CAPSTONE DESIGN COURSE

MIM 1501

Technical Design Report

Fruit Picker 2000
Project# 9
Final Report

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May 25, 2000

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May 25, 2000

Professor Mohammad E. Taslim
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360 Huntington Avenue
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Dear Professor Taslim,

The FP2000 Design Team is extremely proud and excited to submit a completely assembled prototype of our FP2000 Fruit Picker.

This design allows users to easily pick a great variety of fancy and commons fruits. The user does not need a ladder or any electrically powered features to be able to use our design. Other important and more detailed information regarding our design is attached to this letter.

Since our last presentation, our design has improved tremendously. We are ready and anxious to present our design to you May 31, 2000.

Again, thanks a lot for all the help and counseling you have provided to our Design Project. The design team feels you have become more than a mentor and advisor.

Sincerely,

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Design of an Economical Fruit Picker Mechanism

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Abstract
The main goal of the Fruit Picker 2000 Design Team was to develop a fruit picker mechanism that is manually operated by a single user with out the use of any electrical operated hardware. Our FP2000 is uniquely designed with an adjustable pole mechanism, making it capable to reach fruits at different heights. The device is also equipped with a chute that catches and decelerates the picked fruit. Each component of FP2000 is designed ergonomically to reduce fatigue, stress and to require minimal amount of strain. The device is targeted for homeowners therefore, the entire assembly is collapsible, making easy to transport and priced at an affordable cost of $35.99. This unique package together with a carefully designed marketing strategy should be a great SUCCESS!
Fruit-picking is an activity that not only provides a stress free setting to interact with nature, but it also allows users to spend time with family and friends. Currently anyone interested in such an activity is forced to choose between two possible approaches. The first one is climb on a ladder to pick each fruit by hand. And the second approach is to purchase a small pruning shear then climb on to a ladder and pick each fruit. Therefore, it was important to develop a fruit picker to serve such users. The goal of Fruit Picker 2000 Design Team was to provide an easy to operate, inexpensive tool package for anyone interested in picking fruits.

The Design Project Objectives and Requirements

**Design Objectives**

The main objective of this project was to design a manually operated fruit picker that can be used by homeowners and small farms to pick fancy fruits such as apples, oranges, peaches and pomegranates, and figs. A single user should be able to manually operate the device without the use of ladders or any electrical devices. The primary focus of the project was to develop a device that is safe, lightweight, easy to use and also inflict no damage on the fruits that are being picked. Therefore, ergonomic and safety were addressed when developing each component of the fruit picker. The goal met by our design team was to provide an easy, inexpensive tool for anyone looking to pick fruits. The specific design requirements follow below.

**Design requirements**

There are nine major design requirements used by the FP2000 design team to decide on our final design. Our design will be extremely simple, making our FP2000 easy to maintain and mass-produce.

1. The device must be easily operated by a single user to separate fruit from a tree.
2. Our product must be targeted for user of approximately ages 12 and up.
3. Our product will require a minimum physical input from the user.
4. The device must be manual & hand-operated.
5. The device will be priced at an affordable cost for an average homeowner or small farmer.
6. The device should be able to reach different ranges of tree heights.
7. The device will be able to retrieve a wide variety of fruits.
8. The device will protect the fruit from being damaged or bruised during any part of the retrieval process.
9. Our device will highly consider ergonomics.
Design Concepts considered

In the initial conceptual phase the design team decided that the most efficient way to begin the FP2000 concepts was to come up with a list of all of the components that would make up the Fruit Picker. Once the list was created, all of the components were classified into two main categories; Primary Components and Secondary Components. The Primary Components are the following: the two adjustable heads (Cutter and Puller), and the telescopic pole. These primary components are the components which the group felt were vital to the project and thus should be designed first. The secondary components which are: the chute assembly, the picking bag, and the grip; could then be designed fitting the specification and dimensions of the primary components. Following is a description of the concepts developed for these components.

Cutter Concepts

In order to create a market-dominating product, the design team decided to make a product that would allow the user to easily retrieve any fruit safely and neatly. Thus, the design team focused on making a cutter assembly that would attach to the top of the telescopic pole. Before such cutter assembly could be designed, the group had to first focus on the cutting geometry. It was in this phase where the group realized the importance of such cutting geometry and its role in ensuring the user of a successful cut. It was also during this phase of our project where the group noticed that a simple “Pac Man” geometry would not be ideal in order to meet our Project Specifications. For example, as the stem thickness increases the fruit stem becomes increasingly harder to cut. Thus a simple cutting geometry would expell the thicker stems without cutting them.

Pulling Concepts

Early on in the Conceptual phase the FP2000 team realized that one Cutting Head would be an overkill depending on what type of fruit the user decided to pick. Thus, the design team realized that the only way to make our design fully competitive in today’s Fruit Picker Market, we needed to design a second “Pulling” Head in order to give the user a more simplistic/low maintenance choice that will do the job just as easily as the cutter would.

The group then developed two different pulling mechanism concepts. The first was a hook like feature located at the top of a pole. The user would then aim the hook around the back of the fruit and then pull it down to retrieve it. Another pulling concept developed was a slot located on a can like feature at the top of the pole. The user would aim the stem through the center of this...
Design Concepts considered

of this slot and the pull the fruit down in order to retrieve it. Both of these pulling concepts would then be used later on when designing the second attachable Head of our FP2000.

Grip

The grip was another vital component that was to be carefully designed. The group also realized that if this component felt awkward at all to the user, the success of the project would then be compromised.

Recommended Design Concept

This design includes two easily adjustable heads, a chute assembly, and an ergonomical picking bag.

Design Description

The final design included most of the features evolved during the conceptual phase. This design included all of the components named above and also introduced the chute assembly that transports the fruit down from the tree and onto an ergonomical picking bag. In addition, this design includes two adjustable heads: 1) a Cutter Head and 2) a Pulling Head which are easily interchangeable and can be adjusted under a minute. The user can access these heads and decide which one to use depending on what fruit is being picked. The Pulling Head would be used for fruits such as apples and oranges while the Cutter Head would be used for fruits such as Peaches and Pomegranates.

Puller Head Attachment

Cutter Head Attachment
Detailed Analysis

Deflection of the Pole

The pole is subject to deflection due to the distributed weight of the pole and the end loading. Each of the two sections is modeled as a cantilever beam, with the reaction at the wall being transferred to the next section, and eventually to the user. This deflection of the pole was calculated by using simple beam methods. Thus, the deflection due to the weight of the cutter and fruit, F, and the distributed weight of the chute and pole, W, was calculated as 0.19 inches downward. (Rep 8.1)

Stress Analysis

The components needed for the prototype that could not be purchased off the shelf needed to be manufactured in house. This necessitated a detailed stress analysis of the parts to ensure quality and safety. The Mechanica extension of Pro/Engineer was used to perform the structural analysis to determine the stress and displacements in both cutter block and the chute clamp assembly. The analysis of the cutter block showed a maximum strength of 165-psi (Rep 8.2). The clamp that holds the chute to the pole also passed the stress analysis with a max stress of 289 psi. (Rep 8.3)

The constraints on both parts are in all directions and rotations at the inner surfaces of the large hole in both parts, where the pole mates with the parts. The load was defined as a 20-lb. Load on the face furthest from the mating hole, shown on the right side of the figure. The material for these parts on the prototype is aluminum 6061-T6, as it was readily available, which has yield strength of 39.9 ksi.

After the preliminary analysis, it was apparent that the parts could be constructed from a high strength plastic or nylon, rather than aluminum. A second run was done for each part, modeled as nylon with yield strength of approximately 10 ksi. This gave maximum deflections of the parts of 0.0002 inches, which are negligible, and maximum stresses of 265 psi. Thus, the parts could be made from nylon and be reasonably safe. The large factor of safety guarantees a product that will perform under both normal operation, and be durable to withstand a moderate level of abuse.

Financial Issues

The total cost to manufacture the prototype was $150 excluding labor cost, with mass production facilities the projected cost to consumers is $35.99. This target could be met with a custom pole and cutting head, and by using moldable plastics instead of aluminum.

Recommended Improvements

Further Improvements:
- custom design cutting head rather than modified off the shelf components
- custom design pole
- use of plastics and nylon instead of heavy aluminum
Abstract

The main goal of the Fruit Picker 2000 Design Team was to develop a fruit picker mechanism that is manually operated by a single user without the use of any electrical operated hardware. Our FP2000 is uniquely designed with an adjustable pole mechanism, making it capable to reach fruits at different heights. The device is also equipped with a chute that catches and decelerates the picked fruit. Each component of FP2000 is designed ergonomically to reduce fatigue, stress and to require minimal amount of strain. The device is targeted for homeowners therefore, the entire assembly is collapsible, making easy to transport and priced at an affordable cost of $35.99. This unique package together with a carefully designed marketing strategy should be a great SUCCESS!
Fruit Picker 2000

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Fruit Picker 2000

1 Introduction

Fruit-picking is an activity that not only provides a stress-free setting to interact with nature, but it also allows the picker to spend much needed time with family and friends. Currently, anyone that decides to partake in such activity is forced to choose between two possible approaches 1) climb onto a ladder and pick each fruit by hand or 2) purchase a small pruning shear and then climb onto a ladder and pick each fruit by hand. The primary goal of the Fruit Picker design is to provide an easy, inexpensive tool package for anyone looking to pick a couple of fruits. The following section states the goal and the Fruit Picker 2000 Design Team’s solution to the lack of creativity found in the fruit picking market.

1.1 Report Overview

Early in the Winter quarter, the FP2000 design team decided that the best way to solve the fruit picking dilemma was to brainstorm and come up with all the components that would provide an incomparable fruit picking package.

![Figure 1.1. Fruit Picker Components](image-url)
As seen on Figure 1.1, Fruit Picking Components, the FP2000 Design Team decided on the following components as “vital” for the success in meeting the design goal. These components are a cutter, a chute, a picking bag, and a telescopic pole with an ergonomic grip.

This report communicates all the breakthroughs made since the FP2000 group was created. This will be completed by the following 9 sections 1) Introduction, 2) State of the Art, 3) Fruit Picker Requirements and Specifications, 4) Safety/Ergonomics, 5) Developed Concepts, 6) Concept Selection, 7) Detailed Design, 8) Detailed Engineering Analysis, and 9) Conclusion.

1.2 Project Need and Objectives

The objective was to develop a fruit picker that is both affordable and easily used by most homeowners and small farms. A single user will manually operate this fruit picker without a ladder or any electrical devices. By taking into consideration ergonomic aspects and at the same time maintaining a low cost, this picker has the capability to reach fruits at different heights and cut various stems thickness. Moreover, our product is also equipped with a chute-like feature that protects the fruits from being damaged or bruised as they travel down from a high elevation into a storage/transporting unit.

Every part of our product is made of lightweight materials that in turn require a minimal physical strain and cuts down on the fatigue usually experienced while picking fruits.

The following are the features that make our product more efficient and stand out from the rest. These features are a chute for the fruit to travel through once it is picked, and a pouch or picking bag. We recognized that this feature saves users a lot of time and effort that otherwise would be spent in emptying a fixed bucket attached to the cutter. Also, the user does not have to worry about any extra weight that would accumulate over time as the fruits build up in a basket instead of automatically being transported to the storage bag.
2 STATE OF THE ART REVIEW

The group located roughly about two dozen patents that pertained to our fruit picker project. This section contains:

- detailed look and explanation of all the researched patents
- a review of all the current products on the market

2.1 Patents

First of all, we narrowed our list to eleven patents that directly share a common ideology with our specifications. All of the following patents consist basically of a hand held pole with either a “shearing” or “pulling” assembly at the end of the shaft in order to remove the fruit from the tree. Figure 2.1 illustrates what is meant by a “pulling” mechanism. This mechanism type works by having the user aim the stem of the fruit into the slotted cylinder. The user then pulls down and retrieves the fruit from its tree. Figure 2.2, on the other hand, illustrates what the Shearing mechanism concept looks like.

![Figure 2.1. “Pulling” Mechanism Example](image1)

![Figure 2.2. Fiskars Universal Cutting Tool (“Shearing Mechanism”)](image2)

The group noted many advantages and disadvantages that helped in the development of the final design. A copy of all the patents discussed in this report can be found in Appendix A.
1. **Patent number: US 4835955**  
**Entitled: “Hand-operated Fruit Picker”**

**Synopsis:**
Consist of a pole and a fruit-receiving cage. This cage is an adjustable, outwardly concave scoop. It has a gap that helps capturing and gathering the picked fruit. The interior of the cage is a cushioned lining that provides protection to the fragile fruits.

**Advantages:**
The design of the hand fruit picker helped us develop ideas about fruit gathering. It is more efficient to have the picked fruits come down the tree, and into a basket, instead of fruits gathering up at the top of the fruit picker.

**Disadvantages:**
This particular fruit picker has two disadvantages. First, the fruit has to be pulled from the branch, leaving the a great potential for fruit damage. Second, by gathering fruits in the cage at the end of the pole, large moment will be produced, causing operator fatigue.

**Judgment:**
This patent helped to develop ideas that were applied to the final design. This patent provided enough information to guide our design towards an approach where the fruit will travel down to the user trough a chute. In order to avoid user fatigue and possible damage.
2. **Patent number: US 3949440**  
**Entitled “Combined Tree Saw, Pruner, and Paint Sprayer”**

**Synopsis:**  
This design was geared towards sawing tree limbs and spraying paint on the stumps. It consists of an elongated handle with a fixed anvil with a saw. An adjustable blade is opposite the anvil. The tree branches have to pass through the area between the blade and the anvil in order to cut them.

**Advantages:**  
The advantage of this design is the cutting mechanism that could be adapted to cut fruit stems rather than branches. The group’s design specifies a cutting tool that can grab on to the fruit as well as cutting it.

**Disadvantages:**  
The disadvantage of this cutting tool is the heavy weight due to the anvil & the heavy metal bracket that supports the blade.

**Judgment:**  
This patent helped develop crucial aspects of our design. For example, the lack of having a cutting tool does not supply any means of gentle removal from the tree. Also producing a lightweight product is another major concern for the group.
3.  

**Patent number: US 4531352**  
**Entitled: "Fruit picker with stem cutting jaws"**

**Synopsis:**  
This is a fruit picker that utilizes a sharpened cutting edge. This fruit picker consists of a “double ring jaw assembly” which is attached to the top of a rod. The bottom jaw has a receiving bag or chute attached to it. The upper one, a cutting edge, is movable by a control on the pole handle to close down against the lower jaw to cut the fruit stem. The fruit then drops through the bottom ring.

**Advantages:**  
The design described in this patent provides some necessary aspects the group needs to keep in mind while designing the fruit picker. These features include: protecting the fruit throughout its entire journey from the tree into the storage pouch, providing a chute for the fruit to travel from the tree into the pouch, removing the fruit from the tree by means of a cutter.

**Disadvantages:**  
Although this design has many advantages the final assembly is not visually appealing. The main disadvantage noticed while reviewing this patent was the weight and the appearance of the final assembly. The group has decided that the final product must have a good fit and finish. For fruits such as apples this device not only is useless but causes the drop of many ripe apples with one pulling motion.
Judgment:
This design was very useful. The use of a chute to gather the fruit off the pole was proposed by the group prior to reviewing this patent, thus reinforcing the preliminary design.

4.

**Patent number: US 4959949**

**Entitled: “Fruit Picker”**

**Synopsis:**
Consists of a box shaped fruit “receptacle” attached to the end of a telescopic pole. The fruit is removed from the tree by engaging the stem in a slot on top of the box, and pulling down on the pole.

**Advantages:**
The main advantage of this design is the telescopic pole. This allows for a more compact design for easy storage as well as an adjustable length for optimum performance.

**Disadvantages:**
The disadvantage of this design is the “pulling” of the fruit from the tree. Although this is good practice when hand picking a fruit, it is potentially damaging when using such devices as the user is distanced away from the actual fruit picking operation.

**Judgment:**
Overall, this design was helpful since it provided insight on the developing a collapsible pole for the design of the fruit picker. The use of a collapsible pole has become a major factor in the design.
5.

**Patent number: US 5787698**

**Entitled: “High-reach Fruit Picker”**

**Synopsis:**
This design consists hollow sleeve with an open top. It has at the top opening a mechanism that consists of a string. The string runs all the way down to the user. The string is adjusted for the size of the fruit. When the fruit fits the hole, the user pulls down the string to reduce the size of the opening and trap the fruit. Finally, the fruit is detached from the tree branch by pulling down on the sleeve down.

**Advantages:**
The advantage of this design is the fact that a simple string or light duty cord controls the picking mechanism. The fruit is simply picked through adjusting the variable size of the opening by a string and pulling the sleeve downwards. The equipment consists of few parts made from light weighed material.

**Disadvantages:**
The disadvantages the design is the pulling mechanism might be impossible to apply to some fruits such as pomegranate. Therefore, picking such fruits might require users to apply tremendous amount of force, which would limit the number of people capable of using the equipment.

**Judgment:**
This model presented another way of picking fruits without having to use any cutter or shear. It brought the idea of manually fitting a fruit into an adjustable hole or ring. This design pointed out the necessity of cutting the fruit from the tree rather than pulling the amount, to limit the force applied by the customer.
6. 

**Patent number US 4471604**  
**Entitled: “Fruit Picker”**

**Synopsis:**  
Consists of a “scalloped ring” attached to a bag to collect the fruit. In order to pick the fruit from the tree, the fruit stem should slide in the scalloping, while pulling down on the shaft. The force against the stem of the fruit will cause the separation from the tree and drop into the container.

**Advantages:**  
The advantage of this patent is again, the simplicity of the mechanism and operation.

**Disadvantages:**  
This also turns out to be the disadvantages, as the design specification states the need of a cutting tool. Without this there would not be a clean and precise cut made in order to separate the fruit from the tree. This is potentially dangerous to the fruit, as it increases the likelihood of damage.

**Judgment:**  
This patent design helped us focus on a fruit picker that uses a cutter to separate the fruit from the tree. The use of cutter with a hand control will reduce the physical activity necessary for the operator to pick the fruit.
7.

**Patent number:** US 03855765  
**Entitled: “Fruit Picker”**

**Synopsis:**
This design consists of a picking basket that is equipped with “fingers” that reach, catch, and separate the fruit from the tree. The picking basket is connected with a container that also works as a “fruit conveyor.” This design uses a fabric for the container, therefore, reduces the velocity of the fruit coming down to the user.

**Advantages:**
The design of the stretch fabric that catches and decelerates the movement of the fruit has been highly considered in our project. A long container that would bring the fruit to the ground has been also considered. The conveyor is made from a stretch fabric that decreases the fruit acceleration as it moves down to the ground, therefore, prevents the fruit from being bruised or damaged. A long container that touches the ground is also a smart idea since there is no need to collect the fruit at the upper end of the pole. Instead, it collects the fruit at the ground level as fruit is picked.

**Disadvantages:**
The picking basket with fingers safely to grab the fruits does not separate the fruit from the tree. Pulling the fruit from the stem is not as precise as a cutter would be. In some cases, the fruit is very hard to pick, thus, by pulling the fruit with the picking basket will not guarantee that the fruit will be easily retrieved.

**Judgment:**
The idea of the stretch fabric for the container that also works as a conveyor applied directly to our project. Based on this idea, the fruits that are being picked are also
transported simultaneously to the ground or container. This has been a consideration of
the design group since the preliminary stage.

8.

**Patent number: US 5083418**

**Entitled: “Hand-Operated Fruit Picker”**

**Synopsis:**
Consists of a telescopic pole connected to a container at one end to receive the fruit as it being removed from the tree. The fruit is picked by the use of two hoop members connected to the end of the upper section of the pole, which pulls the fruit from the tree and deposits the fruit in the container.

**Advantages:**
This use of a telescopic pole is an advantage since it allows for adjustment and easy transport and storage of the device.

**Disadvantages:**
The disadvantage of this design is the location of the container bag at the end of the pole. The user will need to bring all the collected fruit to the ground whenever it gets heavy and repeat this step several times as needed. This patent brought out the need to design a fruit picker that reduces as much physical activity as possible, therefore this design does not apply to our project. The rope used to operate the hoops for picking can also get tangled.

**Judgment:**
This patent has shown that any control wires should be internal to the shaft to eliminate tangling on the branches. Also, with the use of a collection bag, the bag should be
mounted near the ground or as close to the operator as possible. This will eliminate any possible operator fatigue.

Entitled: “Mechanical Fruit Picker with Delivery System”
Synopsis:
Consists of two spring-loaded jaws at the mouth of a chute, mounted to a rigid pole. The jaws are controlled by a rod. When pulled, these jaws open up to accept the fruit. When the rod is released, the jaws clamp onto the fruit, and the entire device downward to removes the fruit from the tree. The fruit then travels down a sleeve to the operator uses.

Advantages:
The advantages of this design are the use of a flexible sleeve to deliver the fruit to the operator. This is a crucial aspect of the preliminary design the group has come to developed.

Disadvantages:
The disadvantages of this design are the pulling of the fruit, rather than the cutting of the fruit. Also, the use of a non-adjustable pole may add inconvenience to some users who need a more comfortable length of reach and a small storage size.

Judgment:
This patent has helped develop more ideas on the use of a flexible chute to deliver the fruit to the operator. Also, the use of a cutter rather than pulling jaws used in this design were more appealing since it limits the damage to the fruit.
Patent number: US 4098062

Entitled: “Hand Operated Fruit Picker, with Holder”

Synopsis:
Consists of a spherical like cage to retrieve the fruit. The cage is closed around the fruit, as the users pulls downward on the pole to remove the fruit. Upon release from the tree the fruit travels down a sleeve to the operator for collection. The spring loaded gate usually closed and is controlled by a wire.

Advantages:
The advantage of this design is the use of the flexible chute that delivers the fruit safely to the ground for collection.

Disadvantages:
This design has two disadvantages. The first disadvantage is the pulling rather than a cutting action of the device. Also the pole is a fixed length design, which can be problematic for users to transport and store.

Many important aspects related to the scope of the FP2000 project were acquired from the patent search. In specific, several concept ideas that the design team came up with was the development of the awareness of fruit protection throughout the whole fruit picking process. In addition, the design team was also exposed to another issue that was confirmed during the search of any existing products.
3 Fruit Picker Requirements

3.1 Requirements

There are certain requirements that our product had to meet. They are the following:

1. The device must be easily operated by a single user to separate fruit from a tree.
The target of the product is for one person and it should simply cut the fruit stem to separate the fruit from the tree.

2. Our product must be targeted for user of approximately ages 12 and up.

This product is designed to be simple enough for a user, age 12 and up, to easily operate this device since it is designed and intended to be an easy and simple product to use, in a non mass-production environment. (Refer to Appendix B)

3. Our product will require a minimum physical input from the user.

One of the aims of our design is to reduce physical strain as much as possible. This can be done by several ways such as reducing the required force to control the device. Also, features such as tightening and loosening of the pole to make an adjustment, rotating the cutter, or even operating the grip are all mechanisms that will be easy to operate. (Refer to Appendix B)

4. The device must be manual & hand-operated.

This device must be a manually operated device; that does not rely on batteries, motors, servos, or any electrically operated hardware.

5. The device will be priced at an affordable cost for an average homeowner or small farmer.

Since our target is home owners, the product should be at a reasonable price so that anyone will be able to purchase it. In addition, the price of our final product will be considerably less than the existing products available.
6. **The device should be able to reach different ranges of tree heights.**
The device will contain an adjustable pole mechanism making it able to reach a wide variety of tree heights. (Refer to Appendix B)

7. **The device will be able to retrieve a wide variety of fruits.**
Since our product targets different types of fruits such as apples, peaches, pears and pomegranates, it had to have two heads, cutter and hook. Depending on the type of fruits that are being picked, the user should easily be able to switch between the two. For fruits that are hard to pick the cutter can be used while fruits that are easily picked can be separated from the tree by the hook. The average force exerted by the cutter should be strong enough to cut through the average stem thickness of the fruit, to properly remove the fruit from the tree.

8. **The device will protect the fruit from being damaged or bruised during any part of the retrieval process.**
Most of the available devices just concentrate on separating the fruit from the tree and not on the handling of it. Therefore, it is necessary to include a chute feature that will catch and decelerate the fruit as it travels down from the tree to the user. This will protect the fruit from any damaged.

9. **Our device will highly consider ergonomics**
The heavier the device, the less time a person is going to use it, and thus, the more fatigue it will cause. We want to make sure that the device will not cause any stress or fatigue, and to be comfortable for the user to hold and use.

3.2 **Specifications**

This section contains all of the specifications that the FP2000 design team agreed upon as vital to the success of the project.

1. **Original project statement**
   - Intended for single user
   - Manually operated
   - Safe
Lightweight
To be used without a ladder or platform.
Low cost.
Not to cause damage to the fruit.
Intended for homeowners or small farms.

2. Developed project statement

The device will take into account the weight threshold for human hand and arms.

Device will target the following fruits: apples, oranges, pears, pomegranates, peaches and figs.

The device will also be equipped with a cutting mechanism that will be able to cut the appropriate stems of the fruits mentioned above.

The device should be also take into consideration each independent fruit dimension.

The following will be taken into consideration when planning the cutter design: strength, gripping, and cutting ability.

The device will be made in order to take into consideration a wide variety of user heights: 4’10” up (Refer to Appendix B)

The device will target users of the following age: 12 years old and up.

The device will take in to account the average tree heights of the fruits named above (Refer to Appendix B)

The device will also take into account any ergonomic issues in order to reduce fatigue and stress on the user.

This device will require little to no maintenance by the user
This design will require the use of lightweight materials in order to reduce stress, strain, and fatigue.

This device will contain an adjustable rod in order to attain the different tree heights required.

This device will also be easy to store, transport.
• This device will also be easy to assemble in order to keep down manufacturing costs

• Our design will require a minimal amount of off-the-shelf components needed in order to keep the cost of the product down

3.3 Refined specifications

Most of the fruit pickers found had an average cost from $90 to $110. We also found cheaper cutting tools in the market that averaged between $25 to $65. However, they did not have features such as an adjustable rod or chute. Our aim was to produce a device that is collapsible and easy to transport, has the ability to reach different heights, and also provides a mechanism for the fruit to travel down to the user. This whole package should not exceed $60. Our product should cost less than any competitor and at the same time more efficient and provides improved features. In addition, the time required to assemble our product was important. Therefore, we planned a design that will only require the user a maximum of ten minutes to assemble. Also the design of the product will take into account the height and age difference of the various users & safety. The overall weight of our finished product is approximately 10 lbs., light enough for anyone to handle easily.
4 Safety/Ergonomics

Ergonomics is the science of fitting a job task to the person who does the work, instead of forcing the person to fit the job. The use of an ergonomically well designed hand device reduces the risk of certain types of injuries and illnesses, it provides safer conditions, and increases job efficiency. Some injuries can be caused by the impact and vibration caused by the device. Other injuries occur when over exhausted muscles swell, reducing the blood flow. According to the Consumer Product Safety Commission, in 1982 there was an estimation of 240,000 medical injuries by chain saws and 133,000 injuries by garden tools. Therefore, ergonomic aspects had great impact when designing the fruit picker. Those ergonomics aspects are discussed below.

4.1 Weight

Heavy or unbalanced devices tire the upper arm, and shoulder muscles, especially when the job task requires you to straighten your arm out. In some cases, the user needs to straighten the arm out to reach fruits at higher elevations. The amount of weight that can be handled comfortably varies from one person to another. The recommended safe load of carrying is approximately between 25 to 50 pounds. However, the fruit picker is carefully designed to weigh less than that, approximately 10 pounds. Furthermore, maintaining balance device would reduce injuries associated with the back pain since 20% of garden tools injuries and illnesses occurs from back pain.

4.2 Neck Postures

The neutral position for the neck is facing forward and slightly bending downward between 10° to 15°. Yet neck flexion of over 20° is a risk factor for the neck. Therefore, the pole design reach maximum length of 8 ft in order to reduce any backward bending of the neck that is greater than 20°.
### 4.3 Grip Design

A good handle design includes a cylindrical shape handle that is at least 4 inches long with thickness between 1 to 2 inches. It is important to keep the device captive in your hands; that is, it does not slip. A counter torque in the hand can prevent slipping. Torque can be reduced by having a smaller moment or by having a good bearing in surface to minimize slippage. In addition to that, by adding soft plastic or rubber pad, the grip becomes more secure. It also provides more friction to the hand, and reduces pressing on the hands’ nerves, which leads to normal blood flow throw the nerves. Moreover, power grips are best when exertion of high forces are needed. Figure 4.1 presents maximum grip strength vs. opening grip axis.

![Figure 4.1 Maximum grip strength vs. opening grip](image)

### 4.4 Elbow’s Angle

The elbow angle is very important to consider. The strength of the arm varies greatly with the elbow’s angle. Therefore, a comfortable position of the arm would reduce its stress and raise its strength. Having the elbow at 90 ° or at 180° of bending would cause arm’s stress due to full muscle stretching, which is hard to bend easily. The Figure 4.2 shows various elbow angles while performing a task. Also the Table 4.1 below demonstrates the best elbow angle, which is between 120° and 150°. At this angle
the muscles are not stretched at their full length, therefore, it gives them enough potential carrying strength.

![Figure 4.2 Various elbow angles while performing a task](image)

Table 4.1 The optimum elbow angle

<table>
<thead>
<tr>
<th>Movement</th>
<th>ELBOW ANGLE, DEGREES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
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<tr>
<td>Pull</td>
<td>28.6</td>
</tr>
<tr>
<td>Push</td>
<td>41.8</td>
</tr>
<tr>
<td>Move right</td>
<td>19.1</td>
</tr>
<tr>
<td>Move left</td>
<td>22.6</td>
</tr>
<tr>
<td>Up</td>
<td>22.3</td>
</tr>
<tr>
<td>Down</td>
<td>23.2</td>
</tr>
</tbody>
</table>

### 4.5 Moment

Since the moment equals forces times perpendicular distance, the longer the pole, the greater the moment \( (M = F \times \text{Perpendicular D}) \). Therefore, the pole is designed to have a maximum length of 10 feet in order to keep the moment reduced as much as possible. Furthermore, while force equals to mass times acceleration of gravity \( (F = m \times a) \), the greater the mass the greater the force, causing the moment to increases. Therefore, the fruit picker is designed with a chute in order to reduce strain on the arm and keeping
the device’s weight stable that otherwise would be there if the fruits were stored at the top of the fruit picker.

Table 4.3 Relationship between moment and perpendicular distance.

4.6 Wrist angle

A good design using ergonomics allows users to keep their wrists straight and their elbows’ close to the body. It is also important for the users to grasp and hold the device with their wrists held straight. Therefore, the fruit picker is designed to require no excessive twisting or bending, to reduce strain on the nerves tendons and muscles.
5 Existing Product Review

While researching the fruit picker market, it became rather apparent that there is no product that meets all of the requirements of our project.

First of all, most of the fruit pickers out on the market consist of just a pair of small cutting shears, as seen on Figure 5.1. The obvious disadvantage to this relies on the fact that this product does not give the user the ability to reach fruits at high altitudes due to being limited by the reach of a human arm. Another disadvantage with this fruit picking approach is that the user is required to retrieve the fruit with one hand, while cutting the stem with the other. This becomes extremely inconvenient when the user is attempting to retrieve several fruits. After dozen or so fruits, not only do the user's hands become tired and begin to cramp, the user eventually runs out of space to hold all of the picked fruits.

Another category of the fruit pickers found are the “clip and pick” fruit pickers, as seen on Figure 5.2. These fruit pickers are quite handy and helpful but most include a basket like structure connected to the cutter. It is here where the fruits stay until the user decides to bring the basket down in order to retrieve the fruit. This dramatically increases the strain and discomfort experienced while picking fruits.

A different product trend in the fruit picker market was also noticed. As seen on Figure 5.3. Supreme Fruit Picker, this trend includes a series of modified tree pruners. Our team also studied these products and several weaknesses were found. The major weakness found was that most of these products were not.
adjustable. The ones that were adjustable did not offer a design that would collapse down into an overall dimension small enough to make it easy for the user to carry around. In other words, most of the designs were awkwardly large and annoying to carry around. The group felt that this would limit the amount of potential customers who would be looking for something lighter, smaller, and easy to use. We also felt that most homeowners that would be looking into buying such a product would not be willing to spend more than $50. In addition, the average homeowner does not have quick access to any fruit picking area nearby, therefore, this would mean that travel and transportation of the fruit picker would be required. Now, it becomes quite apparent how having to carry around a 15 foot fruit picker can easily become a nuisance.

Furthermore, another group of fruit pickers was found that tend to be more of the high powered pruners approach as the one seen on Figure 5.4, the Hydraulic Precision Pruner. Although having a hydraulic shearing device gives a great advantage when it comes to cutting various stem thickness, we found that adding 36 lbs to the back of the user would definitely cause a great amount of discomfort. The other great fault about such products is that there is no protection offered to the fruit after it is picked of the tree.

Overall, the FP200 design team did not find any product currently available on the market that meets all of the set requirements. Therefore, the team concluded that the current fruit picker market lacks substantial creativity but it does not provide a clean cut simple solution to the fruit picking problem statement developed earlier in Section 1.

6 Developed Concepts and Final Concept Selections

Many concepts were discussed during the various brainstorming sessions the FP 2000 team participated in. One of the first items in our agenda, however, included deciding on a convention in which we would all refer to later on in our conceptual phase.

The team then broke the Fruit Picker design down into the following vital components: **Adjustable pole, Grip, Cutter Head, Pulling Head, Chute, and Pouch**.
These main components combined will come together to form a fruit picker that will clearly stand out from all the rest in the market.

The **adjustable pole** feature will serve several purposes. These include allowing the fruit picker to reach a wide range of heights while also making the fruit picker unit compact enough for stress-free transport.

The **grip** feature will be designed taking into account ergonomic and safety aspects. This grip will include an actuating mechanism that will serve to activate the cutter. Figure 6.1. shows how this concept will look.

The **cutter head** feature will be responsible for detaching the fruit from the tree. During this design phase, the group realized the importance of choosing a blade for the final design. As seen on Figure 6.2, as the stem of the fruit increases in diameter it becomes harder to cut. Thus in this figure we can see how, depending on the hardness of the material, the stem would be expelled outward and thus causing possible damage to fruit.

The FP2000 design team’s solution to this geometry issue was to include a completely different blade design approach similar to the geometry found in Figure 6.3. As seen in the figure, due to the geometry of the blade, the stem is forced to remain centered to the blades as it is being cut therefore making a much cleaner than the cut attained by the geometry seen in Figure 6.2.

The pulling concept was developed to give the user more flexibility depending on which type of fruit is being picked. The design team realized early in the Conceptual phase that designing a cutter head would be an overkill depending on what the user decided to pick. It was for this very reason that several concepts were studied in order to...
create a second head attachment in which the user could interchange with the cutter in less than a minute.

The first concept seen here in Figure 6.4 illustrates a hook-like feature at the end of the telescopic assembly. The user would engage this hook behind the given fruit and then he/she would pick the fruit by pulling down on it. The great advantage observed in this concept is the ease of manufacturing and maintenance. Also, because of the simplicity of the components, the group felt confident in that this second head attachment would not add any significant cost to the FP2000.

The second concept shown in Figure 6.5 portrays a v slot located in the top part of the can which is attached to the telescopic pole. The user aims the stem of the fruit into the slot and then pulls it down in order to retrieve the fruit. The stem is the sheared off the tree and successfully retrieved. This concept again portrays various advantages similar to the concept discussed earlier. For example, this design is very simple thus making it extremely easy to manufacture and to maintain. The problem with this concept is that it can not be easily adapted on to the cutter block mount. Therefore, this concept was discarded.

After the fruit is cut or pulled, the fruit should drop into the chute. This chute will serve for two functions. These are 1) to safely transporting the fruit down to from the tree to the transporting bag and 2)to slow the fruit velocity enough so that the fruit does not get damaged when it falls in the bag.

The fruit will decelerate within this chute to a safe velocity to drop into the pouch or picking bag. This pouch will also be ergonomically designed to provide a maximum comfort to the user while at the same time maximize the amount of storage for the picked fruit.

After deciding on the vital elements of the fruit picker, concepts were developed for both the cutter and puller within the overall appearance of the fruit picker itself.
The combination of all the features described above in addition with a very low cost, without any doubt our product will **outperform** any other existing product out on the market. These are the features will make our Fruit Picker extremely competitive.

### 7 Detailed Design

This section contains the detail designs of all of the components that make up the Fruit Picker. Note that all the dimensions for the components of the Fruit Picker can be found in the attached drawings located under Appendix C. In addition, all the parts and components used in the Fruit Picker are located in the Components Table. Also each component will be displayed and each of its functions will also be thoroughly explained.

#### 7.1 Telescopic Pole

As stated in the Requirements and Specification section, the Fruit Picker will have the ability to reach fruits at different heights, and also be able to effectively function at these same heights as well. It was clear from the beginning that the pole design would have to lean towards a “telescopic” design. Therefore, the team focused on the various aspects that would entail producing such telescopic assembly.

The Figures 7.1 and 7.2 show the telescopic function of the pole. During this part of the research, the team determined the telescopic pole assembly involved tedious labor and tight tolerancing. Therefore, the design team decided to purchase an already existing off-the-shelf product instead of going with an outside vendor that could custom build a telescopic assembly to meet all of our team’s specifications.
After some careful considerations the group has decided to purchase MrLongarm’s SuperTabLock telescopic pole.

This telescopic assembly features two concentric poles: an aluminum pole within a fiberglass pole. Also this telescopic assembly has a retracted length of 4.5 feet while extended this pole reaches 8 feet. The base diameter of this assembly is 1.25 inches while the top threaded diameter is $\frac{1}{2}$ inch. This pole assembly was ideal for many reasons. Primarily, the overall length would provide enough reach for an 5 foot person to be able to reached the heights specified in our Specifications and Requirements section 3.1. Also this pole assembly is very light in weight (no greater than 3 pounds) and does not feel awkward when handling.

### 7.2 Cutter Design

As stated earlier in the Requirements and Specification section, the fruit picker must retrieve the fruit by means of cutting the fruit stem off from the tree branch. During the preliminary design phase, the team was urged to use off the shelf shears in order to eliminate any possible lead time and complications that would arise when attempting to design a shearing feature.

After all the design considerations the design team decided that in the effort of saving time and money, the simplest way of acquiring a cutter for our fruit picker would be to purchase an off the shelf shear pruner that closely meets all of the project requirements and specifications. Therefore, the FP2000 group did a series of information gathering surveys in order to find out what pruners where available out on the market. It was during this stage that the group found the Corona™ Bypass Pruner. As seen on Figure 7.3, this pruner comes close to satisfying our blade geometry constraint but it also comes with a spring-loaded handle. Therefore the group decided to purchase the Corona pruner in order to begin the prototype phase with some form of blade design.

Once the blade was purchased, the design team met with the sole purpose of figuring out how to adapt the blade geometry on the Corona pruner to meet the geometry discussed the the early Cutter Concept Section 6. The group agreed that this grabbing
concept should be used on the Corona pruner. Therefore, the group figured the only way to create such geometry was by purchasing two Corona pruners and then take them apart. After each blade was machined to have a precise radius, the pruners were then put together to make the new modified Cutter assembly. This new geometry, again, allows the user to successfully easily grab onto the stem as well as cleanly cut it from the tree.

### 7.3 Chute Design

As seen on Figure 7.4, the FP2000 design team chose to go with a dryer chute-like approach in order to solve the collapsibility and durability concerns. Since the team was concerned in obtaining a chute that would not get caught in the tree branches and at the same time not add too much weight to the fruit picker assembly. The team decided to look at the aluminum foil chute. In addition, the particular chute purchased by the FP2000 design team has a polymer coating on the inside that protects the fruit from being scratched or bruised and adds durability to the chute. The overall diameter of the chute for the Fruit Picker will be 6 inches.

### 7.4 Actuating Mechanism Design

Out of all the components in the Fruit Picker design, the Actuating Mechanism will most likely be the one with the most modifications. Again, as stressed earlier in the report, ergonomics is an important factor for consideration of the FP2000 design team. Therefore, no matter what grip is designed and analyzed, there is no way to get an idea of how the component will actually feel unless a prototype is built. The grip design has
been modified already a number of times, however, the design team has agreed on the latest grip design. As seen on Figure 7.5 the latest actuating handle is meant to resemble a bicycle brake mechanism. In fact, everything from the handle on the bottom of the picker, to the cable geometry at the cutter assembly region as seen on Figure 7.6, was designed with such brake mechanism in mind.

To activate the cutter, the user pulls back on the handle similar to a bike rider pulling back on a brake lever. This will cause the cable to be pulled in a downward fashion. This motion causes a decrease in length of the cable that connects the pruners handles. The design team agrees that this type of mechanism will provide the user with enough mechanical advantage to easily cut the stem of almost any fruit.

7.5 Refined Actuating Mechanism Design

After the Winter Quarter, the FP2000 design team met in order to address several issues regarding some flaws observed in the actuating mechanism; in particular the cutter mechanism. One of the main flaws detected had to do with the vulnerability of the cutting mechanism when placed into the tree. The team noticed that the current actuating mechanism did not protect the cable enough from existing debris that could obstruct any of the moving objects. Therefore the group began to redesign the cutter block that would be located at the top of the Fruit Picker. Figure 7.8 shows the design of the new redesigned block. As it becomes apparent in the Refined actuating mechanism figure, another issue that was addressed was the issue regarding the fixed perpendicular angle that was shown in the first Mechanism developed in the Winter Quarter. Th FP2000 team realized that having a fixed angle would make it extremely difficult to guarantee a perfect cut to the user as he/she decides to change the angle of operation. Therefore, as seen in Figure 7.8, the team decided to go with a rotary hinge (seen in yellow) in order to provide easy angle adjustment. Also the cutter block was modified in order to accommodate most of the cable, thus protecting it from any form of debris that might interfere and obstruct any of the motion.
The Pulling Mechanism was also developed as the same time with the refined Actuating mechanism. As seen on Figure 7.9 the pulling mechanism was refined keeping in mind the idea of having a simple mechanism that would be easy to manufacture, low in cost, and easily interchangeable with the Cutting mechanism. As see on the Figure 7.9, the Pulling Head slides into the same slot as the Cutter Head. This design uses both features developed in the pulling concepts. These two features are the hook and slot features. The user aim the stem of the fruit within the slot and then as the two rubber coated arms go around the fruit, the user then pulls the pole down successfully retrieving the fruit from the tree. As mentioned earlier, the hooks have been coated with a rubber compound in order to provide the user with two main benefits:

1) Bright Orange Coloring will allow the user to easily see what is going on
2) The rubber coating provides a smooth surface that will not damage the fruit and at the same time it will provide a good grip for the Pulling Head to hold on to the fruit

A principal component in the actuating mechanism that can not be overlooked is the cable. The cable used in this actuating design represents the backbone of the Fruit Picker product. Without an efficient, strong, and durable cable, the Fruit picker will be useless and ineffective. As seen on Figure 7.10 the cable chosen for this fruit picker is a 302 Stainless Steel Wire cable with a 7X7 strand core. This particular cable geometry has an excellent strength for hoisting and effectively transmits power. With this cable the design team agrees that the mechanical advantage given by the grip mechanism will be efficiently conveyed over to the cutter on the top of the fruit picker.
7.6 Picking/Storage Bag

The next vital component for the Fruit Picker design overall dimensions of this pouch will be calculated thoroughly to provide the right volume needed to carry the accumulating fruit. Figure 7.9 illustrates a currently available picking bag that includes an ergonomically designed strap. This particular bag can accommodate up to 80 pounds worth of fruit. The design team also agreed that this bag should also be ordered in order to include in the final fruit picker package.

8 Detailed Analysis

The design of the fruit picker contains many parts of the design that are new and unique to the groups overall design. The critical parts were considered in the stress analysis. The parts that were critical were either load bearing structural parts or parts that actuated the cutting mechanism. The results of the following analysis provided the group with reasonable confidence to begin the construction and the testing phase.

8.1 Deflection of the Pole

The pole is subject to deflection due to the distributed weight loading of the pole and end loading. This deflection of the pole was calculated by using simple beam methods. The main problem with the analysis of the pole design is that it has two variations in diameter throughout the length of the pole. These two sections were isolated and the relevant beam equations were applied. Each section is modeled as a cantilever beam, with the reaction at the wall being transferred to the next section, and eventually to the user. Figure 8.1 shows the forces relevant to each of the two sections.
Force $F$ is the end loading on the pole section, and $w$ is the distributed weight of the pole section, modeled as an equivalent force acting at the center of gravity of the section. The interactions between the two pole sections were calculated once the free body diagrams were determined.

The system of equations used to determine the section interactions are shown in Appendix D. These detailed free body diagrams and equations show that for section one, $F$ is the weight of the cutter, mounting plate, and the fruit. Segment two has the end load $F$ load as the weight of the cutter, mounting plate, and fruit, as well as the weight of section one.

The forces and moments cause the deflection of the pole. The deflection due to the end loading was calculated first. A value of 2 pounds for $F_1$ was chosen to account for 1.5 lbs. of the cutter assembly with plate, and an additional weight of 0.5 lbs. was added to simulate the weight of a piece of fruit. The fruit could potentially get caught up in the chute entrance or cutting assembly. This was considered as a measure of the safety of the pole design. The following equations were used to calculate the deflection of each pole segment due to these loads:

$$\theta_F = -\frac{FL^2}{2EI} \quad \text{(eq. 8-1)}$$
$$y_{F_{\max}} = -\frac{FL^3}{3EI} \quad \text{(eq. 8-2)}$$
The other source of deflection, the weight of each pole section acting on itself, defined as \( w \), weight per length, of the pole. Although this deflection is much smaller, approximately 1/10 of the deflection due to the end load, the goal was to calculate the theoretical deflection as accurately as possible. Thus, the following equations were used:

\[
\theta_w = \frac{-wL^3}{6EI} \quad (\text{eq. 8-3}) \\
y_{w_{\text{max}}} = \frac{wL^4}{8EI} \quad (\text{eq. 8-4})
\]

The reaction combined to give us the total deflection, \( \delta_t \), which was calculated as

\[
\delta_t = \sum y_w + \sum y_F \quad (\text{eq. 8-5})
\]

The maximum total deflection due to the weight of the pole and the end loading was calculated as 0.1494 inches downward.

This maximum deflection occurs when the pole is held horizontal to the ground. When the pole is lifted to reach a piece of fruit, the angle of the pole with respect to horizontal increases, and the axis of the force causing deflection changes. This decreases the resultant deflection force. This decreases the deflection of the pole. This effect is shown in figure 8.2.

![Figure 8.2 - Angle of operation and resultant force components](image)

Thus, to calculate the deflection throughout the angles of operation, \( F \) is replaced in the previous deflection equations with the equation 8-6. In addition, the weight of the section is replaced with equation 8-7.
When the user lifts the pole from the ground, the maximum deflection is 0.1911 inches, which approaches zero as the pole is rotated to the vertical position. The complete set of relevant calculated values are included in spreadsheet form in Appendix D. Excel was used in all calculations and plotting. These results of the angle of operation calculations are shown in figure 8.3. Figure 8.3 Deflection vs. angle of operation

The following sections show the Finite Element Analysis, performed on a computer, highlight some of the critical parts of our design. Due to complexity, we decided to perform the analysis entirely in the CAD program.

\[ F_x = F \cos \theta \quad \text{(eq. 8-6)} \quad \quad w_y = w \cos \theta \quad \text{(eq. 8-7)} \]
8.2 Actuating Mechanism/Cutter Plate
The stresses on the plate at the top of the pole were calculated by using Pro Mechanica, a companion program to Pro-Engineer, which was used to design the parts. The exact print was used in the analysis. Figure 8-4 shows the part as built for the prototype.

![Figure 8.4 - Actuating mechanism/cutter plate](image)

This plate attaches to the cutting end of the pole, and serves as a mount for the cutting blades and routes the cable for the actuator. Figure 8.5 shows the stress analysis of the cutter plate.

<table>
<thead>
<tr>
<th>Stress Von Mises (Maximum)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Max</td>
<td>+5.7417E+02</td>
</tr>
<tr>
<td>Avg. Min</td>
<td>+5.5439E-01</td>
</tr>
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<td>Deformed Original Model</td>
<td></td>
</tr>
<tr>
<td>Max Disp</td>
<td>+3.4087E-03</td>
</tr>
<tr>
<td>Scale</td>
<td>3.3884E+01</td>
</tr>
<tr>
<td>Load: 20 lb Load</td>
<td></td>
</tr>
</tbody>
</table>

![Figure 8.5 - Stress plot for actuating mechanism/cutter plate](image)
The constraints on the part are in directions and locations at the inner surfaces of the large hole in the part, where the end of the pole mates with the part. The load was defined as a 20-lb. load on the face where the cutter mates with the part. The material for this part on the prototype is aluminum 6061-T6, as it was readily available, which has yield strength of 39.9 ksi. After the preliminary analysis, it was apparent that this part could be constructed from a high strength plastic or nylon, rather than aluminum. Therefore, for the stress analysis that was shown in figure 8.5, the material for the part was chosen as Nylon with a yield strength of approximately 10 ksi. This gave a maximum deflection of 0.003 inches, which is negligible, and a maximum stress of 574 psi. Thus, the part could be made from nylon or plastic and be reasonably safe.

8.3 Chute Mount Clamp Assembly

The stresses on the clamp assembly that attaches the chute to the pole were calculated using Pro Mechanica, a companion program to Pro-Engineer, which was used to design the parts. The exact print was used in the analysis. Figure 8-6 shows the part as built for the prototype.

![Figure 8.6 - Chute Clamp Assembly](image)

This clamp attaches to the chute to the pole. Figure 8.7 shows the stress analysis of the chute clamp assembly.
The constraints on the part are in directions and locations at the inner surfaces of the large hole in the part, where the end of the pole mates with the part. The load was defined as a 20-lb. load on the face where the chute rod mates with the part, shown on the right side of the figure. The material for this part on the prototype is aluminum 6061-T6, as it was readily available, which has yield strength of 39.9 ksi. After the preliminary analysis, it was apparent that this part could be constructed from a high strength plastic or nylon, rather the aluminum. Therefore, for the stress analysis that was shown in figure 8.5, the material for the part was chosen as Nylon with a yield strength of approximately 10 ksi. This gave a maximum deflection of 0.0002 inches, which is negligible, and a maximum stress of 265 psi. Thus, the part could be made from nylon or plastic and be reasonably safe.
8.4 Actuator Clamp Block

The stresses on the grip mount, which attaches the grip actuator to the pole were calculated using Pro Mechanica, a companion program to Pro-Engineer, which was used to design the parts. The exact print was used in the analysis. Figure 8-8 shows the part as built for the prototype.

![Grip Mount Clamp](image1)

This mounting bracket attaches to the actuating grip to the pole. Figure 8.9 shows the stress analysis of the grip mount.

![Stress plot for actuating mechanism/cutter plate](image2)

The constraints on the part are in directions and locations at the inner surfaces of the large hole in the part, where the end of the pole mates with the part. The load was defined as a 20-lb. load on the face where the grip handle mates with the part, shown on
the right side of the figure. The material for this part on the prototype is aluminum 6061-T6, as it was readily available, which has yield strength of 39.9 ksi. After the preliminary analysis, it was apparent that this part could be constructed from a high strength plastic or nylon, rather than aluminum. Therefore, for the stress analysis that was shown in figure 8.5, the material for the part was chosen as Nylon with yield strength of approximately 10 ksi. This gave a maximum deflection of 0.0002 inches, which is negligible, and a maximum stress of 170 psi. Thus, the part could be made from nylon or plastic and be reasonably safe.

9 Cost
The relative costs of all the parts required to build the prototype are included as appendix E. The detailed manufacturing plan suggestion, will allow us to determine a manufacturers suggested retail price. The prototype cost is calculated the first quarter of the Design Project was $363. However, after the design team refined all of the components into a sleeker/simpler design, the cost, as seen in Appendix E was brought down to $150. This was due mainly because of the decision made to purchase an off-the-shelf pole instead of custom making one. Also, the total number of components made per assembly was dramatically reduced and simplified.

10 Conclusion
By the end of the Spring Quarter, the Fruit Picker 2000 group has completed a functioning prototype with detailed manufacturing plan and instruction manual. The group has performed all the analysis needed to find out exactly what dimensions should be used for the final prototype.

The concept developed offers the best features of all the currently available fruit pickers, however in one design. The final design will compete in the limited fruit picker market. The design consists of an adjustable length pole with a cutting and pulling device that safely removes the fruit from the tree. A chute will deliver the fruit safely to the user for collection. The entire assembly is collapsible and easy to transport.

The existing fruit pickers are either fixed length or moderately adjustable. Also, they are only designed or marketed to pick a specific fruit. The FP2000 design will be able to pick a variety of fruits such as peaches, apples, oranges, pomegranates, figs and
more. The price range for the currently available fruit picker ranges from twenty dollars for the basic shears, to one hundred dollars for the more elaborate models. The goal is to produce a fruit picker with equal or better features than the current competitors that costs $34.99.
Appendix A. Patents
United States Patent [19]

Guerre [54]

3,949,440

1111 Apr. 13, 1976

[12] Filed: Jan. 6, 1975

[21] Appl. No.: 530,512

[51] Int. Cl. ...... 78/3 R 30/123.3; 30/165 B

[51] Int. CI, ...... 383.1 A; 378R 23/00

[51] Field of Search ...... 30/166, 123.3, 123.4, 7/13 R, 14.1 A, 47/1, 6

[50] Primary Examiner -- Al Yamasaki Smith

Assistant Examiner -- Francis V. Parker

[52] ABSTRACT

An improved handle supports a fluid paint can and a saw attachment fixture. A removable paint bottle is attached to the saw and has a removable pulley. A flexi- ble conduit joining the pulley and the fluid paint can moves the blades upward towards the saw and thus cuts the lines interconnected between the blade and the saw. The handle also supports a pressurised screen containing paint and propellant, the can having a conical-shaped dispensing nipple on its top which permits a jet of paint and propellant to be ejected from the can when depressed. A solid vertically elongated rod is disposed above the nipple, with the top end of the can being attached to the rod and moving downwardly towards the nipple as the blade moves upwardly towards the saw. The tube depresses the nipple and thus causes a jet of paint to be sprayed. A spray nozzle projects the blades downwardly away from the saw.

2 Claims, 2 Drawing Figures
ABSTRACT

The applicant's hand operated fruit picker and bag is characterized by a cage which has a rectangular midsection, horizontal arm or arms, the upper section of which is coated in shape, forming a pocket, a pole to which the cage is attached at the pole's upper extremity, a horizontally pivoted gate facing the cage, which gate is held in normal closed position by springs attached to it and within the cage, the said gate having an upper section and a lower section, the angle between the two sections being about 137°, the gate being of a size to fit within the cage when completely closed, the upper section of the gate not extending to the top of the cage when in closed position, thus leaving a space whereby when the unit of fruit that is being picked is within the specified pocket, it is easily detached upon a pull upon the pole by the operator of the picker, a control cable attached to the gate at its outer end, and at its lower end pivoted to the pole, whereby the operator can act against the force of the springs, thus to open the gate and admit the fruit unit to be picked to the cage

5 Claims, 4 Drawing Figures
U.S. Patent
July 4, 1978
4,098,062

FIG. 2

FIG. 3

FIG. 1

FIG. 4
"MY $500 IS WORTH A LOT TO ME.

United States Patent

Inventing

FRUIT PICKER WITH STEM CUTTING JAWS

Inventor: Barnwell W. Henninggaard, 501 5th Ave. S., Minneapolis, Minn. 55402

App. No.: 692,823

Filed: Apr. 22, 1984

Patent Number: 4,531,352

Date of Patent: Jul. 30, 1985

References Cited

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99,457 6/1880 Wood ........................................ 36/334
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1,365,532 8/1920 Smith ........................................ 36/334
1,796,211 6/1930 Mathias ........................................ 36/334
3,199,200 8/1964 Viskari ........................................ 36/334

FOREIGN PATENT DOCUMENTS
W3751 7/1918 United Kingdom ................................ 36/334

Primary Examiner—Gene Mancuso
Assistant Examiner—David J. Thrall
Attorney, Agent, or Firm—Williamson, Baiocchi & Hines

ABSTRACT

A pole mounted, fruit picking device for collecting fruit from trees. The fruit picker comprises of a double jaw assembly enclosed on the top end of a pole, with the bottom jaw being stationary and having a receiving bag or flag attached to it. The upper jaw has a cutting edge and is pivotally movable by a pull device on the pole handle to snap down against the lower jaw and sever a fruit from the tree. The severed fruit drops through the bottom ring into the receiving bag. Flexible guard bands on the lower ring extend inward both sides of the cutting edge, and serve to protect the fruit against damage as a fruit stem is severed.

4 Claims, 5 Drawing Figures
United States Patent [19]

[45] Date of Patent: Jan. 6, 1989

Primary Examiner—John W. Wilson
Attorney, Agent, or Firm—Walter L. Fosler

[57] ABSTRACT

A hand-operated fruit picker having a cage defining a fruit gagglowing chamber with a fruit receiving front plate equipped with an upper concavity and a top central forwardly directed slot, and a gate hinged to the cage for movement from a closed to an open position, is provided with an outwardly diverging scoop-like extension formed at the top forward margin of the opening to envelope the lateral members of a fruit cluster and is further provided with removable chamber and gate linings of resilient taut burlap material contoured to extend the concavity of the chamber and serving to protect ripe fruit from fragile fruits against bruising.
United States Patent [19]

Patent Number: 4,959,949

Date of Patent: Oct. 2, 1990

ABSTRACT

A fruit picker includes a rectangular receptacle having four vertical sides with a bottom plate. The receptacle has an open top and a hollow interior for receiving picked fruit. A vertical one-half inch wide slot is formed in one side wall for receiving the stem of a fruit to be picked. A telescopically extensible handle is secured to the receptacle and includes an internally threaded clamping sleeve surrounding a first tubular member and in threaded engagement with an end portion of a second tubular member. A flexible central core surface in the sleeve is in abutment with a resilient ring within the sleeve surrounding the first tubular member for securing the handle in a released adjusted position. In a second embodiment, a resilient flap members on opposite sides of the slot engage a tubular.
Hand-Operated Fruit Picker

Inventor: Deval C. Reese, Florence, Ala.
Assignee: Riggsby, Garvin & Webster, F. C., Northviewville, Ala.; a part interest

Filed: Nov. 1, 1990

Abstract

A portable hand-operated fruit picker for mounting on a telescoping pole having a container or bag at one end and a hoop for receiving the fruit when removed from a tree. The portable hand-operated fruit picker consists of a telescoping pole, a first hoop member fixed to the distal end of the upper section of the telescoping pole, a second hoop member pivotally mounted to the upper section of the telescoping pole adjacent its distal end, a container or bag fixed to the second hoop member, and a member for actuating the second hoop member relative to the first hoop member to facilitate the fruit picking process.
United States Patent

Morgan

MECHANICAL FRUIT Picker WITH DELIVERY SYSTEM

Inventor: Bob Morgan, P.O. Box 22, Grandville, W. Va. 20414

Filed: Apr. 2, 1992

Abstract

A mechanical fruit picker is comprised of a housing, (9, 16, 18, 17), it has two jaws mounted on the top perimeter of the said housing (5, 6). They are mounted in such a manner that one slides through the other. This is accomplished by them being being kept a small distance apart (8). A control rod (20) is inserted through a bracket (18) which is a ring provided on the top end that enters the slots of the jaws (19) is energized by a spring (15) to open and close the jaws. A rod (22) attached to the bottom of the rod takes the jaws down with a light pull. When released they keep shut. The ring then holds them shut until it is again pulled to engage another fruit. The fruit is then engaged, then drawn through the housing into a flexible sleeve (23, 25) to the operator. A snap-on cap (22-24) of flexible material in placed, if only a few fruits are desired. The object of this picker is to economize the waste of orchardists that have been looking for a better method of harvesting fruit without effort and damage.

1 Claim, 2 Drawing Sheets
US3952488: Fruit picker

Inventor(s): Coulter; Mark B., St. Petersburg, FL 33731

Application Number: US1975000539257

IPC Class: A01D 046/24;
Class: Current: 056/333;
Original: 056/333;

Field of Search: 056/332,333,334 294/22,115

Abstract:
A fruit picker positions a fixed and a movable jaw on a pole-like handle and encloses a majority of the jaw area with an open top fabric bag. Springs are provided normally urging the jaws toward or away from one another and act to hold the uppermost portion of the fabric bag in open position at all times. An actuating cord extends downwardly along the pole-like handle for manual operation of the device. An adjustable stop limits the degree of closure of the jaws to avoid clamping engagement on a limb or a twig.

Attorney, Agent, or Firm: Harpman; Webster B.;
Primary/Assistant Examiners: Kinsey; Russell R.;

U.S. References:

<table>
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<td>US068030*</td>
<td>8/1867</td>
<td>Barnes</td>
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<td>US602551*</td>
<td>4/1898</td>
<td>Anderson</td>
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<td>6/1905</td>
<td>Gallup</td>
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* some details unavailable
United States Patent

Coulter

3,952,488

[54] DRIFT PICKER

[76] Inventor: Mark S. Coulter, P.O. Box 3202, St. Petersburg, Fla. 33734

[22] Filed: Jan. 7, 1975

[51] Appl. No.: 539,357

[52] U.S. Cl. 121 69/283

[57] Field of Search

[52] 69/101,424

ABSTRACT

A drift picker provides a fixed and a movable jaw on a pole-like handle and receives a majority of the jaw area with an open top fabric bag. Springs are provided normally rodig the jaws upward or away from one another and are held in the uppermost position of the fabric bag in open position at all times. An actuating cord extends downwardly along the pole-like handle for manual operation of the device. An adjustable stop limits the degree of closure of the jaws to avoid clamping engagement on a limb or twig.

6 Claims, 2 Drawing Figures
United States Patent


[S4] FRUIT PICKER


[71] Appl. No.: 622,434

[72] Filed: Sep. 30, 1930

[51] Int. Cl. 2556/45

[52] U.S. Cl. 2556/45

[56] References Cited

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1,050,291 4/71 Tordy 30/234
1,064,974 4/71 Taylor 30/234

FOREIGN PATENT DOCUMENTS
253,455 6/1984, Fed Rep of Germany... 36/339

Primary Examiner—J. M. Broome

Assistant Examiner—S. A. A. Appr

Attorneys, Agents, or Firm—Jack C. Murno

ABSTRACT

A fruit picker which takes the form of an elongated handle section which is secured at its center end to a ring shaped member. The gripping surface of the ring shaped member is divided into a form of a ratchet arrangement. The stem of the fruit is in contact with a scallop with the fruit held to be located immediately of the ring shaped member and by a pressing force against stem will cause the stem to break resulting in the fruit being separated from the tree and falling within the collecting container.

Claim 10 Drawing Figures
A fruit picker includes a rigid, hollow sleeve having an opening at the top end thereof, and a fruit engaging mechanism connected to the sleeve at the top end for engaging a piece of fruit. The fruit engaging mechanism includes a string attached at one end thereof to a first point on the sleeve, the string passing through a hole provided in the sleeve at a second point which is separated from the first point by a predetermined arcuate distance along a side of the sleeve. The opposite end of the string extends down the outside of the sleeve so that it can be grasped by a user of the fruit picker. The string defines, in conjunction with the side of the sleeve, a variable size opening in which the piece of fruit to be picked is received. The fruit engaging mechanism further includes a biasing mechanism which is slidably attached to the string for biasing the string away from the first and second point so as to increase the size of the variable size opening. After the piece of fruit has passed through the variable size opening, the user pulls on the opposite end of the string to thereby reduce the size of the variable size opening and trap the piece of fruit within the sleeve. Thereafter, downward movement of the sleeve causes the fruit engaging mechanism to sever the piece of fruit from the tree branch.
A fruit picker includes a cable in a sleeve having an opening at the top end. A fruit engaging mechanism connects to the sleeve at the top end for engaging a piece of fruit. The fruit engaging mechanism includes a string attached at one end to a fast point on the sleeve. The string passing through a hole provided in the sleeve at a second point which is separated from the first point by a predetermined distance along a side of the sleeve. The opposite end of the string extends down the sleeve so that it can be grasped by a user of the fruit picker. The string is located in conjunction with the side of the sleeve, a variable size opening in which the piece of fruit to be picked is received. The fruit engaging mechanism includes a hinging mechanism which is hinged to the string for biasing the string away from the fast and second point so as to increase the size of the variable size opening. After the piece of fruit has passed through the variable size opening, the user pulls on the opposite end of the string to thereby reduce the size of the variable size opening and trap the piece of fruit within the sleeve. The fruit picker provides the proper closing of the sleeve causes the fruit engaging mechanism to secure the piece of fruit from the tree branch.
Appendix B. Data
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<td>height of semi-Dwarf Tree: 12-18 ft</td>
<td><a href="http://www.dirtgardener.com/Tipsheets/FruitTreeStuff.html">www.dirtgardener.com/Tipsheets/FruitTreeStuff.html</a></td>
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### Dist. Of Trees by Height

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<th>Number</th>
<th>Percent</th>
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</thead>
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<td>639</td>
<td>24.80%</td>
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<tr>
<td>Height 5 - 9 M</td>
<td>1'147</td>
<td>44.50%</td>
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<tr>
<td>Height 10-19 M</td>
<td>468</td>
<td>18.10%</td>
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<tr>
<td>Height 20-29 M</td>
<td>306</td>
<td>11.90%</td>
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<tr>
<td>Height 30+/ M</td>
<td>19</td>
<td>0.70%</td>
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2'579
100.00%

Distribution of Trees by Height
### Height and Weight Tables - Men

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<th>Large</th>
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</thead>
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<td>Frame</td>
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</tr>
<tr>
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<td>2</td>
<td>128 - 134</td>
<td>131 - 141</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>130 - 136</td>
<td>133 - 143</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>132 - 138</td>
<td>135 - 145</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>134 - 140</td>
<td>137 - 148</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>136 - 142</td>
<td>139 - 151</td>
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<tr>
<td>5</td>
<td>7</td>
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<td>142 - 154</td>
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<td>5</td>
<td>8</td>
<td>140 - 148</td>
<td>145 - 157</td>
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<td>5</td>
<td>9</td>
<td>142 - 151</td>
<td>148 - 160</td>
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<td>151 - 163</td>
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<td>154 - 168</td>
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<td>2</td>
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<td>3</td>
<td>158 - 172</td>
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<td>6</td>
<td>4</td>
<td>162 - 176</td>
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### Height & Weight Table - Women

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<th>Large</th>
</tr>
</thead>
<tbody>
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<td>Feet</td>
<td>Inches</td>
<td>Frame</td>
<td>Frame</td>
</tr>
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<td>10</td>
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<td>109 - 121</td>
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<td>4</td>
<td>11</td>
<td>103 - 113</td>
<td>111 - 123</td>
</tr>
<tr>
<td>5</td>
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<td>6</td>
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<td>6</td>
<td>0</td>
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<td>148 - 162</td>
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Appendix C. Drawings
FP2000 TEAM

Cutter Block Plate

Design by: ACH
Date: 3-25-06

for sixt screw 8-32 x 4

\( \Phi 0.130 \)

\( \Phi 0.125 \)

\( \Phi 0.150 \)

\( 0.375 \)

\( 0.35 \)

\( 0.450 \)

\( 1.000 \)

\( 0.78 \)

\( 0.75 \)

SCALE 0.500
45° CHAMFER BY .15 X 4

.303

3.25

2.50

Ø .160

THREADED THRU HOLE FOR

6.00

.410

600
Appendix D. Stress Analysis
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<tr>
<th>Material</th>
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<td>Specific Wt.</td>
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<tr>
<td>E</td>
<td>10007760 lb/in²</td>
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</tr>
<tr>
<td>Overlap</td>
<td>1.3125 in</td>
<td></td>
</tr>
<tr>
<td>Sections</td>
<td>3 -</td>
<td></td>
</tr>
<tr>
<td>F₁</td>
<td>2 lb</td>
<td></td>
</tr>
<tr>
<td>F₁ corrected</td>
<td>2 lb</td>
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### Section 1

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<th>L₁</th>
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<th>F₁</th>
<th>2 lb</th>
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<td>OD</td>
<td>1.375 in</td>
<td>δ₁₁</td>
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</tr>
<tr>
<td>ID</td>
<td>1.25 in</td>
<td>δ₁₁</td>
<td>-0.0768 in</td>
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<tr>
<td>I₁</td>
<td>0.05552 in⁴</td>
<td>δ₁₁</td>
<td>-0.0029 rad</td>
</tr>
<tr>
<td>W₁</td>
<td>0.02514 lb/in</td>
<td>θ₁₁</td>
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<table>
<thead>
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<td>F₁</td>
<td>1.931851653 lb</td>
<td>δ₁₁</td>
<td>-0.0145 in</td>
</tr>
<tr>
<td>θ₁₁</td>
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### Section 2

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<tr>
<td>I₂</td>
<td>0.073007 in⁴</td>
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<td>W₂</td>
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<td>θ₂₂</td>
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<table>
<thead>
<tr>
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<td>Angle Oper</td>
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<td>-----------</td>
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<td>$F_1$</td>
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<td>$\delta_{w1}$</td>
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<td>$\theta_{w1}$</td>
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<tr>
<td>$\theta_{11}$</td>
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</table>

<p>| Angle Oper | 45 deg | | Angle Oper | 45 deg | | Angle Oper | 45 deg |
|-----------|--------| | |--------| | | |
| $F_2$     | 2.376  | lb | $F_2$     | 2.4197 | lb | $F_2$     | 2.0055 | lb |
| $\delta_{w2}$ | -0.0121 | in | $\delta_{w2}$ | -0.0121 | in | $\delta_{w2}$ | -0.0121 | in |
| $\theta_{w2}$ | 0.0000 | rad | $\theta_{w2}$ | 0.0000 | rad | $\theta_{w2}$ | 0.0000 | rad |
| $\delta_{12}$ | -0.0799 | in | $\delta_{12}$ | -0.0707 | in | $\delta_{12}$ | -0.0586 | in |
| $\theta_{12}$ | -0.0030 | rad | $\theta_{12}$ | -0.0026 | rad | $\theta_{12}$ | -0.0022 | rad |
| Deflect. F | -0.1730 | in | Deflect. F | -0.1515 | in | Deflect. F | -0.1235 | in |</p>
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<th>deg</th>
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Appendix E. Cost Analysis
FP2000 Bill of Materials

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<td>Cable Triangle</td>
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Total Fruit Picker Prototype Cost ($) $148.00
## FP2000 Bill of Materials

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**Total Fruit Picker Prototype Cost ($)** 365.17

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Appendix F. References
References

**Fruit Picker**

Web Sites:

Clip and Pick
http://gate.net/~tfnews/pickerad.htm

IBS Engineering

**Specialty Pruners**

Web Sites:

Frostproof

**Tree Pruners**

Web Sites:

Husqvarna
http://www.macnifisense.com/husqvarna/catalog/pruner.html

**Cutting Tools**

Web Sites:

GardenScape Tools
http://www.gardenscape.on.ca/pages/toolscutter.htm

**Picking Techniques**

Web Sites:

Fine Wood Working
http://www.finewoodworking.com/kg/features/techniques/13picker.htm

**Ergonomics**

http://msc.org/csinfo/staley.htm
http://www.industrialhygiene.com/calc/lift.html
http://www.cpsc.gov/cpscnew/5011.html
Patent Searches

Web-sites:


* All web-sites are current as of Jan 25, 2000.

Overall Info


