HAWORTH®

Enabling the Organic Workspace: Emerging Technologies that Focus on People, Not Just Space

Without an integrated feedback capability embedded in the workspace, sensing and adapting to changing employee needs is cumbersome. However, technology is evolving to meet this challenge. Haworth believes new technologies can make work better by helping people be their best, and soon we'll see employees drawn to the office in their search for increased well-being, engagement, and effectiveness. Why? Because their workspace responds to how they work best. Let's explore what that means…

Today's business climate is constantly changing.

The rate of change is increasing, and business success requires quick pivoting to ensure company resources are aligned with business needs. This kind of rapid workspace evolution requires systems that can easily adapt to allow employees to achieve their best work. However, the workspace itself is often static and inhibits quick adaptation.

Today, a certain amount of flexibility is provided through space planning guidelines linked with employment policies that, together, allow greater selection in where, how, and when to work. These Alternative Work Space (AWS) programs are the logical result of the fixed nature of our current office environments. In a way, these programs are a proxy for the better solution provided through an "Organic Workspace"[1] that provides easy spatial alteration in response to user needs.

But more can be done.

Emerging technology places us on the cusp of real-time optimization for both workspace and employee performance. Sensors embedded in the workspace will seamlessly gather an array of information in three domains:

- **Occupancy:** monitor and control the use of space.
- **Environmental:** monitor and control lighting, air, sound, enclosure, and furniture.
- **Personal:** monitor physical, emotional, and cognitive states of employees themselves and trigger appropriate environmental responses.

An expert system will use that information to autonomously adapt the space, regulate environmental systems, and inform employees and facilities managers of ways to achieve peak effectiveness for both the space and its occupants. These new capabilities, coupled with a people-centered approach to HR and IT policies, are converging to produce a more humanized work environment that maximizes benefits for both employees and organizations. But, how?

1 O'Neill, Bahr, Bridgman, Helstrand, and Kiss, 2014.

The promise of new technologies can be intoxicating. The Real Test: Does any new technology help people? It's tempting to be swept away by the latest gadget, but we need to ensure people come first. Haworth believes new technologies can make work better by helping people be their best—especially within the framework of Organic Workspaces®.

Responding to employee workspace needs requires feedback. Without a current integrated feedback capability embedded in the workspace, sensing and adapting to changing employee needs is cumbersome. However, technology is evolving to meet this challenge. Soon we'll see employees drawn to the office in their search for increased well-being, engagement, and effectiveness. Why? Because their workspace responds to how they work best.

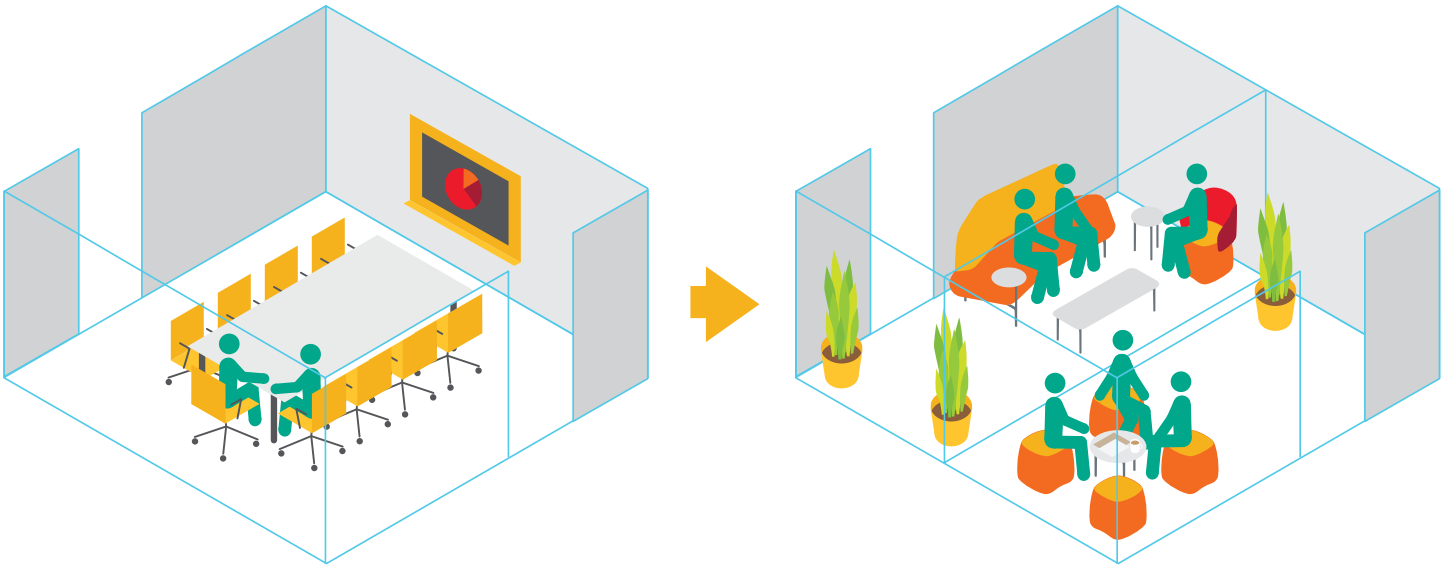
Occupancy Systems: The Basis for Accurate Reconfigurations

Successful organizations understand that office space should not be stagnant and unyielding to adaptation.[2] The first step to change is to understand how space is currently used.

Underutilized space may signal a problem such as poor room location, poor configuration, lack of amenities, or a variety of other design and environmental issues. It may also signal organizational issues about space ownership, workstyles, and employee habits. Beyond any reason why, poorly used spaces are a financial drain, and understanding which spaces have low occupancy allows consideration for new use and reconfiguration.

Gathering occupancy information has traditionally been a manual process. A staff member or a consultant physically visits each room at set time periods to record room utilization, if the room was used and how many people were present, and workpoint utilization (or station utilization), determining the use of specific areas within the room. Typically, the occupancy survey would last one to two weeks, charting each room several times per day. What this technique doesn't capture are after-hours, weekend, monthly, seasonal, or holiday work habits— leaving organizations with incomplete and misleading information about actual space use and employee patterns. Relying on incomplete information prompts changes in the work environment that may not be suitable.

Automated sensors can now replace the manual occupancy survey—continuously monitoring circulation areas, rooms, and workpoints—capturing space use at a finer level of detail that yields more accurate results and a richer understanding of activity within each space. This increased precision allows reconfiguration based on actual use statistics. This is the essence of the Organic Workspace: measure use, understand it, and make changes to increase the utility of the space, based on need.



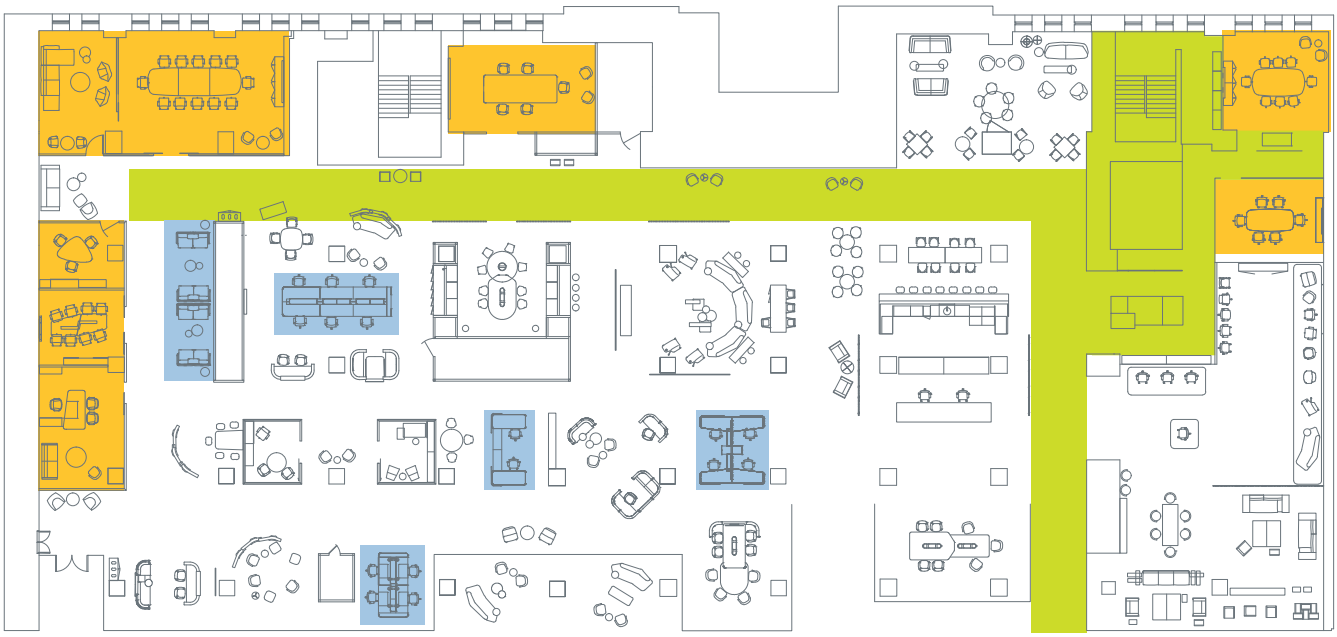
Identifying underutilized spaces presents an opportunity to transform the environment and bring new life to the space. A low occupancy conference room could be reconfigured into two smaller spaces for more relaxed, collaborative meetings.

The Challenge:

Employees may believe occupancy monitoring is yet another way for supervisors to track their employees. That level of tracking is possible with certain technologies, but is not a requirement for the scenarios presented in this paper. It may be useful for companies deploying these systems to clearly communicate the scope of the system and what is being tracked.

2 O'Neill et al., 2014

Continuous occupancy monitoring is useful for answering questions about use at a number of locations:



Circulation Areas

How do people move through the building? How does movement differ depending on time of day? Are there bottlenecks? Or empty areas? Understanding the flow of people through circulation spaces during the daily cycle of arrivals and departures is essential to understanding how to provide the highest and best use of these public spaces. Perhaps additional queuing space is needed in front of an information desk or an elevator, or space that is underutilized most of the day but vital for a specific time can serve multiple purposes. Completely unused spaces can be converted for other uses such as customer or employee services, or revenue generating space such as a banking kiosk or refreshment stand. Continuous occupancy monitoring reveals these patterns, exposing opportunities to tweak circulation spaces to maximize their value to the organization.

Rooms

How often do people meet in a particular room? Has a large conference room turned into an ad hoc office for a single person? Is a room empty even though it was reserved? Continuous room occupancy monitoring provides real-time information about room use as well as insights about long-term cycles. It is common to discover that a large conference room is often occupied, but by only two or three people. The space is underutilized and suggests that employees have other needs that may be easily addressed to maximize space, either through a change management program or a simple reconfiguration of the space. Organizations concerned with their real estate costs are already studying room occupancy trends. Perhaps most immediately useful to users, room occupancy sensors can indicate if a room is available regardless of what a room reservation system may report.

Workpoints

Are four people routinely meeting in a room designed to accommodate twenty? Where are people working in a given space? Is the whiteboard ever actually used? And, is Deborah at her assigned desk? Workpoint monitoring provides specific information about the frequency of use of specific locations within a space and offers insight into whether the space is "right sized" to the need. It provides the basis for further discussion about better ways to use the space. Perhaps several smaller focus rooms would be useful instead of a large meeting room; or, maybe the space could be converted to available workspaces for unassigned or travelling workers; or, even more simply, maybe there is not enough whiteboard space. Lastly, as workers become more agile, knowing someone is sitting on the other side of the office in Deborah's assigned workpoint could be useful for trying to find Deborah.

Occupancy monitoring systems will continue to improve, becoming more accurate and easier to deploy as sensor technologies evolve. Not only will they be able to report simple "yes / no" for occupancy but systems will soon be available that will report the number of occupants and the activity level of each. Having this information will not only support Organic Space—allowing companies to maximize the use of their spaces and make informed decisions about reconfigurations—but also help workers find the spaces and people they need for their work.

Environmental Monitoring and Control Systems: Intelligent Adaptation

Most of us are aware of the traditional building sensors that open doors, turn on room lighting, or enable HVAC when you enter a room. HVAC, lighting, and security companies developed these monitoring systems that play a major role in reducing building energy use. However, these sensors are not perfect. If you sit still and quietly for too long these sensors may lose track of you and plunge you into darkness and stale air. Traditionally, each of these sensors has operated in isolation; the lights turn on when the occupancy sensor triggers or air flows when the thermostat notices a drift in temperature. An important evolution for these systems will occur when all the sensor data is routinely combined and evaluated more completely, to intelligently react to occupant needs.

Basic integration has been available since the early 2000's, allowing for lighting and HVAC systems to share occupancy sensors. More recently, smart building designers and the developers of advanced Building Automation Systems (BAS)/Building Management Systems (BMS) have started to experiment with digital controls that not only monitor the sensors of companion systems but also allow limited processing to better understand the activities within a space. Unfortunately, we are not quite there yet. For the majority of buildings with intelligent BAS/BMS you may still unintentionally "fool" the system if you open a door or window and the HVAC system may happily attempt to continue maintaining room temperature. Or, oftentimes, an occupancy sensor turns on lighting when someone merely walks by an office with an open door. Both of these situations can be resolved when the systems know more about the human activities occurring within the space.

New advances in environmental monitoring focus on sensors that provide more insight of the human use of the space. Light intensity and spectrum[3], sound amplitude and direction, air quality[4], odor, and occupant location and activity may soon all be integrated to provide the more detailed information necessary for the environmental systems to react to actual user needs.

For instance, the system may monitor a meeting and determine that most people have been sitting for twenty minutes with little major posture change, or if there has been a single dominant speaker for the past ten minutes, or that the level of carbon dioxide has exceeded a threshold. Facial muscle strain and skin temperature can be evaluated to confirm participants' attention is waning. In response, the system may adjust light intensity and color, slightly lowering the temperature, increasing airflow, and it may even add specific scents to the air in an attempt to bring the occupants back to a state of attention.[5]

This could occur with systems already available in the market. What is missing? Fully integrating these systems into a master system with a sufficiently intelligent controller could reduce energy use and increase employee effectiveness.

It won't be long until we have modular systems that allow a range of sensors to be plugged into tracks on walls, ceilings, or even furniture partitions. Monitored by smart systems, this data will build better awareness of the true activities occurring in the space so the systems can respond intelligently.

The Challenge:

True integration will not occur until the industries agree upon a common method for devices to communicate with each other. There have been several false starts, with different factions vying for control. Until there is agreement between manufacturers we may remain with devices unable to contribute to the ultimate success of the working environment.

3 Chellappa et al., 2011. Elliot, Maier, Moller, Friedman, and Meinhardt, 2007. Elliot and Maier, 2007. Knez and Enmarker, 1998. Mills, Tomkins, and Schlangen, 2007.

4 Satish et al., 2012.

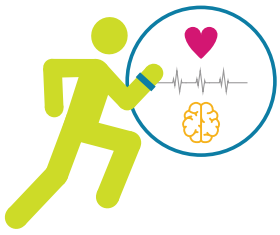
5 Chellappa et al., 2011. Fenko and Loock, 2014. Grafsgaard, Boyer, Wiebe, and Lester, 2012. Knez and Enmarker, 1998. Satish et al., 2012.

Personal Systems: Optimizing for Employee Effectiveness

How many steps did you walk this morning? What's your afternoon resting heart rate? Consumer wearable technology is fueling interest and discussion about personal "biometrics." What if these same wearable devices could share information with systems that respond, real-time, to the individual needs of each person? This path is the natural evolution for the industry, which has focused on monitoring and controlling space to lower operating costs. In the best situation, the systems attempt to manage the environmental conditions through assumed rules about human comfort which, ironically, are constructed so that 20 percent of occupants are uncomfortable.[6] We are humans, not statistical anomalies. The past focus of space and building management has missed the greatest opportunity of all: to directly monitor the needs of the occupants, not just the function of the space.

The Power of Personal Tracking

Hardly noticeable five years ago, the number of health tracking devices has exploded. It is now possible, and very simple, to continuously track your heart rate, body temperature, perspiration, and movement using any number of affordable devices.

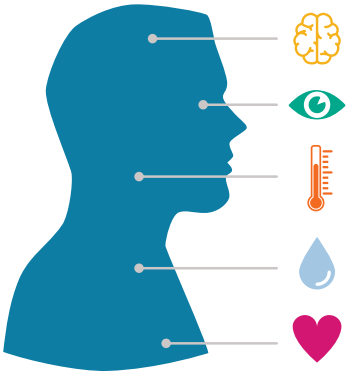


The market for consumer wearables has spawned the "quantified self" and "life logging" movements intended to improve self-knowledge through metrics and self-tracking.

We now have medical grade wearable systems that monitor EEG (brain activity), EKG (heart activity), glucose level, blood oxygen levels, and other biometrics. This explosion fueled e-health initiatives and the sharing of data between devices and health service organizations. The abilities of these systems are transforming the personal health industry and may even contribute to fundamental health research.[7] Although other medical and research systems are currently available only through medical intervention or within research laboratories, it is only a matter of time until they enter the consumer market. What does this mean for the workplace?

Personal Monitoring for Effective Working Conditions

Together, these personal health tracking devices and occupancy and environment systems may provide the insight necessary to understand the physical, emotional, and cognitive issues that impact us in all we do—modifying the work environment to help achieve and maintain effective working conditions. In addition to personal tracking devices, there already are less known imaging systems available that monitor nonverbal behaviors: measuring body posture, movement, eye tracking, facial expression, and even facial temperature. All of which could be used to identify activity, emotion, and concentration.[8] There is also strong evidence connecting biometrics such as heart rate, perspiration, temperature, gaze, and EEG (to name just a few) with task difficulty and stress and, thus, the impact on cognitive functions.[9] Instead of assuming a "standard range" for the human condition, the system can set a baseline for each user and directly measure change in the physical metrics known to correlate to certain states.



Sensors may monitor heart rate, gaze direction, facial temperature, skin moisture, skin temperature, and brain waves to gauge if the user is focused on intense work, is recharging, or is frustrated.

Once identified, the system may change the environmental conditions and the physical state of the furniture to either support the continuation of desired behavior or nudge the user into a useful mental state or behavior.

What is missing? Why isn't this happening now?

We need the real-time system that uses all of the sensor information to diagnose the human activity and make the environmental changes necessary to enhance activities within the space. We also need further research to quantify the connections between human performance and environmental factors. It is only a matter of time until we fully correlate the metrics of space and the metrics of the human condition. Research and policy makers must also address data and personal identity issues to ensure privacy and dignity for all occupants. Once done, we will be able to fully develop the work environment that reacts in response to occupant needs.

The Challenge:

This type of information is extremely personal and access to the information is regulated by a variety of laws. Voluntary self enrollment by an employee to share this information may not be sufficient to allow its use in some countries. The security of this information, and ethics of use, will be resolved as personal use of these devices grows.

6 ASHRAE TECHNICAL COMMITTEE 2.1 and ASHRAE STANDARDS COMMITTEE 2009-2010, 2010.

7 Boulos, Wheeler, Tavares, and Jones, 2011. Collins, 2015.

8 Bao, Gowda, Mahajan, and Choudhury, n.d. Grafsgaard et al., 2012. Gunes and Pantic, 2010. Heritage, 2014. Nicolaou, 2009.

9 Fritz, Begel, Müller, Yigit-Elliott, and Züger, 2014.

Design Guidelines: Future Ready for Advancing Technology

Deploying each of the current systems individually has benefits. Together, sharing data and capabilities, they hold the promise of organically optimizing the workspace to increase benefits for the organization and its employees in cost effectiveness, employee engagement, and well-being.

Effectiveness of these systems depends on full integration into the building. Although these systems are rapidly evolving and we do not know the specifics of what may be available in the market, we still can prepare for change and help future-proof spaces. Considering person-centered organizational needs, designers can take a holistic approach and prepare.

1. **Research systems** prior to design to ensure full integration with design intent, then **evaluate the technology** to ensure it truly solves user issues, or leverages other technologies you've already invested in. Don't chase new technology: Chase the desired results.
2. **Maximize free span** to provide for flexible enclosure and partition systems.
3. **Design for raised access flooring and underfloor air** with an 18-inch depth to allow flexibility in distribution of HVAC, electrical, and data systems, and to avoid duct runs that may impede reconfiguration.
4. **Design data systems** to maximize bandwidth, provide many access locations, and minimize interference of the working bands for WI-FI, NFC, RFID, and Bluetooth.
5. **Design flexibly distributed power systems**, such as modular wiring with expansion capacity.

Our Future is Nearly Here

These ideas may sound like science fiction. They are not. Some of the components are available now, and others will soon emerge from the lab. Forward-thinking companies are considering how to embed these sensors into the work environment and integrate the systems. Once done, all of the systems will work in harmony to imbue the environment with the ability to respond to, and support the needs of the occupants in a natural and organic way. Our ability to harness these systems and enable increased effectiveness is just around the corner.

Contributors

Mike Bahr is an architect who has specialized in leading client engagement and design management for 25+ years. As a Haworth Senior Research Specialist based in the US, Mike leads research programs to help clarify the impact space has on people, and vice versa, to help clients produce high performance spaces.

Dr. Mike O'Neill holds a B.A. in psychology, an M. Arch, and Ph.D. in Architecture. With 20+ years in the industry, Dr. Mike is based in the US as Haworth's Senior Research Strategist, leading the research group. This group takes a broad global perspective to identify future trends and create research that offers practical insights for workspace strategy, planning, and products.

Beck Johnson holds a B.S. in Scientific and Technical Communication and an M.A. in Communication. With 14 years of experience in social science research methodologies and as a Research Specialist at Haworth she conducts primary and secondary research addressing workplace issues.

Iolanda Meehan is Haworth's Head of Business Unit Services for Asia Pacific, the Middle East and Africa. She is responsible for new business development, marketing, and B2B and B2C strategy across multi-cultural environments.

Dr. Gabor Nagy holds a Ph.D. in Engineering with an emphasis on workplace performance. As Haworth's Ideation Manager in San Francisco, he is responsible for applied research on corporate culture, workstyle, and workplace performance, and provides consulting services to clients.

References

ASHRAE TECHNICAL COMMITTEE 2.1, P. A. H. E., & ASHRAE STANDARDS COMMITTEE 2009-2010. ANSI/ASHRAE Standard 55-2010, Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigeration, and Air-Conditioning Engineers, 2010.

Bao, X., Gowda, M., Mahajan, R., & Choudhury, R. R. (n.d.). The Case for Psychological Computing.

Boulos, M. N. K., Wheeler, S., Tavares, C., & Jones, R. How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX. *Biomedical Engineering Online, 10,* (2011): 24. doi:10.1186/1475-925X-10-24

Chellappa, S. L., Steiner, R., Blattner, P., Oelhafen, P., Götz, T., & Cajochen, C. Non-visual effects of light on melatonin, alertness and cognitive performance: Can blue-enriched light keep us alert? *PLoS ONE, 6,* (2011) (1).

Collins, C. Leader in Clinical Research Tech Reacts to Apple's #ResearchKit | Open Health News. (2015) Accessed June 1, 2015, from http://www.openhealthnews.com/story/2015-03-16/leader-clinical-research-tech-reacts-apples-researchkit

Elliot, A. J., & Maier, M. A. Color and psychological functioning. *Current Directions in Psychological Science, 16,* (2007): 250–254. doi:10.1111/j.1467-8721.2007.00514.x

Elliot, A. J., Maier, M. A., Moller, A. C., Friedman, R., & Meinhardt, J. Color and psychological functioning: the effect of red on performance attainment. *Journal of Experimental Psychology. General, 136*(1), (2007): 154–168.

Fenko, A., & Loock, C. The influence of ambient scent and music on patients' anxiety in a waiting room of a plastic surgeon. *Health Environments Research and Design Journal, 7*(3), (2014): 38–59. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84898774839&partnerID=tZOtx3y1.

Fritz, T., Begel, A., Müller, S. C., Yigit-Elliott, S., & Züger, M. Using Psycho-physiological Measures to Assess Task Difficulty in Software Development. *Proceedings of the 36th International Conference on Software Engineering,* (2014): 402–413. doi:10.1145/2568225.2568266.

Grafsgaard, J. F., Boyer, K. E., Wiebe, E. N., & Lester, J. C. Analyzing Posture and Affect in Task-Oriented Tutoring. *Proceedings of the Twenty-Fifth International Florida Artificial Intelligence Research Society Conference,* (2012): 438–443.

Gunes, H., & Pantic, M. Automatic, Dimensional and Continuous Emotion Recognition. *International Journal of Synthetic Emotions, 1*(1), (2010): 68–99. doi:10.4018/jse.2010101605.

Heritage, J. A Hidden Markov Model Approach to Distinguishing Between Non-Prototypical Displays of Boredom and Interest, 2013–2014, 2014.

Knez, I., & Enmarker, I. Effects of Office Lighting on Mood and Cognitive Performance And A Gender Effect in Work-xRelated Judgment. *Environment and Behavior,* 1998.

Mills, P. R., Tomkins, S. C., & Schlangen, L. J. M. The effect of high correlated colour temperature office lighting on employee wellbeing and work performance. *Journal of Circadian Rhythms, 5,* (2007): 2.

Nicolaou, M. A., Imperial College London Department of Computing Discrete & Continuous Audio-Visual Recognition of Spontaneous Emotions by, (September), 2009.

O'Neill, D. M., Bahr, M., Bridgman, M., Helstrand, K., & Kiss, S. *Organic Spaces: The New Platform for Business Transformation.* Haworth white paper. Retrieved from http://www.haworth.com/docs/default-source/white-papers/organic-spaces-the-new-platform-for-business-transformation.pdf?sfvrsn=4, 2014.

Satish, U., Mendell, M. J., Shekhar, K., Hotchi, T., Sullivan, D., Streufert, S., & Fisk, W. J. Is CO2 an indoor pollutant? Direct effects of low-to-moderate CO2 concentrations on human decision-making performance. *Environmental Health Perspectives, 120*(12), (2012): 1671–1677.

Haworth research investigates links between workspace design and human behavior, health and performance, and the quality of the user experience. We share and apply what we learn to inform product development and help our customers shape their work environments. To learn more about this topic or other research resources Haworth can provide, visit www.haworth.com.