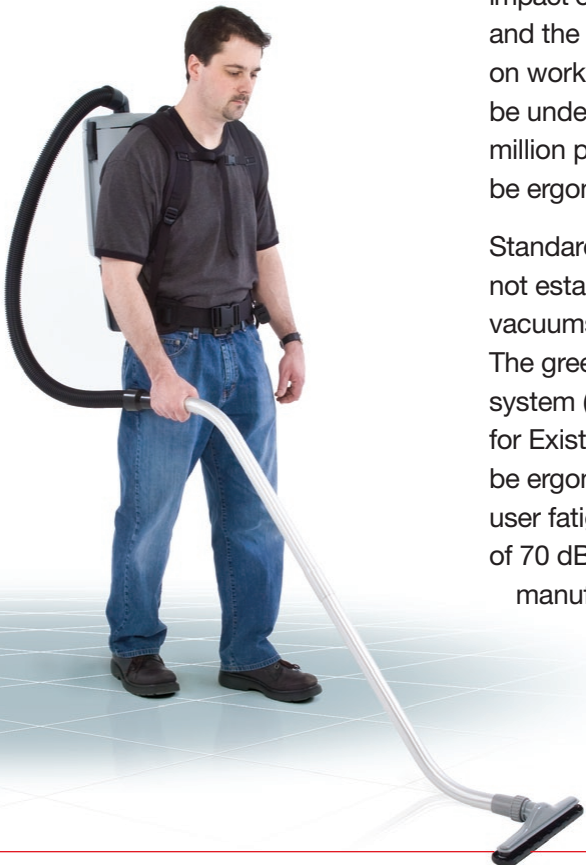


An analysis of backpack vacuum features:

Design attributes for maximum operator comfort, safety and cleaning productivity

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Research has shown that minor differences in total weight, weight distribution, harness comfort, sound level and air discharge direction can have significant impact on perceived effort, actual cleaning productivity and potential for repetitive stress injuries.



Introduction

Backpack vacuum cleaners play an important role in the commercial cleaning industry where they are favored for their superior mobility, low maintenance and high productivity—especially when used to clean around many physical obstacles. In fact, in field tests, the cleaning rate for backpack vacuums was 3.25 times greater than for upright vacuums at the same level of energy expenditure¹ when cleaning around desks, chairs and cubicles in facilities such as offices and schools.

As with any type of power equipment, the overall design of the unit can have a significant impact on the operator's performance in the field. Since a backpack vacuum is a piece of equipment that the operator wears, the total weight, weight distribution, sound level, harness comfort and air discharge direction can impact operator fatigue, overall cleaning effectiveness, productivity and the potential for repetitive stress injuries. Also, the impact on workers using poorly designed cleaning equipment cannot be underestimated. With a cleaning workforce of more than two million people in the U.S. alone, cleaning equipment needs to be ergonomically designed to minimize risk of injury².

Standard-setting organizations within the cleaning industry have not established specific ergonomic standards for backpack vacuums, but they do recognize the importance of such design. The green cleaning guidelines published in the LEED-EB rating system (Leadership in Energy and Environmental Design – for Existing Buildings) recommends that “power equipment be ergonomically designed to minimize vibration, noise and user fatigue.” However, except for noise level (a maximum of 70 dB(A) for any vacuum), LEED leaves it to equipment manufacturers to interpret the design specifics and only encourages manufacturers to design equipment that is ergonomic.



Ergonomic studies have indicated that if a given weight is carried close to the body and higher on the back, there is less perceived weight.



While most commercially available backpack vacuums meet the noise standard, there are differences among various designs that can impact issues of comfort, fatigue and productivity. All three of these issues affect the cleaning effectiveness as well as the productivity of individual operators. Based, in part, on an independent study of backpack vacuums by Sweden's Två Ergonomer testing bureau, this paper will analyze how various backpack vacuum design elements impact operators and productivity³.

Basic design factors

Backpack vacuums available on the market today are similar in basic design, generally consisting of a motor housing and tank, a support harness that rests on the shoulders and hip girdle, and a hose, cleaning wand and various accessory heads. While the designs are similar, research has shown that minor differences in total weight, weight distribution, harness comfort, sound level and air discharge direction can have significant impact on perceived effort, actual cleaning productivity and potential for repetitive stress injuries. In controlled tests, the best backpack vacuum design led to productivity increases of 10 percent over competing designs³.

1. *Total weight* – Studies from the outdoor recreation industry indicate that carrying camping-style backpacks that exceed 13.2 pounds (6.0 kilograms) for extended periods may impair lung function, cause extensive skin irritation and risk thoracic nerve injury⁴. This relates directly to carrying a backpack vacuum, since the total weight, harness design and typical duration of use are very similar. When lung function is reduced, perceived effort increases, the backpack vacuum user is fatigued more easily and cleaning efficiency declines. The outdoor recreation industry also found that the negative effects of backpack wear were directly proportional to the amount of weight. Most backpack vacuums weigh less than this suggested upper limit, and a general design trend is the development of smaller and lighter units consistent with durability and good vacuuming performance.



The design of the support harness is critical for distributing the total weight of the backpack vacuum in such a way that reduces perceived weight



2. *Perceived weight/weight distribution* – Perceived weight is a subjective measure of weight that is influenced by total weight, harness design and weight distribution. Various ergonomic studies have indicated that if a given weight is carried close to the body and higher on the back, there is less perceived weight³. Conversely, when the weight is distributed low on the back or tends to lean away from the body, there is significantly higher perceived weight. In addition to restricting mobility, weight distributed low on the body tends to pull the shoulders back and put continuous strain on abdominal muscles. This attribute of weight distribution was first recognized in the outdoor recreation industry and led to packing recommendations for hikers that called for putting the lightest items in the bottom of the pack and the heaviest items near the top⁵. Backpack vacuums that follow this weight distribution design principle offer lower perceived weight, and better mobility and comfort.

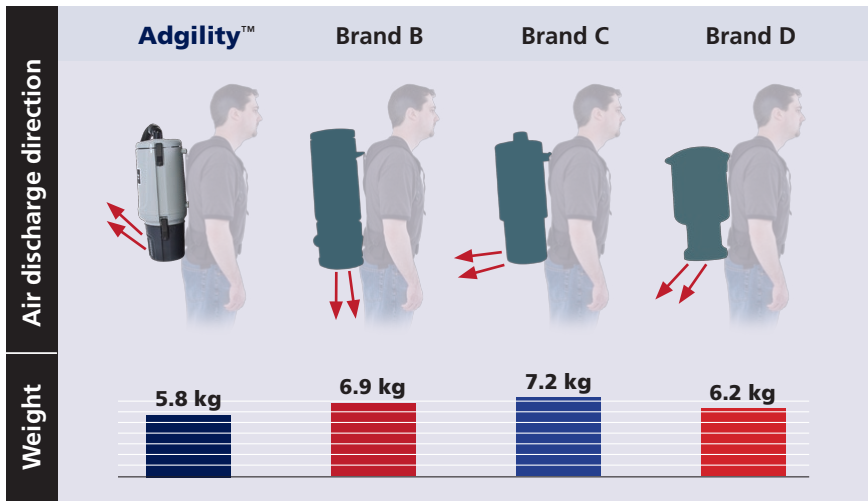
3. *Harness* – The design of the support harness is critical for distributing the total weight of the backpack vacuum in such a way that reduces perceived weight, while allowing sufficient mobility for effective cleaning. Harness comfort is a function of total surface-bearing area, padding thickness and density, and the flexibility, texture and resiliency of the harness materials. Since backpack vacuums are worn by both male and female operators, harnesses must be adjustable to fit a wide range of body sizes. Harnesses with large bearing surfaces, good padding and a wide range of adjustability will offer the best overall comfort. In order to compensate for poor weight distribution, some backpack vacuum designs force the operators to tightly cinch the harness. However, operational studies have shown that harnesses which are overly tight will restrict mobility, impair lung function, and lead to rapid fatigue and lower productivity⁶. By designing backpack vacuums with better weight distribution (higher on the back and close to the body), the harness can be looser, more comfortable and allow the operator more flexibility.

Units that direct the hot-air discharge away from the operator and upward have been judged to offer the most comfort and also to be less likely to disturb papers or surface dust.

4. *Sound level* – LEED has established an upper limit of 70 dB(A) for all vacuums, including backpacks, and several popular backpack brands meet this requirement. However, sound levels across brands vary from 59 dB(A) to 75 dB(A) for units with comparable vacuuming performance. High sound levels are known to increase stress and induce fatigue in workers. When fatigue increases, productivity drops. Backpack vacuums with the lowest sound levels tend to have the highest perceived comfort levels when other subjective measures are equal³.

5. *Air discharge* – For standard upright or canister vacuums, the direction, temperature or sound level of the discharge air is often of little concern. However, because the operator of a backpack vacuum is wearing the device, the proximity to the hot discharge air can impact comfort and fatigue. Some backpack vacuums discharge their exhaust air straight down; some discharge it down at an angle away from the operator; some discharge it straight back; and one design discharges it back and upward away from the operator. Designs that discharge straight down and constantly blow hot air onto the operator’s legs can lead to a decrease in comfort. Others that blow down and away at an angle

are more comfortable for the operator but may have a tendency to disturb nearby surface dust or papers on desks. Units that direct the hot-air discharge away from the operator and upward have been judged to offer the most comfort and also to be less likely to disturb papers or surface dust.



Ergonomic assessment studies indicate that low vacuum weight and exhaust air that is directed up and away from the operator both contribute to better comfort and productivity.

**Advance
Adgility XP
backpack
vacuums offer
unequaled
ergonomics**



Advance's new Adgility XP backpack vacuums combine ergonomic research with excellent cleaning performance. The unit's cushioned harness distributes the vacuum's weight more evenly and higher on the back than other backpack vacuums, resulting in less operator fatigue and greater productivity. Because the Adgility vacuum moves with the operator when bending or twisting, the unit feels lighter and more balanced. Also contributing to operator comfort is the design of the air discharge, which blows back and away from the operator, not down on the lower extremities. Other features include an operating sound level of only 62 dB(A) and four levels of filtering, plus an optional HEPA filter that removes 99.97 percent of dust particles down to three microns. Vacuum bags have a unique SaniSeal™ self-sealing adhesive rim that folds to keep dust inside the bag and allows disposal without scattering particles back into the air. Adgility XP backpack vacuums have earned the CRI (Carpet Research Institute) Seal of Approval for cleaning effectiveness. For more information, contact your local Advance dealer or visit www.advance-us.com.

Conclusions:

Due to their flexibility and productivity, backpack vacuums are an important tool for commercial cleaners. However, poorly designed or ill-fitting backpack vacuums can have a deleterious effect on worker fatigue and productivity, and increase the risk of repetitive stress injuries. The most ergonomically designed models combine a harness that distributes the load evenly between the shoulders and the hips, offer a wide range of adjustability to accommodate both male and female workers, and permit ample flexibility for accomplishing cleaning tasks. When considering the purchase of backpack vacuums for a cleaning workforce, look for units that: 1) have the lowest total weight; 2) have low sound levels; 3) position the weight high on the back and close to the body; and 4) have an ergonomic design that offers significant maximum worker comfort while minimizing fatigue and risk of injury.

Footnotes:

1. International Sanitary Supply Association, 1994
2. Mengelkoch and Clark, 2006
3. Wheatley, E. and Lundgren, E., 2007, Ergonomic assessment of a backpack vacuum cleaner designed by Nilfisk-Advance, using a comparative study design
4. Holewijn, M., 1990, Physiological strain due to load carrying. European Journal of Applied Physiology and Occupational Physiology
5. Howe and Getchell, 1995
6. Bygrave, et al., 2004

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