The Workplace App: Toward Continuous Office Space Improvement

Figure 1: Spatial and personal metrics in the context of office space present a multidisciplinary challenge. The metrics used to evaluate the design of the Autodesk office in Toronto are highlighted in blue.
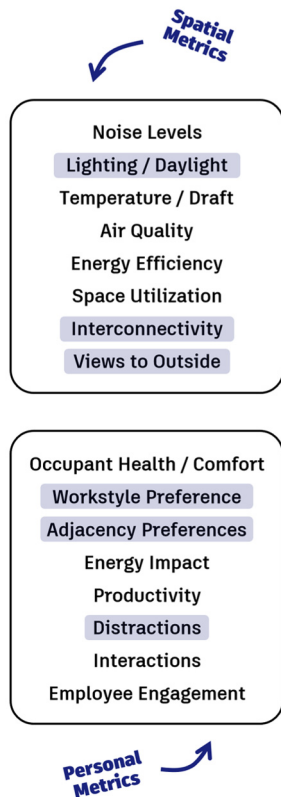
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Abstract

This paper describes a system to collect and integrate data on both building performance and occupant satisfaction in support of advanced design and evaluation tools for the continuous improvement of workplaces. A living lab approach which has involved the use of novel techniques for office layout and the deployment of a mobile app for gathering ongoing user feedback is presented.

Author Keywords

Generative design, building performance, wellness, occupant satisfaction continuous improvement, living labs.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

Introduction

The built environment influences human health, wellbeing, and behaviour through a complex and nuanced set of factors while, simultaneously, human behaviour has a profound influence on the performance of buildings. Both the study of cause and effect between buildings and their occupants, and the development of smarter tools for design and building

operations, require the integration of data from disparate sources [1].

We envision a system framework to collect quantitative and qualitative data on both building performance and occupant satisfaction in support of the continuous improvement of workplaces. Toward this goal, we are developing the Workplace App, a mobile app that enables data integration for the next generation of building design and operations tools which will learn from real world complexity and provide actionable insights to its users.

This paper introduces our approach to the design and operations of the Autodesk Toronto office as a living laboratory. The office layout was algorithmically optimized through a generative design approach using a combination of spatial simulations and occupant survey results. We are developing the Workplace App to engage with occupants in the building operations process by providing an interface to submit ongoing feedback. By bringing traditional data (e.g., organizational structure) together with data-driven design and methods for ongoing data collection, the Workplace App enables the continuous evaluation of building performance as it relates to occupant satisfaction and business needs. Lastly, having a data source that integrates qualitative and quantitative data, we strive to enable future cycles of office layout optimization to be based on the ever-changing reality of office life and occupant behaviour.

Generative Design

The generative design process is centered on the pairing of a design generator with a design evaluator. The generator creates a new design, based on rules

and systems that a design team devises, and the evaluator executes a formulation of goals and constraints (see Figure 2) to automatically evaluate how well a particular design satisfies the design intent criteria. It is important to note that the effectiveness of generative design tools for architectural projects is dependent on the quality and completeness of the data used in the evaluation of each design iteration (see Figure 3).
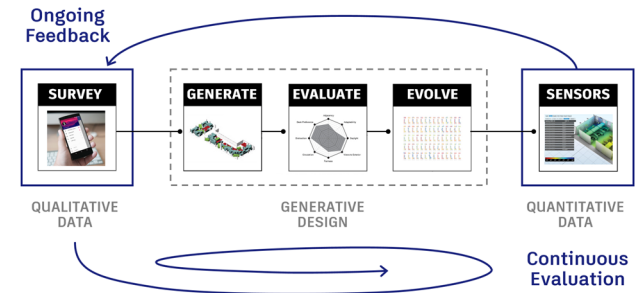
Figure 3: The generative design process can be extended, as a tool for continuous evaluation of building performance, by updating qualitative and quantitative data sets and re-running the process to create a new design that better matches current needs and conditions.

To bootstrap the process, it may be started with a static snapshot of the personal preferences of individual employees collected in a survey [2]. But in the post-occupancy phase of a building project, not only do teams change over time but an individual's preferences may evolve based on their immediate environment and active projects. The technology behind the generative design process is such that, with access to the right data, we can continually assess and learn from the performance of a space against its ever changing reality.
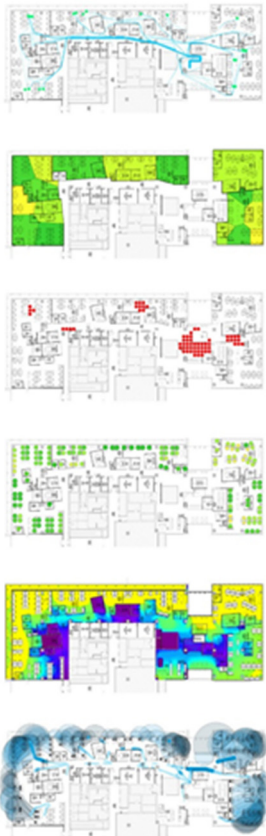
Figure 2: Six goals were developed to evaluate the generated layouts, a subset of which relied on preference data collected from occupants (top to bottom): adjacency, workstyle, interconnectivity, low visual distraction, daylight, and views to the outside.
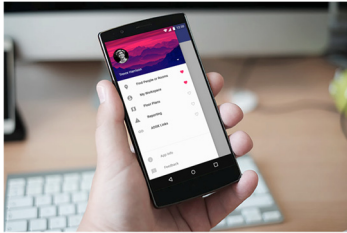
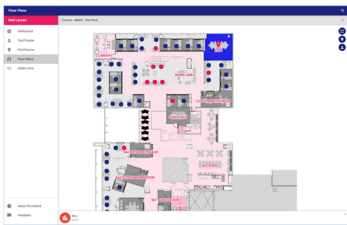**Figure 4**: The Workplace App runs on both mobile and desktop.

Figure 5: Searchable employee desk and room locations shown on the floorplan of the Autodesk office in Toronto.

Figure 6: Air quality data visualized in the context of the 3D model of the Autodesk office in Toronto.

We know every employee is a unique user when it comes to office space – we each have our nuanced habits and know our personal discomforts – so the question is, how do we gather this multifaceted data and begin to quantify it into useful metrics. As can be seen from Figure 1, this is a multidisciplinary challenge.

Workplace App

To learn from the variability of human experience we are building the Workplace App as an answer to the questions above. As an interactive tool for everyday office life the app will capture personal preferences (e.g., work style) and gather ongoing feedback on spatial performance (e.g. perceived comfort and levels of distraction) from individual employees.

The advantage of this approach is that the same data required to evaluate a workplace is also of value for the creation of new and useful tools for both individual occupants of the space and the facilities personnel who are tasked with managing it. In addition to collected data, we can leverage the 3D models, resulting from the design process, as a rich context for feedback on the space and for visualizations that benefit the user (Figure 6) [3]. With the goal of ensuring engagement with the system, the initial implementation of the app includes basic user orientation features such as interactive floor plans and search functionality for finding rooms and people (see Figure 4 and 5). Our goal is to provide individual occupants with a level of agency over their personal workplace experience while simultaneously gathering their input as a key factor that adds value to the Workplace system as a whole.

Workplace Graph
The Workplace Graph is a system that supports the continuous collection and integration of disparate data sources into a unified and up to date 'source of truth' that pertains to the ever-changing reality of office life.

In the context of our living lab in Toronto we are actively working to integrate data into the Workplace Graph from HR (e.g., organization structure), facilities (e.g., amenities, equipment), building management system and sensors (e.g., air quality, environmental conditions, spatial occupancy, lighting systems), building design (e.g., room sizes, solar exposure), and occupants (e.g., comfort levels, personal preferences, social interactions). Once integrated this data becomes available through an API and can be used for various purposes such as analyzing the interactions between occupants and their built environment or for new front end applications like the Workplace App (see Figure 7).

Several novel use cases could take advantage of the encoded knowledge and interlinked data in such a system. Examples include a smart room booking tool or a predictive HVAC control system that enables customizable conditions for individuals [4]. In the case of smart room booking, with the right data in the system (e.g. room locations, sizes, ratings, daylight levels, views, average temperatures, available equipment) the tool could suggest a room that best fits the attendees needs (e.g., number of attendees, their proximity, and personal preferences). This could be extended to include business needs such as the necessity to impress a client or keep content confidential.

Autodesk Toronto as a Living Lab

This past year, Autodesk relaunched its Toronto office in Canada's largest innovation hub, the MaRS Discovery District. The new space, a 60,000 square foot blank slate in a recently constructed tower, provided an opportunity to push the boundaries of design practice. We developed [5] and applied the generative design process to the project in an effort to realize an innovative workplace. The resulting office space is the first example of generatively designed architecture, meaning the interior layout was conceived by a computer algorithm. Because of this novel design approach, the office offers the perfect basis for further study as a living laboratory. We are looking at how real world data, paired with simulation tools and

optimization technology, can augment the performance of the built environment to the mutual benefit of occupants and business needs.

A Framework for Continuous Improvement

Our vision is a system for the continuous improvement of office layouts to support human wellness and productivity [6] while meeting business needs. With the existence of the Workplace App as described above, generative design tools provide an opportunity for both understanding and improving building performance on an ongoing basis through the regeneration, optimization, and simulation of office space configurations. We posit that the convergence of real world data with simulated data will enable a human centred approach to building design, operations, and management that would not be possible without a system where the various components can learn from each other.

As it stands today our generative design process considers access to daylight and alignment to work style preferences as indicators of occupant wellness but we endeavour to include more subjective factors in our continuous improvement framework. For instance, in the case of these subjective measures, the Workplace Graph will enable new tools that simultaneously gather data, learn from its complexity, and strive to make sense of the complexity in a multidisciplinary space.

Conclusion

We have presented the Workplace App and Workplace Graph as part of our vision to support the continuous improvement of building performance throughout their operational lifecycle. The purpose being to find ways to improve the health and wellbeing of occupants while
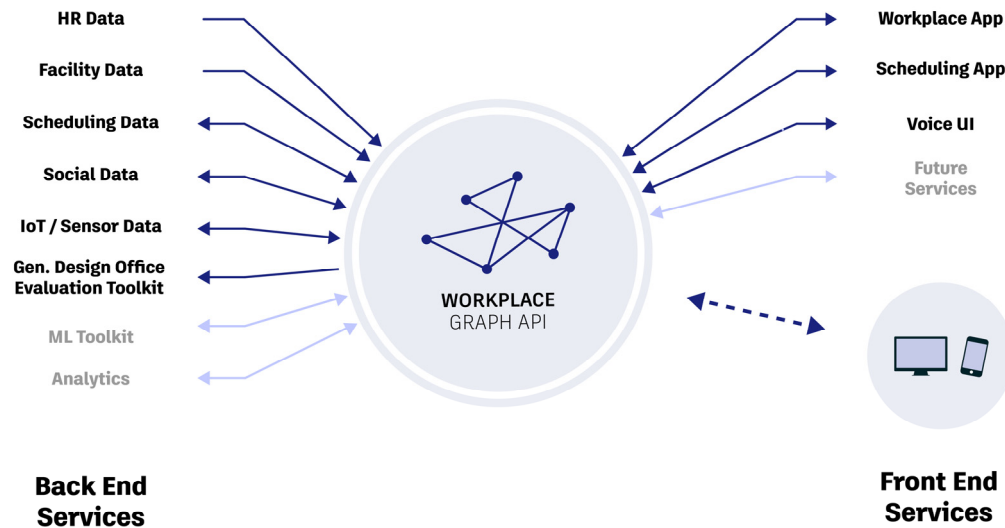

HR Data
Facility Data
Scheduling Data
Social Data
IoT / Sensor Data
Gen. Design Office Evaluation Toolkit
ML Toolkit
Analytics

WORKPLACE GRAPH API

Workplace App
Scheduling App
Voice UI
Future Services

Back End Services

Front End Services

Figure 7: The Workplace Graph combines back-end services so that multiple applications (front-end services) can easily expose the data elements appropriate to their function.

simultaneously supporting business needs via increased employee productivity. The app participates in a continuous generative design process to recommend improvements to the location of people and the overall layout of the office. Finally, we presented Autodesk's Toronto office as living lab for the development of new tools to meet our goals. Together, these components form a system that best leverages qualitative and quantitative inputs to support continuous improvement.

Acknowledgements

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