THE OFFICE BUILDING OF THE FUTURE
Floor Module

COORDINATED SYSTEMS

The structural floor system of the OBF incorporates mechanical, electrical, communications, fire suppression and lighting systems into a single, integrated assembly. Constructed using precast concrete, structural sections measuring 95 feet by 10 feet span the width of the floorplate and are envisioned to be 24 inches deep, one-half of the traditional plenum depth. This savings in plenum depth is achieved by alternating the ceiling and floor cavities and interweaving them within the necessary structural depth. Incorporated within the precast concrete elements are hydronic cooling/heating loops to maintain proper building temperature, integral air highways to distribute supply and exhaust air, and a cast-in mounting system for electrical and communication routes.

The precast elements are fabricated off-site in a factory setting where all of the building mechanical and electrical systems can be pre-fitted. As the building elements arrive on-site, they are simply lifted off the delivery trucks and set directly in place. A topping slab joins the individual components to create a continuous diaphragm and the necessary systems are connected.
The ORF will be filled with natural light and fresh air and respond to the specific needs of each inhabitant. Its occupants will demand floorplates that allow democratic and universal access to the building perimeter. The ORF will be organized as a narrow building that maximizes light, air and views in and through both sides of the lease depth. With plenum spaces in the ceiling and floor deployed more efficiently, space is freed up to produce significantly higher ceiling heights. When natural ventilation is not possible, fresh air can be supplied through a matrix of small floor-mounted vents to provide each occupant the option to control local flow. Inconspicuous overhead radiant heating and cooling will efficiently maintain the proper temperature.

01 Cross Ventilation Across Building Floorplate
02 Fresh Air From Floor Vents
03 Exhaust Air Through Ceiling
04 Radiant Cooling/Heating From Exposed Concrete Ceiling
05 Task Lighting
06 Dimmable Fluorescent Space Lighting
07 Roller Shades
08 Access To Floor Plenum
09 Vertical Solar Shades With BIPV Solar Collection
10 Cast-in Insulation
Wall Module

**THE INTEGRATED FACADE**

The conventional office building construction has long been to separate the structure and facade of the building perimeter into two distinct components, requiring two trades working on site and two steps in the construction process. For the OFB, the structure and facade is combined in the factory and delivered to the site as a complete single wall unit. As the perimeter columns and spandrel beams are being lowered into place, so also are the glazing, shading and facade systems—a clean, single-step process to erect a dried-in building. The columns and spandrel beam that make up each structural bay (to feet x floor) are presently continuous frames that are then re-filled with the latest building fenestration technology—specifically fine-tuned to the site conditions and wall orientation. The building facade of the OFB is designed using high R-value materials, such as millfibre made of pultruded fiber reinforced polymer composites (FRP), which is fibreglass that has been formed into linear components to replace extruded aluminium, triple-pane glazing to minimize heating and cooling loads and translucent insulating panels using aerogel, interpenetrated to reduce loads. Solar radiation is blocked by large vertical shading devices and converted to electric energy with translucent amorphous silicon photovoltaic cells. In an effort to maximize the interior space planning, perimeter columns are shifted to the exterior of the wall—these external precast elements will be cast with integrated insulation to prevent thermal bridging to the interior.

01 High-Strength Precast Concrete Frame

02 Triple-Glazed High Efficiency Vision Zone

03 Pultruded Fiber-Reinforced Polymer Composite Mullion System

04 Translucent Fiberglass Panel With Aerogel Infill

05 Computer-Synchronized Operable Window For Airflow

06 Cast-In Structural Mounting Sleeve

07 Photovoltaic-Integrated Vertical Sunshades
Central Core Module

RETHINKING THE CENTER

In a conventional office building, the core is typically a tightly packed conglomeration of large structural members for lateral support and utilitarian programmatic spaces, such as egress stairs, mechanical rooms, and restrooms. It is generally treated as a necessary yet mundane grouping of spaces relegated to the center of the floorplate and obscured from natural light. The OBF will define a new paradigm, one that embraces the core as the heart of the building, a unifying open space. Rather than group all of the lateral bracing into a massive, solid concrete cluster at the building center, the OBF expands the bracing system into a large open tube of precise concrete lattice work, surrounding light-filled centralized areas. Because lateral loads are more broadly distributed, the assemblage is more structurally efficient and less material intensive. Stairs and elevator shafts are now independent of the structure and surrounded by natural light. Additionally, due to the system’s inherent “plug & play” flexibility, it is intended that the independence of the structural core would allow for programmatic units such as mechanical rooms or elevators to be added or replaced at the discretion of the owner years after the completion of the initial project thereby allowing the building to be repurposed.

01 Modular Star Section
02 Modular Wall Panel
03 Shear Wall Diagrid Module
04 Floor System (Shown in Atrium Condition)
05 Elevator Module
06 Bathroom Module
07 Atrium Bridge Connection
Putting It All Together

IMPLEMENTATION

On-site assembly of the OBF will be a fast and exciting grand finale to a process that began, and largely took place, in a controlled factory environment. As modules are assembled to create dynamic spaces, and spaces assembled to form an elegant building, a new and futuristic icon will redefine the Seattle skyline.

The OBF will represent healthier work environments for office inhabitants, responsible use of natural resources, and a secure financial investment for owners. The city will be proud of its new monument to progress. Tenants will readily lease space in a building that they know will promote employee productivity and well-being.

BUILDING STRUCTURE

It is expected that the OBF will have a useful life spanning many decades into the future. Careful consideration has been given to ensure its durability and longevity through the use of potential natural disasters, particularly in a city with significant seismic activity. As the modules of the OBF are lowered into place, they are structurally fixed together by weld points and NMR shakers—a specially designed coupling system that effectively unites two adjacent reinforcing bars from separate precast units into a continuous reinforced concrete member.

In the high-rise office tower, lateral loads will be resisted by a "core-only" approach, in which a central diagrid tube will resist both moment and shear forces. Structural analysis confirms that, through the modules’ use of high-strength materials, this structural configuration is more than sufficient to keep tower deflection within acceptable limits. It is anticipated that in the near future, higher-strength concrete and reinforcing steel will become more economical and widely available, therefore to use concrete and use kevlar steel were the assumed materials for the structural testing of the OBF. The core-only structural model of the tower is fully expressed in the building form, by transferring perimeter vertical loads to the core at the bottom of the office core, and allowing the core to stand alone for the bottom third of the office building.
77% reduction

Building Energy Use Intensity (kBtu/yr/5F)

- CBECs Average of All Office Buildings: 92.9
- CBECs Regional Office Building Average: 72.0
- CBECs Regional (mixed use): 64.5
- ASHRAE (90.1-2007): 44.7
- Proposed: 21.5

28,154 MBtus per year
Total energy usage

100% renewable energy
**Strategies**

**ENERGY STRATEGIES**

**PASSIVE DESIGN STRATEGIES**
- Air tightness enhances stack effect
- Sun shades manage summer solar gain
- Thermal mass creates a thermal flywheel effect
- Night flushing cools the thermal mass
- Operable windows provide natural ventilation
- Daylight access reduces artificial lighting

**HIGH PERFORMANCE ENVELOPE**
- Triple-glazed low-e Krypton filled curtain wall glass: U-value as low as 0.19
- Translucent Aerogel panels: U-value 0.09
- Fiberglass curtain wall framing: U-value 0.09 (vs. 0.64 for mechanically fastened aluminum curtain wall)³
- Continuous insulation avoids thermal breaks
- Green roof: cool by evapotranspiration and increases summer thermal resistance

**HIGH EFFICIENCY HEATING & COOLING**
- Radiant heating and cooling decouples conditioning from ventilation
- Geothermal exchange heating and cooling plant
- High efficiency magnetic bearing chillers
- High efficiency hot water condensing boiler plant; option to connect to Seattle Steam District Energy
- Cooling towers for one third of cooling (peak) load only

**MIXED-MODE EFFICIENT VENTILATION**
- Displacement ventilation with fresh air rising from floor
- Demand-controlled ventilation controls that supply fresh air when CO₂ is too high
- Energy recovery enthalpy wheels with dehumidification condition fresh air intake with heat from exhaust air

**EFFICIENT LIGHTING**
- Daylighting reduces need for artificial lighting
- Daylight sensors and dimming controls provide necessary light in varying light conditions
- Automatic interior roller shades provide glare control
- Efficient direct/indirect T5 fluorescent fixtures or LED fixtures

**VERTICAL TRANSPORTATION**
- Open stairs increase physical activity of occupants and reduce elevator demand
- Efficient new elevator belt technology can reduce energy by up to 50%; adding a regeneration drive that recaptures energy lost in braking can save an additional 25%⁶

**OCCUPANT BEHAVIOR**
- Tenant sub-metering incentivizes and encourages tenant efficiency
- Online building energy management systems provide real-time feedback to encourage better energy usage
- Tenant plug load reductions encourage more efficient equipment
- Task lighting encouraged to reduce general illumination

**RENEWABLE ENERGY HARVEST**
- Solar hot water (thermal) collectors are inexpensive and highly efficient
- Conventional monocrystalline photovoltaic panels with 16% conversion offer the highest production per square foot on roof⁸
- Amorphous silicon building-integrated photovoltaics offer the most production in conditions with diffused lighting and vertical surfaces⁹

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Strategies

WATER STRATEGIES

HIGH-EFFICIENCY WATER FIXTURES
- Waterwise-approved faucets, showers and toilets assure quality and reduced consumption
- Motion-activated and auto shut-off fixtures, reduce demand and waste

RAIN WATER COLLECTION & STORAGE
- Collection from all surfaces, including roofs, green roofs and site
- 1,300 cubic foot cistern sized for cost-effectiveness

EFFICIENT LANDSCAPE IRRIGATION
- Efficient and effective drip irrigation method
- Drought-tolerant landscaping minimizes irrigation needs

MECHANICAL PROCESS WATER COLLECTION & STORAGE
- Reduction of cooling tower blow down and condensate water flows (these can account for 40% of a building’s water demand)
- 13,800 cubic foot cistern captures a large volume of water to vastly reduce demand and waste

WASTE WATER COLLECTION
- Managing grey water and black water flows together is more cost effective than managing separately

LIVING MACHINE
- A low-energy system for treating all waste water on site, and includes the following:
  - Settling tank for equalizing flow of settling solids;
  - Control system to manage flow and monitor performance and quality;
  - Wetlands installations located inside or outside for removal of nutrients and particulate — this is the visible, odorless portion of the system;
  - Disinfection system to kill any remaining pathogens

REVERSE-OSMOSIS PLANT
- For final purification of Living Machine output as well as collected effluents to produce potable water

REUSE OF COLLECTED & TREATED WATER
- System meets 86% of potable water needs
- Drought reduction in city water and sewer services substantially reduces utility costs
- Tenants are charged for water services provided by the owner through on-site water collection and recycling services
- Payback on systems in as little as 4 years

2. In recognition of low-cost, 3D, small, scalable, and renewable.