ISSN: 2582-8304

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COLLABORATIVE SYSTEM DESIGN BUILDING: PERPETUAL

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ISSN: 2582-8304

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Clöe Lemaire comes from Jacksonville, Florida, where she got her Bachelor's in Coastal Biology and French from the University of North Florida. She moved to Savannah in 2021 to pursue her Masters in Marine Science at Savannah State University. She studied estuarine water chemistry and how it impacts Eastern oyster growth. Clöe joined the Savannah Riverkeeper team for the lower Savannah River watershed in 2024. She is the project manager responsible for phasing out single-use packaging in Savannah by working with local and national nonprofits to introduce a city-wide reusable foodware system as an upstream solution to pollution. When not working she loves to read, thrift, spend time outdoors, play with her two cats, Monkey and Pearl, and sew as a way to give secondhand clothes a new life.

ISSN: 2582-8304

ABSTRACT

As cities grapple with mounting waste from single-use foodware, reusable systems are emerging as a scalable, sustainable solution. However, achieving meaningful impact requires more than swapping disposables for reusables: it demands thoughtful, collaborative system design rooted in community, context, and equity. This article explores the collaborative methods behind the implementation of city-scale reusable foodware systems, with a focus on the work of Perpetual, an innovative organization building reusable systems. Perpetual has begun this nationwide initiative by partnering with four U.S. cities: Hilo (HI), Galveston (TX), Savannah (GA), and Ann Arbor (MI). Through a deeply participatory approach, Perpetual works with local nonprofit partners, universities, and community members to co-design systems that are operationally viable and culturally resonant. Methods include ecosystem mapping, community design workshops, behavioral research, financial and life cycle modeling, and ongoing public-private engagement. These efforts aim to create reuse systems that are not only effective and scalable but also equitable, accessible, and reflective of local needs and values.. By highlighting the collaborative infrastructure behind these programs, this article offers a practical and replicable framework for other municipalities looking to transition from single-use to reuse. The success of these initiatives illustrates how investing in inclusive system design can transform reuse into a shared civic practice, supported by public infrastructure, to lay the foundation for circular economies nationwide.

Keywords: ***Reusable, disposable, system design***

ISSN: 2582-8304

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The Plastic Problem

Nearly one trillion individual pieces of disposable foodware and packaging are used by U.S. restaurants and food service businesses each year, becoming at least five million tons of waste [1, 2]. Single-use foodware also contributes to plastic and other materials entering waterways and the ocean. Food-related products dominate the International Coastal Cleanups' Top 10, representing eight of the top categories in terms of number of items collected [3]. Disposable foodware also imposes costs on local governments. In 2016, conservative estimates indicate that it cost over $1 billion to manage the waste from food service disposables. Improperly managed disposables further confer a significant economic, social, and environmental cost [1].

What is a City-scale reusable foodware system?

City-scale reusable foodware systems allow consumers to borrow reusable cups and/or containers from anywhere they normally purchase food and drinks, such as restaurants, cafeterias, gas stations, convenience stores, and music venues, and return them when they are done, either in the same location or at one of many collection bins around the the city. These systems operate within participating food service establishments and can be found globally, most notably across Europe and Asia. In North America, these systems are less common, however not nonexistent. Canada hosts a number of reusable cup and container programs; while in the states, the reusable cup and container programs are mostly concentrated in the Northeast and West Coast regions.

Once customers are finished with their cups and containers, they return them to the appropriate collection bin and a third party collects, cleans, and redistributes the reusable items to local businesses to ensure the system is efficient, hygienic, and convenient. In order to cover the costs of operating the system, many programs use different business models (i.e., customer subscription model, business pay-per-use model, utility service model).

Customer subscription model: Customers pay a monthly fee, often in the range of $20/mo, to be able to use reusable takeout cups and containers, typically limiting the consumer to a max number of items checked out at any one time

Business pay-per-use model: Businesses pay a per reuse cost each time they use a reusable item

Utility service model: Similar to a municipal recycling service, the government uses taxpayer funding (either in general or through a fee for service) to pay for the reuse service.

Figure 1: Business models for reusable container systems

Each of these models are referred to as 'foodware-as-a-service' models. This means that local restaurants or other foodservice businesses can access reusables the same way they might use a linen service. In all except for the customer subscription model, customers do not incur any fees as long as they return the items in an agreed amount of time. Reusable foodware systems track and retain their reusable items with any of the above options (subscription, deposit or penalty). Subscriptions require the customers to pay a monthly fee to checkout items. In a deposit system, customers pay a small deposit (~$1-$5) at the point of check out then receive the deposit back once the reusable item is returned. In a penalty system, customers would check the item out for free and only get charged the penalty fee (~$1-$5) if they do not return the reusable item.

As reuse scales, systems can expand to include other types of packaging, initially expanding into locally produced food items such as milk, juice, salsa, yogurt, and hummus, and eventually expanding to connect with broader reuse systems for packaged goods including food, personal care, and household care products. These systems could also be expanded to wash, sanitize, and redistribute secondary and tertiary packaging (packaging used for bulk shipping).

What is missing from current reuse systems?

Reusable foodware programs for take-out food and beverages have the potential to be better for the environment than single-use plastics, create good local jobs, be economically sustainable over time, help cities manage their waste generation and collection, and be cost competitive with disposables for local businesses.

However, it is only possible to achieve these benefits when systems are operating at scale. There needs to be a sufficient volume of reusable items moving through the system to achieve economic and environmental benefits. Additionally, there needs to be enough market saturation that reusable items are widely available and enough collection bins around the city so that returning a reusable item is almost as easy as throwing something in the trash. Reuse pilots have demonstrated that this immersive availability and convenience are key to align user behavior with reuse. The convenience of a reusable foodware system increases as the adoption rate increases and supportive infrastructure is built out, which is to say that as more businesses choose to offer reusable items and more customers choose to use the reusable items, the system becomes more ubiquitous. When reuse is available throughout a city, it can become the new norm and can become an 'automatic' behavior for community members.

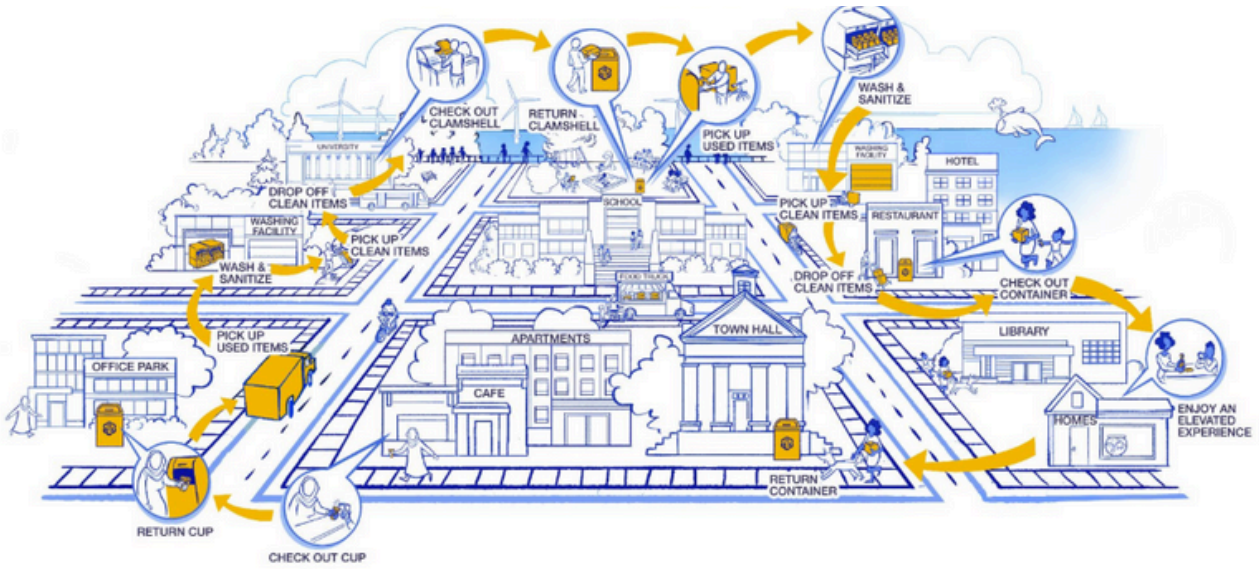

Figure 2: The Reusable Foodware Ecosystem

ISSN: 2582-8304

Perpetual has been developing city-scale reusable foodware systems for the last four years by working with four smaller U.S. cities to design and implement city-scale open-loop reusable foodware systems:

- **Hilo, Hawai'i**
- **Galveston, Texas**
- **Savannah, Georgia**
- **Ann Arbor, Michigan**

Perpetual is a team of reuse experts and innovators, cofounded by Ellie Moss and Dagny Tucker in 2021. After having worked in diverse roles in the reuse sector, from mapping reuse solutions around the world to building and operating a reusable cup service system , the team recognized several challenges with launching sub-scale reuse systems. Through their observations, they identified the following elements to be the most critical challenges reuse stems face: system scalability, operational economics, and collaboration between reuse service providers, local government, and partners across regions.

Across each city, Perpetual prioritizes four major focal points to ensure reuse systems will have long-term success and high-positive impact to the communities:

1. **Community Accessibility**
2. **Economic and Environmental Sustainability**
3. **Health and Safety, and**
4. **Immersiveness.**

These priorities are critical to building reuse systems founded in lasting sustainability and maximized community benefits rather than short-term pilot experiences.

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Community Connection

The local partners have strong ties to the community positioning them well to lead the on-the-ground work and take co-responsibility for local stakeholder and community engagement. In order to design reuse systems that can both represent and work for the communities in which they operate, they must be locally grown and designed with local input. Although there are best practices that should be deployed across all reuse systems, system design should represent the values of the community and be optimized for its local context. This is where the partnership between Perpetual and the local partner is critical to building a locally-driven initiative founded in technical expertise. Perpetual and its local partners conduct a series of participatory design workshops in each city with community members, businesses, local mission-driven organizations, and other interested stakeholders to inform the reuse system design for that municipality.

Once local partners are established, the team conducts an Ecosystem Assessment, mapping the key characteristics of the city/county, the local geography, tourism flows, climate and weather, key languages, community assets, and more. Additionally, Perpetual's partners at the University of Georgia's Circularity Informatics Lab conduct their Circularity Assessment Protocol, which provides information about the current material and waste flows, existing systems for managing them, and recommendations to increase circularity.

Design Phase

The Design Phase involves designating specific recommendations for each of the following design elements:

1. ***Revenue models***
2. ***Scope***
3. ***Reusable assets***
4. ***Technology (front- and back-end technology)***
5. ***Return incentives***
6. ***Collection bins: design, management, and locations***
7. ***Washing***
8. ***Reverse and forward logistics***
9. ***Governance***
10. ***Labor***
11. ***Surge event planning***

The Design Phase begins with a series of interactive Community Design Workshops, offered in person and virtually, and including food and drink, child care and participation stipends for people who need them. During the Design Phase, the insights from local community engagement are synthesized with learnings from corporate engagement on requirements for reuse systems, identification of local assets, such as underutilized dishwashing facilities or transport vehicles, optimization of asset location and vehicle routing, in partnership with the Data Science Institute at the University of Chicago, and testing different design configurations through their Life Cycle Assessment (LCA) parametric model, developed by independent academic LCA experts at the University of Michigan's Center for Sustainable Systems. Life cycle assessments show that reusable foodware systems outperform disposables on greenhouse gas (GHG) emissions, waste generation, water use, energy demand, and pollution [4]. The system design is developed to align with behavioral science learnings and to align with emerging reuse standards such as those being established by standards organization PR3. The governance model determined through the Design Phase structures the framework for long-term decision making, management and other important details such as asset ownership, how reuse service providers will collaborate within the system, the pricing model for participating businesses, and the mechanism by which the community will continue to have a voice in how the system is operated – all foundational to long-term system success and critical early to mobilize funding from public and private sources for reuse infrastructure and assets.

In the Pre-Launch Phase we set the stage for a successful system launch through educational campaigns, community outreach, staff training, and extensive system testing. The system is then publicly launched with hands-on support mobilized through local partners and Perpetual to ensure the first few weeks run smoothly and help everyone learn about the new system. Following the launch of the system, Perpetual and the local partners will continue to support the success of the system as it gains adoption and grows. This will include identifying operational improvements as well as regularly reviewing economic and impact reporting. Perpetual intends for these four city/county reuse systems to provide models for establishing reuse systems in other cities and counties as well. To this end, Perpetual has created templates, tools and other resources, including a Community Workshop Toolkit in 7 languages, sample Request for Proposals, and more tools for other communities to replicate the process.

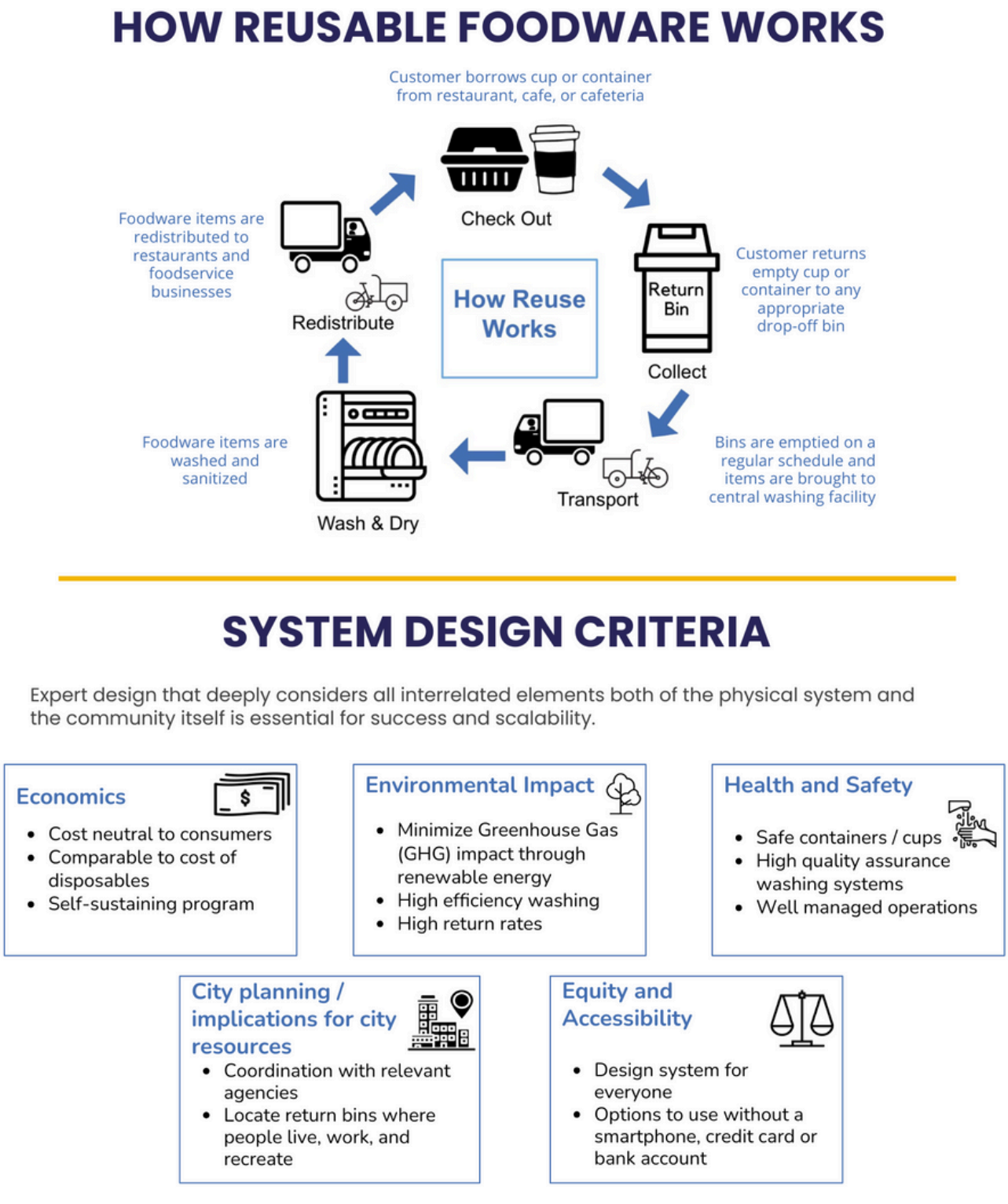

Figure 3: System Design Criteria

Collaborative Methods

Figure 4: Reusable Foodware Community Workshop

Participatory Community Design Process

Working closely with local partners, the team crafts and conducts a series of in-person and virtual opportunities for community members to come together to provide feedback, with special attention to ensuring that these workshops and meetings are accessible to all members of the community by providing food, child care and participation stipends for those who need them. These opportunities include going to existing group meetings as well as holding dedicated workshops and discussion sessions.

Financial Modeling: **Drawing on the best data available, Perpetual is using a custom-built financial model to explore the economics of reuse systems, including up-front investment costs, unit economics for the reuse system at different levels of scale and volume, the impact of adoption and return rates on profitability, and what needs to be true to ensure the long-term economic sustainability for the system.**

Reuse Capabilities Landscape: **Perpetual closely tracks the progress of existing reuse service providers to stay up to date on the status of emerging technology and asset tracking solutions, cup and container designs, washing capabilities, and other relevant developments in the frontier of reuse solutions. This ensures that the System Design builds on the best available solutions and does not specify requirements for a system that is not able to be built today.**

Behavioral Research: **Perpetual is conducting rigorous behavioral studies to understand attitudes and behaviors about reuse. This research will be used to inform messaging towards both consumers and businesses to ensure program adoption and uptake. Research will be conducted prior to and following system launch to measure how attitudes towards reuse and the circular economy may have shifted due to exposure to a city-scale reusable foodware system.**

Corporate Engagement: **Ideally, reusable foodware systems would serve all restaurant and foodservice businesses in a community, including local, regional and corporate. In order to understand the needs of corporate and institutional food and beverage companies so that the system design can accommodate them as well, Perpetual is engaging with beverage companies; food service providers for campuses and cafeterias; grocery and retail chains; convenience store chains, hotels and resorts; and quick service restaurants (QSR).**

Mobilizing Public and Private Funding: **Establishing reuse systems requires significant capital. In addition to raising philanthropic funding for local partners, Perpetual is working to mobilize both public and private funding to support this transition. Reuse infrastructure such as high through-put dishwashing machines, indoor and outdoor collection bins, and transport vehicles, is investable and can be funded by investment capital or grants. To support adoption of reuse, Perpetual is also working to provide funding to local businesses, local community organizations such as Meals on Wheels and other food access programs, and schools to cover their costs of transitioning to the reuse system.**

Governance: **System Governance refers to how the oversight and management of the reuse system is supported long-term, including ensuring environmental and economic viability, equitable access and responsiveness to community needs. Perpetual is exploring governance models to ensure that communities have input into how local reuse systems operate while allowing for multiplayer, technically advanced and integrated systems to flourish and grow.**

ISSN: 2582-8304

Conclusion

City-scale reusable foodware systems represent a transformative opportunity to reduce waste, create sustainable local jobs, and make reuse an everyday behavior rather than the exception. By providing the infrastructure, partnerships, and community-driven design necessary to implement these systems, Perpetual is demonstrating how reuse can be embedded into the fabric of everyday life. Central to this approach is collaboration—bringing together local communities, nonprofits, businesses, and technical experts to co-design systems that are not only effective but also reflective of local needs and values. When diverse stakeholders work together from the outset, the resulting systems are more resilient, inclusive, and likely to succeed. The projects spanned across the four cities—Hilo, Galveston, Savannah, and Ann Arbor—are proving grounds for scalable, equitable, and efficient reuse systems that reflect local values while building toward a broader vision of circularity. As these systems grow and evolve, they provide a roadmap for other municipalities to follow, ensuring that reuse becomes a practical, accessible, and sustainable solution for communities across the country.

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