Building technology’s role in health and wellbeing

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Symposium on Putting Health and Wellbeing Research Findings into Practice

2018.04.18

ARUP
Industry research to practice

Technology and product innovation

Project implementations and Occupant experience transformation

Policy and guideline drivers
Digital changes in our spatial journeys

- **Workplace**
  - Multi-destination workplace

- **Public realm**
  - Urban nature biodiversity
  - Activity, interaction and creation

- **Mobility-aaS**
  - Active transportation, multimodal and sharing system

- **Home**
  - Work from home
  - Home-aaS
Understanding the future of workplace
Understanding the future of workplace

1. Multi-functional spaces and service ecosystems
   From accommodating rapid change to reductions in size and scale, the character of the workplace is being redefined towards a more fluid entity, capable of expanding and contracting on demand.

2. The city as a network of workplaces and workspaces
   There is a shift from a highly-centralised workplace model to one characterised by constellations of distributed ‘urban innovation nodes’, where workers congregate in order to use facilities and collaborate on the delivery of projects.

3. Improved space utilisation as an ever-growing priority
   New business- and operational models deliver a highly-flexible approach to commercial space utilisation, including co-working spaces, new leasing models, new forms of community living and 24-hour workplace access.

4. Digital redefines the value of property portfolios
   Adding a digital layer across commercial assets and portfolios allows property owners and operators to offer new services, create new revenue streams, and enable more flexible on-demand access to space.

5. Towards tailored and targeted approaches to employee wellbeing
   Sensors and data analytics are providing a more granular picture of the actual performance and quality of commercial spaces, thereby increasing our ability to create healthier and more productive workplace environments.

6. The strategic need for workplace curators
   Workplace curators operate at the intersection of HR, corporate strategy and facilities management in order to manage the changing requirements of stakeholders, and utilise the workplace as a strategic tool for the business.
Key environmental & lifestyle factors

- light quality & spectral properties
- in- & outdoor air quality
- hydration
- connection to nature
- diet
- temperature & humidity
- exposure to toxins, allergens & pathogens
- noise
- social relationships
- activity & exercise
- empowerment & social equity (degree of control / influence)
- community context & local amenities
- information and health literacy
- diet
- activity & exercise
- empowerment & social equity (degree of control / influence)
- community context & local amenities
“...the time has come to elevate human health and comfort to the forefront of building practices and reinvent buildings that are not only better for the planet – but also for people.”

Source: [http://wellcertified.com](http://wellcertified.com)

Source: [http://betterplacesforpeople.org/](http://betterplacesforpeople.org/)

Buildings for people
Core architectural themes

- Material safety
- Active design principles
- Prominent access to drinking water
- Biophilic design strategies
- User control / influence
- Envelope design
  - Glazing spec
  - Views
  - Air tightness
  - Moisture control
  - Commissioning
- Comfort
  - Spaces for rest & relaxation
  - Introvert / extrovert
  - Mindful dining
  - Acoustic space planning
- Daylighting
- Flexibility & personalisation
- Post-exercise facilities
- Community context & placemaking
- Inclusive, accessible design
- Beauty & thoughtful detailing
- Maintenance & durability
- Prominent access to drinking water

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Wellness expectation driven by Consumer Electronics industry

• Sound machine → Soundscape
• Voice assistance and smart home hub → Building Automation System
• Motorized blinds → Façade automation
• Smart light bulb → Daylight and circadian lighting control
• Smart refrigerator → Smart vending machine
• Smart speakers/TV → AV over IP
• Fitness tracker → Wellness program
Key Building Technology Pilot Projects

IoT Desk: Integrated Sensing and Control with Open Source development

Acoustic Soundscape and Immersive Environment

Fitting for WELL and FitWel: Arup Boston and SF offices
Internet of Things Desk

Why
WELL/Fitwell compatible sensing
Low power/DC compatible
Interactive graphical user interface
Close the loop between design and operation Demonstrate IoT approach vs traditional integration

How
Off-the-shelf vendor-independent sensors
Open source controllers
Open source integration platform
In-house configuration and maintenance
## Internet of Things Desk – Wellness data source explore

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Landlord provided</th>
<th>Tenant Procured</th>
</tr>
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<tbody>
<tr>
<td>Air</td>
<td>Often no</td>
<td>Own sensor kit (PM, VOC, NO2)</td>
</tr>
<tr>
<td>Water</td>
<td>No</td>
<td>Drinking fountain data (future)</td>
</tr>
<tr>
<td>Nourishment</td>
<td>Smart ambient lighting controls</td>
<td>Food order and vending machine data (future)</td>
</tr>
<tr>
<td>Light</td>
<td>Programmable blinds with glare and sunlight control</td>
<td>Own sensor kit for ambient lighting color and illuminance level</td>
</tr>
<tr>
<td>Fitness</td>
<td>Office wellness classes / Stairs usage data (future)</td>
<td>Task light control</td>
</tr>
<tr>
<td>Comfort</td>
<td>Temp/RH on BMS or local display</td>
<td>Acoustic controllability</td>
</tr>
<tr>
<td>Mind</td>
<td>Personal schedule and location-based recommendation and navigation (future)</td>
<td>Thermal controllability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Own sensor kit for personal Temp/Mean Radiant Temp/RH/Acoustic monitoring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Occupant feedback (future)</td>
</tr>
</tbody>
</table>
Key IAQ monitoring parameters

For health:

1. **PM2.5 and PM10** – effectiveness of air filters

2. **Total Volatile Organic Compounds (TVOCs)** – in a new office: check ‘off-gassing’ or to check VOC content in cleaning products

3. **Nitrogen Dioxide** – to check if being drawn into building from street

For Comfort

4. **Dry Bulb Temperature** – for comparison with Building Management System

5. **Mean Radiant Temperature** – more closely models the temperature a human feels

6. **Relative Humidity**

7. **Carbon Dioxide** – to check if ventilation rates are sufficient
Sensor technology watch-its

- **PM2.5 and PM10** – optical sensor technology provides required accuracy

- **Volatile Organic Compounds (VOCs)** – MOS sensors not recommended. PID sensors better but more expensive – tuned to particular VOCs

- **Nitrogen Dioxide** – electrochemical sensors expensive, require regular calibration and exhibit drift

- **Dry Bulb Temperature, Mean Radiant Temperature and Relative Humidity** – mature sensor technology

- **Carbon Dioxide** – NDIR technology provides required accuracy

- It must be noted that not all sensors perform equally. Calibration against a known entity is required to have confidence in results

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<table>
<thead>
<tr>
<th>Tier</th>
<th>Application Area</th>
<th>Pollutants</th>
<th>Precision and Bias Error</th>
<th>Data Completeness</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Education and Information</td>
<td>All</td>
<td>&lt;50%</td>
<td>≥ 50%</td>
</tr>
<tr>
<td>II</td>
<td>Hotspot Identification and Characterization</td>
<td>All</td>
<td>&lt;30%</td>
<td>≥ 75%</td>
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<tr>
<td>III</td>
<td>Supplemental Monitoring</td>
<td>Criteria pollutants, Air Toxics (incl. VOCs)</td>
<td>&lt;20%</td>
<td>≥ 80%</td>
</tr>
<tr>
<td>IV</td>
<td>Personal Exposure</td>
<td>All</td>
<td>&lt;30%</td>
<td>≥ 80%</td>
</tr>
<tr>
<td>V</td>
<td>Regulatory Monitoring</td>
<td>O3 CO, SO2 NO2 PM2.5, PM10</td>
<td>&lt;7% &lt;10% &lt;15% &lt;10%</td>
<td>≥ 75%</td>
</tr>
</tbody>
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[https://www.epa.gov/air-sensor-toolbox](https://www.epa.gov/air-sensor-toolbox)
Soundscape and immersive experience

Personal choice of acoustic environments
- Sound level
- Sound content (music, nature sounds, white noise)

Considerations
- Privacy
- Concentration
- Relaxation
- Social

Technology
- Sound masking
- Soundscape
- Controlled reverberation
Boston office WELL Certified Gold

POE survey before and after shows:
• WELL certification aids office communication and staff engagement through a retrofit
• Circadian lighting improved Satisfaction and Comfort of the lighting environment to over 70%
• Standing desk reduces sitting time for 30% of staff
• Noise distraction 30% down
• Client visits up 60%

68% of staff said that their productivity is positively impacted by the office’s environmental conditions (comfort, lighting, air quality)
Boston office WELL Certified Gold

- **Active design and space planning**
- **End-of-pipe water filtration** on tap water
- **Dynamic ventilation** with air quality filtration optimization
- **Material selection** that promotes good indoor-air quality through the use of products proven not to emit harmful contaminants, and that disclose health and environmental impacts.
- **Circadian lighting** systems that automatically adjust color and brightness based on the position of the sun to replicate daylight.

WELL/FitWell in-door air quality sensing kit – Aura
Healthier vending options

Art integration

Flexible charrette spaces

Non-emitting and low-emitting materials

Expanded pantry, kitchen, and dining spaces
**Arup SF: WELL/FitWel Lessons Learned**

**Materials:** selecting inherently non-emitting materials simplifies VOC precondition compliance.

**Occupant surveys:** surveys are required for both FitWel and WELL.
- Commute survey [FitWel]
- Occupant satisfaction survey [WELL]
- Pre-fit out survey conducted; post-fit out survey to be conducted.

**Requirements as aspirations:** The requirements in both WELL and FitWel can be used to set reach goals to inform design, even if the required thresholds cannot be achieved.
Organizational approach

Wellness Agenda

Workplace Strategy

Understand business drivers

Assess current situation

Develop workplace brief

Develop workplace strategy

Post occupancy review

Integrated design & implementation

Workshop(s)/inter views to confirm key business objectives and benchmarking

Assess headcount, churn moves, growth
Workplace performance survey
Utilisation Study
Current ways of working
IT / KM review

Workplace Strategy
Aligns with Asset Strategy

Stakeholder, Communications and Change Management

Change Management Stakeholder engagement Communications

Brief and project manage space planners and design teams/deliver planning and design ‘Guardian’ of the brief

Training, Leadership coaching

Measure benefits (Post occupancy evaluation) Lessons learned

Workplace Pilot brief (incl targeted desk sharing ratio)
Space planning IT and KM strategy, KPIs

Change and Stakeholder Management Plan

Lessons learned

Wellness Agenda
Health and wellbeing data landscape

- Medical record
- Health plan
- Off-the-shelf Wearables (sleep, heart, exercise)
- Smart appliances (diet)
- Outbreak exposure
- Lifestyle (employment, travel)
- EPA
- FM logs
- BMS logs
- City open data (Transport, Air quality, Access to green space, Noise)

General Wellness Data

Health History

Treatment history

Building environment data
Current opportunities

- Start monitoring
- Make data available
- Make building connected and controllable
- Address diversity of spaces
- Leverage wireless technology for flexibility
- Pilot, build and share

- Bring-your-own-device and feedback
- Stay tuned with open data
- Wellness coordinator
- Leverage insight from multi-source data
- Manage utilization of diverse spaces

Developer

Designer

Occupant

Operator