Physics Chair Design Log

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Date: Jan. 4, 2016
SPH4U - 05

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Initial Plan

A Problem to be Solved

Standing up is a common part of a daily routine and we are often faced with the problem of spending long periods of time standing during a day. Whether it is waiting at the bus stop, standing in a long queue or even waiting in line to get your OUAC pin code, remaining standing is physically demanding and unproductive. In fact, half of the world's working population spends around 75% of their day in a standing position[1].

While prolonged standing seems like a simple inconvenience, it has many health risks for the human body. First, the entire body undergoes joint compression but the feet undergo the compression of the entire body. Squeezing joints is like squeezing a sponge; essential fluids are flushed out from the spaces. Second, blood returns to the heart with cyclic heart contractions, but with gravity pulling down on the blood, too long of a contraction to get blood up from the feet can create difficulty for blood circulation. As a result blood can begin to pool in the feet causing varicose veins where the veins in the feet become enlarged and tangled causing the possibility of blood to flow backwards in the veins. Finally, postural muscles and joints keep the body up while standing and require nourishment and rest to recoup from working. Prolonged standing fatigues these muscles and deprives them from nutrients causing muscle pains. Although short-term effects may be aching joints and feet, in the long run, the body may suffer permanent muscle damage and painful back problems. Overall, prolonged standing can result in; sore feet, swelling of the legs, general muscular fatigue, low back pain and stiffness in the neck and shoulders.[2]

Another part of the problem of standing for long periods of time is productivity. While spending long portions of the day standing and waiting productivity can decrease significantly within a day. While waiting, no important tasks can be accomplished and time vital to the accomplishment is being wasted. During the time we are waiting standing up, we have no desk to work on in order to attend to important matters, you are simply waiting. In fact, a US study found that people would spend five years of their lives just waiting in line.[3]

As seen, prolonged standing is a hidden danger physically and socially. By spending long hours at a time standing on their feet, people are inducing their bodies to physical pain while diminishing their daily productivity. This is the problem that our cardboard invention is intended to solve.

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[1] Fernandez, C. (2015, July 16). Now Too Much Standing is Bad for You. Retrieved November 26, 2015
[2] Prolonged Standing. (2015). Retrieved November 29, 2015
[3] How Much Time is Wasted Standing in Lines. (2014). Retrieved November 26, 2015

Planning Solution

Finally, a solution to the everlasting problem of people unproductively standing in line for endless hours! The super physics trio of Nader, Josh and Shakil has come up with a lightweight, foldable and portable workstation made out of only cardboard. This modern design is very unique and cannot be bought in any stores. It will be able to assemble in under a minute and in virtually any environment. The way that we will tackle the problem is by making a foldable chair that will be able to support the weight of an average person. Our invention will transform a sheet of cardboard into a chair that will provide support to the aching feet of the tired customer. Our design aims to have several moving parts, including a table with cup holder and adjustable seating. Our exhausted customer will be in dire need of a seat and a place to work, our invention will be very useful and serve its purpose. People do not want to lug around a hefty portable chair, that's why our design will be lightweight and will not include any other material besides reinforced cardboard. Our research shows there is a need for relief of sore feet, swollen legs, stiff neck and shoulders. Our solution includes an ergonomic design based on optimized measurements for maximum comfort. An added benefit to our chair is that is serves multiple purposes, when our customer is being unproductive while standing in line, he can pull out our chair and use the fold away table compartment, to rest their textbook or laptop and proceed with his tasks at hand.

Suggestion to design	Contributor
Addition of a foldable desk that can be folded and stowed under the seat of the chair. Adjustable headrest for taller users to supports head.	Nader
Chair should have adjustable seat heights with varied slots.	Shakil
Creating armrests with add-ons selected by the clients. Switch in and out different parts for a variety of functionality.	Josh

Design 1

Specifications

The chair will be made of a sheet of cardboard with 5-6 folds based on precise measurements horizontally throughout the sheet. These folds will be done based on angles specified in the sketch, they will line up perfectly to support the user. There will be a slot cut at one end of the cardboard and the other end of the sheet will fit into the slit and will be placed on a downward incline to support the backrest of the chair. We will leave excess cardboard on either side, in order for us to design the tabletop and cup holder.

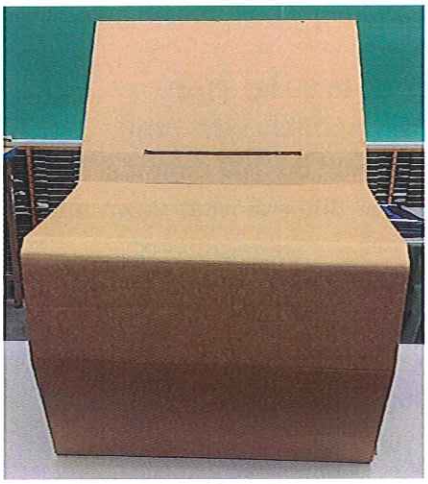
In order to determine the success of our invention there are a few criteria to be tested:

1. Support average weight of a person, up to 80 kg. (**1pt**)
2. Must be able to fold away into a transportable and easily portable size. (**1pt**)
3. While seated, the knees of the person should not be bent more than 90 as that can cause joint pain over prolonged periods of time. (**1pt**)
4. The material of the chair should withstand constant usage and not wear down after many times of packing away and being built up again. (**1pt**)

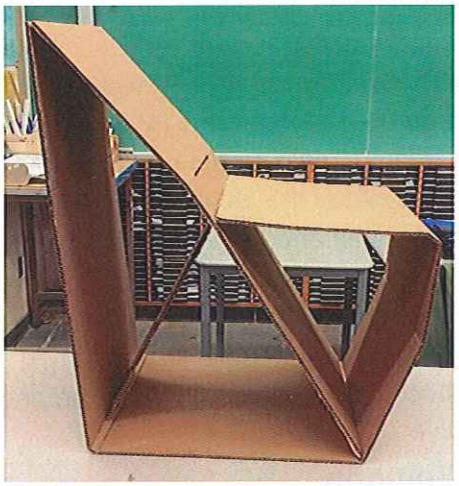
Total: 4 pts.

Build 1

Front View:



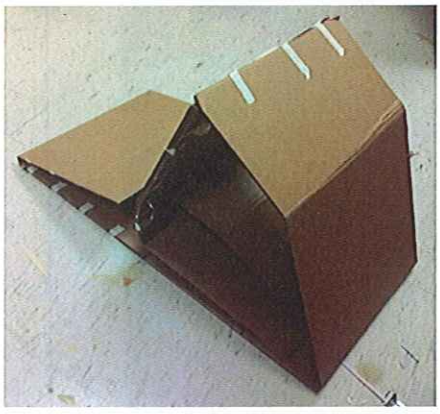
Side View:



Back View:

Top View:

Test 1



The first test failed to hold up the weight of an average person. Improvements would require re-enforcing the cardboard layers.

Pass	Fail
• Folded away into a light and portable package. (**1pt**)	• Couldn't support weight up to 80kg • Material was not able to withstand usage. • Person was not able to sit in order to measure bending of knees.

Results: **1/4 - Fail**

Design 2

Problem

For the second design, specifications were added based on common chair design guidelines for a comfortable and functional chair.

1. Should comfortably support weight of average person, up to 80 kg. (**1pt**)
2. Must be able to fold away into a transportable and easily portable size. (**1pt**)
3. User's feet should be flat on the floor (**.5pts**) with knees bent 90-100 degrees. (**.5pts**)
4. The material of the chair should withstand constant usage and not wear down after any times of packing away and being built up again. (**1pt**)
5. For versatility, seat should change height to accommodate variety of users. (**1pt**)
6. The seat should be 16"-20" above the ground. (**1pt**)
7. Depth of seat should be 15"-18". (**1pt**)
8. The back and seat should make an angle of 90-120 degrees. (**1pt**) wow!

Total: 8 pts.

Planning Solution

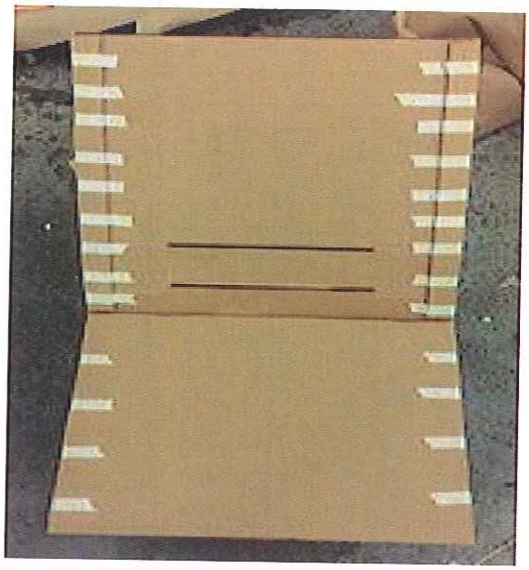
Suggestion to design	Contributor
Back of chair should not be fully vertical as it compromises stability.	Josh
In order to support a person, the layers must be thickened and reinforced. Triangular shapes increase stability.	Shakil
Horizontal slots should be made in the back support of the chair for the seat to slide into at different seat heights.	Nader

✓

Build 2

Front View:

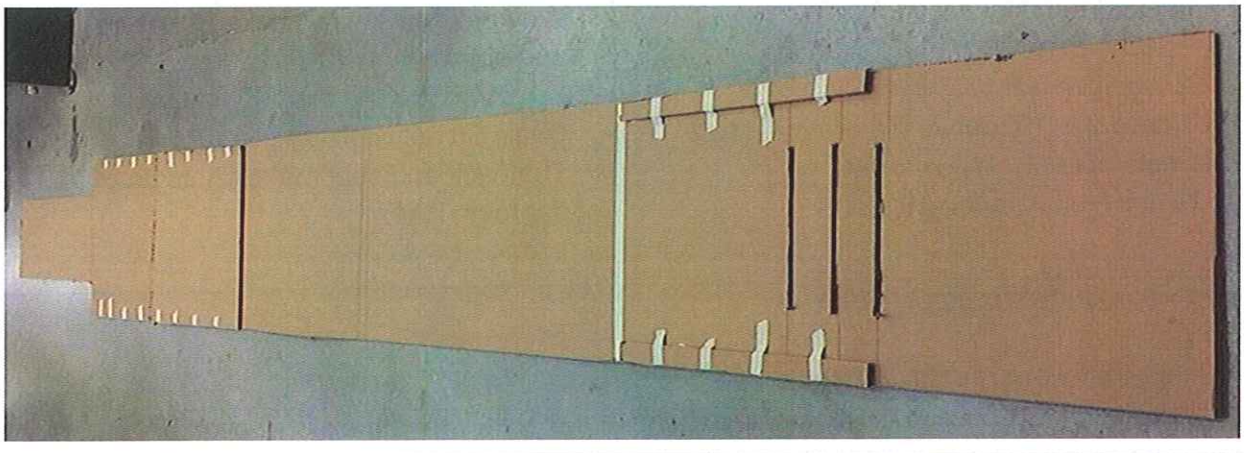
Top View:



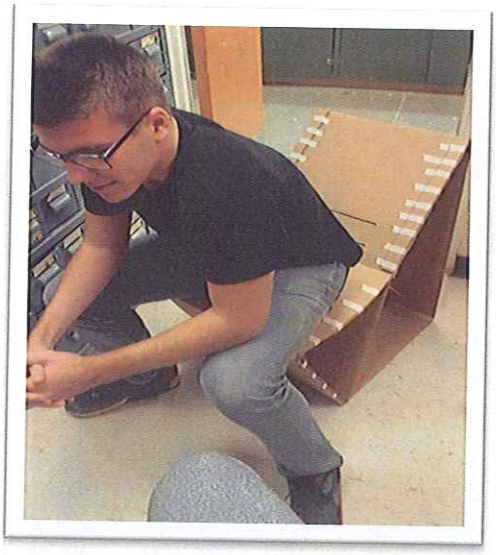
Back View:

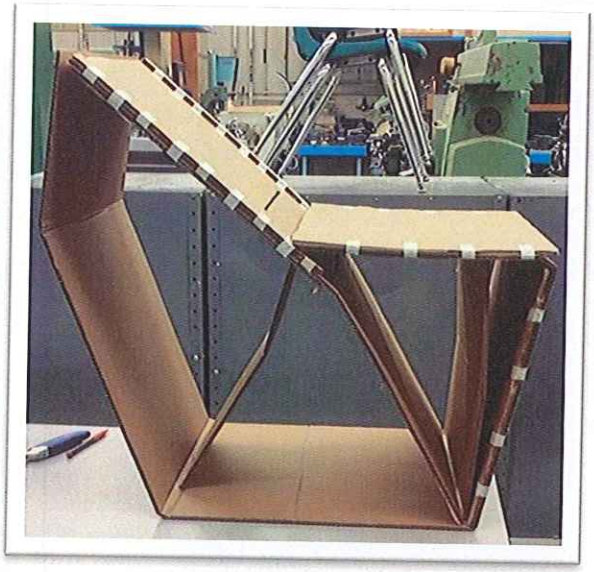
Side View:

Unfolded:



Test 2





In the second test, the chair was able to support 80kg when placed lightly the first time. However after constant use, the chair began to wear down and failed to seat a person due to lack of support. User had to sit near the front of the chair in order to reduce stress on the chair also causing knees to bend more than 90 degrees. Also the changing seat heights reduced the stability of the product ✓

Pass	Fail
• Supported 80 kg once (**.5pts**) • Prototype had 3 different slots for adjustable seat height (**1pt**) • The seat is 16" above the ground. (**1pt**) • Depth of seat is 17 ¾". (**1pt**) • User's feet were flat (**.5pts**)	• When folding away, package was very long and not easily transportable • Knees bent more than 90 degrees • Chair did not withstand usage • The back and seat make an angle of 120 degrees. (**1pt**)

Results: **4/8 - Not ready for use**

Problems that were faced:

- Leaning back caused the backrest to bend at the point where the slot is cut.
- The seat and back shift back and forth due to lack of support. ✓
- The most pressure is applied to the weakest area, slot in the backrest.
- When leaning back, there is no structure to redirect or balance the force applied by the user.

Possible solutions:

- Additional triangular flaps below the seat that redirect pressure to the front of the seat.
- Similar flaps under the backrest for support and diverting force from the back face of the chair.
- These flaps redirect stress applied to the weakest area.
- Preventing the seat from slipping to maintain stability.
- Backrest acts more like a support in order to add to stability to chair.

Final Product

Problem

In the final product, certain specifications were changed:

- Height of seat does not adjust for more stable and reliable structure.
- Additional functionality of storable platform to hold drinks, notebooks etc.

Final specifications:

1. Should support weight of average person, up to 80 kg. (**1pt**)
2. Must be able to fold away into a transportable and easily portable size. (**1pt**)
3. User's feet should be flat on the floor (**.5pts**) with knees bent 90-100 degrees. (**.5pts**)
4. The material of the chair should withstand constant usage and not wear down after any times of packing away and being built up again. (**1pt**)
5. The seat should be 16"-20" above the ground. (**1pt**)
6. Depth of seat should be 15"-18". (**1pt**)
7. The back and seat should make an angle of 90-120 degrees. (**1pt**)
8. Seat should have storable platform for increased functionality (**1pt**)
9. Platform should withstand mass up to 1.0kg (drinks, notebook & other stationary) (**1pt**)
10. Platform must easily slide in and out from under the seat. (**1pt**) ✓

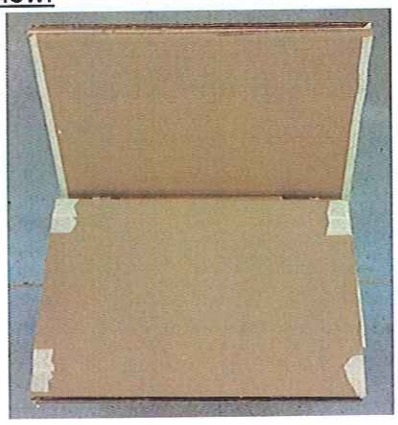
Planning Solution

Suggestion to design	Contributor
Seat will be double layered and platform will slide in and out from the middle layer for workstation. Increased layers also provide more support for usage.	Shakil
Foldable flaps underneath the seat add stable support for sitting. This additional moving part also folds for ease of compacting the chair. Additional foldable flaps underneath back support to withstand sitting at rear of the chair.	Nader
Taping pieces at the joints will help folding and unfolding of moving parts as they acts as hinges.	Josh

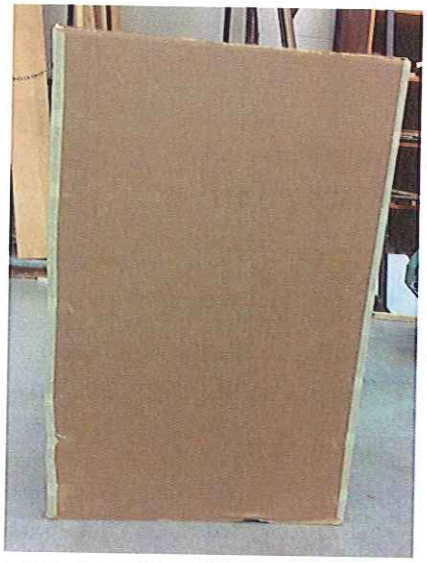
Final Build

Front View:

Top View:

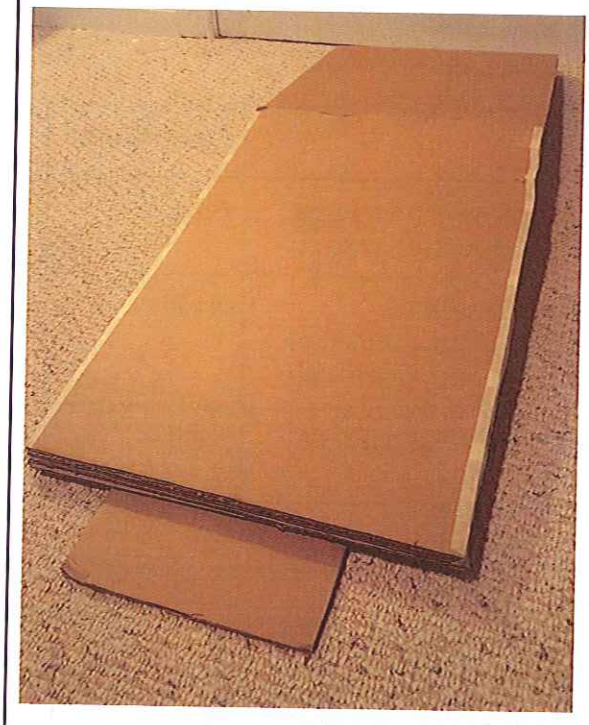


Back View:

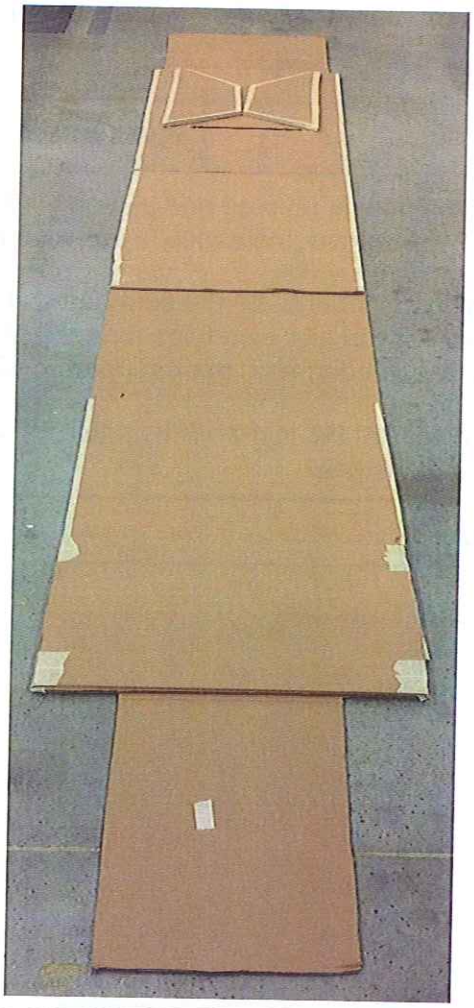


Side View:

Compact:

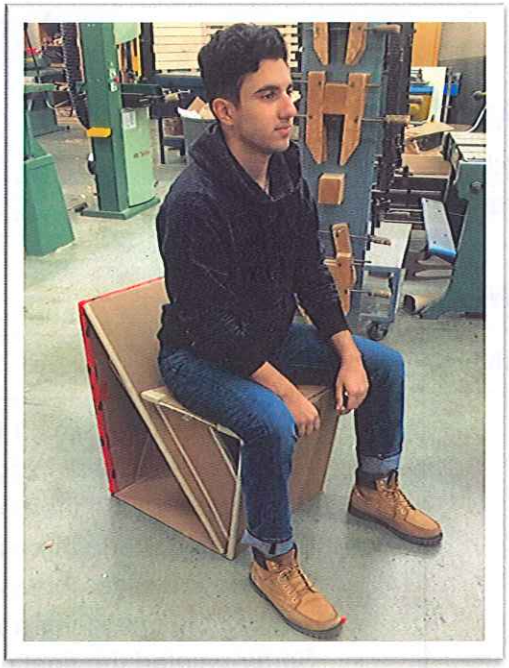


Unfolded:



Final Test

In the final test, the chair performed well in all of the specified criteria.



Pass
• Able to support up to 80 kg. **(1pt)** • Compact mode is light and easy to carry with one arm. **(1pt)** • User's feet are flat on the floor with knees bent 90-100 degrees. **(1pt)** • The chair continues to function after 5 consecutive disassembles **(1pt)** • The seat is 18 ½" above the ground **(1pt)** • Depth of seat is 17 ¾". **(1pt)** • The back and seat make an angle of 116.5 degrees. **(1pt)** • Additional table is stowed flush with the chair under the seat. **(1pt)** • Table holds maximum of 1.0 kg depending on how far out the table is. **(1pt)** • With additional handle, the table pulls out easily without straining the user. **(1pt)**

Results: **10/10 - Ready for use!**

Appendix

Cost Analysis

Roll of duct tape.....$4.95
Black Spray Paint.....$3.88
Total: $8.83

Teamwork Analysis

Member	Contribution
Shakil	• Involved in the brainstorming of possible chair/table ideas. • Responsible for planning solution and specifications in the initial plan. • Came up with the idea of reinforced layers. • Design and made the support flaps underneath the seat. • Created the slide able table with cup holder slot. • Testing the final chair and repairing weak points. • Spray-painted the final product.
Josh	• Came up with ideas for a potential product to be made. • Drew out the design sketch for design cycles 1 and 2. • Created the chair for design cycle 1. • Created the chair for design cycle 2. • Drew out the design sketches for design cycle 3. • Created the chair for design cycle 3.
Nader	• Researching the problem and solution for the invention. • Determining specifications for each round of the build cycle. • Adjusting specifications and success criteria based on results of the tests. • Troubleshooting final design and planning adjustments to meet criteria. • Designing and creating flaps below back support of the chair. • Building prototypes and final version of the chair. • Making sure the chair fit all the design specifications. • Putting together and writing the design log.

Sources

Fernandez, C. (2015, July 16). Now Too Much Standing is Bad for You. Retrieved November 26, 2015

How Much Time is Wasted Standing in Lines. (2014). Retrieved November 26, 2015

Must-have measurements for comfortable seating. (2015, July 17). Retrieved December 15, 2015

Prolonged Standing. (2015). Retrieved November 29, 2015

Work on being concise.
Improve specifications

4

Nader Sabahi
Joshua Wawryk
Shakil Savji
SPH4U-05

Cardboard Box Invention

Problem

Standing up is a common part of a daily routine and we are often faced with the problem of spending long periods of time standing during a day. Whether it be waiting at the bus stop, standing in a long queue or even waiting in line to get your OUAC pin code, remaining standing is physically demanding and unproductive. In fact, half of the world's working population spends around 75% of their day in a standing position[1].

While prolonged standing seems like a simple inconvenience, it has many health risks for the human body. First, the entire body undergoes joint compression but the feet undergo the compression of the entire body. Squeezing joints is like squeezing a sponge, essential fluids are flushed out from the spaces. Second, blood returns to the heart with cyclic heart contractions, but with gravity pulling down on the blood, too long of a contraction to get blood up from the feet can create difficulty for blood circulation. As a result blood can being to pool in the feet causing varicose veins where the veins in the feet become enlarged and tangled causing the possibility of blood to flow backwards in the veins. Finally, postural muscles and joints keep the body up while standing and require nourishment and rest to recoup from working. Prolonged standing fatigues these muscles and deprives them from nutrients causing muscle pains. Although short term effects may be aching joints and feet, in the long run, the body may suffer permanent muscle damage and painful back problems. Overall, prolonged standing can result in; sore feet, swelling of the legs, general muscular fatigue, low back pain and stiffness in the neck and shoulders.[2]

Another part of the problem of standing for long periods of time is productivity. While spending long portions of the day standing and waiting productivity can decrease significantly within a day. While waiting, no important tasks can be accomplished and time vital to the accomplishment is being wasted. During the time we are waiting standing up, we have no desk to work on in order to attend to important matters, you are simply waiting. Infact, a US study found that people will spend five years of their lives just waiting in line.[3]

As seen, prolonged standing is a hidden danger physically and socially. By spending long hours at a time standing on their feet, people are inducing their bodies to physical pain while diminishing their daily productivity. This is the problem that our cardboard invention is intended to solve.

✓

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[3] How Much Time is Wasted Standing in Lines. (2014). Retrieved November 26, 2015

Test 1

Defining the problem

Date: Nov. 23, 2015

The brainstorming and planning stage began with the entire group contributing ideas to the development of the design plan.

Contribution	Contributer
Collapsible drying rack for drying painting canvases. Design contracts to a single box for easy transport. Create designated drying space for canvases without being exposed to damage from the environment.	Nader
Creating a claw machine able to grab objects at a distance bring to user. Design would have a retractable and rotating arm for the claw to have maximized range of motion for the user. The claw itself can open and close with a by the user to grab objects.	Shakil
Retractable and portable coat and hat hanger. Triangular prism that can extend upward and outward to hold the clothes. The base of the hanger extends outward providing three legs to provide a wide base of support for the hanger.	Josh
The design of a chair that can be taken apart into a single piece of cardboard folded for easy transport and mobility. The chair would allow users to sit when subject to long periods of standing to reduce joint and muscle pain. The chair has adjustable seat heights. Design incorporates a foldable table that can be stowed under the chair and used when needing a platform to do work or hold items. Foldable cup holder included in the design for convenience.	Shakil and Josh

Date: Nov. 25, 2015

Group collaborating to decide on the problem to be solved by the invention. Concluded by deciding on the collapsable chair to aid in long periods of upright standing to avoid strain on the muscles and body.

Planned additional features such as foldable desk, headrest and cup holder to be added into the design for further functionality and productivity of the invention.

✓

Suggestion to design	Contributer
Chair should have adjustable seat heights with varied slots.	Shakil
Addition of a foldable desk that can be folded and stowed under the seat of the chair. Adjustable headrest for taller users to supports head.	Nader
Creating armrests with slots for various add-one that can be selected by the clients. Switch in and out different parts for various functionality.	Josh

Planning solution

Finally, a solution to the everlasting problem of people unproductively standing in line for endless hours! The super physics trio of Nader, Josh and Shakil have come up with a lightweight, foldable and portable workstation made out of only cardboard, WOW! This modern design is very unique and cannot be bought in any stores. It will be able to assemble itself in under a minute and will be able to be set up in any type of environment. The way that we will tackle the problem, is by making a foldable workstation that will be able to support the weight of an average person. Our invention will be able transform a sheet of cardboard into a chair including a backrest that will provide support to the aching back of our tired customer. Our design aims to have several moving parts, including a table and cup holder. Our exhausted customer will be in dire need of a seat and a place to work, our invention will definetly come in handy and serve it's purpose. People do not want to lug around a hefty portable chair, that's why our design will be lightweight and will not include any other material besides reinforced cardboard. Based on our research, we have found there is a need for relief to sore feet, swollen legs, stiff neck, back and shoulders. Our solution to this problem will be including an ergonomic design to the chair that will ease the pain of the joints to our fatigued customer. An added benefit to our chair is that is serves multiple purposes, when our worker is being unproductive while standing in line, he can pull out our invention to solve his problem. Our invention will have a folded away table compartment, which our customer can rest his textbook or laptop and proceed with his tasks at hand.

Specifications

The following is brief specifications on how we will manufacture our invention. Our group has thought of using a sheet of cardboard, and making multiple folds horizontally throughout the length of the sheet. These folds will be done based on precise measurements, over a periodic intervals. These folds will be done based on angles specified in the sketch, they will line up perfectly to support the user. We will also make a cut on one end of the sheet, and a slit halfway down the cardboard sheet. The indented cardboard will fit into the slit and will be placed on a downward incline to support the backrest of the chair. We will leave excess cardboard on either side, in order for us to design the tabletop and cup holder. As the design process elongates, we will determine exactly how the chair will be manufactured.

How will you test your product? How will you decide if it succeeds? Does it need to support a real person? How many folds/unfolds?

Suggestion to design	Contributer
Chair should have adjustable seat heights with swivel bars	Jamal
Addition of a foldable desk that can be folded and stowed under the seat of the chair. Adjustable headrest for taller users to support head	Hayley
Creating armrests with slots for various add-ons that can be selected by the clients. Switch in and out different parts for various functionality	Josh

Planning solution

Finally, a solution to the ever-existing problem of people unproductively standing in line for endless hours! The super physios from Hayley, Josh and Shakil have come up with a lightweight, foldable and portable workstation made out of only cardboard! WOW! This modern design is very unique and cannot be bought in any stores. It will be able to assemble itself in under a minute and will be able to be set up in any type of environment. The way that we will tackle the problem, is by making a foldable workstation that will be able to support the weight of an average person. Our invention will be able maneuver a client of cardboard into a chair including a backrest that will provide support to the human back of our ideal customer. Our design aims to have several storage racks including a flash and cup holder. Our advantaged customer will be in the form of a seat and a place to work, our invention will definitely come in handy and solve a real life problem. People do not want to lug around a bulky portable chair, that's why our design will be lightweight and will not include any other material besides cardboard considered. Based on our research we have found one of a kind to solve real problem, which is why our design will be unique. Our solution to this problem will be producing an ergonomic design to the chair that will ease the pain of the joints in our targeted customer. An added benefit is our small to flat size which enables multiple purposes, when our workers is being unproductive while standing in line, he can pull out our invention to solve the problem. Our invention will open a whole new table comparison, which no other company can provide as no competitor will be able to replicate our product as well as it is designed

Specifications

The following is our specifications on how we will create and solve our invention. The group has thought to carry a sheet of cardboard and folding multiple times horizontally through the length of the sheet. These folds will be done based on previous measurements, creating a pleated shape. These folds will be done based on angles, creating in the sheet. They will be in perfectly to support the person. We will also make a section on the sheet, so it is easily shown the cardboard sheet. The cardboard sheet will fit into the slot we placed due to measurement in order to support the backrest of the chair. We will also create a separate section for the leg to design the standing part of the chair. We will create a separate section for the leg to design the standing part of the chair. We will create a separate section for the leg to design the standing part of the chair.