Guerilla Ergonomics: Perceiving the Affordances for Workplace Design

Lin Ye, Milena Petrovic, Marvin J. Dainoff, and Leonard S. Mark

Department of Psychology and Center for Ergonomic Research Miami University, Oxford, OH 45056 USA
yel@muohio.edu, markls@muohio.edu

Abstract. A successful ergonomic intervention involves creating affordances that support safe, effective, productive and comfortable working conditions. Guerilla ergonomics entails creating the requisite affordances using objects that are readily available in the workplace. This often means using objects in ways not intended in their original design. As such this has the advantage of creating viable working conditions quickly and cheaply. Workers learn how to adapt quickly to new problems or changes in the work environment. Our research has shown that the perception of the affordance for an object's intended use can interfere with a person's ability to see other uses for the object. Practice in perceiving new uses for objects as well as compiling a directory of possible solutions may help overcome these limitations.

Keywords: Affordance; workplace ergonomics; ergonomic intervention.

1 Introduction

The need for ergonomic interventions has increased over the course of the past century as a consequence of the mechanization of work in factories and in the modern office as a result of the introduction of computers. Merlie and Paoli [1] reported that the workers in the EU have back pain nearly one-third of the working time and neck/shoulder pain almost one fourth of the working time based on 1000 workers studied in each country of the EU [also 2]. Dainoff [3], Spilling, Eirtheim, and Aaras [4] and Westgaard and Aaras [5] have documented the positive effects of improved workplace design on worker productivity, health and safety. Together, these studies and many others point not only to the need for ergonomic interventions, but also their cost effectiveness, especially when the costs associated with job turnover, missed work and health costs are taken into account.

1.1 Ergonomic Interventions Create Affordances

How do ergonomic interventions improve work environments? Ergonomic interventions create what James Gibson [6] referred to as *affordances*, properties of the work environment that support the ongoing work activities. In creating affordances, ergonomic interventions produce safe, effective, healthy and comfortable

M.J. Dainoff (Ed.): Ergonomics and Health Aspects, HCII 2007, LNCS 4566, pp. 163–168, 2007.

working conditions. One design challenge is to make the affordances visible to prospective workers so that they will take advantage of these possibilities for safe and effective work.

There are two properties of affordances with which we are concerned: First, according to Gibson [6], affordances entail a relationship between a worker and relevant properties of the environment needed to support the action for that worker. Gibson [6] states that, "the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or for ill," and further notes that affordances "have to be measured relative to the animal." Affordances constitute opportunities for action and depend on the actor's body scale and action capabilities. As such, affordances describe the *fit* between a particular aspect of the environment and the actor's capabilities. For example, a chair that is designed for an adult will not afford the same sitting action for a year old child; on the other hand, an infant car seat will not afford sitting for an adult.

Second, affordances exist independently of whether they are actually perceived [6] [7]. Whether an affordance is perceived depends on whether there is information about the affordance for the prospective actor, whether the prospective actor detects that information or has need for the affordance in the course of carrying out a goal-directed activity. That need and the intention to act on that need should, *ideally*, increase the likelihood the user will actually perceive the affordance. To reiterate the point of this section, the goal of an ergonomic intervention is to construct affordances for safe, comfortable and productive work. .

1.2 What Affordances Are Needed to Perform the Work to Be Done?

The requirements for a given workplace are determined by the work to be done [8]. It is here that ergonomists rely on task analysis [9] or work analysis [10] in order to establish the types of activities that the workplace must afford. Toward this aim, ergonomic standards, such as BRS/HFES 100: *Human Factors Engineering of Computer Workstations*; *Department of Defense Handbook for Human Engineering Design Guidelines*, offer statements of current *best practices*—postures, actions and work conditions that must be afforded by the workplace. The end result of the ergonomist's analysis may be conceptualized as a set of affordances that must be created in the workplace to support the work to be done. In the modern office, these include affordances for sitting, reaching, seeing, interacting with computers; factory work adds a variety of affordances related to lifting, and other actions being performed on objects. A further challenge is for ergonomists to integrate the various affordances into a coherent design so that the requirements of individual affordances do not conflict with one another.

Toward these aims, ergonomists and facility managers frequently recommend purchase of expensive ergonomic furniture, chairs, workstations, computer peripherals and other accessories that can be quite expensive, costing several thousand dollars per workstation. Weeks and months may pass while the equipment is being ordered, delivered an installed. But what does an ergonomist do when faced with an immediate problem of workers suffering from musculoskeletal disorders? Waiting several weeks or months may be necessary to obtain the best equipment, but what happens to the worker until the equipment arrives? More importantly, many

organizations cannot afford expensive ergonomic chairs and workstations. Dainoff and Dainoff [11] provide an answer in the form of an ergonomic intervention they refer to as *guerilla ergonomics*.

2 Guerilla Ergonomics: Creating Affordances in the Workplace

2.1 A Case Study

Recently, one of us consulted with a local family resource center, where the director had symptoms of musculoskeletal problems, including neck, wrist, shoulder and back pain. She was working in a makeshift office, sitting for long periods of time in an old nonadjustable chair, while talking on the phone, working on a computer placed on a file cabinet, or interviewing visitors needing assistance. The agency operated with a very limited budget for non-family assistance items and thus state-of-the art ergonomic workstations and chairs were simply not an option. The challenge was to improve her working conditions so that she could continue her work comfortably, in the absence of pain and without spending a large sum of money.

The concept of an affordance provided a useful direction. The goal of the intervention was to create a workplace layout that afforded the work activities that had to be performed. Ultimately, the agency was able to purchase a relatively inexpensive ergonomic chair with adjustable seat pan height and angle and backrest angle. However, this chair did not have all of the affordances needed. For this reason the consultant and director worked together in order to find available (no cost) objects that could create those missing affordances. For instance, a small pillow was tied to the chair's backrest to create an adjustable lumbar support. A footrest was created using a large telephone directory, taped together for stability and appropriately angled by placing it on a wedge. A place for her legs to fit underneath the worksurface was created by placing the monitor on a sheet of plywood the extended beyond the edge of the file cabinet on which the monitor rested; this also created a keyboard shelf and mousing area.

2.2 Guerilla Ergonomics

The above intervention was modeled after the work of Dainoff and Dainoff [11] that focused on creating the requisite affordances using whatever means are available. They coined the term "guerilla ergonomics," which "means making ergonomic improvements with materials which are free, cheap, or readily available—even though your Standard Image-Conscious Corporation would not consider your improvements aesthetically correct." [11] Usually, this means that human artifacts have to be used to create functions for which they were not originally designed.

For this approach to succeed, the creation of affordances has to be based on an understanding of the principles (based on ergonomic research and statements of best practices, including workplace standards) that are entailed in creating a fit between the environment and the worker so that the work activities are supported. Ergonomists have the responsibility for providing workers with information, such that they understand the activities to be afforded and why those affordances are needed. This includes learning about where the body is most vulnerable to injury as well as

principles for safe working postures and movements. A successful intervention may also include training teams of workers to solve problems as they arise, using both their knowledge of ergonomic principles and ability to find available objects to create desired affordances. In the above case study, by providing the agency director with basic information about the human body and how the environment had to support her work activities to avoid the problems she was experiencing, the agency director was able to work with the consultant to create those affordances. Moreover, after the consultant left, she was able to continue to improvise in order to find better solutions and adapt to changing conditions.

Guerilla ergonomics challenges ergonomists, facility managers and workers to identify novel uses for common objects. This is not a simple skill because research has shown that people have difficulty in finding new uses for common objects.

3 Finding New Affordances for Old Objects

People have difficulty finding nontypical uses for objects. In problem solving this is often referred to as *functional fixedness* [12], which can be understood in terms of affordances: When faced with an object that was originally designed to create a specific affordance, people often find it more difficult to notice other affordances for that object that might support other activities. Even 6-7 year old children tend to focus on an object's typical function, though children younger than 5 years do not [13]. People may have difficulty noticing non-typical affordances of an object when the task entails functions that are different from those related to the use for which the object was designed. There is evidence that functional fixedness is a universal phenomenon, even among people from technologically-sparse cultures [14]. Thus, the strong association between the physical properties of an object and its typical use may inhibit the actor from discovering novel uses for the object, especially when the novel use entails different affordances. In the research discussed below, we find evidence that even when the initial affordance perceived for an object is not its primary affordance, people may still have difficulty noticing other uses for the object.

3.1 Perceiving Multiple Uses for an Object

The current investigation examines whether the perception of one of an object's non-primary affordances will interfere with the perceiver's ability to detect a second non-primary affordance for the same object. Does perception of one of an object's affordances interfere with detecting another affordance for that object?

Method. In Experiment 1 participants were presented with a collection of nine objects that could be divided into three classes defined with respect to a pair of affordances. Some of the objects ($O_{AFF\ 1}$) had only the first affordance (e.g., pour-in-able), but not the second affordance (e.g., stretchable). Other objects ($O_{AFF\ 2}$) had only the second affordance, but not the first. The third class of objects ($O_{AFF\ 12}$) had both affordances. (Neither of these affordances was the primary affordance for which the objects had been designed.) Participants performed two tasks: For Task 1, participants identified all of the objects with the first affordance. (The instructors told participants to identify objects with the first "use" because the term affordance would not be familiar to

them.) This would include objects with both affordances ($O_{AFF\ 12}$) as well as objects with only the first affordance ($O_{AFF\ 1}$). Immediately after completing the first task, participants performed Task 2 in which they identified objects with the second affordance, which again included objects with both affordances ($O_{AFF\ 12}$) as well as objects with only that second affordance ($O_{AFF\ 2}$). If the perception of one of an object's affordances affected whether a person notices another of its affordances, on Task 2 participants should be more likely to identify objects with only the second affordance ($O_{AFF\ 2}$) than objects with both affordances ($O_{AFF\ 12}$).

Results and Discussion. Figure 1 shows that for Task 2 participants were far more likely to identify objects that had only the second affordance than objects with both affordances. When people recognized one non-primary affordance of an object, they were less likely to notice another affordance for that same object. Figure 1 shows the mean percentages of second affordance-only objects ($O_{AFF\ 2}$) and both-affordance objects ($O_{AFF\ 12}$) identified for each of the four pairs of affordances in Task 2. Overall, the second affordance-only percentage (M=88.52%) was considerably higher than the both-affordance percentage (M=57.92 %). The results of a second experiment demonstrated that the objects with only the second affordance ($O_{AFF\ 2}$) are not better exemplars of that affordance than the objects with both affordances ($O_{AFF\ 12}$). Together these findings show that the perception of one affordance can interfere with the perception of other affordances for that object.

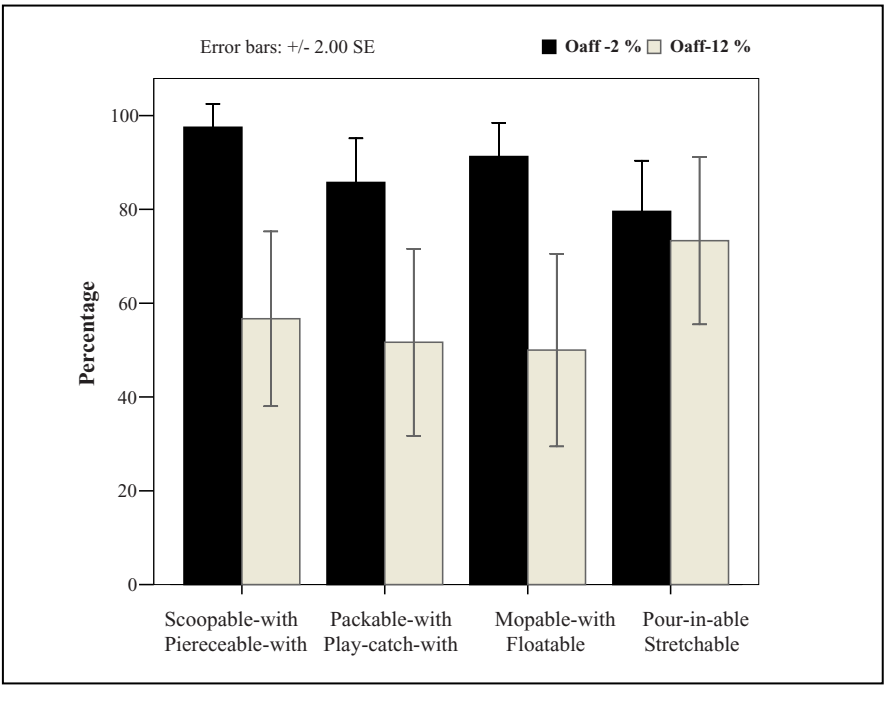

Fig. 1. The mean percentage of identified objects with *only the second affordance ($O_{AFF\ 2}$)* and objects with *both affordances ($O_{AFF\ 12}$)* for each pair of affordances in Task 2

3.2 Implications for Guerilla Ergonomics

Guerilla ergonomics involves perceiving new uses for objects that were originally designed for other purposes. Our research has shown that the perception of one of an object's affordances can interfere with the perception of another of its affordances. Although ergonomists and workers can successfully overcome this *functional fixedness*, we believe that practice may well prove useful [15]. In addition, it may also be important to establish a directory of objects that can be used to create a particular function and thus create a necessary affordance for safe, effective, productive and comfortable work. Such a directory, however, should be organized around the fundamental ergonomic constraints that have been identified in ergonomic research and constitute the foundation for current best practices. Dainoff and Dainoff [11] offer a model for how to organize this information.

References

1. Merllie, M., Paoli, P.: Working Conditions in the European Union. Dublin: European Foundation for the Improvement of Living and Working Conditions (2002)
2. Vink, P.: Comfort and Design: Principles and Good Practice. CRC Press, Newark (2000)
3. Dainoff, M.J.: Ergonomic comparison of VDT workstations. In: Sauter, S.L., Dainoff, M.J., Smith, M.J. (eds.) Promoting Health and Productivity in the Computerized Office, Taylor and Francis, London (1990)
4. Spilling, S., Eitrheim, J., Aaras, A.: Cost-benefit analysis of work environment investment at STK's telephone plant in Kongsvinge. In: Corlett, N., Wilson, J., Manenica, I. (eds.) The Ergonomics of Working Postures, Taylor and Francis, London (1986)
5. Westgaard, R.H., Aaras, A.: The effect of improved workplace design on the development of work-related musculoskeletal illnesses. Applied Ergonomics 16, 91–97 (1985)
6. Gibson, J.J.: The Ecological Approach to Visual Perception. Houghton-Mifflin, Boston, Mass (1979)
7. Torenvliet, G.: We Can't Afford It! The Devaluation of a Usability Term. Interactions, pp. 12–17 (July 2003)
8. Flach, J. M., Dominguez, C.: Use-centered design. Ergonomics in design (1995)
9. Crandall, B., Klein, G., Hoffman, R.R., Working Minds, A.: Practitioner's Guide to Cognitive Task Asnslysis. The MIT Press, Cambridge, Mass (2006)
10. Vicente, K.J.: Cognitive work analysis. Erlbaum Associates, Mahwah, NJ (1999)
11. Dainoff, M. H., Dainoff, M. J.: Ergonomics and Guerilla Ergonomics. WordPerfect Magazine (May 1992)
12. Maier, N.R.F.: An Aspect of Human reasoning. British Journal of Psychology 24, 114–155 (1933)
13. Defeytera, M.A., German, T.P.: Acquiring an Understanding of Design: Evidence from Children's Insight Problem Solving. Cognition 89, 133–155 (2003)
14. German, T.P., Barrett, H.C.: Functional Fixedness in a Technologically Sparse Culture. Psychological Science 16, 1–5 (2005)
15. Klein, G.: The Power of Intuition. Doubleday, New York (2003)