

# Using Embedded Technology Badges to Derive Social Networks, Patterns of Interaction and Space Utilization in a Corporate Headquarters

Jay L. Brand<sup>1</sup>, Gabor Nagy<sup>2</sup>, and Haijie Ding<sup>3</sup>

<sup>1</sup>Ideation Group, Haworth, Holland, MI, USA

Jay.Brand@ideationgroup.org

<sup>2</sup>Ideation Group, Haworth, San Francisco, CA, USA

<sup>3</sup>Reya Group, Shanghai, China

**Abstract.** Badges developed by Hitachi High Technologies (Hitachi calls this process “Business Microscope”) were used to gather interaction data, and sensors stationed in monitored locations recorded space occupancy-utilization from 25 meeting areas and 86 individual workstations in the global headquarters of a large manufacturing firm in the upper Midwest, USA. One hundred thirteen participants in 19 work groups/departments wore individual badges throughout seven work days. Social networks were derived from the interaction data (based on three-minutes cumulative interaction per day). This objective approach to deriving empirical networks and space utilization improves on many existing techniques that rely on inconsistent observation, subjective surveys, individual or group reconstructions (e.g., focus groups).

**Keywords:** Social networks, social network analysis, space utilization, interaction patterns.

## 1 Introduction

Academics, consultants and business leaders have long sought objective methods to rationalize investments in office workspace due to occupants’ overestimates of the time they spend in the office and in specific locations [1], [2]. In addition, these constituencies have become interested in measuring important aspects of knowledge worker productivity [3]. In this regard, some investigators have begun to accept social network analysis as a proxy measure of at least some pertinent aspects of work group performance and organizational effectiveness [4]. However, measurement approaches that meet all the rigorous criteria for experimental control, reliability & validity required for academic research are rare in applied work; at the same time, applied research methods often rely on subjective measures that fail to predict future behavior and thus do not provide adequate business intelligence for decision makers [5].

## 2 Method

In an effort to explore these issues and address some associated methodological limitations, Haworth's Ideation group partnered with Hitachi High Technologies, a Hitachi company that developed an applied measurement system called "Business Microscope" to conduct this research. This study used their approach to empirically derive social networks from patterns of interaction and space utilization within 19 work groups/departments over a 10-day period (seven business days). Participants wore individual badges (called "nodes," featuring infrared senders/receivers, accelerometers) around their necks while in the office throughout the study period (see Figure 1); these nodes were returned to a "base station" each night for downloading data and re-charging (see Figure 2). Twenty-five meeting areas and 86 individual workstations were monitored via sensors (called "beacons") placed in each (see Figure 3). These areas were selected (convenience sample) to represent all three floors in the headquarters of a large manufacturing firm in the upper Midwest, USA (see Figures 4-6). Each individual node and area sensor sampled interaction/use data every 1.5 seconds. From these data, the presence of participants (for objective space utilization) and the nature of their interactions (with a cumulative minimum of three minutes a day, along with identifying "speaker" & "listener") were derived using Hitachi's proprietary software (based on previous studies of 119 companies in Japan).



**Fig. 1.** Participant wearing a badge ("node")

These methods yielded empirical social networks that reflected the frequency and timing of interactions among participants during the seven business days of measurement (see Figure 7). Formal, enterprise-relevant collaboration could not be disentangled from Informal (merely social) communication, yet certain levels of social interaction may facilitate collaboration by influencing trust and other important mediating factors linking workplace strategy to pertinent business

outcomes [6], [7], [8]. In addition, these measures gave precise estimates of space utilization across the 25 meetings areas and 86 individual workstations monitored (see Figures 8-10). These data could be used to rationalize future office floor-plate or real estate strategies.



**Fig. 2.** Depiction of “base station” for “node” storage & data download



**Fig. 3.** Illustration of a sensor (“beacon”) in a meeting area

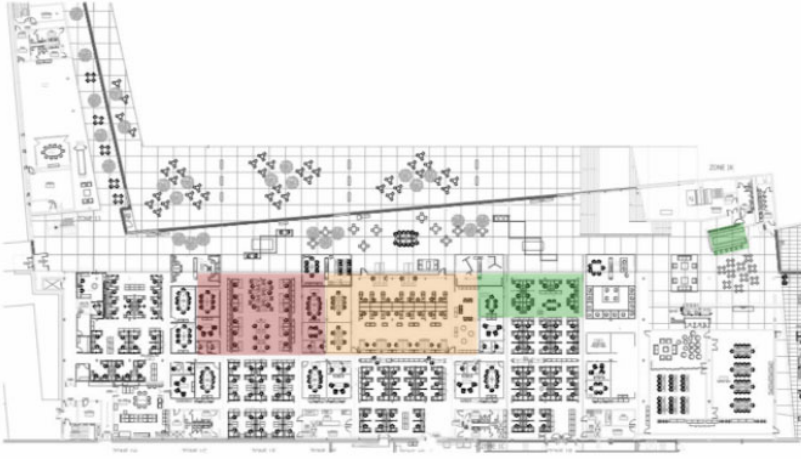


Fig. 4. Areas of the floor-plan monitored/sampled on the first floor

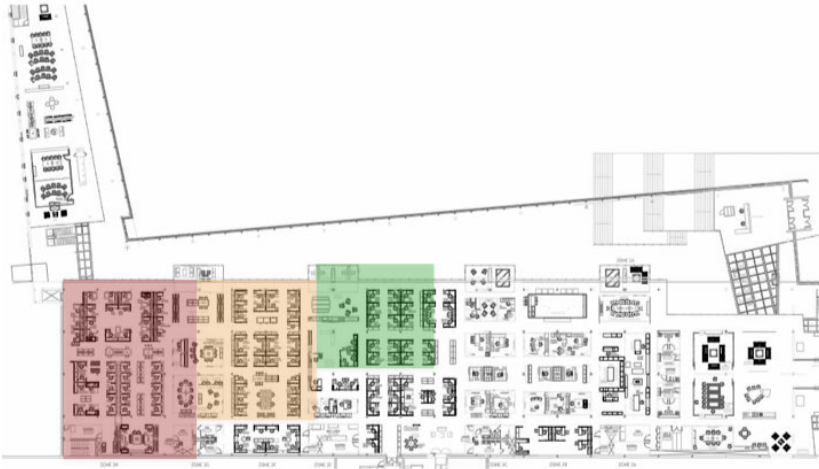


Fig. 5. Areas monitored /sampled on the second floor

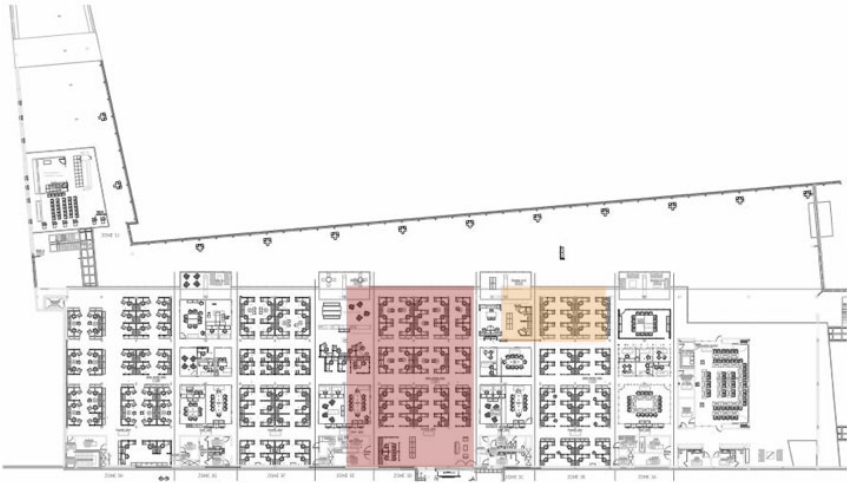


Fig. 6. Areas monitored / sampled on the third floor

Social Network Analysis by Participating Depts by Floors / 3 mins

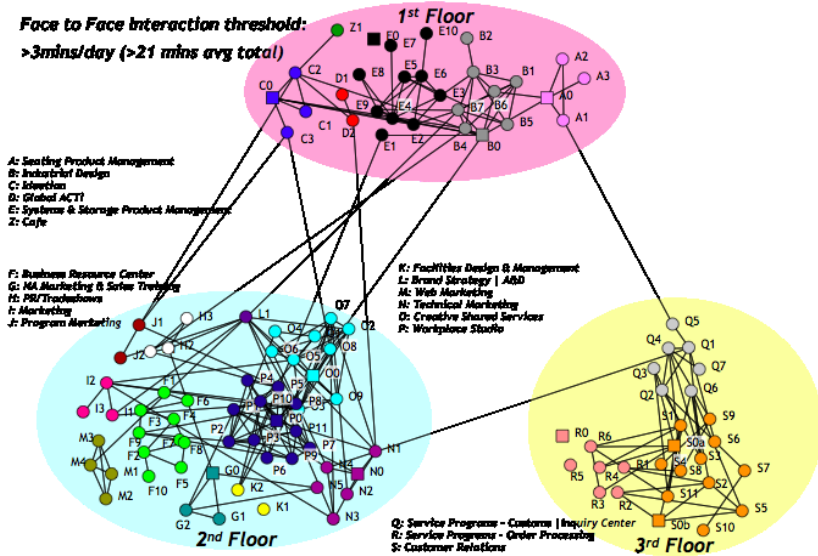


Fig. 7. Illustration of social networks within and among the three floors of the headquarters building

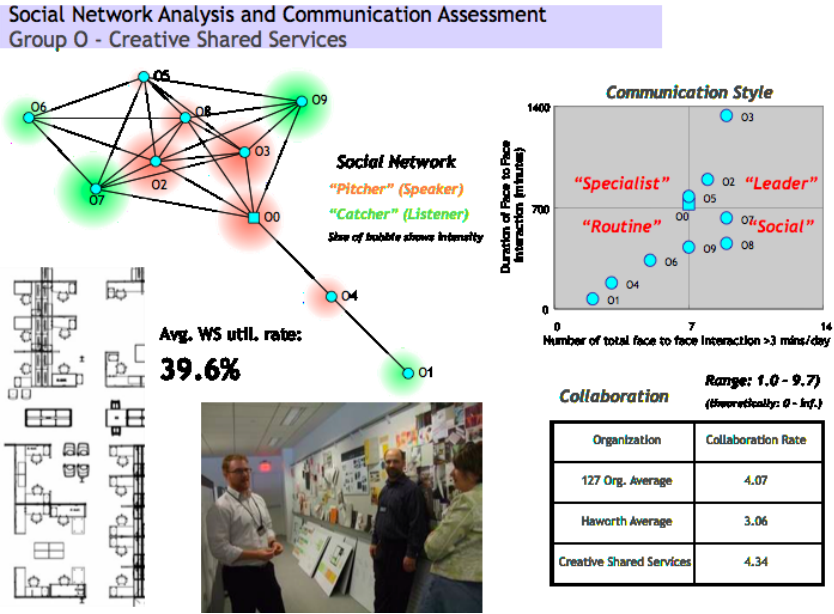


Fig. 8. Illustration of social network and space utilization within one work group

**MEETING AREA UTILIZATION**  
**Zone 1D-W**

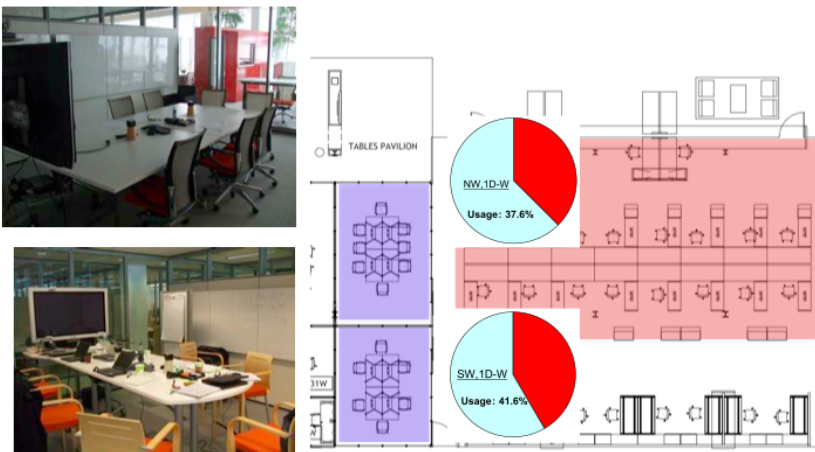
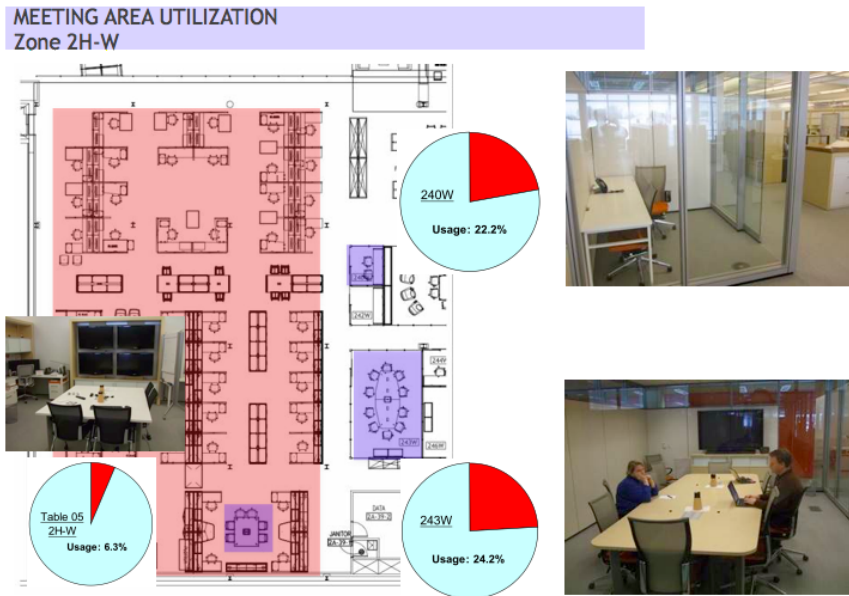


Fig. 9. Illustration of space utilization rates for two group meeting areas



**Fig. 10.** Illustration of space utilization rates for shared meeting spaces

### 3 Conclusion

This exploratory/feasibility study demonstrated the usefulness of Hitachi High Technologies' "Business Microscope" for evaluating face-to-face social networks and documenting objective space utilization within the office environments of large organizations in the United States. Although certain features of their data analyses (e.g., determining "speakers" and "listeners" for particular interactions) may be culture-specific, following further data collection in more companies outside of Japan, the relevant algorithms could be adjusted so that their output indeed reflects these behaviors. This technology could be used to evaluate the impact of a number of independent variables relevant to workplace strategy and design. Techniques that provide decision makers with predictive business intelligence are certainly needed; Hitachi's "Business Microscope" represents real progress in this salient area of applied research.

**Acknowledgements.** The authors would like to thank the following individuals from Hitachi High Technologies for their assistance: Yutaka Tochihara, Akinobu Miyazaki, Norihiko Moriwaki, Yasunori Wakatsuki & two data analysts; and Jackie Neerken, Workplace Studio, Haworth.

### References

1. Brill, M., Margulis, S., Konar, E.: BOSTI: Using office design to increase productivity. In: Workplace Design and Productivity, Inc. in association with Westinghouse Furniture Systems, Buffalo, vol. 1&2, pp. 1984–1985.

2. Kupritz, V.W.: The dynamics of privacy regulation: A conceptual model for HRD and organizations. *J. Ind. Teach. Ed.* 38, 29–59 (2000)
3. Thompson, L.: Improving the creativity of organizational work groups. *Acad. Manag. Exec.* 17, 96–109 (2003)
4. Cross, R., Parker, A., Prusak, L., Borgatti, S.P.: Knowing what we know: Supporting knowledge creation and sharing in social networks. *Org. Dynam.* 30, 100–120 (2001)
5. Brand, J.L.: Office ergonomics: A review of pertinent research and recent developments. In: Carswell, C.M. (ed.) *Reviews of Human Factors and Ergonomics*, vol. 4, pp. 245–282. Human Factors and Ergonomics Society, Santa Monica (2008)
6. Lee, S.Y., Brand, J.L.: Effects of control over office workspace on perceptions of the work environment and work outcomes. *J. Env. Psych.* 25, 323–333 (2005)
7. Lee, S.Y., Brand, J.L.: Can personal control over the physical environment ease distractions in office workplaces? *Ergn.* 53, 324–335 (2010)
8. Newsham, G.R., Brand, J.L., Donnelly, C.L., Veitch, J.A., Aries, M.B.C., Charles, K.E.: Linking indoor environment conditions to job satisfaction: A field study. *Build. Res. Inf.* 37, 129–147 (2009)