

# UNIVERSITY OF BRITISH COLUMBIA ORCHARD COMMONS - CASESTUDY



Image Credit: Michael Elkan Photography

**LOCATION** 6363 Agronomy Rd, Vancouver, BC, V6T 1Z4 , Canada

**COMPLETION DATE** August 2016

**SIZE** 40,439 sm ( 435,281 sf)

**LEED®** Canada NC 2009 Gold Registered

## AWARDS

2017, Award of Excellence, Interior Design Institute of British Columbia (Open Kitchen)

“Orchard Commons will play a significant role in providing a unique classroom experience and celebrating diversity.”

SANTA J. ONO

15th President & Vice-Chancellor, UBC

Orchard Commons is the second of five mixed-use ‘hubs’ planned for the University of British Columbia (UBC) Point Grey Campus. Combining student housing, academic uses, and amenities into one facility, the intent is to promote diversity and social connection by bringing more activity and life to the heart of the campus.

Drawing students from around the globe, Orchard Commons is home to a diverse group of first-year students, most of whom will be living away from home for the first time. As such, the mandate to cultivate positive social interactions through the fabric of the facility is key.

These factors shaped the planning and a range of ‘social spaces’ have been provided, including three-storey interconnected lounges in the two residential towers. Transparency, daylight, and wood are key expressions throughout that support these spaces.

At nearly a half-million square feet, Orchard Commons will provide 1,048 residence beds and dining facilities, with academic and administrative space for UBC Vantage College, an innovative program for international students that combines first-year studies with academic English programming.

The facility embraces a generous walkable outdoor public realm with outdoor classroom and social seating. An outdoor play space accompanies the daycare facility.

The unique façade of the residential towers provides a defining identity. The shapes of the precast concrete cladding were optimized using computational techniques to maximize repetition while maintaining an interesting appearance. The envelope was also optimized to meet UBC’s sustainable energy goals. Computational optimization resulted in a wall system that was very cost-effective and accelerated the schedule.



Social Spaces Three Storey Shared 'Living Rooms' Punctuate the Residential Towers. Image Credit: Michael Elkan Photography

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GREENER UNIVERSITY

UBC is a model green university and is dedicated to advancing sustainability through programs that address its operations and infrastructure, and generate long-term environmental, social and financial benefits. UBC also offers innovative academic curriculum to students, staff and faculty on sustainability issues to empower them to change their behaviors and inspire their peers to follow their lead. Some of the programs include:

- Monthly Green Research Newsletter that informs the research community on the latest green research information and initiatives.

- Self-funding projects aimed at reducing the University’s energy consumption, water consumption and greenhouse gas emissions.
- Green Research Program that takes progressive and innovative steps to reduce the impact of its research activities activities typically requiring an intense use of energy, materials and resources.
- Green Building Program that focuses on reducing UBC’s environmental footprint through efficient building operations and transforming buildings to become visible and enduring elements of their commitment to sustainability.

LEED

The LEED Green Building Rating System is a voluntary, consensus based, market driven program based on existing, proven technology. The rating system is organized into five categories: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources and Indoor Environmental Quality. An additional category, Innovation & Design Process, addresses sustainable design building not covered under the five categories. Improved building performance is recognized through 3rd party verification as Certified, Silver, Gold or Platinum – based on the total number of points earned by a project.



Social Spaces - Large stairs Allow Spaces for Students to Meet, Work and Connect with one Another. Image Credit: Michael Elkan Photography



Hearty Drought Resistant Planting. Image Credit: Michael Elkan Photography

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**WATER EFFICIENCY**

**Landscape**

The lawn area of Orchard Commons includes existing trees and turf that had no existing irrigation system prior to construction. Given that the trees and lawn are well-established, were all efforts where taken to protect them from disturbance during construction. Do to these efforts and the established nature of the existing planting no irrigation was required in this area. Urban agricultural planters on the roof also do not have irrigation but there are two hose bibs provided at the planters for users to hand-water any planting.

**Potable Water Reduction**

Orchard Commons uses water efficient fixtures to reduce potable water use. These fixtures include:

- Low-flow urinals 1.9 LPF
- Low-flow water closets 4.8 LPF
- Low flow showers 9.5 LPM.
- Low flow kitchen sinks. 5.6 LPM.

Through using these low flow fixtures the project has achieved a calculated water use reduction of over %45

**Benifits of Water Reduction**

“Reducing potable water use in buildings for urinals, toilets, showerheads, and faucets decreases the total amount withdrawn from rivers, streams, underground aquifers, and other water bodies. These strategies protect the natural water cycle and save water resources for future generations. In addition, water use reductions, in aggregate, allow municipalities to reduce or defer the capital investment needed for water supply and wastewater treatment infrastructure.”<sup>1</sup>



Hearty Drought Resistant Planting. Image Credit: Michael Elkan Photography

1) LEED® Canada Reference Guide for Green Building Design and Construction 2009 pg 167



Typical Dorm Room. Image Credit: Lisa Logan Photography

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**ENERGY AND ATMOSPHERE**

The Orchard Commons design team made key architectural and mechanical choices to achieve a superior energy performance in the project as compared to the MNECB Baseline Case. These choices include the following as described in the Energy Model for LEED Compliance Report

**Benefits of Energy Efficiency**

“Energy efficiency reduces the environmental burdens associated with producing and using energy. Fossil fuels, such as coal and oil, are the most common source of energy

used in buildings. However, these fuels are also finite resources. The process of extracting and consuming energy from fossil fuels causes many environmental impacts, including air and water pollution, land degradation, solid waste generation, and greenhouse gas emissions. Mounting evidence connects fossil-fuel based energy use with climate change as well as serious risks to environmental and human health and safety. In 2006, the Canadian industrial and commercial sectors accounted for nearly half of the nation’s energy use related greenhouse gas emissions (approximately 46%).<sup>5</sup>

Furthermore, greenhouse gases and other emissions increase every year as overall energy consumption increases. Between 1990 and 2006, annual greenhouse gas emissions from Canadian energy use increased by 18.5%.<sup>6</sup> As the far-reaching implications of global climate change are becoming more apparent and serious, reducing emissions through energy efficiency becomes more important.”<sup>2</sup>

2) LEED® Canada Reference Guide for Green Building Design and Construction 2009 pg 250

**ROOF CONSTRUCTION** Roof thermal transmittance 59% lower overall than for the Baseline case.<sup>3</sup>

Overall opaque roofs at effective RSI-5.3(R-29.9), comprised of:

- Concrete deck roofs at RSI-4.9 (R-27.8) with 5” continuous polystyrene insulation; 80% of net area.
- Wood stud deck roofs at RSI-7.7 (R- 43.5) with 4” continuous rigid glass fibre insulation on top of 4” polyisocyanurate insulation; 20% of net area.

3) Table Source: Energy Model for LEED Compliance Report Curt Hepting, P.Eng., LEED AP (EnerSys) pg 2 , 3

**EXTERIOR WALL CONSTRUCTION** Exterior wall thermal transmittance 34% lower than the Baseline.<sup>3</sup>

Overall opaque walls at effective RSI-2.5 (R-14.5)<sup>1</sup>, are comprised of:

- Precast concrete sandwich panels with 75mm rigid insulation at effective RSI-2.2 (R-12.5); mainly associated with dorms; ~ 38% of the net wall area.
- Metal stud wall with 5.0” exterior semi rigid insulation and stainless steel ties connecting outer brick vaneer to inner structure at effective RSI-4.0 (R-22.7); 31% of the net wall area.
- Metal stud wall with 5.0” exterior semi rigid insulation and fibre glass clips with galvanized screws connecting outer wall panels to inner structure at effective RSI-3.0 (R-17.2); 13% of the net wall area.
- Spandrel panels with semi-rigid insulation at effective RSI-1.4 (R-8.0); ~ 11% of the net wall area.
- Concrete wall with 5.0” exterior semi rigid insulation and stainless steel ties connecting outer brick vaneer to inner structure at effective RSI-3.7 (R-20.8); 6% of the net wall area.

3) Table Source: Energy Model for LEED Compliance Report Curt Hepting, P.Eng., LEED AP (EnerSys) pg 2 , 3

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**WINDOWS CONSTRUCTION**

Low-e windows with argon, warm edge spacers in thermally broken metal frames, with triple pane for lounges, providing for a thermal transmittance that is 35% lower overall than for the Baseline<sup>3</sup>

- Glazing at 39% of vertical wall area.
- Double pane low-e windows with warm edge spacers and argon fill in a thermally broken aluminum frame at rated U-value and shading coefficient of:
- Window wall glazing at USI-1.86 (U- 0.33), SHGC-0.22;
- Curtain wall glazing at USI-2.4 (U- 0.42), SHGC-0.23.
- Triple pane low-e windows with warm edge spacers and argon fill in a thermally broken curtain wall aluminum frame at USI-1.47 (U-0.26) and SHGC-0.21.
- Skylights, comprising only 0.07% of roof area, with warm edge spacers and argon fill in a thermally broken aluminum frame estimated at USI-3.5 (U-0.62) and SHGC- 0.23.

Note that suites have window sensors that turn off power to the electric baseboards when open

3) Table Source: Energy Model for LEED Compliance Report Curt Hepting, P.Eng., LEED AP (EnerSys) pg 2 , 5

**LIGHTING** load 72% lower than for Baseline, including impact of occupancy sensors and daylighting.<sup>3</sup>

Overall opaque walls at effective RSI-2.5 (R-14.5)<sup>1</sup>, are comprised of:

- Space lighting density at 3.2 W/m<sup>2</sup> (0.30 W/ft<sup>2</sup>) overall, including adjustment for lighting occupancy and daylighting sensors.
- Lighting occupancy sensors control about 62% of the annual lighting.
- Exterior lighting 72% lower than MNECB allowance at 1.5 kW.

3) Table Source: Energy Model for LEED Compliance Report Curt Hepting, P.Eng., LEED AP (EnerSys) pg 2 , 5



Student Dorm Windows. Image Credit: Lisa Logan Photography

## UNIVERSITY OF BRITISH COLUMBIA ORCHARD COMMONS

HVAC<sup>3</sup>

## System

- Dedicated outdoor air systems (DOASs)providing 100% outside air directly to uncooled dormitory residences (HRV-1,HRV-3) and institutional spaces with fan coils (HRVs 2, 5, 6 and AHU-2) or VRF A/C units (HRV-2, HRV-4, AHU-6) .
- AHUs with VAV reheat serving southeast 3rd – 4th floor offices (AHU-1) and southwest and 1st – 4th floor offices (AHU- 3).
- Single zone constant volume AHUs serving 1st floor events (AHU-5) and dining (AHU-4) spaces.
- Make-up air units (MAUs) providing 100% O/A to kitchen (MUA-1) and retail tenant fit-out space (MUA-2).

## Supply and Ventilation Air

Demand controlled ventilation applied to about 23% of outside air.

Single zone systems serving dining, events and the CRU with VAV control with VSD fans, versus constant volume for the Baseline case

- Maximum supply air flow at about 191,300 l/s (405,400 cfm), including primary MAUs/HRVs, as well as terminal fan coils and unit heaters.
- Constant flow for most fan systems (although all DOASs have VSDs), except VAV with VSDs for AHUs serving significant single zone systems (AHU-4, AHU-5, MUA-2) and DOASs with CO2 control (HRV-5, 6).
- Minimum design outside air (O/A) at about 65,300 l/s overall; design is nearly
- 35% above minimum ASHRAE 62.1-2007 requirements, including unregulated allowance for process kitchen hood exhaust.
- Installed fan power at 445 kW (1.10 W/cfm)

## Heat Recovery

Exhaust air heat recovery applied to about 71% of the total O/A, ranging from 0.69 – 0.88 rated effectiveness<sup>4</sup> -- including atypical heat recovery on kitchen exhaust. Note that the net effectiveness is actually lower due to about 15% of the fresh air intake being exhausted (i.e., not returning to the HRVs).

## Control

- Heating setpoints for suites at a constant 21°C<sup>5</sup>; non-residential spaces at MNECB default 22°C with setback to 18°C, except kitchen maintained at 20°C; corridors/mechanical/ storage areas at reduced constant setpoints.
- Cooling setpoints at MNECB default 24°F for cooled zones and off during scheduled unoccupied hours.
- No economizer (free cooling), except for AHUs serving offices, events and dining spaces.
- OA scheduled off during unoccupied periods.
- Demand controlled ventilation applied to single zone systems (dining, events and CRU) and classroom DOASs (HRV-5 and 6) with CO2 sensors; applies to about 23% of the total building outside air.

3) Table Source: Energy Model for LEED Compliance Report Curt Hepting, P.Eng., LEED AP (EnerSys) pg 2 , 7

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HVAC CONTINUED<sup>3</sup>

Heating Plant

- Electric baseboards in suites (served by central HRVs with hydronic heating) and some minor periphery service spaces.
- Coincident condenser heat rejection utilized for space heating.
- Heat pumps serving lounges (with VRFs6) at a rating of COP-4.1 to 4.2.
- Space and service hot water provided via central district energy (see DES provisions below).
- Temperature drop of 11°C (20°F).
- Variable flow hot water circulation.
- Hot water circulation at a bhp-weighted 56.6% overall pump efficiency. Total peak pump capacity of 46 kW, but coincident peak load at only 23.5 kW.

Cooling system 43% more efficient

- Mechanical cooling generally applies to only normally occupied non-resident
- spaces, although central DOASs have cooling to temper air as well.
- DX cooling serving lounges (with VRFs8) at a rating of COP-3.8 to 4.1.
- Hydronic cooling provided by central heat pump plant at a rated 2.9 COP, but with an improved part-load curve providing for a seasonal 3.7 COP.
- For chilled water, temperature rise of 6°C (10°F) with variable flow chilled water circulation.
- Chilled water circulation at 75.6% overall pump efficiency. Total peak pump capacity of 20 kW, with coincident peak load at 15.0 kW.

3) Table Source: Energy Model for LEED Compliance Report Curt Hepting, P.Eng., LEED AP (EnerSys) pg 2 , 7

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Daylit Seating Area. Image Credit: Michael Elkan Photography

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**MATERIAL & RESOURCES**

During the construction process, all efforts were made to sort and recycle construction waste. Orchard commons diverted 79% of construction waste from landfill.

**SELECTING WOOD**

The structural members of the project are Glulam beams, columns and Nail Laminated Timber Panels (NLT). These structural wood members were chosen to bring warmth to the space and replace the traditional structural components of concrete and steel.

Wood is a renewable resource which is produced locally and thus has a significantly smaller environmental impact when compared to concrete and steel.

**Low Environmental Impact**

Wood has the lowest embodied energy of typical building material and has nearly twice the thermal mass of concrete by weight.

Thermal mass is a materials ability to absorb and release heat during resulting in HVAC energy savings

**Wood and a Healthy Indoor Environment**

Wood is a low VOC product that has a naturally beautiful appearance that requires minimal finishing.

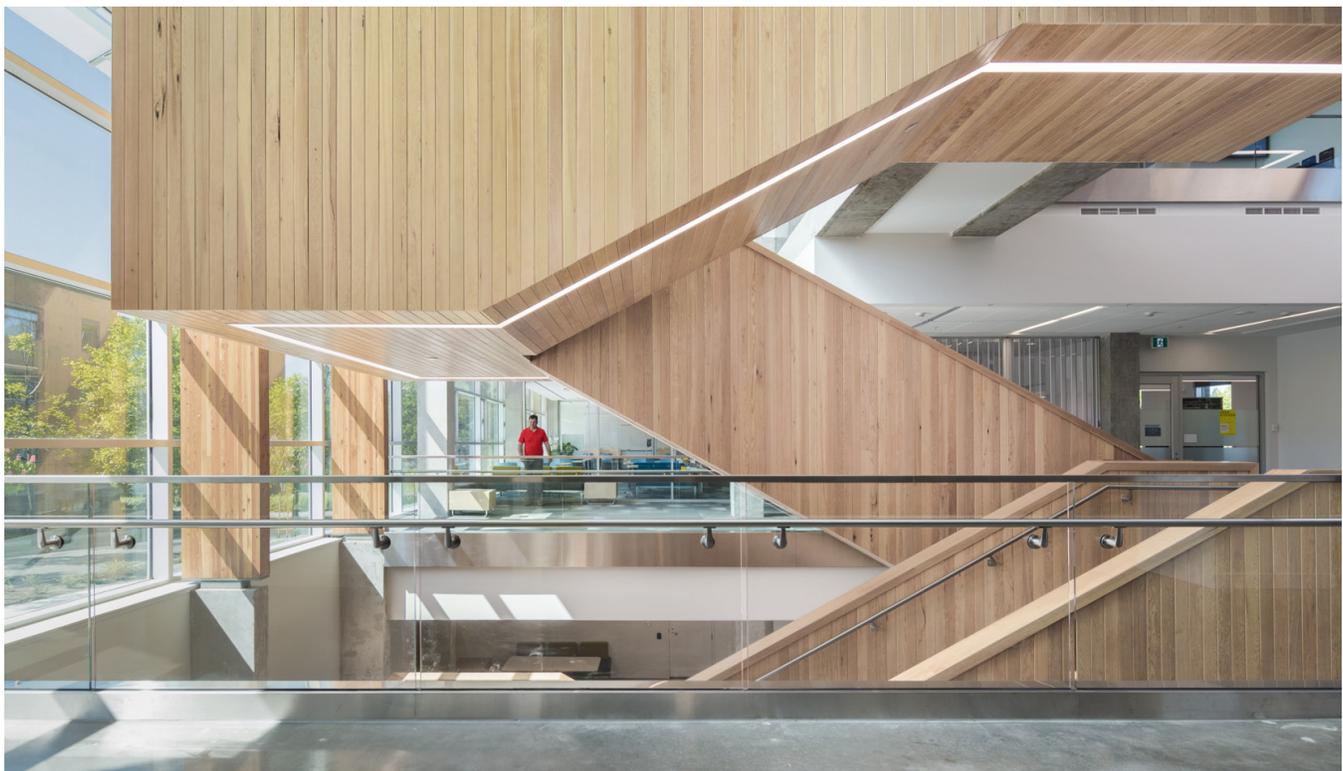
Volatile Organic Compounds (VOCs) are linked to occupant discomfort, cancers and environmental degradation. The project team has also ensured that the glue used in all composite wood products is free of urea-formaldehyde resins. Selecting products free of ureaformaldehyde improves the indoor air quality for the occupants and those

workers installing the wood products by reducing contaminants that would be irritating and harmful.

**More on Formaldehyde**

Formaldehyde “is a naturally occurring VOC found in small amounts in animals and plants, but is carcinogenic and an irritant to most people when present in high concentrations, causing headaches, dizziness, mental impairment, and other symptoms. When present in the air at levels above 0.1 ppm parts of air, it can cause watery eyes, burning sensations in the eyes, nose and throat; nausea, coughing, chest tightness, wheezing, skin rashes, and asthmatic and allergic reactions.” <sup>4</sup>

**WOOD FACT** 1 ton of dry wood sequesters 1.8 - 2.0 tons of CO<sub>2</sub> When compared to other materials wood has lower CO<sub>2</sub> impact due to a less energy intense manufacturing process.



Wood Stair. Image Credit: Michael Elkan Photography



North Facade. Image Credit: Michael Elkan Photography

### FACADE FACTS

- Using the computational model, the design of each of the 1,200 plus concrete panels was distilled to only 18 unique panel types to create the complete enclosure. The repetition of these types provided an efficient solution reducing the cost nearly in half.
- The concrete panels had 4,000 different installation connections. Using the computational model, the location of these connections were simplified, removing complexity thus allowing for easier installation. The installation was so efficient that it was being erected twice as fast as the pouring of the concrete slabs on the towers.
- Using the computational model, the amplitude of the façade's fluid forms was optimized to a

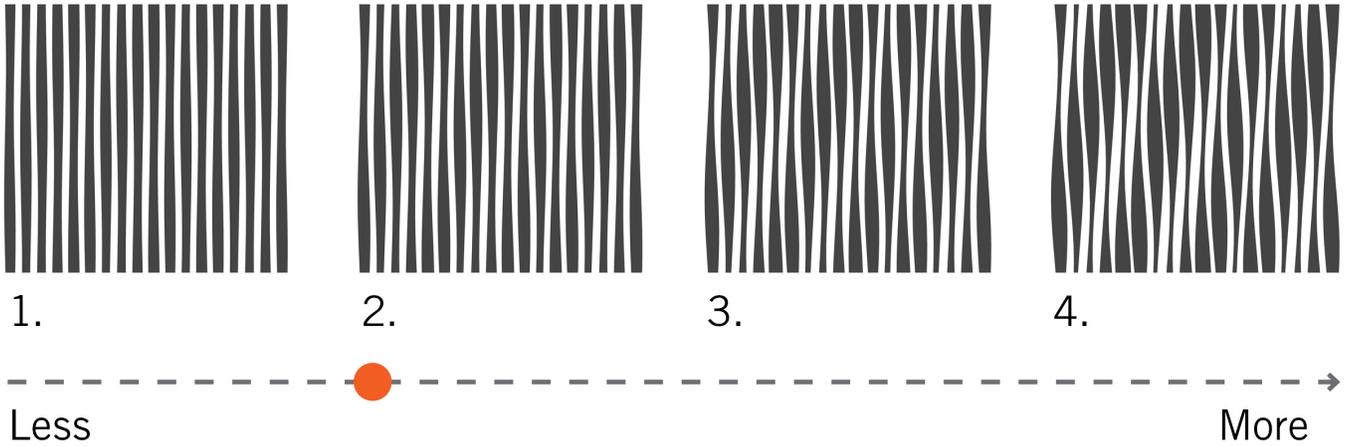
ratio of 60% precast concrete insulated panels to 40% window glass while maintaining the design intent. This ratio was determined to provide an optimal balance of daylight and energy efficiency.

- Normally an extensive set of design documents would be needed to describe the panels and all of their dimensions. In this case with the use of computational design, 80% of the documentation for the panel system is shown in a single drawing sheet.
- Orchard Commons is included as a case study in the UBC thesis
- [Understanding How Advanced Parametric Design Can Improve the Constructability of Building Designs.](#)

### COMPUTATIONAL DESIGN

- Optimized the unique shapes of the façade to meet the University's energy performance goal while maintaining operable windows and daylight requirements.
- Optimized the prefabricated panels to allow for dramatically faster and easier installation reducing the chance for error during construction.
- Assisted in the exploration and evaluation of a wide number of design options quickly by providing the ability to simultaneously explore and lock variables, thus providing more time for design.
- Improved clarity of understanding through simplified documentation that instilled confidence in UBC and the design and construction teams.

# Amplitude Study - 60% Solid / 40% Glass



## Facade Panel Labels

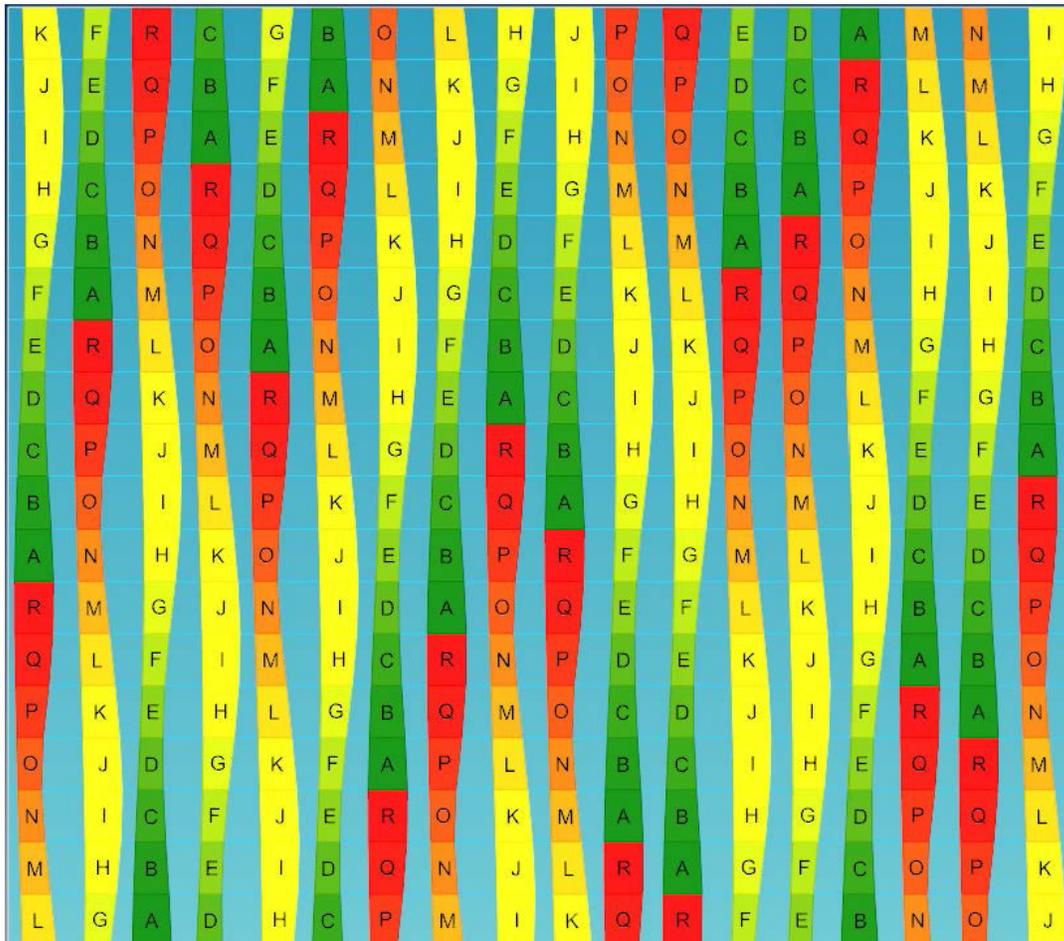




Image Credit: Michael Elkan Photography