

THE NEXT GENERATION OF BUILDINGS: WIRED FOR HEALTH AND WELLBEING

Pai Lin Li Educational Trust Travel Award 2018

The Institutions of Structural Engineers

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Abstract

Over the last year, the construction industry has witnessed a rise in structural design that prioritises the health and wellbeing of a building's occupants. Architects and engineers have worked together for years, creating spaces within buildings where they believe the occupant's needs can be met. Recently the WELL building standard has gained momentum. This standard can be used as a scientific tool to work out exactly how building design affects occupant's health, wellbeing, and performance. This paper seeks to identify the importance of people's health and wellbeing being at the forefront of any building's design. It summarises both the pros and cons of designing to WELL standardisation, and the use of biophilic design within the built environment. This study is focussed on projects in both Sweden and Canada, two countries that have built several successful buildings to WELL standards.

Biography

Amy graduated with First Class Honours in Civil and Structural Engineering from the University of Leeds in 2016, with an international year abroad at the University of New South Wales, Australia. She joined WSP shortly after graduating, where she has been working on a variety of projects within Building Structures for two years. Amy thoroughly enjoys working as a structural engineer, and since starting at WSP has worked on a wide range of projects. Project work has varied from The Royal Academy of Music redevelopment, a prestigious refurbishment project, to Westferry Printworks, a vast redevelopment near Canary Wharf.



Travel Experience

Canada and Sweden are forward thinking countries, up to date or ahead of many countries when it comes to sustainable design practises. Both Canada and Sweden are well known for their sustainable approach to design and the natural environment, making them well equipped to design for WELL standardisation.

This travel award enabled me to travel for six weeks in total, visiting professionals in my chosen field. I visited some of the first buildings designed to achieve WELL certification, many of which were under construction. During my travels I conducted meetings with architects, engineers and sustainability consultants within the health and wellbeing industry. These meetings enabled me to learn from different people's experiences working on complex building design projects.

During the first two years of my career I have learned a lot about designing in steel and concrete but focussed very little of buildings designed sustainably. This award allowed me to combine my passions, building structures and sustainability, while focussing on a unique area of research that I have an interest in. For this reason, I'm indebted to the Institution of Structural Engineers Educational Trust Pai Lin Li travel award. This experience has helped me gain knowledge I never would have been able to acquire at my desk and allowed me to meet a variety of people, building up a network of contacts. The whole experience was truly inspiring and helped me learn so much in such a short space of time.

Introduction

There are numerous reasons why a focus on health and wellbeing in structural design has become important within the construction industry. Firstly, humans now spend on average 90 percent of their time inside buildings¹. This alone is proof that, as engineers, we have the opportunity to build an environment which people will spend most of their time in. For this reason, we have a responsibility to ensure the spaces people spend their time in enable them to live a happy and healthy lifestyle. Secondly, there is a direct tie between chronic health problems and the built environment². Physical health problems commonly seen in the work place include a painful back, arthritis and obesity, which are commonly caused by sitting in a chair for the majority of the working day. Common mental health problems caused by a typical work environment include stress and sociable anxiety.

These reasons are why I have chosen to focus my proposal on Health and Wellbeing. I hope to learn how these chronic health problems can be reduced or eliminated with a new outlook on structural design. Evidence shows that productivity is improved in a healthier work environment. Many companies are now prioritising health and wellbeing when designing their offices, and in doing so claim to attract a more talented workforce.

The WELL Standard

The International WELL Building Institute have developed the WELL Building standard, which is a rating system used to score a building based on how it impacts an occupant's health and wellness.

WELL is developed using "scientific and medical research and literature on environmental health, behavioural factors, health outcomes and demographic risk factors that affect health" due to our built environment ⁶. It is an intelligent system, used in building design to enhance a person's experience and essentially make their lives better. WELL provide a silver, gold or platinum certification, similar to that of the other building standards (e.g. BREEAM and LEED).

WELL is used to measure a building against 7 key criteria; air, water, nourishment, light, fitness, comfort, and mind. The certification is strict, and every construction attempting to achieve WELL certification must have a WELL Accredited professional (WELL AP) involved. The WELL standard can be used to certify core and shell projects or interiors. The projects that affect design and construction, and therefore structural engineering, are those trying to achieve core and shell certification.

Like all building standards, WELL is continuously being improved and updated. WELL Version 2 is the most current, however several buildings certified today were designed to previous standards.

Biophilic Design

Biophilia is a love of living things, a need to be surrounded by nature. "People have an innate and genetically determined affinity with the natural world" ³. Biophilic design uses these principals to design a building and restore nature into the built environment.

We need nature in our cities. Biophilic design has huge economic, health, social and environmental benefits. When a building is designed to incorporate biophilia the health benefits include decreases in blood pressure and heart rate, reduced stress, enhanced concentration and improved memory. These benefits tie into designing for health and wellbeing where one of the key focuses is to reduce common chronic health problems caused by the built environment. Economic benefits tie into health and social benefits: in an office there is less absenteeism and better staff retention; in a classroom improved learning rates and higher cognitive function; in retail spaces people stay longer and are willing to pay more.

Google and Amazon are well known for being some of the first to design their offices with a specific focus on human health and wellbeing. These companies realise that people are staying longer at work, and work-related health problems are on the rise. They have made it their responsibility to provide a work place that is comfortable and improves their employees' health and wellbeing.

In 2016, an estimated 54.5 percent of the world's population lived in urban settlements. By 2030, urban areas are projected to house 60 per cent of people globally, while one in three people will live in cities with at least half a million inhabitants⁴. Despite these alarming statistics, most of the globe's cities have been designed without enough consideration for the environment and alienate us from nature. Recent trends and practises have led to "green building design and construction". This practise focusses on the environmental impact of a building with little focus on the social and economic sides of sustainability.

Biophilic design can be implemented in many ways. *Figure 1* shows biophilic design at University Avenue, Toronto. Large breaks where trees, grasses and shrubs have been planted separate the roads from pedestrians. *Figure 2* shows biophilic design in the workplace at WSP's offices in Stockholm. Internal green space has been used to connect people to nature.

Within the built environment our clients are becoming increasingly interested in this more holistic approach to construction, and structural engineers could benefit hugely by educating themselves in this area.



Figure 1(left)- Biophilic street design at University Avenue, Toronto

Figure 2(right) – Biophilia at WSP Offices, Globen, Stockholm

The Impact on Structural Engineering

Designing buildings wired to health and wellbeing changes the practise of structural engineering. Solutions that would have been adequate before may not work when trying to achieve WELL standardisation and incorporate biophilic design.

Examples of this are divided into some of the 7 categories under which WELL is assessed.

Air

Air can have a detrimental impact on human health, particularly in large cities where air pollution is a problem. In cities, buildings are often built with solutions in mind. Structural engineers now consider biodiversity as a method of reducing the impact construction has on clean air. Structural solutions include landscaping, green walls, and green roofs.

These solutions introduce trees and green spaces into building design, which intake carbon dioxide and help to reduce air pollution. It is worth noting that the challenges that come with these solutions include designing for heavy soil and drainage loading. This can affect the size of the entire structure, particularly if the plants are at roof level.

Light

Allowing as much natural light into the building as possible is important for human's cognitive function, and views can stimulate productivity⁴. Atriums are a typical solution used to allow natural light into a building, and to allow visual, physical and psychological connection between floors in a building.

An atrium within a building changes the whole dynamic of structural design. The challenges that come with atrium design include designing for brittle finishes, which in turn impact deflection limits as well as complex connection detailing.

Buildings in the future may be equipped to store energy. This is because energy is lost if it is not used, and energy is used at varying rates depending on the time of day and weather. On a cloudy day more energy will be used to light the building. This principal applies to the number of people in the building – very little energy is used at night, which could be stored and used in the daytime. The space needed to store this energy will be complex and require advanced structural analysis.

Fitness

A simple step to improving occupant's health and wellbeing is exercise. Office buildings more often than not, are built with bike storage facilities, which promotes cycling to work. This not only encourages exercise to and from work, but vastly reduces the company's carbon footprint. Often these facilities are within the basement of a building. In cities it has become common practise for structural engineers to design buildings with complex basements that maximise the use of space available on site.

Physical activity spaces are advised in a building trying to achieve WELL certification. A gymnasium is becoming a common facility. Designing for a gymnasium within an office building imposes a huge challenge on the structural engineer. With gymnasiums come increased vibration, and loud noises. Acoustic isolation such as box in box construction is an example of a solution that is designed by the structural engineer.

Accessibility is important. A WELL standardised building will have looked more clearly into movement paths of people in and around the building. A typical feature of a WELL build is a large central staircase and wide expansive corridors, while lifts are hidden from view. This encourages people to take the stairs and walk between floors in a building which encourages human interaction.

Comfort

Being able to control your environment makes people feel more comfortable. A simple example of this is opening a window, something people do to control their body temperature and feel comfortable.

A building with varying temperature zones and openable windows will require a more complex MEP solution. This can result in larger openings/ducts due to the nature of the temperatures and air flows in the building. A typical feature of a WELL building is having an advanced air purification system. By filtering the CO₂ out of the air people focus more clearly and feel more awake at work. This facility also requires larger pipes and ducts often increasing the servicing zones in a building.

A larger servicing zone and increased openings within a building alters the building design. The engineer will require information on larger openings earlier on in the design process, to account for these in their design. The larger servicing zones effect the floor to floor height of a building, dictating the overall height of building. This will impact the structural engineer considerably. More design team meetings and increased coordination between the MEP and structural engineers is typical for a WELL build.

Mind

Wellbeing is important. Offices are now becoming flexible spaces, with the mental and physical health of occupants at their core. Within the workspace we are starting to see areas where people can interact more easily: comfortable seating areas, drawing boards and meeting spaces. Buildings are now being built with large, open plan spaces, promoting social interaction within the workplace.

This affects structural engineers, who are now designing to reduce the number of columns, which obstruct open spaces within the building. This means that engineers now design floors that will span the furthest, pushing materials and construction to the limit.

Design will now be flexible and future ready. Changes in use will be possible in the future. This adds complexity to structural design. The structure will have to be designed for various scenarios: commercial, residential or office use, all of which come with varying load, vibration and accessibility requirements.

Objectives

During my time working in the construction industry I have started to see much more of a focus on designing for health and wellbeing and have seen the use of the WELL concept and standard gain momentum. It is a modern outlook on design, and certainly has become a talking point within the industry. Despite this, I believe most structural engineers know little about this concept, and how it affects structural design.

This study took place in two countries; Sweden and Canada. I visited several cities with the intention to learn more about designing for health and wellbeing. My aim was to learn how to design to WELL standardisation, with a focus on Biophilic design and learn how this type of design will change current engineering practise. I aim to learn how this practise varies with project, region, country, changes in the natural environment, working culture and current engineering methods. Finally, I want to know the pros and cons of designing to WELL standards and how it plays a part in future ready design.

Sweden

Sweden is a country that is already well equipped to design for WELL standardisation.

The culture in the country is set up for improving people's health and wellbeing. It is typical in Sweden to have large canteen spaces where everyone in the office eats lunch together. *Figure 3* shows a photo taken in WSP offices in Stockholm and shows spacious, inviting canteen spaces, which encourage social interaction. In Sweden the concept of multi-disciplinary teams has taken off and office spaces are adjusted for collaboration among teams. The recycling culture in Sweden is very strict. In homes and offices waste is separated into categories. See *Figure 4* shows a photo of a typical office waste disposal unit. Water quality in Sweden is superb. The majority of buildings trying to achieve WELL certification have to do very little to pass the water criteria.



Figure 3(left)- Canteen style collaboration spaces, WSP Stockholm

Figure 4(right)- Typical office waste recycling, Stockholm

Finally, people in Sweden are forward thinking. New trends and practises are quickly adopted in the country. People in Sweden are health, wellbeing and sustainability conscious. The concept of WELL was quickly adopted in the country, and large companies want to be the first to house their employees in a WELL certified building. It is now very competitive to be the most sustainable and company. People are choosing to work for one company over another based-on ethics and WELL rating. Companies like E.ON and Castellum have re-branded themselves around health and wellbeing to attract a better workforce, retain staff, and promote themselves.

E.ON HQ

E.ON energy group has teamed up with Castellum to build new headquarters in the attractive Nyhammen district of Malmö. The new E.ON headquarters is sustainability focussed, targeting WELL platinum (core and shell) and BREEAM outstanding certification. The development will see construction of 24,500 square metres of office space.

E.ON are one of many tenants who are willing to pay more for office space designed for WELL certification. The government and country lose millions every year due to lack of productivity. This can be easily measured using absenteeism statistics. Sweden's clients are not necessarily designing to the most efficient design in the quickest time, but are instead asking the occupant what exactly they want. How are these people going to use this space? How do you maximise people's productivity in an office space?

How are they achieving WELL platinum?

Below is a list of innovative measures that E.ON's new headquarters will adopt to improve the building's impact on employee's health and wellbeing.

- A concrete structure with biophilic timber finishes.
- Green biodiverse roof. This roof is located so people can benefit from views of nature while at work.
- Vegetable growing facilities.
- Green roof terraces, mainly south facing. These have outdoor working spaces, which are sheltered against the wind. People have the choice to spend part of their day working outside. When people can choose their environment, they feel in control, which improves their comfort.
- A ground floor gym, focussing on the fitness criteria of WELL.
- Open plan offices for collaboration and reducing partition walls that block out daylight.
- Collaborative or silent working spaces allow people to move depending on the type of environment they choose to work in.
- Large catering facilities so everyone can eat together. These areas will promote healthy eating, and focus on the nourishment criteria of WELL.
- Rainwater harvesting on the roof, used for rainwater flushing toilets.
- Bicycle storage and repair shop.
- Typically, women prefer a warmer environment to men. To ensure everyone is comfortable, and therefore productive, different temperature zones will exist in the offices.
- Circadian lighting used throughout. This lighting systems uses advanced technology to mimic natural sunlight. The sun's light changes colour and temperature from morning to evening. People naturally react to this, feeling more energised in the day and producing melatonin at night, helping them fall asleep⁹. LED lights prevent melatonin production and can be used to stop us falling asleep and feel healthy.

Chalmers University

The combined engineering and architecture department at Chalmers University, Gothenburg, is housed in a building constructed in the 1960s (*Figure 5*). The building was recently refurbished, focussing on health, wellbeing and sustainability.



Figure 5- Chalmers University Original 1960s Interior

The architect and engineering departments were to be combined within the outdated building, resulting in master planning and layout changes.

The student's health and wellbeing was the focus of the design. Light was brought into the building by increasing window sizes. In the basement, lightwells below the buildings atrium were used. *Figure 6 and 7* show the large existing atrium and light wells, intelligently placed to bring natural light into the basement. Some walls which were load bearing were removed. Creating this open plan area meant the light could reach further into the building. Both methods reduced the number of artificial lights needed, and the total energy use of the building.



Figure 6(left) – Chalmers University, the existing atrium

Figure 7(right) – Lightwells within the atrium's floor

Timber floors were used wherever possible. Old masonry walls and internal copper window frames were exposed. This created a connection to nature and the building's history.

Large break out spaces were set up. These spaces felt both comfortable and spacious, great for working and learning. These spaces allowed more collaboration between students. As well as large break out spaces to work, balconies were built in the atrium and are supported by the building's existing frame. These balconies provide an entirely different environment to work in, which the students can choose from depending on their mood.

New stairways were built, cleverly located and enlarged to become the focal point within the building. This influenced people to walk rather than taking the lift wherever possible, promoting health. *Figure 8* shows a new timber staircase, used to get from ground floor to basement.



Figure 8 – Timber Stair Case

When exploring the building it is clear that the refurbishment had been a success. There were architects and engineering students working together and collaborating in every type of space including the labs, library, balconies. The building was colourful, modern and bright. People chose to leave their home and come in for the day to work together, feeling happy and healthy in the spaces provided.

Project Epic

Skanska are a Swedish company and the lead developers on project Epic, a pioneer project for WELL. Skanska have a huge presence in Sweden, known for their creativity and sustainable solutions to construction.

Skanska has only recently developed the in-house knowledge to become involved in developing a WELL certified building. Design and construction in WELL certification is still a relatively new field, and is costly in consultancy and research fees. The majority of Skanska's buildings in Sweden are LEED certified, so it was a natural progression to start certifying with WELL. Skanska believe WELL certification aligns with their values, and most importantly shows they take care of their employees. WELL is a growing market for Skanska, with 80% of Epics office space rented out 1 year in advance of completion, which is unheard of in Malmo. Companies in Sweden are starting to ask for spaces that are WELL certified. A market is forming with a demand.

Epic is a 6 storey office block located near the central station in the heart of Malmo and is currently under construction. The project has a very large plan area (15000 square metres) and is made up of two buildings connected with one large atrium. The atrium is full height, with sky pedestrian bridges connecting one side to the other (see *Figures 9 to 12*). Full height 6 storey tall trees will be planted within the atriums ground floor, providing habitats for a variety of plant and tree species to exist inside the building. The atrium will have so much light that even tropical plants will be able to thrive. The team struggled to find tropical plants that look native and in-keeping with Swedish biodiversity, which is part of the WELL requirement.

At the centre of the building, constructed in steel, is a large central stair case. It will be a focal point upon entering the building while the lifts will be hidden from view. This will encourage people to use the stairs rather than the lift, focussing on the fitness requirement of WELL certification. Both the staircase and atrium add complexity to the design of the structure. The atrium presents a problem with brittle finishes, while the stairs are bespoke, spanning significant heights from floor to floor.

The atrium not only allows light into the building, increases biodiversity and holds the feature staircase, but it connects the two sides of the building. This is important as one side is road and the other calm harbour. Two tempers meet using this atrium, allowing a visual, physical and psychological connection between floors.

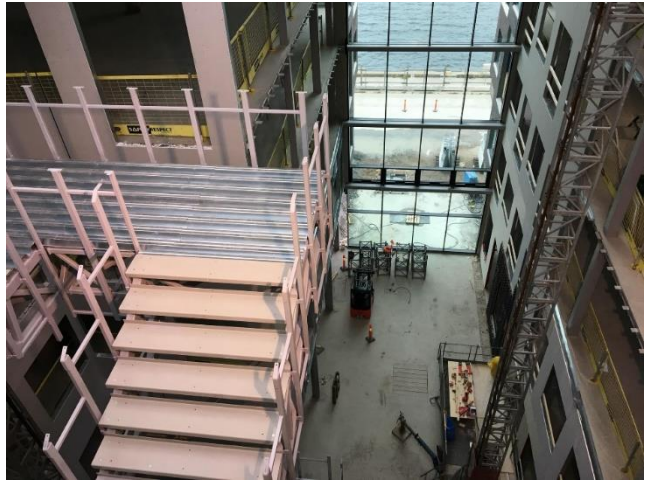


Figure 9 (left)- Central Staircase

Figure 10 (above) – Central Atrium

Multiple key features within the building helped Epic achieve a high WELL rating of platinum core and shell. The façade is made from pre-fabricated brick produced in Poland. The bricks are broken in half as the weight is too great for the façade. The half of the brick not used on the façade is crushed and made into tiles. The interior wood finish is made of old window frames – a simple but sustainable solution. See *Figure 11 and 12* for internal and external finishes.



Figure 11 (left) – Project Epics external finishes

Figure 12 (right) – Project Epics internal finishes

Finally, Skanska have focussed on the impact people will have on climate change once the building is in use. The bike storage in the building is not separate. There will be bike storage by the reception inside the building, and by people's desks. Bike security encourages people to cycle. To be more sustainable every tenant will be provided a sunfleet car pass. This is because tenants were complaining that even if they can cycle to work, they cannot cycle to meetings. To ensure this doesn't stop people cycling in, car sharing can be used during the day.

Eminent

Eminent will be the first core and shell WELL certified building to finish construction in Scandinavia, in late 2018. It is an office building with over 9600 square metres of office space. Castellum act as client, while Kanozi are the architects.

Architects have always tried to design for value, not cost. Kanozi described WELL certification as an opportunity to push value, even if it costs more. Ideas that add value to the project and improve people's lives may have before been scrapped. Now they are included as removing them may reduce WELL points, which out way additional costs.

Eminent is built in Hyllie in Malmo, purposefully at the end of a row of buildings, rather than standalone. This looks better, is well planned and integrated. Heritage and community are a major consideration in design. The building's façade is made of the old brick, typical of Malmos industrial heritage. A community feel is attractive to the public, which is why the entirety of Eminent's ground floor is public space. The building is giving something back to the city.

Eminent was designed with people's health and wellbeing at it's focus. It is a large building on plan area, but only 7 storeys tall. The floors are a very tall 2.9m and open plan. The whole space feels light and airy. There is a Gymnasium at ground floor for occupants to exercise in.

The space on each floor is easily adaptable. There can be up to 4 small offices on each floor, depending on the employee's needs. It is future ready. A large courtyard in the centre of the triangular building not only provides outdoor space, but allows light to reach the rest of the building. Windows have some grey and blue glass panels. Grey and blue light is proven to calm people, adjusting the mood inside the building.

There are large steel trusses at ground floor, exposing the structure. This helps passers-by feel connected to the building's construction/history (see *Figure 13*).



Figure 13- Large Steel Truss at Ground Floor

Eminent was designed for biophilia. There will be patterns on the walls used to mimic nature. There will be a green roof made of Biotaptak. This type of green roof works better than sedum, attracting a

biodiverse range of insects to live within the plants and soil. Hanging gardens in the central stairwell avert the eye away from computer screens. Green walls are to be used on the façade, adding nature and colour to the façade.

The structural engineering solution is typical of Sweden. Precast post tensioned concrete slabs are used throughout. Each slab panel is one way spanning between steel beams. Columns are either steel or composite steel and concrete. Composite columns are used at ground floor to minimise size. *Figure 15* shows bracing between columns used for lateral stability in addition to a single concrete core. There are two types of façade on this building. One is brick stud wall in traditional construction and the other is solid concrete wall.



Figure 14 – Bracing needed for lateral stability, made into a feature

Canada

Canada is a country present in the health and wellbeing sector, with several interesting buildings achieving WELL standardisation.

The majority of new builds in the major cities are designed to LEED, a certification that shares criteria with WELL. If a building has a high LEED score, it is easier to achieve WELL certification. Similarly, Fitwel has become popular for office spaces in Canada. Fitwel is another system used to measure a building for health and wellbeing. It is a more flexible system, where the strategies that are adopted can shape the building's WELL profile. It is commonly used in existing buildings/refurbishments. Office spaces can easily transition from Fitwel to WELL certification if the client so wishes.

Google

Google are bold and ambitious when it comes to designing their own offices and are open to new ways of working and thinking.

Google's new Canadian headquarters were developed with a focus on their occupant's health and wellbeing, before the WELL certification was set up. The offices are in Waterloo, Ontario and were the first offices designed to LEED certification version 4. Google have their own real estate team, and the team is focused on green buildings and the environment. Google were new and innovative, designing from proven studies on human psychology. For example, it has been proven that people feel more secure and protected when their backs are not exposed. As such, Google have ergonomically developed working booths with closed backs, improving the user's comfort and productivity. *Figure 15* shows an example of a booth used within a WSP workplace. A simple but effective solution.



Figure 15 – Working Booths

The construction of the google HQ was split into two phases, one for each of the office blocks. Phase 1 comprised a new building envelope built to fit within an old industrial building, chosen for its heritage. Upon phase 1 and 2 finishing, Google received a lot of press for their unique, quirky and unusual designs. Some unique feature include a climbing wall for fitness, a library with an inbuilt fireplace, a work space inside a tent, and a putting green on the roof terrace¹¹.

In terms of designing for health and wellbeing, Google made sure their offices were connected to a bicycle route, rather than just providing bicycle storage. Rain water harvesting toilets are used in the building, and all finishes are built from healthy materials that are both natural and sustainable. Google has focussed its attention on health, with every item provided in the kitchen labelled with nutritional information ¹¹. Having your own individual desk is a thing of the past for Google, with technology in every room allowing their work force to work on any floor while remaining productive and efficient.

Google claim to have attracted a larger number of applicants, and a more skilled workforce by designing with health and wellbeing in mind. Not only this but Google have received a lot of press for their new outlook on design, increasing their global presence.

CBRE HQ

CBRE are a real estate company who were the first company in Canada to announce a zero-carbon work plan for 2010. They are sustainability focussed. Their new headquarters is on the 11th and 12th floors of King Street West, a 42 storey tower in Downtown Toronto. The offices are designed to WELL platinum and were completed in 2016. The WELL standard was founded in New York, and easily used on building assessments on tall buildings.

How did they achieve WELL platinum?

Below is a list of innovative measures CBRE's new headquarters will adopt to improve the buildings employee health and wellbeing.

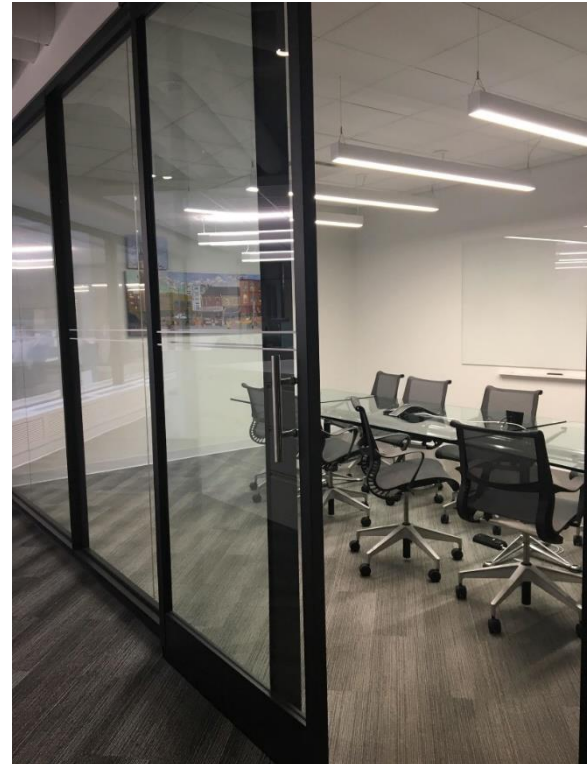
- Artwork is strategically located throughout the office. This creates distraction, averting your eye away from your computer screen occasionally, preventing eye strain.
- Circadian rhythm lighting is used to mimic the sun's natural ability. This provides people with the exact amount of light they need for maximum productivity.
- MERV 13 filters in pipes mean the highest quality air is supplied to the office. You do feel healthier when inside the space. The CO₂ in the offices is kept to a maximum of 80 parts per million using these filters.
- White noise is used in the office spaces, and silence in the meeting rooms. Silence works for a meeting, where your voices need to be heard, however complete silence is distracting in a working desk environment. White noise fractures sound; you will be able to tell someone is talking near you in the office, but not be able to hear what they are saying.
- All desks and meeting rooms are within 25 feet of a window and natural light.
- Carbon filtered hydration stations are strategically placed every 30 metres, encouraging people to drink water.
- All desks have barriers/breaks between each other for privacy. Some breaks are glass to allow in sunlight.
- All desks have smooth surfaces and curved edges to prevent wrist pain.



Figures 16 (top left) – CBRE lunch hall

Figure 17 (bottom left) – Break out spaces

Figure 18 (bottom right) – Meeting room glass technology walls



These offices are an example of successful design. CBRE HQ provides evidence of how to successfully execute a design wired for health and wellbeing. The feedback from employees is outstanding. Employees filed 82-94% satisfaction in the post occupancy office survey relating directly to WELL. People working in the offices have specifically mentioned they feel less tired, and that this is due to the air and lighting in the office. People have said they are more productive during their time at work. Finally, people have enjoyed having more opportunity to control their health.

CIRS Building, UBC

The centre of interactive research at the university of British Columbia runs green building tours all year round. The CIRS building, famous for its state of the art technology, is a unique example of sustainable building design.



Figure 19 – CIRS Building, UBC

As soon as you walk in the building you notice the large timber stairway in *Figure 20*, while the lifts are hidden from view. The atrium in the centre of the building can be used to connect floors, for social interaction and for flooding the building with light.



Figure 20 – Central timber stairway

The building is formed of concrete and structural glulam timber. The structural timber in the lecture theatre is made from wood effected by mountain pine beetle infection, see *figure 21*. The mountain pine beetle is an invasive species that dries out trees by sucking out all the trees moisture. This is a huge problem in Canada, as this wood can cause forest fires, and needs to be removed. Rather than allow the timber to go to waste and inevitably be caught in a forest fire, it is increasingly being used in for construction.

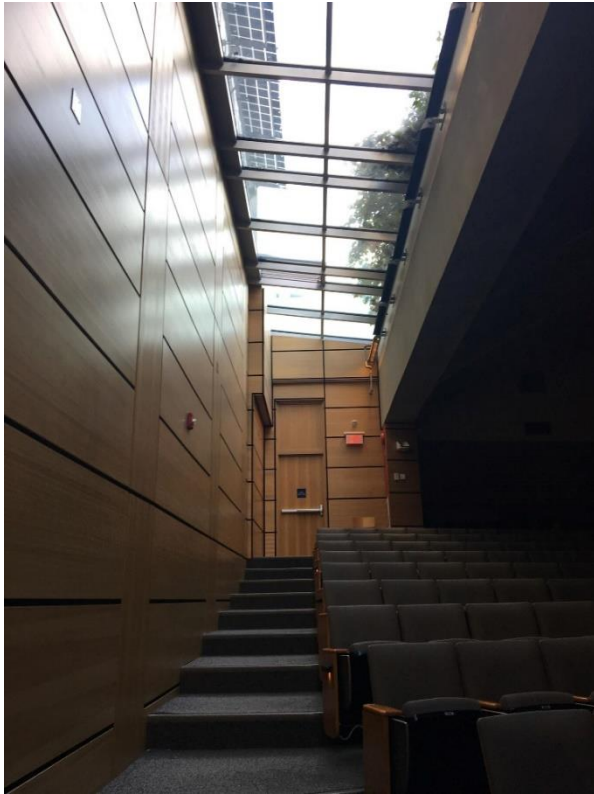


Figure 21 (Left) – Mountain Pine Beetle infected timber



Figure 22 (right) – Solar panels

Air and temperature in the CIRS building is controlled for occupant comfort and wellbeing. There are 3000 sensors in this building, which measure CO₂, motion and temperature. If the temperature levels within the building are too high there are windows in corridor spaces that automatically open, and the heating will automatically turn off. To heat the building, 5 percent of all energy is generated from solar panels. These solar panels provide a dual purpose of shade and energy (see *Figure 22*).

Biophilia is present throughout the whole building. *Figure 23* shows a green roof which houses a large variety of native plant species. These plants intake CO₂ and release oxygen. The MEP system pumps air in at roof level, which is a lot cleaner. The tiles on the green roof are raised, underneath which water is stored. This water collected at roof level is transported to a 83000-litre tank underneath the building. This water is then used for plant irrigation and to flush toilets.



Figure 23 – Biodiverse green roof

There is a green wall on the western face of the building, made up of climbing plants called chocolate vine. These plants were specially selected because they are lush with thick leaves in the summer, shading the building, but bare in the winter, allowing light in to heat the building.

Conclusion

Designing a building with an occupant's health and wellbeing at the focal point is a new concept, brought upon by recent developments in societal needs and advancing technology. It started as a trend, but has now become common practise in many countries. I believe adopting the principles explained in this report will ensure a building is future ready.

This paper has made many observations based on successful projects, whether that is designing to WELL, for health and wellbeing, or incorporating Biophilic design; however, there are still changes that need to be made for the concept to become common practise.

WELL is expensive. Projects that would hugely benefit from adopting these principles may choose not to due to the additional cost to the client. It is the engineer's job to explain to the client the benefits of this type of design, and how they out way the high capital cost. Costs can be mitigated throughout a building's life span. CBRE HQ saw very little additional cost due to WELL being incorporated at such an early stage and adopted into conceptual design. The largest cost to the client comes from consultancy fees. With very few buildings designed to WELL, a lot of hours are spent researching how it can be achieved. Skanska claim with every new building they design and construct to WELL, the lower the consultancy fees, and the faster they become. Another problem with WELL standardisation is maintenance costs, particularly concerning Biophilic design. Green walls and roof gardens must be implemented and maintained correctly; without this plants will die.

This paper lists the benefits designing for health and wellbeing has not only on the occupants in the building, but also the building's owner/employees. It is a design outlook that benefits everyone involved if implemented correctly, however, the challenge that comes with this type of design is awareness. Often the responsibility is passed onto the sustainability consultant, but to become successful it needs a multidiscipline approach. It effects every aspect of a projects life cycle and design.

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