Assistive Technology:
Bagging Device

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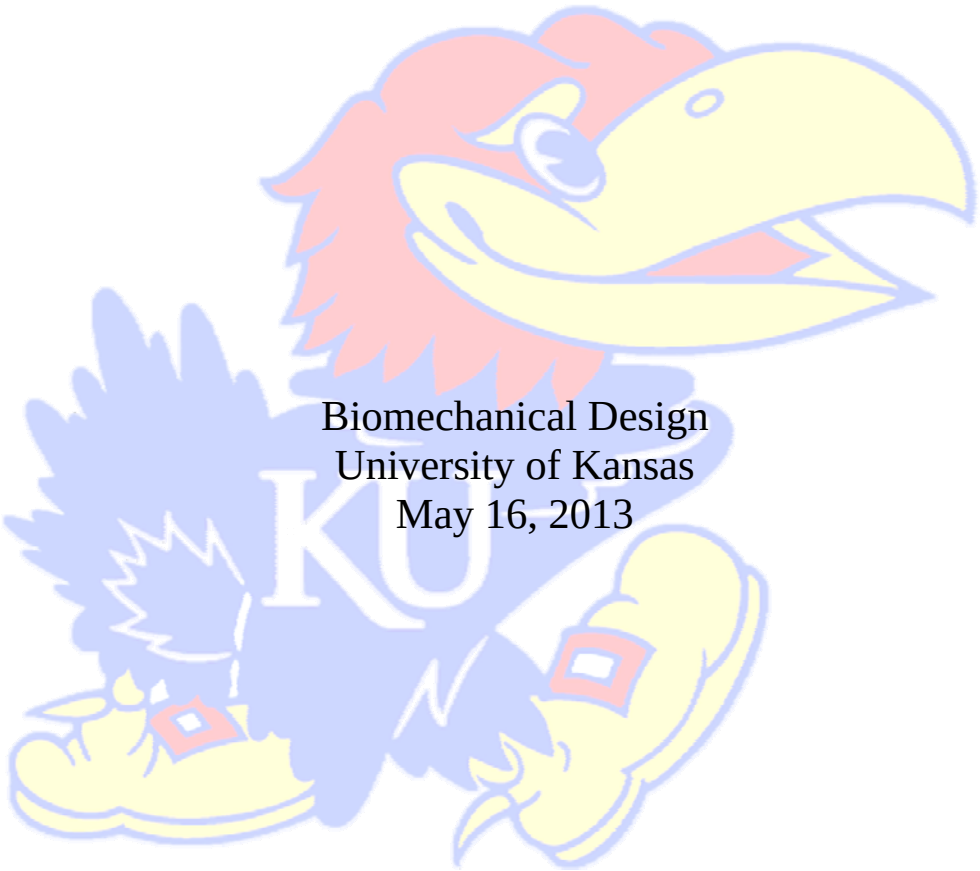

Biomechanical Design
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BAGGING DEVICE TO ASSIST MENTALLY AND PHYSICALLY DISABLED WORKERS

ABSTRACT

Cottonwood Industries is a manufacturing and packaging facility located in Lawrence, Kansas that employs people with mental and physical disabilities. Due to their disabilities, several Cottonwood employees lack coordination skills or have limited use of one or both hands. Not only does this limit their ability to independently and efficiently perform their packaging jobs, but it also causes them to grow frustrated and discouraged on a day-to-day basis. The Bagging Buddy was designed to help these workers with their packaging tasks by holding the bag open and steady so items can be easily packaged. The steel frame and magnetic clips give many bagging options, and therefore each user has the freedom to use the Bagging Buddy however it aides them best.

BACKGROUND

Accommodations for disabilities in the workplace have improved significantly in recent years. Despite these improvements, an analysis (1) found that only "15.6% of workers with disabilities report needing accommodations, and 12.2% report receiving them." Cottonwood Industries was founded in 1972 and is located in Lawrence, KS. A variety of jobs such as labeling, sewing, assembling, and packaging are completed by employees. Approximately 75% of the 140 person workforce at Cottonwood Industries is limited by physical and/or mental disabilities. Of these disabilities, nearly 10 workers have only use of one hand and struggle daily with simple tasks such as packaging. Manager, Steve Steinbach, identified a strong need for a device which would assist these workers by reducing frustration and speeding up the packaging process for them. While the immediate market for industrial applications of such a product is low (2), "over 3 million people in the USA have a disability in their hands and/or forearms, including paralyzations, orthopedic impairments, either congenital or injury related."

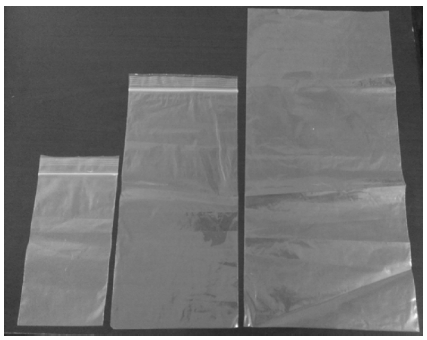

Figure 1: Three Bag Sizes

Cottonwood workers currently package a variety of products in three predetermined bag sizes, as shown in Figure 1. The smallest bag measures approximately 7x4 inches, medium bag measures 11x6 inches, and the large bag measures 14.25x8 inches in size. There are a variety of products packaged at the Cottonwood facility, but only the 4 largest outputs were focused on for this bagging device. In the smallest bag, 5 small wheels are to be packaged. These wheels measure about 1.5" in diameter with a thickness of .25" and weigh approximately .6 oz each. Therefore, the small bag must be able to hold a total of 3 oz without slipping out of the bagging device. In the medium sized bag a variety of small toys and a cardboard cutout must be inserted, as shown in Figure 2. The cardboard cutout measures 8.5x5.5 inches in size and workers identified that it was one of the most difficult products to insert when bagging with one hand. Both the small and medium sized bags can be closed using a basic zip-lock type closure which can be a slow and difficult task for workers limited to use of one hand. The largest bag is primarily used for two different bagging jobs. The first is a 5 lb military strap that is made entirely in the facility, and serves as Cottonwood's largest output with over 500,000 straps shipped per year. This strap can be seen in Figure 3, and is approximately 11x5

Figure 2: Medium Bag with Toys

inches in size and 4 inches thick. The large bag is also used to hold 25 plastic wheels, but is a much smaller scale contract.

When the need for an assistive bagging device for one handed users was identified, management at Cottonwood first developed temporary jigs. These jigs were made out of recycled material, such as a cardboard box or cylinder, and large binder clips. Cottonwood also explored bagging jigs that were on the market. However, these temporary jigs were insufficient because they were not designed with one handed users in mind. Another problem with these bagging jigs was that they were unable to support the weight of the larger products, such as the large wheels and military straps. Due to gravity, these vertical designs failed because the bags would often slip out of the clips. Also, the devices did not aide in the cardboard cutout insertion for the medium sized bags.

Figure 3: Military Strap

"Enhancing employment outcomes through job accommodation and assistive technology resources and services," an article written by Anthony J. Langton and Hunter Ramseur (3), explained the importance of developing assistive technology. This article also outlined the basic steps in designing assistive devices or worksite accommodations. The steps include needs identification, technology assessment, job/task analysis, problem solving, cost analysis, solution development, implementation, training and follow-up. These steps played a fundamental role in the design process of a bagging jig to aid workers with use of one hand in packaging these specific products at Cottonwood Industries. For the job analysis, the team observed workers as they packaged items and took special note of skills, limitations, temperaments, work station layout and tools. The workers only had use of one hand or limited use of both. Of the workers observed, both showed enthusiasm and pride in their work, but grew frustrated when their disabilities cause them to struggle in packaging items. Managers noted that the workers would benefit most from a device that would reduce frustration and therefore allow workers to feel more productive in their jobs. This information was used to develop specific design criteria for a bagging jig that would accommodate workers with the use of one hand at Cottonwood.

PROBLEM STATEMENT

Develop a table-top assistive device that will aid workers in packaging Cottonwood's products. The device should not require a power source and should be simple in design and operation in order to assist the mentally and physically disabled.

RATIONALE

In the past, Cottonwood had used various techniques to suspend the bags open, such as binder clips. Early design ideas stemmed directly from these vertical suspension clip solutions. The biggest concern with this vertical design was the tendency for the bags to slip out of the device when the

weight of the heavier items exceeded the clip's capacity. This fault led to the concept of loading the bags horizontally instead of vertically. Another problem with the temporary jigs was that it was difficult to both hold the bag up while simultaneously activating the clip. The current design uses magnet clips that allow for easy activation and flexibility in their placement. Cottonwood Industries is a NISH affiliated NPA. They are a NISH production facility and have been contracted through them for over 13 years.

DESIGN

The final design is a compact (6.25"x6"x1.5") "window" design. A CAD model of the Bagging Buddy can be seen on the left in Figure 4, and compared to the manufactured device on the right. The gray window block is made entirely out of steel in order to provide a secure base, with the entire Bagging Buddy weighing approximately 10 lbs. With the use of several magnetic clips, the Bagging Buddy allows the user to package the wide variety of products that Cottonwood sees every day.

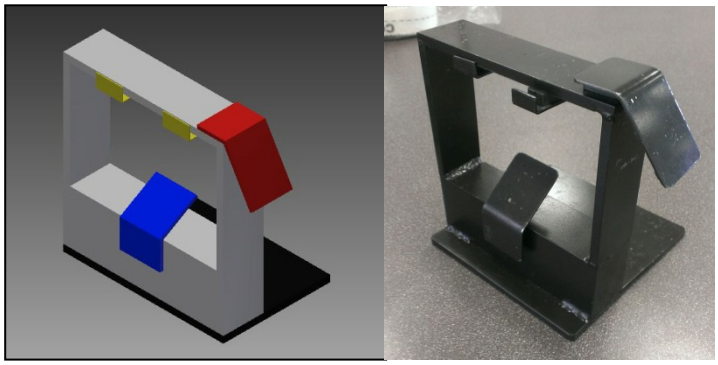

Figure 4: (Left) CAD model, (Right) Prototype

For packaging with the small and medium sized bags, a toggle magnetic clip can be used on the upper outside corner of the Bagging Buddy, as shown in Figure 4 in red. With a steel clip bent at a 120° angle and magnets glued to the inside of this clip, a simple 'see-saw' movement could be created. To explain the function of the magnetic clip process in more detail, the user will use their fingers to slightly open the bag, and pull the corner of the bag up under the open end of the clip. The clip may then be "bumped" to snap the clip down on the inside of the bag. After prototyping this design it was found that this magnetic clip could meet the weight requirements of both the small and medium sized bags (Figure 5). Unfortunately, the military strap was too large and heavy to be packaged in this similar vertical fashion.

Figure 5: Small Bag Secured

For packaging the largest bag, the user can use the 'window' for horizontal loading. They insert their hand into the bag in order to grab it, and push it away from their body through the window (5.5" wide and 4" tall opening). The bag can then be pulled back, catching the lower edge of the opening on the magnetic toggle clip shown in blue in Figure 4. This clip can be easily bumped with their hand to lock down the lower surface of the bag opening. 'Free' flat magnets (shown in Figure 4 in yellow) can then be positioned on the Bagging Buddy to hold the bag open in the jig frame in whatever way the user finds the most accommodating for packaging the military strap or other large products (See Figure 6). The items can then be pushed through the window, into the bag, where they can rest on the table. When finished, the user can simply remove the magnets and pull the bag away from the device.

Figure 6: Large Bag Set-up

The bottom plate can be seen in black in Figure 4. This plate is to the frame to provide more surface area with the table in order to prevent the Bagging Buddy from tipping. The bottom is also be lined with rubber that will provide enough friction to keep the unit from sliding away from the user as products are packaged. In the cases of the small and medium sized bags, the user also needs assistance in zip-locking the bags closed after packaging. For this, the worker can simply lay the bag on the plate, with the zip-lock opening facing the window frame. A toggle magnet may then be used to snap down just the edge of the bag opening, activating the snapping mechanism of the zip-lock. This magnet will provide enough resistance to allow the user to snap the rest of the zip-lock closed by sliding their finger across the zip-lock.

DEVELOPMENT

The manufacturing of the Bagging Buddy is a very straight forward process. Because of the device's simplicity, only a couple hours of machining and welding needed to be done. An online vendor was used to order the steel necessary to fabricate the device and the magnets used in the clips were bought from a local hardware store. The team spent around four hours cutting, facing, and edging the stock steel to reduce any safety concerns due to sharp edges. They then hired an outside professional to weld the steel to complete the frame. Magnets were glued using a steel infused adhesive to the clips. Finally, a rubber pad was attached to the bottom of the Bagging Buddy to assist in keeping the device as immobile as possible while in use. The total cost of the materials for a single Bagging Buddy is X and the estimated machining costs are X. A more detailed budget can be seen in Table 1.

Table 1: Cost to Build One Bagging Buddy unit

Item	Quantity	Cost For One (Dollars)	Total For All (Dollars)
Steel Base	1	8.82	8.82
Frame (bottom)	1	21.73	21.73
Frame (sides and top)	3	2.72	8.16
120° Clip	2	.30	.60
90° Clip	2	.15	.30
Magnets	16	.27	4.32
Rubber Pad	1	.97	.97
Welding	.5 hours	40 / hour	20
		Total Cost	**64.9**

EVALUATION

To quantify the effectiveness of the Bagging Buddy, the team observed several employees attempt to bag the cardboard insert in the manor they have been doing without the jig. This would be timed and compared against the time it took with the bagging device. For example, one employee with limited function in both hands was able to bag the cardboard insert consistently in 1 minute and 15

seconds. With only a brief explanation and a trial run, the employee had the bagging time down to 45 seconds using the Bagging Buddy. This was a 40% time improvement for this one employee. With practice and consistent use he could become even more efficient. A total of 4 employees tested the device and each showed similar improvements. One of these employees had yet to bag the cardboard cutout without management assistance, but in a few minutes accomplished the task twice. Qualification of the Bagging Buddy's success came from both the management and the employees. When asked if the device would make her job any easier, Linda, an enthusiastic employee replied "It helps me hold the bag open and it is much easier to put things in." The workplace manager and project sponsor, Steve Steinbach thought "[The Bagging Buddy] is exceeding expectations and has the potential to make this a more productive, more enjoyable job." Reducing frustration was such a crucial factor to the success of the jig, along with increased efficiency, and these were made evident at the employee trials.

DISCUSSION

There were several objectives that the team identified as the most vital to the success of the Bagging Buddy. First, the device needed to decrease the amount of frustration the users experienced during the bagging process. Second, almost as a result of the first, was to increase the amount of employee productivity. In the evaluation section it can be seen that both objectives were met. In addition to being a workplace assistive device the potential market beyond this specific application could be significant. The device could be manufactured far cheaper if implemented into mass production as well as designed around a plastic frame. This could then be commercialized for use in the home as well. This is where the market opens up dramatically for the device. There is a large amount of physically and mentally limited people that could find the Bagging Buddy helpful for day to day use, in addition those with congenital defects, amputations, strokes, or other neurological disorders.

REFERENCES AND ACKNOWLEDGEMENTS

This device design project was funded completely by a National Science Foundation grant and the BREAK program at the University of Kansas. Without this funding it would not have been possible to develop this device that has had such a positive influence on the efficiency and attitude of one-handed workers at Cottonwood.

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[2] USA 1983-1986, from the Digest of Data on Person with Disabilities, U.S. Department of Education, prepared January 1992

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Submission to the Undergraduate Design Competition

SBC2013-14119

BAGGING DEVICE FOR ONE HANDED USERS

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INTRODUCTION

Accommodations for disabilities in the workplace have improved significantly in recent years. Despite these improvements, an analysis [1] found that only "15.6% of workers with disabilities report needing accommodations, and 12.2% report receiving them." Cottonwood Industries was founded in 1972 and is located in Lawrence, KS. A variety of jobs such as labeling, textiles, medical, and packaging are completed by employees. A large portion of the 140 person workforce at Cottonwood Industries is limited by physical and/or mental disabilities. Of these disabilities, 10 workers have full use of only one hand and struggle daily with simple tasks such as packaging. Manager, Steve Steinbach, identified a strong need for a device which would assist these workers by reducing frustration and speeding up the packaging process for them.

When the need for an assistive bagging device for one handed users was identified, management at Cottonwood first developed temporary jigs. These jigs were made out of recycled material, such as a cardboard box or cylinder, and large binder clips. While the clips were easy for a user to grasp, it was difficult for the worker to get the bag in position to be clamped with the use of only one hand. Workers currently package a variety of products in three predetermined bag sizes. The smallest bag measures approximately 7x4 inches, medium bag measures 11x6 inches, and the large bag measures 14.25x8 inches in size. The items in the small and medium sized bags are consistently light (.5 lb), where the large bag must hold a 5 lb military securing strap.

After the need for an assistive packaging device was identified by managers at Cottonwood Industries, a job analysis was performed on-site by the design team. Following standard guidelines provided in "Enhancing employment outcomes through job accommodation and assistive technology resources and services," an article written by Langton and Ramseur [2], the team observed workers as part of a job task analysis as items were packaged and took special note of skills, limitations, temperaments, work station layout and tools. The workers only had use of one hand or limited use of both. Managers noted that the workers would benefit most from a device that would reduce frustration and therefore allow workers to feel more productive in their jobs. This information was used to develop specific design criteria for a bagging jig that would accommodate workers with the use of one hand at Cottonwood.

When the preliminary design process was completed, the first step in the actual design process was to build a House of Quality using all of the engineering specifications and customer requirements. This was a tool used to help identify the specifications or requirements that had the most influence to the quality of the final design. The most important manufacturing aspects for the jig user was first to increase their productivity on the assembly line. Secondly, there was a need to keep the complexity of the jig to a minimum. Finally, a strong need for the use of platforms, clips, or other assistive techniques was identified. In regards to the management staff, device mobility was very important to work well with the facilities flexible floor plan. It must be noted that all of these design constraints support the main goal of decreasing user frustration so they may fully participate in society with low stress and in a productive workplace.

PRODUCT DESIGN

With needed basic functions of the device identified, the United States Patent and Trademark Office website was consulted and it was concluded that there were no current patents recognized in this application. The next step in the design process was to begin brainstorming as many viable solutions as possible. Cottonwood in the past had used various techniques to suspend the bags open, such as binder clips. While many of the original ideas stemmed directly from these vertical suspension clip solutions, the team continued to explore alternative methods for bag loading. The concept of loading the bags horizontally instead of vertically immediately eliminated any issues with weight capacity and was found to be especially beneficial for

packaging the 5 lb military strap. Also, the horizontal design would allow for an overall shorter and more compact jig to remain effective as a table top device. The team cycled through about 5 design ideas, with each building upon the previous design in order to better meet the customer requirements. Finally, the compact (7”x7”x2.5”) “window” design was reached, as shown in Figure 1. The gray window block will be made entirely out of steel in order to provide a secure base weighing approximately 15 lbs. As clip possibilities developed, a magnetic based clip was chosen because it was more versatile and

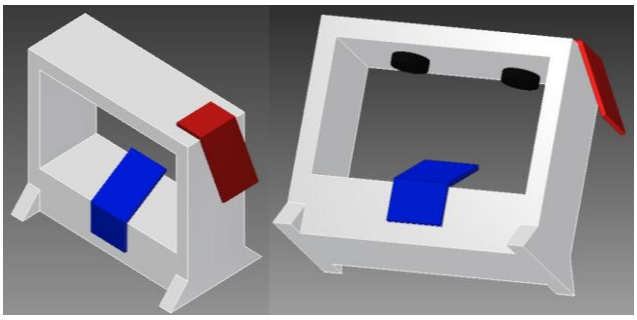

Figure 1: CAD model of device

simpler than the others. With the use of several magnetic clips, this device will allow the user to package the wide variety of products that Cottonwood sees every day.

For packaging with the small and medium sized bags, a toggle magnetic clip can be used on the corner of the device, as shown in Figure 1 in red. With a steel frame bent at a 120° angle and magnets glued to the inside of this frame, a simple ‘see-saw’ movement could be created. After some simple testing and prototyping it was concluded that the bag could be place in the proper position and the clip activated easily with one hand. The magnets could be used to hold the bags in almost any fashion desired. To explain the function of the magnetic clip process in more detail, the user will use their fingers to slightly open the bag, and pull the corner of the bag up under the open end of the clip. The clip may then be “bumped” to snap the clip down on the inside of the bag. After prototyping this design it was found that this magnetic clip could meet the weight requirements of both the small and medium sized bags, as shown in Figure 2 below. Unfortunately, the military strap was too large and heavy to be packaged in this similar vertical fashion.

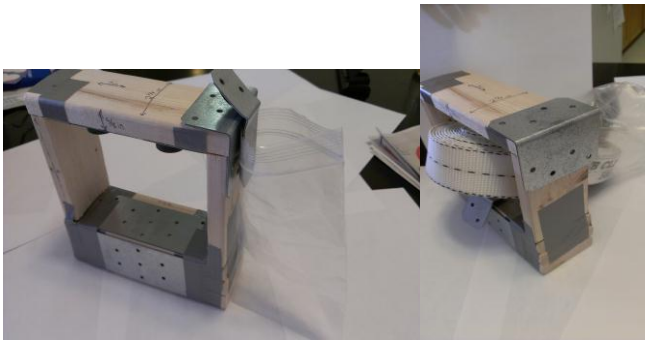

Figure 2: Early prototype holding small and large bags

For packaging the largest bag, the user will insert their hand into the bag in order to grab it, and push it away from their body through the window (5” wide and 4” tall opening). The bag will then be pulled back, catching the lower edge of the opening on the magnetic toggle clip shown in blue in Figure 1. This clip can be easily bumped with their hand to lock down the lower surface of the bag opening. Free circular magnets (shown in Figure 1 in black) can then be positioned on the device to hold the bag open in the jig frame in whatever way the user finds the most accommodating for packaging the military strap or other large products. The items can then be pushed through the window, into the bag, and rest on the table. This idea can be seen in the prototype shown in Figure 2. When finished, the user can simply remove the magnets and pull the bag away from the device.

In conclusion, this device is simple enough to be used by the physically and mentally limited, and it is effective enough to increase the productivity and decrease the frustration of the users with all three bag sizes. In addition, the device is lightweight (estimated at 15lbs using CAD software) and extremely portable, thus suiting the needs of the management staff as well. All customer requirements were met.

BUDGET & MARKET ANALYSIS

The minimalistic and simplistic final design of the product allows for a very affordable product. The initial blocks of steel is estimated to cost $30 total. To assemble the device an estimated 4 hours of welding and detailing will need to be done. An estimated cost to produce two clip frames is $2.50. Finally, the cost of the magnets is estimated to be $4. This would bring the total cost of materials and manufacturing to $50.

The immediate market for the product is somewhat low. The amount of people with limited use of one hand in the workplace is low. The total sales-per-year has been estimated around 200 for a workplace setting. However, the device could also aid in the daily lives of anyone who requires assistance in bagging items, and the potential consumer market increases. [3] “Over 3 million people in the USA have a disability in their hands and/or forearms, including paralyzations, orthopedic impairments, either congenital or injury related.” The retail products for home use will likely sell for 5x or 10x the base price and with a potential market of that size could be very profitable. When looking at the benefits and conveniences the device offers to the customer, as well as its low base cost, the jig would make a good investment.

ACKNOWLEDEMENTS

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From the Cottonwood internal newsletter...

KU Engineering Students

By: Steve Steinbach

One of Work Service's strengths is packaging, and we frequently place items in a bag. A number of the people we serve struggle to hold a bag open and slide an item in. Two KU students, Aaron Porter and Haley McKee, chose that challenge for their senior biomechanical design project for Dr. Ken Fischer's Mechanical Engineering class.

Aaron and Haley met with Cottonwood staff and consumers a number of times to try different strategies and after scrapping their original design they designed "Bagging Buddy", which is small enough to fit on a table top and is portable, and uses magnets that toggle to hold a bag in place so the user can then concentrate on inserting the item. It even has a feature to help hold a bag so that the user can close a zip-lock with one hand.

Funding for this project was provided by the National Science Foundation for the Biomechanical Rehabilitation Engineering Advancement in Kansas. Special thanks to Aaron, Haley and Dr. Fischer for partnering with Cottonwood on a device that will enable the people we serve to be more productive! Hopefully, KU engineering will partner with Cottonwood again in the near future.

Worker of the Month winner: Shirley T.

Other nominees included: Kenny S., Larry W., Terri S., Angela T., Charles B., John D., and Andy C.

"Way to Go" winner: Barclay R.

Other nominees included: Walter G., and Robert C.