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 possess great parks, great schools, walkable streets, accessible transit, and all the health and wellness services residents will need later in life.

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.

(continued on Board 2)
ALTERNATIVE HOUSING IDEAS

Sydney Smart Home.

SMART MIRROR

- Full-length mirror
- Adjusts lighting level desired
- Provides ambient, task and accent lighting
- Accessible from bedroom to bath

SMART TOILET

- Automated dispensers of soap and paper
- Dual function, elevated, front-loading, dual function washer and dryer
- Elevated, front-loading, dual function washer and dryer

TELEHEALTH CONNECTIVITY

- In-Home Medication Dispenser
- Smart Mirror
- Smart Toilet
- Automated Medication Dispenser

DATA COLLECTION

- FALL DETECTION
- GAIT ANALYSIS
- BED SENSORS
- TELEHEALTH CONNECTIVITY

ADJUSTED COLOR LIGHTING

- 30-60 inches of space around fixtures
- Rotated, astigmatism, high in the room
- Generously sized, roll-in showers

SMART HOME UNIT PLAN

- One Bedroom Prototype Axon
- Sydney Smart Home

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.

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 Burnden, the office of his primary care physician, and his daughter.

Within minutes, Burnden 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 Burnden 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
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 gauges 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.

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 their 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.