Bridge Street c. 1890*

Druitt & George c. 1931*

George & Market c. 1901*

Martion Place, 1983*

Children at Rec Center*

Glenmore Bus Stop, 1963*

*City of Sydney Archives

Housing Ideas Challenge - Urban Planning
Our proposal for Sydney's Alternative Housing Ideas Challenge starts with designing urban environments organized around Smart City principles. Gigabit connectivity synchronizes utilities, municipal services, and transportation. As impactful as water and electricity were 100 years ago, our cities of the future must be organized around "connectivity corridors" that allow for optimization of services through the collection and analysis of data.

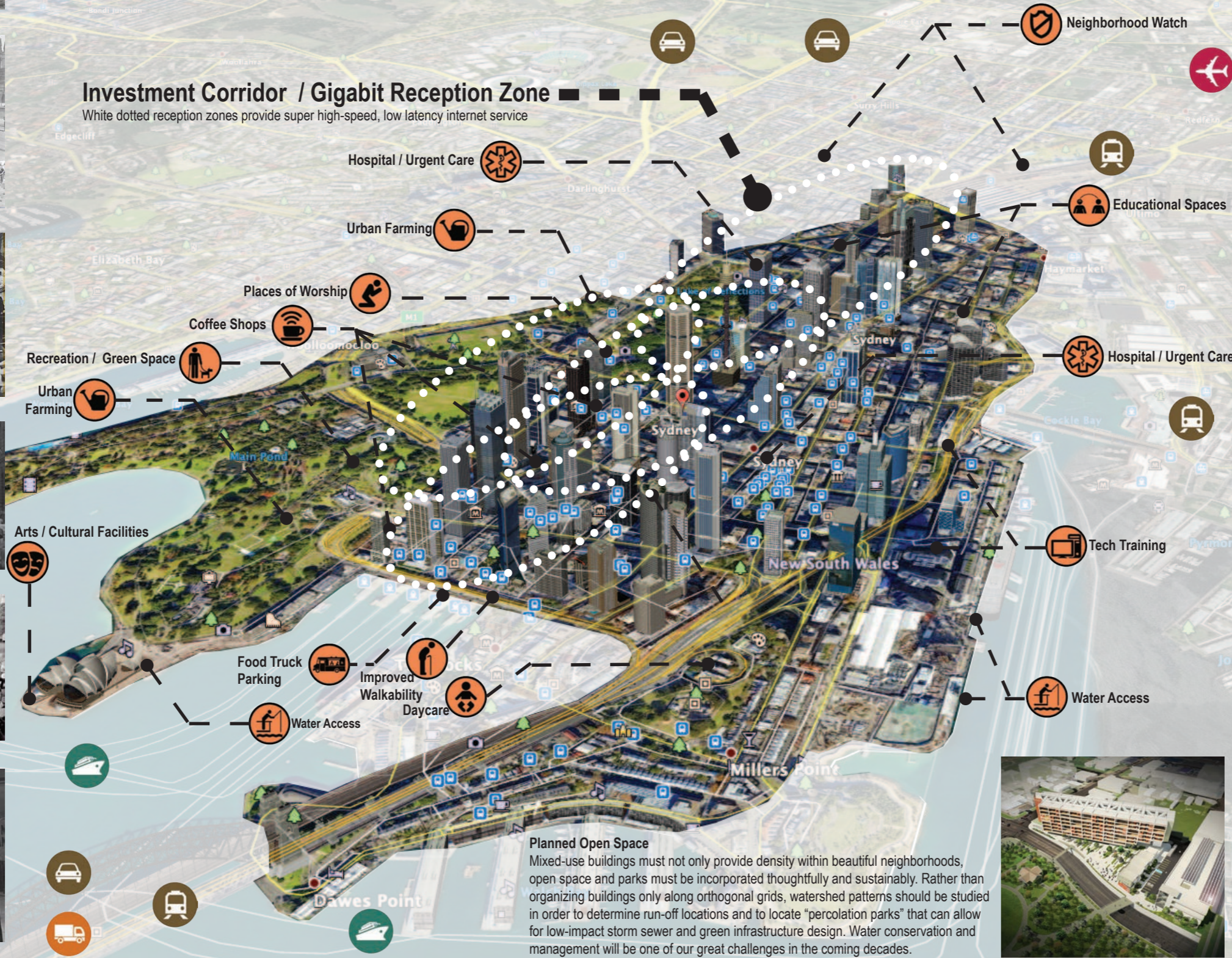**Housing Ideas Challenge - Lifelong Neighborhoods**
The prototype unit presented here must be developed and configured in such a way that provides numerous affordable housing options that create Lifelong Neighborhoods. These are neighborhoods where one can thrive at all stages of life. They posses great parks, great schools, walkable streets, accessible transit, and all the health and wellness services residents will need later in life.

Multi-Modal Transportation

Investment Corridor / Gigabit Reception Zone
White dotted reception zones provide super high-speed, low latency internet service

Neighborhood Watch

Hospital / Urgent Care

Educational Spaces

Urban Farming

Places of Worship

Coffee Shops

Recreation / Green Space

Hospital / Urgent Care

Urban Farming

Tech Training

Arts / Cultural Facilities

Food Truck Parking

Improved Walkability

Daycare

Water Access

Water Access

Planned Open Space
Mixed-use buildings must not only provide density within beautiful neighborhoods, open space and parks must be incorporated thoughtfully and sustainably. Rather than organizing buildings only along orthogonal grids, watershed patterns should be studied in order to determine run-off locations and to locate "percolation parks" that can allow for low-impact storm sewer and green infrastructure design. Water conservation and management will be one of our great challenges in the coming decades.

PROJECT NARRATIVE

Burnden Abraham, 84, is a retired widower living alone in the small flat that he and his deceased wife moved into almost 12 years ago. They moved to a downtown unit near George Street to in order to live in a safe and walkable neighborhood.

While his health has been declining steadily, he is fiercely independent and desires to remain in his home where he has maintained a comfortable routine. Despite pleas to consider a care facility from his adult daughter, who often travels out of town for work, he has become a study in aging-in-place.

On a brisk morning in early July, bed sensors tracking Burnden's heart rate and restlessness recorded that he had only gotten four hours of sleep for the second night in a row. A common occurrence immediately after his diabetes and heart medication dosages are adjusted.

As he walked to the bathroom, accelerometers on the floor joists of his home indicated that the limp caused by his arthritic hip was particularly pronounced, probably due to the high humidity sensed by the small weather tracking device on the flat's balcony.

While completing his normal morning routine, the smart toilet detected that Burnden was dangerously dehydrated. The eye-scanner in the smart mirror also found that his eye tracking was off, indicating a dysfunction in his reflexes.

Remotely, this data was overlaid with environmental conditions: it would be a high of only 10 degrees Celsius that day with a light rain expected to begin mid-morning.

ALTERNATIVE HOUSING IDEAS

ID - 26

CITY OF SYDNEY 2030
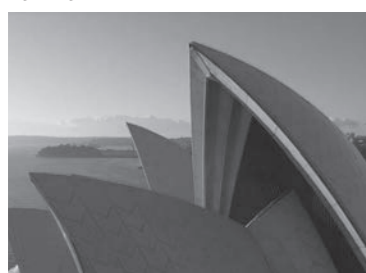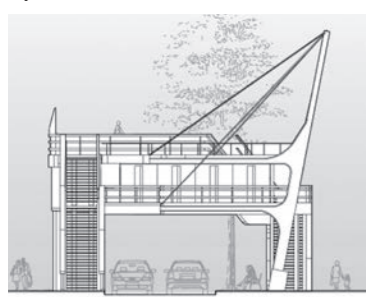
Sydney Smart Home.

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Chronic Care Management Voucher

The American Affordable Care Act provides a health insurance voucher to Primary Care Physicians that are able to deploy monitoring strategies for chronic ailments.

Social Networking Connectivity

Studies show that seniors that withdraw from social interaction are more vulnerable to depression. Social networking can encourage engagement.

Net Zero Energy Construction

The technology-rich infrastructure shown here is focused on health and wellness, however, the same smart-city connectedness is necessary for solar panels, geothermal heating and cooling, water reclamation and management, and high efficiency mechanical systems. Prefabrication also allows for superior insulation of the exterior envelope.

Prefab/Advanced Manufacturing

Prefabricated strategies allow a plug-and-play approach to the technology infrastructure. Not only is it easy to upgrade systems as technology evolves, residents can tap into monitoring systems as they are needed or as their health declines.
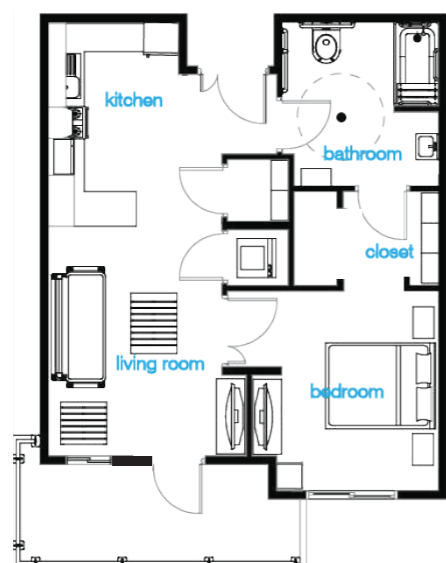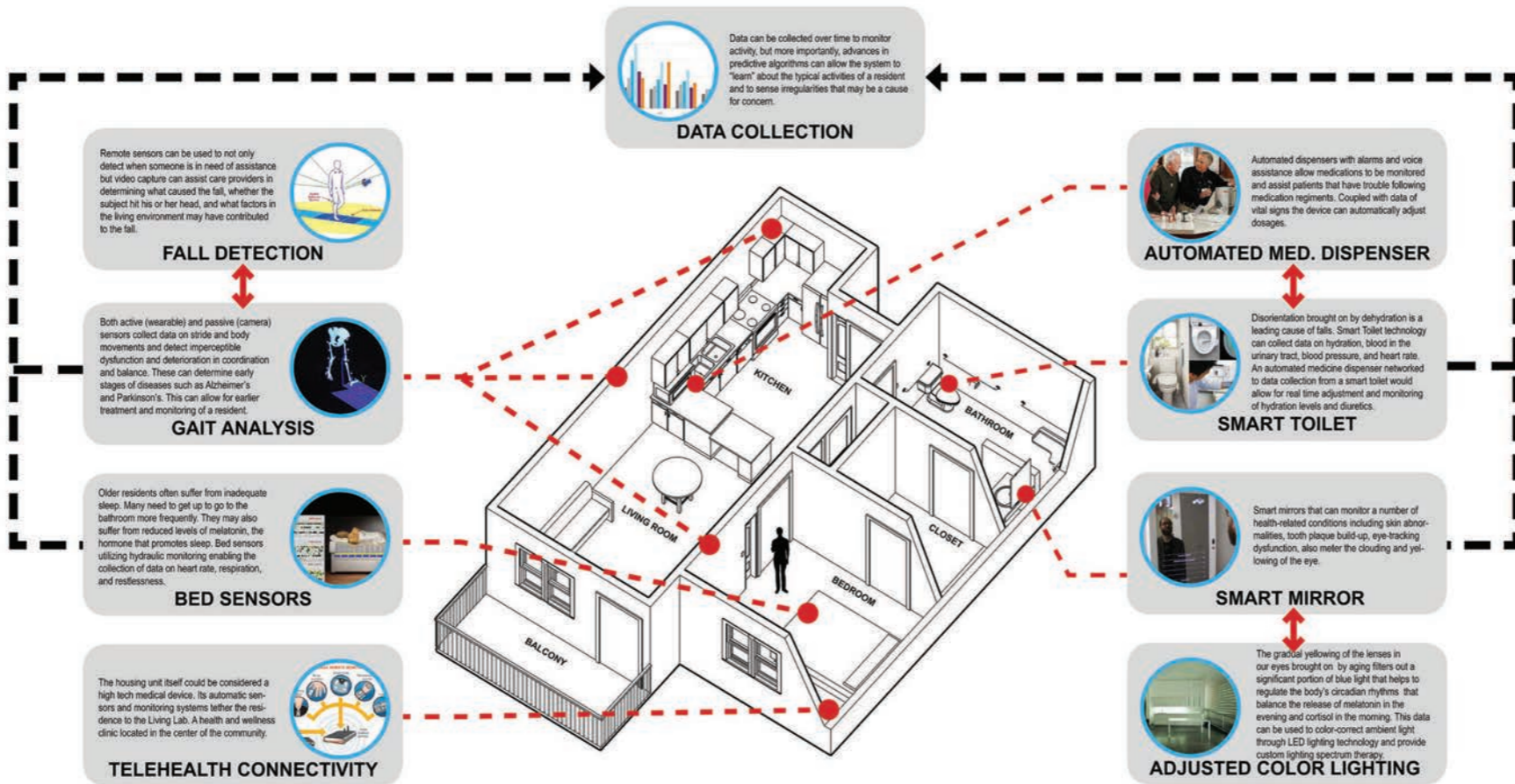
Universal Design Principles

A built environment that caters to people of all ages and physical abilities is rooted in principles of barrier-free design. Visitability and ease of mobility throughout the community values all residents.

Accessible - Adaptable

Accessibility and adaptability are values that support the inclusion of all people with varying needs throughout a community. Wide doors, zero-threshold entrances cater to baby strollers and wheelchairs alike. Large print signage and venues outfitted with assisted listening devices makes a statement that all people are welcomed and valued.

DATA COLLECTION
Data can be collected over time to monitor activity, but more importantly, advances in predictive algorithms can allow the system to "learn" about the typical activities of a resident and to sense irregularities that may be a cause for concern.

FALL DETECTION
Remote sensors can be used to not only detect when someone is in need of assistance but video capture can assist care providers in determining what caused the fall, whether the subject hit his or her head, and what factors in the living environment may have contributed to the fall.

GAIT ANALYSIS
Both active (wearable) and passive (camera) sensors collect data on stride and body movements and detect imperceptible dysfunction and deterioration in coordination and balance. These can determine early stages of diseases such as Alzheimer's and Parkinson's. This can allow for earlier treatment and monitoring of a resident.

BED SENSORS
Older residents often suffer from inadequate sleep. Many need to get up to go to the bathroom more frequently. They may also suffer from reduced levels of melatonin, the hormone that promotes sleep. Bed sensors utilizing hydraulic monitoring enabling the collection of data on heart rate, respiration, and restlessness.

TELEHEALTH CONNECTIVITY
The housing unit itself could be considered a high tech medical device. Its automatic sensors and monitoring systems tether the residence to the Living Lab. A health and wellness clinic located in the center of the community.

AUTOMATED MED. DISPENSER
Automated dispensers with alarms and voice assistance allow medications to be monitored and assist patients that have trouble following medication regiments. Coupled with data of vital signs the device can automatically adjust dosages.

SMART TOILET
Disorientation brought on by dehydration is a leading cause of falls. Smart Toilet technology can collect data on hydration, blood in the urinary tract, blood pressure, and heart rate. An automated medicine dispenser networked to data collection from a smart toilet would allow for real time adjustment and monitoring of hydration levels and diuretics.

SMART MIRROR
Smart mirrors that can monitor a number of health-related conditions including skin abnormalities, tooth plaque build-up, eye-tracking dysfunction, also meter the clouding and yellowing of the eye.

ADJUSTED COLOR LIGHTING
The gradual yellowing of the lenses in our eyes brought on by aging filters out a significant portion of blue light that helps to regulate the body's circadian rhythms that balance the release of melatonin in the evening and cortisol in the morning. This data can be used to color-correct ambient light through LED lighting technology and provide custom lighting spectrum therapy.

Smart Housing Prototype - Features

Shown here are some of the features we are researching with healthcare, home automation consultants, and construction industry partners. The unit plan has been configured to lend itself to prefabrication. Each side of the dwelling is an ideal dimension for being assembled in a warehouse. Living spaces are simple and compact. Openings are wide and accessible. The example shown here has a removable leaf in order for a hospital bed to enter for acute care situations. Doors have been left off closet spaces to better serve seniors with dexterity issues. Bathrooms are oversized to accommodate wheelchair turnaround radius as well as caregiver maneuvering.

Smart Home Unit Plan
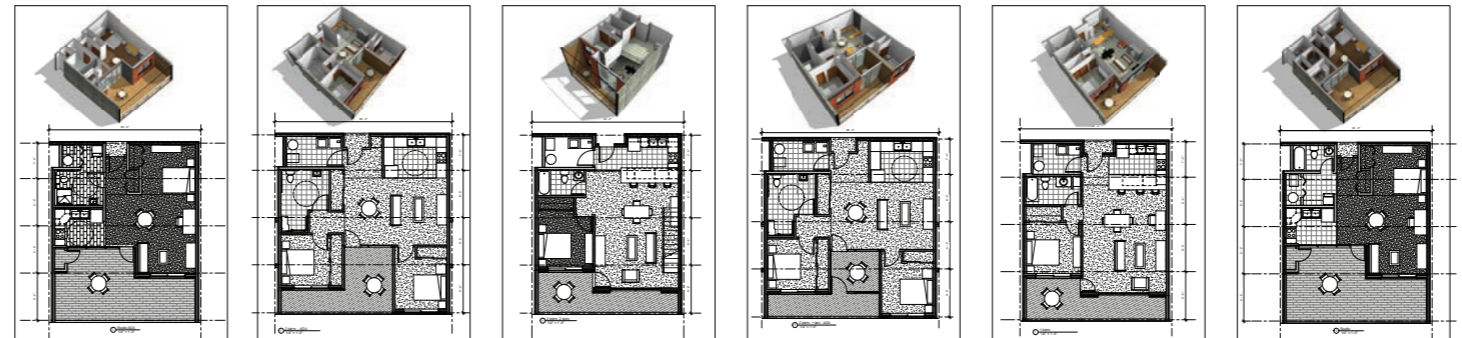
Smart Home Unit - Alternative Configurations
Providing housing options are key to affordable diverse housing.

ALTERNATIVE HOUSING IDEAS

PROJECT DESCRIPTION (Continued)

Predictive algorithms processed at the local Community Population Health Center indicated that similar conditions experienced by similar subjects had resulted in a serious fall almost 99% of the time. A priority notice was sent to Burden, the office of his primary care physician, and his daughter.

Within minutes, Burden received a telephone call suggesting that he take extra care in getting to his scheduled doctor's appointment that afternoon. Soon after, his daughter phoned to say that she had arranged for an Uber pick-up and a grocery delivery. Despite a 99% probability of falling, passive remote monitoring prevented Burden from having a fall that day.

This science fiction scenario of "smart cities" is not as far off as you may believe.

Even more compelling is the potential of a community that may have thousands of housing units outfitted with tools that can assist caregivers provide services more affordably, more effectively, and sometimes before we even know we need them.

Imagine a community with thousands of residents that have remote monitoring. Population Health strategies could allow us to identify some tiny percentage of residents that have a substantial probability of falling and intervene. Say that number is 60 people. Contacting those 60 people or their caregivers would be incredibly powerful.

Since gigabit connectivity has arrived in cities, citizens have been asked, "What would you do with unlimited bandwidth?" Call it the future of Big Data, the Internet of Thing (IoT), or simply Smart Cities, sensor-enabled built environments are transforming the ways in which communities are able to serve their residents and those set to benefit most may be the vulnerable aging demographic.

Gigabit networks allow for the synchronization of city services. No facet of city management will go

Sydney Living Sea Wall, Volvo
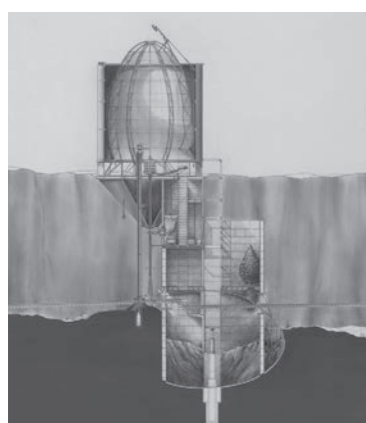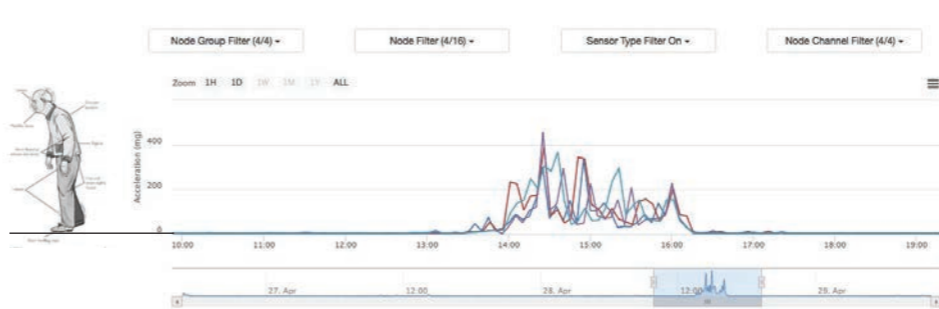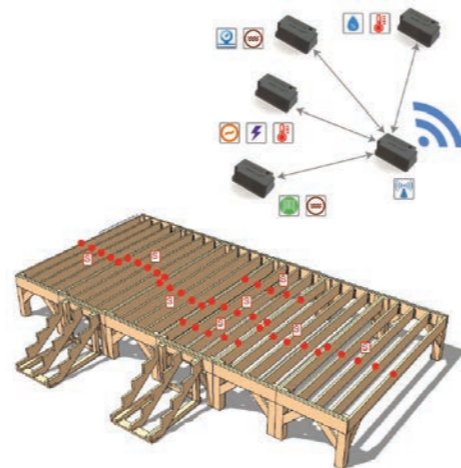

CplusC Sirius

Murcutt House

Godsell House

Tribe House

Darden Oxygen House

Floor Sensors / Gait Analysis

This proof-of-concept has been constructed and we are now working with scientists from a university medical center to determine if the data collected can be used to perform more complex gait analysis This typical residential floor system that is able to collect data on heel strike. Utilizing accelerometers and strain gauges, we are able to monitor activity and detect falls, limp, muscle tremor, dragging of feet, and balance issues. This data can also be used for more advanced gait analysis which can identify and predict such conditions as diabetic neuropathy, Alzheimer's and Parkinson's disease, and other forms of

Smart Home Prototype - Mock-Up

We have constructed a small mock-up of the Smart Home prototype embedded with sensors in order to work with medical professionals in determining whether the gait data is sufficient for predicting falls, limp, and other health issues. It also works as a remote monitoring system for seniors.

Smart Home Prototype / Sustainable Social Equity

Our housing unit solution utilizes embedded sensors to collect data on usage patterns, energy efficiency, air quality, and biometric data. These data sets can be analyzed to predict everything from the most optimal time to run your laundry machine to whether your unit is located in a food desert. Biometric data can be overlaid to activate Population Health strategies that can keep a neighborhood healthy and thriving.
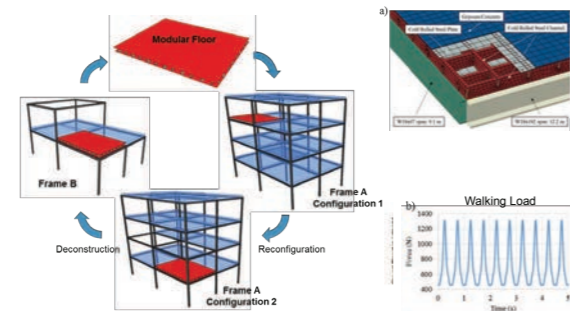
Smart Home Modular Construction / Prefabrication

Wireless accelerometers and strain guages in the floor have been calibrated to pick up 200 readings per second. We are also working with a school of engineering to explore lightweight modular steel flooring systems where non-combustible materials would be required. this prefabricated two-way modular system can be shipped to site in large assembled sections and embedded with sensors that also monitor structural soundness. The Smart Home has been configured to utilize advanced manufacturing techniques. Prefabricated wood panels with integrated high-performance doors, windows, and sensors are assembled in a warehouse and shipped to site. This process is most advantageous for buildings that can be built of combustible materials of 4 - 6 stories.

Proof-of-Concept Construction
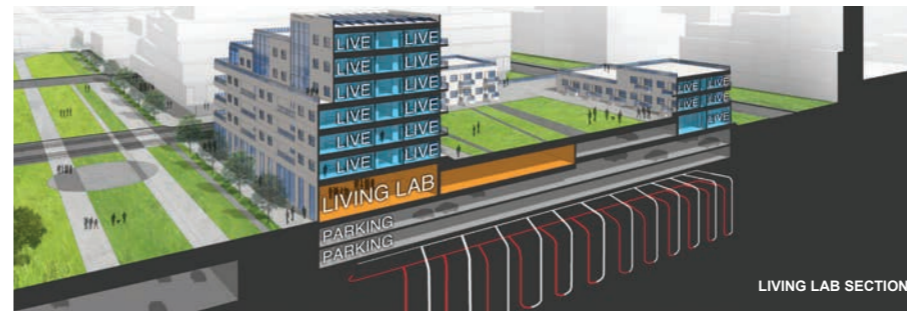
Imagining Alternative Development / Financing Models

The ability to collect usage, energy, and biometric data provides opportunities for new models of development. The scheme above configures data-collecting smart home units over a State-of-the-Art medical office "Living Lab." This health center is able to collect data for use in remote monitoring, acute care settings, and medical research. This space could leverage institutional resources by renting out the lab to a medical company or university. This rent, presumably much higher than the market rate commercial rates of the surrounding neighborhood subsidizes the affordable housing above, any advanced technological upgrades, and even pays for near-net-zero-ready construction. Geothermal heating and cooling systems and solar panels are shown in the concept above.

PROJECT DESCRIPTION (Continued)

unchanged: traffic engineering, police response, trash collection, even pothole repair will be based on predictive analytics. These vast amounts of data, once collected and processed, can also assist municipalities and urban designers in organizing our cities.

Clusters of diabetes may indicate problems with a neighborhood's walkability or a lack of fresh food. Street and bus networks will more effectively respond to peak usage. Data has the potential to be as impactful on the way we design cities as water and electricity were 100 years ago.

While flashy, it must be noted that the technology described here is secondary to health and well-being. Primary to well-being is social connectivity. The key to vibrant communities is creating Lifelong Neighborhoods, those neighborhoods where one can thrive at all stages of life: great schools, great parks, walkability, efficient mass transit, access to job centers, various housing options, and proximity to senior health clinics and community centers.

By its very nature, a Lifelong Neighborhood is intergenerational and supports social connectivity. In order for all ages to thrive, the neighborhood blocks must be scaled appropriately to support a wide range of housing options supported by walkable streetscapes. Complete Streets concepts provide efficient systems of shared roadways and pedestrian-friendly environments.

Finally, housing for Smart Cities should be visitable and designed with adherence to Universal Design Principles. The connectivity of Smart Cities will transcend home automation and devices. It has the potential to connect a diverse community of neighbors and create a place that serves your needs as you transition through different phases of your life.

The Smart Home Prototype provides a vision of the future that includes dense, diverse, and thriving urban neighborhoods.

ALTERNATIVE HOUSING IDEAS