The Pik-Pokket:
A device that easily removes bank cards, credit cards and licenses from wallets of varied design.

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I. BACKGROUND

In the United States the use of cash is becoming less and less common as debit cards and credit cards continue to take its place. Individuals using paper currency to pay for their transactions still require the use of a bank card to access an ATM. The use of a credit card can be categorized as an instrumental activity of daily living under shopping and fiscal management. The inability to perform instrumental activities of daily living becomes increasingly prevalent among aging populations [1].

The purpose of the project was to design a device that facilitates the acquisition of a card from a wallet. An individual may have difficulty removing a card from where it is kept due to increasing number of cards and the small size of cards. An individual with limited hand function may have further difficulty with this task. There are varying conditions that are known to limit standard function of the hand such as carpometacarpal osteoarthritis, Parkinson's disease (PD), Multiple Sclerosis (MS). In addition, muscle weakness and decreased grip strength can limit hand functionality. Lastly, survivors of stroke, individuals with carpal tunnel syndrome and others with injury or surgery could suffer from limited hand function [1, 4].

Pinch grip specifically is important in the handling of small objects. Pinch grip is known to decrease with age as seen in previous studies [2, 3], and the elderly can also be affected by underlying conditions. For example, as of 2013, with the elderly population number over 44 million, 14% of the US population are over the age of 65. Of that sub-population of the United States whose ages are over 65, 49.7% reported medically diagnosed arthritis. American adults also report functional limitations in common daily activities. Three million say it is "very difficult" or they "cannot do" grasping small objects. Additional sub-populations can suffer from a decreased pinch grip strength due to previously mentioned or other various conditions.

In response to this issue, a device was designed to make acquiring a credit card easier. Improvements on the ability to remove the card as well as maintaining functionality and simplicity were addressed in this design.

II. METHODS AND SOLUTIONS CONSIDERED

The FDA waterfall design process was implemented in the creation of a device. After considering the background and scope, the customer needs for the device were determined by collaboration with the occupational therapy team members from American International College on the needs of individuals for this type of device. The core requirements for the device determined during this meeting were separated into eight categories ordered by level of importance. Each core requirement is subdivided into individual user needs that are ranked in a hierarchy from high to low levels of importance. Technical specifications were derived from the user needs and assigned a value of measurement. Each technical specification number correlates to a specific customer need. Table I below shows the user needs and the translated technical specifications for this design.

TABLE I
USER NEEDS AND TECHNICAL SPECIFICATIONS

Requirement	#	Need	Rank	Technical Specification	Value
Strength	**1**	Will lower force required for card retrieval	High	Force reduction for card retrieval	20%
Texture	**2**	Will have surface features	Mid	The device has surface features	Pass
	3	Will include rubberized surface	Low	The device has rubberized surface	Pass
Portability	**4**	Will fit in a typical wallet or purse	High	Maximum length and width of device	100 mm
	5	Will be lightweight	Mid	Maximum weight of device	15 g
	6	Will be low profile	Mid	Maximum thickness of device	10 mm
Cost	**7**	Cost appropriate for the market	High	Maximum cost of the device	5 USD
Handling	**8**	Is easy to use	High	No instruction required for use	75%
	9	Will allow for the neutral thumb position	Mid	Device allows neutral thumb position	Pass
	10	Will lower fine motor/dexterity need	Mid	Requires no hand position change	75%
Color	**11**	Will come in multiple colors for preference	Mid	Multiple colors provided	Pass
	12	Must possess color contrast for easy ID	Low	Bright color contrasting credit card	Pass
Simplicity	**13**	Will have a simple design.	Mid	Maximum number of parts	1

Within the concept generation process a total of 10 individual concepts were formed from rough sketches and problem decomposition exercises. These were further developed and considered until a total of 8 designs were created on SolidWorks. Figure 3 below shows concepts.

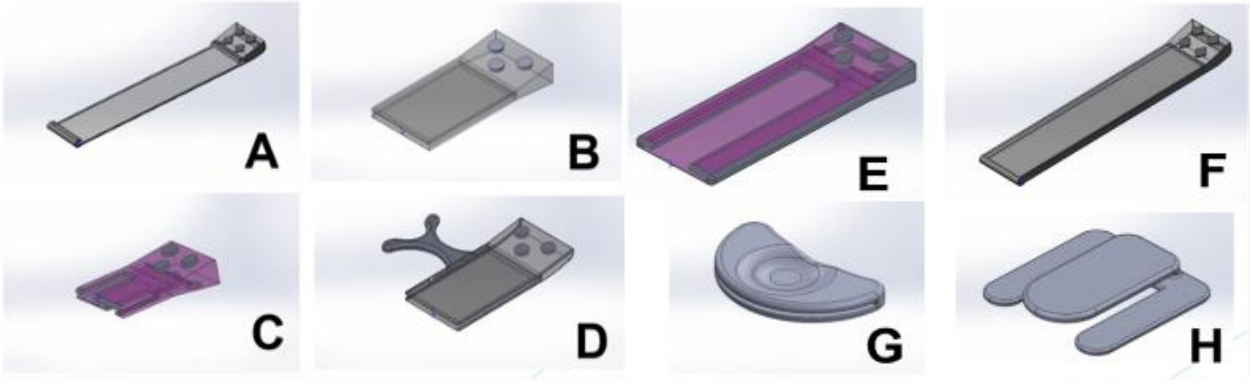

FIG. 1. The designs of an assistive device to attach to a credit card.

III. FINAL DESIGN

The final design is an assistive device for people with diminished hand function that can limit the ability to remove a card, such as a credit card or a bank card, from a container, such as a wallet. The final design was an early design that proved to be optimized for credit card acquisition. The final design is shown in Fig. 1 below.

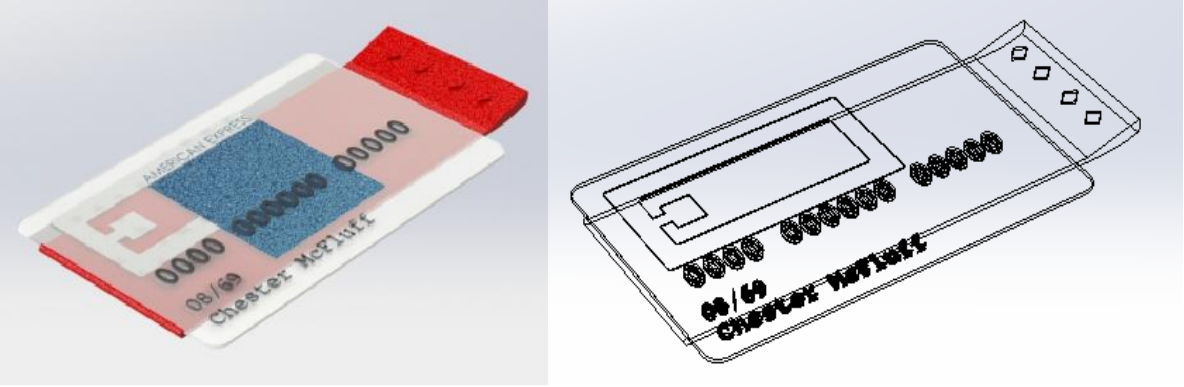

Fig. 2. The final design of the device attached to a credit card.

The width of the device allows the assistive device to be used without prepositioning with a card. The lip at the end catches the card with an audible click when it passes the rear edge of the card allowing individuals to know when the device has latched on cards from their wallet. In addition, the lip is small enough to grab only one card at a time.

The handle of the device is at a slight angle allowing for a visual differentiation that provides a visual confirmation on how far the assistive device was inserted and allows for a physical separation between a rear surface and the wallet and other cards to assist in removal. It also allows the rear surface to remain flat while the handle is thickened, providing leverage when removing the card, engages the users finger when pulling, and allowing the wallet to be closed without impeding the users comfort or causing pressure on the device.

On the handle of the device are pad member surface features that allows the individual to engage the member with their finger and aid them in grasping the assistive device. The surface features are a diamond shape but different shapes and well as different device colors could be used to sit behind multiple cards and allow for differentiation between different cards and as a memory aid.

The device can be used in vertical and horizontal card holder slots and is small enough and to store even multiple devices in the wallet when not in use. The device serves as a wallet accessory allowing individuals to continue to use their favorite card holder devices which may hold some sentimental value to them.

IV. OUTCOME AND FEEDBACK

For verification, multiple prototypes of the design will be made and tested. After several iterations and brainstorming, the device was optimized various considerations. Given that the assistive device provides a seemly unique solution to the problems stated above, an effort was made to validate the device as novel design. A patent search was conducted and after considerable review, intellectual property was pursued. The team has submitted a provisional patent application titled Assistive Device for Card Retrieval with application number 62/484053. An engineering drawing is shown in Fig. 3. below.

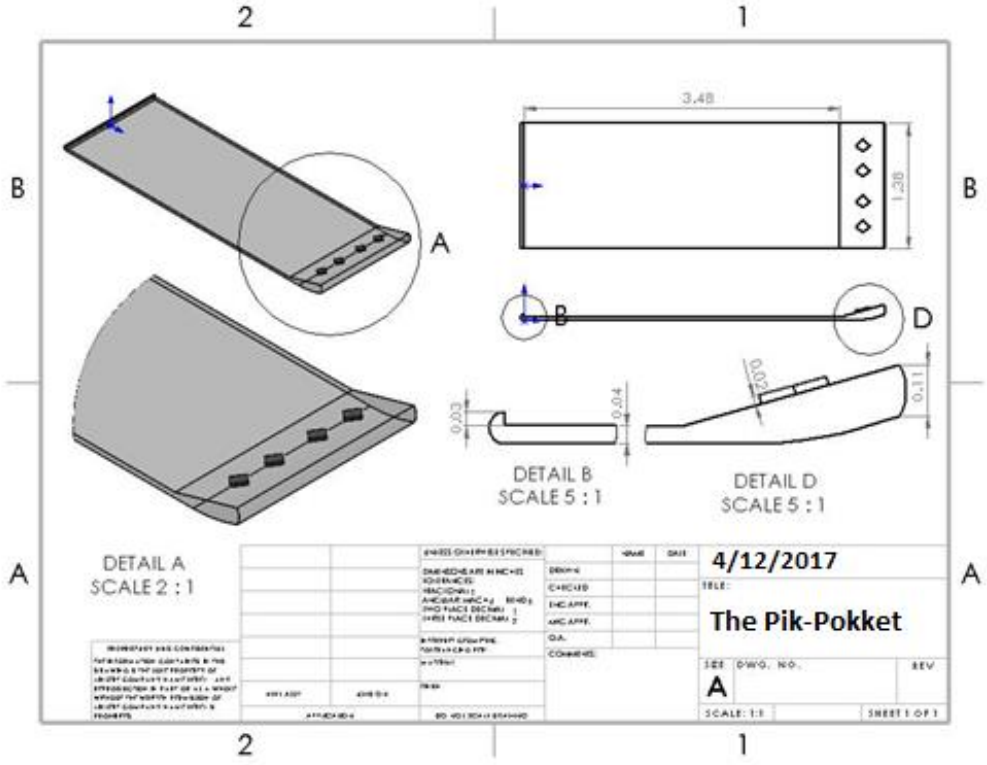

Fig. 3. Drawing of The Pik-Pokket assistive device

To quantify the effectiveness of the assistive device, the device was tested for the force required to remove the card from a card holder slot as compared to a card without the device. As IRB approval has not yet been received, a mechanical test set up was used to quantify force without human use. A wallet was clamped in place below a pulley. One end of the pulley was connected to the card while the other end of the pulley was equipped with a mass holder. Masses were added on the one end, until the card slid up out of the wallet and was completely removed. The test was then repeated for the card with the assistive device attached. During testing, a 15% reduction in force was noted when the assistive device was used over the card alone. Further testing is expected as well as a user survey of the device after IRB approval is received.

V. SIGNIFICANCE

The importance of this design is to allow individuals the capability of performing the tasks required when using a credit card, which can be considered an instrumental activity of daily living. The device should be able to assist most individuals in acquiring credit card. Conditions where this device may be most beneficial are diverse but mostly linked to limited hand function, likely that of a diminished key pinch grip. The affected population are primarily elderly, with pinch strength decreasing with age. A major population affected with a condition limiting hand function would be those with arthritis. Other individuals that could benefit from this device are those recovering from injury or surgery, stroke patients or those with carpal tunnel, or those with multiple sclerosis. In discussing significance, it is also important to consider prevalence of individuals that may benefit from this device.

When considering the prevalence of muscle weakness, it is important to note: 5% of adults aged 60 and older have weak muscle strength. 13% of adults aged 60 and older have intermediate muscle strength. There were no differences between males and females. The prevalence of reduced muscle strength increases with age [5]. Individuals with muscle weakness also specifically report having upper extremity weakness, and have reported difficulties using their upper extremities to rise from a chair.

When considering the prevalence of grip strength, normative data from hand grip strength studies was used to determine the decrease in hand strength in older adults. Males and females with weak grip strength is defined as decreased strength being below 2.5 SDs below gender-specific means. Methods of measurement included the use of a dynamometer [6]. 23% of males had decreased grip strength by age 80 and 27% of females had decreased grip strength by age 80.

When considering the prevalence of Parkinson's disease (PD), 60,000 Americans are diagnosed with PD each year. Incidence of PD increases with age, and about 4% of individuals with PD are diagnosed before the age of 50. Men are 1 ½ times more likely to become diagnosed with PD [7].

Prevalence of Multiple Sclerosis (MS): About 400,000 people in the US are diagnosed with MS. Onset is between 20-40 years of age (M = 32 years) [8].

Prevalence of osteoarthritis of the hand: prevalence of osteoarthritis (OA) of the hand increases with age. In a study conducted by Wilder, Barrett, and Farina, the DIP joint demonstrated the highest OA prevalence, while the PIP joint showed the lowest prevalence (N = 3,327) [9]. Joint-specific hand OA prevalence rates for second DIP, third PIP, and first CMC were 35%, 18%, and 21%, respectively. Women demonstrated higher hand OA prevalence rates.

VI. COST

When producing the device, it cost around $1.00-$2.00 per prototype to print from a 3D printer. The price varied depending on the price of the filament, or plastic that is used to create the device, as well as the exact amount of material that is used to create individual device. About 1 meter of material cost about 45 cents to make. With the complexity of the design put into consideration, as well as the many dimensions the device possesses, the estimated price of the device to produce is between $1.00-$2.00.

When considering the expected pricing it is important to consider the manufacturing method and well as final product material. Ideally, the production method will involve the creation of molds for injection molding with nylon material. Nylon has beneficial low friction properties while having high performance in other mechanical, thermal and chemical properties making it an excellent choice for a part that may undergo considerable wear. Similar devices of comparable size, weight, complexity, and manufacturing type usually sell for under five dollars per part. An expected pricing would be 5 dollars for a singular device with multiple devices possibly selling in assorted colors and with different surface features selling for 10 dollars in three packs.

VII. FUTURE WORK

Future work includes further validation of the device through quantitative data testing. Force will be measured using FSR 402 sensors (Interlink Electronics, Camarillo, California) in a circuit that will allow comparison of forces needed to use credit card with and without the attached. With IRB approval the testing will be performed on twenty subjects. A one-tailed paired t-test will be conducted to determine if there is a 20 percent reduction in force with the device compared to the credit card alone during the acquisition task. Individuals will also be given the opportunity to use the device without instruction. The occupational therapy team members will test the device with a costumer survey to further ensure the product design conforms to their needs.

REFERENCES

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ADDITIONAL RESOURCES

For more information regarding individuals with peripheral nerve injuries and individuals with orthopedic injuries, and their difficulties with fine motor skills and pinch strength, please refer to the resource provided below:

[5] Lewis, S.C. (2003). *Elder care in occupational therapy* (2nd ed., pp. 72-73; pp 265-266). Thorofare, NJ: SLACK Incorporated.

For more information regarding individuals with carpal tunnel syndrome, and their difficulties with fine motor skills and pinch strength, please refer to the article provided below:

[6] Fernandez-de-las-Penas, C., Perez-de-Heredia-Torres, M., Martinez-Piedrola, R., Llave-Rincon, A.I., & Cleland, J. (2009). Bilateral deficits in fine motor control and pinch grip force in patients with unilateral carpal tunnel syndrome. Experimental Brain Research, 194(1), pp. 29-37.

For more information regarding individuals with Parkinson's disease, and their difficulties with fine motor skills, refer to the article provided below:

[7] Simpson, H. (2012). Fine motor coordination activities for patients with parkinson's. *Center for Movement Disorders and Neurorestoration.* Retrieved from http://movementdisorders.ufhealth.org/2012/10/26/fine-motor-coordination-activities-forpatients-with-parkinsons/

For more information regarding individuals with left or right hemiparesis post-stroke, and their difficulties with fine motor skills and muscle strength, refer to the resource provided below:

National Stroke Association. (2006). Muscle weakness after stroke: Hemiparesis. Retrieved from https://www.stroke.org/sites/default/files/resources/NSA_Hemiparesis_brochure.pdf