Team CASH (Converted Affordable Ship Housing)

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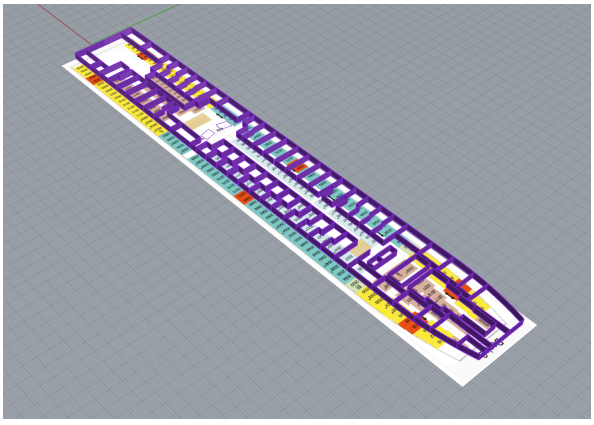
This study evaluated the feasibility of converting a cruise ship into an affordable housing community. The idea is motivated by a confluence of factors: the affordable housing crisis besetting many cities and regions across the United States, the windfall of cruise ships available for purchase at reasonable prices in a post-pandemic world, and the apparent suitability of cruise ships to be repurposed for housing. This project aimed to address whether that last assumption was actually valid and whether this sort of proposal could prove feasible and cost-competitive against a traditional, land-based housing approach.

Early in the design process, the team contacted and interviewed various subject matter experts who had previously explored this idea in order to better develop our design parameters and associated requirements. The two main design parameters were affordability and desirability, as we strove to maintain the proper balance between these two central, and at times competing, qualities. They drove the design process as we attempted to not just convert cabins into housing units but to create a space where people would actually want to live, and could afford to do so.

To assess this idea's feasibility, we selected a baseline cruise ship variant based on vessel size, potential housing capacity, price, and availability of a representative model. Our 3D model was used primarily for weight estimations, intact and damaged stability analysis, and baseline remodeling to render a final proposed ship design. In order to properly account for conversion-related weight changes, a pre-conversion weight estimate was calculated on a per-deck basis using the Ship Work Breakdown Structure (SWBS) group weight allocations for a similar-sized U.S. naval warship, and modified with applicability factors to better reflect the cruise ship's weight contributors. Publicly available 2D deck plans were used as the basis for arrangement modifications. Each deck was evaluated and redesigned to provide some aspect of the affordable housing community.

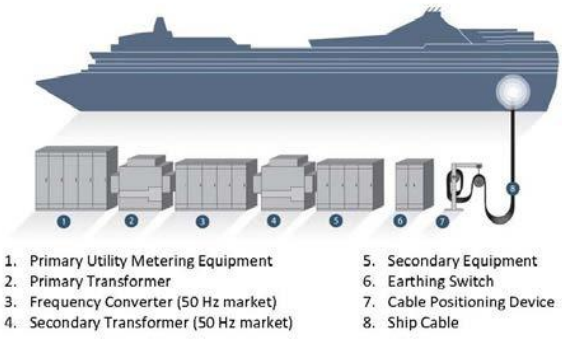


The five current cabin decks were repurposed for the actual housing units. The most common unit merged four existing small-sized cabins in order to provide a desirable unit size and permit the installation of an in-unit kitchen. This "base unit" was priced such that the median Boston income earner could reasonably afford it, *i.e.* spend no more than 30% of their gross income on rent. A spectrum of smaller and larger housing units was established to cover a wider range of income earners. In total, our design proposed 246 housing units of varying sizes and prices that were able to accommodate approximately 350 people.

The remaining decks were modified to provide all the additional amenities, facilities, and furnishings deemed necessary in order to provide a desirable living space. These included: an

enhanced fitness center, indoor pool, business center, grocery store, movie theater, multiple green spaces, daycare center, and three decks of parking. Weight removal and addition estimates were calculated on a per-deck basis in order to determine a post-conversion weight estimate and facilitate post-conversion stability analysis, which demonstrated improved stability performance compared to the pre-conversion model.

To provide the major utilities required for onboard living–electricity, water, sewage–we proposed concurrent investments in pierside and shipboard infrastructure and equipment upgrades to allow the cruise ship to connect to the city's power, water, and waste distribution systems on a permanent basis. The continued use of installed onboard systems to account for these needs proved either infeasible or unwise, whereas investments in ship-to-shore power technology and interoperability with the city's distribution systems were shown to have long-term environmental, operational, and economical benefits. Despite this approach rendering much of the installed onboard equipment no longer necessary, we were unable to identify compelling reasons to pursue large-scale engine room equipment removal. The final design maintained the engine room largely in the as-is configuration but with systems and equipment no longer necessary being retired in place in order to avoid undue maintenance and upkeep costs. To ensure the vessel's relocatability, our design maintained two of the four main diesel engines in an operational status to provide redundant sources of organic power generation.



Cost estimates for all aspects of the conversion process–acquisition, refurbishment, retrofit, operations, maintenance, and staffing–were estimated using comparable historical data and SME input to determine the overall feasibility of the proposal. The key cost consideration was whether the annual rent revenue could cover the annual operational costs. We determined that the expected revenue would not fully cover all of these expenses, but that this shortfall could be accounted for with a small amount of additional public funding or more favorable utility discount rates. A comparative cost analysis between the proposed design and a similarly-sized land-based apartment complex was also conducted, which concluded that by avoiding new construction costs, the cruise ship conversion would be significantly less expensive overall.

This project determined that the conversion of a cruise ship into affordable housing is both technically and financially feasible, and offers crucial advantages over comparable land-based approaches.

	Fixed Costs ($M)		**Operational Costs ($M)**
Purchase:	45.0	Utilities:	2.6
Refurbishment:	53.3	Staffing:	1.1
Infrastructure:	23.3	Lease:	0.2
Total:	**121.6**		**3.9**