Aviation safety

Adventures in Supercomputing Challenge

Final Report

Team #023

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Executive Summary

Though the problem of aircraft injuries and fatalities is not a new one, modern advancements in high- tech safety features have brought closer public scrutiny and criticism of the occurrence of any untimely deaths related to air travel. The addition of safety features has caused national and world- wide attention and with that publicity about the amount of fatalities occurring each and every day, more emphasis is being placed on ways to increase safety on passenger aircraft- the cause of most aircraft deaths. Many airline companies recognize that with more safety features their planes are more likely to be sold, which leads to how a parachute was in fact installed onto two passenger airplanes (see “results”). This project was originally designed as a way to prevent many aircraft fatalities and to add multiple safety features, but developments since then have modified the goal to one focused on parachute attachments and the relative safety of these parachutes.

Introduction

The Issue

During the week of September 4-17 2002, it was found from the F.A.A. Preliminary Accident and Incident site that there were 18 fatal accidents of fixed wing aircraft. This is why we selected a project that will model an improved safety feature of an aircraft. We feel that some of these accidents could have been prevented and we have started modeling the effectiveness of different safety features. These accidents were both the result of human and mechanically error; although both types of accidents may have been avoided if these safety features were added to the aircrafts. We also feel that although some aircraft companies are now adding more safety features on to their private passenger airplanes, overall this issue is not being given as much attention as is needed to produce significant leaps in aviation safety for fixed- wing aircraft.

The Project

Our project has modeled the flight of a fixed- wing aircraft and simulated how its impact with the ground can be changed when variable materials are attached to different parts of the aircraft. We will assume that materials such as foam, springs and parachutes could be deployed if necessary so that upon impact the aircraft would not explode. We will assume that the aircraft is still mostly intact. Some factors that are important are the weight of the aircraft, the altitude from which the aircraft started the descent, the ground terrain on which the aircraft will hit, the speed at which the aircraft is traveling, the aerodynamics of the aircraft, the weather at the time of the descent, the time that the aircraft has been in flight, the experience of the pilot and co- pilot, and the angle of the descent. We will start by taking a predetermined altitude and an aircraft and testing the freefall of that aircraft and then expanding from there. We understand that all fixed wing aircraft accidents can not be prevented, but we believe that this is an important issue that must be investigated.

Background Information

During the weeks of September 4-17 this year it was found from the F.A.A. Preliminary Accident and Incident site that there were 18 fatal accidents of fixed wing aircraft. This is why we selected a project that will model an improved safety feature of an airplane. We feel that some of these accidents could have been prevented, and we will model the effectiveness of the safety feature.

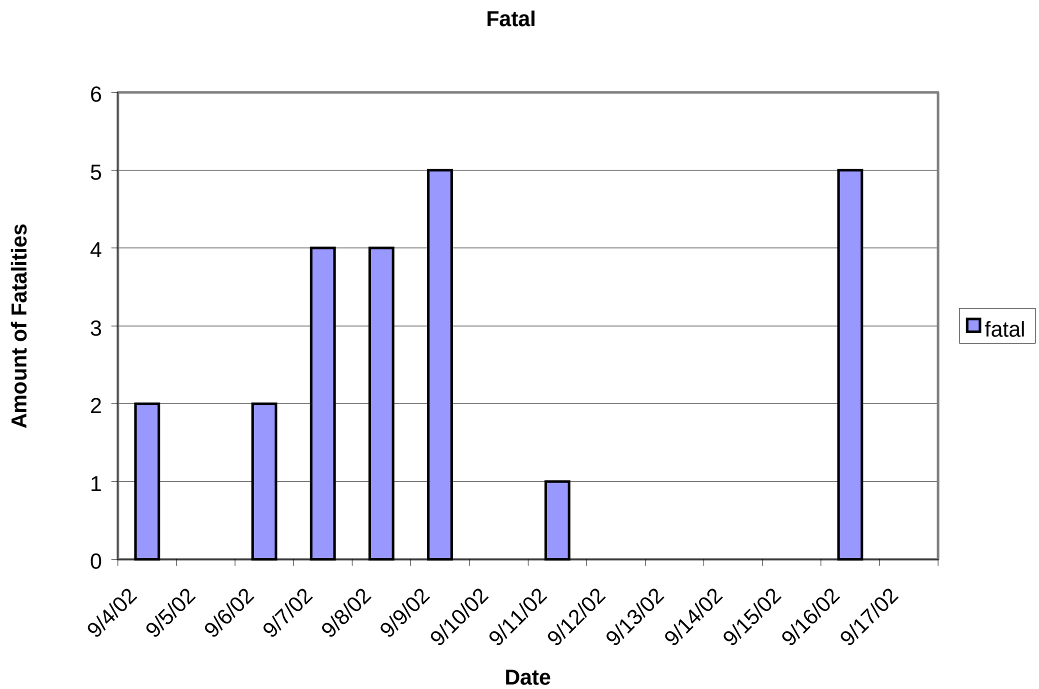

Figure 1. Number of fatalities in the US during September 4th-17th, 2002

Figure 1. - However much attention is brought to these accidents, more can always be brought and today, this era, not enough attention is brought to these accidents, and this is why this project is trying to bring more attention to these accidents. . Figure 1 restates how deter mental this is to society and brings these deaths closer to home. On both the 9th and 16th of September, there were five crashes resulting in fatal injuries. During the 12th through the 15th there were no accidents that contained fatal injuries. These 18 deaths are about average for the amount of deaths during one average week.

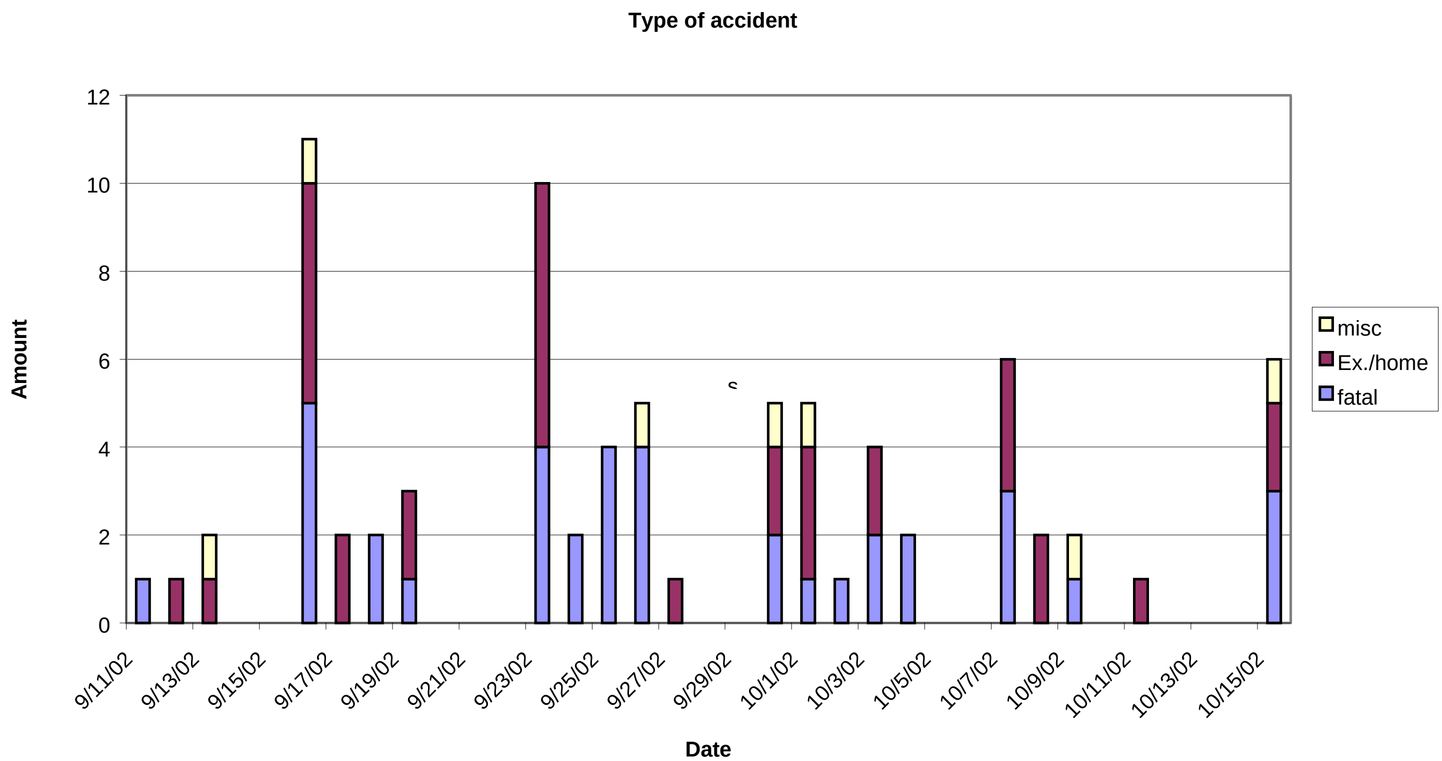

Figure 2. Types of accidents occurring between September 11th -October 15th, 2002

Figure 2. - When looking at this graph we are documenting the type of accident that occurred between the set periods of time- September 11th 2002, through October 15th, 2002. On the graph, the light blue shows the umber of fatal crashes on each of the days for the set period of time September 11th through October 15th 2002. On 16 of the week days there were crashes resulting in fatalities. The information obtained for this graph came from the F.A.A. site, which does not have information about the weekends available to the public on their website, which is why on some dates there are blanks. The dark purple represents crashes that contained

experimental aircraft or homebuilt aircraft. This is what the ex/home means on the key. The last color, light yellow, is for miscellaneous crashes, or for example, when the aircraft in question was not experimental or homebuilt neither did it contain any fatalities. In regards to the amount of crashes on each day, you would add up both the light blue, the dark purple and the light yellow and to determine the number of crashes for that one day. For example on September 17th there were 5 fatal crashes, 5 experimental or homebuilt crashes, and 1 miscellaneous crash, totaling eleven for that day.

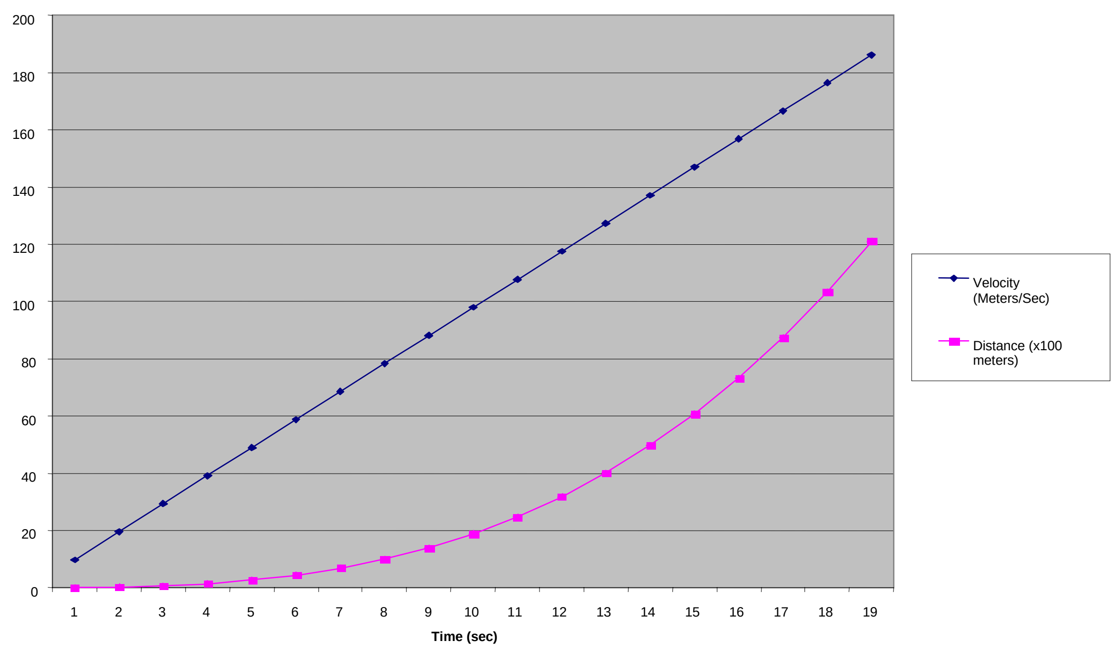

Figure 3. How the Airplane Falls

- On the graph the blue line and squares represent the velocity of the aircraft and the amount of force upon which the aircraft will hit the ground. The pink line and squares represent how high in the air the aircraft must be at freefall to reach the velocity marked above it. This graph is essential for our project because in order to add any safety features onto our aircraft, we first must determine the velocity of the dysfunctional aircraft for both our java code and in order to see whether or not it would be possible to add the safety precautions to the aircraft.

Options

Height (Meters)	Height (Miles)	Velocity(meters/sec)	time(sec)
0	0	0	0
4	0	9	1
24	0	19	2
68	0	29	3
147	0	39	4
269	0	49	5
445	0	58	6
686	0	68	7
999	0	78	8
1396	0	88	9
1886	1	98	10
2479	1	107	11
3185	1	117	12
4013	2	127	13
4973	3	137	14
6076	3	147	15
7330	4	156	16
8746	5	166	17
10334	6	176	18
12103	7	186	19
14063	8	196	20
16223	10	205	21

Table 1. - Result of Code

Table 1-This is the result of our code. In the first column, the height above the ground when the object starts to fall is displayed in meters. In the second column, the same height is displayed, except in miles, rounded to the nearest whole number. The velocity, in meters per second, is displayed in the third column. This is the velocity when the object hits the ground,

the amount of time from when the object starts falling until impact is displayed in the last column.

Project Description

Our project has modeled the flight of a fixed- wing aircraft and simulated how its impact with the ground can be changed when variable materials are attached to different parts of the aircraft. We also understand that even with attachments such as the parachute, some fatalities might still result and there is still the possibility of an accident in which the pilot could not prevent where he or she hit, resulting in fatalities at impact. We will assume that safety precaution materials such as foam, springs and parachutes could be deployed if necessary so that upon impact the aircraft would not explode. We have started by testing the weight, the altitude and speed of the aircraft that is about to crash. We understand that all fixed wing aircraft accidents could not be prevented, but we believe that this is an important issue that must be investigated.

Results

At the beginning of this project we had high hopes for aiding in future aviation safety. As we went along, we began to realize that this dream was a far way off. We would have had to produce something that was pure genius to even begin to help aviation safety, so we started with monitoring how an aircraft fell. This helped because if an aircraft fell a certain way, such as upside down or on its side, any safety features could not help it. Once we determined that we could add some sort of safety feature to the aircraft we began to play with different safety features, such as padding, airbags, and parachutes.

We eventually settled on the safety feature that would be the easiest to test and eventually attach to the aircraft- this was the parachute. Since we already knew how the aircraft would fall without a parachute, our next step was to demonstrate how the aircraft fell with a parachute. We then discovered that two small passenger suited aircraft (the SR20 and SR22) had been equipped with a parachute but had only been successfully proven to work once. After discovering this new factor, we decided that our next step should be to better ensure aircraft parachutes would work and to make them safer. So we went to our java code; we designed a program that would demonstrate the falling plane and the effects of a parachute being added to it. But before we could accomplish this step we needed the program we had created earlier that modeled the airplane in freefall without a parachute (see figure 3 and table 1). After obtaining the two programs, we then continued to investigate different scenarios in which the aircraft would dysfunction and thus continue to crash. As we continued to investigate, it was decided that to further produce attachable safety features would take considerable more research, and thus we decided to improve on the parachute and work later, if there was time, on the other safety features. After finishing the parachute improvements we discovered time was needed to perfect our java code and began the finishing touches on our project.

Conclusions

Although Figure 2 shows on average 3.63 accidents and incidents a day, it is in reference to both accidents and incidents, meaning that an incident could be failed equipment or a crash in which no injuries occur. Apparently, *incidents* are not considered major on other web sites, so these were not reported and therefore cut the average in half. Consequently, this graph could be read in two ways- with or without incidents- although all information is needed to understand the impact of these accidents and incidents upon pilots.

Although incidents are important in the statistics of Figure 2, to adequately determine how many of these accidents could have been helped by safety features it is necessary to look at only the accidents. By looking at the reports of accidents it is clear that about 75 % or less of the accidents could have been prevented by a parachute of even safety feature. It was concluded that the fatal accidents could almost always have been prevented by the safety features and 90 % of the time by parachutes.

After determining these factors, it is then necessary to average how many of the pilots could have been calm enough and in a position in which they could have pulled the trigger to release the parachute. Since these are variables which were not worked into our program, it was assumed that not all of the aircrafts with attached parachutes could help the pilot and passengers survive the accident.

Recommendations

This project set out to overcome many variables, some of which would have been impossible to answer, but as the project developed it was necessary to drop some of these, thus leaving large gaps in how aviation safety could be improved. Consequently this project was not as comprehensive as it was once intended to be.

Airplane Crashes

With the vast differences in the types of airplane crashes that were examined, it was impossible to create a program that continuously modeled all types of scenarios occurring. Therefore the program simply states the freefall distance, velocity and time the aircraft was in the air and could consequently be enlarged and expanded to include more obstacles and scenarios.

Safety Attachments

Safety attachments may include a wide variety of features including airbags, parachutes and padding. Too adequately model two or more of these attachments would take at least a year, so a program would have to model just one of these features. Therefore we are attempting to model one feature- which is the parachute program.

The parachute model (see appendix b) has dealt with the factor of adding a parachute although at the moment it is still lacking a solution on how to release the parachute and other variables. This model could be extended to a wide variety of scenarios, i.e. it could be used to determine the velocity of a free falling plane fitting a building and expanding from there or it could be used to test the effect of padding around the aircraft in different places. Thus far, due to time constraints, it has only been used in the testing of a parachute.

Acknowledgements

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Dorothy Ashmore- for her never ending support and help with learning the basics of super computing, and for all the items that she came up with to help our project on the last minute.

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And last but not least;

Jassmine Safier- for editing all of our written work and putting up with last minute pleas to edit them.

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<www.mansfieldct.org/schools/mms/staff/hand/lawsgravprac.htm>

Appendices

Appendix A-Model of a falling object without aids

The following is our code to display the velocity of a falling object when it hits the ground from a certain height.

```
public class Vel //Defines the Class
{
    double V; // Velocity
    int t; // Time (seconds)
    double M; // Height (meters)
    double L; // Height (miles)
  public void test()
  {
System.out.println("Height (Meters)\t" + "Height (Miles)\t" + "Velocity(meters/sec)\t" + "time(sec)");      // Display the phrases that are in quotations.  The \t's indicate where indentations are used.

M=0.0; //Defines M as zero
    for (t=0; t<=21; t++){ //define t as an integer, starting at zero and counting upward by one until t is equal to Twenty one.
      V=9.8*t;
      M=M+(t*9.8)*t/2;
      L=M/1600;
      System.out.println((int)M + "\t\t\t" + (int)L + "\t\t" + (int)V + "\t\t\t" + t);     //Every time t is defined, display the variables.  Again, the \t's are used to insert indentations.

    }
  }
}
```

In the first part of our code, we are defining several variables that are going to be used later on. We then tell the computer to display four phrases with indentations between each other, so you can read them. These will be the head of four columns of numbers. The computer then performs a for loop, computing and then displaying the velocity and height, in two different measurements, for every second of time passing.

The following is the result of our code when we run it:

Height (Meters)	Height (Miles)	Velocity (meters/sec)	Time (sec)
0	0	0	0
4	0	9	1
24	0	19	2
68	0	29	3
147	0	39	4
269	0	49	5
445	0	58	6
686	0	68	7
999	0	78	8
1396	0	88	9
1886	1	98	10
2479	1	107	11
3185	1	117	12
4013	2	127	13
4973	3	137	14
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7330	4	156	16
8746	5	166	17
10334	6	176	18
12103	7	186	19

14063	8	196	20
16223	10	205	21

This is the result of our code. In the first column, the height above the ground when the object starts to fall is displayed in Meters. In the second column, the same height is displayed, except in Miles, rounded to the nearest whole number. The Velocity, in meters per second, is displayed in the third column. This is the velocity when the object hits the ground. The amount of time from when the object starts falling until impact is displayed in the last column. In order to correctly read this table, you must read from left to right. First, you must find the height you wish to model the airplane falling from in one of the two left columns. Next, find the number in the third column that is in the same row. This is the velocity of an object that has fallen from the specified height when it hits the ground. If you continue looking to the right, you will encounter the time that the object had been falling.

Appendix B-Model of a falling object with a parachute attached.

The Following is our code to display the velocity of a falling object that is hindered by a parachute.

```
import java.lang.Math.*;
public class Para
{
        int a; //Area of the parachute
        double P; //Velocity with parachute
   public void test()
   {

      System.out.println("Area of the parachute\t" + "Velocity");//display these two phrases
      for(a=100; a<=250; a=a+10){//define a as an integer starting at 100 and increasing by ten until it reaches 250
         P=Math.sqrt((2*649)/(0.0017*0.8*a)); //Compute this equation
         System.out.println(a + "\t\t\t" + (int)P);//Display the area of the parachute and the velocity
      }
   }
}
```

In the first part of the code, we define two variables: the area of the parachute, and the velocity of the object, which will depend on the area of the parachute. As in our other program, we tell the computer to display two phrases. We create another for loop, and have the computer solve an equation. We then display the results.

Appendix C- Mathematical Model 1

- $V=(9.8m/sec^2)(t)$

This is the first equation we used to create our Mathematical Model. . This describes the acceleration of gravity multiplied by the time that is used to show the acceleration of a falling plane, as it says. The "m/sec^2" represents meters per second squared. The "t" represents time in seconds. It models the velocity of a falling object when it hits the ground.

Appendix D-Mathematical Model 2

This is our second equation:

$v^2=(2w)/(\rho CS)$

This mathematical equation, $v^2= (2w)/ (\rho CS)$ was found on a website by Dr. Jean Potvin**,** and is designed to find all possible mathematical equations for different types of parachutes. This equation also describes the rate of descent for a dysfunctional aircraft with a round parachute. In this mathematical equation, v^2 is equal to the square of the vertical descent velocity, where v is expressed in ft/sec or m/sec; C is equal to the parachute drag coefficient, which is approximately 0.8 for a parachute without holes or slits cut in the fabric; same value in both metric and English unit systems, rho (at sea level) is equal to 0.00237 sl/ft^3 (English units) and 1.225kg/m^3 (Metric units), W is equal to the weight of the parachute and load, in pounds (English) or Newtons (Metric) and S is the parachute's surface area when measured on a flat surface. It models the rate of descent of an object that has a parachute hindering it.