Cypernex

the Coal loader

Aquaponics Automation Project 2020

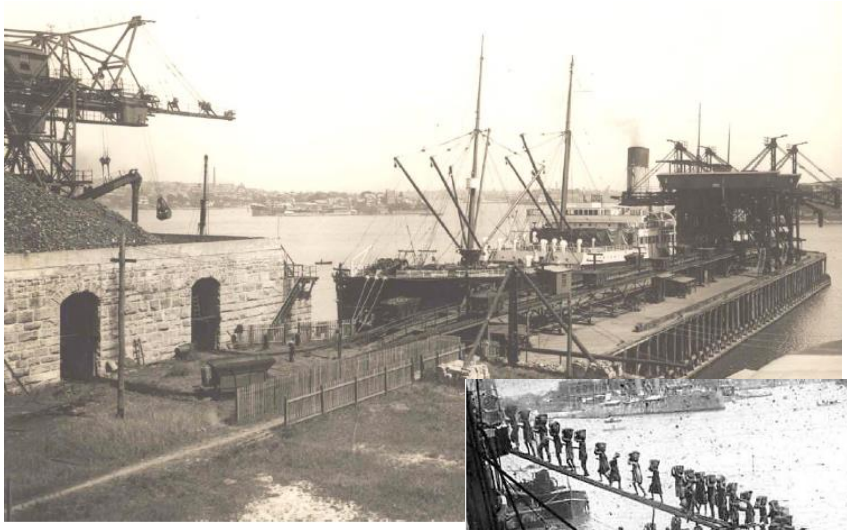
progressive *vibrant* diverse

NORTH SYDNEY COUNCIL

The Coal Loader is a 10+ year project to convert a historically significant site at the end of Waverton peninsula, into a multi-purpose public space for tourism and the local community.

The site featured in a variety of articles such as the US based Landscape Architecture Magazine (August 2019 edition) Journal, was the location used for coal bunkering and export facility from the early 1920s to the early 1990s.

Coal Bunkering



Historical heritage

The site also holds Aboriginal heritage, with evidence of the Cammeraygal people's presence, including a rock carving, predating the industrial age.

An Engineering Marvel

The site is an engineering marvel, featuring an impressive elevated platform, tunnels, and a cable-hauled railway system for efficient coal transfer, representing a significant engineering feat of its time.

Its transformation into a public park and sustainability centre demonstrates the potential for repurposing industrial sites, preserving heritage while promoting environmental awareness.

Today it's a focal point of community activity, hosting events, university research projects, live music events and safe meeting place for teens.

Aquaponics beds were built into the landscape providing gardens for local volunteers to grow fresh produce where their place of residence has no green space.

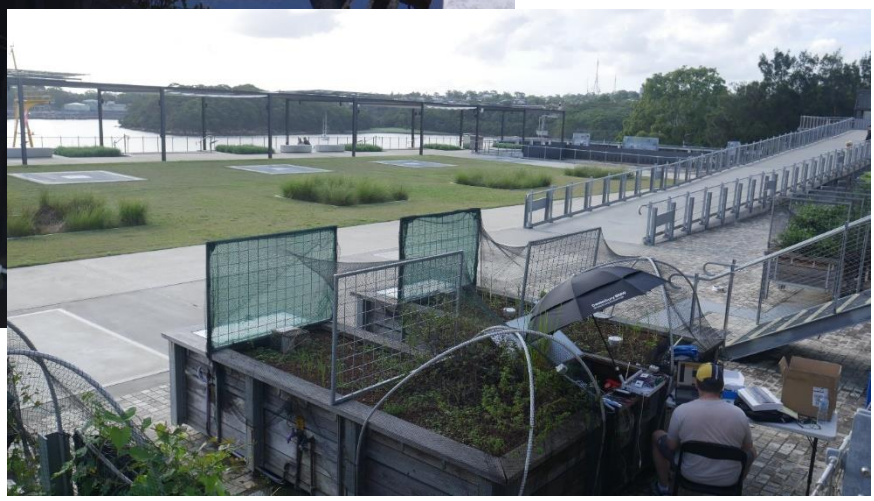
Multi-purpose public spaces

North Sydney Council engaged Cypernex to produce automated **Aquaponics monitoring** and facilities management capabilities for the 11 Aquaponics beds placed around the site.

Project objectives

- Real time monitoring for fish colonies, including seasonal clustering behaviour, response to external influences, water purity and flow rate and other factors
- Owing to the number of data points to measure using discrete IOT sensors purchased individually was impractical but individual sensors are not only cost less, but are smaller, connected by cables hidden in conduit, more robust in this wet environment, use less space, and more secure and reliable in a public setting.
- Accessible anywhere by volunteers, alerts, notifications and analytics
- Foster community spirit and collaboration with universities and industry
- Obtain knowledge that can be commercialized, shared with academia, exported or used for refining sustainability and NetZero best practices
- Share data with the public using Digital Twins and Smart Data models (FIWARE)
- Foster innovation of automation of AI, Data Science, electromechanics and supporting software and visualizations

A dual processor multi-sensor control system is mounted within the U shaped Aquaponics bed, where a colony of between 10 to 30 carp are located in tanks under the garden beds shown here.



The central controller is connected with dozens of sensors, with the capacity for up to 60 separate measurement sources each with individual sampling schedules can be controlled from the cloud platform, which proved to be essential for running both management, experiments and simulations simultaneously.

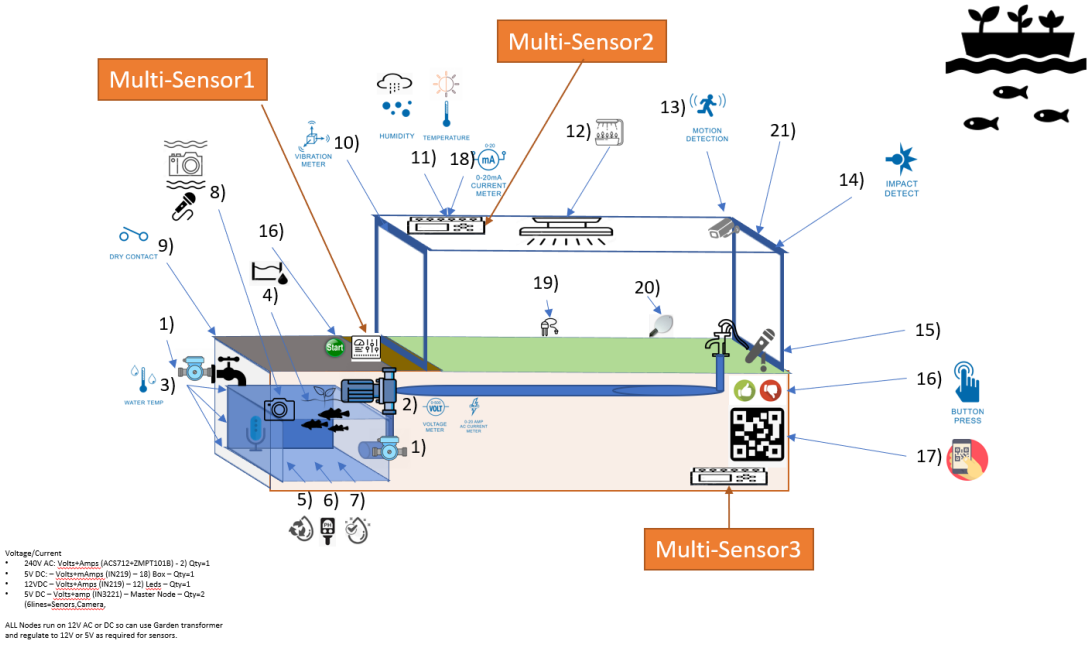


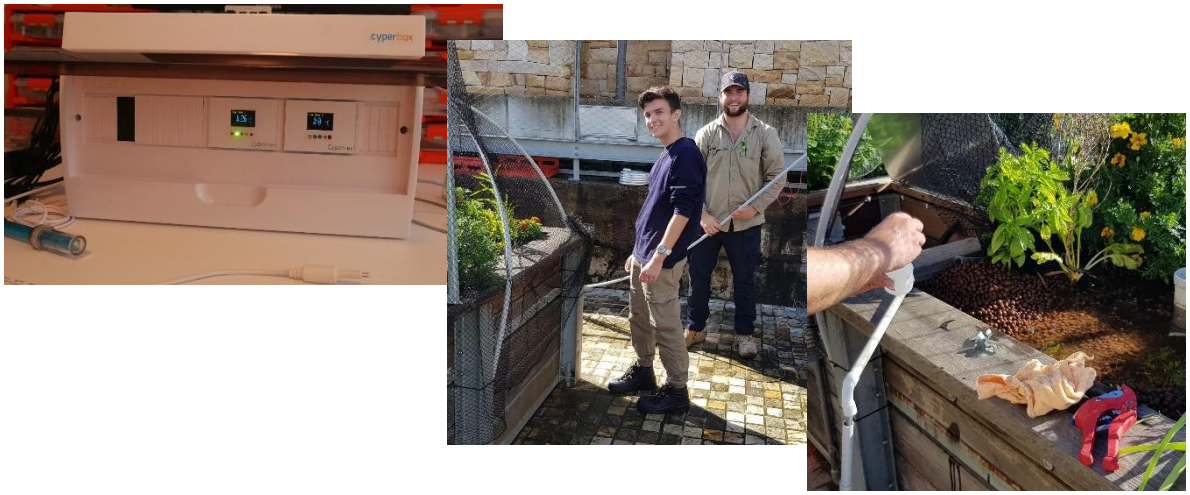
Diagram 1 – Data capture and control functions

Data capture and control table for Diagram 1

Sensor No	Name	Explanation
	Multi-Sensor1	MCU managing tank environment
	Multi-Sensor2	MCU for garden bed
	Multi-Sensor3	MCU for public services sensors
1	Waterflow	Measures water flowing into tank
2	Waterflow	Flow from tank to garden
3	Water temp	Measures at top/middle/bottom of tank (suggested by Matt)
4	Water level	Water level tank
5	Turbidity	Part of water quality management
6	Ph	Measures Ph
7	Water quality	TDP water quality
8	Hydraphone	Basically an underwater microphone use for multiple purposes
9	Door open	Triggers when tank door open
10	Vibration	Costs only 60 cents used for storm intensity
11	Humidity	Environment – Multiple purposes
12	Temperature	Environment – Multiple purposes
13	Motion	Microwave based movement detector for birds, possum, cats, human
14	Impact	Costs only 60 cents used for storms / intrusion / damage through impact
15	Loadness	Measure noise levels during public events
16	Feedback	Customer satisfaction survey buttons
17	QA code	Scan code to link to a dashboard for this Aquaponics unit
18	Current	Measures consumption / power
	Voltage	Measures voltage used in power consumption
19	Moisture	Soil moisture and temperature
20	Leaf moisture	Measure moisture/frost accurately
21	Residual Moist	Residual moisture is indication of frost, slippery surfaces after rain

Table 1 – Sensor types

Each Cyperbox (the control units designed and manufactured by Cypernex) is a self contained connection hub for sensors and actuators. Mounted in a secure lockable space, each unit was designed for IPX-5 rated water proofing.



The facility was to also measure the characteristics of the surrounding public spaces, traffic density, noise, air quality, ground moisture, leakage. In the garden leaf wetness, soil temperature and pioneered new innovative designs using lasers to measuring water level within the soil of gardens during water rotations.

Sonar and conventional level sensors were used for tank water levels and Infrared cameras monitored fish clustering and behavioural patterns, to dispose a popular hypothesis that the larger fish occasionally become hostile to smaller fish, potentially consuming them in the process.

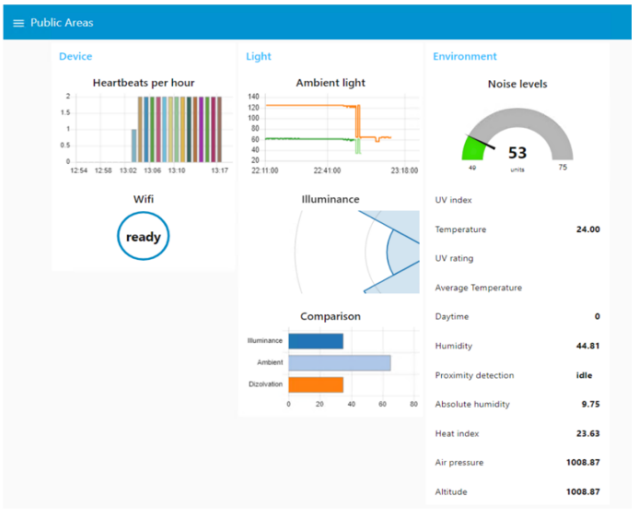
After Aquaponics automation was complete, it was thought this “public space measuring” capabilities could be extended to measure and track the movement of bat colonies in the caves under the terraced platform.

In 2023, Cypernex shared its findings with researchers from the University of Wolverhampton (UK), who were embarking on a project examining the effects from partial and complete refreshing of tank water on fish development, within colonies.

Data analytics was incredibly important with new visualizations created to convey meaning aiding volunteers as they interpreted the information.

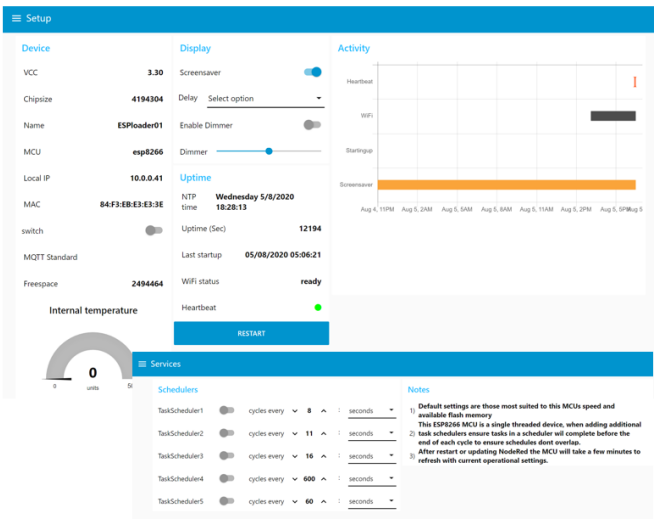
Analytics

- Default display is real time data, and when the dashboard is reloaded that history lost. For this reason, your pipeline should save the incoming data to a database on the NAS
- Once saved there is then the opportunity to create graphs/charts that compare time periods with real time and projected figures.



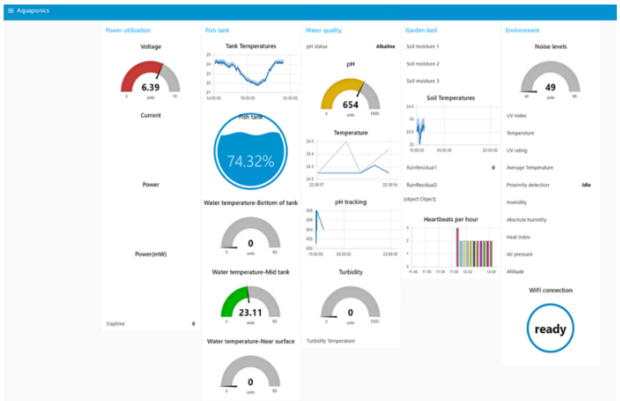
Analytics

- Dashboards also contain buttons, sliders and other visual tools that transforms the Dashboard into an interactive application
- With these visual tools it's possible to control the IoT device, the pipeline or information processing
- By offering different "Flows" to each user audience you can restrict access to information or controls where needed



Analytics

- Telemetry and calculated data is pre-processed and the displayed using customer formulae
- Popular open-source well documented programs were used with a wide variety of examples and tutorials on line
- Dashboards deployed as a stand alone views available to the public or as part of a private information portal accessed after login
- The top left corner ≡ Aquaponics displays a "hamburger" menu used to select the dashboard topic, allowing a single Dashboard to provide data on a number of topics
- For the best visual experience this might translate to a Dashboard topics for Fish tank, another for Garden, yet another for public areas



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Guiding principles ..

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