vancouver to Denver)	0.77 X
Denver Land Cost (PSF)	$34
House (Sq. Ft.)	1,990
Land Required (Sq. Ft.)	6,000
Costs	
Construction Cost	$850,246
Land Cost	$201,240
Total Cost	**$1,051,486**
Total Cost PSF	**$528 PSF**
Operating Costs	
Property tax	$331
Insurance	$263
Utilities	$290
Maintenance	$359
Mortgage (30 year, interest @4.74%, 20% down)	$4,360
Total Monthly Cost	**$5,603**
Required HH Income	**$174,400**

Figure 2- Financial Break Down of Third Space Common if Built in Glendale, Denver

Third Space Commons in Denver, Colorado

For this project to be successful, we understand that there must be a need in the market to justify the additional set-up costs associated with low embodied-carbon buildings. Fortunately, we are not the only stakeholder group that understands this need, as the City of Vancouver has recently approved plans to cut down on the embodied carbon levels of new builds. The Climate Emergency Action Plan (CEAP) has stated that by 2030, new builds must reduce overall embodied carbon levels by 40% compared to the 2018 baseline, and by 2025 - a 20% reduction.

Third Space Commons is exceeding this goal with carbon savings of 60%, showing the building community how to attainably hit these set targets. This means that anyone who wants to purchase new housing stock will be an indirect part of our target market.
Vancouver is a coastal city that is already starting to see the effects of climate change. From larger forest fires to the faster melt of our snow reserves, its residents are becoming increasingly more worried about what the extended future has in store. As a result, these wealthy residents are willing to expend more capital towards personal initiatives that aim to fight the climate crisis. We are already one of the most sustainable cities in North America and have historically made monetary sacrifices for the betterment of our environment. Not only are we willing to make these sacrifices but we are, in part, mandated by provincial and local governments through various carbon policies and taxes. Given the unique institutional nature of this project, there is no way to assess if there is a market need. However, given its demographic, the highest likelihood of success for this type of building is right here in Vancouver.

Characteristics	Target Market
Location of Hypothetical Site	East Vancouver, British Columbia
Target Demographic	Working Professionals
Profession(s)	Self-Employed Architect & Designer
Family Size	2 Parents, 2 Kids
Household Income	$390,000 (before tax)
Housing Needs	Live/Work Studio Space

Figure 3- Target Market

Affordability and Cost-Effectiveness

Given the high barrier for entry for detached single family home ownership, the building's affordability must be contextualized correctly. The target demographic for single family homes in Vancouver are wealth

Vancouver that is wealthy enough to respond to this cost. As such, our example illustrates a household that makes $390,000 CAD ($286,386 USD) per annum and needs a space to raise two children while working from home (Figure 3). As both parental figures are self-employed entrepreneurs who work in the design industry, they require configurable studio space that can be used for pin-ups, sufficient room to host clients, and appropriate space to house employee desks. As live/work housing is rare in Vancouver, this demographic has opted to build a custom home that will suit their specific needs. In terms of location, the house will be built on a single-family lot in a specific live/work zone a few minutes east of the downtown core – the Downtown Eastside (DTES).

According to provincial property assessments, land in this location is valued at $319 PSF CAD ($234 PSF USD). Combining the interior, loft, and sunroom space we get a total square footage of 1,990 – implying the 0.7 FSR used in this zone – we get a total required lot size of 2,843 sq. ft. As a result, the cost of land for this build is $908,871 CAD ($667,406 USD). Adding in the construction costs of $1,247,344 CAD ($915,956 USD) (Figure 4), the upfront cost of the project is $2,154,215 CAD ($1,581,894 USD) or $1,083 PSF CAD ($796 PSF USD).

Taking advantage of Vancouvers cheap energy and water grids, in addition to energy generating PV panels located on the roof, our monthly utility bill is only $62 CAD ($46 USD) ((13.27 cents CAD (9.76 cents USD) per kWh * (total usage of 10,925 kWh - PV generation of 5,295 kWh))/12). Property tax and insurance rates are also relatively low, only

List of Activities	Market Cost
Permitting	$ 19,029
Survey & Layout	$ 1,640
Fences, Hoarding & Railings	$ 10,891
Supervision & Administration	$ 42,000
Freight & Courier	$ 5,000
Site Office	$ 9,500
Field Offices & Sheds	$ 8,087
Temporary Heating	$ 10,092
Surface & Ground water control	$ 1,400
General Equipment Rental	$ 16,976
Utilities	$ 18,500
Earthwork	$ 75,978
Wood, Plastics, and Composites	$ 164,843
Plumbing	$ 60,000
Heating, Ventilating, and Air Conditioning (HVAC)	$ 10,000
Electrical	$ 130,594
Thermal and Moisture Protection	$ 254,715
Openings	$ 67,000
Finishes	$ 83,508
Exterior Improvements	$ 15,000
Framing and General Construction Labour Cost	$ 182,592
Project and Design Costs	$ 60,000
TOTAL COST	**$ 1,247,344**

Figure 4- Third Space Commons Home Construction Cost

costing $482 CAD ($354 USD) (0.2693% * the home's value) and $148 CAD ($109 USD) per month, respectively. Additionally, given that this is a brand-new home with low maintenance landscaping, the estimated monthly maintenance cost comes out to $359 CAD ($264 USD). This equates to a monthly total of $1,053 CAD ($773 USD) in operating expenses.

To finance the property and construction, the family will take on a personal mortgage collateralized by the property itself and through their take-home income. The terms of the mortgage include an average interest rate of 4.74%, 20% down and a 30-year amortization. This equates to a monthly mortgage payment of $9,686 CAD ($7,113 USD) and a total monthly housing payment (Op Ex + Mortgage) of $10,739 CAD ($7,886 USD). Assuming no more than 30% of their income is spent on the mortgage, we circle back to a household income of just below $390,000 CAD ($286,386 USD) per annum.

Relative Affordability Claim

The breakdown above illustrates how unaffordable detached single-family housing is in the City of Vancouver, as a household has to make nearly $400,000 CAD ($293,730 USD) to live in less than 2,000 sq. ft. However, in the case of our demographic, this house is relatively affordable when comparing to a common, alternative scenario where they own a smaller home and rent an office.

Scenario 1 – Third Space Commons Live/work

The first example will be if our demographic lives and works out of Third Space Commons.

Working from home offers many benefits compared to a conventional office space, both in terms of monetary savings (reduction in gas, parking, and meal costs) and flexibility (no commute time, reduced dependance on childcare, access to at-home conveniences, and reduction in carbon emissions). Figure 5 shows a breakdown of how the space is divided for live and work. In Canada, at-home office space is tax deductible, so 35% of the operating cost and mortgage can be charged to the business, helping cover some of the overhead. Although the full household income of $387,440 CAD ($284,507 USD) is required to qualify for the mortgage, their personal wage only needs to be $250,760 CAD ($184,139 USD) to afford the living accommodation. The remaining $136,680 CAD ($100,367 USD) is what the business needs to produce for this scenario to pencil, an accessible goal for this line of work. Finally, the total monthly cost of Third Space Commons is $10,739 CAD ($7,886 USD).

Scenario 1 (Third Space Live/Work)			
	House	Office	Total
Assumptions			
% of Total	65%	35%	100%
Sq. Ft	1288	702	1990
DTES Assessed Land PSF	N/a	N/a	$319
Set-up Costs			
Land	$586,960	$319,911	$906,871
Building	$807,326	$440,018	$1,247,344
Total	**$1,394,286**	**$759,929**	**$2,154,215**
Operating Costs			
Property Tax	$313	$171	$483
Insurance	$40	$22	$62
Utilities	$96	$52	$148
Maintenance	$232	$127	$359
Mortgage	$6,269	$3,417	$9,686
Total Monthly Cost	**$6,950**	**$3,788**	**$10,739**
Required Income	**$250,760**	**$136,680**	**$387,440**

Figure 5- Third Space Commons Home Construction Cost

Scenario 2 (Purchased Townhouse + Rented Office)			
	Townhouse	Rented Office	Total
Assumptions			
Sq. Ft.	1,288	1,096	
PSF	$1,181	$35	
Purchase Price	$1,521,443	N/a	
Office Fit-out	N/a	$87,680	
Operating Costs			
Property Tax	$280	N/a	$280
Insurance	$100	N/a	$100
Utilities and Strata Fees	$701	N/a	$701
Mortgage	$6,308	N/a	$6,308
Office Rent	N/a	$3,197	$3,197
Amortized Office Fit-out	N/a	$1,461	$1,461
Parking Spot	N/a	$275	$275
Total Monthly Cost	**$7,389**	**$4,933**	**$12,322**
Required Income	**$252,320**	**$197,320**	**$449,640**

Figure 6- Purchased Townhouse + Rented Office Cost Breakdown

Scenario 2 – Townhouse + Rented Office

The second example will be if our demographic purchased the same size living accommodation - in the form of a townhouse - and rented an office in the downtown core.
Looking at the available office stock, there are no spaces that are the same square footage as the office provided within Third Space Commons. As a result, the target market would have to upsize to 1,096 sq. ft. and incur the additional costs. Not only this, but a monthly parking spot and office fit-out cost are added (amortized over 5 years, an average lease agreement duration). Figure 5 also displays additional costs associated with the living accommodations as all stratified property comes with mandatory "Strata Fees" that go towards common space maintenance and reserve funds. The monthly charge reflects these additions and results in a total cost of $12,322 CAD ($9,048 USD).

Scenario Comparison

Third Space Commons wins outright against a direct alternative when evaluating the cost savings and impact on quality of life. To put this into perspective, there is a 13.8% reduction or $62,200 CAD ($45,675 USD) savings of the required income needed to support both the living and work spaces. Additionally, owning Third Space Commons is a more intelligent long-term financial decision as the homeowner can take advantage of property price appreciation. In comparison, the rented office is a constant equity drain that counteracts any price growth experienced by the townhouse.

Livability

Located just east of the downtown core, our locality is in close proximity to neighbourhood shops, parks, and necessities. As our target market will live and work within the same space, there is very little need for a personal vehicle. Instead, the residents can walk, cycle, take public transit, or use car sharing services. Having access to amenities without the need for a car encourages a healthy lifestyle and puts an emphasis on sourcing locally. With the land constraint mentioned earlier, the city is no longer able to expand road infrastructure. This is an issue when considering that the province welcomed nearly 100,000 immigrants last year. However, the residents of Third Space Commons will not have to worry as there is no commute time between the live and work spaces. It provides the convenience of stepping out of bed and into the next room, saving valuable sleep in the process. The home is also equipped will all modern amenities, allowing the occupants to stay at home for as long as they need.

Not only is the building itself low-carbon, but it also encourages the homeowner to be carbon cognisant and use fewer resources. Simplistic in its design, the space will stand against home fads and constant remodeling. As home renovations are becoming commonplace, it is important to understand the environmental impact and waste associated with keeping up-to-date with the latest trends. With one partition wall and finishes in timeless materials, there is no desire for any renovation within the lifetime of this building. This is accompanied by the fact that all materials were, in part, chosen for their durability. The Accoya wood siding and metal roof have a 25+ year warranty, the engineered hardwood is some of the toughest on the market, and the hempcrete walls should easily outlast the occupants. Although the market value of these materials is higher than standard products, there are significant long-term savings as the finishes will not need replacement for the foreseeable future.

The sunroom and north deck were designed with the intent of fostering a home garden – a rare amenity within a dense city. This not only helps to reduce grocery store and produce dependence, but also shapes how the occupant views consumption. In fact, the whole building was designed to influence how a homeowner looks at materiality and circularity.

Buildability

Although the construction techniques employed by this building are unique, they are easily replicable and can be adopted by traditional home builders. In fact, most components of the build are easy to construct – however, it does require more labour than a typical build. No advanced machine tools or techniques were used, instead we utilized only readily available resources and materials that are common across the industry.

Foundation – Helical Piles

Although slightly more complex compared to a standard concrete pad, helical piles are relatively simple to install given accurate site surveys and a pre-planned layout. There is a design challenge associated with piles as their placement evolves depending on structural changes. However, once the number and location of the piles is determined, they only take about one working day to place and drill. The fabrication of helical piles is done off-site, which also helps to expedite the construction schedule. When constructing in remote locations, there is an added benefit to the piles as they are lighter and easier to transport compared to concrete. During the spring months, some roads in Canada enact “Half-Load Road Conditions” where a max weight is set for all vehicles as the ground heats up and becomes less stable. When constructing during these times, homes that use concrete are at a serious disadvantage as the trucks have difficulty accessing site. Helical pile transportation does not have this issue, cutting down on cost and construction time. This efficient foundation is extremely easy to install and only requires a small crew.
T OUR HELICAL PILE PHOTO

Framing – Double Stud Wall

Third Space Commons uses conventional framing that any typical construction company would be able to complete. The structural system is simple, consisting of light wood framing with engineered wood beams and trusses to support the roof and floor. Other than needing a small truck crane to maneuver these beams into place, the rest of the structure can be constructed by general carpenters with hammers and access to scaffolding.

Rough MEP – HRV + Electrical Heating Mats

Some key items for rough MEP that were implemented in our building included a heat recovery ventilator (HRV), electrical heating mats, and a rainwater collection system. It was important for our project to incorporate an HRV as it reduces energy consumption while providing high air quality to occupants. Implementing the system requires planning, integration, commissioning, and training, but any typical HVAC contractor is capable of installation. For heat, electrical heating mats were incorporated for their ease of installation, cost effectiveness, and low maintenance requirements. Electrical heating mats can be laid out quickly and efficiently – students were able to help with minimal guidance. The mats are designed to be laid out in a single, continuous layer, and they come in a variety of sizes and shapes to fit the required area.

Insulation – Hempcrete + Dense Pack Cellulose

As hempcrete is a brand-new material, there were very few reference points available to us during the construction process. Fortunately, the material was easy to mix and install, simple enough for any student to complete without much supervision. The only thing it required was time. The process is quite labour intensive as all batches were mixed in small portions, hand carried in buckets, dumped into the forms then manually packed down. The hempcrete was installed in our 18” double stud stick wall that ranged from lows of 8’ to peaks of 25’.

Dense pack cellulose was used in our floor and roof assembly. Given its blown in application, the process is quick and efficient and does not require any special tools or equipment besides an insulation blower which is readily available no matter where you live. Additional benefits to building with this recycled newspaper is it is adaptable to almost any space, requires no cutting, and generates little to no waste. For all these reasons, it is a preferred insulation material and can be easily implemented for any typical construction company.

Reused Window Wall

The reused window wall is one of the most accessible components of this project. To source the materials, the team turned to Facebook Marketplace and Craigslist to find individuals selling old, single pane windows. They were easy to source and could be purchased at a low cost. The only requirement for this was time. All the windows we purchased needed refurbishing, requiring a re-paint and putty. Although intensive, it was low skill work that any individual could accomplish.

Scalability

Given the prototype nature of Third Space Commons, students and industry team members were learning as we went. There was little time to optimize as the main focus was to finish construction by the set deadline. As a result, we encountered a few delays and errors, inevitable when trying something new. However, if we had the opportunity to replicate this design and build at scale, there are many components that could be optimized to create a strong business case. To make this a reality, we have highlighted a course of action that could drastically reduce the cost and time required to construct this style of building.

Pre-Fabrication

Nearly all components of this build could be built off-site at specialized facilities. Although there is no infrastructure to support the pre-fabri-

cation of hempcrete walls, it is something that could be a reality if the material proves itself over the coming years. There are already innovations out of Europe that allow contractors to "blow-in" hempcrete, and companies like Dun Agro Hemp Group (Figure **) who are specializing in prefabricated hemp panels. An ideal scenario would be to pre-fabricate full sections of the wall assembly – equipped with all mechanical and electrical rough-ins. This would drastically reduce the construction time as the hempcrete took us months to pack and cure. Using a Just-in-Time approach would allow us to have walls ready when needed, only taking a few days to install. The floor assembly could also be built elsewhere, craning in pre-built sections instead of framing on-site.

Figure 7- Dun Agro Hemp Group Prefab Hemp Panels

Market Impact

Similar to other sustainable materials (e.g., pre-fabricated CLT panels), hempcrete is currently more expensive than conventional techniques. With time and adoption, these sustainable materials will start to become cheaper. The real cost savings comes from the reduction in labour and time needed to install. When financing a project, every month is important as the longer a project carries out for, the larger the interest payment. Reducing what normally takes a few months to only a few weeks or days can off-set the higher materials cost.
If pre-fabricated hempcrete shows to be effective, future adopters can take advantage of economies of scale. When facilities that specialize in manufacturing spec hempcrete walls start to open, costs will level off. This will only add to the savings in labour and time. Additionally, the modular nature of Third Space Commons can allow for simplified construction in remote locations. When constructing where labour and materials must be transported far distances, it is crucial to limit on-site modifications to reduce cost.

Innovation

This entire project was an exercise to rethink the way we look at housing. The pandemic showed us how we no longer need a home to function solely as a home, but also a place where we work, live, entertain, and think. Third Space Commons has not only innovated in its construction techniques but has pushed the notion of how we live.

Livability

This building is the embodiment of flexibility, effortlessly adapting to the needs of the occupants at any given time. The space can used for living in the morning, working in the afternoon, and entertaining in the evening. It is difficult to call this a house because it is so much more than that. Once complete, it will be handed over to UBC Applied Science to host workshops and house keen students that want to push the frontier of sustainability while simultaneously using it as a test bed for new ideas. This building is not only an innovation in and of itself, but will continue to produce innovations for years to come.

A large emphasis was placed on occupant health throughout the design process. The materials chosen do not produce harmful off-gassing or unpleasant odors. Additionally, the windows and skylights were positioned to provide diffused daylighting while programmed to allow in fresh ventilation. Access to natural light and air has a host of physical and mental benefits, ensuring our occupants are

comfortable at any given time.

Buildability

All aspects of the construction process were centered around low-carbon emissions. For example, our helical pile foundation was not only chosen to forfeit the need of a concrete slab but to eliminate excavation. Trapped carbon is released into the atmosphere when the earth is dug up. Our goal was to leave the ground relatively untouched and prevent any additional CO2 from being released.
Looking beyond this project, we hope to leverage our industry connections and apply our learnings throughout the community.

Funding Structure

Over the course of a year and a half, the team has fundraised $1,778,395 CAD ($1,305,919 USD) through monetary ($902,283 CAD / $662,569 USD) and in-kind donations ($876,112 CAD / $643,351 USD). This number will continue to grow as the remainder of our donations are processed and we expect another $115,000 CAD ($84,447 USD) to be received. As a result, Third Quadrant Design (TQD) has easily raised the most amount of money compared to any other student team in UBC's history. This was done in part through leveraging our existing connections while foraging new ones throughout the industry and at UBC.
Figure ** outlines where these donations came from with some notable donors including UBC Applied Science (contributing $315,000 CAD / $231,312 USD), Ledcor (contributing $300,000 CAD / $220,298 USD), Third Space (contributing $100,000 CAD / $73,433 USD), the previous president of UBC (contributing $50,000 CAD / $36,716 USD), the Dean of The Sauder School of Business (contributing $25,000 CAD / $18,358 USD), and so many more. This project would not have been possible without these generous contributions.

Donation by Category	
Source	**Amount**
Design Industry	$ 160,000
Construction Industry	$ 666,395
Development Industry	$ 272,000
Institutional Donors	$ 510,000
Private Donors	$ 180,000